PHYSICS

BOOKS - PRADEEP PHYSICS (HINGLISH)

PROPERTIES OF BULK MATTER

Sample problem

1. A steel wire of length 4m and diameter 5mm is stretched by 5 kg-wt. Find the increase in its length , if the Young's modulus of steel wire is $2 \cdot 4 \times 10^{-12} dyne/cm^2$

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2. A steel wire of length $4 \cdot 0m$ and cross-section $25mm^2$ strectched by the same anount as a copper wire of length $3 \cdot 0m$ and cross-section $32mm^{-2}$ under a given load. Find the ration of the young's modulus of steel to that of copper?

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3. When the pressure on a sphere is increased by 80 atmospheres then its volume decreases by 0.01%. Find the bulk modulus of elasticity of the material of sphere. (in N/m^2)

A. 5.4 x 10^10

B. 11.4 x 10^10

C. 6.4 x 10^10

D. 8.1 x 10^10

Answer: D

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4. One litre of ideal gas is conpressed isothermally at 0.72m of Hg-column so that its volume becomes 0.9 litre. Find its stress, if the mercury is $13.6 \times 10^3 kg/m^3$.

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5. A $0.05m$ cube has its upper face displaced by $0.2cm$ by a tangential force of $8N$. Calculate the shearing strain, shearing stress and modulus of rigidity of the material of the cube.

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6. A steel wire $4.0m$ in length is stretched through $2.0mm$ .The cross -sectional area of the wire is $2.0mm^2$.If young's modulus of steel is $2.0 \times 10^{11} N/m^2$,Find:

(a) the enrgy density of wire,

(b) the elastic potential energy stored in the wire.

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7. A 15 kg mass is attached to one end of a copper wire 2m ling and 2mm in diameter. Calculate the lateral compression produced in it. Poission's ratio is 0.30 and ypung's modulus of the material of the wire is $12 \times 10^{10} Nm^{-2}$. Use , g=10ms^(-2)`.

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8. A tank 5 m high is half filled with water and then is filled to top with oil of density $0.85 g/cm^3$ The pressure at the bottom of the tank, due to these liquids is

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9. Two differenent liqiud of masses 10g and 20 g and density $0.84 g/cc$ and $0.95 g/cc$ are mixed toghther. Find the density of the mixture.

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10. At a depth of 500m in an ocean (a) what is the absolute pressure? (b) What is the gauge pressure? Density of sea water is $1.03 \times 10^3 kg/m^3, g = 10 ms^{-2}$. Atmospheric pressure = $1.01 \times 10^5 Pa$.

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11. Two pistons of hydraulic press have diameter of $30.0 cm$ and $2.5 cm$, find the force exerted on the longer piston when 50.0kg wt. is placed on smaller piston.

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12. A piece of wax weight $18.80 gwt$ in air. A piece of metal is found to weight $17.03 gwt$ in water. It is tied to the wax and both together weight $15.23 g$, in water . Find the sp. Gravity of wax.

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13. A unifrom rod has a mass attached to one end to make it float upright in liquild. If 3.0 cm of the rod is immersed when floats in water and 3.5 cm when it floats in a liquid of sp. Gravity 0.9 , what length of it will be immersed, when it floats in a liquid of sp. gravity 1.2?

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14. A rectangular plate of dimension $6cm \times 4cm$ and thickness $2mm$ is placed with its largest face flat on the surface of water. Find the downward force on the plate due to surface tension. Surface tension of water is $7.0 \times 10^{-2} Nm^{-1}$.

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15. A wire ring of 4 cm radius on the surface of a liquid and then raised. If surface tension of the tension of the liquid is $78.8 dyne/cm$, find the pull (in g wt) required to raise the ring more before the film breaks than it is afterwards.

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16. A rectangular film of liquid is extended from $5cm \times 3cm \rightarrow 6cm \times 5cm$. If the workdone is $3.0 \times 10^{-4} J$. Find the surface tension of liquid.

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17. A tube of 1mm bore is dipped into a vessel containing a liquid of density $\rho = 800kgm^{-3}$ and of surface tension , $S = 49 \times 10^{-3}Nm^{-1}$ and angle of contact , $\theta = 0^{\circ}$. The tube is held inclined to the verticle at an angle of 60^(@), find the height to which the liquid can rise and the length which the liquid will oc cupy in the tube.

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18. A capillary tube of inner radius $0.5mm$ is dipped keeping it vertical in a mercury of soecific gravity 13.6, surface tension $545dyne/cm$ and angle of contact 135°. Find the depression or elevation of liquid in the tube.

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19. The velocity of water in a river is $72kmh^{-1}$ near the surface. If the river is 4 m deep, find the shearing stress between horizontal layers of water. Coefficient of viscosity of water = 0.01 poise.

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20. A circular metal plate of radius 5 cm, rests on a layer of castor oil 2mm thick, whose coeffeicient of viscosity os $15.5dynecm^{-2}s$. Calculate the horizontal force required to move the plate with a speed of $5cms^{-1}$. Also calculate strain rate and shearing stress.

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21. A $16cm^3$ volume of water flows per second through a capillary tube of radius r cm and length l cm , when connected to a pressure head of h cm of water. If a tube of same length and radius $r/2$ is connected to the same pressure head, find the mass of water flowing per minutes through the tube.

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22. A liquid Flows through a pipe 2.0 mm radius and 20 cm length under a pressure 10^3 dyne cm^{-2}. Determine the rate of flow and the speed of the liquid coming out of the tube. The coefficient of viscosity of the liquid is 1.25 centipoise.

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23. A rain drop of radius 0.5 mm has a terminal velocity in air $2ms^{-1}$. The viscosity of air is 18×10^{-5} dyne $cm^{-2}s$. Find the viscous force on the rain drop.

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24. A metal ball of radius 2 mm and density $10.5g/c.c.$ is dropped in glycerine of coefficient of viscosity

9.8dyne $cm^{-2}s$ and density $1.5g/c.c.$ find the terminal velocity of the ball.

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25. What should be the maximum average velocity of water in a tube of diameter 0.5 cm , so that the flow is laminar? The viscosity of water is $0.00125Nsm^{-2}$.

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26. Water flows at a speed of $6ms^{-1}$ through a tube of radius 1 cm. Coefficient of viscosity of water at room temperature is 0.01 poise. What is the nature of the flow?

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27. Water flows through a horizontal pipe of radius 1 cm at a speed of $2ms^{-1}$. What should be diameter of its nozzel if the water is to come out at a speed of $10ms^{-1}$?

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28. At what speed will the velocity head of stream of water be $50cm$? Use $g = 10m/s^2$.

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29. Water is flowing with a speed of $2m/s$ in a horizontal pipe with cross-sectional area decreasing from $2 \times 10^{-2}m^2$ to $0.01m^2$ at pressure 4×10^4 pascal. What will be the pressure at smaller cross-section?

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30. Calculate the rate of flow of glycerine of density $1.25 \times 10^3 kgm^{-3}$ through the conical section of a pipe, if the radii of its ends are0.1 m and 0.04 m and the pressure drop across its length is $10Nm^{-2}$.

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31. Convert $30\,^\circ C$ temperature into (a) Fahrenheit scale and (b) kelvin scale.

Here, $t_c = 30\,^\circ C$

(a) $\dfrac{t_C}{100} = \dfrac{t_F - 32}{180}$ or 30

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32. A piece of steel has a length $30 cm at 15\,^\circ C$ at $90\,^\circ C$ its length increases by $0.027cm$ find the coefficient of cubical expansion of steel

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33. A metal half $11cm$ in radius is beated from $10^\circ C \rightarrow 80^\circ C$ calculate the increase in surface area of the hall given coefficient of linear expansion of metal hall is $0.000017k^{-1}$

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34. 0.80gram of petroleum was burnt in a bomb calorimater which contains $2.5kg$ of water and has water equivalent $500gram$ The rise in temperature was $5^\circ C$ Find the calorific value of petroleum

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35. Calculate the amount of head required to convert $1.00kg$ of ice at $-10 ^{\circ} C$ into stream at $100 ^{\circ} C$ at normal pressure Specific heat of ice $= 2100Jkg^{-1}K^{-1}$ intent heat of fusion of ice $= 3.36 \times 10^{5}Jkg^{-1}$ specific heat capacity of water $= 4200Jkg^{-1}k^{-1}$ and latent head of vaporisation of water $= 2.25 \times 10^{6}Jkg^{-1}$

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36. A lead bullet penetrates into a solid object and melts Assuming that 50% of its K.E. was used to heat it , calculate the initial speed of the bullet , The initial temp , of bullet is $27 ^{\circ} c$ and its melting point is $327 ^{\circ} C$ Latent heat of fasion of lead $= 2.5 \times 10^{4}Jkg^{-1}$ and sp heat capacity of lead $= 1.25Jkg^{-1}K^{-1}$

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37. Find the value of C_V and C_P for nitrogen $R = 8.3 J \text{ mole}^{-1} K^{-1}$, also for a diatomic gas $C_V = (5/2)R$

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38. An iron boiler is 10 mm thick and has a heating area $2m^2$. The two surfaces of the boiler are at $240\ ^{\circ} C$ and $100\ ^{\circ} C$ respectively. Find the mass of the water evaporated into steam per minute. Given that latest heat of steam is $536 kcal kg^{-1}$ and thermal conductivity of iron is $1.6 \times 10^{-2} kcal s^{-1} m^{-1}.\ ^{\circ} C^{-1}$.

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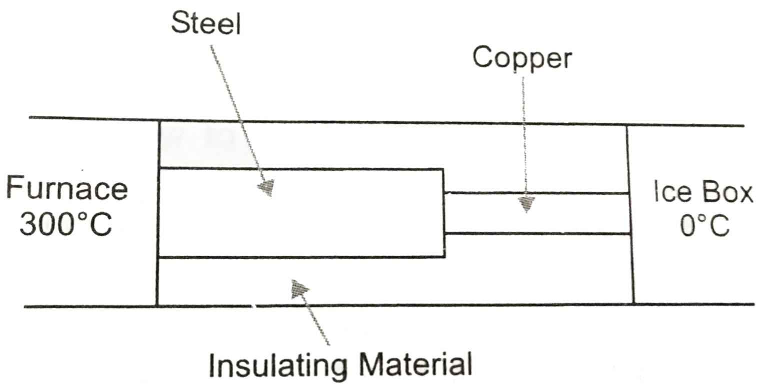
39. What is the temperature of steel-copper jumction in the steady state of the system shown in fig. Length of the steel rod = 30.0 cm, length of the copper rod = 20.0 cm, temperature of the furnace = $300\,^{\circ}C$, temperature of cold end $= 0\,^{\circ}C$. The area of cross-section of the steel rod is twice that of the copper rod. thermal conductivity of steel = $50.2 Js^{-1}m^{-1}.\,^{\circ}C^{-1}$ and of copper = $358 Js^{-1}m^{-1}.\,^{\circ}C^{-1}$.



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40. A liquid contained in a beaker cools from $80^\circ C$ to $60^\circ C$ in 10 minutes. If the temperature of the surrounding is $30^\circ C$, find the time it will take to cool further to $48^\circ C$. Here cooling take place ac cording to Newton's law of cooling.

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41. How much faster does a cup of coffee cool off from $100^\circ C$ than from $30^\circ C$? Assume the coffee to act as a black body and temp. of surrounding = $20^\circ C$.

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42. A body which has a surface area $5.0cm^2$ and a temperature of $727^{\circ}C$ radiater 300 J energy each minute. What is its emissivity? Stefan's Boltzmann's constat is $5.76 \times 10^{-8}Wm^{-2}K^{-4}$.

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43. Two stars radiate maximum energy at wavelength $3.6 \times 10^{-7}m$ and $4.8 \times 10^{-7}m$ respectively. What is the ratio of their temperature?

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Curiosity Questions

1. How does the knowlefge of elasticity help in the construstion of steel bridges and sports domes, which remain safe during stroms and quakes.

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2. If an athelete were somehow scaled up proportionally to twice the original size, would he be stronger of weaker?

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3. What basic principle is involved in the up and down motion of a fish in water and how is it achieved?

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4. What is the biological connection of capillarity action?

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5. The top surface of the helmet used while driving high speed vehicle is provided with two ducts and two ripple strips on each side. Why?

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6. How does the study of specific heat of newly found elements useful in chemistry?

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7. Why do fruit growers spray their trees with water, when frost is expected?

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8. How has the Physics of heat been utillsed by fire figthers?

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9. Can temperature be assigned to a vacuum?

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Very short answer questions

1. What is more elastic : water or air, why?

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2. Out of the following , Quartz, paraffin wax, puttuy and phosphor bronze, which are perfactly plastic bodies and which are perfectly elastic bodies.

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3. What is the value of Young's moduls for a perfectly rigid body?

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4. The bulk modulus for an incompresssible liquid is

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5. What is value of modulus of rigidity for a liquid?

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6. How does Young's modulus change with rise in temperature?

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7. The length of wire increase by 1 mm under 1 kgf. What will be increase in length under

(i) 2 kgf? (ii) under 100 kgf?

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8. A wire is roplaced by another wire of same length and material but of twice diameter.

(i) What will be the effect on the increases in its length under a given load?

(ii) What will be the effect on the maximum load which it can bear?

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9. Two wires are made of same metal. The length of the first wire is half that of the second wire and its diameter is double that of the second wire. If equal loads are applied on both wires, find the ratio of increases in their lengths.

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10. Which state of matter has volume elasticity?

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11. Which type of strain is three, when a spiral spring is stretched by a force?

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12. What does the slops of stress versus strain graph indicate?

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13. What are the factors on which the modulus of elesticity depends?

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14. Out of solids , liquids and gases, which one has all the three types of modulus ofelasticity and why gases have only bulk modulus of elasticity.

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15. Stress and pressure are both force per unit area. How do you differentiate between them?

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16. On what factors does the elastic limit of a material depend?

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17. The ratio stress/strain remains constant for small deformation. What will be the effect on this ratio when the deformation made is very large?

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18. What is the possible value of Poisson's ratio of a substance?

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19. When we stretch a wire, we have to perform work. Why? What happens to the energy given to the wire in this process?

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20. What will happen to the potential energy of the atoms of a solid when

(i) compressed ? (ii) on stretching a wire?

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21. A wire of length L and cross sectional area A is made of a material of Young's modulus Y. If the wire is streched by an amount x, the work done is..................

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22. Two identical springs of copper and steel are equally strectched. On which more work will have to be done?

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23. There are two idential springs of copper and steel. They are stretched by equal forces. For which spring more work will have to be done?

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24. There are two electric poles, one is with hollow structure and other with a solid structure. They are made from the same and equal amount of material. Which electric pole do you perfer? Why.

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25. What is a fluid? Show that fluid exerts a thrust.

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26. Pressure is a scalar or vector quantity.

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27. The bags and suitcases are proveded with broad handles. Why?

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28. What is 1 torr?

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29. What is 1 bar?

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30. We can cut an apple easity with a sharp knife as compared to a blunt knife? Explain why?

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31. It si diffecult for a man to walk bare footed on sand. Why ? How can this difficulty be removed?

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32. It is difficult to stop bleeding from a cut in human body at high altitude. Why?

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33. A beaker containing a liquid is kept inside a big closed jar. If the air inside the jar is continuously pumped out, the pressure in the liquid near the bottom of the liquid will

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34. Why is the dam of water reservoir thick at the bottom?

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35. What is the relation between millibar and pascal.

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36. If a drop of water vapour is introduced in a mercury barometer, how will the barometric height change?

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37. What is buoyancy and centre of buoyancy?

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38. Under which condition (i) the centre of buoyancy coincides with the center of gravity (ii) the centre of bouyancy does not coincide with the centre of gravity.

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39. An iceberg floats in water with about one - tenths of its volume outside the water. What is the fractional volume submerged for an iceberg on a fresh water lake of a planet whose gravity is five times that of earth?

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40. Two pieces of cork, one small and another big are pushed below the surface of water. Which has greater tendency to rise swifty?

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41. A wooden cylinder floats in a vessel containing water with it axis horizontal. How will level of water in the vessel change if the cylinder floats in a vessel with its axis vertical?

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42. A body is just floating in a liquid whose density is equal to the density of body. What happens to the body if it is slightly pressed and released?

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43. A boat carrying a large number of stones is floating in a water tank. What will happen to water level if the stone are unloaded into water?

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44. A block of wood is floating in a lake. Whatis apparent weight of the floating block?

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45. Does Archimede's principle hold in a vessel in free fall?

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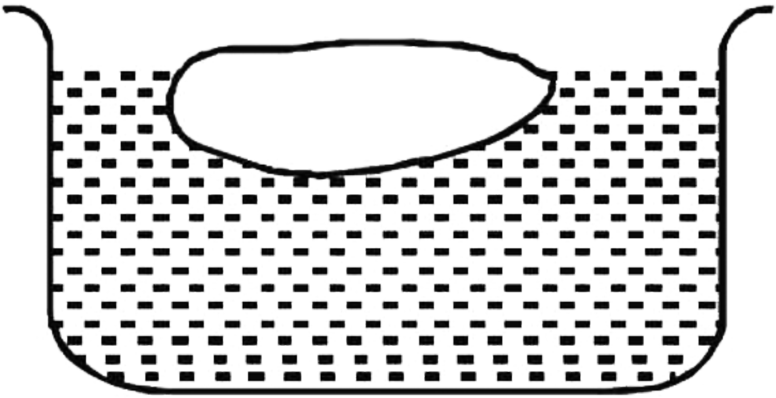
46. A body floats in a liquid contained in a beaker. The whole system as shown in Figure falls freely under gravity. The upthrust on the body is



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47. A piece of ice is floating in a vessel containing water and inside the ice is a bubble of air. What will be the effect on the level of water, when the ice melts?

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48. A piece of ice is floating in a jar containing water. What will be the effect on the level of water in jar, when ice melts and the temperature of water falls from $4^{\circ}C \rightarrow 1^{\circ}C$.

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49. A block of ice is floating in a liquid of specific gravity 1.2 contained in the beaker. What will be the effect on the level of liquid in the beaker when the whole ice melts?

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50. Equal masses of two substance of densities ρ_1 and ρ_2 are mixed together. What is the density of the mixture?

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51. Mercury does not cling to glass. Why?

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52. why does the free surface of a liquid at rest behave like a stretched elastic membrane?

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53. When a deop is split into large number of drops, the change in the total potential energy of small drops and the potential energy of the bigger drop is zero, positive or negative.

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54. A number of small drops of mercury coalesce isothermally to from a single drop. What will be the effect on temperature of the drop?

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55. What will the effect on the temperature, if the number of small drops fo mercury coalesce adiabatically to form a single drop?

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56. What is the work done in blowing a soap bubble of radius r and surface tension S?

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57. When a shaving brush is taken out of water its hair cling together, why?

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58. When a greased iron needle is placed gently on the surface of water at rest, it floats on the surface of water. Why?

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59. Surface tension of all lubricating oils and paints is kept low. Why?

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60. In soldering, addition of flux makes soldering easily. Why ?

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61. Why are the droplets of mercury when brought in contact pulled together to form a bigger drop? Also state with reasons whether the temperature of this bigger drop will be the same, or more, or less than the temperature of the smaller drop.

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62. When bits of comphor are dropped on water, they move helter-skelter. Why?

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63. Explain why some oil spread uniformly on water, when other floats as drops?

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64. It becomes easier to spray the water in which some soap is dissolved. Why?

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65. why excess pressure in a soap bubble is twice the excess pressure of a liquid drop of the same radius.

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66. The soap bubble formed at the end of the tube is blown very slowly. Draw the graph between excess of pressure inside the bubble with time.

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67. What will be the effect on the angle of contact of a liquid if the temperature increases?

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68. what is the effect of impurities on the surface tension of liquid.

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69. When wax is rubbed on cloth becomes water proof, why?

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70. what is the effect of solute on the surface tension of liquid?

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71. Water can rise up to a height of 10 cm in a capillary tube. If a capillary of same diameter but of length 6 cm is held vertically in water, will the water come out in the form of a fountain? Explain.

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72. A liquid of density ρ and surface tension S rises to a height h in a capillary tube of diameter D. what is the weight of the liquid in the capillary tube? Angle of contact is 0°.

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73. Put a piece of chalk into water. The chalk will emit bubbles in all directions . Explain this phenomenon.

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74. How is the rise of liquid affected if top of the capillary is closed?

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75. Why the tip of the nib of a pen is split?

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76. What is the importance of wetting agents used by dyers?

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77. What is the importance of water proofing agents?

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78. A stirred liquid comes to rest after sometime. Why?

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79. If water in one flask and castor oil in other area violently shaken and kept on a table, which will come to rest earlier

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80. Out of friction force and viscous force which depends upon velocity.

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81. Two liquids of densities rhp_1 and ρ_2 coefficient of viscosity η_1 and η_2 are found to flow through a capillary tube at the same rate. What is the ration of η_1/η_2?

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82. The hotter liquid flows faster than the colder ones. Explain, why.

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83. What are the SI unit and cgs unit of viscosity . Give the relation between them.

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84. Why should the lubricant oil be of high viscosity?

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85. What is the ac celeration of a body falling through a viscous medium after terminal velocity is reached?

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86. The diameter of Ballll A is twice of that of B. What will be the ratio of their terminal velicities in water.

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87. Why dust generally sttles down in a closed room?

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88. Draw a graph between terminal velocity of a spherical body and square of its radius?

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89. Fog particles appear suspended in the atmosphere. Why?

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90. What is meant by critical velocity of a liquid?

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91. What is the value of Reynold's number, when the flow of liquid in a tube is

(i) laminer (ii) turbulent?

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92. Can two stramlines cross each other in a flowing liquid ? Explain.

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93. When water flows through a pipe in the form of coaxial layers, which layer moves faster?

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94. What happen to the external energy maintaining the flow of liqiud when the flow becomes turbulent.

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95. What will be the velocity of water when it passes from narrow tube to wider tube?

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96. The liquid is flowing steadily through a tube of varying diameter. How are the velocity of liquid flow (V) in any portion and the diameter (D) of the tube in that portion are related?

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97. What happeds to the pressure of an ideal liquid when it passes through a region where its speed increases?

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98. What are the porperties of a liquid satisfying the Bernoulli's theorem?

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99. Whan air is blown in between two balls suspended close to each other, they are attracted towards each other. Why?

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100. The speed of a liquid flowing through a pipe increases and its pressure decreases when liquid passes through a narrow constriction in the pipe. Why?

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101. What is effecto on the equilibrium of a physical balance when air is blown below one pan?

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102. Water is coming out of a hole made in the wall of a fresh water tank . If the size of he hole is increasesd, (i) will velocity of efflux of water change? (ii) will the volume of the water coming out per second change?

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103. What is pressure head and velocity head?

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104. Water and mercury are filled in two cylindrical vessels up to same height. Both vessels have a hole in the wall near the bottom. If υ_1 and υ_2 are the velocity of water and mercury coming out of the holes, find the relaton between υ_1 and υ_2.

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105. What are the SI and cgs units of heat? How are they related?

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106. Density of solid decrease/increases with rise in temperature. Explain.

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107. The heat is supplied to a given mass of water. Draw the variation of volume of water with its temperature.

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108. two copper balls having masses 5 gm and 10 gm collide with a target with the same velocity. If the total energy is used in heating the balls. Which ball will attain higher temperature?

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109. The holes which the fist plates are fitted to join the rails are oval in shape. Why?

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110. What is the value of isothermal bulk modulus of elasticity of air at NTP?

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111. Two thermometer are constructed in the same way except that one has a spherical bulb and the other has an elongted cylindrical bulb. Which out of the two will respond quickly to temperature change?

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112. Can you measure temperature upto $500^{\circ} C$ with a mercury thermometer, knowing that the mercury boils at $357^{\circ} C$?

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113. The diameters of steel rods A and B having the same length are 3 cm and 6 cm respectively. They are heated through $80\ ^{\circ}C$. What is the ratio of increase in length of A to that B?

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114. A beaker filled with water at $4.\ ^{\circ}C$ over flows if the temperature of water increases or decreases. Explain why?

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115. What is the value of specific heat of water in SI unit? Does it very with temperature?

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116. What is the most likely value for C_T (molar heat capacity at constant temperature) ?

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117. Do water and ice have the same specific heats?

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118. Is the specific heat of water greater than that of sand?

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119. What is relegation?

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120. What is sublimation?

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121. What is specific heat of a gas is an isothermal process?

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122. What is specific heat of a gas is an adiabatic process?

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123. What will be the specific heat of the liquid at its boiling point when it is being converted into steam?

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124. How many specific heat does a gas passes?

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125. How many calories of heat are required for external work when one gram mole of a as is heated by $1^\circ C$ at constat pressure?

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126. What is the physical signficance of the difference of two principal specific heat of a gas?

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127. Do you think a body at higher temperature contains more heat? Explain.

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128. What is critical temperature?

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129. What is the relation between heat capacity and water equivalent of a substance?

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130. What is thermal conductivity of a perfect heat conductors of a perfect heat conductor and a perfect heat insulator?

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131. When glass and copper pieces heated upto same temperature are touched, why copper piece seems warmar than glass piece?

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132. How do you arrange Cu, Al and Ag in the order of increasing thermal conductivity?

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133. Give two examples of natural convection.

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134. Give two examples of forced convection.

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135. Which metel is the best conductor of heat?

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136. Which mode of transfer of heat is quickest?

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137. Solar pond is a device for collecting solar heat. The pond is about one metre deep, filled with saturated salt solution and protected from air current and other disturbances. When exposed to sun, the temperature at the bottom can go as high as $80^\circ C$ or more. why is this possible?

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138. What kind of thermal condcutivity , specifie heat and coefficient of expansion requirements would you specify for cooking utensils?

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139. Why are two thin blankets are warmer than a single blanket of double the thickness?

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140. We can easily boil water in a paper cup. Why?

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141. Why snow is better heat insulator than ice?

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142. What is the basic condition for Newton's law of cooling to be obeyed?

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143. What is temperatrue gradient?

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144. Can the rate of loss of heat be the same for two liquids? Comment.

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145. Ac cording to Newton's law of cooling, the rate of cooling of a body is proportional to $(\Delta\theta)^n$, where $\Delta\theta$ is the difference of the temperature of the body and thae surrounding. What is the value of n out of 4,3,2,and 1?

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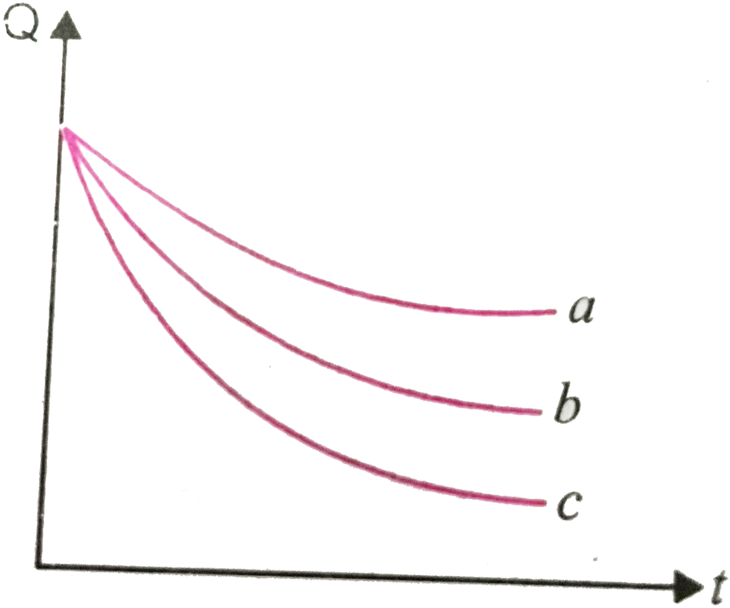
146. Cooling curves are drawn for three liquids a,b,c, shown in fig. for which liquid specific heat is least?



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147. A good heat reflector is a poor emitter, why?

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148. Why are clear nights colder than cloudy nights ?

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149. Under which condition the rate of cooling is obeyed (i) under Newton's law of cooling and (ii) under Stefan's law?

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150. The young's modulus for steel is much more then that for rubber. For the same longitudinal strain, which one will have greater tensil stress ?

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151. Is stress a vector quantity ?

Watch Video Solution

152. Identical spring of steel and copper are equally stretched. On which, more work will have to be done ?

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153. What is the value of Young's modulus for a perfectly rigid body?

Watch Video Solution

154. what is the Bulk modulus for a perfect rigin body ?

Watch Video Solution

155. Is viscosity a vector ?

Watch Video Solution

156. Is surface tension a vector ?

Watch Video Solution

157. Iceberg floats in water with part of it submerged. What is the fraction of the volume of iceberg submerged if the density of ice is $\rho_i = 0.917 gcm^{-3}$?

Watch Video Solution

158. A vessel filled with water is kept on a weighing pan and the scale adjusted of zero. A block of mass M and density ρ is suspended by a masselss spring of spring constant k. This block is submerged inside into the water in the vessel. What is the reading of the scale /

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159. A cubical block of density ρ is floating on the surface of water. Out of its height L, fraction x is submerged in water. The vessel is in an elevator ac celerating upward with ac celeration a. What is the fraction immersed ?

Watch Video Solution

160. Is the bulb of a thermoeter made of diathermic or adiabatic wall ?

Watch Video Solution

161. Why does a metal bar appear hotter then a wooden bar at the same temperature ? Equivalently it also appears cooler then wooden bar if they are both colder then room temperature.

Watch Video Solution

162. Calculate the temperature which has same numberal value on Calsius and Fahrenheit scale.

Watch Video Solution

163. These days people use steel utensils with copper bottom. This is supposed to be good for uniform heating of food. Explain this effect using the fact that copper is the batter conductor.

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Short Answer Questions

1. Distinguish between elasticity and plasticity of materials.

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2. The length of a steel wire is l_1 when the stretching force is T_1 and l_2 when the stretching force is T_2. The natural length of the wire is

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3. When a weight W is hung from one end of a wire of length L (other end being fixed), the length of the wire increases by l. If the same wire is passed over a pulley and two weights W each are hung at the two ends,what will be the total elongation in the wire?

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4. One end of a uniform rod of mass M and cross-sectional area A is suspended from a rigid support and an equal mass M is suspended from the other end, what is the stress at the mid point of the rod.

Watch Video Solution

5. A thick rope of density ρ and length L is hung from a rigid support. The increase in length of the rope due to its own weight is (Y is the Young's modulus)

Watch Video Solution

6. Two wires made of same material are subjected to forces in the ratio 1:4 their lengths are in the ratio 2:1 and diameters in the ratio 1:3, what is the ratio of their extensions?

Watch Video Solution

7. A cable is replaced by another cable of the same length and material but of duouble the diameter.

(i) Under a given load which cable wil show greater extension?

(ii) How many times the second cable can support the maxium load without exceeding the elastic limit?

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8. A copper wire of negligible mass, length l and corss-section A is kept on a smooth horizontal tabel with one end fiexed. A ball of mass m is attached to the other end. The wire and the ball are rotating with an angular velocity ω. If elongation in the wire is Δl, obtain the expression for the Young's modulus.

Watch Video Solution

9. A hollow shaft is found to be stronger than a solid shaft made of same equal material.

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10. A metal bar of length L and area of cross-section A is rigidly champed between two walls. The Young's modulus of its material is Y and the coefficient of linear expansion is α. The bar is heated so that its temperature is increased by $\theta^\circ C$. Find the force exerted at the ends of the bar.

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11. Two rod A and B of the same material and dame length have radii r_1 and r_2 respectively. When they are rigidly fixed at one end and twisted by the same couple applied at the other end, find the ratio of the angles of twist at the ends of A and B.

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12. A metallic wire of length L, area of cross-section A is suspended by attaching some wieght to it. If α is the longitudinal strain and Y is Young's modulus, find the ratio between elastic potential energy and the elastic energy density.

Watch Video Solution

13. The longer side of cross-section of the girder is used as depth. Why?

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14. Explain elastic behaviour of solids.

Watch Video Solution

15. Explain the terms (i) stress, (ii) strain.

Watch Video Solution

16. State and prove Hooke's law.

Watch Video Solution

17. Discuss experimental determination of Young's modulus of a metallic wire.

Watch Video Solution

18. Explain (i) ducitile materials (ii) brittle materials and (iii) elastromers.

Watch Video Solution

19. Explain (i) Elastic after effect and (ii) Elastic fatique with illustrations.

Watch Video Solution

20. What do you understand by potential energy in a stretched wire? Find a relation for it and hence determine the elastic potential energy per unit volume of the wire.

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21. Explain Poisson's ratio. What are theoretical value and practical value of Poisson's ratio for all substance?

Watch Video Solution

22. Railway tracks are laid on large sized wooden, iron or cement sleepers. Why?

Watch Video Solution

23. A barometer kept in an elevator accelerating upward reads 76 cm. The air pressure in the elevator is

Watch Video Solution

24. A barometer kept in an elevator accelerating upward reads 76 cm. The air pressure in the elevator is

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25. What is the height of mercury level in a barometer which is set up in a sealed cabin on the moon containing air at our usual atmospheric pressure.

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26. A uniformly tapering vessel of height h whose lower and upper radii are r and R is completely filled with a liquid of density ρ The force that acts on the base of the vessel due of the liquid is

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27. Explain why an air bubble in water rises frim bottom to top and grows in size.

Watch Video Solution

28. The food is cooked faster in the pressure cooker? Why? It becomes difficult to cook food at the mountains . Why?

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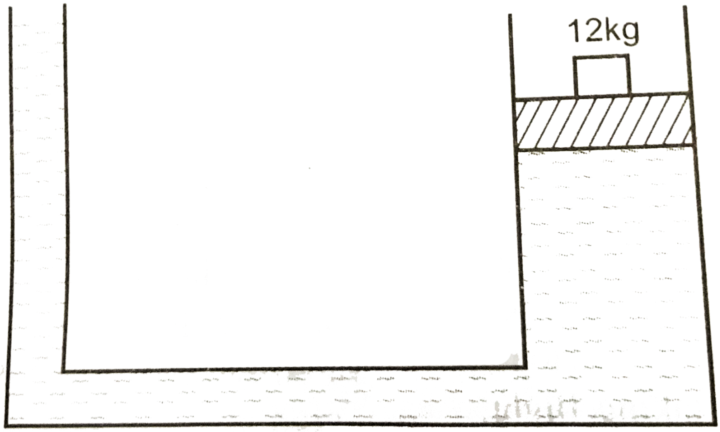
29. The passengers flying in aeroplane are advised to remove the ink from their pens while going up in the aeroplane , why?

Watch Video Solution

30. A cylindrical vessel closed at bottom is of radius 'R' and height 'H'. it is filled with a liquid of density ρ upto its top. What is the thrust of liquid at the curved surface of vessel

Watch Video Solution

31. The area of cross-section of the wider tube shown in fig., is $800 cm^2$. If a mass of 12 kg is placed on the massless piston, what is the difference in the level of water in two tubes.



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32. A bucket of water is suspended from a spring balance. What happens to reading of balance

(a) when a piece of stone suspended from a string is immersed in the water without touching the bucket

(b) when a piece of lead or cork is put in the water in the bucket.

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33. A $20N$ metal block is suspended by a spring balance. A beaker containing some water is placed on a weighing machine which reads $40N$. The spring balance is now lowered so that the block gets immersed in the water. The spring balance now reads $16N$. The reading of the weighing machine will be.

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34. A block of wood, specific gravity 0.6 and mass 90.0 g is floting in water. A hole is drilled in it removing 8.0 g of wood. The hole is filled with lead of density $11.43 g/cm^3$. What will be the effect on the block?

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35. A man is sitting in a boat which is floating in a pond. If the man drinks some water from the pond, the level of water in the pond decreases.

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36. A block of wood is floating on water at $0^{\circ} C$ with a certain volume V above water level. The temperature of water is slowly raised to $20^{\circ} C$. How does the volume V change with the rise of temperature ?

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37. A ball floats on the surface of water in a container exposed to the atmosphere. Will the ball remain immersed at its initial depth or will it sink or rise somewhat if the container is shifted to the moon?

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38. A glass plante of negligible mass and thickness is held against the end of a tube and pushed 10 cm under the surface of water. When released, the plate does not fall off. What depth of kerosene oil of relative density 0.8 must be poured into the tube so that the plate just falls off?

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39. A block of ice in which a piece of stone is embedded is floating on water contained in a beaker. When all the ice melts the level of water in the beaker

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40. A wooden cylinder is floating on water in a beaker which is placed in a lift. When the lift is at rest, $1/3$ of the volume of wood is exposed above the water . The lift now moves up with an ac celeration equal to $g/2$. What is the fraction of the volume exposed now?

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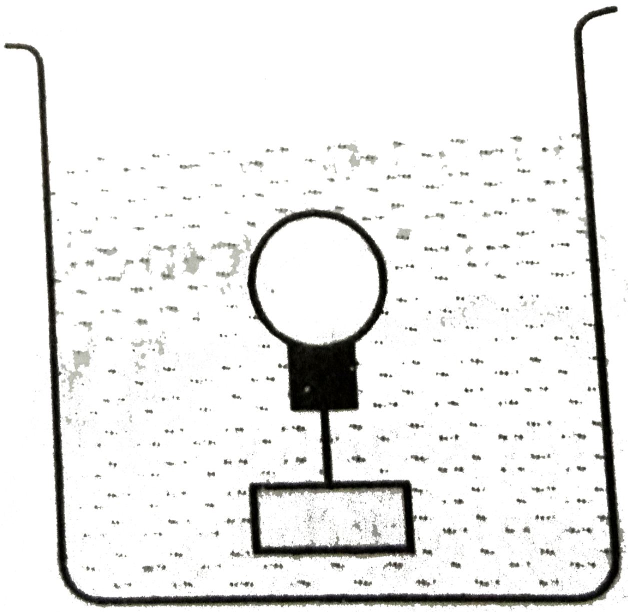
41. A balloon filled with air is just floating in water in a beaker, as shown in fig. If the balloon is submerged more by a small distance and released, then the balloon will move up or move down to bottom or remains at the same location where released. Explain.



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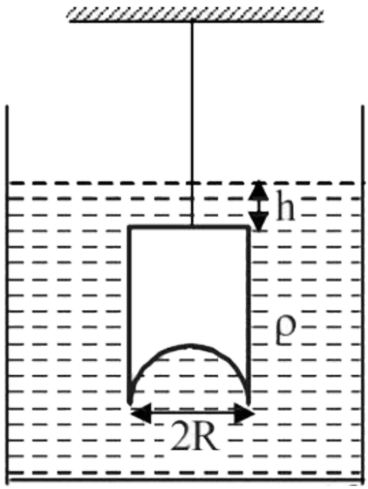
42. A hemispherical portion of radius R is removed from the bottom of a cylinder of radius R. The volume of the remaining cylinder is V and its mass M. It is suspended by a string in a liquid of density ρ where it stays vertical. The upper surface of the cylinder is at a depth h below the liquid surface. The force on the bottom of the cylinder by the liquid is



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43. What will be the shape of the bigger drop of mercury on a glass sheet (a) on the surface of earth (b) at the centre of the earth, and why?

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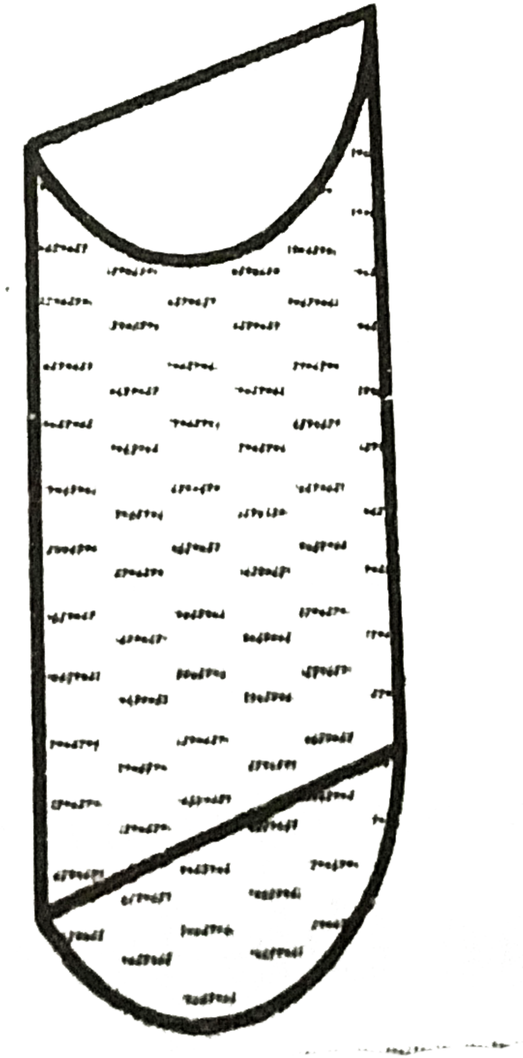
44. Explain why it is difficult to make mercury enter a fine therometer tube?

Watch Video Solution

45. Why does a glass rod coated with wax not becomes wet when dipped in water?

Watch Video Solution

46. A liquid is contained in a vertical tube of semi-circular cross-section. The angle of contact is zero fig. What is the ratio of the force of surface tension on the curved part and the flat part of the tube?



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47. The oil is sprinkled on sea waves to calm them down. Why ?

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48. Why are the droplets of mercury when brought in contact pulled together to form a bigger drop? Also state with reasons whether the temperature of this bigger drop will be the same, or more, or less than the temperature of the smaller drop.

Watch Video Solution

49. A soap bubble of radius r si blown up to form of bubble of radius 3r under isothermal conditions . What is the energy spent in doing so if the surface tension of soap solution is S.

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50. The excess pressure inside a soap bubble is thrice the excess pressure inside a second soap bubble. What is the ratio between the volume of the first and the second bubble?

Watch Video Solution

51. A glass tube of radius r is dipped vertically into a container of mercury of density ρ with its lower end at a depth h below the mercury surface . If S is the surface tension of mercury, what must be the gauge pressure of air in the tube to blow a hemispherical bubble at the lower end?

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52. A small drop of water of surface tension S is squeezed between two clean glass plates so that a thin layar of thickness d and area A is formed between them. If the angle of contact is zero, what is the force required to pull the plates apart?

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53. Two soap bubbles have radii in the ratio 2:3. comare the excess of pressure inside these bubles. Also compare the works done in blowing these bubbles.

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54. If a capillary tube is put in water in a weightlessness state, how will the rise of water in a capillary tube will be observed as compared to one under normal condition?

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55. A capillary tube when immersed vertically in a liquid records a rise of 3cm.if the tube is immersed in the liquid at an angle of 60° with the vertical, then find the length of the liqiud column along the tube.

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56. If a capillary tube is immersed at first in cold water and then in hot water, the height of capillary rise will be smaller in the second case. How can this be explained?

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57. What is fluid? Show that fluid exerts pressure and prove that the force acting on a fluid in equilibrium of rest have to be perdicular to its surface.

Watch Video Solution

58. Show that liquid in equilibrium of rest exerts normal force on the surface in contact with it.

Watch Video Solution

59. What is pressure? Give its units and demensions. How can you measure it?

Watch Video Solution

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60. State Pascal's law.Give the construction and working of Hydraulic brakes.

Watch Video Solution

61. How can you measure atmospheric pressure experimentally?

Watch Video Solution

62. What do you understand by hydrostatic paradox. Explain it with an illustration.

Watch Video Solution

63. Find the height of atmosphere.

Watch Video Solution

64. State the various units of atmospheric pressure.

Watch Video Solution

65. Describe a simple experiment for measuring the surface tension of a liquid.

Watch Video Solution

66. Explain surface energy. Establish its relation with surface tension.

Watch Video Solution

67. Show that there is always an excess pressure on the concave side of the meniscus of a liquid. Obtain expression for the excess pressure inside liquid bubble

Watch Video Solution

68. What do you understand by angle of contact? On what factors does it depend? Where is the angle of contact obtuse, acute or zero degree.

Watch Video Solution

69. What is surface tension? Define angle of contact of a liquid with a solid surface. Why does it vary for different liquids?

Watch Video Solution

70. What happens when a capillary tube of insufficient length is dipped in a liquid?

Watch Video Solution

71. Discuss the effect of presence of impurities and the temperature on the surface tengion of a liquid.

Watch Video Solution

72. How dirty clothes can be cleaned using a detergent in hot water?

Watch Video Solution

73. Write two factors affecting viscosity. Which one is more viscous : Pure water or saline water?

Watch Video Solution

74. Under a constant pressure head, the rate of streamlined volume flow of a liquid through a capillary tube is V. if the length of the capillary tube is double and diameter of the bore is halved, find the rate of flow of the liquid through the capillary tube.

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75. Explain the difference between solid friction and viscosity.

Watch Video Solution

76. Explain the effect of (i) density

(ii) temperature and (iii) pressure on the viscosity of liquids and gases.

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77. Two capillaries of same length and radius in the ratio of 1:2 are connected in series and a liquid flows through this system under streamline conditions . If the pressure across the two extreme ends of combination is 1m of water, what is the pressure difference across the (i) first capillary (ii) second capillary?

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78. A small ball of mass m and density ρ is dropped in a viscous liquid of density σ. Ather some time the ball falls with a constant velocity. Calculate the viscous force acting on the ball.

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79. Give an example for a force proportional to velocity . Prove that terminal velocity of a solid object moving in a viscous medium is directly proportional to square of its size and inversely proportional to the viscoisity of the medium.

Watch Video Solution

80. Two equal drops of water are falling through air with a steady velocity v. If the drops coalesced, what will be the new velocity?

Watch Video Solution

81. The cloud's are seen floating in the sky. Why?

Watch Video Solution

82. How will the weight of a body be affected, when it falls with its terminal velocity through a viscous medium?

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83. The velocity of fall of a man jumping with a parachute first increases and then becomes constant. Explain.

Watch Video Solution

84. A small sphere of mass 'm' is dropped from a great height. After it has fallen 100m, it has attained its terminal velocity and continue to fall at that speed. The workdone by air friction against the sphere during 100m fall is W_1 and during next 100m fall is W_2, then compare W_1 and W_2.

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85. A parachute is advised to be used by a person, while jumping out of an aeroplane. Explain why?

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86. What happens when the velocity of the liquid flowing through a horizontal tube is gradually increased?

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87. The velocity of water in a river is less on the bank and large in the middle : why?

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88. Deep water runs slow. Explain.

Watch Video Solution

89. The cylindrical tube of a spray pump has radius R, one end of which has n fine holes, each of radius r. If the speed of the liquid in the tube is V, the speed of the ejection of the liquid through the holes is:

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90. Distinguish between streamline motion and turbulent motion.

Watch Video Solution

91. Flags flutter in breeze. Why?

Watch Video Solution

92. It is advised not to stand near a running train. Why?

Watch Video Solution

93. Why two boats moving in parallel directions close to each other get attracted?

Watch Video Solution

94. An aeroplane runs for some distance on the run way before taking off. Why?

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95. The water level on a tank is 5m high. There is a hole of $1cm^2$ cross-section at the bottom of the tank. Find the initial rate with which water will leak through the hole. ($g = 10ms^{-2}$)

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96. In a test experiement on a model aeroplane in a wind tunnel, the flow speeds on the lower and upper surfaces of the wing are υ and $\upsilon\sqrt{2}$ respectively. If the density of air is ρ and the surface area of the wings is A, what is the dynamic lift on the wing of aeroplane.

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97. The stream of water flowing at high speed from a garden hose pipe tends to spread like a fountain when held vertically up, but tends to narrow down when held vertically up, but tends to narrow down when held vertically down. Explain how?

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98. There are two holes, each of cross-sectional area a, on the opposite side of a wide rectangular tank containing a liquid of densityρ. When the liquid flows out of the holes, find the net force on the tank. Given h is the vertical distance between two holes.

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99. Explain viscosity of a liquid. Discuss its cause.

Watch Video Solution

100. Explain coeffecient of viscosity , its units and give its dimensional formula.

Watch Video Solution

101. State Poiseuille's formula. Derive it with the help of dimensional analysis.

Watch Video Solution

102. State and Establish Stokes' law.

Watch Video Solution

103. What do you understand by terminal velocity. Find the relation for it?

Watch Video Solution

104. Mention some particle uses of the knowledge of viscosity.

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105. What do you understand by critical velocity?

Watch Video Solution

106. What do you understand by Reynold number? Give its physical significance.

Watch Video Solution

107. What is venturimeter ?

Watch Video Solution

108. State and explain Torricelli's theorem.

Watch Video Solution

109. What do you mean by blood pressure and heart attack? Explain.

Watch Video Solution

110. Why a clinical thermometer should not be sterilized by boiling water?

Watch Video Solution

111. Is it possible that there is change in temperature of a body without giving//taking heat to//from it?

Watch Video Solution

112. Explain why cooking is faster in a pressure cooker.

Watch Video Solution

113. What is meant by triple point ? Give the values fo triple point pressure and triple point temperature of water.

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114. A metal tube and a rod of same length same material and same outer diameter are given same amount of heat. Which will show less expansion and why ?

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115. A body suspended from a spring balanc ce is immersed in water. If the coefficient of cubicacl expansion of water is twice that of the suspended body, then on heating the water, the reading on the spring balance decreases, increases or reamains the same, Explain.

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116. A mercury therometer is transferred from melting ice to a hot liquid. The mercury rises 0.95 of the distance between lower and upper fixed points. What is the temperature of the liquied in . $^{\circ}C$ and in . $^{\circ}F$?

Watch Video Solution

117. Water is not considered suitable for use in thermometers. Give the reason for the same.

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118. There are two sphers of same radius and material at the same temperature but one being solid while the other hollow. Which sphere will expand more if they are given the same amount of heat ?

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119. What is principle of calorimetry ?

Watch Video Solution

120. Why does a gas not have a unique value of specific heat ?

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121. Two bodies of specific heats $C_1 \text{ and } C_2$ having same heat capacities are combined to form a single composite body. What is the specific heat of the composite body?

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122. Define thermal capacity and water equivalent of a body. State their units and how are they related ?

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123. The gases have two principal specific heats but solids and liquied have only one specific heat. Why ?

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124. Briefly explain the concept of heat and concept of temperature.

Watch Video Solution

125. What is absolute scale of temperature?

Watch Video Solution

126. Mention some applications of thermal expansion in daily life.

Watch Video Solution

127. ANOMALOUS EXPANSION OF WATER

Watch Video Solution

128. How does specific heat of a solid vary with temperature?

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129. How does specific heat of a solid vary with temperature?

Watch Video Solution

130. Stainless steel cooking pans are perferred with extra copper bottoms. Why?

Watch Video Solution

131. In winter, if we touch steel chair , we feel cold but so when touched wooden chair , though both are at the same temperature. Why?

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132. Woolen cloths are worn in winter but not in summer. Why?

Watch Video Solution

133. Heat is generated continuously in an electric heater, but its temperature becomes constant after some time. Why?

Watch Video Solution

134. How heat can be transferred from one place to the other? Which is the fastest on and why?

Watch Video Solution

135. What are the basic differences between , conduction, convection and radiation?

Watch Video Solution

136. What is the effect of temperature on thermal conductivity of substances?

Watch Video Solution

137. Water is heated from below but not from top. Why?

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138. Room are provided with the ventilators near the roof. Why?

Watch Video Solution

139. In what respect, the thermal radiations are different from light radiations,

Watch Video Solution

140. Black body radiation is white and a hole in the cavity of a radiator is a black body. Explain.

Watch Video Solution

141. Is the rate of cooling the same thing as the rate of loss of heat? Explain.

Watch Video Solution

142. "Good reflectors are poor emitters of thermal radiation." explain.

Watch Video Solution

143. If the earth did not have an atmosphere, it would become intoleraby cold. Why?

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144. In which of the following process, convection does not take place primarily?

(a) Sea and land breeze

(b)Boiling of water

(c) Warming of glass of bulb due ot filament

(d) Heating air around a furnace

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145. Mention atleast three applications of conductivity in daily life.

Watch Video Solution

146. Discuss the variation of temperature of hot body with time during cooling process. What do you conclude from this?

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147. State Kirchhoff's law of radiations.

Watch Video Solution

148. Explain Stefan's law and Wien's displacement law.

Watch Video Solution

149. A wire of length L and radius a rigidlyl fixed at one end. On stretching the other end of the wire with a force F, the increase in its length is L, if another wire of same material but of length 2 L and radius 2 a is stretched with a force 2 F, the increase in its length will be

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150. A steel rod $\left(Y = 2.0 \times 10^{11} N/m^2\right.$ and $\alpha = 10^{-50}.^0C^{-1}$) of length $1m$ and area of cross-section $1cm^2$ is heated from $0^\circ C$ to $200^\circ C$ without being allowed to extended or bend. Then the tension produced in the rod is

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151. To What depth must a rubber ball be taken in deep sea so that its volume is decreased y 0.1 %. (The bulk modulus of rubber is $9.8 \times 10^8 Nm^{-2}$, and the density of seac water is $10^3 kgm^{-3}$.)

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152. A truck is pulling a car out of a ditch by means fo a steel cable that is $9.1m$ long and has a radius of $5mm$.

When the car just beings to move, the tension in the cable is $800N$. If Young's modulus for steel is $2 \times 10^{11} N/m^2$ then the strecth in the cable is (neraly)

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153. Two idential solid balls, one of ivory and the other of wet caly, are dropped from the same height on the floor. Which one will rise to a greater height after striking the floor and why ?

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154. The sap in trees, which consists mainly of water in summer, rises in a system of capillaries of radius $r = 2.5 \times 10^{-5} m.$ The surface tension of sap is $T = 7.28 \times 10^{-2} Nm^{-1}$ and the angle of contact is 0°. Does surface tension alone ac count for the supply of water to the top of all tress ?

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155. The free surface of oil in a tanker, at rest, is horizontal if the tanker starts ac celerating the free surface will be titled by an angle θ. If the ac celeration is a ms^{-2} what will be the slope of the free surface ?

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156. Two mercury droplets of radii 0.1 cm and 0.2 cm collapse into one single drop. What amount of energy is released? The surface tension of mercury $T = 435.5 \times 10^{-3} Nm^{-1}$

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157. If a drop of liquid breaks into smaller droplets, it result in lowering of temperature of the droplets. Let a drop of radius R, breaks into N small droplets each of radius r. Estimate the drop in temperature.

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158. The surface tension and vapour pressure of water at $20^{\circ}C$ is $7.28 \times 10^{-2} Nm^{-1}$ and $2.33 \times 10^{3} Pa$, respectively. What is the radius of the smallest spherical water droplet which can form without evaporating at $20^{\circ}C$?

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159. find out the increase in moment of inertia I of a uniform rod (coefficient of linear expansion α) about its perpendiuclar bisector when itsw temperature is slightly increased by ΔT.

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160. During summers in india, one of the common practice to keep cool is to make ice balls of crushed ice, dip it in flavoured suger syrup and sip it. For this a stick is inserted into crushed ice and is squeezed in the palm to make it into the ball. Equivalently in winter in thouse ares where it snows, people make snow balls and throw around. Explain the formation of ball out of crushed ise or snow in the light of P - T diagram of water.

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161. 100 g of water is supercooled to - $10^{\circ} C$. At this point, due to same disturbance mechanised or otherwise some of it suddenly freezes to ice. What will be the temperautre of the resultant mixture and how much mass would freeze ?

$\left[s_w = 1cal/g/.^\circ C \text{ and } L^w_{Fusion} = 80cal/g\right]$

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162. One day in the morning, Ramesh filled up 1//3 bucket of hot water from geyser, to take bath, Remaining 2//3 was to be filled by cold water (at room temperature) to bring mixture to a comfortable temperature. Suddenly Ramesh had to attend to something which would take some times, say 5 -10 minutes before he could take bath. Now he had two options : (i) fill the remaining bucket completely by cold water and then attend to the work, (ii) first attend to the work and fill the remaining bucket just before taking bath. Which option do you think would have kept water warmer ? Explain.

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Long Answer questions

1. Explain modulus of elasticity and its various forms.

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2. Discuss atleast three important applications of elasticity.

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3. Explain the working of (i) hydraulic lift (ii) hydraulic breaks.

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4. Show that atmosphere exerts pressure and describe Torricelli's experiment to study the atmospheric pressure.

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5. Define the terms molecular range, sphere of influence and surface film.

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6. Explain surface tension. Discuss molecular theory of surface tension.

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7. Derive an expression for the excess pressure (i) inside a liquid drop (ii) inside a soap bubble.

Watch Video Solution

8. Define Capillarity and angle of contact. Derive an expression for the ascent of a liquid in a capillary tube.

Watch Video Solution

9. Expalin streamline flow, laminar flow and turbulent flow.

Watch Video Solution

10. What are different forms of energy possessed by a flowing liquid? Write expression of them.

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11. State and prove Bernoulli's theorem.

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12. Define three coefficeints of thermal expansion. Establish relation between them.

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13. Explain what is meant by specific heat of a substance. What are its units? How is molar specific heat different from specific heat?

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14. Define two principal specific heats of a gas. Which is greater and why?

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15. What do you mean by change of state of a substance?

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16. Explain the three modes of transfer of heat with illustrations.

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17. what is meant by thermal conductivity and its coefficient . What are its SI units and cgs units.

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18. State and explain Newton's law of cooling. Also discuss its experimental verification.

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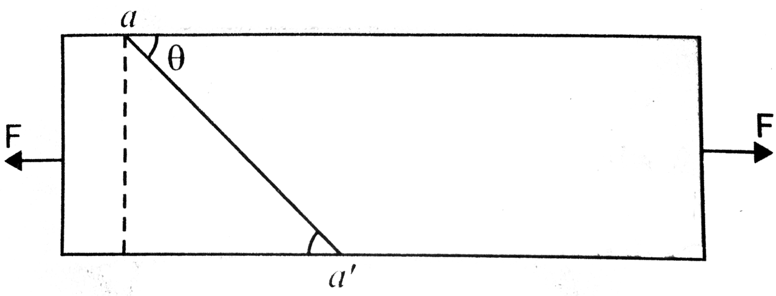
19. Consider a long steel bar under a tensile stress due to forces F, acting at the edges along the length of the bar



Consider a plane making an angle θ with the length. What are the tensile and shering stresses on this plane ? (a) For what angle is the tensile stress a maximum ? (b) For what angle is the shearing stress a maximum ?

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20. A steel wire of mass μ per unit length with a circular cross-section has a radius of $0.1 cm$. The wire is of length $10 m$ when measured lying horizontal, and hangs from a hook on the wall. A mass fo $25kg$ is hung from the free end of the wire. Assume the wire to be uniform and laterla strain $<<$ logitudinal strain. If density of steel is $7860kgm^{-3}$ and Young's modulus is $2 \times 10^{11} N/m^2$ then the extension in the length fo the wire is

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21. A steel rod of length 2l cross-sectional area A and mass M is set rotating in a horizontal plane about an axis passing through its centre and perpendicular to its length with constant angular velocity ω. If Y is the Young's modulus for steel, find the extension in the length of the rod. (Assume the rod is uniform.)

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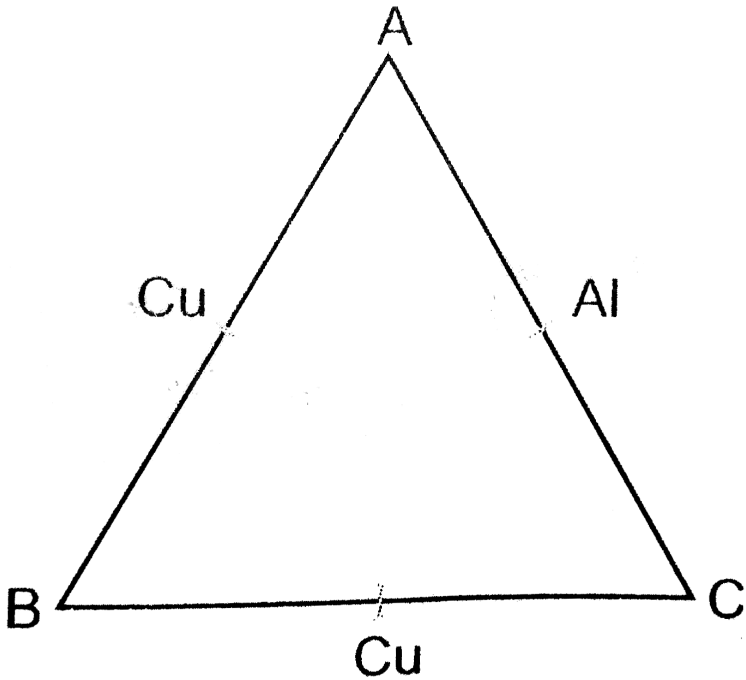
22. An equilateral triangle ABC if formed by two Cu rods AB and BC and one Al rod



it is heated in such a way that temperature of each rod increases by ΔT. Find change in the angle ABC. [Coeff. Of linear expansion for Cu. is α_1, Coeff. of linear expansion for Al is α_2]

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23. In nature, the failure of structural members usually result from large torque because of twisting or bending rather than due to tensile or compressive strains. This process of structural breakdown is called buckling and in cases of tall cylindrical structures like trees, the torque is caused by its own weight bending the structure. Thus, the vertical through the centre of gravity does not fall within the base. The elastic torque caused because of this bending about the central axis of the tree is given by $\frac{Y\pi r^4}{4R}$. Y is the Young's modulus, r is the radius of the trunk and R is the radius of curvature of the bent surface along the height of the tree containing the centre of gravity (the neutral surface). Estimate the critical height of a tree for a given radius of the trunk.

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24. A stone of mass m is tied to an elastic string of negligble mass and spring constant k. The unstretched length of the string is L and has negligible mass. The other end of the string is fixed to a nail at a point p. Initially the stone is at the same level as the point P. The stone is dropped vertically from point P.

(a) Find the distance y from the top when the mass comes to rest for an instant, for the first time.

(b) What is the maximum velocity attained by the stone in this drop?

(c) What shall be the nature of the motion after the stone has reached its lowest point?

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25. (a) Pressure decreases as one ascends the atmosphere. If the density of air is ρ, What is the change in pressure dp over a differential height dh ? (b) Considering the pressure p to be proportional to the density, find the pressure p at a height h if the pressure on the sureface of the earth is p_0. (c) If $p_0 = 1.03 \times 10^5 Nm^{-2}, \rho_0 = 1.29 kgm^{-3}$ and $g = 9.8 ms^{-2}$, at what height will the pressure drop to $(1/10)$ the value at the surface of the earth ? (d) This model of the atmosphere works for relatively small distance. Identify the underlying assumption that limits the model.

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26. Surface tension is exhibited by liquids due to force of attraction between molecules of the liquid. The surface tension decreases with increase in temperature and vanishes at boiling point. Given that the latent heat o vaporisation for water $L_v = 540\text{k cal kg}^{-1}$, the mechanical equivalent of heat $J. 4.2\text{J cal}^{-1}$, density of water $\rho_w = 10^3 kgl^{-1}$, Avagardro's number $N_A = 6.0 \times 10^{26}\text{Kmole}^{-6}$ and the molecular weight of water $M_A = 10$ kg for 1 k mole.

(a) Estimate the energy required for one molecules of water to evaporate.

(b) Show that the inter-molecular distance for water is

$d = \left[\frac{M_A}{N_A} \times \frac{1}{\rho_w}\right]^{1/3}$ and find its values.

(c) 1 g of water in the vapour state at 1 atm occupies $1601 cm^3$. Estimate the inter-molecules distance at boiling point, in the vapour state.

(d) During vaporisation a molecules overcomes a force F, assumed constant, to go from an inter-molecules distance d to d'. Estimate the value of F.

(e) Calculate F/d , which is a measure of the surface tension.

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27. A hot air balloon is a sphere of radius 8 m . The air inside is at a temperature of $60^{\circ} C$. How large a mass can the balloon lift when the outside temperature is $20^{\circ} C$? (Assume air is an ideal gas $R = 8.314 J mole^{-1} K^{-1}, 1 atm. = 1.013 \times 10^{5} Pa$, the membrane tension is $5 Nm^{-1}$)

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28. We would like to perpare a scale whose length does not change with temperature. It is proposed to prepare a unit scale f this type whose length remains, say 10 cm. We can use a bimetallic strip made of brass and iron each of different length (both components) would change in such a way that differnece between theri lenght rermain constant. If $\alpha_{iron} = 1.2 \times 10^{-5}/K$ and $\alpha_{brass} = 1.8 \times 10^{-5}/K$, what should we take as lenght of each strip ?

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29. We would like to make a vessel whose volume does not change with temperature (take a hing from the problem aobve). We can use brass and iron $\left(\beta_{brass} = 6 \times 10^{-5}/K \text{ and } \beta_{iron} = 3.55 \times 10^{-5}/K\right)$ ot create a volume of 100 c c. How do you think you can achieve this.

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30. Calculate the stress developed inside a tooth cavity filled with copper when hot tea at temperature of $57^\circ C$ is drunk. You can take body (tooth) temperature to be $37^\circ C$ and $\alpha_{Cu} = 1.7 \times 10^{-5} / ^\circ C$ bulk modulus for copper $B_{Cu} = 140 \times 10^9 N/m^2$.

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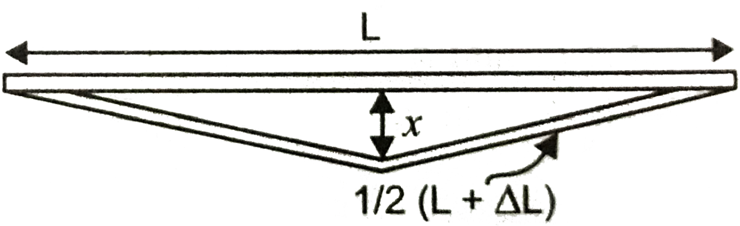
31. A rail track made of steel having length 10 m is clamped on a railway line at its two ends



on a summer day due to rise in temperature by $20^\circ C$, it is deformed as shown in fig. Find x (displacement of the centre) if $\alpha_{steel} = 1.2 \times 10^{-5} / {}^\circ C$.

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32. A thin rod, length L_0 at $0\,^\circ C$ and coefficient of linear expansion α has its two ends mintained at temperatures θ_1 and θ_2 respectively Find its new length .

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33. Ac cording to Stefan' law of radiation, a black body radiates energy σT^4 from its unit surface area every second where T is the surface temperature of the black body and $\sigma = 5.67 \times 10^{-8} W/m^2K^4$ is known as Stefan's constant. A nuclear weapon may be thought of as a ball of radius 0.5 m When detoneted, it reachs temperature of $10^6 K$ and can be treated as a black body. (a) Estimate the power it radiates. (b) if surrounding has water at $30\,^\circ C$ how much water can 10% of the energy produced evaporate in 1s ? $\left[s_w = 4186.0 J/KgK \text{ and } L_\upsilon = 22.6 \times 10^5 J/kg\right]$ (c) If all this energy U is in the form of radiation, corresponding momentum is $p = U/c$. How much momentum per unit time does it impart on unit area at a distance of 1 km ?

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Solved Examples

1. A wire of length 3.0m has a percentage strain of 0.015% under a tensile force.Determine the extension in the wire.

A. 0.60 mm

B. 0.45 mm

C. 0.75 mm

D. 0.90 mm

Answer: B

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2. Calculate the percentage increase in length of a wire of diameter 1 mm stretched by a force of half kilo gram weight. Young's modulus of elasticity of wire is $12 \times 10^{11} dyne / cm^2$

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3. A suructural steel rod has a radius of 10mm and a length of 1m. A 100 kN force stretches it along its length. Calculate (a) the stress (b) elongation, and (c) percentage strain on the rod. Given that the Young's modulus of elasticity of structural steel is $2.0 \times 10^{11} Nm^{-2}$.

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4. A hollow cylindrical column of steel supports a load of 20,000 kg. The inner and the outer radii of the column are 50 cm and 60 cm respectively. Assuming the load distribution to be uniform, calculate the compressional strain of the column. Given, Young's modulus of steel $= 2.0 \times 10^{11} Nm^2$ and $g = 10ms^{-2}$.

A. 7×10^{-16}

B. 2.895×10^{-10}

C. 5.8×10^{-12}

D. 2.895×10^{-6}

Answer: D

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5. Find the greatest length of copper wire, that can hang without breaking. Breaking stress $= 7.2 \times 10^7 N/m^2$. Density of copper $7.2g/cc. \ g = 10m/s^2$.

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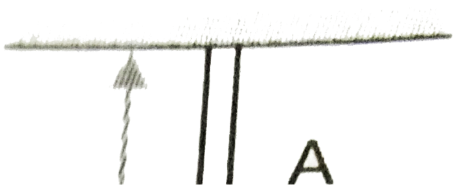
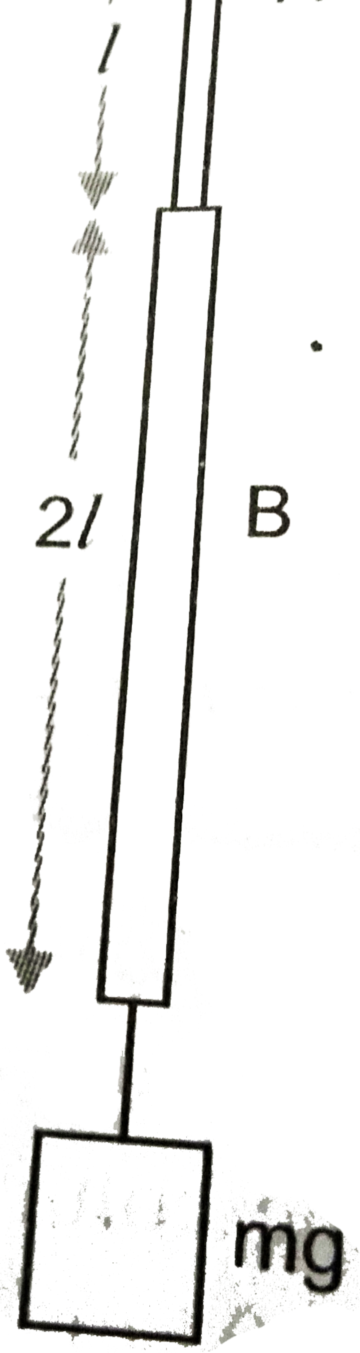
6. Two wire A and B of length l, radius r and length 2l, radius 2r having same Young's modulus Y are hung with a weigth mg, fig. What is the net elonetion in the two wires?





l
2l
B
mg

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7. A composite wire of uniform diameter 3.0 mm consisting of a copper wire of length 2.2m and a steel wire of length 1.6m stretches under a load by 0.7 mm. Calculate the load, given that the Young's modulus for copper is $1.1 \times 10^{11} Pa$ and for steel is $2.0 \times 10^{11} Pa$.

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8. A Copper wire of length 2.2m and a steel wire of length 1.6m, both of diameter 3.0mm are connected end to end. When stretched by a load, the net elongation is found to be 0.70 mm. Obtain the load applied . Young's modulus of copper is $1.1 \times 10^{11} Nm^{-2}$ and Young's modulus of steel is $2.0 \times 10^{11} Nm^{-2}$.

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9. A sphere contracts in volume by 0.02% when taken to the bottom of a sea 2km deep. Find the value of bulk modulus of the material of the sphere. Density of sea water $1g/cc, g = 10ms^{-2}$.

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10. By howmuch the pressure on one litre of water be changed to compress it $0.2\ \%$? Given the bulk modulus of water $-2.2 \times 10^9 Pa$.

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11. A cube is subjected to pressure of $5 \times 10^5 N/m^2$. Each side of the cube is shortened by 1%. Find volumetric strain and bulk modulus of elasticity of cube.

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12. The average depth of indian Ocean is about 3000 m. The fractional compression, $\frac{\Delta V}{V}$ of water at the bottom of the ocean is (Given Bulk modulus of the water $= 2.2 \times 10^9 Nm^{-2}$ and $g = 10 ms^{-2}$)

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13. If the normal density of sea water is $1.00 g/cm^3$, what will be its density at a depth of 4km? Given compressibility of water = 0.00005 per atmosphere. 1 atmospheric pressure $= 10^6 dyne/cm^2, g = 980 cm/s^2$.

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14. A metallic cube of side 8cm is under a tangential force. The top face of the cube is sheared through 0.15 mm with respect to the bottom face. Find (a) shearing stain (b) shearing stress and (c) shearing force.

Given , modulus of rigidity of the metal

$= 2.08 \times 10^{11} dyne. / cm^2$.

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15. Two metal plates are held together by two rivets width radii of 0.2cm. If the maximum shear stress a single rivet can withstand is $5 \times 10^8 Nm^{-2}$, how much force must be applied parallel to the plates to shear off both the rivets?

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16. A square lead slab of side 50 cm and thickness 10 cm is subjected to a shearing force (on its narrow face) of $9 \times 10^4 N$. The lower edge is riveted to the floor. How much will the upper edge be displaced? (Shear modulus of lead $= 5.6 \times 10^9 Nm^{-2}$)

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17. Two parallel and opposite forces each 5000 N are applied tangentially to the upper and lower faces of a cubical metal block of side 25 cm. the angle of shear is (The shear modulus of the metal is 80 Gpa)

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18. Two parallel and opposite forces each 5000 N are applied tangentially to the upper and lower faces of a cubical metal block of side 25 cm. the angle of shear is (The shear modulus of the metal is 80 Gpa)

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19. Calculate the increases in energy of a brass bar of length 0.4 m and cross-sectional are $1cm^2$. When compressed with a load of 4kg wt along its

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20. A steel wire of length 3.0m is stretched through 3.0 mm. the cross-sectional area of the wire is $5.0mm^2$. Calculate the elastic potential energy stroed in the wire in the stretched condition. Young's modulus of steel is $2.0 \times 10^{11} Nm^{-2}$.

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21. When the load on a wire is slowly increased from $3kgwt$ to $5kgwt$, the elongation increases from 0.61 to $1.02mm$. The work done during the extension of wire is

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22. A 45 kg boy whose leg bones are $5cm^2$ in area and 50 cm long falls through a height of 2m with out breaking his leg bones. If the bones can stand a stress of $0.9 \times 10^8 Nm^{-2}$, Calculate the Young's modulus for the material of the bone. Use , $g = 10ms^{-2}$

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23. A 10 kg mass is attached to one end of a copper wire, 3m long and 1 mm in diameter. Calculate the lateral compression produced in it. (Possion's ration is 0.25and Young's modulus, of the metereal of the wire is modulus of the material of the wire is $12.5 \times 10^{10} N/m^2 \big)$.

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24. If the volume of a wire remains constant when subjected to tensile stress, the value of poisson's ratio of material of the wire is

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25. A material has a Poisson's ratio 0.3. If a uniform of it suffers longitudinal strain 4.5×10^{-3}, calculate the percentage change in its volume.

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26. The Young's modulus for steel is $2.0 \times 10^{11} Nm^{-2}$. If the interatomic spacing for the metal is 2.0Å, Find the increases in the interatomic for a force of $10^{9} Nm^{-2}$ and the force constant.

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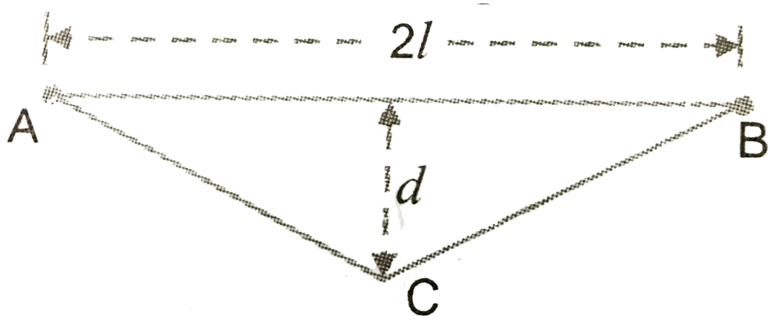
27. A wire of radius r stretched without tension along a straight line is tightly fixed at A and B. fig. What is the tension in the wire when it is pulled in the shape ACB?

Assume Uoung's modulus of material of the wire to by Y.



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28. A steel wire of length 20 cm and unifrom crossection mm^2 is tied rigidly at both the ends. If temperature of the wre is altered from $40\,^{\circ}C$ to $20\,^{\circ}C$, calcutlate the change in tension. Given coeffeicient of linear expansion of steel is $1.1 \times 10^{-5}.\,^{\circ}C^{-1}$ and Young's modulus for steel is $2.0 \times 10^{11} Nm^{-2}$.

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29. What is the density of lead under a pressure of $2.0 \times 10^8 N/m^2$, if the bulk modulus of lead is $8.0 \times 10^9 N/m^2$ and initially the density of lead is $11.4 g/cm^3$?

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30. The two thigh bones (femurs) each of cross-sectional are $10 cm^2$ support the upper part of a human bodu of mass 40 kg . Estimate the average pressure sustained by the femurs. $g = 10 m/s^2$

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31. Find the pressure at the tip of a drawing pin on area $0.2mm$ square if it is pushed against a board with a force of 5 kg wt.

(use $g = 10m/s^2$)

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32. Force on a phonograph needle is 120 gf. The needle end has a circular cross-section of radius 0.1 mm. Find the pressure (in atm) it exerts on the record. Given,

1 atm = $1.013 \times 10^5 Pa. Use g = 10ms^{-2}$

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33. How much pressure will man of weight 60 kg exert on the ground when (a) he is standing on his feet and (b) he is lying on ground. Given that the area of a foot is $100cm^2$ and areaa of the body of a man in contact with ground =$0.6m^2$. Use $g = 10m/s^2$

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34. What is the pressure on a swimmer 10m below the surface of lake? $g = 10ms^{-2}$, atmospheric pressure = $1.01 \times 10^5 Pa$

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35. The density of the atmosphere at sea level is $1.29kg/m^3$. Assume that it does not change with altitude. Then how high would the atmosphere extend ? $g = 9.8ms^{-2}$. Atmospheric pressure $= 1.013 \times 10^5 Pa$.

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36. The base of a ractangular vessel is $10cm \times 15cm$. It is taken at a depth of 4 m into the water. What is the pressure and thrust on the base of the vessel? Take $g = 10ms^{-2}$. Density of water = $10^3 kgm^{-3}$.

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37. A cylinder has a radius 20 cm. To what height should it be filled with water so that thrust in its walls is equal to that on its bottom? Find the mass of water filled in cylinder.

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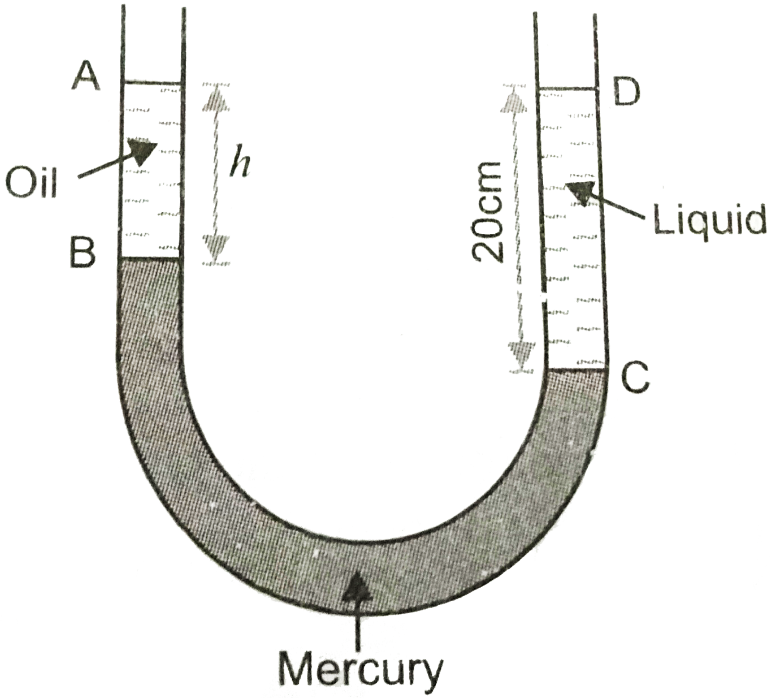
38. Determine height h of oil in the U tube as shown in fig. Density of oil $= 0.9g/cc$, Density of liquid is $1.6g/cc$

and density of mercury. $= 13.6g/c.$



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39. At a depth of 1000 m in an ocean (a) what is the absolute pressure? (b) what is the auge pressure? (c)

Find the force acting on the windown of area $20cm \times 20cm$ of a submarine at this depth, the interior of which is maintained at sea-level atmospheric pressure. The density of sea water is $1.03 \times 10^3 kgm^{-3}$, $g = 10ms^{-2}$. Atmospheric pressure = $1.01 \times 10^5 Pa$.

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40. The average mass that can be lifted by a hydraulic press is 100kg. If the radius of the larger piston is six times that of a smaller poston. What is the minimum force (in kg wt) that must be applieed? Use $g = 10ms^{-2}$.

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41. To lift an automobile of 2000 kg, a hydraulic pump with a large piston 30 cm square in area is employed. Calculate the force that must be applied to pump a small piston of area 10 square cm to achieve it.

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42. In a car lift, compressed air exerts a force F_1 on a small piston having a radius of $0.5cm$. This pressure is transmitted to a second piston of radius 10.0 cm . If the mass of the car to be lifted is 1350 kg. calculate F_1. What is the pressure necessary to ac complish this task?

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43. The area of smaller piston of a hydraulic pressure is $2cm$ square and that of larger piston is 20 cm square. How much weight can be raised on the larger piston when a force 200kg f is exerted on the smaller piston? $g = 10m/s^2$

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44. Two syringes of different cross-sections (with out needles) filled with water are connected with a tightly fitted rubber tube filled with water. Diameters of the smaller pison and larger pistom are 1.0cm and 3.0 cm respectively.

(a) Find the force on the larger piston when a force of

10N is applied to the smaller piston.

(b) The smaller piston is pused in through 6.0 cm, much does the larger piston move out?

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45. A body of mass 6 kg is floating in a liquid with $2/3$ of its volume inside the liquid. Find (i) buoyant force acting on the body and (ii) ratio between the density of the body and density of liquid. Take $g = 10m/s^2$.

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46. A metallic block weighs $15N$ in air. It weights $12N$ when immersed in water and $13N$ when immersed in another liquid. What is the specific gravity of the liquid?

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47. A solid body floating in water has $1/5th$ of its volume above surface of water. What fraction of its volume will project upwards if it floats in a liquid of specific gravity 1.3?

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48. A piece of alloy has a mass 240g in air. When immersed in water, it has an apparent weight of 1.83N and in oil has an apparent weight $2.10N$. Calculate the specific gravity of (a) metal and (b) oil.

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49. A piece of pure gold of density $19.3gcm^{-3}$ is suspected to be hollow inside. It weighs 38.250 g in air and 33.865 g in water. Calculate the volume of the hollow portion of the gold, if any:

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50. A cube of wood floating in water supports a 200g mass resting at the centre of its top face. When the mass is removed, the cube rises 2 cm. find the volume of the cube.

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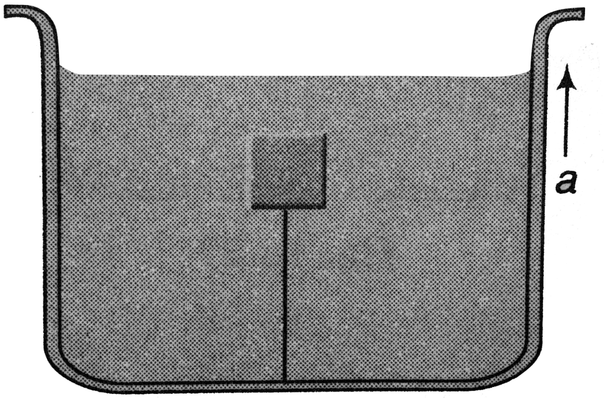
51. The tension in a string holding a solid block below the surface of a liquid (of density greater than that of solid) as shown in figure is T_0 when the system is at rest. What will be the tension in the string if the system has an upward acceleration a?



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52. A jeweller claims that he sells ornaments made of pure gold that has the relative density of 19.3. he cells an ornament weighing $20.250gf$ to a person. The clever person weighs the ornament immersing it in pure water and find it weights 19.075 gf. Is teh ornaments made of pure gold? what is the percentage of impurty in the ornament if any?

View Text Solution

53. A liquid drop of mass $0.0129g$ drips from a capillary. When the drop breaks away, the diameter of the neck of capliiary is 1mm. Find surface tension of liquid.

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54. (a) there is a rectangular frame of wir measuring $20cm \times 13cm$. Calculate (i) the perimeter of the square and (ii) radius of the circle, which will have the same

perimeter as the rectangular frame, (b) shown that of the three, the circle has the maximum surface area.

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55. A glass plate of length 10 cm, breadth 4 cm, and the thickness 0.4cm , weighs 20g in air. It is held vertically with long side horizontal and half the plate immersed in water. What will be its apparent weight? Surface tension of water = $70 dyne / cm$.

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56. Calculate the energy evolved when 8 droplets of water (surface tension $0.072 Nm^{-1}$) of radius $1.2mm$ each combine into one.

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57. Find the work done in blowing a soap bubble of surface tension $0.06 Nm^{-1}$ from 2 cm radius to 5 cm radius.

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58. Two mercury droplets of radii 0.2 cm and 0.4 cm collapse into one single drop. What amount of energy is released? The surface tension of mercury $440 \times 10^{-3} Nm^{-1}$ and $g = 10 ms^{-2}$.

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59. If the excess pressure inside a spherical soap bubble of radius 1 cm is balanced by that due to column of oil of specific gravity 0.9, height 1.36 mm. Calculate the value of surface tension of soap solution.

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60. A glass tube of 1 mm bore is dipped vertically into a container of mercury, with its lower end 5 cm below the mercury surface. What must be the gauge pressure of air in the tube to a hemispherical bubble at its lower end? Given density of mercury $= 13.6 \times 10^3 kg/m^3$, surface tension of mercury = $440 \times 10^{-3} Nm^{-1}$ and $g = 10 m/s^2$

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61. What will be the total pressure inside a spherical air bubble of radius 0.2 mm at a depth of 2m below the surface of a liquid of density $1.1 g/cm^3$ and surface tension $50 dyne/cm$. Atmospheric pressure is $1.01 \times 10^5 Nm^{-2}$.

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62. The lower end of a capillary tube of diameter 2.0 mm is dipped 8.00cm below the surface of water in a beaker. What is the pressure required in the tube in order to blow a hemispherical bubble at its end in water? The surface tension of water at temperature of the experiments is $7.30 \times 10^{-2} Nm^{-1}$. 1 atmospheric pressure =$1.01 \times 10^5 Pa$, density of water $= 1000 kg/m^3, g = 9.80 ms^{-2}$. also calculate the excess pressure.

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63. Water rises in a capillary tube upto a certain height such that the upward force of surface tension balances the force of $75 \times 10^{-5} N$ due to weight of the liquid. If surface tension of water is $6 \times 10^{-2} Nm^{-1}$, what must be the internal circumference of the capillary tube?

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64. Liquid rises to a height of 5.0 cm in a capillary tube and mercury falls to a depth of 2.0 cm in the same capillary tube. If the density of liquid is $1.2 g/cc$, of mercury is $13.6 g/cc$ and angles of contact of liquid and mercury with capillary tube are 0° and 135°

respectively. find the ratio of the surface tension for mercury and liquid.

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65. The tube of mercury barometer is 4mm in diameter. How much error does the surface tension cause in the reading? Surface tension of mercury = $540 \text{ cc } 10^{-3} Nm^{-1}$, angle of contact = $135°$. Density of mercury $= 13.6 \times 10^{33} kgm^{-3}$.

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66. A U tube is supported with its limbs vertical and is partly filled with water. If the inner diameter of the limbs are 1cm,and 0.01 cm , respectively, what will be the difference in height of water in the two limbs? S.T. or water $70 \times 10^{-3} Nm^{-1}$. Angle of contact , $\theta = 0°$.

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67. Two soap bubbles of radii 4cm and 6 cm are in contact with each other. What is the radius of the common boundary?

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68. A stream line body with relative density ρ_1 falls into air from a height h_1 on the surface of a liquid of realtive density ρ_2, where $\rho_2 > \rho_1$. Find the time of immersion of the body into the liquid.

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69. A body weighs W_1 in a liquid of density ρ_1 and W_2 in a liquid of density ρ_2. What is the weight of body in a liquid of density ρ_3?

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70. A vessel contains oil (density $= 0.8 gm/cm^3$) over mercury (density $= 13.6 gmcm^3$). A homogeneous sphere floats with half its volume immersed in mercury and the other half in oil. The density of the material of the sphere in gm/cm^3 is

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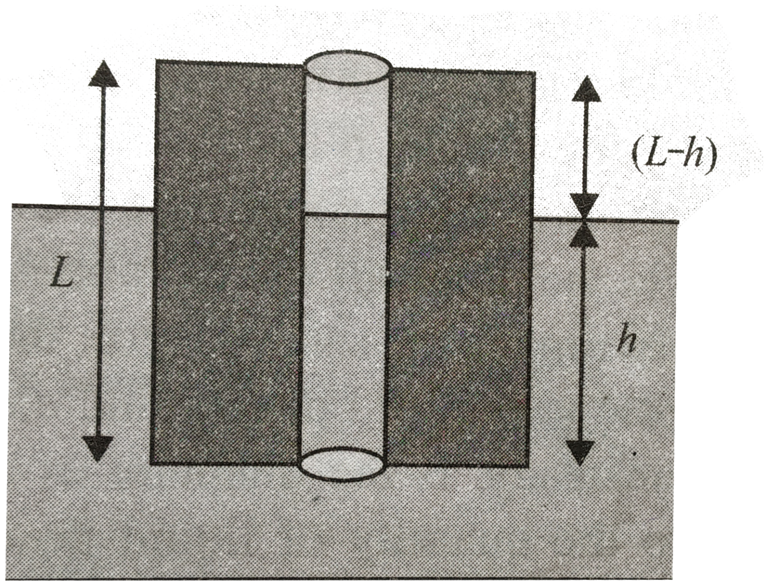
71. A large block of ice $5m$ thick has a vertical hole drilled through it and is floating in the middle of a lake. What is the minimum length of a rope required to scoop up a bucket full of water through the hole? Relative density of ice $= 0.9.$



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72. Two soap bubble of radii r_1 and r_2 combime to form a single bubble of radius r under isothermal conditions .

If the external pressure is P, prove that surface tension of soap solution is given by $S = \frac{P\left(r^3 - r_1^3 - r_2^3\right)}{4\left(r_1^2 + r_2^2 - r^2\right)}$.

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73. A plate of metal 10 cm sq. rests on a layer of caster oil 2mm thick whose coefficient of viscosity is $15.5 dyne cm^{-2} s$. Calculate the horizontal force required to move the plate with a speed of $3 cm s^{-1}$. Also calculate strain rate and shearing strees.

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74. A square plate of 20 cm side moves over another plate with velocity $5cms^{-1}$, both plates immersed in water. If the viscous force is $0.205gf$ and viscosity of water is 0.01 poise, what is the separation between the plates?

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75. A circular metal plate of radius 6 cm rests on a layer of caster oil 1.5 mm thick, whose coefficient of viscosity is 15.5 poise. Find the horizontal force (in kg wt) required to move the plate with a speed of $60ms^{-1}$.

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76. A metal plate of area $0.10m^2$ is connected to a $0.01kg$ mass via a string that passes over an ideal pulley (considered to be friction-less), as shown in the figure. A liquid with a film thickness of $3.0mm$ is placed between the plate and the table. When released the plate moves to the right with a constant speed of $0.085ms^{-1}$. Find the coefficient of viscosity of the liquid.

Watch Video Solution

77. In giving a patient a blood transfusion, the bottle is set up so that the level of blood is 1.3 m above the needle, which has an internal diameter of 0.36 mm and 3 cm in length . If $4.5cm^3$ of blood passes through the meedle in one minute, calculate the viscosity of blood. The density of blood is 1020 kg m^{-3}.

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78. Two capillary tubes AB and BC are joined end to end at B, AB is 16cm long and of diameter 4mm whereas BC is 4cm long and of diameter 2mm. The composite tube is held horizontally with A connected to a vessel of water giving a constant head of 3cm and C is open to the air. Calculate the pressure difference between B and C.

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79. A capillary tube of 2 mm diameter and 20 cm long is fitted horizontally to a vessel kept full of alcohol of density $0.8 g/cm^3$. The depth of the centre of capillary tube below the free surface of alcohol is 30 cm. If viscosity of alchole is 0.112 poise, find the amount that will flow in 5 minutes.

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80. A rain drop of radius 0.4 mm falls through air with a terminal velocity of $50 cms^{-1}$. The viscosity of air is 0.019 Pa-s`. Find the viscous force on the rain drop.

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81. The velocity of a small ball of mass 10 g and density $7.8g/cc$. When dropped in a container filled with glycerine becomes constant after some time. If the density of glycerine is $1.3g/cc$. What is the viscous force acting on the ball?

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82. In Millikan's oil experiement, what is the terminal velocity of a liquid droplet of radius 0.02 mm and density $1.2g/cc$. Take the viscosity of air the temperature of the experiment to be $1.8 \times 10^{-5} Nm^{-2}s$. Find the viscous force on the broplet at the given velocity. Neglect the buoyancy of the droplet due to air.

Watch Video Solution

83. A drop of water of radius 0.001 mm is falling in air. If the coeffcient of viscosity of air is $1.8xcx10^{-5}kgm^{-1}s^{-1}$, what will be the terminal velocity of the drop? Neglect the density of air.

Watch Video Solution

84. Find the terminal velocity with which an air bubble of density $1kgm^{-3}$ and 0.6 mm in diameter will rise in a liquid of viscosity $0.15Nm^{-2}s$ and of specific gravity 0.9 ? What is the teminal velocity of the same bubble in water of coefficient of viscosity $10^{-3}Nm^{-2}s$?

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85. With what terminal velocity will an air bubble $0.8mm$ in diameter rise in a liquid of viscosity $0.15N - s/m^2$ and specific gravity 0.9? Density of air is $1.293kg/m^3$.

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86. Eight spherical rain drops of equal size are falling vertically through air with a terminal of $0.10ms^{-10}$. What should be the velocity if these drops were to combine to form one large spherical drop?

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87. The flow rate of water from a tap of diameter 1.25 cm is $0.48L/min$. The coefficient of viscosity of water is $10^{-3}Pa - s$. After sometime, the flow rate is increased to $3L/min$. Characterise the flow for both the flow rates.

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88. What should be the average velocity of a water in a tube of radius 0.005m, so that the flow is just turbulent? The viscosity of water is 0.001 Pa-s.

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89. Water flows through a horizontal pipe of varying cross-section at the rate of 20 litres per minuts , determine the velocity of water at a point where diameter is $4cm$

Watch Video Solution

90. Water flow througyh a horizontal pipe whose internal diameter is $2.0cm$ at a speed of $1.0ms^{-1}$ What should be the diameter of the nozzle, If the water is to emerge at a speed of $4.0ms^{-1}$?

Watch Video Solution

91. A liquid is flowing through a horizontal pipe line of varying cross - section .At a certin point the diameter of the pipe is $6cm$ and the velocityof flow of liquid is $2.0cms^{-1}$ Calculate the velocity of flow at another point where the diameter is `1.5 cm.

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92. At what speed will the velocity head of a stream of water be equal to 20 cm of mercury . Taking $\left(g = 10ms^{-2}\right)$.

Watch Video Solution

93. Calculate the total energy per unit mass possessed by water at a point, where the pressure is 10 gh f//sq mm, velocity is $0.1ms^{-1}$ and height of water level from the graund is $0.20m\left(g = 9.8ms^{-2}\right)$.

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94. Water at a pressure of $4 \times 10^4 Nm^{-2}$ flows at $2ms^{-1}$ through a horizontal pope of $0.02m^2$. What is the pressure in the smaller cross-section of the pipe?

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95. The reading of pressure meter attached with a closed pipe is $3.5 \times 10^5 Nm^{-2}$. On opening the value of the pipe, the reading of the pressure meter is reduced to $3.0 \times 10^5 Nm^{-2}$. Calculate the speed of the water flowing in the pipe.

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96. An aeronautical engineer observed that on the upper and the lower surface of the wing of an aeroplane the speed of the air are $120 ms^{-1}$ and $90 ms^{-1}$ respectively during flight. What is the lift on the wing of aeroplane if its area is $3.2m^2$? Given density of air is $1.29 kg/m^3$.

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97. Calculate the minimum pressure required to force the blood from the heart to the top of the head (vercical distance = 40 cm). Assume that the denisity of blood to be $1.04 gcm^3$. Friction is to be neglected.

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98. The cross-sectional area of water pipe entering the basement is $4cm^{-2}$. The pressure at the point is $3.5 \times 10^5 Nm^{-2}$ and the speed of water is $2.2ms^{-1}$. This pipe tapers to a cross-sectional area of $2cm^2$ when it reaches the second floor 10 m above . Calculate the speed and pressure at the second floor. use $g = 10m/s^2$.

Watch Video Solution

99. A drum of 40 cm radius has a capacity of $440dm^3$ of water. It contains $396dm^3$ of water and is palece on a solid block of exactly the same size as of drum. If a small hole is made at lower end of the durm perpenduclar to its length , find the horizontal range of water on the ground in the beginning. given $g = 10m/s^2$.

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100. Find the velocity of efflux of water from an oriffice near the bottom of a tank in which pressure is $500gf/sq$ cm above atmosphere.

Watch Video Solution

101. Water from a tap emerges vertically downward with an initial speed of $1.0ms^{-1}$. The cross-sectional area of the tap is $10^{-4}m^2$. Assume that the flow is steady. What is the cross-sectional area of the stream 0.15 m below the tap? Use $g = 10ms^{-2}$.

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102. The diameter of a pipe at two points , where a venturimeter is connected is 8 cm and 5 cm and the difference of levels in it is 4 cm. Calculate the volume of water flowing through the pipe per second.

Watch Video Solution

103. The flow of blood in a large artery of an anaeshetized dog is diverted throg]ugh a venturimeter. The wider part of the meter has a cross sectional area equal to that of the artery i.e. $8mm^2$. The narrower parts has an are $4mm^2$. The pressure dorp in the artery is $24Pa$. what is the speed of the blood in the artery ? Given that density of the blood = $1.06 \times 10^3 kg/m^3$

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104. A sphere is dropped under gravity through a fluid of viscosity η. Taking the average ac celeration as half of the initial ac celeration, show that the time to attain the terminal velocity is independent of the fluid density.

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105. A garden hose having an internal diameter 2.0 cm is connected to a lawn sprinkle that consists of an enclosure with 24 holes , each 0.125 cm in diameter. If water in the hose has a speed of $90.0cms^{-1}$, find the speed of of $90.0cms^{-1}$, find the speed of the water having the sprinkler hole.

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106. A fully loaded Boeing aircraft has a mass of $3.3 \times 10^5 kg$. Its total wing area is $500 m^2$. It is in level flight with a speed of $960 km/h$.

(a) Estimate the pressure difference between the lower and upper surfaces of the wings

(b) Estimate the fracitional increases in the speed of the air on the upper surfaces of the wing relative to the lower surface. The density of air is $1.2 kg/m^3$.

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107. Water flows through a capillary tube of radius r and length l at a rate of 40 mL per second, when connected to a pressure difference of h cm of water. Another tube of the same length but radius $r/2$ is conncected in series with this tube and the combination is connected to the same pressure head. Calculate the pressure difference across each tube and the rate of flow of water through the combination.

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108. A cylinderical tank of height 0.4 m is open at the top and has a diameter 0.16m. Water is filled in it up to height of 0.16 m. Find the time taken to empty the tank through a hole of radius $5 \times 10^{-3} m$ in its bottom.

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109. consider a cylinder of radius R. At its bottom, there is a hole of radius r. the cylinder is filled upto the height h and the hole is opened. If t is the time in which the cylinder is emptied, then find the relation between t and h.

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110. At what temperature , If any do the following pairs of scales given the same reading

(a) Celslus and Fahrenhelt?

(b) Fahrenhelt and kelvin?

Watch Video Solution

111. A celsins and faren hite thermometer are put in an oil bath The reading on farembile thermometer is $3/2$ times the reading on celsius thermometer .What is the temperature of both on celsins, farenhelt and kelvin 's scales

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112. A thermometer has wrong calibration it recordes the melting point of ice -$5^{\circ}C$ If reads $55^{\circ}C$ instend of $50^{\circ}C$ Find the temperature of holding point of water on the given scale

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113. A brass disc has a hole of diameter 2.5 cm at $27\,^{\circ}C$. Find the change in the diameter of the hole of the disc when heated to $327\,^{\circ}C$. Given coefficient of linear expansion of brass = $1.9 \times 10^{-5}.\,^{\circ}C^{-1}$

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114. How much should the temperature of a brass rod be increased so as to increse its length by $1\,\%$? Given α for brass is $0.00002.\,^{\circ}C^{-1}$.

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115. Railway lines are laid with gaps to allow for expansion. If the gap betweeen steel rails 60 m long be 3.60 cm at $10\,^{\circ}C$, then at what temperature will the lines just touch? Coefficient of linear expansion of steel $= 11/10^{-6}.\,^{\circ}C^{-1}$.

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116. Show that the coefficeint of area expansions $(\Delta A/A)/\Delta T$ of a rantangular sheet of the solid is twice its linear expansitivity α.

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117. A blacksmith fixes iron ring on the rim of the wooden wheel of a bulkock cart. The diameter of the rim and the ring are $5.243m$ and $5.231m$ respectively at $27^\circ C$. To what temperature should the ring be heated so as to fit the rim of the wheel ? Coefficient of linear expansion of iron =$1.20 \times 10^{-5} K^{-1}$

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118. What should be the length of steel and copper rods at $0^\circ C$ that the length of steel rod is 5 cm longer than copper at all termperature? Given $\alpha_{Cu} = 1.7 \times 10^5 . ^\circ C^{-1}$ and $\alpha_{steel} = 1.1 \times 10^5 . ^\circ C^{-1}$.

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119. A tooth cavity is filled with a copper having coefficient of linear expansion $1.7 \times 10^{-5} . ^\circ C^{-1}$ and bulk modules $1.4 \times 10^{11} Nm^{-2}$. The temperature of the tooth $3. ^\circ C$. Calculate the thermal stress developed inside the tooth cavity when hot milk at temperature of $60. ^\circ C$ is drunk.

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120. An iron sphere of radius $10cm$ is at temperature , $10 ^\circ C$. If the sphere is heated upto temperature $110 ^\circ C$, find the change in the volume of the sphere coefficient of linear expansion of iron = $11 \times 10^{-6} . ^\circ C^{-1}$

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121. A 1-L flask contains some mercury. It is found that at different temperature, the volume of air inside the flask remains the same. What is the volume of mercury in the flask, given that the coefficient of linear expansion of glass $= 9 \times 10^{-6} / {}^{\circ}C$ and the coefficient of volume expansion of $Hg = 1.8 \times 10^{-4} / {}^{\circ}C$?

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122. The water of mass 75 g at $100\,{}^{\circ}C$ is added to ice of mass $20g$ at $-15\,{}^{\circ}C$. What is the resulting temperature. Latent heat of ice = $80 cal/g$ and specific heat of ice = 0.5.

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123. Calculate the heat required to convert 3 kg of ice at $-12^{\circ}C$ kept in a calorimeter to steam at $100^{\circ}C$ at atmospheric pressure. Given,

specific heat capacity of ice = $2100 Jkg^{-1}K^{-1}$

specific heat capicity of water = $4186 Jkg^{-1}K^{-1}$

Latent heat of fusion of ice = $3.35 \times 10^{5} Jkg^{-1}$

and latent heat of steam = $2.256 \times 10^{6} Jkg^{-1}$.

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124. A sphere of alumininum of mass 0.047 kg placed for sufficient time in a vessel containing boling water, so that the sphere is at $100\,^{\circ}C$. It is then immediately transferred to 0.14 kg copper calorimeter containing 0.25 kg of water at $20\,^{\circ}C$. The temperature of water rises and attains a steady state at $23\,^{\circ}C$. calculate the specific heat capacity of aluminum. Specific heat capacity of copper = $0.386 \times 10^{3} Jkg^{-1}K^{-1}$.

Specific heat capacity of water = $4.18 \times 10^{-3} Jkg^{-1}K^{-1}$

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125. When 0.15 kg of ice at $0\,^{\circ}C$ is mixed with 0.30 kg of water at $50\,^{\circ}C$ in a container, the resulting temperature is $6.7\,^{\circ}C$. Calculate the heat of fusion of ice. $\left(s_{water} = 4186 Jkg^{-1}K^{-1}\right)$

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126. How many grams of ice at $-14.^{\circ}C$ are needed to cool 200 gram of water form $25.^{\circ}C$ to $10.^{\circ}C$? Take specific heat of ice $= 0.5 cal g^{-1}.^{\circ}C^{-1}$ and latant heat of ice = $80 cal g^{-1}$.

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127. How much metres can a 50 kg man climbs by using the energy from a slice of a bread which produces 420 kJ heat? Assuming that the human body effciency working is 30%. Use $g = 10 m/s^2$.

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128. A gaeyser heats water flowing at the rate of 3 kg per minute from $27\,^{\circ}C$ to $77\,^{\circ}C$. If the geyser operates on a gas burner, what is the rate of consumption of fuel if the heat of combustion is $4 \times 10^4 J/g$? Given specific heat of water is $4.2 \times 10^3 J/kg/K$.

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129. What amount of heat must be supplied to $2 \times 10^{-2} Kg$ of nitrogen at room temperature to rise its temperature by $45\,^{\circ}C$ at constant pressure? Given molecular mass of nitrogen is 28 and $R = 8.3 J mole^{-1} K^{-1}$

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130. Calculate the difference between the two principal specific heats of 2 gram of hilium gas at S.T.P. Given atomic weight of hilium = 4 and $J = 4.186 Jcal^{-1}$ and $R = 8.31 Jmol^{-1}K^{-1}$.

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131. Calculate the specific heat capacity at constant volume for a gas. Given specific heat capacity at constant pressure is $6.85 calmol^{-1}K^{-1}, R = 8.31 Jmol^{-1}K^{-1}$.

$J - 4.18 Jcal^{-1}$.

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132. Specific heat of argon at constant pressure is $0.125 cal. g^{-1} K^{-1}$, and at constant volume $0.075 cal. g^{-1} K^{-1}$. Calculate the density of argon at N.T.P. Given $J = 4.18 \times 10^7$ erg cal^{-1} and normal pressure = 1.01×10^6 dyne cm^{-2}.

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133. The difference between the two specific heat capacities (at constant pressure and volume) of a gas is $5000 Jkg^{-1} K^{-1}$ and the ratio of these specific heat capacities, i.e., C_V and C_p.

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134. The height of Niagra falls is 50 m. Calculate the difference in temperature of water at the top and at the bottom of fall, if $J = 4.2 Jcal^{-1}$.

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135. Calculate heat of combustion of coal, when 0.5kg of coal on burning raise the temperature of 50 liters of water from $20^{\circ} C$ to $90^{\circ} C$

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136. The heat of combustion of ethane gas at 373 k cal per mole. Assume that 50% of heat is useful, how many be burnt litres to convert 60 kg of water at $20^{\circ} C$ to steam at $100^{\circ} C$? One mole of gas oc cupies 22.4 litre at S.T.P. Latent heat of steam = $2.25 \times 10^6 Jkg^{-1}$.

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137. Calculate the rate of loss of heat through a glass window of area $1000cm^2$ and thickness 0.4 cm when temperature inside is $37^{\circ} C$ and outside is $-5^{\circ}\big)C$. Coefficient of thermal conductivity of glass is $2.2 \times 10^{-3} cals^{-1} cm^{-1} K^{-1}$.

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138. A metal rod of length 20 cm and diamter 2 cm is convered with a non conducting substance. One of its ends is maintained at $100\ ^\circ C$, while the other end is put at $0\ ^\circ C$. It is found that 25 g ice melts in 5 min. calculate the coefficient of thermal conductivity of the metal. Latent that of ice = $80calg^{-1}$.

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139. A cubical ice box of side 50 cm has a thickness of 5.0 cm. if 5 kg of ice is put in the box, estimate the amount of ice remaining after 4 hours. The outside temperature is $40\ ^\circ C$ and coefficient of thermal conductivity of the material of the box = $0.01 Js^{-1} m^{-1} . ^\circ C^{-1}$. Heat of fusion of ice = $335 Jg^{-1}$.

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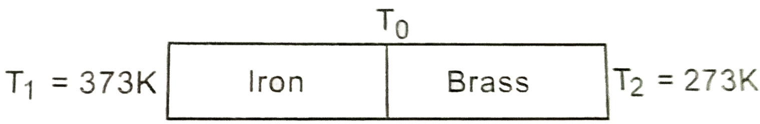
140. An iron bar ($L_1 = 0.1m, A_1 = 0.02m^2, K_1 = 79 Wm^{-1}K^{-1}$) and a brass bar $\left(L_2 = 0.1m, A_2 = 0.02m^2, K_2 = 109 Wm^{-1}K^{-1}\right)$ are soldered end to end as shown in fig. the free ends of iron bar and brass bar are maintained at 373 K and 273 K respectively. Obtain expressions for and hence compute (i) the temperature of the juction of the two bars, (ii) the equivalent thermal conductivity of the compound bar and (iii) the heat current through the compound bar.



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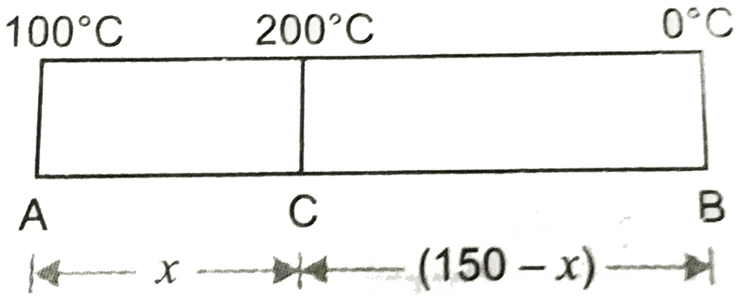
141. One end of a copper rod of uniform cross-section and length 150 cm is in contact with ice and the other end with water at $100^\circ C$. At what point along its length should a temperature of $200^\circ C$ be maintained so that in steady state, the mass of the ice melting is equal to that of steam produced in the same interval of time? Assume that whole system is insulated from the surroundings. Latent heat of steam $=537 cal g^{-1}$ and lalent heat of fusion of ice $= 80 cal g^{-1}$.



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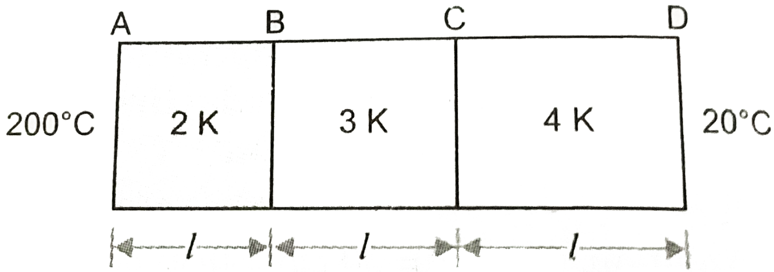
142. Three bars of equal lengths and equal area of cross-section are connected in series fig. their thermal conducitives are in the ratio $2:3:4$. If at the steady state the open ends of the first and the last bars are at temperature $200\,^{\circ}C$ and $20\,^{\circ}C$ respectively, find the temperature of both the junctions.



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143. An electric heater is used in a room of total wall area $137 m^2$ to maintain a temperature of $+20\ ^\circ C$ inside it when the outside temperature is -$10\ ^\circ C$. The walls have three different layers materials . The innermost layer is of wood of thickness 2.5 cm, in the middle layer is od cement of thickness 1.0 cm and the outermost layer is of brick of thickness 25.0 cm. find the power of the electric heater. Assume that there is no heat loss through the floor and the ceiling. The thermal conductives of wood, cement and brick are $0.125, 1.5$ and $1.0wa/m/.^{\circ}C$ respectively.

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144. A body initially at $64^{\circ}C$ cools to $52^{\circ}C$ in 5 minutes. The temperature of surroundings is $16^{\circ}C$. Find the temperature after furthre 5 minutes.

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145. A body initially at $80^\circ C$ cools to $64^\circ C$ in 5 minutes and to $52^\circ C$ in 10 minutes. What is the temperature of the surroundings?

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146. A pan filled with hot food cools from $94^\circ C$ to $86^\circ C$ in 2 minutes when the room temperature is at $20^\circ C$. How long will it take to cool from $71^\circ C$ to $69^\circ C$? Here cooling takes place ac cording to Newton's law of cooling.

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147. A body cools in 7 minutes from $60^{\circ}C$ to $40^{\circ}C$. What will be its temperature after the next 7 minutes? The temperature of the surrounding is $10^{\circ}C$. Assume that Newton's law of cooling holds good throughout the process.

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148. Calculate the temperature (in K) at which a perfect black body radiates energy at the rate of $5.67 Wcm^{-2}$. Given $\sigma = 5.67 \times 10^{8} Wm^{-2}K^{-4}$.

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149. The temperature of a body in increased from $27^\circ C$ to $127^\circ C$. By what factor would the radiation emitted by it increase?

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150. Due to change in main voltage, the temperature of an electric bulb rises from 3000K to 4000K. What is the percentage rise in electric power consumed?

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151. Determine the surface area of the filament of a 100W incandescent lamp radiating out its labelled power at 3000K. Given $sigam = 5.7 \times 10^{-8} Wm^{-2} K^{-4}$, and emissivity ε of the material of the filament = 0.3.

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152. An indirectly heated filament is radiating maximum energy of wavelength $2.16 \times 10^{-5} cm$. Find the net amount of heat energy lost per second per unit area, the temperature of the surrounding air is $13^{\circ} C$. Given $b = 0.288 cm - K. \sigma = 5.77 \times 10^{-5} erg/s - cm^2 - K^4$).

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153. A room heater is made of 10 polished thin walled tubes of copper, each one meter long are 5cm in diameter. If hot water at $70\,^{\circ}C$ circulates constantly through the tubes, calculate the amount of heat radiated in an hour in a room where the average temperature is $15\,^{\circ}C$. Emissivity of copper = $4 \times 10^{-2} cal/degree/\sec/sq.\,metre.$

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154. Calculate the maximum amount of heat which may be lost per second by radiation by a sphere 14cm in diameter at a temperature of $227\,^{\circ}C$, when placed in an enclosure at $27^\circ C$. Given Stefan's constant = $5.7 \times 10^{-8} Wm^{-2}K^{-4}$.

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155. A man, the surface area of whose skin is $2m^2$, is sitting in a room where air temperature is $20^\circ C$ if his skin temperature is $28^\circ C$ and emissivity of his skin equals 0.97, find the rate at which his body loses heat.

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156. Light from the moon, is found to have a peak (or wevelenght of maximum emission) at $\lambda = 14 \mu m$. Given that the Wien's constant b equals $2.8988 \times 10^{-3} mK$, estimate the temperature of the moon.

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157. The surface temperature of the hot body is $1127\,^{\circ}C$ find the wavelenght at which it radiates maximum energy. Given Wien's constant = 0.2898 cm K. To which spectrum region this wavelength belongs?

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158. A layer of ice 29 cm thick has formed on a pond. The temperature of air is $-10\,^{\circ}C$. Find how long will it take for another 0.1 cm layer of water to freeze? Conductivity of ice = $2.1 Js^{-1}m^{-1}K^{-1}$. Latent heat capacity of ice $= 3.36 \times 10^5 Jkg^{-1}$ and density of ice $= 1000 kgm^{-3}$.

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159. A room heater is made of 10 polished thin walled tubes of copper, each one meter long are 5cm in diameter. If hot water at $70\,^\circ C$ circulates constantly through the tubes, calculate the amount of heat radiated in an hour in a room where the average temperature is $15\,^\circ C$. Emissivity of copper = $4 \times 10^{-2} cal/degree/\sec/sq.\,metre.$

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Conceptual Problems

1. Which one is more elastic rubber or steel? Explain.

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2. A wire stretches by a certain amount under a load. If the load and radius are increased to four times, find the stretch caused in the wire.

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3. The maximum load that a wire can sustain is W. If the wire is cut to half its value, the maximum load it can sustain is

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4. Why is a spring made of steel, not of copper?

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5. A wire of length l and radius r has a weight W and the Young's modulus of elasticity Y. it is suspended vertically from a fixed point. Calculate the increase in length of wire porduced due to its own weight.

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6. The density of a metal at normal pressure is ρ. Its density when it is subjected to an excess pressure p is ρ'. If B is the bluk modulus of the metal, then find the ratio ρ' / ρ.

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7. If F is the breaking force of a wire, what will be the breaking force for (a) two parallel wires of the same size (b) for a single wire of double the thickness?

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8. A uniform pressure P is exerted by an external agent on all sides of a solid cube at temperature $t\,^\circ C$. By what amount should the temperature of the cube be raised in order to bring its volume back to its original volume before the pressure was applied if the bulk modulus is B and co-efficient of volumetric expansion is γ?

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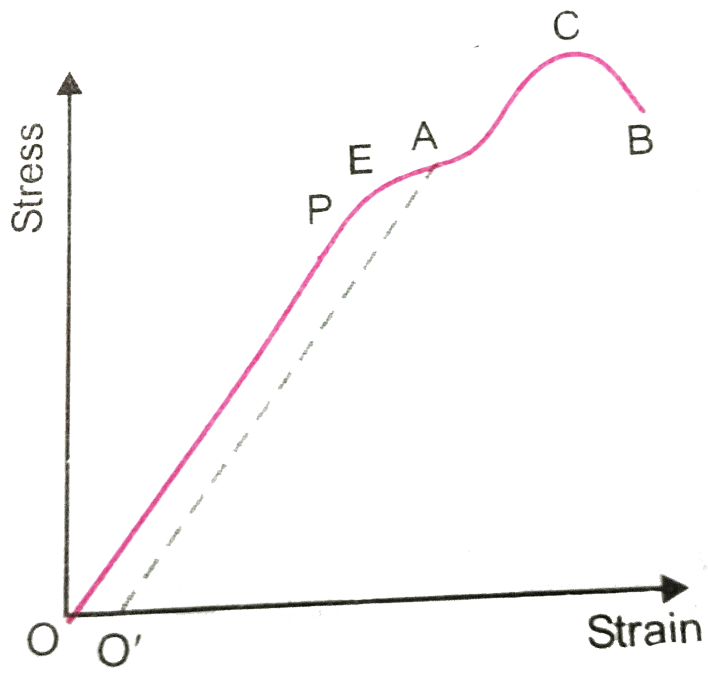
9. The stress strain graph for a metal wire is shown in the fig. Upto the point E, the wire returns to its original state O along the curve EPO, when it is gradually unloaded. Point B corresponds to the fracture of the wire. (a) Upto what point on the curve is Hooke's law obeyed? (this point some times called proportional limits).



(b) Which point on the curve corresponding to elastic limet or yield point of the wire?

(c) Indicate teh elastice and plastic regions of the stree-strain graph.

(d) Describe what happens when the wire is loaded upto a stress corresponding to the point A on the graph and then unloaded gradulally. In particular explain the dotted curve.

(e) Wht is peculiar about the protion of the stree- strain graph from C to B? Upto what stress can the wire be subjected with out causing fracture?

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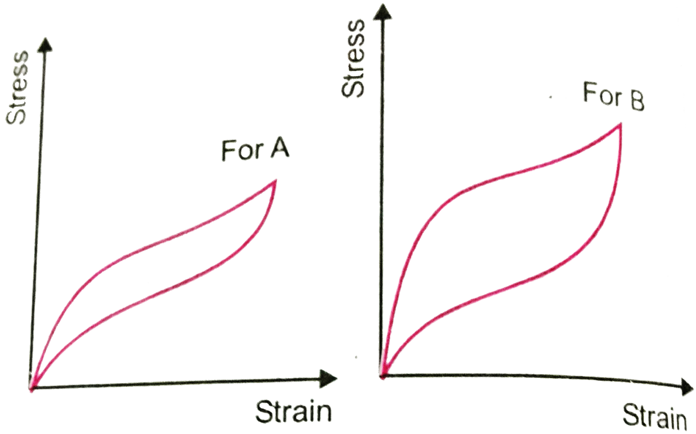
10. Two different types of rubber are found to have the stree-strain curves shown in fig.



(a) In which significant ways do these curves differ form the stree-strain curve of a metal wire.

(b) A heavy machine is to be installed in a factory. To absorb vibrations of the machine, a block of rubber is placed between the machinery and the floor. which of the two rubbers A and B would you perfer to use for this purpose? why?

(c) Which of the two rubber materials would you choose for a car tyre ?

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11. Why are the bridge declared unsafe after long use?

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12. Why a spring balance does not give correct measurements when it has been used for a long time?

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13. A wire gets heated when it is bent back and forth. Why?

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14. Two cylinder A and B of radii r and 2r are soldered co-axially. The free end of A is clamped and the free end of B is twisted by an angle ϕ. Find twist at the junction taking the material of tow cylinders to be same and of equal length.

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15. A matallic wire is stretched by suspending weight to it. If α is the longitudinal strain and Y its Young's modulus of elasticity, shown that the elastic potential energy per unit volume is given by $Y\alpha^2/2$

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16. What is the force on a common man due to atmospheric pressure? Why one does not feel it?

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17. A bottle full of a liquid is fitted with a tight cork. Explain why a slight blow on the cork may be sufficient to break the bottle.

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18. A tank of square cross-section of each side is filled with a liquid of height h . Find the thrust experienced by the vertical surfaces and bottom surface of the tank.

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19. Why is mercury perferred as a barometric substance over water?

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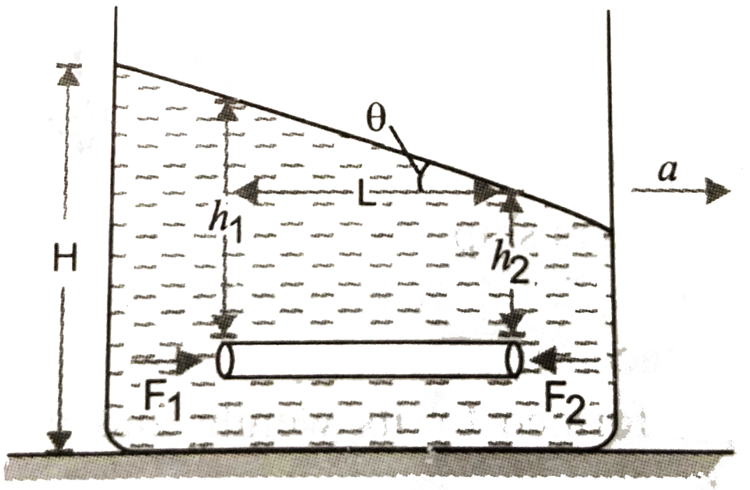
20. What angle will the free surface of a liquid subtend with the horizontal when the liquid in a container is moving horizontally with constat ac celeration a as shown in fig.



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21. A car is to be lifted by a hydraulic jack which consists of two pistons. The large piston is 80 cm in diameter and the smaller piston is 16 cm in diameter. If W is the weight of the car, then how much smaller force is needed on small pistonto lift the car?

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22. A balloon filled with helium does not rise in air indefinitely but halts after a certain height. (Neglect winds). Explain

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23. The force required by a man to move his limgs immersed in water is smaller than the force for the same movement in air.

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24. Ice floats in water with about nine tenths of its volume submerged. What is the fractional volume submerged for an ice berg floating on a fresh water lake of a (hypothetical) planet whose gravity is ten times that of the earth?

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25. What is the fractional volume of an ice cube in a pail of water produced in an enclosure which is freely falling under gravity?

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26. Explain why a small ireon needle sinks in water while a large iron ship floats?

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27. A block of wood floats in a bucket of water in a lift. Will the block sink more of less if the lift starts ac celerating up ?

Watch Video Solution

28. A big size balloon of mass M is held stationary in air with the help of a small block of mass $M/2$ tied to it by a light string such that both float in mid air. Describe the motion of the balloon and the block when the string is cut. Support your answer with calcutations

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29. A man while walking is carrying a fish in the bucket full of water in the other water and thinks, he is now carrying less-weight as weight of fish will reduce due to upthrust. What do you say about it.

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30. Why a sinking ship often turns over as it becomes immeresed in water?

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31. A piece of ice having a stone frozen in it floats in a glass vessel filled with water. How will the level of water in the vessel change when the ice melts?

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32. A body of density ρ is released gently on the surface of a layer of liquid of depth d and density $\rho' (\rho' < \rho)$.

Show that it will reach the bottom of the liquid after a time.

$$\left[\frac{2d\rho}{g(\rho - \rho')}\right]^{1/2}.$$

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33. A small ball of density ρ is immersed in a liquid of density $\sigma(> \rho)$ to a depth h and released. The height above the surface of water up to which the ball will jump is

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34. A body of density ρ floats with volume V_1 of its total volume V immersed in a liquid of density ρ_1 and with the remainder of volume V_2 immersed in another liquid of density ρ_2 where $\rho_1 > \rho_2$. Find the volume immersed in two liquids. (V_1 and V_2).

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35. A razor blade can be made to float on water. What force act on this blade? Is Archimedes principle applicable?

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36. While sewing, a person often wets the end of a thread before, trying to put it through the eys of the needle. Why?

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37. Explain why water can be poured into a bottle with a narrow neck with the aid of glass tube?

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38. Explain why small drops of mercury are spherical and large drops become flat?

Watch Video Solution

39. A shot is obtained by pouring molten lead through narrow holes into water from certain height. The falling lead solidifies and takes the form of small spheres, Explain the phenomenon.

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40. Explain why some oil spread uniformly on water, when other floats as drops?

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41. Why surface tension concept is only held for liquids and not for gases which are also fliuds?

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42. Why an oil drop on a hot cup of soup spreads over when the temperature of the soup falls?

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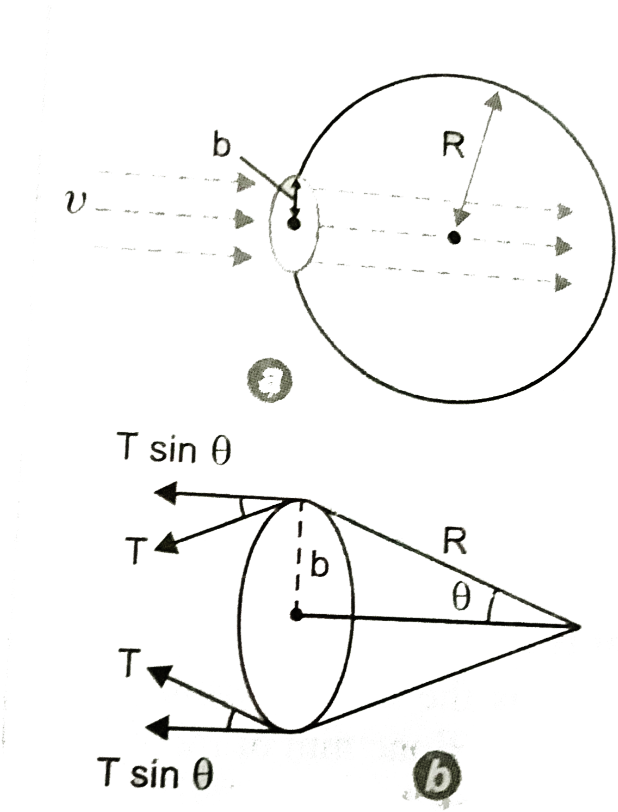
43. A bubble having surface tension T and radius R is formed on a ring of radius b $(b < \ > R)$. Air is blown inside the tube held in front of the ring , with velocity υ

as shown in fig. The air molecules collides perpendicularly with the wall of the bubble and stops. Calculate the radius R at which the bubble and stops. Calculate the radius R at which the bubble separates from the ring.



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44. Why undergarments are usually made of cotton?

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45. Water is depressed in a glass tube whose inner surface is cotated with paraffin wax. Why?

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46. Why does an iron needle float on clean water but sink when some detergent is added to this water?

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47. When one end of a tube of radius r is immersed vertically in a liquid of density ρ, surface tension S, the rise of liquid in the tube is h and angle of contact is θ . If the tube is broken and its length is made $h'(< h)$, then find the value of height of rise of liquid in the tube and angle of contact.

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48. It is better to wash the clothes in hot soap solution. Why?

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49. If a capillary tube is put in water in a weightlessness state, how will the rise of water in a capillary tube will be observed as compared to one under normal condition?

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50. What is the reason that a constant driving force is always required for the maintenance of the flow of oil through the pipe lines in the oil refineries?

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51. Water flows faster than honey. Why?

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52. From where viscous force come about in moving liquids. Discuss the factors on which viscous drag of liquid depends.

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53. Machine parts are jammed in winter. Why?

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54. Why oils of different viscosity are used in different seasons?

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55. Discuss the effect of temperature on the viscosity of liquids and gases.

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56. Explain viscosity. Give some examples. Where is its part being played in nature?

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57. The sides of a horizontal pipe carrying dirty water get dirty. Explain.

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58. Two capillary tubes of equal length and inner radii 2r and 4r respectively are added in series and a liquid flows through it. If the pressure difference between the ends of the whole system is 8.5 cm of mercury, find the pressure difference between the ends of the first capillary tube.

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59. what is the origin of viscous drag on a body falling through a fluid?

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60. Are there some conditions for stoke's law to be obeyed. If no, explaine. If yes mention those conditions .

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61. What is terminal velocity? Discuss the factors on which it depends.

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62. Rain drops falling under gravity do not acquire very high velocity. Why?

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63. Under what conditions, the velocity of a body falling in a medium (i) increases with time (ii) becomes constant with time (iii) becomes zero with time.

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64. What are the qualities of an ideal liquid?

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65. Why dies velocity increase when water flowing in broader pipe enters a narrow pipe?

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66. The shapes of cars and planes are streamlined. Why?

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67. Two row boats moving parallel to each other and near by, are pulled towards each other. Explain.

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68. Ac cording to Bernoulli's theorem the pressure of water should remain uniform in a pipe of uniform

radius. But actually it goes on decreasing, why is it so?

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69. If a small ping pong ball is placed in a vertical jet of water or air, it will rise to a certain geight above the nozzle and will be spinning there.

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70. In an emergency, the vacuum brake is used to stop , the high speed train. How does this vacuume brake work?

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71. A uniform pressure p is exerted on all sides of a solid cube of a meterial at temprature $t^{\circ}C$. By what amount should the temperature of the cube be raised in order to bring its original volume back to the value it had before the pressure was applied ? K is the bulk modulus and α is the coefficient of linear expansion of material of solid cube.

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72. If I is the moment of inertial of a disc about an axis passing through its centre then find the change in moment of inertial due to small change in its moment of inertia due to small change in its temperature Δt. α is the coefficient of linear expansion of disc.

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73. A hollow sphere and a solid sphere of equal radii and of same material are heated to raise their temperature by equal amounts. How will the change in their volume expansion be related?

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74. The triple point of water is a standard fixed point in mordern thermometry. Why?

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75. Why is inver used in making a clock pendulum?

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76. A block of wood is floating in water at $0^{\circ}C$. The temperature of water is slowly raised from $0^{\circ}C$ to $10^{\circ}C$. How will the precentage of volume of block above water level change with rise in temperature?

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77. Two rods, one of aluminium and other made of steel, having initial lenghts l_1 and l_2 are connected together to form a singel rod of length $(l_1 + l_2)$. The coefficient of linear expansions for aluminium and steel are α_a and α_s respectively. If length of each rod increases by same amount when their tempertures are raised by $t\,^\circ C$, then find the ratio $l_1(l_1 + l_2)$.

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78. Is J a physical constant or a conversion factor?

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79. Two bodies at different temperature T_1 and T_2. If brought in thermal contact do not mecesserily settle to the mean temperature $(T_1 + T_2)/2$.

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80. The coolant in a chemical or nuclear plant (i.e. the liquid used to prevent different parts of a plant from getting too hot) should have hight specific heat, comment?

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81. Why burns from steam are more serious than those from boling water?

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82. How does skating is possibel on snow?

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83. Can water be boiled without heating?

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84. Why water is preferred to any other liquid in the hot water bottles?

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85. At the triple point of water wheater the relative amounts of ice, water and vapour fixed or not. Explain.

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86. What happens if water vapour at a pressure of 0.003 atmosphere is cooled to $0^\circ C$?

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87. The ice at $0^{\circ}C$ is converted into steam at $100^{\circ}C$.

State the isothermal changes in the process.

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88. Why do electrons in insulators not contribute to its conductivity?

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89. As air is a bad conductor of heat, whu do we not feel warm without clothes?

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90. Why is it hotter at the same distance over the top of a fire than in front of it?

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91. On a hot day, a car is left in sunlight with all the windows closed. After sometimes, it is found that air inside the car is considerably warmer than the air outside. Explain why?

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92. Why felt is used for thermal insulation in preference to air?

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93. Two rods A and B are of equal length. Each rod has the ends at temp T_1 and T_2 . What is the condition that will ensure equal rates of flow of heat through the rods A and B ?

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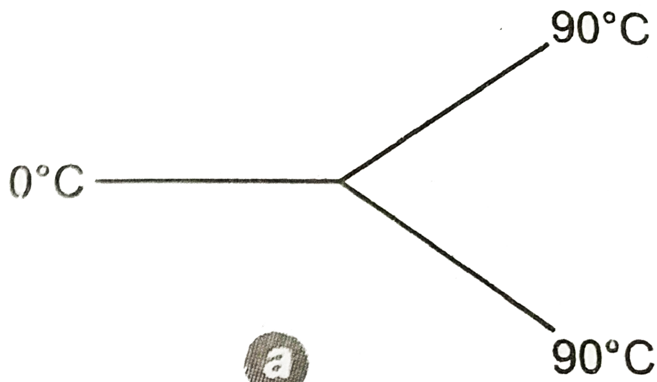
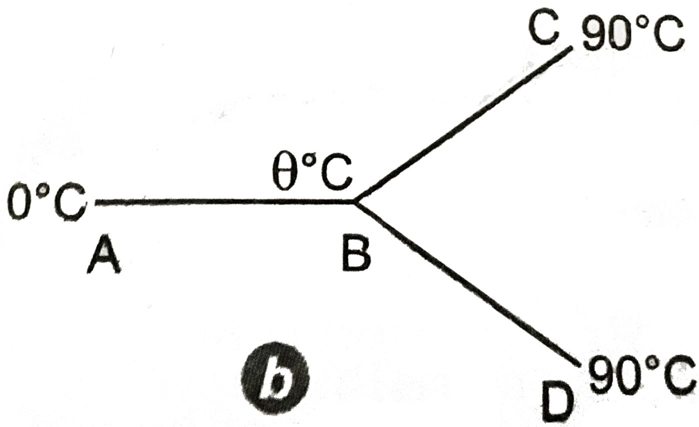
94. Three rods made of same material and having the same cross-section have been joined as shown in fig. each rod is of the same length. The left and the right ends are kept at $0\,^{\circ}C$ and $90\,^{\circ}C$ respectively. What will be the temperature of the junction of the three rods?



a



b

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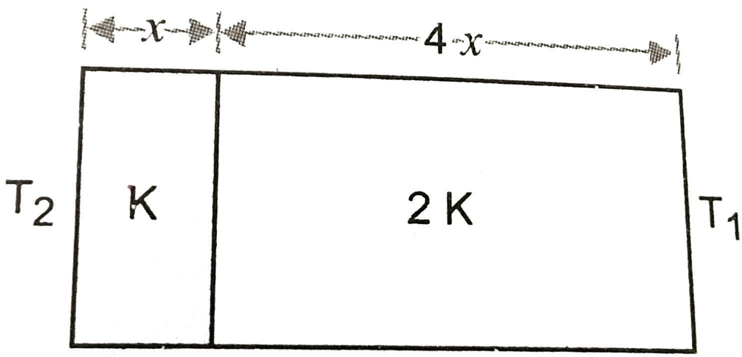
95. The temperature of the two outer surfaces of a composite slab, consisting of two materials having coefficients of thermal conductivity K and 2K and thickness x and 4x respectively. Temperatures on the opposite faces of composite slab are T_1 and T_2 where $T_2 > T_1$, as shown in fig. what is the rate of flow of heat through the slab in a steady state?



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96. If a drop of water falls on a very hot iron, it does not evaporates for a long time. Give reason.

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97. We cannot boil water inside the earth's satellite. Explain.

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98. A sphere of radius r, density,ρ and specific heat s is heated to temperature θ and then cooled in an enclosure at temperature θ_0 . How , the rate of fall of temperature is related with r, ρ and s?

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99. The earth constantly receives heat radiation from the sun and gets warmed up. Why does the earth not get as hot as the sun is ?

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100. Is it necessary that all black coloured objects should be considered black bodies ?

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101. when a piece of red glass heated in a furnace is taken out, it glows with green light. Why?

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102. White clothes are more comfortable in summer while coloured clothes are more comfortable in winter. Why?

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103. Animals curl into a ball, when they feel very cold.

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Advanced problems for competitions

1. A steel wire of length 20 cm and uniform cross section $1mm^2$ is tied rigidly at both the ends. If temperature of the wire is altered from $40^\circ C$ to $20^\circ C$, calcutlate the change in tension. Given coefficient of linear expansion of steel is $1.1 \times 10^{-5} \wedge (\circ) C^{-1}$ and Young's modulus for steel is $2.0 \times 10^{11} Nm^{-2}$.

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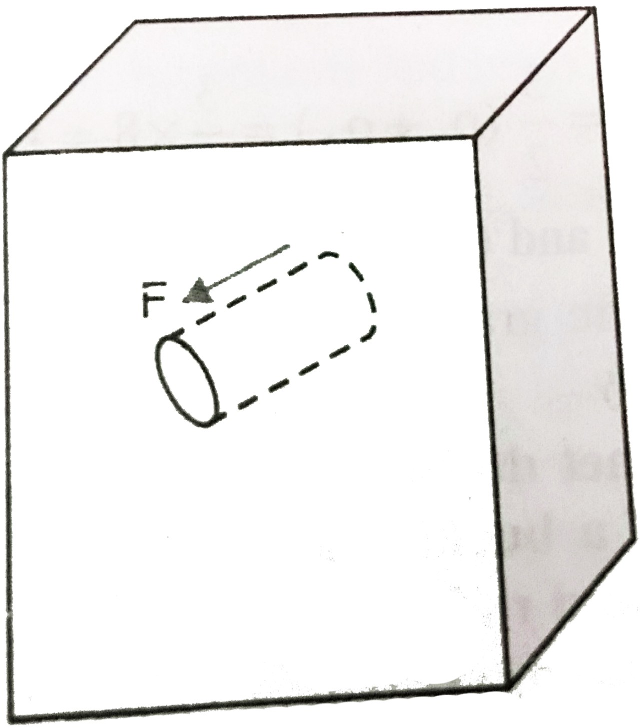
2. Calculate the force F needed to punch at 1.46 cm diameter hole in a steel plate $1.27 cm$ thick fig. The ultimates shear stress of steel is $3.45 \times 10^{8} Nm^{-2}$.



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3. A bob of 1 kg wt is suspended by a rubber cord 2m long and of cross section $0.5cm^2$ it is made to descrbie a horizontal circle of radius 50cm, 4 times a second. Find the extension of the cord, Young's modulus of rubber is $5 \times 10^8 N/m^2$

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4. A load of 981 N is suspended from a steel wire of radius 1 mm. what is the maximum angle through which the wire with the load can be deflected so that it does not break when the load passes through the equilibrium poision? Breaking stress is $7.85 \times 10^8 Nm^{-2}$.

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5. Compare the densities of water at the surface and bottom of a lake 100 metre deep , given that the compressibility is $10^{-3}/22$ per atmosphere and 1 atmosphere = $1.015 \times 10^5 Pa.$

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6. When equal volumes of two metals are mixed together the specific gravity of alloy is 4. When equal masses of the same two metals are mixed together the specific gravity of the alloy becomes 3. find specific gravity of each metal?

(specific gravity $= \frac{\text{density of substance}}{\text{density of water}}\Bigg)$

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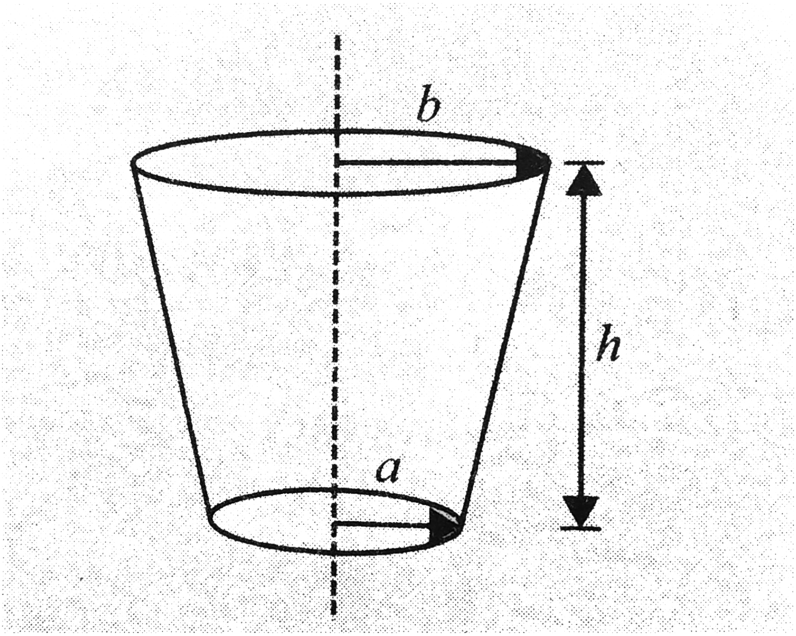
7. Find the net downward thrust on the inclined surface of a bucket full of water of height h and radii a and b.



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8. A balloon filled with hydrogen has a volume of 1000 litres and has mass of 1kg. What would be the volume of the block of very light material which it can just lift? One litre of the material has a mass 91.3g and density of air is $1.3g \quad \text{litre}^{-1}$.

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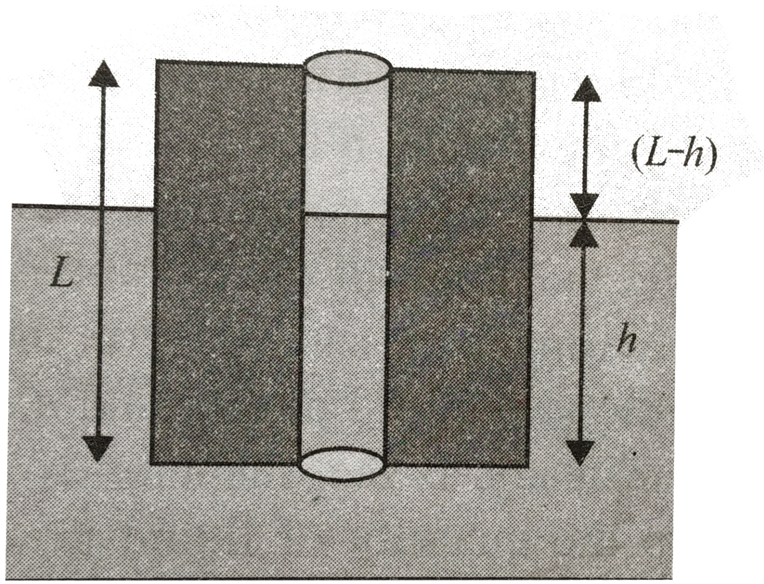
9. A large block of ice $5m$ thick has a vertical hole drilled through it and is floating in the middle of a lake. What is the minimum length of a rope required to scoop up a bucket full of water through the hole? Relative density of ice $= 0.9$.



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10. A barometer contains two uniform capillaries of radii $1.4 \times 10^{-3} m$ and $7.2 \times 10^{-4} m$. If the height of liquid in narrow tube is $0.2 m$ more than that in wide tube, calculate the true pressure difference. Density of liquid

$= 10^3 kg/m^3$, surface tension $= 72 \times 10^{-3} N/m$ and $g = 9.8 ms^{-12}$.

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11. A capillary tube sealed at the top has an internal radius of 0.05 cm. the tube is placed vertically in water, open end first . What should be the length of such a tube for the water column to rise in it to a length of 1 cm?

Atmospheric pressure, $P_0 = 1$ atmosphere $= 1.01 \times 10^5 Nm^{-2}$, and surface tension of water $= 70 \times 10^{-3} Nm^{-1}$.

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12. There is a soap bubble of radius $2.4 \times 10^{-4} m$ in air cylinder at a pressure of $10^5 N/m^2$. The air in the cylinder is compressed isothermal until the radius of the bubble is halved. Calculate the new pressure of air in the cylinder. Surface tension of soap solution is $0.08 Nm^{-1}$.

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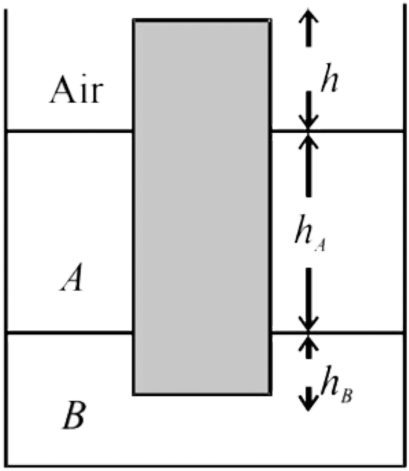
13. A uniform solid cylinder of density $0.8 g/cm^3$ floats in equilibrium in a combination of two non-mixing liquids A and B with its axis vertical.

The densities of the liquids A and B are $0.7 g/cm^3$ and $1.2 g/cm^3$, respectively. The height of liquid A is $h_A = 1.2 cm$. The length of the part of the cylinder immersed in liquid B is $h_B = 0.8cm$.



(a) Find the total force exerted by liquid A on the cylinder.

(b) Find h, the length of the part of the cylinder in air.

(c) The cylinder is depressed in such a way that its top surface is just below the upper surface of liquid A and is then released. Find the acceleration of the cylinder immediately after it is released.

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14. A liquid is kept in a cylindrical vessel which is rotated along its axis. The liquid rises at the sides, if the radius of vessel is $0.05m$ and the speed of rotation is $2rev/s$, find difference in the height of the liquid at the centre of the vessel and its sides.

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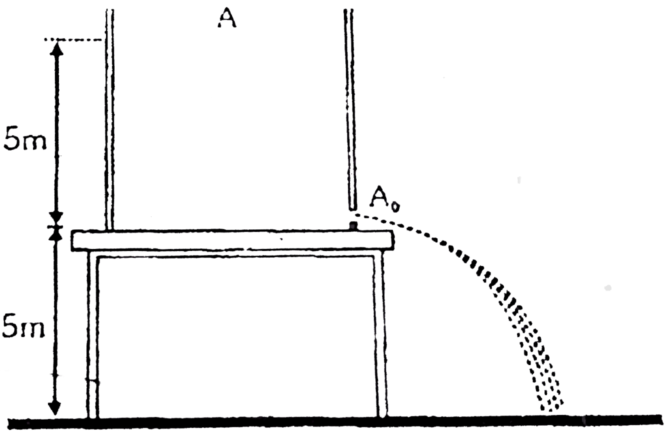
15.



A cylinderical tank 1 m in radius rests on a plaform 5 m high. Initially the tank is filled with upto a height of 5m a plug whose area is $10^{-4} cm^2$ is removed from an orifice on the side of the tank at the bottom.

Calculate (a). Initial speed with which the water flows from the orifice

(b). Initial speed with which the water strikes the ground.

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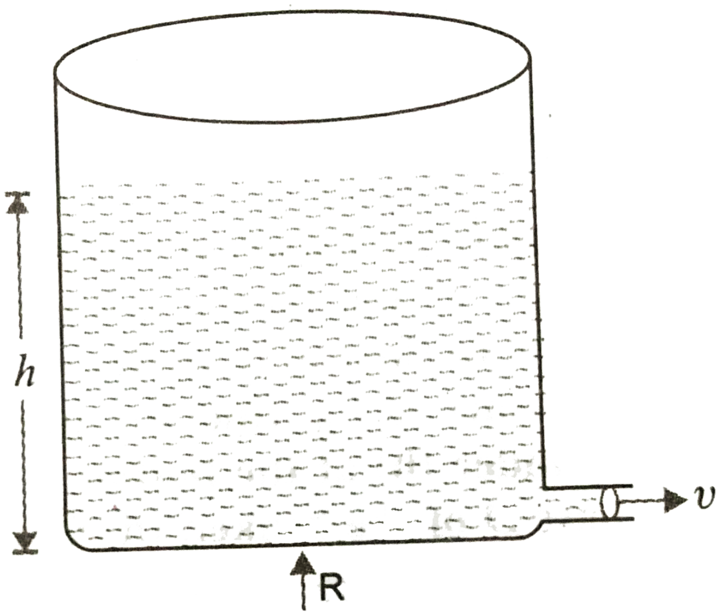
16. A light cylindrical vessel is kept on a horizontal surface. Its base area is A. a hole of cross sectional area a is made just at its bottom side (where a less than A). Find minimum coefficeint of friction necessary for sliding of the vesssel due to the impact force of the emerging liquid.



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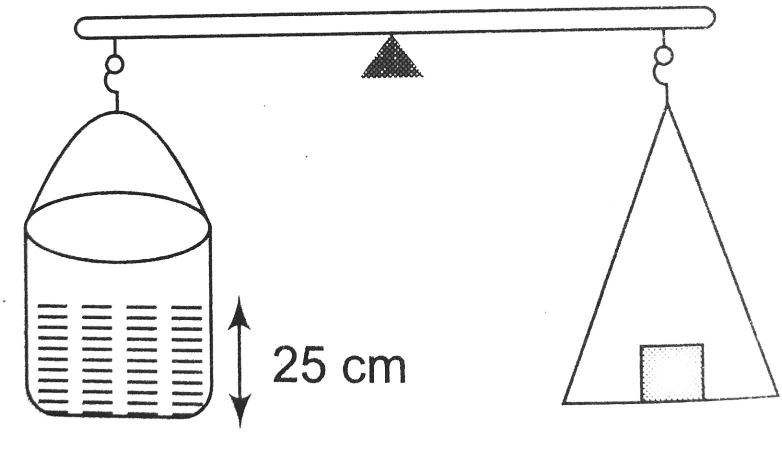
17. A cylinder containing water up to a height of $25cm$ has a hole of cross-section $\frac{1}{4}cm^2$ in its bottom. It is counterpoised in a balance. What is the initial change in the balancing weight when water begin to flow out?



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18. Spherical particles of pollen are shaken up in water and allowed to settle. The depth of water is $2 \times 10^{-2}m$. What is the diameter of the largest particles remaining in suspension one hour later?

Density of pollen $= 1.8 \times 10^3 kgm^{-3}$ viscosity of water $= 1 \times 10^{-2}$ poise and density of water $= 1 \times 10^3 kgm^{-3}$

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19. A cylinderical tank of height 0.4 m is open at the top and has a diameter 0.16m. Water is filled in it up to height of 0.16 m. Find the time taken to empty the tank through a hole of radius $5 \times 10^{-3}m$ in its bottom.

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20. A piece of copper of mass 7.5 g at $27^{\circ}C$ is dropped in boling liquid oxygen (boling point $-183^{\circ}C$). The released oxygen oc cupies 1.89 letres at $20^{\circ}C$ and a pressure of 750 mm. Find the latent heat of vaporisation of oxygen. Given that specific heat of copper= $0.08 cal g^{-1}.^{\circ}C^{-1}$ and density of oxygen at NTP is $1.429 g/litre$.

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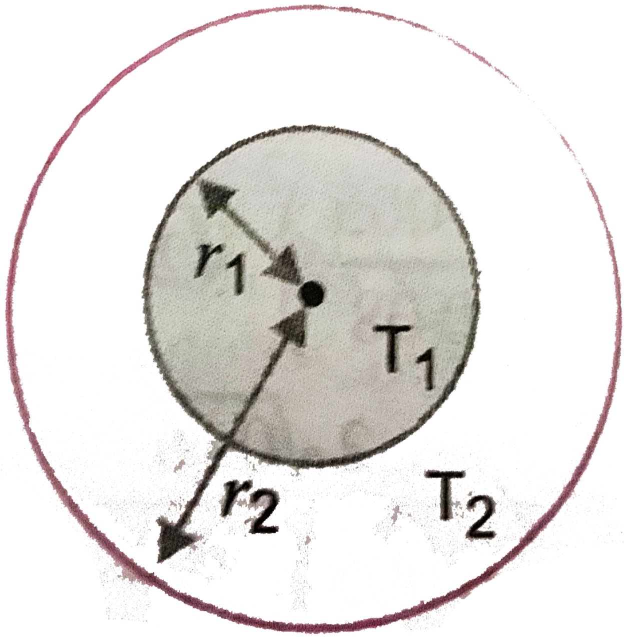
21. Fig, shows a system of two concentric spheres of radii r_1 and r_2 and kept at temperature T_1 and $T_2 \left(T_1 > T_2\right)$ respectively. Find the expression for radial rate of flow of heat through the substance.



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NCERT Questions

1. A steel wire of length $4.7m$ and cross-sectional area $3 \times 10^{-6} m^2$ stretches by the same amount as a copper wire of length $3.5m$ and cross-sectional area of $4 \times 10^{-6} m^2$ under a given load. The ratio of Young's modulus of steel to that of copper is

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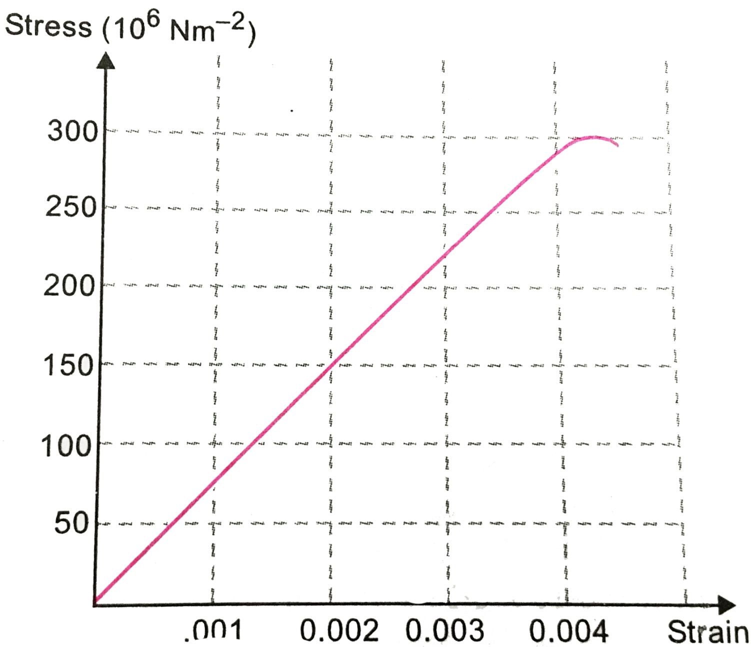
2. Fig., shows the stress-strain curve for a given materal. What are (a) Young's modulus and (b) approximate yield

strength for this material?



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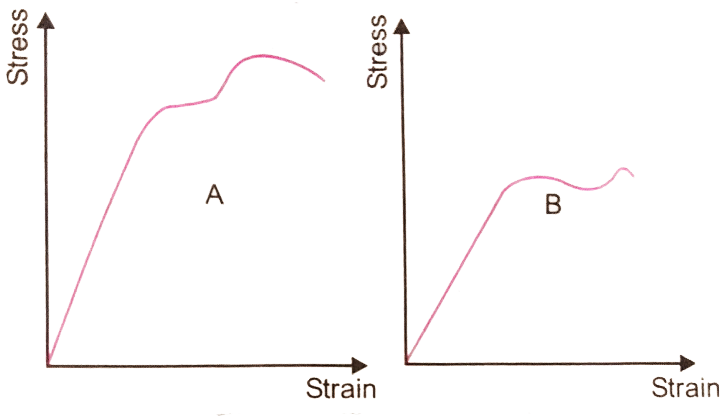
3. The stress versus strain graph for two materials A and B are shown in fig. the graph are on the same scale. ltbr.

(a) Which materail has greater Young's modulus?

(b) which of the two is stronger materail?



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4. Read each of the statement below carefully and state, with reasons, if it is true or false.

(a) The modulus of elasticity of rubber is greater than that of steel.

(b) the stretching of a coil is determined by its shear modulus.

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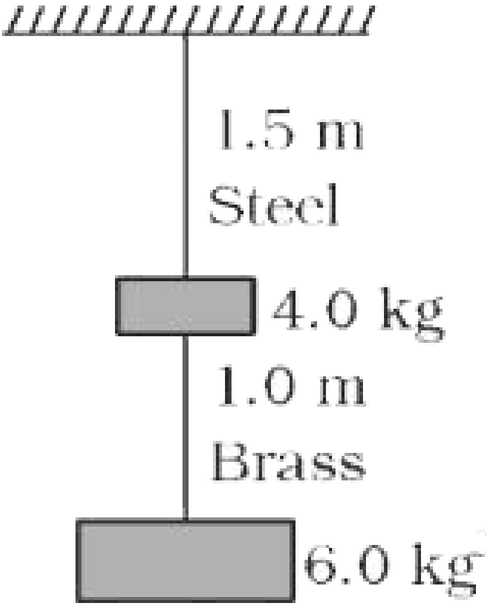
5. Two wires of diameter 0.25 cm, one made of steel and the other made of brass are loaded as shown in figure. The unloaded length of steel wire is 1.5 m and that of brass wire is 1.0 m. Compute the elongations of the steel and the brass wires .Young's modulus of steel is

2.0×10^{11}Pa and that of brass is 9.1×10^{11} Pa.



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6. The edges of an aluminum cube are $10cm$ long. One face of the cube is firmly fixed to a vertical wall. A mass of $100kg$ is then attached to the opposite face of the cube. Shear modulus of aluminum is $25 \times 10^9 Pa$, the vertical deflection in the face to which mass is attached is

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7. Four identical hollow cylindrical cloumns of steel support a big structure of mass 50.000 kg. the inner and outer radii of each column are 30 cm and 60 cm respectively. Assume the load distribution to be uniform , calculate the compressional strain of each column. the Young's modulus of steel is $2.0 \times 10^{11} Pa$.

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8. A piece of copper having a rectangular cross section of $15.2 \times 19.1mm$ is pulled in tension with 45,500N, force producing only elastic deformation. Calculate the resulting strain. Shear modulus of elasticity of copper is $42 \times 10^9 Nm^{-2}$.

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9. A steel cable with a radius of 1.5 cm support a chairlift at a ski area.if the maximum stress is not to exceed $10^8 Nm^{-2}$, what is the maximum load the cable can support?

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10. A rigid bar of mass 15 kg is supported symmetrically by three wires each 2 m long. Those at each end aer of copper and middle one is of iron. Determine the ratio of their diameters if each is to have the same tensoin. Young's modulus of elasticity for copper and steel are $110 \times 10^9 Nm^{-2}$ and $190 \times 10^9 Nm^{-2}$ respectively.

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11. A 14.5 kg mass, fastened to the end of a steel wire of unstretched length 1m, is whirled in a vertical circle with an angular velocity of $2rev./s$ at the bottom of the circle. The cross-sectional area of the wire is $0.065cm^2$.

Calculate the elongation of the wire when the mass is at the lowest point of its path $Y_{steel} = 2 \times 10^{11} Nm^{-2}$.

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12. Compute the bulk modulus of water from the following data : initial volume = 100.0 litre, pressure increase = 100.0 atmosphere. Final volume - 100.5 litre . (1 atmosphere = $1.013 \times 10^5 Pa\big)$. Compare the ulk modulus of water that of air (at constant temperature). explain in simple terms why the ratio is so large.

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13. What is the density of ocean water at a depth, where the pressure is 80.0 atm, given that its density at the surface is $1.03 \times 10^3 kgm^{-3}$? Compressibilty of water $= 45.8 \times 10^{-11} Pa^{-1}$. Given 1 atm. $=1.013 \times 10^5 Pa$.

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14. Compute the fractional change in volume of a glass slab, when subjicted to a hydrautic pressure of 10 atmosphere. Bulk modulus of elasticity of glass = $37 \times 10^9 Nm^{-2}$ and 1 atm = $1.013 \times 10^5 Pa$.

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15. The volume change of a solid copper cube 20 cm on an edge, when subjected to a pressure of 14 MPa is (Bulk modulus of copper 140 GPa)

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16. How much should the pressure on a litre of water be changed to compress it by 0.10%? Bull modulus of elasticity of water = $2.2 \times 10^9 Nm^{-2}$.

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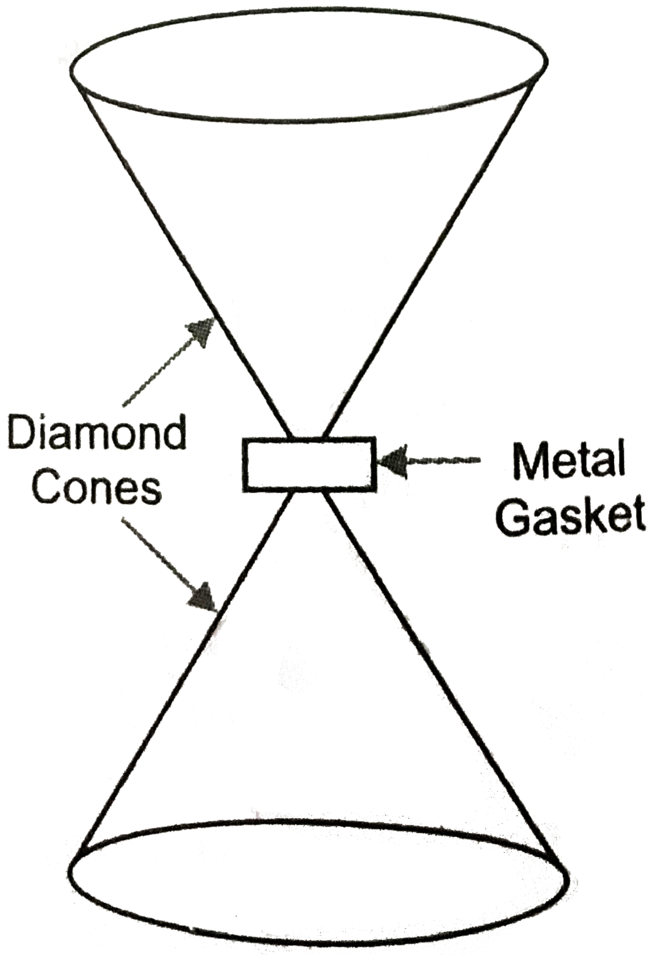
17. Anvils made of single crystal of diamond , with shape as shown in fig. are used to investigate behaviour of materials under very high pressure. Flat faces at the narrow end of the anvil have a diameter of 0.5 mm, and the wide ends are subjected to a compressional force of 50,000 N. What is the pressure at the tip of the anvil?



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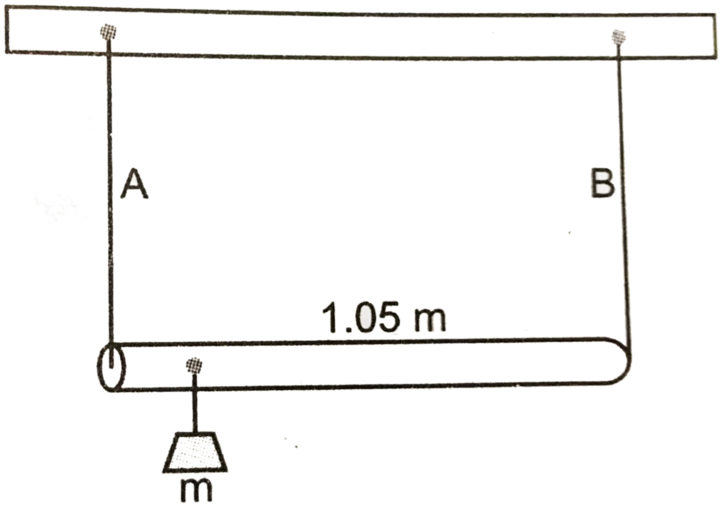
18. A rod of length 1.05 m having negliaible mass is supported at its ends by two wires of steel (wire A) and aluminium (wire B) of equal lengths as shown in fig. The cross-sectional area of wire A and B are $1mm^2$ and $2mm^2$, respectively . At what point along the rod should a mass m be suspended in order to produce (a) equal stresses and (b) equal strains in both steel and aluminium wires. Given,

$Y_{steel} = 2 \times 10^{11} Nm^{-2}$ and Y - $(aluminium) = 7.0 \times 10^{10} N^{-2}$



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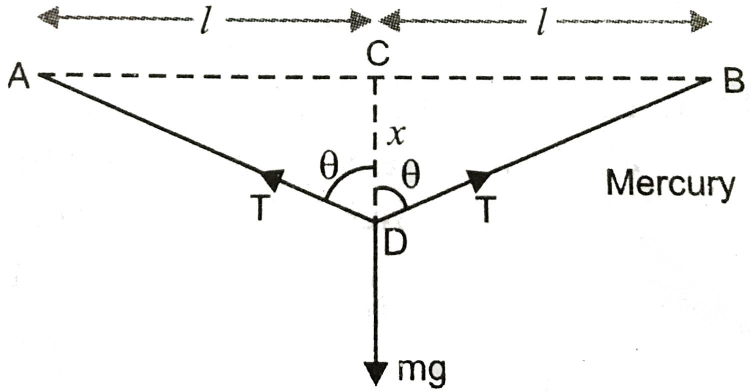
19. A mild steel wire of length 1.0 m and cross-sectional are $0.5 \times 10^{-20} cm^2$ is streached, well within its elastic limit, horizontally between two pillars. A mass of 100 g is suspended from the mid point of the wire, calculate the depression at the mid point.

$g = 10ms^{-2}, Y = 2 \times 10^{11} Nm^{-2}$.



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20. Two strips of metal are riveted together at their ends by four rivets, each of diameter 6mm. What is the maximum tension that can be exterted by the riveted strip if the shearing stress on the rivet is not to exceed $6.9 \times 10^7 Pa$? Assume that each rivet is to carry one quarter of the load .

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21. The marina Trench is located in the pacific ocean, and at one place it is nearly eleven km beneath the surface of water. The water pressure at the bottom of the Trench is about $1.1 \times 10^8 Pa$. A steel ball of initial volume $0.32m^3$ is dropped into the ocean and falls to the bottom of the Trench. what is the change in the volume of the ball when it reaches to the bottom? Bulk modulus for steel =$1.6 \times 10^{11} Nm^{-2}$.

Watch Video Solution

22. Explain why (a) the blood pressure is humans is greater at the feet than at the brain.

(b) Atmospheric pressure at a height of about 6 km decreases to nearly half its value at the sea level through the 'height' of the atmospheric is more than 100 km.

(c) Hydrostatic pressure is a scalar quantity even though pressure is force divded by area , and force is a vector.

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23. Explain why

(a). The angle of contact of mercury with galss is obtuse, while that of water with glass is acute.

(b). Water on a clean glass surface tends to spread out while mercury on the same surface tends to form drops. (Put differently, water wets glass while mercury does not).

(c). Surface tension of a liquid is independent of the area of the surface

(d). Water with detergent disolved in it should have small angles of contact.

(e). A drop of liquid under no external forces is always spherical in shape.

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24. Find in the blanks using the word (s) from the test appended with each statement.

(a) Surface tension of liquid generally .....with temperatures (increase//decreases).

(b) Viscosity of gases ..... With temperature, whereas viscosity of liquids ......with temperature. (increases//decreases)/

(c) For solids with elastic modulus of rigidity, the shearing force is proportional to .....while for fluids it is proportional to ....(shear strain//rate of shear strain).

(d) For a dluid in a steady flow, from .....(conservation of mass// Bernoulli's principle)

(e) For the model of a plane in a wind tunnel, turbulence oc curs at a ...... speed for turbulence for an actual plane (greater//smaller)/

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25. Explain why

(a). To keep a piece of paper horizontal, you should blow over, not under, it

(b). When w try to close a water tap with our fingers, fast jets of water gush through the openings between our fingers

(c). The size of the needle of a syringe controls flow rate better than the thumb pressure exerted by a doctor while administering an injection

(d). A fluid flowing out of a small hole in a vessel results in a backward thrust on the vessel

(e). A spinning cricket ball in air does not follow a parabolic trajectory.

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26. A 50 kg. girl wearing high heel shoes balance on a single heel. The heel is circular with a diameter 1 cm. what is the pressure exerted by the heel on the horizontal floor?

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27. Torricelli's barometer used mercury. Pascal duplicated it using French wine of density $984 kgm^{-3}$. Determine the height of the wine column for normal atmospheric pressure.

Watch Video Solution

28. A vertical off-shore structure is built to withstand a a maximum stress of $10^9 Pa$. Is the structure suitabel for putting upon top of an oil well in bombay high? Take the depth of the sea to be roughly 3 km, and ignore oceam currents.

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29. A hydraulic automobile lift is designed to lift cars with a maximum mass of 300 kg. the area of cross-section of the piston carrying the load is $425 cm^3$. What maximum pressure would smaller piston have to bear?

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30. A U tube contains water and methylated spirts separated by mercury columns in the two arms are in level with 10.0cm of water in one arm and 12.5 cm of spirit in the other. What is the relative density of spirit?

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31. in previous question, if 15 cm of water and spirit each are further poured into the respective arms of the tube. Difference in the level of mercury in the two arms is (Take, relvative density of mercury = 13.6)

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32. Can Bernoulli's equation be used to describe the flow of water through a rapid in a river? Explain.

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33. Does it matter if one uses gauge instead of absolute pressures in applying Bernoulli's equation. Explain.

Watch Video Solution

34. Glycerine flows steadily through a horizontal tube of length 1.5m and radius 1.0 cm. if the amount of glycerine collected per second at one end is $4.0 \times 10^{-3} kgs^{-1}$, what is the pressuer difference between the two ends of the tube? (density of glycerine = $1.3 \times 10^3 kgm^{-3}$ and viscosity of glycerine =$0.83 Nsm^{-2}$).

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35. In a test experiment on a model aeroplane in a wind tunnel, the flow speeds on the upper and lower surface of the wing are $70 ms^{-1}$ and $63 ms^{-1}$ respectivley. What is the lift on the wing if its area is $2.5 m^2$? Take the density of air is $1.3 kgm^{-3}$.

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36. The steady flow of (non-viscous) liquid. Which of the two figure is incorrect?why?

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37. The cylinderical tube of a spray pump has a cross-section of $8.0cm^2$ one end of which has 40 fine holes each of diameter 1.0mm. If the liquid flow inside the tube is 1.5 m per minute, what is the speed of ejection of the liquid through the holes?

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38. A U-shaped wire is dipped in a soap solution, and removed. A thin soap film formed between the wire and a light slider supports a weight of $1.5 \times 10^{-2} N$ (which includes the small weigh of the slider). The length of the slider is 30cm. What is the surface tension of the film?

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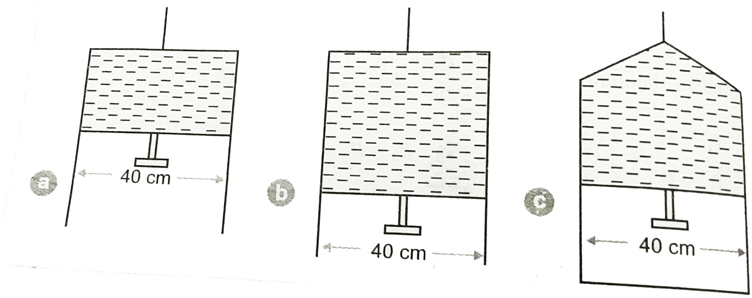
39. Fig, shown a thin film supporting a small weight = $4.5 \times 10^{-2} N$. What is the weight supported by a film of the same liquid at the same temperature in fig. explain your answer physically.

FIGURE 7(NCT).9



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40. What is the pressure inside a drop of mercury of radius 3.0mm at room temperature? Surface tension of mercury at that temperature $\left(20^{\circ} C\right)$ is $4.65 \times 10^{-1} Nm^{-1}$. The atmospheric pressure is $1.01 \times 10^{5} Pa$. Also give the excess pressure inside the drop.

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41. What is the excess pressure inside a bubble of soap solution of radius 5.00mm, given that the surface tension of soap solution at the temperature $\left(20^{\circ} C\right)$ is $2.50 \times 10^{-2} Nm^{-1}$? If an air bubble of the same dimension were formed at a depth of 40.0 cm inside a container containing the soap solution (of relative density 1.20), what would be the pressure inside the bubble? (1atm. is 1.01 xx 10^(5)Pa`).

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42. A tank with a square base of area $1.0m^2$ is divided by a vertical parition in the middle. The bottom of the partition has a small hinged door of area $20cm^2$. The tank is filled with water and an acid (of relative density 1.7) in the other, both to a height of $4.0m$. Compute to force necessary the force nec cessary to keep the door closed.

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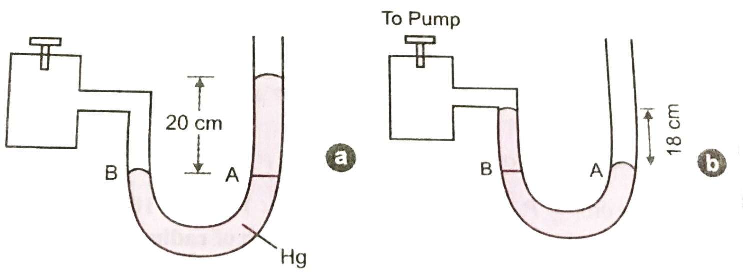
43. A manometer reads the pressure of a gas in an encloure as shown in fig. when some of the gas is removed by the pump, the manometer reads as in fig. the liquid used in mano-meters is mercury and the atmospheric pressure is 76 cm of mercury.

(i) Given the absolute and gauge pressure of the gas in the two cases (in units of cm. of mercury).

(ii) How would the levels change in case(b) if $13.6cm$ of water are poured into the right limb of manometer? (Ignore the change in volume of the gas).



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44. Two vessels have the same base area but differnent shapes. The first vessel takes twice the vloume of water that the second vessel requires to fill up to a paricular common height . Is the force exerted by water on the base of the vessel the same in the two case? If so, why do the vessels filled with water to that same height give different reading on a weighting scale ?

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45. During blood transfusion the needle is inserted in a vein where the gauge pressure is $2000 Pa$. At what height must the blood container be placed so that blood may just enter the vein? Density of whole blood = $1.06 \times 10^3 Kg/m^3$.

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46. In deriving Bernoulli's equation , we equated the workdone on the fluid in the tube to its change in the potential and kinetic energy (a) How does the pressure change as the fluid moves along the tube if dissipative forces are present ? (b) Do the dissipative forces becomes more important as the fluid velocity increase? Discuss qualitatively.

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47. (a) What is the largest average velocity of blood flow in an artery of radius $2 \times 10^{-3} m$ if the flow must remian laminar?

(b) What is the corresponding flow rate? Take viscosity of blood to be $2.084 \times 10^{-3} Pa - s$. Density of blood is $1.06 \times 10^3 kg/m^3$.

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48. A plane is in level flight at constant speed and each of its wings has an area of $25m^2$. If the speed of the air is $180km/h$ over the upper wing surface, determine the plane's mass . (Take air density to be $1kg/m^3$). $g = 9.8m/s^2$.

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49. In Millikan's oil experiment, what is the terminal speed of a speed of a drop of radius $2.0 \times 10^5 m$ and density $1.2 \times 10^3 m^{-3}$? Take the viscosity of air at the temperature of the expermental to be $1.8 \times 10^{-5} Nsm^2$. How much is the viscous force on the drop at that speed? Neglect buoyancy of the drop due to air.

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50. Mercury has an angle of contact equal to 140° with soda lime galss. A narrow tube of radius $1.00mm$ made of this glass is dipped in a through containing mercury. By what amount does the mercury dip down in the tube relative to the mercury surface outside? Surface tension of mercury at the temperature of the experiment is $0.465Nm^{-1}$. Density of mercury = $13.6 \times 10^3 kgm^{-3}$.

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51. Two narrow bores of diameters 3.0mm and 6.0 mm are joined together to form a U-shaped tube open at both ends. If th U-tube contains water, what is the difference in its levels in the two limbs of the tube? Surface tension of water at the temperature of the experiment is $7.3 \times 10^{-2} Nm^{-1}$. Take the angle of contact to be zero. and density of water to be $1.0 \times 10^3 kg/m^3$. $\left(g = 9.8ms^{-2}\right)$

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52. (a). It is known that density ρ of air decreases with height y as

$\rho = \rho_0 e^{-y/y(\_o)}$ ltb rgt where $p_o = 1.25 kgm^{-3}$ is the density at sea level, and y_o is a constant. This density variation is called the law of atmospheres. Obtain this law assuming that the temperature of atmosphere remains a constant (isothermal conditions). Also assume that the value of g remains constant

(b). A large He balloon of volume $1425 m^3$ is used to lift a payload of 400 kg. Assume that the balloon maintains constant radius as it rises. How high does it rise?

[take $y_o = 8000 m$ and $\rho_{He} = 0.18 kgm^{-3}$]

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53. The triple point of neon and carbon dioxide are $24.57K$ and $216.55K$ respectively. Express these temperature on the Celsius and Fahreaheit scales.

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54. Two absolute scales A and B have triple points of water defined to be $200A$ and $350B$. What is the relation between T_A and T_B?

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55. The electrical resistance in ohms of a certain thermometer varies with temperature ac cording to the approximate law: $R = R_0\left[1 + \alpha\left(T - T_0\right)\right]$

The resistances is 101.6Ω at the triple-point of water $273.16K$, and 165.5Ω at the normal melting point of lead $(600.5K)$. What is the temperature when the resistance is 123.4Ω?

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56. Answer the following :

(a) The triple-point of water is a standard fixed point in modern thermometry. Why ? What is wrong in taking the melting point of ice and the boiling point of water as standard fixed points (as was originally done in the Celsius scale) ?

(b) There were two fixed points in the original Celsius scale as mentioned above which were assigned the number $0\,^{\circ}C$ and $100\,^{\circ}C$ respectively. On the absolute scale, one of the fixed points is the triple-point of water, which on the Kelvin absolute scale is assigned the number 273.16 K. What is the other fixed point on this (Kelvin) scale ?

(c) The absolute temperature (Kelvin scale) T is related to the temperature t_c on the Celsius scale by

$t_c = T - 273.15$

Why do we have 273.15 in this relation, and not 273.16 ?

(d) What is the temperature of the triple-point of water on an absolute scale whose unit interval size is equal to that of the Fahrenheit scale ?

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57. Two ideal gas thermometer A and B use oxygen and hydrogen respectively . The following observations are made:

Temperature, Pressure therometer A, Pressure therometer B

Triple point of water, $1.250 \times 10^5 Pa$, $0.200 \times 10^5 Pa$

Normal melting point of sulphur, $1.797 \times 10^5 Pa$, $0.287 \times 10^5 Pa$

(a) What is the absolute temperature of normal melting point of sulphur as read by thermometers A and B ?

(b) What do you think is the reason for the slightly different answers from A and B ? (The thermometers are not faulty). what further procedure is needed in the experiment to reduce the discrepancy between the two readings.

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58. A steel tape 1m long is correctly calibrated for a temperature of $27\,^\circ C$. The length of a steel rod measured by this tape is found to be $63.0cm$ on a hot day when the temperature is $45.0\,^\circ C$. What is the acutual length of the steel rod on that day? what is the length of the same steel rod on a day when the temperature is $27.0\,^\circ C$? coefficient of linear expansion of steel $= 1.20 \times 10^{-5}.\,^\circ C^{-1}$.

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59. a large steel wheel is to be fitted on to a shaft of the same material. At $27^\circ C$, the outer diameter of the shaft is $8.70cm$ and the diameter of the central hole in the wheel is $8.69cm$. The shaft is cooled using 'dry ice' , At what temperature of the shaft does the wheel slip on the shaft? Assume coefficient of linear expansion of the steel to be constant over the required temperature range: $\alpha_{steel} = 1.20 \times 10(-5)K^{-1}$.

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60. A hole is drilled in a copper sheet. The diameter of the hole is $4.24cm$ at $27.0^\circ C$. What is the change in the diameter of the hole when the sheet is heated to $227^0 C$?

α for copper $= 1.70 \times 10^{-5} K^{-1}$

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61. A brass wire $1.8m$ long at $27\,^\circ C$ is held taut with little tension between two rigid supports. If the wire cooled to a temperature of $-39\,^\circ C$, what is the tension developed in the wire, if its diameter is $2.0mm$? Coefficient of linear expansion of brass $= 2.0 \times 10^{-5} / ^\circ C$, Young's modulus of brass $= 0.91 \times 10^{11} Pa$.

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62. A brass rod length 50 cm and diamteer 3.0 mm is joined to a steel rod of the same length and diameter. What is the change in length of the combined rod at $250\,^{\circ}C$ if the original length are at $40\,^{\circ}C$? Coefficient of linear expansion of brass and steel are $2.10 \times 10^{-5}.\,^{\circ}C^{-1}$ and $1.2 \times 10^{-5} \wedge (\circ)C^{-1}$ respectively.

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63. The coefficient of volume expansion of glycerine is $49 \times 10^{-5} / \,^{\circ}C$. What is the fractional change in its density (approx.) for $30\,^{\circ}C$ rise in temperature?

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64. A $10kW$ drilling machine is used to drill a bore in a small aluminium block of mass $8.0kg$. How much is the rise in temperature of the block in 2.5 minutes, assuming 50% of power is used up in heating the machine itself or lost to the surrounding? Specific heat of aluminium $= 0.91J/g^{\circ}C$.

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65. A copper block of mass $2.5kg$ is heated in a furnace to a temperature of $500^{\circ}C$ and then placed on a large ice block. What is the maximum amount (approx.) of ice that can melt? (Specific heat copper $= 0.39J/g^{\circ}C$ heat of fusion of water $= 335J/g$).

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66. In an experiment to determine the specific heat of a metal,a $0.20kg$ block of the metal at $150.^{\circ}C$ is dropped in a copper calorimeter (of water equivalent $0.025kg$) containing $150cm^3$ of water at $27.^{\circ}C$. The final temperature is $40.^{\circ}C$. The specific heat of the metal is.

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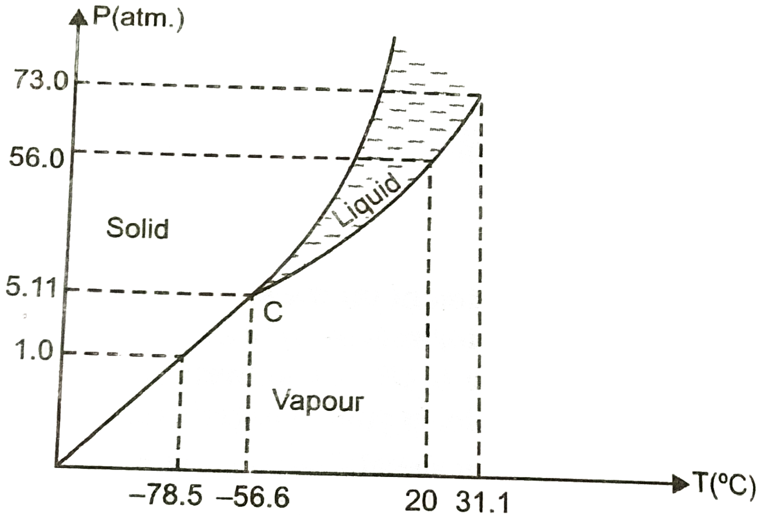
67. Answer the following question beased on tbhe P-T phase diagram of carbon dioxide.



(a) At what temperature and pressure can the solid, liquid and vapour phases of CO_2 co-exist is equilibrium ? (b) What is the effect of decrease of pressure on the fusion and bolling point of CO_2 ? (c) What are the critical temperature and pressure for CO_2 ? What is their significane ? (d) Is CO_2 solid, liquid or gas at (a) -$70^\circ C$ under 1 atm, (b) -$60^\circ C$ under 10 atm, (c) $15^\circ C$ under 56 atm ?

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68. Answer the following questions based on the P – T phase diagram of CO_2:

(a) CO_2 at 1 atm pressure and temperature $-60\,^{\circ}C$ is compressed isothermally. Does it go through a liquid phase ?

(b) What happens when CO_2 at 4 atm pressure is cooled from room temperature at constant pressure ?

(c) Describe qualitatively the changes in a given mass of solid CO_2 at 10 atm pressure and temperature $-65\,^{\circ}C$ as it is heated up to room temperature at constant pressure.

(d) CO_2 is heated to a temperature $70\,^{\circ}C$ and compressed isothermally. What changes in its properties do you expect to observe ?

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69. A child running a temperature of 101^{F} is given and antipyrin (i.e. a madicine that lowers fever) which cause an increase in the rate of evaporation of sweat from his body. If the fever is brought down to $98^{\circ} F$ in 20 min., what is the averatge rate of extra evaporation caused, by the drug ? Assume the evaporation mechanism to the only way by which heat is lost. The mass of the child is 30 kg. The specific heat of human body is approximately the same as that of water and latent heat of evaporation of water at that temperature is about $580 cal. g^{-1}$.

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70. A cubical thermocol ice box of side length $30cm$ has thickess of $5.0cm$ If $4.0kg$ of ice is put in the box estimate the amount of ice remaining after $6hr$ The outside temperature is $45^{\circ}C$ and co-efficient of the thermal conductivity of the thermocol is $0.01 Js^{-1}m^{-1}K^{1}$ (Latent Heat of fusion of water $= 335 \times 10^{3} Jkg^{-1}\big)$.

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71. A brass boiler has a base area of $0.15m^2$ and thickness 1.0 cm it bolis water at the rate of 6.0 kg/min, when placed on a gas stove. Estimate the temperature of the part of the flame in contact with the bolier. Thermal conductivity of brass $= 609Js^{-1}.{}^{\circ}C^{-1}$. Heat of vaporisation of water $= 2256 \times 10^3 Jg^{-1}$

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72. Explain why : (a) A body with large reflectivity is a poor emitter. (b) A brass tumbler feels much colder then a wooden tray on a chilly day. (c) an optical pyrometer (for measuring high temperatures) calibrated for an ideal black body correct value for the temperature when the same piece is in the furnace. (d) The earth without its atmosphere would be inshospitably cold. (e) Heating system based on circulation of steam are more effecient in warming a building than those based on circulation of hot water.

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73. A body cools from $80^\circ C$ to $50^\circ C$ in 5 min-utes Calculate the time it takes to cool from $60^\circ C$ to $30^\circ C$ The temperature of the surroundings is $20^\circ C$.

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Higher Order thinking skells

1. To what height should a cyclindrical vessel be filled with a homogeneous liquid to make the force with which the liquid pressure on the sides of the vessel equal to the force exerted by the liquid on the bottom of the vessel ?

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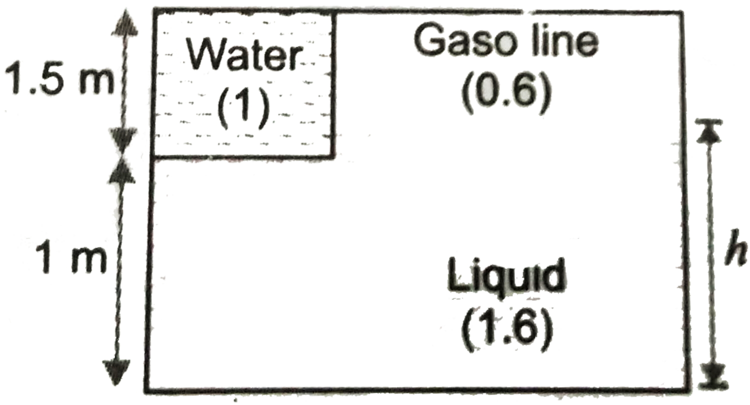
2. A stell wire is suspended vertically from a rigid support. When loaded with weight in air, it extends by x_1. When the weight is completely inside the water, the extension becomes x_2. Find the relative density of the meterial fo the weight ?

3. Water and gasoline surface of relative density 1 and 0.6 are open to the atmosphere at the same elevation. Find the height h of the third liquid of relative density 1.6 in the right leg as shown in



4. Is the force of attraction or repulsion responsible in the interatomic or intermolecular potential for the formation of a solid ? Explain it.

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5. A steel ring of radius r and cross section area A is fitted on to a wooden disc of radius $R(R > r)$. If Young's modulus be R, then the force with which the steel ring is expanded is

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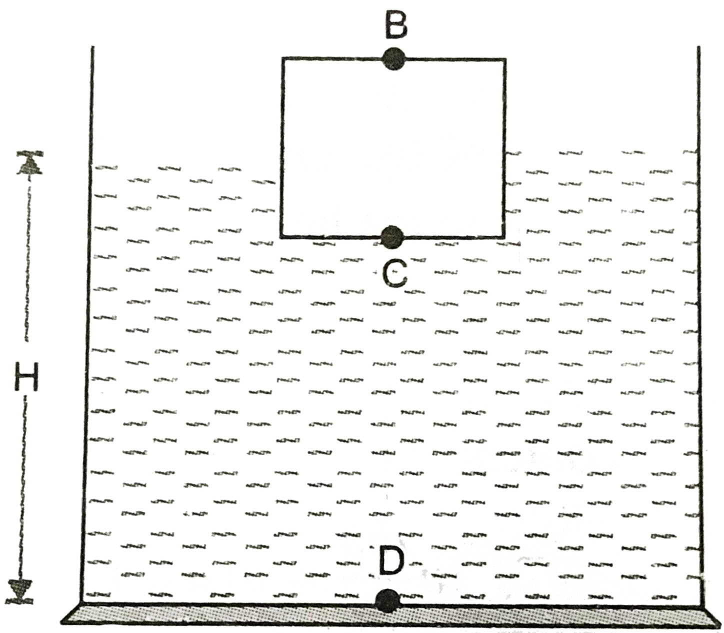
6. A liquid of density ρ is filled in a beaker of cross section A to a height H and then a cylinder of mass M and cross-section a is made to float in it as shown in



If the atmospheric pressure is P_0 find the pressure (a) at the top face B of the cylinder (b) at the bottom face C of the cylinder and (c) at the base D of the beaker. (d) Can ever these pressure be equal ?

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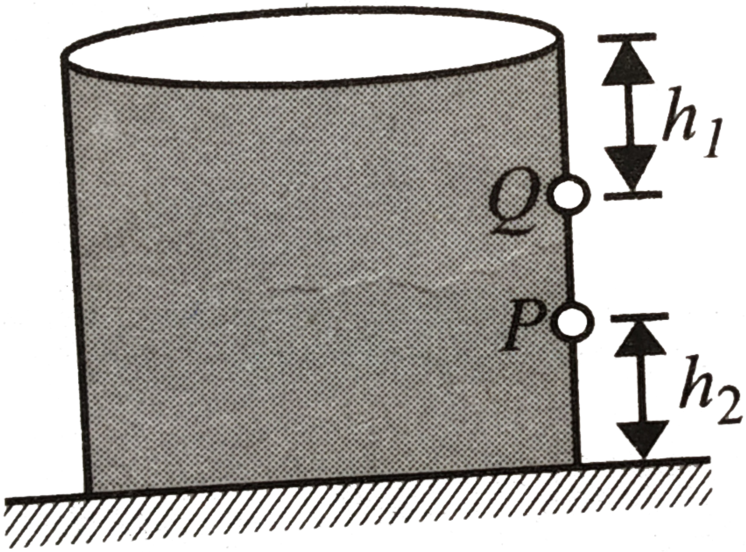
7. In a cylindrical water tank there are two small holes Q and P on the wall at a depth of h_1 from the upper level of water and at a height of h_2 from the lower end of the tank, respectively, as shown in the figure. Water coming out from both the holes strike the ground at the same

point. The ratio of h_1 and h_2 is



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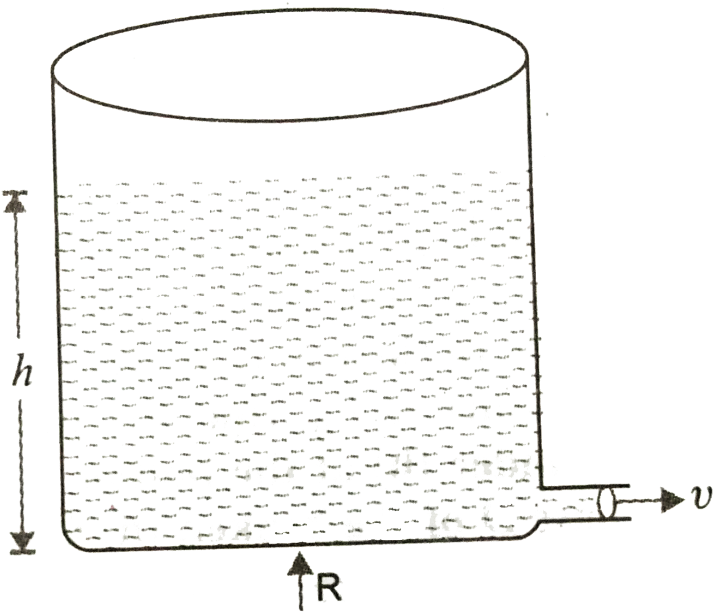
8. A light cylindrical vessel is kept on a horizontal surface. Its base area is A. a hole of cross sectional area a is made just at its bottom sdie (where a ltlt A). Find minimum coefficeint of friction necessary for sliding of

the vesssel due to the impact force of the emerging liquid.



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9. A squre hole of side length l is made at a depth of h and a circular hole is made at a depht of 4 h from the surface of water in a water tank kept on a horizontal surface (where l ltlt h). Find the radius r of the circular hole if equal amount of water comes out of the vessel through the holes per second.

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10. A metal sphere is suspended from one pan of a sensitive balance and is immersed completely in water. The other pan carries weights to balance the immersed sphere. The water is then heated to a high temperature. The water expandes, the sphere sinks in water. To balance the sphere, the weights are to be added or removed from the other pan , explain.

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11. Three capillary tubes of the same radius r but of length l_1, l_2 and l_3 are fitted horizontally to the bottom of a long cylinder containing a liquid at constant head and flowing through these tubes. Find the length of a single overflow tube of the same radius r, which can replaced the three capillaries.

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12. A large tank filled with water to a height h is to be emptied through a small hole at the bottom. The ratio of times taken for the level of water to fall from h to $\frac{h}{2}$ and from $\frac{h}{2}$ to zero is

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13. The coefficient of apparent expansion of a liquid when determined using two different vessle A and B are γ_1 and $\gamma_{2,}$ respectily. If the coefficient of linerar expansion of vesel A is α. Find the coefficient of linear expension of the vessel B.

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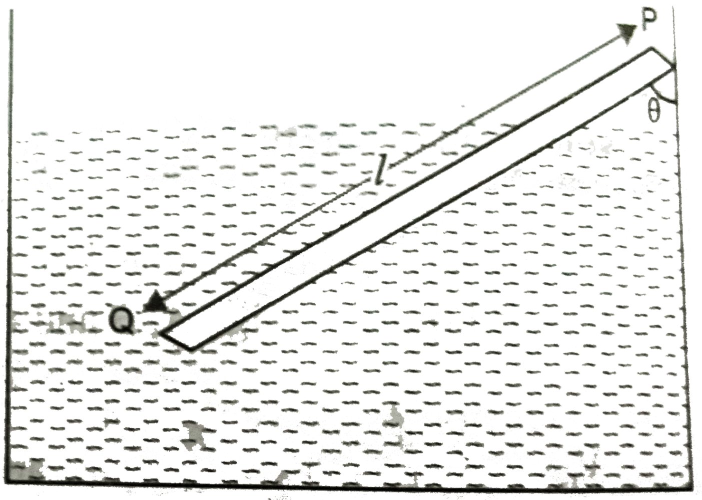
14. A uniform wooden bar of length l and mass m hinged on a vertical wall of a containing water, at one end.



$3/5th$ part of the bar is submerged in water. Find the ratio of densities of the liquid and the bar.

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15. Two separate air bubbles (radii $0.002cm$ and 0.004) formed of the same liquid (surface tension $0.07N/m$) come together to form a double bubble. Find the radius and the sense of curvature of the internal film surface common to both the bubbles.

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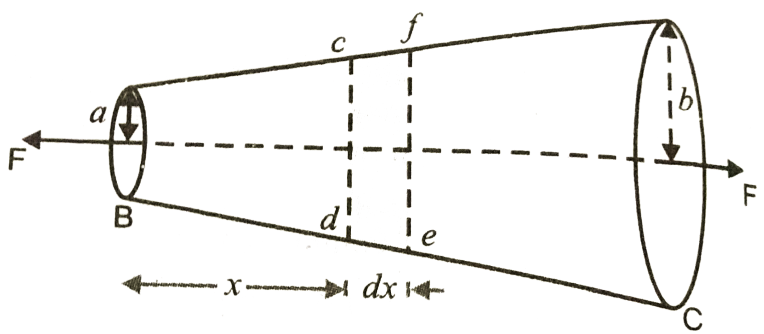
16. A slightly tapring wire of length L and end radii 'a' and 'b' is subjected to stretching forces F, F as shown in



If Y is the Young's Modulus, calculate the extension prouduced in the wire.

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17. If 10 g of ice is added to 40 g of water at $15^{\circ}C$, then the temperature of the mixture is (specific heat of water $= 4.2 \times 10^3 jkg^{-1}K^{-1}$, Latent heat of fusion of ice $= 3.36 \times 10^5 jkg^{-1}$)

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Value Based Question

1. The property of a body by virtue of which it tends to regain its original conifguration as soon as the deforming forces applied on the body are removed is called elasticity. Coefficient of elasticity, $E = \frac{stress}{\text{strain}} = \frac{F/a}{\Delta l/l} = \frac{Fl}{\pi r^2(\Delta l)}$ The value of E depends upon nature of meterial. A meterial with higher value of E is said to be more elastic. Read the above passage and answer the following question : (i) Which is more elastic steel or rubber ? Why ? (ii) What values of life so you learn from this concept ?

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2. Ac cording to Pascal's law, the increases in pressure at one point f enclosed liquid in equilibrium of rest is transmitted equally to all other points of the liquid and also to the walls of the container, provided the effect of gravity is neglected. Hydraulic lift and hydraulic brakes are based on this very law. Read the above passage and anser the following question : (i) How do hydraulic brakes work ? (ii) What are the implication of this law in day to day life ?

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3. Ac cording to Archimede's principle, when a body is immersed wholly or partly in a liquid at rest, it loses some of its weight. The loss in weight of the body in the liquid is equal to weight of liquid displaced by the immersed part of the body. From this principle, the law of floatation, is dedcued which states : A body will float in a liquid, if weight of liquid displaced by the immersed part of the body is atleast equal to or greater then the weight of the body. Read the above passage and answer the following questions : (i) A boat having a lenght of 3 m and breadth 2m is floating on a lake. The boat sinks by 1 cm when a man gets on it. What is the mass of the man ? (ii) What values of life do you learn from the law of floatation ?

Watch Video Solution

4. Surface tension is the property of a liquid by virtue of which free surface of liquid at rest tries to have minimum surface area. In doing so, the free surface of liquid at rest behaves as if it is covered with a stretched membrane. Surface tension (S) of a liquid is measured by from (F) acting on unit length fo a line (l) imagined to be drawn tangentially anywhere on the free surface i.e., $S = \frac{F}{l}$. S is measured in Nm^{-1} Read the above passage and answer the following question : (i)What is the cause of surface tension ? (ii) A wire ring of 30 mm diameter resting flat on the surface of a liquid is raised. The pull required is 1.5 gf more before the film breaks then it is after. What is surface tension of the liquid ? (iii) What are the implication of this phenomenon in day to day life ?

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5. Ac cording to Bernoulli's theorem for the streamline flow of an ideal liquid, the sum of pressure energy/mass, kinetic energy/mass and potential energy /mass remains constant at every cross section, throughout the liquid flow. i.e., $\frac{P}{\rho} + \frac{1}{2}\upsilon^2 + gh$ = cosntant, where the symbols have their usual meaning. Note that an ideal liquied is the one, which is perfectly incompressible, irrotational and non visous. Read the above passage and answer the following question ? (i) At what speed will the velocity head of a stream of water be equal to 40 cm ? (ii) What is the implication of Bernoulli's theorem in day to day life ?

Watch Video Solution

Test Your Grip A

1. Young's modulus of a substance depends of

A. its length

B. its area

C. acceleraton due to gravity

D. none of the above

Answer: D

Watch Video Solution

2. The effect of temperature on the value of modulus of elasticity for various substances in general

A. it increases with increase in temperature

B. remains constant

C. decreases with rise in temperature

D. sometimes increases and sometimes decreases

Answer: C

Watch Video Solution

3. A wire of length L and radius a rigidlyl fixed at one end. On stretching the other end of the wire with a force F, the increase in its length is L, if another wire of same material but of length 2 L and radius 2 a is stretched with a force 2 F, the increase in its length will be

A. L//4

B. L

C. L//2

D. 2 L

Answer: B

Watch Video Solution

4. The pressure of a medium is charged from $1.01 \times 10. Pa$ to $1.165 \times 10. Pa$ and change in volume is $10\ \%$ keeping temperature constant. The Bulk modulus of the medium is

A. $204.8 \times 10^5 Pa$

B. $102.4 \times 10^5 Pa$

C. $51.2 \times 10^5 Pa$

D. $1.55 \times 10^5 Pa$

Answer: D

Watch Video Solution

5. An alumminium rod and steel wire of same length and cross-section are attached end to end. Then compound wire is hung fron a rigid support and load is suspended from the free end. Y for steel is $\left(\frac{20}{7}\right)$ times of aluminium. The ratio of increase in length of steel wire to the aluminium wire is

A. $20:3$

B. $10:7$

C. $7:20$

D. $1:7$

Answer: C

Watch Video Solution

6. Two wires 'A' and 'B' of the same material have radii in the ratio $2:1$ and lengths in the ratio $4:1$. The ratio of the normal forces required to produce the same change in the lengths of these two wires is

A. $1:1$

B. $2:1$

C. $1:2$

D. $1:4$

Answer: A

Watch Video Solution

7. The Young's modulus of the meterial of a wire is $2 \times 10^{10} Nm^{-2}$ If the elongation strain is 1% then the energy stored in the wire per unit volume is Jm^{-3} is

A. 10^6

B. 10^8

C. 2×10^6

D. 2×10^8

Answer: A

Watch Video Solution

8. Two springs have their force constant K_1 and K_2. Both are strectched tilll their elastic energies are equal. If stretching forces are F_1 and F_2, then $F_1 : F_2$ si

A. $K_1 : K_2$

B. $K_2 : K_1$

C. $\sqrt{K}_1 / \sqrt{K}_2$

D. K_1^2 / K_2^2

Answer: C

Watch Video Solution

9. The length of a metal wire is l when the tension is F and x l when the tension si y F. Then the natural length of the wire is

A. $\frac{(x - y)l}{x - 1}$

B. $\frac{(y - x)l}{(y - 1)}$

C. $\frac{(x - y)l}{(x + 1)}$

D. $\frac{(y - x)l}{y + 1}$

Answer: B

Watch Video Solution

10. A wire can support a load Mg without breaking. It is cut into two equal parts. The maximum load that each part can support is

A. $Mg/4$

B. $Mg/2$

C. Mg

D. 2 Mg

Answer: D

Watch Video Solution

Fill in the Blanks A

1. What is the value of Young's modulus for a perfectly rigid body?

Watch Video Solution

2. What is value of modulus of rigidity for a liquid?

Watch Video Solution

3. The bulk modulus for an incompresssible liquid is

Watch Video Solution

4. The breaking force is independent of the ....of the wire till its........... Remains constant.

Watch Video Solution

5. A meterial is more elastic if its value of modulus of elasticity is ....

Watch Video Solution

6. The solids are .... Elastic and gases are .... Elastic.

Watch Video Solution

7. Youn'g modulus of the meterial of a wire is numerically equal to stress which will .... of a wire.

Watch Video Solution

8. In case of a rod of length l and radius r fixed at one end, angle of share ϕ is related to angle of twiest θ by the relation, θ = ...

Watch Video Solution

9. A wire 2m in length suspended vertically stretches by 1mm when a mass of 20 kg is attached to the lower end.

The elastic potential energy gained by wire is .... (use $g = 10m/s^2$)

Watch Video Solution

10. The force in newton required to increase by 1% length of a rod of area of cross section 10^{-3}m squre is ...., Modulus of elaticity of rod is $1.2 \times 10^{12} Nm^{-2}$

Watch Video Solution

Test Your grip B

1. A block of aluminium of mass 1 kg and volume $3.6 \times 10^{-4} m^3$ is suspended from a string and then completely immmersed in a container of water. The decreases in tension in the string after immersion is (use $g = 10 ms^{-2}$)

A. 9.8 N

B. 6.2 N

C. 3.6 N

D. 1.0 N

Answer: C

Watch Video Solution

2. A U-tube is partially filled with water. Oil which does not mix with water is next poured into one side untill water rises by 25 cm on the other side. If the density of oil be 0.8, the oil level will stand higher then the water level by

A. 6.25cm

B. 12.50 cm

C. 31.75 cm

D. 62.50 cm

Answer: A

Watch Video Solution

3. Two water droplets merge with each other to from a larger droplet. In this proces

A. energy is liberated

B. energy is absorbed

C. energy is neither liberted nor absorbed

D. some mass is converted into energy

Answer: A

Watch Video Solution

4. A long cylinderical glass vessel has a small hole of radius r at its bottom. The depth to which the vessel can be lowered vertically in a deep water (surface tension S) without any water entering inside is

A. $\frac{4S}{r\rho g}$

B. $\frac{3S}{r\rho g}$

C. $\frac{2S}{r\rho g}$

D. $\frac{S}{r\rho g}$

Answer: C

Watch Video Solution

5. Tow soap bubbles A and B are formed at the two open ends of a tube. The bubble A is smaller then bubble B. If the valve on the tube connecting the two bubbles is opened and air can flow freely between the bubbles, then

A. there is no change in the size of the bubbles

B. the two bubbles will becomes of equal size

C. A will becomes smaller and B will become larger

D. B will becomes smaller and A will becomes larger

Answer: C

Watch Video Solution

6. The workdone in increasing the size of a soap film from $10cm \times 6cm$ to $10cm \times 11cm$ is $3 \times 10^{-4}J$. The surface tension of the film is

A. $1.5 \times 10^{-2} Nm^{-1}$

B. $3.0 \times 10^{-2} Nm^{-1}$

C. $6.0 \times 10^{-2} Nm^{-1}$

D. $11.0 \times 10^{-2} Nm^{-1}$

Answer: B

Watch Video Solution

7. A liquid drop of radius R is broken into 1000 drops each of radius r. If T is surface tension, change in surface energy is

A. $4\pi R^2 T$

B. $7\pi R^2 T$

C. $16\pi R^2 T$

D. $36\pi R^2 T$

Answer: D

Watch Video Solution

8. In a surface tension experiment with a capillary tube water rises upto $0.1m$. If the same experiment is repeated in an artificial satellite, which is revolving around the earth, water will rise in the capillary tube upto a height of

A. 0.1 m

B. 0.2 m

C. 0.98 m

D. full length fo tube

Answer: D

Watch Video Solution

9. A capillary tube of radius r is immersed in a liquid. The liquid rises to a height h. The corresponding mass is m. What mass of water shall rise in the capillary if the radius of the tube is doubled?

A. 2 M

B. M

C. M//2

D. 4 M

Answer: A

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10. A capillary tube is dipped in water with the lower and 10 cm below the surface. Water rises in the tube to a height of 5 cm. The pressure required to blow a bubble at the lower end of the tube will be (atmospheric pressure $= 10^5 Nm^{-2}$ and $g = 10 m/s^2$)

A. $10^5 Nm^{-2}$

B. $1.015 \times 10^5 Nm^{-2}$

C. $2 \times 10^5 Nm^{-2}$

D. $2.5 \times 10^5 Nm^{-2}$

Answer: B

Watch Video Solution

Fill in the Blanks B

1. Pressure is a scalar or vector quantity.

Watch Video Solution

2. A beaker is filled with a liquid of density ρ upto a height h If the beaker is at rest, the mean pressure at the walls is:

Watch Video Solution

3. The .... at a point in a liqud is the difference of total pressure at that point and atmospheric pressure.

Watch Video Solution

4. The weight of a vertical columm of air of unit cross-sectional area extending from a point to the top of the erth's atmosphere is called.......... At that point.

Watch Video Solution

5. The upward force acting on the body immersed in a fluid is called........ Force.

Watch Video Solution

6. If two liquids of same mass but densities ρ_1 and ρ_2 respectively are mixed, then the density of the mixture is:

Watch Video Solution

7. The maximum distance upto which a molecule can exert some measurable attraction on other molecules is called............

Watch Video Solution

8. When mercury is split on a clean glass plate, it.........

Watch Video Solution

9. Oil drop may....... On a hot water.

Watch Video Solution

10. Surface energy per unit area of liquid surface is called...............

Watch Video Solution

Test Your Grip C

1. Under a pressure head, the rate of orderly volume of liquid flowing through a capillary tube is Q. If the length of capaillary tube were doubled and diameter of the bore is halved, the rate of flow would become

A. $Q/4$

B. $Q/8$

C. $Q/32$

D. 16 Q

Answer: C

Watch Video Solution

2. When water flows through a tube of radius r placed horizontally, a pressure difference p develops across the ends of the tube. If the radius fo the tube is doubled and the rate fo flow halved, the pressure differnece will be

A. 80 p

B. p

C. $p/8$

D. $p/32$

Answer: D

Watch Video Solution

3. Tow sphares of equal masses but radius r_1 and r_2 are allowed to fall in liquid of infinit columm. The ratio of their terminal velocityes are

A. 1

B. $r_1 : r_2$

C. $r_2 : r_1$

D. $\sqrt{r_1} : \sqrt{r_2}$

Answer: C

Watch Video Solution

4. Two drops of the same radius are falling through air with a steady velcoity of $5cms^{-1}$. If the two drops coalesce, the terminal velocity would be

A. $10cms^{-1}$

B. $2.5cms^{-1}$

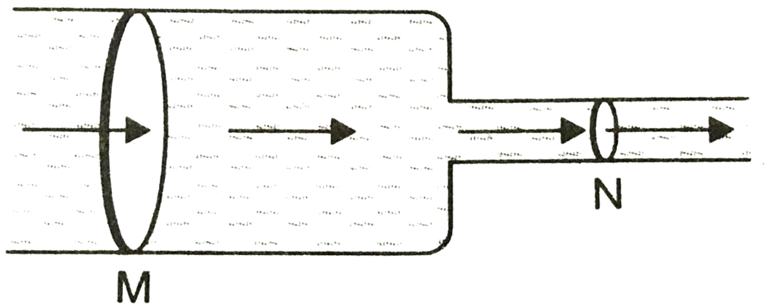
C. $5(4)^{1/3}cms^{-1}$

D. $5(3)^{1/3}cms^{-1}$

Answer: C

Watch Video Solution

5. A horizontal tube of non uniform cross section has radii fo 0.1 m and 0.05 m respectively at M and N,



For a streamline flow of liquid the rate of liquid flow is

A. continuously changes with time

B. greater at M then at N

C. greater at N then at M

D. same at M and N

Answer: D

Watch Video Solution

6. For a ball falling in a liquid with constant velcoity, ratio of resisitance force due to the liquid to that due to gravity is

A. 1

B. $\frac{2a^2\rho g}{9\eta^2}$

C. $\frac{2a^2(\rho - \sigma)g}{9\eta}$

D. none of these

Answer: A

Watch Video Solution

7. There is a hole at the bottom of a large open vessel. If water is filled upto a height h, it flows out in time t. if water is filled to a height 4h, it will flow out in time

A. 4 t

B. t/4

C. t/2

D. 2t

Answer: D

Watch Video Solution

8. The workdone by pressure in forcing $1m^3$ of water through a pipe if the pressure difference across the pipe is 10^4 Pa, is

A. $10^5 J$

B. $10^4 J$

C. $10^3 J$

D. $10^2 J$

Answer: B

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9. The tangential force or viscous force on any layer of the liquid is directly proportional to the velcoity gradient $d\upsilon/dx$. Then the direction of velcoity gradient is

A. parallel to the direction of the flow of the liquid

B. opposite to the direction of the flow of the liquid

C. independent of the direction of the flow of the liquied

D. perpendicular to the direction of flow of the liquid

Answer: A

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10. It is observed that during storm, the roof's of some houses are blown off. It is because

A. the wind creates high pressure over the roof

B. the wind creates low pressure over the roof

C. of the structure and shape of the roof

D. of natural calamity

Answer: B

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Fill in the Blanks C

1. With increase in temperautre, the viscosity of liquid........ But viscosity of gases.............

Watch Video Solution

2. If 1 newton tangential force is required to maintain the velocity gradient of $1ms^{-1}$//m between two parallel layers of liquid each of area 1 sq m, the coefficient of viscosity of liquid is said to be............

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3. The perciprocal of viscosity is called........

Watch Video Solution

4. The maximum constant velocity acquired by the body while falling freely in a viscous medium is called.

Watch Video Solution

5. With increase in pressure, the viscosity of liquid .... but the viscosity of water..........

Watch Video Solution

6. The velocity of liquied flow, upto which its flow is stremalined and above which its flow becomes turbulent is called...........

Watch Video Solution

7. in river, the deep water runs............ And less deep water runs............

Watch Video Solution

8. The equation of continuity leads to

Watch Video Solution

9. Bernoulli's theorem is an outcome of the conservation of .... Applied to a liquid in motion.

Watch Video Solution

10. A device used for measuring the rate of flow of liquid through pipes is called..........

Watch Video Solution

Test Your Grip D

1. The density of a substance at $0\,^{\circ}C\,10g/cc$ and $100\,^{\circ}C$, its density is $9.7g/cc$. The coefficient of linear expansion of the substance is

A. $10^{-4}, .\,^{\circ}C^{-1}$

B. $10^{-2}, .\,^{\circ}C^{-1}$

C. $10^{-3}, .\,^{\circ}C^{-1}$

D. $10^{-5}, .\,^{\circ}C^{-1}$

Answer: A

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2. A copper wire of length l increases in length by 0.3 % on heating from $20^{\circ}C$ to $40^{\circ}C$. Then percentage change in area of copper plate of dimensions $3l \times 2l$ on heating from $20^{\circ}C$ to $40^{\circ}C$ is

A. 0.05%

B. 0.3%

C. 0.4%

D. 0.6%

Answer: D

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3. The ratio of densites or iron at $10^{\circ} C$ is (alpha of iron $= 10 \times 10^{-6}, . ^{\circ} C^{-1}$)

A. 1.003

B. 1.0003

C. 1.006

D. 1.0006

Answer: D

Watch Video Solution

4. A pendulum clock shows correct time at certain time at certain temperature. At a higher temperature the clock

A. loses time

B. gains time

C. neither gains nor loses time

D. firstly gains and then loses

Answer: A

Watch Video Solution

5. Thermal stress does not depend upon

A. nature of the meterial

B. coefficient of linear expansion

C. Young'modulus

D. length of the rod

Answer: D

Watch Video Solution

6. Certain amount of heat is given to 100 g of copper to increase its temperature by $21^{\circ} C$. If same amount of heat is given to 50 g of water, then the rise in its temperature is (specific heat capacity of copper $= 400 J kg^{-1} K^{-1}$ and that for water $= 4200 J kg^{-1} K^{-1}$)

A. $4^{\circ} C$

B. $5.25^{\circ}C$

C. $8^{\circ}C$

D. $10.5^{\circ}C$

Answer: A

Watch Video Solution

7. Specific heat of a substane at the melting point becomes

A. low

B. high

C. remains unchanged

D. infinite

Answer: D

Watch Video Solution

8. At atmospherice pressure, 2 g of water having a volume of $2.00cm^3$ becomes $3342cm^3$ of steam when boiled. The latent heat of vaporisation of water is $539cal/g$ at 1 atm. The amount of heat added to the system is

A. 539 cal

B. 1078 cal

C. 3342 cal

D. 6684 cal

Answer: B

Watch Video Solution

9. A person weighing 60 kg takes in 2000 kcal diet in a day. If this energy were to be used in heating the person without any losses, his rise in temperature would be nearly (Given sp. Heat of human body is $0.83 cal g^{-1}, . ^\circ C^{-1}$

A. $30 ^\circ C$

B. $40 ^\circ C$

C. $35 ^\circ C$

D. $45\,^{\circ}C$

Answer: B

Watch Video Solution

10. Given, for air $c_{\upsilon} = 0.162 cal g^{-1} K^{-1}$ and density at NTP is $0.001293 g cm^{-3}$ What is the value of c_p?

A. $0.123 cal g^{-1} K^{-1}$

B. $0.23 cal g^{-1} K^{-1}$

C. $0.246 cal^{-1} g^{-1} K^{-1}$

D. $0.46 cal^{-1} g^{-1}$

Answer: B

Watch Video Solution

Fill in the Blanks D

1. Heat is a form of .... Which produces in use the ....

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2. Amount of heat required to raise the temperature of a body through $1K$ is called its.

Watch Video Solution

3. A platinum resistance thermometer is used for measuring temperatures ranging from....... To ....

Watch Video Solution

4. The quantity of heat required to raise the temperature fo a unit mass of a substance through one degree celsius called ____

Watch Video Solution

5. Specific heat of water is 1 cal $g^{-1}.^{\circ}C^{-1}$

Watch Video Solution

6. Water equivalent of a body is equivalent to the product of .... And .... Of the body

Watch Video Solution

7. The boiling point of a liquid _______ with the increase in pressure.

Watch Video Solution

8. The change from solid sate to vapour state without passing through the liquid state is called.........

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9. The phenomenon of refreezing of ice on reducing the pressure from ice is called............

Watch Video Solution

10. The value of specific heat of a solid or liquid is .... But .... for gases.

Watch Video Solution

Test Your Grip E

1. Three metal rods of same length and same cross - sectional area are connected in parallel. If their conductivities area 70, 110, 180 $Wm^{-1}K^{-1}$ respectively, the effective conductivity (in $Wm^{-1}K^{-1}$) of the combination is

A. 90

B. 260

C. 130

D. 360

Answer: B

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2. The metal rods of same length and same area of cross-section are connected in series. If their condcutivites are $120Wm^{-1}$ and $240Wm^{-1}K^{-1}$ the effective conductivity of the combination is

A. $150Wm^{-1} \quad K^{-1}$

B. $160Wm^{-1} \quad K^{-1}$

C. $180Wm^{-1} \quad K^{-1}$

D. $80Wm^{-1} \quad K^{-1}$

Answer: B

Watch Video Solution

3. Two rods A and B have lengths l_1 and l_2. Each rod has its ends at temperature T_1 and T_2 Radii fo cross section of the two rods are same. The condition for equal flow of heat through those two rods is $\left(K_1, K_2\right.$ are thermal conductivities of two rods)

A. $K_1 I_1 = K_2 I_2$

B. $K_1 I_2 = K_2 I_1$

C. $K_1 = K_2$

D. $I_1 = I_2$

Answer: B

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4. Two cylindrical rods of same meterial have the same temperature difference between their ends. The ratio of rates of flow of heat through them is 1 : 8. The ratio of the radii of the rods are 1 : 2. What is the ratio of their lengths ?

A. $2:1$

B. $4:1$

C. $1:8$

D. $1:32$

Answer: A

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5. A cylindrical metallic rod in thermal contact with two reservation of heat at its two ends conducts an amount of heat Q in time t. The metallic rod is melted and the material is formed into a rod of half the radius of the original rod. What is the amount of heat conducted by the new rod when placed in thermal contact with the two reservation in time t?

A. $Q/4$

B. $Q/16$

C. 2 Q

D. $Q/2$

Answer: B

Watch Video Solution

6. A cup of tea cools from 65.5°C to $62.55^{\circ}C$ in one minute is a room at $225.^{\circ}C$. How long will the same cup of tea take to cool from $46.5^{\circ}C$ to $40.5^{\circ}C$ in the same room ? (Choose the nearest value in min).

A. 1

B. 2

C. 3

D. 4

Answer: D

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7. A liquid takes 5 minutes to cool from $80^{\circ}C$ to$50^{\circ}C$.

How much time will it take to cool from $60^{\circ}C$ to $30^{\circ}C$?

The temperature of surroundings is $20^{\circ}C$.

A. 9 minutes

B. 10 minutes

C. 11 minutes

D. 12 minutes

Answer: D

Watch Video Solution

8. Two spherre of the same material and radii 4 m and 1m respectively are at temperature 1000 K and 2000 K respectively. The ratio of energies radiated by them per second is

A. $1:2$

B. $2:1$

C. $1:1$

D. $1:4$

Answer: C

Watch Video Solution

9. Why the walls and roof of the green house are made of glass ?

A. The glass equally transmits the radiations from the sun as well as those from outside

B. The glass transmits the radiations coming from sun but not those given out by the bodies inside

C. The glass absorbs most of the radiations coming from sum

D. The glass neither transmits nor absorbs any radiation coming from sun

Answer: B

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10. Cloudy nights are warmer than the nights with clean sky. Explain.

A. clouds absorb heat in the day and supply it in the night

B. clouds reflect back heat radiations to the erath

C. clouds absorb cold radiations and reflect back hot radiations

D.

Answer: B

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Fill in the Blanks E

1. A mode of transfer of heat from one part of the body to another part, from paticle to particle in the direction of fall of temperature without any actual movement of the heated particle is called....

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2. Sea breeze is caused by ....

Watch Video Solution

3. The state of the rod, in which temperature of each part becomes constant and there is no further absorption of heat anywhere in the rod during propagation of heat is called..........

Watch Video Solution

4. The rate of flow of heat per unit area per unit temperature gradient across the solid is called...........

Watch Video Solution

5. When the animals feel cold, they curl their bodies into the .... So as to .... The surface area of their bodies.

Watch Video Solution

6. A cloudy night is .... then a .... night.

Watch Video Solution

7. Which metal is the best conductor of heat?

Watch Video Solution

8. Stainless steel cooking pans are perferred with extra copper bottoms. Why?

Watch Video Solution

9. During transfer of heat, if path of heat transfer is straight line, the mode of transmission of heat is.........

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10. if the process of transfer of heat is slow, then it can be............. Process.

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Problmes for Practice

1. What force would be required to stretch a streel wire fo $4mm^2$ cross section, so that its length becomes 3 times its original length ? Given that Young's modulus of the meterial of the steel wire is $2.4 \times 10^{12} dy \ne / cm^2$.

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2. What is the percentage increase in length of a wire of diameter 3.0 mm stratched by a force 150 kg wt ? Young's modulus of elasticity of wire is $12.5 \times 10^{11} dynecm^{-2}$

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3. A steel wire of length 4 m and diameter 5 mm is stretched by kg-wt. Find the increase in its length if the Young's modulus of steel wire is $2.4 \times 10^{12} dynecm^{-2}$

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4. A wire elongates by 8 mm when a load of 9 kg is suspended from it. What is the elongation when its radius is doubled, if all other quantites are the same as before ?

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5. Two parallel wires A and B of same meterial are fixed to rigid support at the upper ends and subjected to same load at the lower ends. The subjeted to same load at the lower ends. The lengths of the wire are in the ration 4 : 5 and their radii are in the ratio 4 : 3 the increase in the length of wire A is 1 mm. Calculate the increase in the length of wire A is 1mm. Calculate the increase in the length of the wire B.

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6. A wire loaded by a weight of density $7.8 g/cc$ is found to be of length 100 cm. On immersing the weight in water. The length decrease by 0.20 cm find the original length of the wire.

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7. The breaking stress of aluminium is $7.5 \times 10^7 Nm^{-2}$ Find the greatest length of aluminum wire that can hang vertically without breaking Density of aluminium is $2.7 \times 10^3 kgm^{-3}$

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8. Two exactly similar wires of steel and copper are stretched by equal forces. If the total elogation is 1cm.

Find by how much is each wire elongated ? Given Y for steel

$= 20 \times 10^{11} dyne/cm^2$ and Yf or $copper = 12 \times 10^{11} dyne/cm^2$

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9. A mass of 100 grams is attached to the end of a rubber string 49 cm. long and having an area of cross section 20 sq. mm. The string is whirled round, horizontally at a constant speed of 40 r.p.s in a circle of radius 51 cm. Find Young's modulus of rubber.

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10. Two wires of equal cross section but one made of steel and the other of copper, are joined end to end. When the combination is kept under tension, the elongations in the two wires are found to be equal. Find the ratio of the lengths of the two wires. Young modulus of steel $= 2.0 \times 10^{11} Nm^{-2}$ and that of copper $= 1.1 \times 10^{1} Nm^{-2}$

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11. A lift is tied with a thick iton wires and its mass is 800 kg. if the maximum ac celeration of lift is $2.2 ms^{-2}$ and the maximum safe stress is $1.4 \times 10^{8} Nm^{-2}$ find the minimum diameter of the wire take $g = 9.8 ms^{-2}$

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12. A spherical ball contracts in volume by 0.01% when subjected to a normal uniform pressure of 100 atmospheres. Calculate the bulk modulus of the meterial.

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13. Find the change in volume which 1c.c. of water at the surface will undergo, when it is taken to the bottom of the lake 100 m deep, given that volume elasticity is 22000 atmosphere.

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Watch Video Solution

14. A solid ball 3 cm in diameter is submeraged in a lake at such a depth that the pressure exerted by water is $1 kgf / sq$ cm. Find the change in volume of the ball if bulk modulus of ball is $10^7 dyne / sqcm$.

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15. what will be the density of lead under a pressure of $3 \times 10^8 Nm^{-2}$? Given normal density of lead is $11.4 g / cm^3$ and Bulk modulus of lead is $8.0 \times 10^9 Nm^{-2}$

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16. If the normal density of sea water is $1.00 g/cm^3$, what will be its density at a depth of 4km? Given compressibility of water = 0.00005 per atmosphere. 1 atmospheric pressure $= 10^6 dyne/cm^2, g = 980 cm/s^2$.

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17. Calculate the pressure requird to stop the increase in volume of a copper block when it is heated from $60^{\circ} C$ to $80^{\circ} C$. Coefficient of linear expansion of copper is $8.0 \times 10^{-6}, .^{\circ} C^{-1}$ and Bulk modulus of elasticity $= 3.6 \times 10^{11} Nm^{-2}$

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18. A metallic cube whose each side is 10 cm is subjected to a shearing force of 100 kgf. The top face is displaced through 0.25 cm with respect to the bottom ? Calculate the shearing stress, strain and shear modulus.

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19. A square lead slab of side 50 cm and thickness 10 cm is subjected to a shearing force (on its narrow face) of $9 \times 10^4 N$. The lower edge is riveted to the floor. How much will the upper edge be displaced? (Shear modulus of lead $= 5.6 \times 10^9 Nm^{-2}$)

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20. A rubber cube of side 8 cm has one side fixed, while a tangential force equal to the weight fo 300 kilogram is applied to the opposite face. Find the shearing strain produced and distance through which the strain side moves. Modulus of rigidity for rubber is $2 \times 10^7 dynecm^{-2}$

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21. Two parallel and opposite forces each 5000 N are applied tangentially to the upper and lower faces of a cubical metal block of side 25 cm. the angle of shear is (The shear modulus of the metal is 80 Gpa)

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22. A wire suspended vertically from one of itsends is strached by attached a weight of $200N$ to the lower end . The weight streches the wire by $1mm$. Then the elastic energy stored in the wire is

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23. A steel wire of 4.0 m is stretched through 2.0 mm. The cross - sectional area of the wire is $2.0mm^2$. If young's modulus of steel is $2.0 \times 10^{11}Nm^{-2}$ find (i) the energy density of the wire, (ii) the elastic potential energy stored in the wire.

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24. When load on a wire is increased from 4 kgf to 6 kgf, the elongation increases from 0.71 mm to 1.12 mm. Find the workdone during the extension of the wire.

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25. A 45 kg boy whose leg bones are $5cm^2$ in area and 50 cm long falls through a height of 2m with out breaking his leg bones. If the bones can stand a stress of $0.9 \times 10^8 Nm^{-2}$, Calculate the Young's modulus for the material of the bone. Use , $g = 10ms^{-2}$

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26. A load of 31.4 kg is suspended from a wire of radius 10^{-3} m and density $9 \times 10^3 kg/m^3$ Calculate the change is temperature of the wire if 75% of the work done is converted into heat. The Young's modulus and the specific heat capactiy of the meterial of the wire are $9.8 \times 10^{10} N/m^2$ and $490 J/kg/K$ respectively.

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27. One end of a nylon rope of length 4.5 m and diameter 6 mmis fixed to a tree limb. A monkey weighing 100 N jumps to catch the free end and stays there. Find the elongation of the rope and the corresponding change in the diameter. Young modulus of nylon =0.2.

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28. A 5 kg mass is attached to one end of a copper wire 2m long and 2mm in diameter. Calculate the leteral compression produced in it. Posisson's ration is 0.3 and Young's modulus of the meterial of the wire is $12.5 \times 10^{10} Nm^{-2}$

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29. A material has Poisson's ratio 0.5, If a uniform rod of it suffers a longtiudinal strain of 2×10^{-3} then the percentage increases in its volume is

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30. When the weight on a string is change from 3.0 kg to 5.0 kgs the elengation changes from 0.61 mm to 1.02 mm. How much work is done during this extension of the string ? Find the Young's modulus of meterical of string if it is 1m in length and has a cross-sectional area $0.4 \times 10^{-4} m^2$.

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31. A solid sphere of radius R made of a material of bulk modulus K is surrounded by a liquid in a cylindrical container. A massless pistion of area A floats on the surface of the liquid. When a mass M is placed on the piston to compress the liquid the fractional change in the radius of the sphere, $\delta R / R$, is ....

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32. A rubber cord has a cross -sectional area $1mm^2$and total unstretched length$10.0cm$. It is streched to $12.0cm$ and then released to project a missile of mass 5.0 g.Taking young's modulus Y for rubber as $5.0 \times 10^8 N/m^2$ .Calculate the velocity of projection .

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33. A steel wire 2mm in diameter is stretched between two clamps, when its temperature is $40\ ^{\circ}C$ Calculate the tension in the wire, when its temperature falls to $30\ ^{\circ}C$ Given, coefficient Y for steel $= 21 \times 10^{11} dyne/cm^2$

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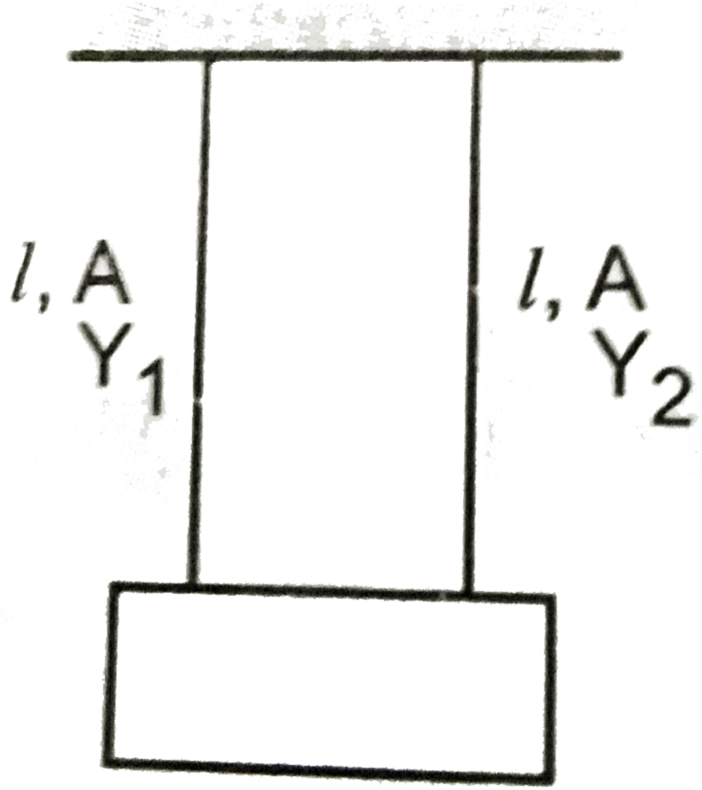
34. Two wires of equal length and cross sectional area suspended as shown in



Their Young's modulii are $Y_1 = 2 \times 10^{11}$ Pa and $Y_2 = 0.90 \times 10^{11}$ Pa respectively. What will be the equivalent Young's modulus of combination?

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35. A bob of 1 kg wt is suspended by a rubber cord 2m long and of cross section $0.5cm^2$ it is made to descrbie a horizontal circle of radius 50cm, 4 times a second. Find the extension of the cord, Young's modulus of rubber is $5 \times 10^8 N/m^2$

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36. A wire of cross -sectional area $4 \times 10^{-4} m^2$, modulus of elasticity $2 \times 10^{11} Nm^{-2}$ and length 1 m is stretched between two rigid poles . A mass of 1 kg is suspended at its middle . Calculate the angle it makes with horizontal . Take g = $10 ms^{-2}$

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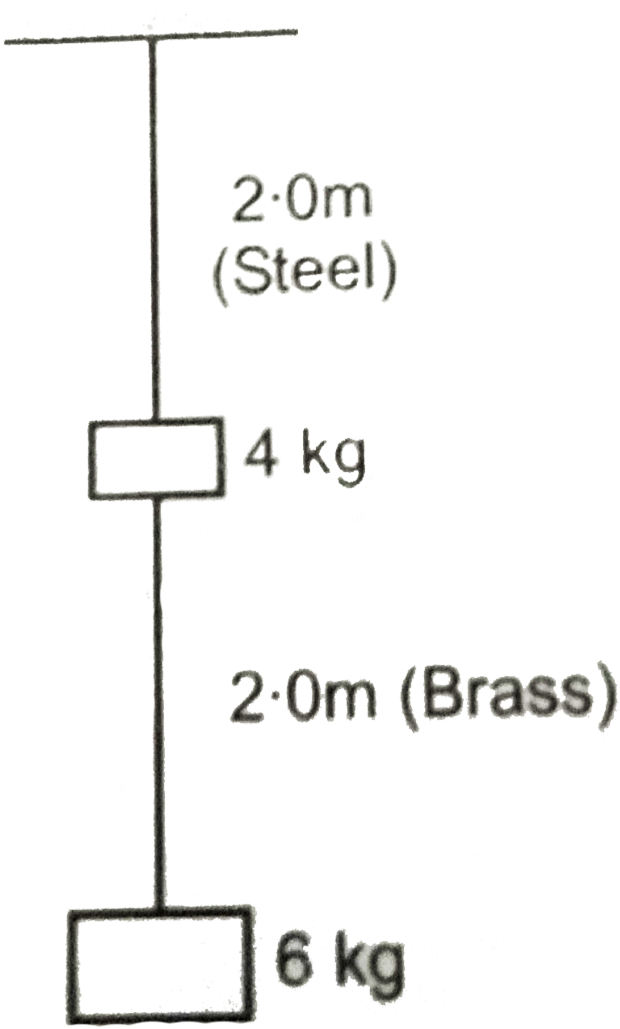
37. Compute the elongation of the steel wire and brass wire in the given



Given unloaded length of steel wire = 2.0 m, unloaded length of brass wire = 1.0m. Area of cross-section of each wire $= 0.049cm^2$.

$Y_{steel} = 2 \times 10^{11} Pa$

and $Y_{Brass} = 0.90 \times 10^{11} P_a, g = 9.8ms^{-2}$

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38. A barometer kept in an alevator ac celerating upward reads 76 cm of mrecury. If the elevator is ac celerating upwards at $4.5ms^{-2}$ find the air pressure in the elevator in cm of mercury. Density of mercuty $= 13.6 \times 10^3 kgm^{-3} G = 9.8m/s^2$

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39. The gauge perrssure in both the tyres of a bicycle is $7.0 \times 10^5 Pa$ If the bicycle and the person riding it have a combined mass of 100 kg. find the area of contact of each tyre with ground.Use $g = 10ms^{-2}$

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40. How much pressure will a boy of wieght 50 kg f exert on the ground when (i) he is lying on ground and (ii) he is standing on his feet ? It is given that the area of the body of the boy is $0.5m^2$ and that of foot is $60cm^2$. Use $g = 10m/s^2$.

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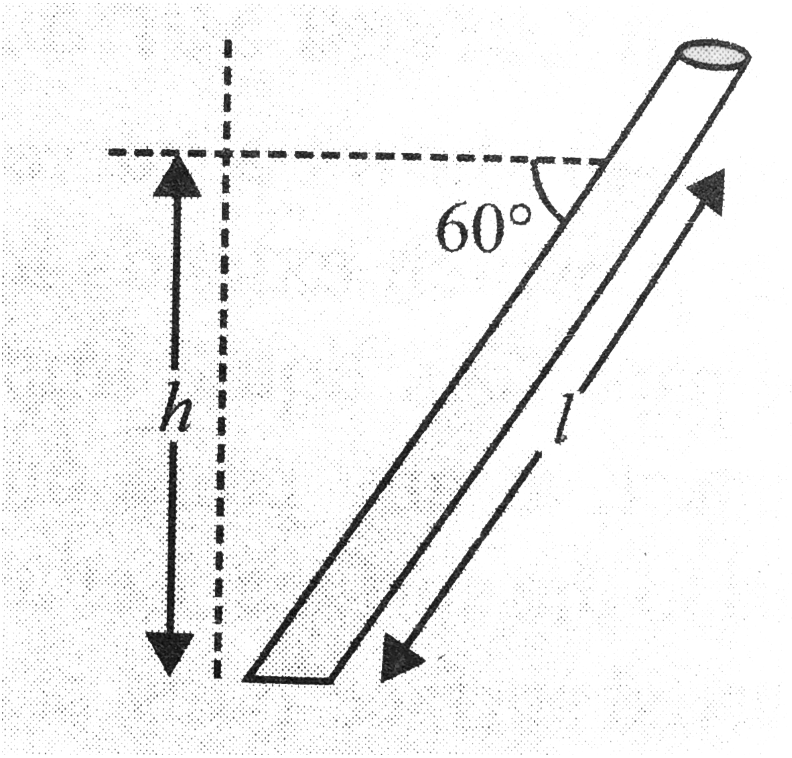
41. What will be the length of mercury column in a barometer tube when the atmospheric pressure is $75 cm$ of mercury and the tube is inclined at an angle of 60° with the horizontal direction?



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42. The menual of a car instructs the owner to inflate the tyres to pressure of 200 kPa. (a) What is the recommended gauge pressure ? (b) What is the recommended absolute pressure ? (c) If after the required inflation of the tyres, the car is driven to a mountain peak. where the atmospheric pressrre is 10 % below that at sea level, what will be the tyre gauge read ? Atmospehric pressure $= 1.01 \times 10^5 Pa.$

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43. A tank 5 m high is half filled with water and then is filled to top with oil of density $0.85 g/cm^3$ The pressure at the bottom of the tank, due to these liquids is

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44. The volume of an air bubble becomes 8 times the original volume in rising from the bottom of a lake to its surface. If the barometice height is 0.76 m of mercury (density of mercury is $13.6gcm^{-3}$ and $g = 9.8ms^{-2}$) what is the depth of the lake ?

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45. A loaded lory has a total weight of 12000 kg . Its 6 tyres are identical and show an air pressure of $50kgwt/cm^2$ each. If the load is distributed equally on all

6 tyres. Find the area of contact of each tyre with the road.

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46. A cylinder has a radius 10 cm. To what height should is be filled with water so that the thrust in its walls is equal to that on its bottom ?

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47. Reading of a barometer at the top and ground floors of a buliding are 75.000 cm. and 75.125 cm. respectively.

The density of mercry is $13600 kg/m^2$ and that of air is $1.36 kg/m^2$ What is the height of the buliding ?

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48. A room has length 16 m, breadth 12m and height 10 m. The air pressure inside the entire room is 100 k Pa. Find the force exerted by air on the (i) floor (ii) sides of the room.

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49. The neck and bottom of a bottle are 2 cm and 20 cm in diameter respectively if the cork is pressed with a force of 1.2 kgf in the neck of the bottle, calculate the force exerted on the bottom of the bottle.

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50. In car lift compressed air exerts a force F_1 on a small piston having a radius of 5 cm. This pressure is transmitted to a second piston of radius 15 cm. If the mass of the car to be lifted is 1350 kg, what is F_1? What is the pressure necessary to ac complish this task ?

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51. A hydraulic press with the larger piston of diameter 35 cm at a heigth of 1.5 m relative to the smaller piston of diameter 10 cm. The mass on the smaller piston is 20 kg. What is the force exerted on the load placed. On the larger piston ? The density of oil in the press is $750kgm^{-3}$

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52. The neck and the bottom of a bottal of a bottle filled with incompressible liquid are 3 cm and 8 cm in diameter respectively. If the cork is pressud with a force 1.4 kg f in the neck of the bottle, find the force exerted on the bottom of the liquid.

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53. An automobile back is lifted by a hydraulic jack that consists of two pistons. The large piston is 70 cm in diameter and the small piston is 8 cm in dimater. If W is the weight of the car, how much smaller a force is required on the small piston in order to lift the car ?

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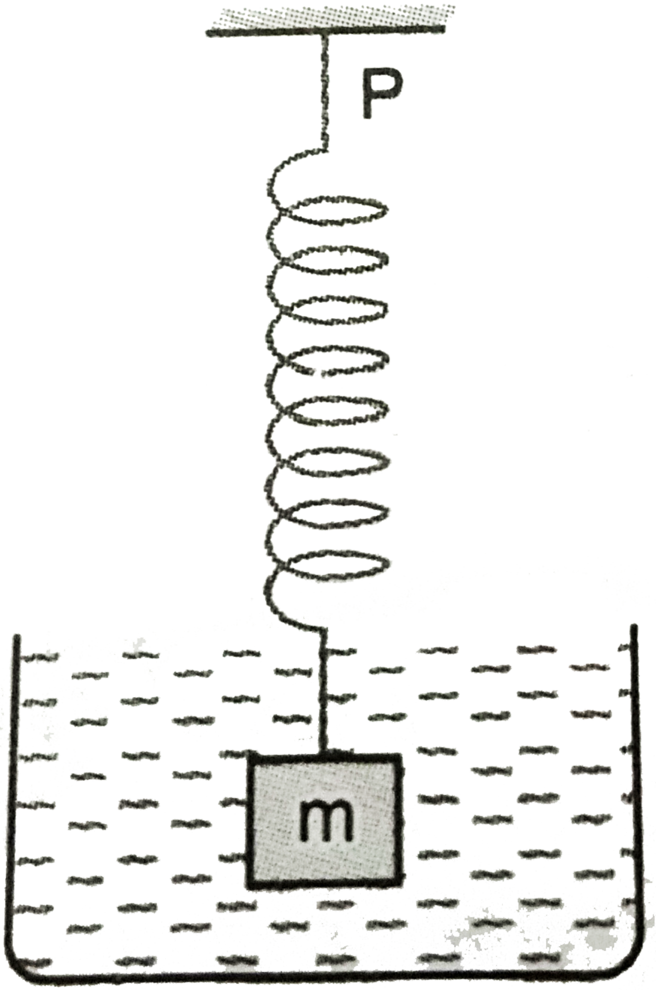
54. A cube of mass m and densituy D is suspended from the point P by a spring of stiffness k,



The system is kept inside a beaker filled with a liquid of density d, where D gt d. What is the elongation in the spring ?

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55. A wooden cube floating in water supports a mass 0.2 kg on its top. When the mass is removed the cube rises by 2cm. What is the side legnth of the cube ? Density of water $= 10^3 kg/m^3$

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56. A boat having a length 4m and breadth 2.5 m is floating on lake. The boat sinks by 2 cm when a load is loaded on it. What is the weight of the load ? Use $g = 10ms^{-2}$, density of water $= 10^3 kgm^{-3}$

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57. When a body of mass 240 kg is placed on a ice berg floating in sea water, it is found that the ice berg just sinks. What is the mass of the ice berg ? Take the relative density of ice as 0.9 and that of seac water as 1.02.

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58. A solid shell loses half of its weight in water. Relative density of shell is 5.0 What fraction of its volume is hollow ?

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59. A solid body floating in water has $\frac{1}{4}th$ of the volume above surface of water. What fraction of its volume will project upward if it floats in a liquid of specific gravity 1.1 ?

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60. A rubber ball of mass 10 gram and volume $15cm^3$ is dipped in water to a depth of 10m. Assuming density of water uniform throughtout the depth, find (a) the ac celeration of the ball, and (b) the time taken by it to reach the surface if it is relased from rest. $\left(Take g = 980cm/s^2\right)$

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61. A stone of density $2.5 \times 10^3 kgm^{-3}$ completely immersed in sea water is allowed to sink from rest in 2 s. Neglect the effect of vicosity. Relative density of sea water is 1.025.

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62. A spring balance reads 10 kg when a bucket of water is suspended from it. What is the reading on the spring balance when (i) an ice cube of mass 1.5 kg is put into the bucket (ii) an iron piece of mass 7.8 kg suspended by another spring is immersed with half its volume inside the water n the bucket. Relative density of iron = 7.8

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63. A sample of milk diluted with water has density $1036kgm^{-3}$. if pure milk has a density $1080kgm^{-3}$ what is the percentage of water by volume in milk ?

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64. A wooden ball of density D is immersed in water of density d to a depth h//2 below the surface of water and then relased. To what height will the ball jump out of water ?

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65. A concrete sphere of radius R has cavity of radius r which is packed with sawdust. The specific gravities of concrete and sawdust are respectively 2.4 and 0.3 for this sphere to float with its entire volume submerged under water. Ratio of mass of concrete to mass of swadust will be

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66. A thin soap film is formed on a U shaped wire loop having a slider (of negliglibe mass) of length 10 cm. it is found that the film can support a weight of 0.012 N, before it breaks. What is the surface tension of the film ?

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67. A squre wire frame of side 10 cm is dipped in a liquid of surface tension $28 \times 10^{-3} Nm^{-1}$ On taking out, a membrane is formed. What is the force acting on the surface of wire frame ?

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68. (a) A rectangular parallelopiped has diamensions $10cm \times 5cm \times 2.5cm$. Calculate (i) the radius of the sphere and (ii) the side of the cube which will have the same volume as the paralleopiped. (b) Which out of the three has miniumum surface area ?

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69. The meterial of a wire has density of 1.4 g/c c. If it is not wetted by a liquid of surface tension 44 dyne / cm., find the maximum radius fo the wire which can float on the surface of the liquid.

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70. A soap film is formed on a rectangular frame of 7 cm side dipping into a scop solution. The frame hangs from the arm of a balance. An extra weight of 0.4 gram is to be placed in the opposite pan to balance the pull on the frame. Caluclate the surface tension of the soap solution.

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71. A glass plate of length 10 cm., breadth 1.5 cm. and thickness 0.2 cm., weighs 8.2 gm. In air. It is held vertically with long side horizontal and half the plate immersed in water. What will be its apperent weight ? Surface tension of water = 73 dynes//cm.

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72. Calculate the work done in blowing out a soap bubble of diameter 1 cm. given that the surface tension of soap solution is $28 \times 10^{-3} Nm^{-1}$

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73. A soap film in on a rectangular wire of size 4 cm xx 4 cm. If the size of the film is changed to 5 cm xx 5 cm, then calculate the work done in this process. The surface tension of soap film is $6 \times 10^{-2} Nm^{-1}$

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74. A soap bubble is blown to a diameter of 7 cm. if 36960 ergs of work is done in blowing if further find the new radius, if surface tension of the soap solution is 40 dynes/cm.

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75. A liquid drop of diameter 4 mm breaks into 1000 droplets of equal size. Calculate the resultant change in surface energy, the surface tension of the liquid is $0.07Nm^{-1}$

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76. What amount of energy will be liberted if 1000 droplets of water each of diameter 10^{-6} cm. coalesce to from a bigger drop. Surface tension of water is $75 \times 10^{-3} Nm^{-1}$

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77. If a number of litle of droplets of water of surface tension S, all of the same radius r combine to from a single drop of radius R and the energy relased is converted into kinetic energy. Find the velocity acquired by the bigger drop. If the energy relased in converted inot heat, find the rise in temperature.

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78. A small hollow sphere which has a small hole in it is immersed in water to a depth of 40 cm, before any water is penetrated into it. If the surface tensionof water si $0.073Nm^{-1}$, find the radius of the hole.

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79. A glass tube of 1mm diameter is dipped vertically into a tube of mercury, with its lower end 3 cmm below the mercury surface. What must be the gauge pressure of air in the tube to blow a hemispherical bubble at its lower and ? Given, density of mercury $= 13.6g/cc$ and surface tension of mercury $= 0.540Nm^{-1}. g = 10ms^{-2}$.

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80. Calculate the total inside a spherical air bubble of radius 0.1 mm at a depth of 10 cm below the surface of a liquid of density 1.1 g/c.c and surface tension 50 dynes/cm. (Height of Hg barometer = 76 cm).

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81. There is an air bubble of radius 2.0 mm in a liquid of surface tension $0.070Nm^{-1}$ and density $10^3 kgm^{-3}$ The bubble is at a depth of 12.0 cm below the free surface of liquid. By what amount is the pressure inside the bubble is greater then the atmospheric pressure ? Use $g = 10m/s^2$.

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82. The excess pressure inside a soap bubble of radius 5 mm in balanced by 3 mm column of oil of specific gravity 0.6 Find the surface tension of soap solution.

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83. Mercury in a capillary tube suffers a depression of 13.2 mm. Find the diameter of the tube. If angle of contact of mercury is $140\,^\circ$ and density $13.6 \times 10^3 kgm^{-3}$

Surface tension of mercury is $540 \times 10^{-3} Nm^{-1}$

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84. The tube of mercury barometer is 4mm in diameter. How much error does the surface tension cause in the reading? Surface tension of mercury = $540 \text{ x } 10^{-3} Nm^{-1}$, angle of contact = $135\,^\circ$. Density of mercury $= 13.6 \times 10^3 kgm^{-3}$.

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85. Water rises to a height of 10 cm. in a certain capillary tube. If in the same tube, level of Hg is depressed by 3.42 cm., compare the surface tension of water and mercury. Sp. Gr. Of Hg is 13.6 the angle of contact for water is zero and that for Hg is 135°.

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86. Water rises in a capillary tube to a height 2.0 cm. In an another capillary tube whose radius is one third of it, how much the water will rise ? If the first capillary tube is inclined at an angle of 60° with the vertical then what will be the position of water in the tube.

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87. One end fo a capillary tube of radius r is immersed verticaly in water and the mass of water rises in the capillary tube is 5 g. if one end of another capillary tube of radius 2 r is immersed vertically in water, what will be the mass of water that will rise in it ?

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88. When a capillary tube of radius r is immersed in a liquid of density ρ, the liquid rises to a height h in it. If m is the mass of the liquid in the capillary tube, find the potential energy of this mass of the liquid in the tube.

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89. Water rises in a capillary tube to a height of 2.5 cm. in another capillary tube whose radius is one third of it, how much the water will rise ? If the first capillary is inclined at an angle 30° With the vertical, then water will be the position of water in the tube ?

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90. A capillary tube whose inside radius is 0.6 mm is dipped in water in a bucket of surface tension 75 dyn e cm^{-1} To what height is the water raised in the capillary tube above the level water in bucket ? What is the weight of water raised ?

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91. Two air bubbles of radii 0.002 m and 0.004 m of same liquid come together to form a single bubble under isothermal condition. Find the radius of the buble formed. Given surface tension of liquid is $0.072 Nm^{-1}$

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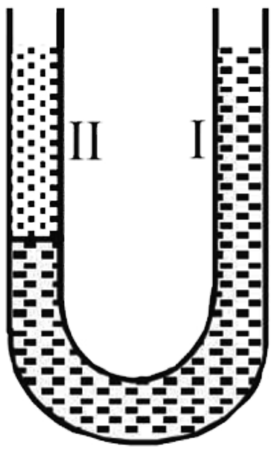
92. A U-tube of uniform cross section (see figure) is partially filled with a liquid I. Another liquid II which does not mix with liquid I is poured into one side. It is found that the liquid levels of the two sides of the tube are the same, while the level of liquid I has risen by 2cm. If the specific gravity of liquid I is 1.1, the specific gravity of liquid II must be



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93. What is the power requird to raise 300 liters of water per minute through a height of 6 m using a pipe of diameter 2.5 cm ? $g = 10m/s^2$.

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94. A given mass of a gas is subjected to an external pressure of $0.5 \times 10^{10} Nm^{-2}$ the bulk modulus of the gas is $0.5 \times 10^{10} Nm^{-2}$ Find the ratio of the density of the gas before and after applying the external pressure.

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95. Two pistons of hydraulic press have diameter of $30.0cm$ and $2.5cm$, find the force exerted on the longer piston when 50.0 kg wt. is placed on smaller piston.

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96. If a number of litle of droplets of water of surface tension S, all of the same radius r combine to from a single drop of radius R and the energy relased is converted into kinetic energy. Find the velocity acquired by the bigger drop. If the energy relased in converted inot heat, find the rise in temperature.

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97. A long capillary tube of radius 2 mm open at both ends is filled with water and placed vertically, What will be the height of the coluum of water left in the capillary ? The thickness of the capillary walls is negligible. Surface tension of water is $73.5 \times 10^{-3} Nm^{-1}$

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98. A squre metal plate of 10cm side moves parallel to another plate with a velocity of $10 cms^{-1}$, both plates immersed in water. If the viscous force is 200 dyne and viscosity of water is 0.01 poise, what is their distance a part.

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99. A flat plate of 20 cm squre moves over another similar plate with a thin layer of 0.4 cm of a liquid between them. If a force of one kg. wt. moves one of the plates uniformly with a velocity with a velcoity of $1ms^{-1}$ calculate the strain rate, sheraing stres and coefficient of viscosity.

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100. in a plate, a sucrose solution of coefficient of visocity $1.5 \times 10^{-3}Nsm^{-2}$ is driven at a velocity of $10^{-3}ms^{-1}$ throught x ylem vessel of radius 2μ m and length5μm. Find the hydrostatic pressure difference across the length of xylem vessel.

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101. A capillary tube of 1mm diameter and 20 cm long is fitted horizontally to a vessel kept full of alcohol of density 0.8 gm//c.c. The depth of centre of capillary tube below the surface of alcohol is 20 cm. If the visosity of oil is $0.12 dynecm^{-2}$ s, find the amount of liquid that will flow in 5 minuts.

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102. Two capillary tubes of length 15 cm and 5 cm and radii 0.06 cmand 0.02 cm respectively are connected in series. If the pressure difference across the end faces is equal to pressure of 15 cm high water column, then find the pressure difference across the (i) first tube and (ii) second tube.

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103. A liquid flows through a pipe 1.0 mm radius and 20 cm length under a pressure of $10^4 dyne/cm^2$ Calculate (i) the rate of flow and (ii) the speed of the liquid coming out of the tube. The coefficient of viscosity of liquid is $1.23 \times 0^2 dynecm^{-2}s$.

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104. Two tubes A and B of length 80 cm and 40 cm have radii 0.1 mm and 0.2 mm respectively are connected in series end to end. If a liquid passing through tow tubes is entering A at a pressure of 82 cm of mercury and leaving B at a pressure of 76 cm of mercury. Find the pressure at the junction of A and B.

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105. The level of liquid in a cylindrical vessel is kept constant at 30cm. It has three identical horizontal tubes A, B and C of length 40 cm each coming out at heights 0, 5 and 10 cm respectively. Calculate the length of a single overflow tube of the same radius as that of identical tubes which can replace the three when placed horizontally at the bottom of the cylinder.

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106. If two capillary tubes of radii r_1 and r_2 and having length l_1 and l_2 respectively are connected in series across a heaed of pressure p, find the rate of flow of the liqid through the tubes, if η is the coefficient of viscosity of the liquid.

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107. What is the viscous force on the drop of liquid of radius 0.2 mm moving with a constant velocity $4cms^{-1}$ throught a medium of viscosity $1.8 \times 10^{-5}Nm^{-2}s$.

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108. An air bubble of $10mm$ radius is rising at a stready rate of $2mm/\sec$ through a liquid of density $1.47 \times 10^{8}kgm^{-3}$. Calculate the coffe. Of viscosity of liquid $\left(g = 9.8ms^{-2}\right)$ neglect density of air.

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109. The terminal velocity of a copper ball of radius $2mm$ falling through a tank of oil at $20^{\circ} C$ is $6.5 cm/s$. Find the viscosity of the oil at $20^{\circ} C$. Density of oil is $1.5 \times 10^3 Kg/m^3$, density of copper is $8.9 \times 10^3 Kg/m^3$.

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110. With what terminal velocity will an air bubble of density $1 kgm^{-3}$ and 0.6 mm diameter rise in a liquid of viscosity $0.15 Nsm^{-2}$ and specific gravity 0.9 ? What is the terminal velocity of the same bubble in water of $\eta = 1 \times 10^{-3} Nsm^{-2}$?

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111. Two equal drops of water falling through air with a steady velocity $5cm/s$. If the drops combire to from a single drop, what will be new terminal velocity?

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112. Eight rain drops of radius $1mm$ each falling downwards with a terminal velocity of $5cmc^{-1}$ coalesce to form a bigger drop. Find the terminal velocity of bigger drop.

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113. If n equal rain droplets falling through air with equal steady velocity of $10cms^{-1}$ coalesce, find the terminal velocity of big drop formed.

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114. The flow rate from a tap of diameter $1.25cm$ is 3 L//min. The coefficient of viscosity of water is 10^{-3} pa-s. Characterize the flow.

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115. What should be the average velocity of water in a tube of diameter $0.4cm$ so that the flow is (i) laminar (ii)turbulent ? The viscosity of water is $10^{-3}Nm^{-2}s$.

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116. What is the maximum flow rate of water (in m^3s^{-1}) for laminar flow in a pipe having diameter of 6 cm. Given that coefficent of viscosity of water is 0.01 poise. Density of water 10^3kgm^{-3}.

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117. Water flow through horizontal pipe of varying cross-section at the rate of $1/2$ liter per second. Determine the velocity of flow of water at a point where the diameter is (a) $4cm$ (b) $2cm$.

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118. Water flow at a speed of $7cms^{-1}$ through a pipe of tube of radius $1.5cm$. What is the nature of the flow ? Cofficient of viscosity of water is $10^{-3}kgm^{-1}s^{-1}$ and its density is $10^{3}kgm^{-3}$

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119. A boat strik with under water rock which creates a hole $4cm$ in diameter in the hull which is $1.2m$ below the water line. At what rate in litre per second dose water enter?

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120. At what speed will the velocity head of a stream of water be equal to 20 cm of mercury . Taking $\left(g = 10ms^{-2}\right)$.

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121. Calculate the total energy possessed by one kg of water at a point where the pressure is $30gf/mm^2$, velocity is $0.1ms^{-1}$ and height is $60cm$ above the ground level.

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122. Water flows along the horizontal pipe of which the cross-section is not uniform. The pressure is $30mm$. Of Hg where the velocity is $0.20ms^{-1}$. Find the pressure at a point where the velocity is $1.20ms^{-1}$.

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123. Water flow through a horizontal pipe. The area of cross-second at one place $A_1 = 10cm^2$, velocity of water flow is $1ms^{-1}$ and pressure is 2000 Pa. At another place area $A_2 = 5cm^2$. Whate is the pressure at area A_2 ?

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124. Each of the two wings of an aeroplane has area $30m^2$. The speed of the air on the upper and lower surfaces of theon the wing of aeroplane are $90ms^{-1}$ and $70ms^{-1}$ respectively. If the plane is in level flight at constant speed, find the uplift and the mass of the aeroplane. Given density of air $= 1.29kgm^{-3}$.

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125. 600 kg. of water is to be pumped in a tank per minute under the perssure of 10 g. wt//sq. mm. Find the horse power needed. $1H.P. = 746$ watts.

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126. A hole of area $1mm^2$ opens near the bottm of a large- water storage tank, and a stream of water shoots from it. If the top of water in the tank is to be kept at 20 m above the point of leak , how much water in litres//s should be added to the reservoir tank to keep this level ? $\left(g = 10m/s^2\right)$.

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127. Water flows at the rate of 4 litres per second through an orifice at the bottom of tank which contains water 720 cm deep .Find the rate of escape of water if additional pressure of 16 $kg\frac{f}{(cm)^2}$ is applied at the surface of water.

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128. What is filled in a cylindrical container to a height of $3m$. The ratio of the cross-sectional area of the orifice and the beaker is 0.1. The square of the speed of the liquid coming out from the orifice is $\left(g = 10m/s^2\right)$.

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129. A boat strik an under water rock which rock which is $2.0m$ below the water line. How much water in litre will enter the boat in 1 minute? (use g $= 10ms^{-2}$)

Watch Video Solution

130. Air of density $1.3kg/m^3$ flow horizontally with a speed $106km/h$. A house has a plane roof of area $40m^2$. Find the magnitude of aerodynamic lift on the roof.

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131. The opening near the bottom of the vessel shown in the figure has an area A. A disc is held against the opening keep the liquid from running out. Let F_1 be the net forces on the disc applied by liquid and air in this case. Now the disc is moved away from the opening a short distance. The liquid comes out and strikes the disc in elastically. Let F_2 be the force exerted by the liquid in this condition. The F_1/F_2 is

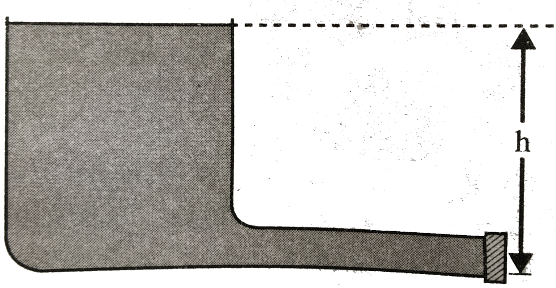

Fig. 4.183

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132. A cubical vessel of height 1 m is full of water. What is the workdone in pumping water out of the vessel?

Watch Video Solution

133. The dimeter of a pipe at two point, where a venturimeter is connection is 9 cm 4 cm and the difference of level in it is 4 cm. Calculate the volumw of water flowing through the pipe per second.

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134. A large open tank has two holes in the wall. One is a square hole of side L at a depth h from the top and the other is a circular hole of radius r at a depth $4h$ from the top. Whwn the tank is completely filled with water, the quantity of water flowing out per second from both the holes are the same. What is the value of r?

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135. A venturimeter is $37.5cm$. Diameter in mains and $15cm$. Diameter in throat. The difference between the pressure of water in the mais and the throat is $23cm$ of Hg. Find the discharge in $litres/\min unte$. Sp. Gravity of Hg. 13.56.

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136. A venturimeter is connected to two points in the mains where its radii are $20cm$. And $10cm$. Respectively and the levels of water column in the tube differ by $10cms$. How much water flows through the pipe per minute?

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137. The rate of flow of the liquid through the tube of length l and radius r, connected across a perssure haed h be V. If two tubes of the same length but of radius r and $r/2$ are connected in series, across the same pressure head h, find the rate of flow of liquid through the combination. If both the tubes are connected inparallel to the same pressure head, then find the rate of flow of liquid through the combination.

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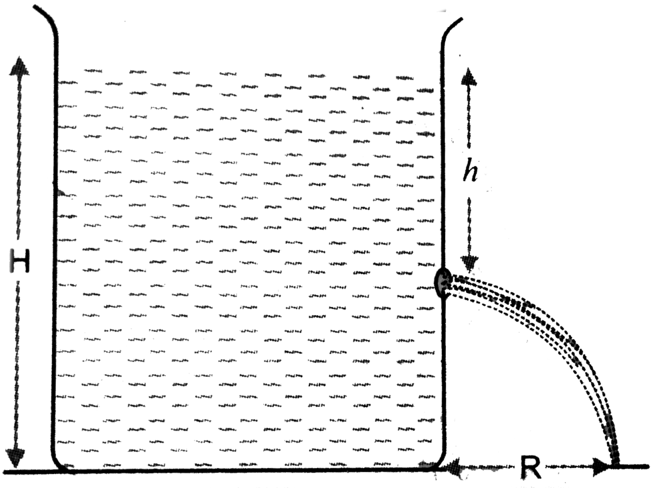
138. Water stand at a heigh H in a tank whose sides are vertical. An orifice is made at the depth h on one of the wall Fig. $7(c).25$. The emerging stream of water strikes at the distance R from the tank on the floor./ Find the relation for R in term of h, and H. When R is maxmimum, how h and H are related.



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139. There capillaries of length l, $2l$ and $l/2$ are connected in series. Their radii are r, $r/2$ and $r/3$ respectively. If stream line flow is maintained and the pressure difference across the first capillary tube is P_1,

find the pressure difference across (i) the second and (ii) the thired capillary tube.

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140. Air is streaming past a horizontal air plane wing such that its speed is $120ms^{-1}$ over the upper surface and $90ms^{-1}$ at the lower surface. If the density of air is $1.3kgm^{-3}$m find the difference in pressure between the top and bottom of the wing. If the wing is $10m$ long and has an average width of $2m$, calculate the gross lift of the wing.

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141. Calculate the rate of flow of glycerine of density $1.25 \times 10^3 kgm^{-3}$ through the conical section of a pipe, if the radii of its ends are 0.1 m and 0.04 m and the pressure drop across its length is $10 Nm^{-2}$.

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142. The normal temperature of the human body is $98.4^\circ F$.Calculcate this temperature on celsius scale and absolute scale.

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143. At what temperature on celsius scale, the Farenheight scale reading is double of celsius scale reading?

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144. A faulty thermometer has its fixed points marked as 5° and 95°. The temperature of a bady as measured by the faulty therature is 59°. Find the correct temperature of the body on Celsisus scale.

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145. when a thermometer is taken from the melting ice to a warm liquid, the mercury level rises to $\frac{2}{5}th$ of the distance between the lower and the upper fixed points. Find the temperature of liquid in $.^{\circ}C$ and K.

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146. The volume of a metal sphere is increased by 2% of its original volume when it is heated from $300K$ to $604K$. Calculate the coefficient of linear, superficial and cubical expansion of the metal.

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147. An iron sphere has a radius $8cm$ at a temperature of $0\,^{\circ}C$. Calculate the change in volume of the sphere if is temperature is raised to $80\,^{\circ}C$. Coefficient of liner expansion of iron $= 11 \times 10^{-6}.\,^{\circ}C^{-1}$.

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148. It is required to prepare a steel metre scale, such that the millimetre intervals are to be ac curate within $0.0005mm$ at a certain temperature. Determine the maximum temperature variation allowable during the rulling of millimetre marks. Given, α for steel $= 1.322 \times 10^{-5}.\,^{\circ}C^{-1}$

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149. A clock with an Iron Pendulum keeps correct time at $20\,^{\circ}C$ How much will it lose or gain if temperature changes to $40\,^{\circ}C$? [Given cubical expansion of iron $= 36 \times 10^{-6}\,^{\circ}C^{-1}$]

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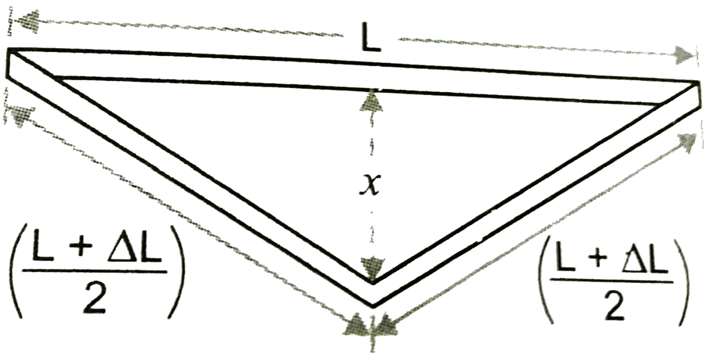
150. A rail track made of steel having $20m$ is clamped on a railway line at its two ends as show in Fig. $7(d).17$. On a summer day due to rise in temperature by $22\,^{\circ}C$, it is deformed as show in Fig. $7(d).17$ .Find displacement of the center (x) . Given cofficient of liner expansion of steel is $1.2 \times 10^{-5} . ^{\circ} C^{-1}$.



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151. When a 0.45 kg of ice at $0 ^{\circ} C$ mixed with 0.9 kg of water at $55 ^{\circ} C$ in a container, the resulting temperature is $10 ^{\circ} C$. Calculate the heat of fusion of ice. Specific heat of water is $4186 jkg^{-1} K^{-1}$.

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152. Calcuate the heat required to convert 0.6 kg of ice at - $20\ ^{\circ}C$, kept in a calorimeter to steam at $100\ ^{\circ}C$ at atmospheric pressure. Given the specific heat capacity of ice = $2100 jkg^{-1}K^{-1}$, specific heat capacity of water $= 4186 jkg^{-1}K^{-1}$ latent heat ice $= 3.35 \times 10^{5} jkg^{-1}$ and latent heat of steam $= 2.256 \times 10^{6} jkg^{-1}$

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153. A thermally isolated vessel contains 100g of water at $0\ ^{\circ}C$ when air above the water is pumped out, some of the water freezes and some evaporates at $0\ ^{\circ}C$ itself. Calculate the mass at $0\ ^{\circ}C = 2.10 \times 10^{6} j/kg$ and latent heat of fusion of ice $= 3.36 \times 10^{5} j/kg$.

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154. A piece of iron of mass $100g$ is kept inside a furnace for a long time and then put in a calorimeter of water equivalent $10g$ containing $240g$ of water at $20^{\circ}C$. The mixture attains an equilibrium temperature of $60^{\circ}C$. Find the temperature of the furnace.

Specific heat capacity of iron $= 470Jkg^{-1}.^{\circ}C^{-1}$

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155. A refrigeratior converts 50 gram of water at $15^{\circ}C$ intoice at $0^{\circ}C$ in one hour. Calculate the quantity of heat removed per minute. Take specific heat of water $= 1$ cal $g^{-1}. ^{\circ}C^{-1}$ and latent heat of ice $= 80$ cal g^{-1}

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156. A 50 g lead bullet (specific heat 0.02) is initially at $30^{\circ}C$. It is fired vertically upward with a speed of $840ms^{-1}$. On returning to the starting level it strikes a cake of ice at $0^{\circ}C$. How much ice is melted ? Assume that all energy is spent in melting only. Latent heat of ice $= 336jg^{-1}$.

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157. Calculate the ratio of specific heats for nitrogen. Given that the specific heat of nitrogen at cinstant pressure $= 0.236$ cal $g^{-1}K^{-1}$ and density at S.T.P. is $0.001234 g/cc$. Atmospheric pressure $= 1.01 \times 10^6 dyne/cm^2$.

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158. A tank of volume $0.2m^3$ contains helilum gas at a temp. of 300 K and pressure $10^5 N/m^2$. Find the amount of heat required to raise the temp. to 500 K. The molar heat capacity of helium at constant volume is $3.0 cal/mole\text{-}K$. Neglect any expansion in the volume of the tank. Take $R = 8.31 j/mole\text{-}K$.

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159. A cylinder of fixed capacity 44.8 litres constains helium gas at standard temperature and pressure. What is the amount of heat needed to raise the temperature of the gas in the cylinder by $15^\circ C$? Given $R = 8.31 jmole^{-1}K^{-1}$. (For monoatomic gas, $C_v = 3R/2$)

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160. Calculate difference in specific heats for 1 gram of air at $N.T.P.$ Given density of air at N.T.P. is $1.293 glitre^{-1}, j = 4.2 \times 10^7$ erg cal^{-1}.

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161. One mole of a monoatomic gas is mixed with 3 moles of a heat of the mixture at constant volume ? Take $R = 8.31 jmole/K$.

For monoatomic gas, $C_v = 3R/2$ and for diatommic gas, $C_p = 5R/2$.

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162. A tank of volume $0.2m^3$ contains helium gas at a temperature of $300K$ and pressure $1.0 \times 10^5 Nm^{-2}$. Find the amount of heat required to raise the temperature to $400K$. The molar heat capacity of helium at constant volume is $3.0 cal K^{-1} mol^{-1}$. Neglect any expansion in the volume of tank.

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163. Calculate the value of mechanical equivalent of heat from the following data. Specific heat capacity of air at constant volume =$170 cal kg^{-1} K^{-1}$, $\gamma = \frac{C_p}{C_v} = 1.4$ and the density of air at STP is $1.29 kg m^{-3}$. Gas constant $R = 8.3 J K^{-1} mol^{-1}$.

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164. 40 g of Argon is heated from $40^{\circ}C$ to $100^{\circ}C(R = 2cal/mol.)$ What is the heat absorbed at the constant volume by the Argon?

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165. The heat of combustion of ethane gas at 373 k cal per mole. Assume that 50% of heat is lost, how many litres of ethane measured at STP must be convert 50 kg of water at $10^{\circ}C$ to steam at $100^{\circ}C$? One mole of gas oc cupies 22.4 litres at STP. Take latent heat of steam $= 2.25 \times 10^6 jkg^{-1}$.

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166. Two moles of oxygen is heated at a constant pressure from $0^\circ C$. What must be the gas for the volume to be doubled ? The specific heat of oxygen under these condition is $0.218 cal g^{-1} K^{-1}$.

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167. From what heigh should a piece of ice fall so that it melts completely ? Only one quarter of the heat produced is absorbed by the ice. Latent heat of ice is $3.4 \times 10^5 jkg^{-1}$ and $g = 10ms^2$.

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168. A ball is dropped on a floor from a height of $2.0m$. After the collision it rises up to a height of $1.5m$. Assume that 40% of the mechanical energy lost goes as thermal energy into the ball.Calculate the rise in the temperature of the ball in the collision. Heat capacity of the ball is $800JK^{-1}$

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169. A slab of stone of area of $0.36m^2$ and thickness $0.1m$ is exposed on the lower surface to steam at $100^{\circ}C$. A block of ice at $0^{\circ}C$ rests on the upper surface of the slab. In one hour $4.8kg$ of ice is melted. The thermal conductivity of slab is

(Given latent heat of fusion of ice $= 3.63 \times 10^5 Jkg^{-1}$)

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170. Thick ness of ice on a lake is 5 cm. and the temperature of air is $-20\,^{\circ}C$. If the rate of cooling of water inside the lake be $20000 cal min^{-1}$ through each square metre surface, find K for ice.

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171. Steam at $100\,^{\circ}C$ is passed through a tubeof radius 5 cm and length 3 m. If the thickness of tube be 2 mm and conductivity of its material be 2×10^{-4} cal $cm^{-1}K^{-1}s^{-1}$, calculate the rate of loss of heat in js^{-1}. The outside temperature is $20\,^{\circ}C$.

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172. An iron boiler is 1 cm thick and has a heating area $2.5m^2$. The two surface of the boiler are at $230^\circ C$ and $100^\circ C$ respectively. If the latent heat of the steam is $540kcalkg^{-1}$ and thermal conductivity of iron is $1.6 \times 10^{-2}Kcals^{-1}m^{-1}K^{-1}$, then how much water will be evaporated into steam per minute ?

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173. Estimate the rate at which ice would melt in a wooden box 20 mm thick and of inside measurement 200 cm x 100 cm x 100 cm assumming that external temperature is $27^{\circ} C$ and coefficient of thermal conductivity of wood is $0.0004 cal s^{-1} cm^{-1}. {}^{\circ} C^{-1}$.

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174. Estimate the rate at which ice would melt in a wooden box 2.5 mm thick and of inside measurement 100 cm x 60 cm x 40 cm, assumming that external temperature is $32.^{\circ} C$ and coefficient of thermal conductivity of wood is $0.168 Wm^{-1} K^{-1}$. Given $L = 80 cal/g$.

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175. The outer face of a rectangular slab of equal thickness of iron and brass are maintained at $100^\circ C$ and $0^\circ C$, respectively. Find the temperature of the interface. The conductivities of iron and brass are 14 and $126 Wm^{-1}K^{-1}$ respectively.

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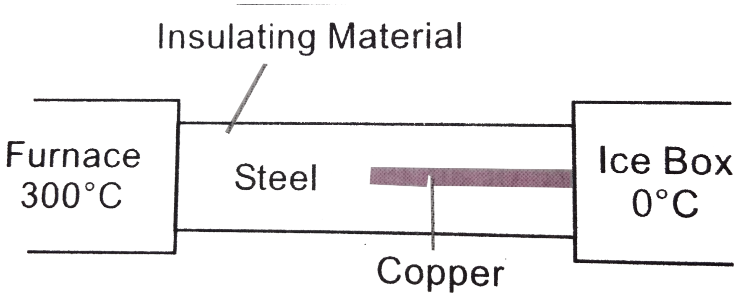
176. What is the temperature of the steel-copper junction in the steady state system show in Fig. $7(e).17$? Length of steel rod = 15.0 cm, length of the copper rod = 10.0 cm, temperature of the furnace $= 300^\circ C$, temperature of other end $0^\circ C$. The are of cross-section of the steel rod is twice that of the copper rod. (Thermal conductivity of steel $= 50.2 js^{-1}m^{-1}K^{-1}$ and of copper $= 3895 js^{-1}m^{-1}K^{-1}$).



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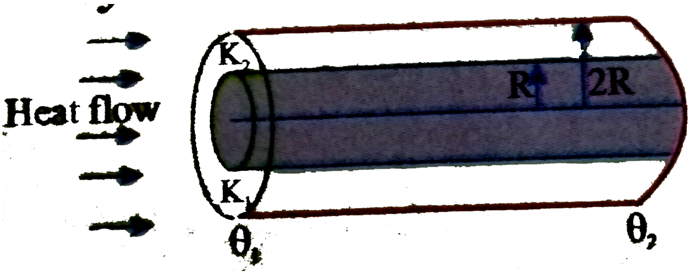
177. A cylinder of radius R made of a material of thermal conductivity K_1 is surrounded by cylindrical shell of inner radius R and outer radius $2R$ made of a material of thermal con-ductivity K_2 The two ends of the combined system are maintained at two differnet tem-peratures There is no loss of heat across the cylindrical surface and system is in steady state What is the effective thermal conductivity of the system



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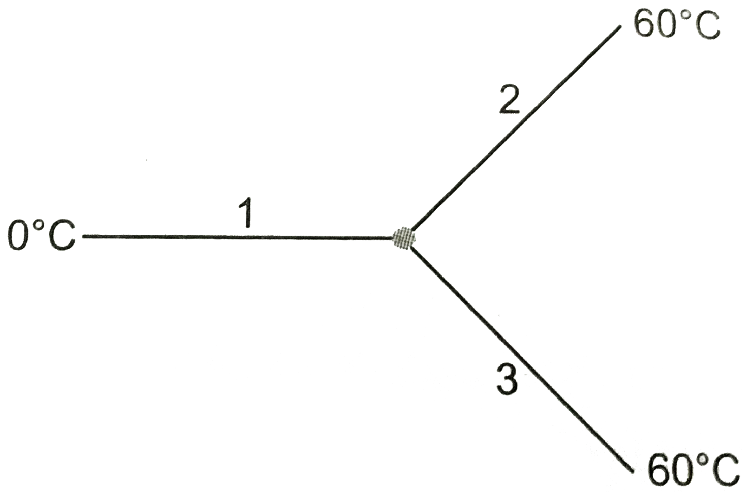
178. Three rods made of same material and having same cross-section have been joined as shown in Fig. 7(e).18. Each rod is of the same length. The left and the right ends are kept at $0\,^{\circ}C$ and $60\,^{\circ}C$ respectively. What is the temperature of the junction of the three rods.



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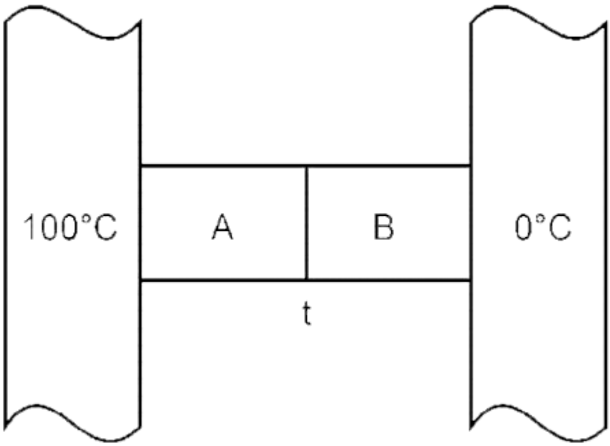
179. Two metal cubes A and B of same size are arranged as shown in Figure. The extreme ends of the combination are maintained at the indicated temperatures. The arrangement is thermally insulated. The coefficients of thermal conductivity of A and B are

$300 W/m^{\circ} C$ and $200 W/m^{\circ} C$, respectively. After steady state is reached the temperature t of the interface will be ......



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180. A liquid initally at $70^{\circ} C$ cools to $55^{\circ} C$ in 5 minutes and $45^{\circ} C$ in 10 minutes. What is the temperature of the surrounding ?

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181. A body cools from $70\ ^{\circ}C$ to $50\ ^{\circ}C$ in 6 minutes when the temperature of the surrounding is $30\ ^{\circ}C$. What will be the temperature of the body after further 12 minutes if coolilng proseeds ac cording to Newton's law of cooling ?

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182. A hot liquid kept in a beaker cools from $80\ ^{\circ}C$ to $70\ ^{\circ}C$ in two minutes. If the surrounding temperature is $30\ ^{\circ}C$, find the time of coolilng of the same liquid from $60\ ^{\circ}C$ to $50\ ^{\circ}C$.

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183. A calorimeter containing a hot lilquid is placed inside an enclosure whose walls are at $10\,^{\circ}C$ and cools from $80\,^{\circ}C$ to $60\,^{\circ}C$ in 10 minutes. How long will it take to cool from $60\,^{\circ}C$ to $40\,^{\circ}C$, if Newton's law of cooling holds good ?

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184. A body cools from $80\,^{\circ}C$ to $70\,^{\circ}C$ in 5 minutes and further to $60\,^{\circ}C$ in 11 minutes. What will be its temperature after 15 minutes from the start ? Also determine the temperature of the surroundings.

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185. A black body at 20000 K, emits maximum energy at a wavelength of $1.56 \mu m$. At what temperature will it emit maximum energy at a wavelength of $1.8 \mu m$?

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186. A spherical black body with a radius of 12 cm radiates 450 W power at 500 K. What would be the power of radiation if radius were to be halved and the temperature is doubled ?

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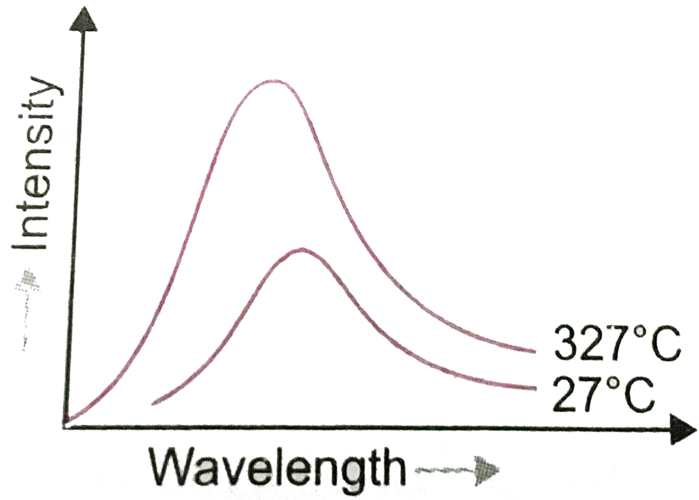
187. The specturm of a black body at two temperatures $27^\circ C$ and $327^\circ C$ is show in the Fig. $7(e).20$. Let A_1 and A_2 be the respective areas tunder the two curved. Estimate the ratio A_2/A_1.



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188. If each square metre, of sun's surface radiates energy at the rate of $6.3 \times 10^7 jm^{-2}s^{-1}$ and the Stefan's constant is $5.669 \times 10^{-8}Wm^{-2}K^{-4}$ calculate the temperature of the sun's surface, assuming Stefan's law applies to the sun's radiation.

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189. How much faster dose a cup of tea cool by $1^{\circ}C$ when at 373 K than when at 303 K. Consider the tea as a black body. Take the temperature as 293 K and Sreafan's constant as $5.7 \times 10^{-8}Wm^{-2}K^{-4}$.

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190. Two bodies A and B have thermal emissivities of 0.01 and 0.81 respectively. The outer surface areas of the two bodies are same. The two bodies emit total radiant power at the same rate. The wavelength λ_B corresponding to maximum spectral radiancy from B is shifted from the wavelength corresponding to maximum spectral radiancy in the radiation from A by 1.0 μm. If the temperature of A is 5802 K, calculate (a) the temperature of B, (b) wavelength λ_B.

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191. The tungsten filamet of an electric lamp, has a length of 0.25 m and a diameter of 6×10^{-5} m. The power rating of the filament is 0.8, estimate the steady temperature of filament. Stefan's constant $= 5.67 \times 10^{-8} W/m^{-2}/K^4$.

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192. A black ened metal sphere of radius 7 cm is encllosed in as evacuated chamber maintained at a temperature of $27^\circ C$. At what rate must energy be supplied to the sphere so as to keep its temperature constant at $127^\circ C$?

$\sigma = 5.7 \times 10^{-8} W m^{-2} K^{-4}$.

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193. A body which has a surface area$5.00 cm^2$ and a temperature of $727^{\circ} C$ radiated 300 j of energy each minute. What is the emissivity of body? Steafan's constant $= 5.67 \times 10^{-8} Wm^{-2} K^{-4}$.

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194. The spectral energy distribution of the sun has a maximum at 4754Å. If the temperature of the sun is 6050 K, what is the temperature of a star for which this maximum is at 9506Å?

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195. A sphere of radius 10 cm is hung inside an oven walls are at a temperature of 1000 K. Calculate total energy incident per second (in Js^{-1}) on the sphere. Given $\sigma = 5.67 \times 10^{-8} SI$ units.

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196. A bar of copper of length $75cm$ and a bar of steel of length $125cm$ are joined together end to end. Both are of circular cross section with diameter $2cm$. The free ends of the copper and the steel bars are maintained at $100^{\circ}C$ and $0^{\circ}C$ respectively. The curved surface of the bars are thermally insulated. What is the temperature of the copper-steel junction? What is the amount of heat transmitted per unit time across the junction? Thermal conductivity of copper is $386 Js^{-1} m^{-1}. {}^{\circ} C^{-1}$ and that of steel is $46 Js^{-1} m^{-1}. {}^{\circ} C^{-1}$

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197. The only possibility of heat flow in a thermos flask is through its cork which is $75 cm^2$ in area and 5 cm thick. Its thermal conductivity is $0.0075 cal / cm \sec {}^{\circ} C$. How lolng will 500 g of ice at $0 {}^{\circ} C$ in thermos flask will is $40 {}^{\circ} C$ and latent heat of ise is $80 cal. / gram$.

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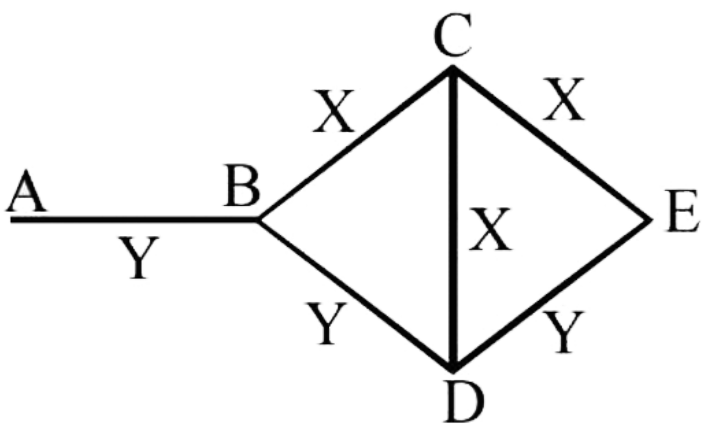
198. Three rods of material X and three rods of material Y are connected as shown in the figure. All the rods are of identical length and cross-sectional area. If the end A is maintained at $60\,^{\circ}C$ and the junction E at $10\,^{\circ}C$. Calculate the temperature of the junction B, C and D. The thermal conductivity of X is $0.92 cal/\sec\text{-}cm\,^{\circ}C$ and that of Y is $0.46 cal/\sec\text{-}cm\text{-}^{\circ}C$.



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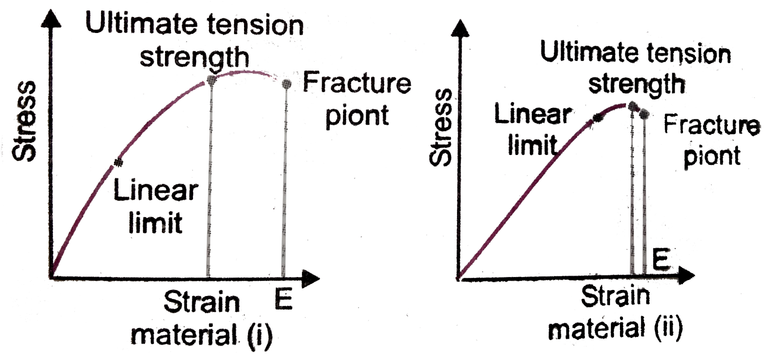
Multiple choice questions-II

1. The stress-strain graphs for two materials are shown in Fig. 7(EP).3 (assume scale).



A. Material (ii) is more elastic than material (i) and hence material (ii) is more brittle.

B. Material (i) and (ii) have the same elasticity and the same brittleness.

C. Material (ii) is elastic over a larger region of strain as compared to (i).

D. Material (ii) is more brittle than material (i).

Answer: C::D

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2. A wire is suspended from the ceiling and stretched under the action of weight F suspended from its other end. The force exerted by the ceiling on it is equal and opposite to the weight.

A. Tensile stress at any cross section A of the wire is

F/A.

B. Tensile stress at any cross section is zero.

C. Tensile stress at any cross section A of the wire is 2

F/A.

D. Tension at any cross section A of the wire is F.

Answer: A::D

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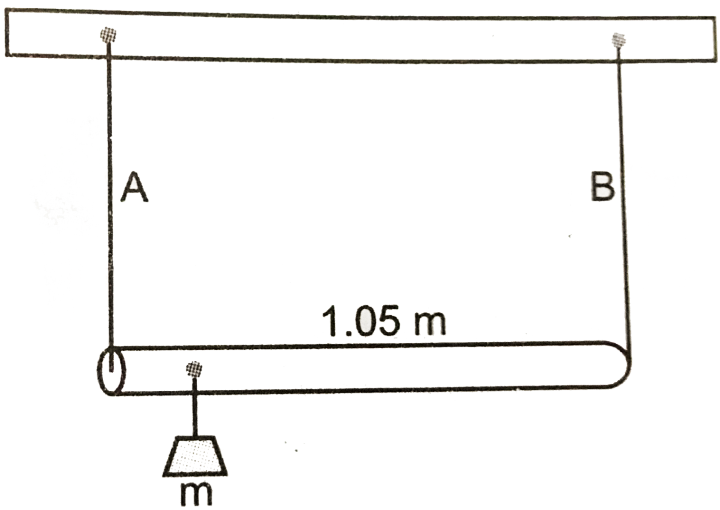
3. A rod of length 1.05 m having negliaible mass is supported at its ends by two wires of steel (wire A) and aluminium (wire B) of equal lengths as shown in fig. The cross-sectional area of wire A and B are $1mm^2$ and $2mm^2$, respectively . At what point along the rod should a mass m be suspended in order to produce (a) equal stresses and (b) equal strains in both steel and aluminium wires.

Given,

$Y_{steel} = 2 \times 10^{11} Nm^{-2}$ and $Y\text{-}(aluminium) = 7.0 \times 10^{10} N^{-2}$



A. Mass m should be suspended close to wire A to have equal stresses in both the wires.

B. Mass m should be suspended close to B to have equal stresses in both the wires.

C. Mass m should be suspended at the middle of the wires to have equal stresses in both the wires.

D. Mass m should be suspended close to wire A to have equal strain on both wires.

Answer: B::D

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4. For an ideal liquid

A. the bulk modulus is infinite

B. the bulk modulus is zero

C. the shear modulus is infinite

D. the shear moduluIs is zero.

Answer: A::D

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5. A Copper wire and steel of the same diameter and length are connected end to end and a force is applied, which stretches their combined length by 1 cm. The two wires will have

A. the same stress

B. different stress

C. the same strain

D. different strain

Answer: A::D

Watch Video Solution

6. For a surface molecule,

A. the net force on it is zero

B. there is a net downward force

C. the potential energy is less than that of a molecule inside.

D. the potential energy is more than that of a molecule inside.

Answer: B::D

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7. Pressure is a scalar quantity, because

A. it is the ratio of force to are and both force and area vectors.

B. it is the ratio of the magnitude of the force to area.

C. it is the ratio of the component of the force normal to the area.

D. it dose not depend on the size of the area chosen.

Answer: C::D

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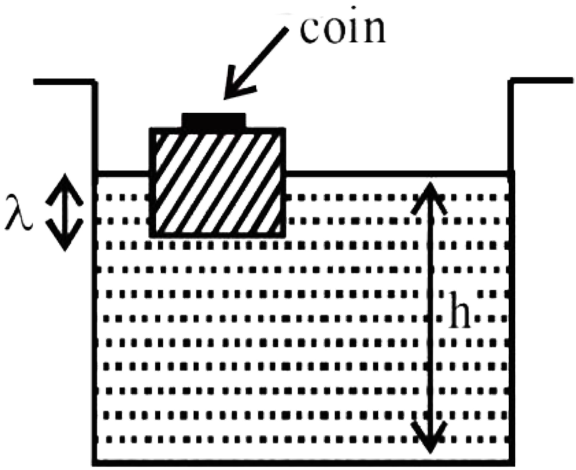
8. A wooden block, with a coin placed on its top, floats in water as shown in figure. The distance l and h are shown here. After some time the coin falls into water. Then



A. l decreases

B. h decreases

C. l increases

D. h increase

Answer: A::B

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9. With increase in temperature the viscosity of

A. gases decreases

B. liquids increases

C. gases increases

D. liquids decreases

Answer: C::D

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10. Streamline flow is more likely for liquid with

A. high density

B. high viscosity

C. low density

D. low viscosity

Answer: B::C

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11. Mark the correct option:

A. A system X is in thermal equililbrium with Y but not with Z. System Y and Z may be in thermal equilibrium with each other.

B. A system X is in thermal equlibrium with Y but not with Z. System Y and Z are not in thermal equilibrium with each other.

C. A system X is neither in thermal equilibrium with Y nor with Z. The system Y and Z must be in thermal equilibrium with each other.

D. A system X is neither in thermal equilibrium with Y nor with Z. The system Y and Z may be in thermal equilibrium with each other.

Answer: B::D

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12. Gulab jamuns (assumed to be spherical) are to be heated in on oven They are available in two sizes, one twice bigger (in radius) than the other Pizzas (assumed to discs) are also to be heated ibn oven They are also in two sizes, one twice bigger (in radius) than the other All four are put together to be heated option to oven temperature. Choose the correct option from the following .

A. Both size gulab jamuns will get heated in the same time.

B. Smaller gulab jamuns are heated before biffer ones.

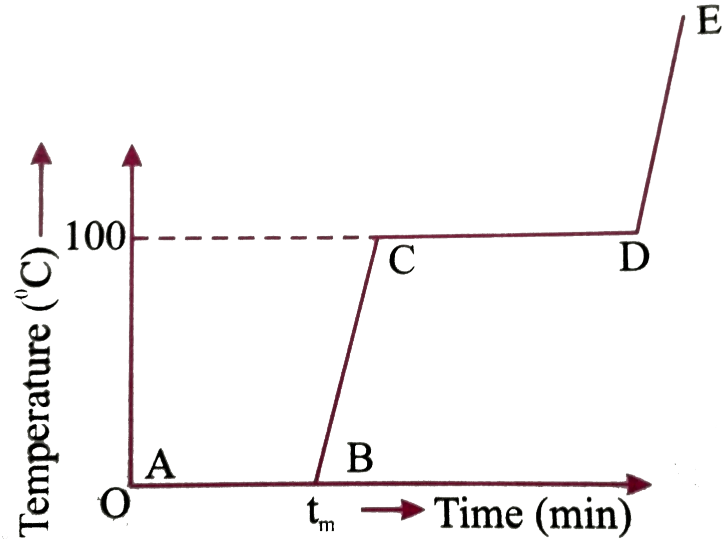
C. Smaller pizzas are heated before bigger ones.

D. Bigger pizzas are heated before smaller ones.

Answer: B::C

Watch Video Solution

13. Refer to the plot of temperature versus time (figure) showing the changes in the state if ice on heating (not to scale). Which of the following is correct ?



A. The region AB represents ice and water in thermal equilibrium.

B. At B water start boiling.

C. As C all the water gets converted into steam.

D. C to D represents water and steam in equilibrium at bloiling point.

Answer: A::D

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14. A glass full of hot milk is poured on the table. It begins to cool gradually. Which of the following is correct ?

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Multiple choice questions-I

1. Modulus of rigidity of a liquid

A. infinity

B. unity

C. zero

D. some finite small non-zero constant value.

Answer: B

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2. The maximum load a wire can withstand without breaking, when its length is reduced to half of its original length, will

A. be double

B. be half

C. be four times

D. remain same

Answer: D

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3. The temperature of a wire is doubled. The young's modulus of elasticity

A. Will also double

B. will become four times

C. will remain same

D. will decrease

Answer: D

Watch Video Solution

4. A spring is stretched by applying a load to its free end. The strain produced in the spring is

A. volumetric

B. shear

C. longitudinal and shear

D. longitudinal

Answer: C

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5. A rigid bar of mass M is supported symmetrically by three wires each of length l. Those at each end are of copper and the middle one is of ion. The ratio of their diameters, if each is to have the same tension, is equal to

A. $\dfrac{Y_{copper}}{Y_{iron}}$

B. $\sqrt{\dfrac{Y_{iron}}{Y_{copper}}}$

C. $\dfrac{Y_{iron}^2}{Y_{copper}^2}$

D. $\dfrac{Y_{iron}}{Y_{copper}}$

Answer: B

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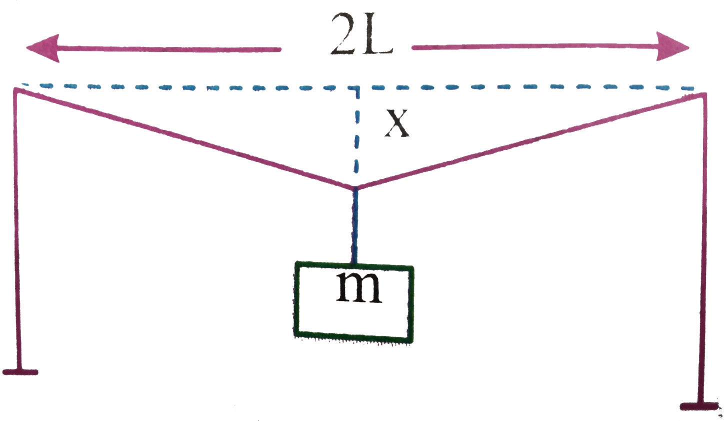
6. A mild steel wire of length $1.0m$ and cross sectional area $2L$ is strethched, within its elastic limit horizontally between two pillars(figure). A mass of m is suspended form the midpont of the wire. Strain in the wire is



A. $\frac{x^2}{2L^2}$

B. $\frac{x}{L}$

C. $\frac{x^2}{L}$

D. $\frac{x^2}{2L}$

Answer: A

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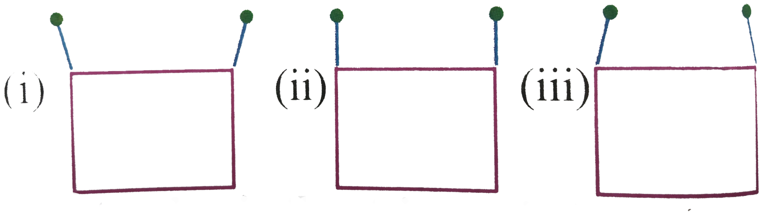
7. A recantangular frame is to be suspended symmetrically by two strings of equal length on two supports (figure).It can be done in one of the following three ways:



A. the same in all cases

B. least in (a)

C. least in (b)

D. least in (c)

Answer: C

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8. Consider two cylindrical rods of indentical dimesnions, one of rubber and the other of steel. Both the rods are fixed rigidiy at one end to the roof. A mass M is attached to each of the free ends at the centre of the rods.

A. Both the rods will elongate but there shall be no perceptible change in shape

B. The steel rod will elongate and change shape but the rubber rod will only elongate.

C. The steel rod will elongate without any perceptible change in shape, but the bottom edge will change to an elipse.

D. The steel rod will elongate, without any perceptible change in shape, but the rubber rod will elongate with the shape of the bottom edge tapered to a tip at the center.

Answer: D

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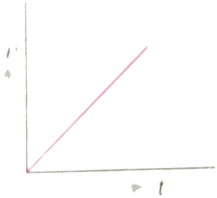
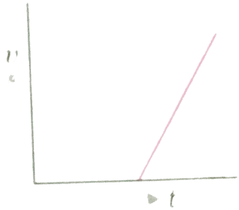
9. A tall cylinder is filled with viscous oil. A round pebble is dropped from the top with zero initial velocity. From the plot shown in figure, indicate the one that represents the velocity (v) of the pebble as a function of time (t)

A. 

(a)

B. 

(b)

C.

Answer: C

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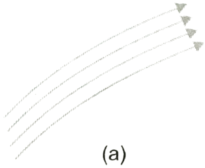
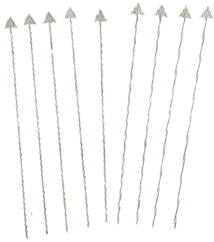
10. Which of the following diagrams does not represent a streamline flow?

A. 

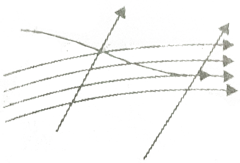
(a)

B. 

(b)

C. 

(c)

D. 

(d)

Answer: D

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11. A long a steamline

A. the velocity of a fluid particle remains constant.

B. the velocity of all fluid particles crossing a given position is constant.

C. the velocity of all fluid particles at a given instant is constant.

D. the speed of a fluid particle remains constant.

Answer: B

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12. An ideal fluid flows through a pipe of circular cross-section made of two sections with diameters $2.5cm$ and $3.75cm$. The ratio of the velocities in the two pipes is

A. $9:4$

B. $3:2$

C. $\sqrt{3}:\sqrt{2}$

D. $\sqrt{2}:\sqrt{3}$

Answer: A

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13. The angle of contact at the interface of water glass is 0° ethylalcohol-glass is 0° mercury glass is 140° and methyliodide-glass is 30° A glass capillary is put in a through containing one of these four liquids. It is observed that the meniscus is convex. The liquid in the through is

A. Water

B. ethylalcohol

C. mercury methyliodide.

D.

Answer: C

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14. A bimetallic strip is made of aluminium and steel $\left(\alpha_{Al} > \alpha_{steel}\right.$. On heating, the strip will

A. remain strainght

B. get twisted

C. will bend with aluminium on concave side

D. will bend with steel on concave side

Answer: D

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15. A uniform metallic rod rotates about its perpendicular bisector with constant angualr speed. If it is heated uniformly to raise its temperature slightly, then

A. its speed of rotation increases

B. its speed of rotation decreases

C. its speed of rotation remains same

D. its speed increases because its moment of inertia increases

Answer: B

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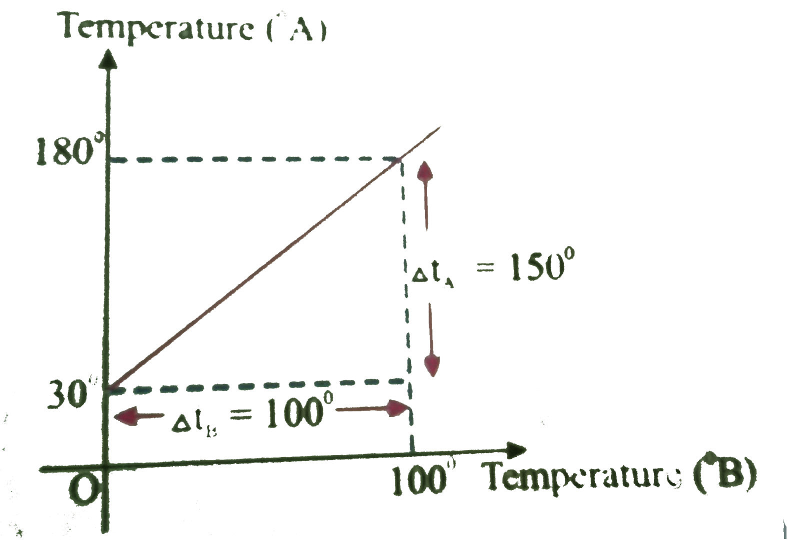
16. The graph between two temperature scales A and B is shown in Fig. Between upper fixed point and lower fixed point there are 150 equal divisions on scales A and 100 on scale B. The relation between the temperature in two scales is given by_



A. $\frac{t_A - 180}{100} = \frac{t_B}{150}$

B. $\frac{t_A - 30}{150} = \frac{t_B}{100}$

C. $\frac{t_B - 180}{150} = \frac{t_A}{100}$

D. $\frac{t_B - 40}{100} = \frac{t_A}{1080}$

Answer: B

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17. An aluminium sphere is dipped into water. Which of the following is true ?

A. Bouancy will be less in water at $0^{\circ} C$ than that in water at $4^{\circ} C$.

B. Bouncy will be more in water at $0^{\circ} C$ than that in water at $4^{\circ} C$.

C. Bouncy in water at $0^\circ C$ will be same as that in water at $4^\circ C$.

D. Bouncy may be more less in water at $4^\circ C$ depending on the radius of the sphere.

Answer: A

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18. A the temperature is increased, the time period of a pendulum

A. increases as its effective length increases even though its centre of mass still remains at the centre of the bob.

B. decreases as its effective length increases even though its centre of mass still remains at the centre of the bob.

C. increases as its effective length increases due to shifting of centre of mass below the centre of the bob.

D. decreases as its effective length remains same but the centre of mass shift above the centre of the bob.

Answer: A

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19. Heat is associated with

A. kinetic energy of random motion of molecules.

B. kinetic energy of orderly motion of molecules.

C. total kinetic energy of random and orderly motion of molecules.

D. kinetic energy of random motion in some casses and kinetic energy of orderly motion in other.

Answer: A

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20. The radious of a metal sphere at room temperature T is R, and the coefficient of linar expansion of the metal is α. The sphere is heated a little by a temperature ΔT so that its new temperature is $T + \Delta T$. The increase in the volume of the sphere is approximately

A. $2\pi R\alpha\Delta T$

B. $\pi R^2\alpha\Delta T$

C. $4\pi R^3\alpha\Delta t/3$

D. $4\pi R^3\alpha\Delta T$

Answer: D

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21. A sphere a cube and thin circular plate, all made of the same material and having the same mass are initially heated to a temperature of $1000\ ^{\circ}C$. Which one of these will cool first?

A. plate will cool fastest and cube the slowest

B. Sphere will cool fastest and cube the slowest

C. plate will cool fastest and sphere the slowest

D. Cube will cool fastest and plate the slowest

Answer: C

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22. The approximate depth of an ocean is $2700m$. The compressibility of water is $45.4 \times 10^{-11} Pa^{-1}$ and density of water is $10^3 \frac{kg}{m^3}$. What fractional compression of water will be obtained at the bottom of the ocean?

A. 1.0×10^{-2}

B. 1.2×10^{-2}

C. 1.4×10^{-2}

D. 0.8×10^{-2}

Answer: B

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23. The Young's modulus of steel is twice that of brass. Two wires of the same length and of the same area of cross section, one of steel and another of brass are suspended from the same roof. If we want the lower ends of the wires to be at the same level, then the weight added to the steel and brass wires must be in the ratio of

A. $1:1$

B. $1:2$

C. $2:1$

D. $4:2$

Answer: C

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24. A pendulumd made of a uniform wire of cross sectional area (A) has time T.When an additionl mass (M) is added to its bob, the time period changes to T_M. IftheYoung's mod usofthematerialofthewireis(Y)then 1/Y` is equal to:

A. $\left[\left(\frac{T_M}{T}\right)^2 - 1\right]\frac{A}{Mg}$

B. $\left[\left(\frac{T_M}{T}\right)^2 - 1\right]\frac{Mg}{A}$

C. $\left[1 - \left(\frac{T_M}{T}\right)^2\right]\frac{A}{Mg}$

D. $\left[1 - \left(\frac{T_M}{T}\right)^2\right]\frac{Mg}{A}$

Answer: A

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25. The bulk modulus of a spherical object is B if it is subjected to uniform pressure p, the fractional decrease in radius is:

A. $\frac{P}{B}$

B. $\frac{B}{3p}$

C. $\frac{3p}{B}$

D. $\frac{p}{3B}$

Answer: D

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26. A man grows into a giant such that his linear dimension increase by a factor of 9. Assuming that his density remains same, the stress in the leg will change by a factor of

A. 81

B. $\frac{1}{81}$

C. 9

D. $\frac{1}{9}$

Answer: C

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27. A material has Poisson's ratio 0.20. If a uniform rod suffers a longitudinal strain 2×10^{-3}, then the percentage change in volume is

A. $+0.12$

B. -0.12

C. 0.28

D. -0.28

Answer: A

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28. Wires A and B are made from the same material. A has twice the diameter and three times the length of B. If the elastic limits are not reached, when each is stretched by the same tension, the ratio of energy stored in A to that in B is

A. $2:3$

B. $3:4$

C. $3:2$

D. $6:1$

Answer: B

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29. An alumminium rod and steel wire of same length and cross-section are attached end to end. Then compound wire is hung fron a rigid support and load is suspended from the free end. Y for steel is $\left(\frac{20}{7}\right)$ times of aluminium. The ratio of increase in length of steel wire to the aluminium wire is

A. $20:3$

B. $10:7$

C. $7:20$

D. $1:7$

Answer: C

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30. A steel ring of radius r and cross section area A is fitted on to a wooden disc of radius $R(R > r)$. If Young's modulus be R, then the force with which the steel ring is expanded is

A. AER/r

B. $AE(R - r)/r$

C. $E(R - r)/Ar$

D. Er/AR

Answer: B

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31. A wire of length L and cross sectional area A is made of a material of Young's modulus Y. If the wire is streched by an amount x, the work done is..................

A. $\frac{YxA}{2L}$

B. $\frac{Yx^2A}{L}$

C. $\frac{Yx^2A}{2L}$

D. $\frac{2Yx^2A}{L}$

Answer: C

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32. A steel wire of length 20 cm and uniform cross-section $1mm^2$ is tied rigidly at both the ends. If the temperature of the wire is altered from $40^\circ C$ to $20^\circ C$, the change in tension. [Given coefficient of linear expansion of steel is $1.1 \times 10^5 . ^\circ C^{-1}$ and Young's modulus for steel is $2.0 \times 10^{11} Nm^{-2}$]

A. 22 N

B. 44 N

C. 66 N

D. 88 N

Answer: B

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33. Two rods of different materials having coefficient of thermal expansion α_1, α_2 and young's modulii Y_1, Y_2 respectively are fixed between two rigid massive walls. The rods are heated such that they undergo the same increase in temperature. There is no bending of rods. If $\alpha_1 : \alpha_2 = 2 : 3$, the thermal stresses developed in the two rods are equal provided $Y_1 : Y_2$ is equal to

A. $2 : 3$

B. $1:1$

C. $3:2$

D. $4:9$

Answer: C

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34. What is the density of lead under a pressure of $2.0 \times 10^8 N/m^2$, if the bulk modulus of lead is $8.0 \times 10^9 N/m^2$ and initially the density of lead is $11.4 g/cm^3$?

A. $11.3 g/c.c.$

B. $11.5g/c.c.$

C. $11.6g/c.c.$

D. $11.7g/c.c.$

Answer: D

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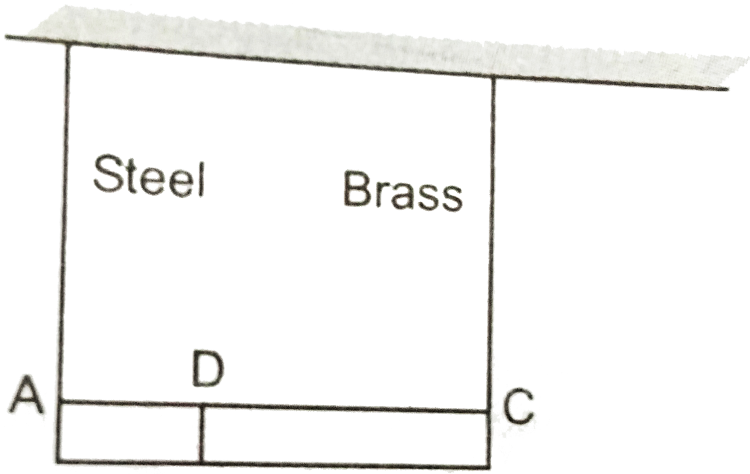
35. A light rod AC of length 2.00 m is suspended from the ceiling horizontally by means of two vertical wires of equal length tied to its ends. One of the wires is made of steel and is of cross-section $10^{-3}m^2$ and the other is of brass of cross-section $2 \times 10^{-3}m^2$. The position of point D from end A along the rod at which a weight may be hung to produce equal stress in both the wires is

[Young's modulus of steel is $2 \times 10^{11} Nm^2$ and for brass

is $1 \times 10^{11} Nm^{-2}$]



A. $1.00m$

B. $(2/3)m$

C. $(4/3)m$

D. $(5/3)m$

Answer: C

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36. In the above question, the position of point D from end A of the rod at which there is equal strain on both the wires is

A. $1.0m$

B. $(2/3)m$

C. $(4/3)m$

D. $(5/3)m$

Answer: A

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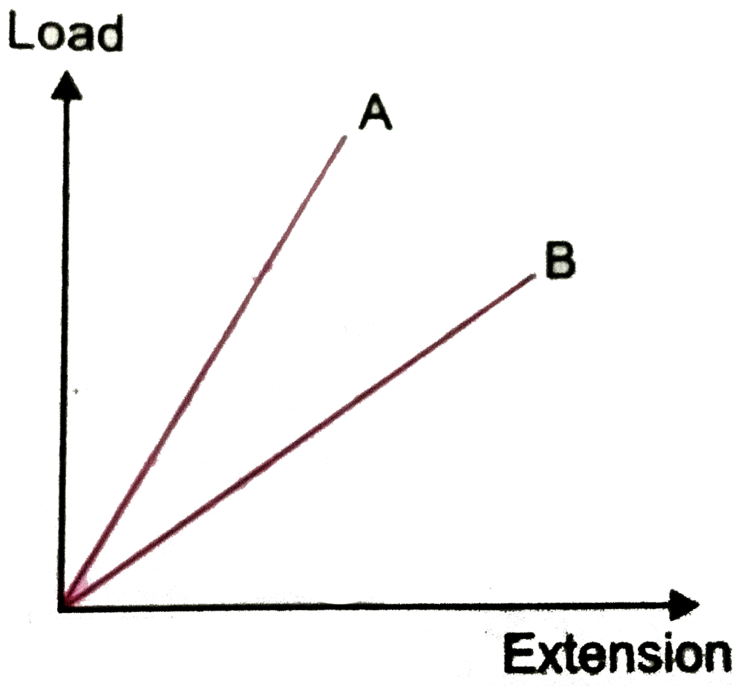
37. In the given Fig. 7(CF).2, if the dimensions of the two wires are the same and materials are different, Young's modulus is



A. more for A than B

B. more for B than A

C. equal for A and B

D. none of the above

Answer: A

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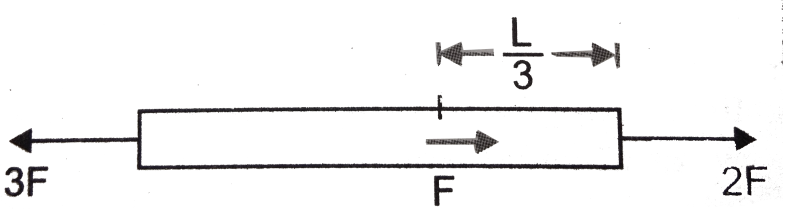
38. A uniform cylindrical rod of length L, cross-section area A and Young's modulus Y is acted upon by the force as shown in Fig. 7(CF).3. The elongation of the rod is



A. $\frac{2FL}{5AY}$

B. $\frac{3FL}{5AY}$

C. $\frac{3FL}{8AY}$

D. $\frac{8FL}{3AY}$

Answer: D

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39. A highly rigid cubical block A of small mass M and side L is fixed rigidly on the other cubical block of same dimensions and of modulus of rigidity η such that the lower face of A completely covers the upper face of B. The lower face of B is rigidly held on a horizontal surface

. A small force F is applied perpendicular to one of the side faces of A. After the force is withdrawn , block A executes faces of A. After the force is withdrawn , block A exceutes small oscillations , the time period of which is given by

A. $2\pi\sqrt{M\eta L}$

B. $2\pi\sqrt{\frac{M\eta}{L}}$

C. $2\pi\sqrt{\frac{ML}{\eta}}$

D. $2\pi\sqrt{\frac{M}{\eta L}}$

Answer: D

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40. Copper of fixed volume V is drawn into wire of length l. When this wire is subjected to a constant force F, the extension produced in the wire is $\triangle l$. Which of the following graphs is a straight line?

A. Δl versus $1/l$

B. Δl versus l^2

C. Δl versus $1/l^2$

D. Δl versus l

Answer: B

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41. A copper wire of length 2.2m and a steel wire of length 1.6m, both of diameter 3.0mm are connected end to end. When stretched by a force, the elongation in length 0.50 mm is produced in the copper wire. The streching force is $\left(Y_{copper} = 1.1 \times 10^{11} Nm^{-2},\right.$ $\left.Y_{steel} = 2.0 \times 10^{11} Nm^{-2}\right)$

A. $1.8 \times 10^{2} N$

B. $2.4 \times 10^{2} N$

C. $3.6 \times 10^{2} N$

D. $5.4 \times 10^{2} N$

Answer: A

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42. In the above question the ratio of the elongation produced in the copper wire and steel wire are

A. $7:2$

B. $5:2$

C. $2:5$

D. $5:7$

Answer: B

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43. In the determination if Young's modulus $\left(\left(Y = \frac{4MLg}{\pi l d^2}\right.\right.$ by using searle's method, a wire of length $L = 2m$ and diameter $d = 0.5mm$ is used. For a load $M = 2.5kg$, an extension $l = 0.25mm$ in the length of the wire is observed. Quantites D and l are measured using a screw gauge and a micrometer, respectively. they have the same pitch of $0.5mm$. the number of divisions on their circular scale is 100. the contrubution to the maximum probable error of the Y measurement

A. due to the errors in the measurement of d and l are the same

B. due to the errors in the measurement of d is twice that due to the error in the measurement of l.

C. due to the error in the measurement of l is twice that due to the error in the measurement of d

D. due to the error in the measurement of d is four times that due to the error in the measurement of l.

Answer: A

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44. The upper end of a wire of radius 4 mm and length 100 cm is clamped and its other end is twisted through an angle of 30°. Then angle of shear is

A. 12°

B. 1.2°

C. 0.12°

D. 0.012°

Answer: C

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45. A metal rod has length of 100 cm and cross-section of $1.0cm^2$. By raising its temperture from $0\,^{\circ}C$ to $100\,^{\circ}C$ and holding it so that it is not permitted to expand or bend, the force developed is (Given $Y = 10^{12}$ dyne cm^{-2} and $\alpha = 10^{-5}.\,^{\circ}C^{-1}$)

A. 10^8 dyne

B. 10^9 dyne

C. 10^{10} dyne

D. 10^{14} dyne

Answer: B

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46. The mean distance between the atoms of iron is 3×10^{-10} m and interatomic fore constant for iron is $7N/m$. The Young's modulus of elasticity for iron is

A. $2.33 \times 10^5 N/m^2$

B. $23.3 \times 10^{10} N/m^2$

C. $2.33 \times 10^{10} N/m^2$

D. $2.33 \times 10^{12} N/m^2$

Answer: C

Watch Video Solution

47. The pressure that has to be applied to the ends of a steel wire of length 10cm to keep its length constant when its temperature is raised by $100\,^{\circ}C$ is : (For steel Young's modulus is $2 \times 10^{11} Nm^{-2}$ and coefficient of thermal expansion is $1.1 \times 10^{-5} K-1$)

A. 2.2×10^{7} Pa

B. 2.2×10^{6} Pa

C. 2.2×10^{8} Pa

D. 2.2×10^{9} Pa

Answer: C

Watch Video Solution

48. The length of a metal wire is l_1 when the tension in it is T_1 and is l_2 when the tension is T_2. Then natural length of the wire is

A. $\frac{l_1 + l_2}{2}$

B. $\sqrt{(l_1 l_2)}$

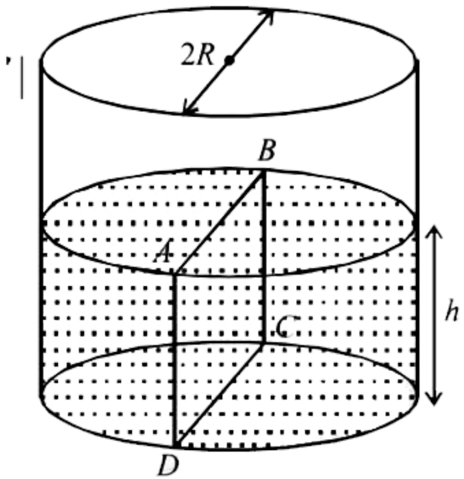
C. $\frac{l_1 T_2 - l_2 T_1}{T_2 - T_1}$

D. $\frac{l_1 T_2 - l_2 T_1}{T_1 + T_2}$

Answer: C

Watch Video Solution

49. Water is filled up to a height h in a beaker of radius R as shown in the figure. The density of water is ρ, the surface tension of water is T and the atmospheric pressure is P_0. Consider a vertical section ABCD of the water column through a diameter of the beaker. The force on water on one side of this section by water on the other side of this section has magnitude



A. $\left[2P_0Rh + p\pi R^2\rho gh - 2RT\right]$

B. $\left[2P_0Rh + R\rho gh^2 - 2RT\right]$

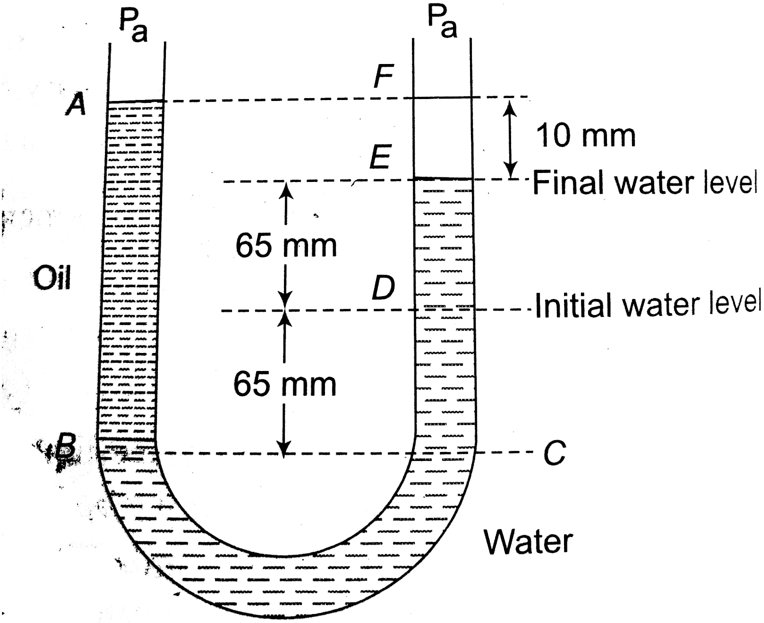
C. $\left[P_0\pi R^2 + R\rho gh^2 - 2RT\right]$

D. $\left[P_0\pi R^2 + R\rho gh^2 + 2RT\right]$

Answer: B

Watch Video Solution

50. A U-tube with both ends open to the atmosphere is partially filled with water. Oil, which is immiscible with water. Is poured into one side until it stands at a distance of $10mm$ above the water level on the other side. Meanwhile the water rises by $65mm$ from its original level (see diagram). The density of the oil is:



A. $650 kgm^{-3}$

B. $425 kgm^{-3}$

C. $800 kgm^{-3}$

D. $928 kgm^{-3}$

Answer: D

Watch Video Solution

51. An ice cube containing a galss ball is floating on the surface of water contained in a trough. The whole of the ice melts, the level of water in the trough

A. rises

B. falls

C. remains unchanged

D. first falls and then rises

Answer: B

Watch Video Solution

52. A boat floating in a tank is carrying passengers. If the passengers drink water, the water level of the tank

A. rises

B. falls

C. remains unchanged

D. depends upon the atmospheric pressure

Answer: C

Watch Video Solution

53. A wooden ball of density ρ is immersed in a liquid of density σ to a depth H and then released. The height h above the surface of which the ball rises will be

A. H

B. $\frac{\sigma}{\rho}$

C. $\left(\frac{\sigma - \rho}{\rho}\right)H$

D. $\frac{\rho}{\sigma}H$

Answer: C

Watch Video Solution

54. A glass of water upto a height of 10 cm has a bottom of area $10cm^2$, top of area $30cm^2$ and volume 1 litre. The downward force exerted by water on the bottom is...

(Taking $g = 10 m/s^2$,density of water $= 10^3 kg/m^3$, atmosphereic pressure $= 1.01 \times 10^5 N/m^2$)

A. 100 N

B. 102 N

C. 110 N

D. 120 N

Answer: B

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55. In the above question, the resultant upward force exerted by the sides of the glass on the water is

A. 100 N

B. 102 N

C. 303 N

D. 211 N

Answer: D

View Text Solution

56. In making an alloy, a substance of specific gravity s_1

and mass m_1 is mixed with another substance of specific

gravity of the alloy is

A. $\left[\frac{s_1 s_2}{m_1 + m_2}\right]$

B. $\left[\frac{s_1 + s_2}{m_1 + m_2}\right]$

C. $\left[\frac{m_1 l s_1 + m_2 l s_2}{(m_1 + m_2)}\right]$

D. $\left[\frac{m_1 + m_2}{(m_1 l s_1 + m_2 l s_2)}\right]$

Answer: D

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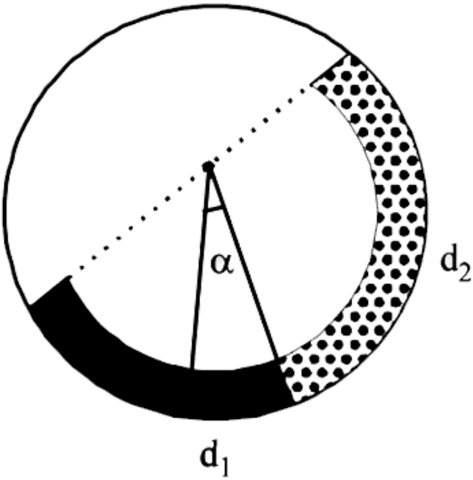
57. There is a circular tube in a vertical plane. Two liquids which do not mix and of densities d_1 and d_2 are filled in the tube. Each liquid subtends 90° angle at centre. Radius joining their interface make an angle α with vertical. Ratio $\frac{d_1}{d_2}$ is :



A. $\frac{1 + \tan\alpha}{1 - \tan\alpha}$

B. $\frac{1 + \sin\alpha}{1 - \cos\alpha}$

C. $\frac{1 + \sin\alpha}{1 - \sin\alpha}$

D. $\frac{1 + \cos\alpha}{1 - \cos\alpha}$

Answer: A

Watch Video Solution

58. A piece of material weighing 50.0 gram is conated with 6.3 gram of wax of sp. Gravity 0.9. If the conated pice weighs 16.3 gram in water, then the density of the material in g/cc is

A. 1.515

B. 2.112

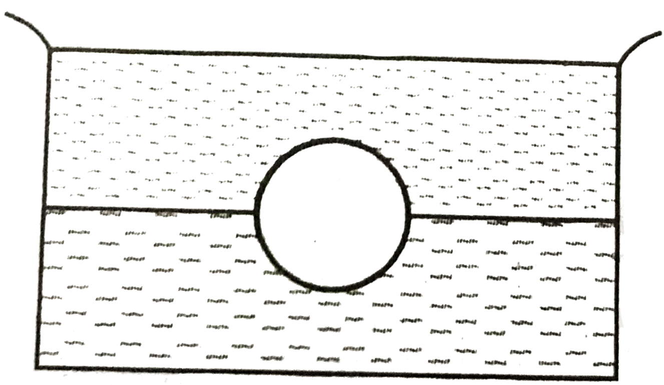
C. 2.351

D. 4.613

Answer: A

Watch Video Solution

59. A solid uniform ball having volume V and density ρ floats at the interface of two unmixible liquids as shown in Fig. 7(CF).7. The densities of the upper and lower liquids are ρ_1 and ρ_2 respectively, such that $\rho_1 < \rho < \rho_2$. What fractio9n of the volume of the ball will be in the lower liquid.



A. $\dfrac{\rho - \rho_2}{\rho_1 - \rho_2}$

B. $\dfrac{\rho_1}{\rho_1 - \rho_2}$

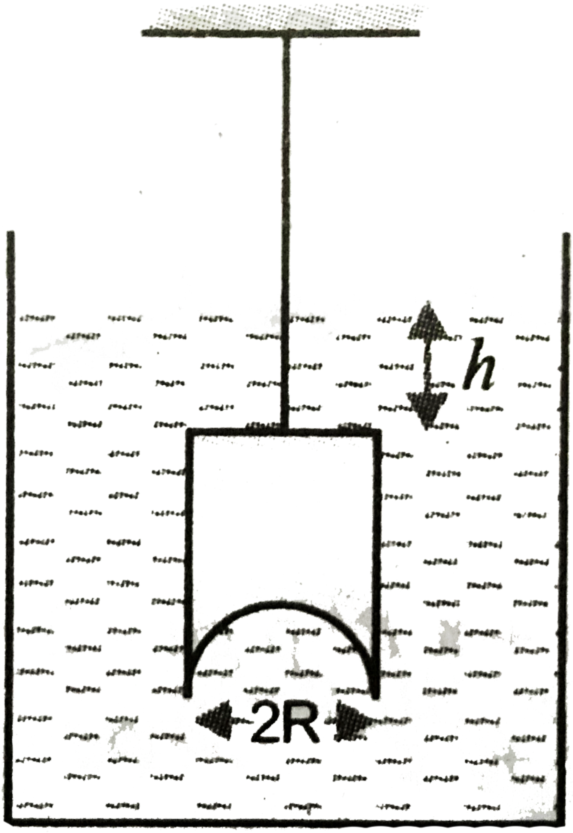
C. $\frac{\rho_1 - \rho}{\rho_1 - \rho_2}$

D. $\frac{\rho_1 - \rho_2}{\rho_2}$

Answer: C

Watch Video Solution

60. A hemispherical portion of radius R is removed from the bottom of a cylinder of radius R. The volume of the remaining cylinder is V and its mass is M. It suspended by a string in a liquid of density ρ where it stays vertical. The upper surface of cylinder is at a depth h below the liquid surface. The force on the bottom of the cylinder bby the liquid is



A. Mg

B. Mg - h ρ g

C. $Mg + \pi R^2 h\rho g$

D. $\rho g\left(V+\pi R^2 h\right)$

Answer: D

Watch Video Solution

61. A piece of solid weighs 120 g in air, 80 g in water and 60 g in a liquid. The relative density of the solid and that of the liquid are respectively

A. 3,2

B. $2, 3/4$

C. $3/2, 2$

D. $3, 3/2$

Answer: D

Watch Video Solution

62. A bird resting on the floor of an airtight box which is being carried by a boy star flying. The boy will fell that the box is now :

A. heaviner

B. lighter

C. show no change in weight

D. lighter in beginning and heaveier later.

Answer: B

Watch Video Solution

63. An iceberg is floating partly immersed in sea water, the density of sea water is $1.03 gcm^{-3}$ and that of ice is $0.92 gcm^{-3}$. The fraction of the total volume of the iceberg above the level of sea water is

A. 8.1%

B. 11%

C. 34%

D. 0.8%

Answer: B

Watch Video Solution

64. An ornament weighing $50g$ in air weighs only $46g$ is water. Assuming that some copper is mixed with gold the prepare the ornament. Find the amount of copper in it. Specific gravity of gold is 20 and that of copper is 10.

A. 25 g

B. 30 g

C. 35 g

D. 22 g

Answer: B

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65. A solid ball of density half that of water falls freely under gravity from a height of 19.6 m and then enters water. Neglecting air resistance and viscosity effect in water, the depth up to which the ball will go is $\left(g = 9.8m/s^2\right)$

A. 19.6 m

B. 9.8 m

C. 14.7 m

D. 12.7 m

Answer: A

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66. In the above question, the time taken by the ball to come again to the water surface is

A. 2 s

B. 4 s

C. 6 s

D. 8 s

Answer: B

View Text Solution

67. An empty plastic box of mass m is found to accelerate up at the rate of g/6 when placed deep inside water. How much sand should be put inside the box so that it may accelerate down at the rate of g/6?

A. 1.5 kg

B. 2 kg

C. 2.5 kg

D. 4 kg

Answer: B

Watch Video Solution

68. A ball whose density is $0.4 \times 10^3 kg/m^3$ falls into water from a height of 9 cm. To what depth does the ball sink ?

A. 4.5 cm

B. 6.0 cm

C. 7.5 cm

D. 9.0 cm

Answer: B

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69. A block of wood floats in water with $(4/5)th$ of its volume submerged. If the same block just floats in a liquid, the density of liquid in $\left(kgm^{-3}\right)$ is

A. 1250

B. 600

C. 400

D. 800

Answer: D

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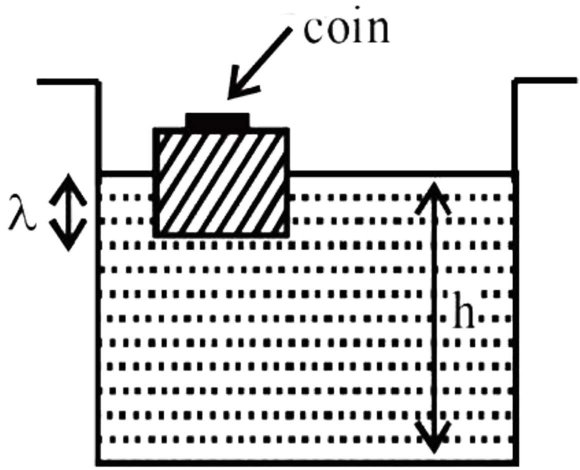
70. A wooden block, with a coin placed on its top, floats in water as shown in figure. The distance l and h are shown here. After some time the coin falls into water.

Then



A. l decreases and h increases

B. l increases and h decreases

C. both l and h increases

D. both l and h decrease

Answer: D

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71. A thin uniform cylindrical shell, closed at both ends, is partially filled with water. It is floating vertically in water in half-submerged state. If ρ_c is the relative density of the material of the shell with respect to water, then the correct statement is that the shell is

A. more than half-filled if ρ_c is less than 0.5

B. more than half-filled if ρ_c is more than 1.0

C. half-filled if ρ_c is more than 0.5

D. less than half-filled if ρ_c is less than 0.5

Answer: D

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72. A uniform cylinder of length L and mass M having cross-sectional area A is suspended, with its length vertical, from a fixed point by a massless spring such that it is half submerged in a liquid of density σ at equilibrium position. The extension x_0 of the spring when it is in equlibrium is:

A. $\frac{Mg}{k}$

B. $\frac{Mg}{k}\left[1 - \frac{La\sigma}{M}\right]$

C. $\frac{Mg}{l}\left[1 - \frac{LA\sigma}{2M}\right]$

D. $\frac{Mg}{k}\left[1 + \frac{LA\sigma}{M}\right]$

Answer: C

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73. Two non-mixing liquids of densities ρ and $(n > 1)$ are put in a container. The height of each liquid is h. A solid cylinder of length L and density d is put in this container. The cylinder floats with its axis vertical and length $pL(p < 1)$ in the denser liquid. The density d is equal to :

A. $[1 + (n + 1)p]\rho$

B. $[2 + (n + 1)p]\rho$

C. $[2 + (n - 1)p]\rho$

D. $[1 + (n - 1)p]\rho$

Answer: D

Watch Video Solution

74. Pressure inside two soap bubbles are 1.01 and 1.02 atmospheres. Ratio between their volumes is

A. 16

B. 8

C. 4

D. 2

Answer: B

Watch Video Solution

75. A capillary tube of radius r is immersed in a liquid. The liquid rises to a height h. The corresponding mass is m. What mass of water shall rise in the capillary if the radius of the tube is doubled?

A. 2 M

B. M

C. $M/2$

D. 4 M

Answer: A

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76. The work done in increasing the size of a soap film from $10cm \times 6cm$ to $10cm \times 11cm$ is 3×10^{-4} Joule. The surface tension of the film is

A. $1.5 \times 10^{2} N/m$

B. $3 \times 10^{-2} N/m$

C. $2.5 \times 10^{-2} N/m$

D. $1.2 \times 10^{-2} N/m$

Answer: B

Watch Video Solution

77. Work done in increasing the size of a soap bubble from a radius of 3cm to 5cm is nearly (Surface tension of soap solution $= 0.03Nm^{-1}$)

A. $0.4\pi mj$

B. $4\pi mj$

C. $0.2\pi mj$

D. $2\pi mj$

Answer: A

Watch Video Solution

78. Two small drop of mercury, each of radius R coalesce in from a simple large drop. The ratio of the total surface energies before and after the change is

A. $1:2^{1/3}$

B. $2^{1/3}:1$

C. $2:1$

D. $1:2$

Answer: B

Watch Video Solution

79. Work W is required to form a bubble of volume V from a given solution. What amount of work is required to be done to form a bubble of volume $2V$?

A. W

B. 2 W

C. $2^{1/3}W$

D. $4^{1/3}W$

Answer: D

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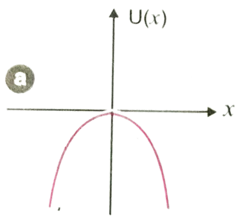
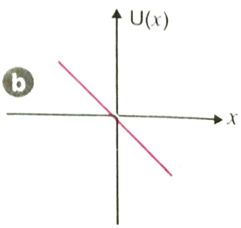
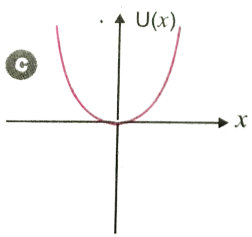
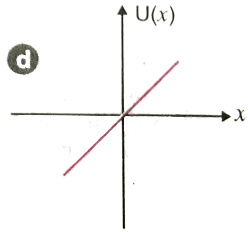
80. A particle is placed at the origin and a force F=Kx is acting on it (where k is a positive constant). If $U_{(0)} = 0$, the graph of $U(x)$ verses x will be (where U is the potential energy function.)

A. 

B. 

C. 

D. 

Answer: A

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81. The potential energy function for the force between two atoms in a diatomic molecule is approximate given by $U(r) = \frac{a}{r^{12}} - \frac{b}{r^6}$, where a and b are constants and r is the distance between the atoms. If the dissociation energy of the molecule is $D = \left[U(r = \infty) - U_{\text{at equilibrium}}\right]$, D is

A. $\frac{b^2}{12a}$

B. $\frac{b^2}{4a}$

C. $\frac{b^2}{6a}$

D. $\frac{b^2}{2a}$

Answer: B

Watch Video Solution

82. A certain number of spherical drops of a liquid of radius r coalesce to form a single drop of radius R and volume V. If T is the surface tension of the liquid, then

A. Energy $= 4VT\left[\frac{1}{r} - \frac{1}{R}\right]$ is released

B. Energy $3VT\left[\frac{1}{r}+\frac{1}{R}\right]$ is absorbed

C. Energy $=3VT\left[\frac{1}{r}-\frac{1}{R}\right]$ is released

D. Energy is neither relesed nor absorbed.

Answer: C

Watch Video Solution

83. Assume that a drop of liquid evaporates by decreases in its surface energy, so that its temperature remains unchanged. What should be the minimum radius of the drop for this to be possible? The surface tension is T, density of liquid is ρ and L is its latent heat of vaporization.

A. $\rho L / S$

B. $\sqrt{S / \rho L}$

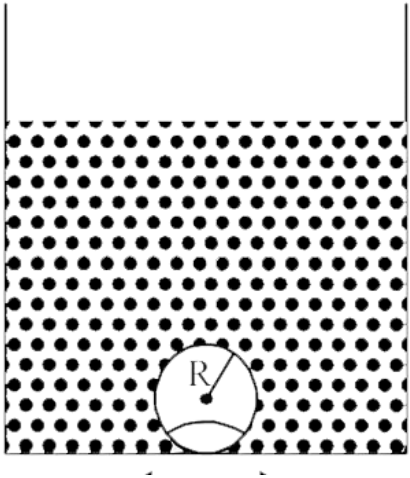
C. $S / \rho L$

D. $2S / \rho L$

Answer: D

Watch Video Solution

84. On heating water, bubbles being formed at the bottom of the vessel detach and rise. Take the bubbles to be spheres of radius R and making a circular contact of radius r with the bottom of the vessel. If $r < < R$ and the surface tension of water is T, value of r just before bubbles detach is: (density of water is ρ_w)



A. $R^2\sqrt{\frac{\rho_w g}{T}}$

B. $R^2\sqrt{\frac{3\rho_w g}{T}}$

C. $R^2\sqrt{\frac{2\rho_w g}{3T}}$

D. $R^2\sqrt{\frac{\rho_w g}{6T}}$

Answer: C

Watch Video Solution

85. Under isothermal condition two soap bubbles of radii r_1 and r_2 coalesce to form a single bubble of radius r. The external pressure is p_0. Find the surface tension of the soap in terms of the given parameters.

A. $\dfrac{P_0\left(r^3 - r_1^3 + r_2^3\right)}{4\left(r_1^2 + r_2^2 - r^2\right)}$

B. $\dfrac{P_0\left(r^3 + r_1^3 - r_2^3\right)}{4\left(r_1^2 + r_2^2 - r^2\right)}$

C. $\dfrac{P_0\left(r^3 - r_1^3 - r_2^3\right)}{4\left(r_1^2 + r_1^2 - r^2\right)}$

D. $\dfrac{P_0\left(r^3 - r_1^3 - r_2^3\right)}{4\left(r_1^2 - r_2^2 - r^2\right)}$

Answer: C

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86. The lower end of a capillary tube is dipped in water. Water rises to a height of 8 cm. The tube is then broken at a height of 6 cm. The height of water colume and angle of contact will be

A. $6cm, \sin^{-1}\left(\frac{3}{4}\right)$

B. $6cm, \cos^{-1}\left(\frac{3}{4}\right)$

C. $4cm, \sin^{-1}\left(\frac{1}{2}\right)$

D. $4cm, \cos^{-1}\left(\frac{1}{2}\right)$

Answer: B

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87. The lower end of a capillary tube of radius r is placed vertically in water of density ρ, surface tension S. The rice of water in the capillary tube is upto height h, then heat evolved is

A. $+\left(\pi^2 r^2 h^2 \rho g\right)$

B. $+\frac{\pi r^2 h^2 \rho g}{2j}$

C. - $\frac{\pi p^2 r^2 h^2 \rho g}{2j}$

D. - $\frac{\pi r^2 h^2 \rho g}{j}$

Answer: B

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88. A capillary tube of radius r is immersed in water and water rises in to a height h. The mass of water in the capillary tube is 5g. Another capillary tube of radius 2 r is immersed in water. The mass of water that will rise in this tube is

A. 2.5 g

B. 5.0 g

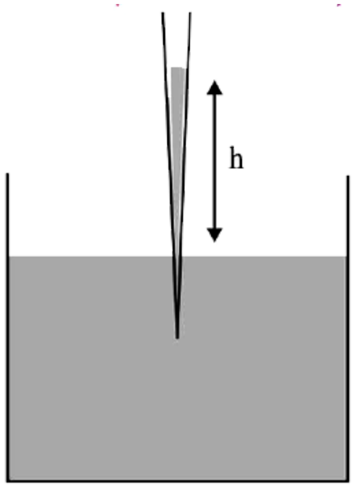
C. 10 g

D. 20 g

Answer: C

Watch Video Solution

89. A glass capillary tube is of the shape of a truncated cone with an apex angle α so that its two ends have cross sections of different radii. When dipped in water vertically, water rises in it to a high h, where the radius of its cross section is b. If the surface tension of water is S, its density if ρ, and its contact angle with glass is θ, the value of h will be (g is the acceleration due to gravity)



A. $\frac{2S\cos(\theta - \alpha)}{b\rho g}$

B. $\frac{2S\cos(\theta + \alpha)}{b\rho g}$

C. $\frac{2S\cos(\theta + \alpha/\alpha)}{b\rho g}$

D. $\frac{2S\cos(\theta + \alpha/2)}{b\rho g}$

Answer: D

Watch Video Solution

90. Water rises to height h in capillary tube. If the length of capillary tube above the surface of water is made less than h then

A. Water dose not rise at all

B. Water rises upto the of capillary tube and then starts overflowing like a fountain

C. Water rises upto the top of capillary tube and stays there without overflowing

D. Water rises upto a point little below the top and stays there

Answer: C

Watch Video Solution

91. if a ball of steel (density $\rho = 7.8g/cm^3$) attains a terminal velocity of $10cm/s$ when falling in a tank of water (coefficient of viscosity, $\eta_{water} = 8.5 \times 10^{-4}$Ps s), then its terminal velocity in glycerine $\left(\rho = 1.2g/cm^2, \eta = 13.2Pas\right)$ would be nearly

A. $6.45 \times 10^{-4}cm/s$

B. $1.5 \times 10^{-5}cm/s$

C. $1.6 \times 10^{-5}cm/s$

D. $6.25 \times 10^{-4}cm/s$

Answer: D

Watch Video Solution

92. The velocity of small ball of mass M and density d_1 when dropped a container filled with glycerine becomes constant after some time. If the density of glycerine is d_2, the viscous force acting on ball is

A. $mg\sigma/\rho$

B. $mg(1 + \sigma/\rho)$

C. $mg\left(1 - \frac{\sigma}{\rho}\right)$

D. mg

Answer: C

Watch Video Solution

93. A small sphere of mass m is dropped from a great height. After it has fallen 100m, it attains the terminal velocity and continues to all at that speed. The work done by the air friction against the sphere during first 100m is

A. equal to 100 mg

B. greater than 100 mg

C. less than work done by air friction in the section 100 m fall

D. more than the work done by air friction in the second 100 m fall

Answer: C

Watch Video Solution

94. The rate of steady volume flow of water through a capillary tube of length ' l ' and radius ' r ' under a pressure difference of P is V . This tube is connected with another tube of the same length but half the radius in series. Then the rate of steady volume flow through them is (The pressure difference across the combination is P)

A. $V/16$

B. $V/17$

C. $16V/17$

D. $17V/16$

Answer: C

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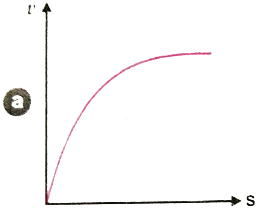
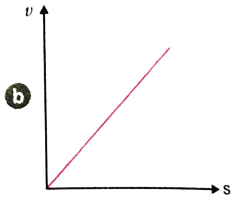
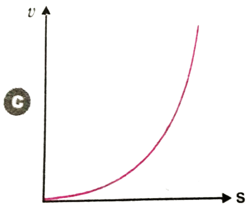
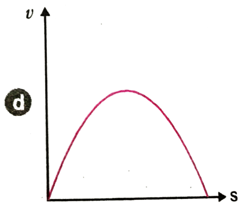
95. A lead shot of 1 mm diameter falls through a long colummn of glycerine. The variation of the velocity v with distance covered (s) is represented by

A. 

B. 

C. 

D. 

Answer: A

96. Two solild spheres manufactured of the same material freely fall down in the air. One sphere has a dimeter twice as large as the other. The force due to air resistance is proportional to the cross-section area of a moving object and is quadration function of the speed of an object and is quadration function of the speed of an object. In sometime after the beginning of motion in the presence of air resistance, the velocity of each sphere become constant. It is called the terminal velocity v_{big}/v_{small} is

A. $\frac{1}{\sqrt{2}}$

B. $\frac{1}{2}$

C. $\sqrt{2}$

D. 2

Answer: C

Watch Video Solution

97. A spherical solild of volume V is made of a material of density ρ_1. It is falling through a liquid of density $\rho_2\left(\rho_2 < \rho_1\right)$. Assume that the liquid applies a viscous froce on the ball that is proportional ti the its speed v, i.e., $F_{viscous} = -kv^2(k > 0)$. The terminal speed of the ball is

A. $\sqrt{\frac{Vg\left(\rho_1 - \rho_2\right)}{k}}$

B. $\frac{Vg\rho_1}{k}$

C. $\sqrt{\frac{Vg\rho_1}{k}}$

D. $\frac{Vg(\rho_1 - \rho_1)}{k}$

Answer: A

Watch Video Solution

98. Two solid spheres of same metal but of mass M and 8M fall simultaneously on a viscous liquid and their terminal velocitied are v and n v, then value of n is

A. 16

B. 8

C. 4

D. 2

Answer: C

Watch Video Solution

99. A wind with speed $40m/s$ blows parallel to the roof of a house. The area of the roof is $250m^2$. Assuming that the pressure inside the house is atmospheric pressure, the force exerted by the wind on the roof and the direction of the force will be : $\left(\rho_{air} = 1.2kg/m^3\right)$

A. 4.8×10^5N, upwards

B. 2.4×10^5N, upwards

C. 2.4×10^5N downwards

D. 4.8×10^5N, downwards

Answer: B

Watch Video Solution

100. An engine pumps liquid of density d continuosly through a pipe of cross-section are A. If the speed with which liquid passes through the pipe is v, then the rate at which kinetic energy is being imparted to the liquid by the pump is

A. Adv^2

B. $\frac{1}{2}Adv^2$

C. $\frac{1}{2}Adv^3$

D. $\frac{1}{2}Adv$

Answer: C

Watch Video Solution

101. An incompressible fluid flows steadily through a cylindrical pipe which has radius 2 R at point A and radius R at point B farther along the flow direction. If the velocity at point A is v, its velocity at point B is

A. $2v$

B. v

C. $v/2$

D. $4v$

Answer: D

Watch Video Solution

102. Applications of Bernoulli's theorem can be seen in

A. dynamic lift of aeroplane

B. hydraullic press

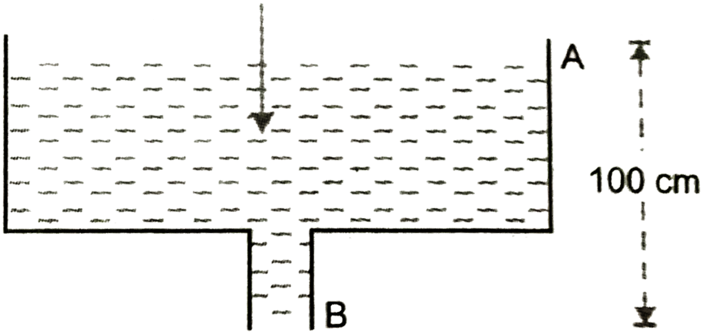
C. helicopter

D. none of the above

Answer: A

Watch Video Solution

103. Water flows through a vertical tube of varible cross-section. The area of cross-section at A and B 6 and 3 mm^2 respectively. If 12c c of water enters per second through A, find the pressure difference $P_A - P_B$. $\left(g = 10m/s^2\right)$. The separation between the cross-section at A and B is 100 cm.



A. $1.6 \times 10^5 dyne/cm^2$

B. $2.29 \times 10^5 dyne/cm^2$

C. $5.9 \times 10^5 dyne/cm^2$

D. $3.9 \times 10^5 dyne/cm^2$

Answer: A

Watch Video Solution

104. Water is flowing continuously from a tap having an internal diameter 8×10^{-3}m. The water velocity as it leves the tap is $0.4ms^{-1}$. The diameter of the water stream at a distance 2×10^{-1}m below the tap is close to $\left(g = 10m/s^2\right)$

A. $7.5 \times 10^{-3}m$

B. $9.6 \times 10^{-3}m$

C. $3.6 \times 10^{-3}m$

D. $5.0 \times 10^{-3}m$

Answer: C

Watch Video Solution

105. A cylinderical vessel is filled with water up to height H. A hole is bored in the wall at a depth h from the free surface of water. For maximum range h is equal to

A. $H/4$

B. $H/2$

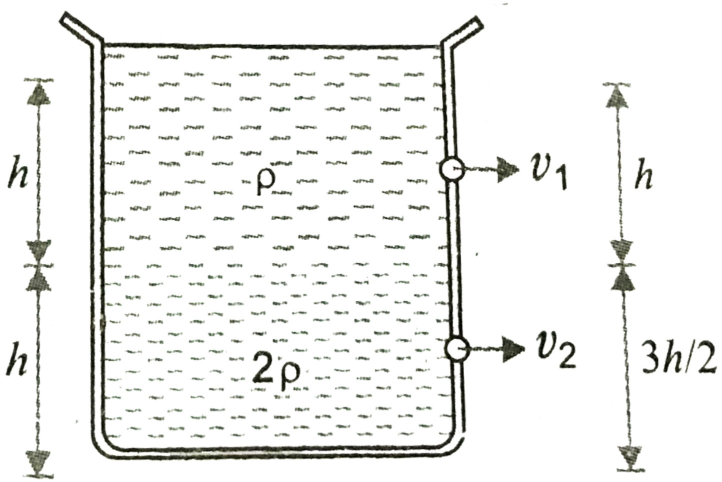
C. $3H/4$

D. H

Answer: B

Watch Video Solution

106. Equal volume of two immissible liquid of densities ρ and 2ρ are filled in a vessel as shown in Fig. 7(CF).15. Two small holes are punched at depth $\frac{h}{2}$ and $\frac{3h}{2}$ from the surface of lighter liquid. If v_1 and v_2 are the velocities of efflux at these two holes, then v_1/v_2 is



A. $\frac{1}{4}$

B. $\frac{1}{2}$

C. $\frac{1}{\sqrt{2}}$

D. $\frac{1}{2\sqrt{2}}$

Answer: C

Watch Video Solution

107. The cylinderical tube of a spray pump has radius R, One end of which has n fine holes, each of radius r. If the speed of the liquid in the tube is V, the speed of the ejection of the liquid through the holes is :

A. $\frac{V^2R}{nr}$

B. $\frac{VR^2}{n^2r^2}$

C. $\frac{VR^2}{nr^2}$

D. $\frac{VR^2}{n^3r^2}$

Answer: C

Watch Video Solution

108. The heat of a man pumps 5 litres of blood through the arteries per minute at a pressure of 150 mm of mercury. If the density of mercury be $13.6 \times 10^3 kg/m^3$ and $g = 10m/s^2$ then the power of heat in watt is :

A. 1.50

B. 1.70

C. 2.35

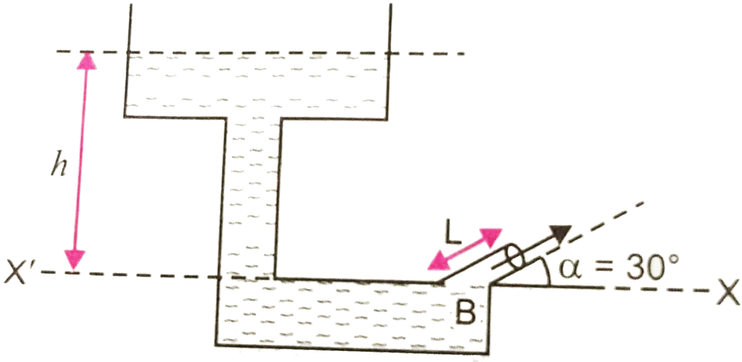
D. 3.0

Answer: B

Watch Video Solution

109. Determine the hight above the dashed line XX' attained by the water stream coming out through the hole is situtade at point B in the diagram given below.

Given that $h = 10m, L = 2m$ and $\alpha = 30°$.



A. 10 m

B. 7.1 m

C. 5 m

D. 3.2 m

Answer: D

Watch Video Solution

110. Coefficient of linear expansion of brass and steel rods are α_1 and α_2. Length of brass and steel rods are l_1 and l_2 respectively. If $(l_2 - l_1)$ is maintained same at all temperature, which one of the following relations holds good?

A. $\alpha_1 l_2 = \alpha_2 l_2$

B. $\alpha_1 l_2^2 = \alpha_2 l_1^2$

C. $\alpha_1^2 l_2 = \alpha_2^2 l_1$

D. $\alpha_1 l_1 = \alpha_2 l_2$

Answer: D

Watch Video Solution

111. The two ends of a metal rod are maintained at temperatures $100^{\circ}C$ and $110^{\circ}C$. The rate of heat flow in the rod is found to be $4.0j/s$. If the ends are maintaind at temperatures $200^{\circ}C$ and $210^{\circ}C$, the rate of heat flow will be :

A. $16.8j/s$

B. $8.0j/s$

C. $4.0j/s$

D. $44.0j/s$

Answer: C

Watch Video Solution

112. Two rods of different materials having coefficient of thermal expansion α_1, α_2 and young's modulii Y_1, Y_2 respectively are fixed between two rigid massive walls. The rods are heated such that they undergo the same increase in temperature. There is no bending of rods. If $\alpha_1 : \alpha_2 = 2 : 3$, the thermal stresses developed in the two rods are equal provided $Y_1 : Y_2$ is equal to

A. $2 : 3$

B. $1 : 1$

C. $3 : 2$

D. $4 : 9$

Answer: C

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113. An external pressure P is applied on a cube at $0\,^{\circ}C$ so that it is equally compressed from all sides. K is the bulk modulus of the material of the cube and α is its coefficient of linear expansion. Suppose we want to bring the cube to its original size by heating. The temperature should be raised by

A. $\frac{3\alpha}{PK}$

B. $3PK\alpha$

C. $\frac{P}{3\alpha K}$

D. $\frac{P}{\alpha K}$

Answer: C

Watch Video Solution

114. A copper ball of mass 100 gm is at a temperature T. It is dropped in a copper calorimeter of mass 100 gm, filled with 170 gm of water at room temperature. Subsequently, the temperature of the system is found to be $75^\circ C$. T is given by : (Given : room temperature = $30^\circ C$, specific heat of copper $= 0.1 cal/gm^\circ C$)

A. $1250^\circ C$

B. $825^\circ C$

C. $800^\circ C$

D. $885^\circ C$

Answer: D

Watch Video Solution

115. One end of thermally insulated rod is kept at a temperature T_1 and the other at T_2. The rod is composed of two section of length l_1 and l_2 thermal conductivities k_1 and k_2 respectively. The temerature at the interface of two section is

A. $\dfrac{(k_1 l_1 T_1 + k_2 l_2 T_2)}{(k_1 l_1 + k_2 l_2)}$

B. $\dfrac{(k_2 l_2 T_1 + k_1 l_1 T_2)}{(k_1 l_1 + k_2 l_2)}$

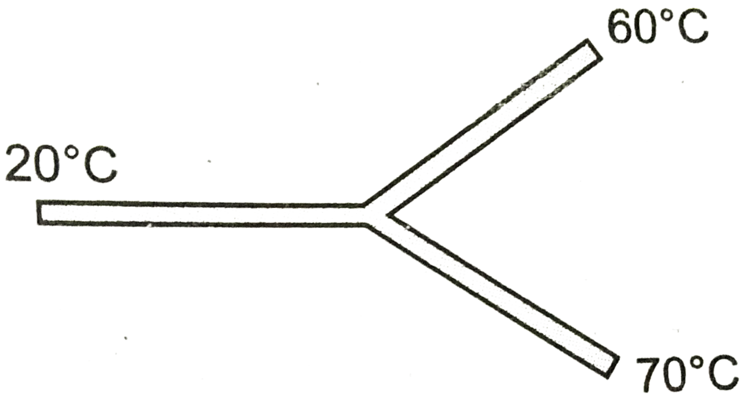
C. $\frac{(k_2 l_1 T_1 + k_1 l_2 T_2)}{(k_2 l_1 + k_1 l_2)}$

D. $\frac{(k_1 l_2 T_1 + k_2 l_1 T_2)}{(k_1 l_2 + k_2 l_1)}$

Answer: D

Watch Video Solution

116. There indectical thermal conductors are connected as shown in Fig. 7(CF).17. Considering no heat is lost due to radition, the temperature of the junction is



A. $60^{\circ} C$

B. $20^{\circ} C$

C. $50^{\circ} C$

D. $10^{\circ} C$

Answer: C

Watch Video Solution

117. C_p and C_v denote the molar specific heat capacities of a gas at constant pressure and volume respectively. Then :

A. $a = 14b$

B. $a = 28b$

C. $a = \frac{1}{14}b$

D. $a = b$

Answer: A

Watch Video Solution

118. An ideal gas is expanded such that $PT^2 = a$ constant. The coefficient of volume expansion of the gas is

A. $\frac{1}{T}$

B. $\frac{2}{T}$

C. $\frac{3}{T}$

D. $\frac{4}{T}$

Answer: C

Watch Video Solution

119. Stream at $100\,^{\circ}C$ is passed into 20 g of water at $10\,^{\circ}C$. When water acquires a temperature of $80\,^{\circ}C$, the mass of water present will be [Take specific heat of water $= 1calg^{-1}.\,^{\circ}C^{-1}$ and latent heat of steam $= 540calg^{-1}$]

A. $24g$

B. $31.5g$

C. $42.5g$

D. $22.5g$

Answer: D

Watch Video Solution

120. When the temperature of a rod increases from t to $t + \Delta t$, its moment of inertia increases from I to $I + \Delta I$. If α is coefficient of linear expansion, the value of $\Delta I / I$ is

A. $2\alpha\Delta t$

B. $\alpha\Delta t$

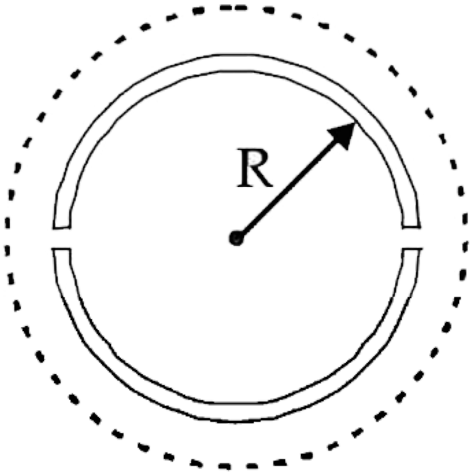
C. $\alpha\Delta t / 2$

D. $\Delta t / \alpha$

Answer: A

Watch Video Solution

121. A wooden wheel of radius R is made of two semicircular part . The two parts are held together by a ring made of a metal strip of cross sectional area S and length L. L is slightly less than $2\pi R$. To fit the ring on the wheel, it is heated so that its temperature rises by ΔT and it just steps over the wheel. As it cools down to surrounding temperature, it process the semicircle parts together. If the coefficient of linear expansion of the metal is α, and it Young's modulus is Y, the force that one part of the wheel applies on the other part is :



A. $2\pi SY\alpha\Delta T$

B. $SY\alpha\Delta T$

C. $\pi SY\alpha\Delta T$

D. $2SY\alpha\Delta T$

Answer: D

Watch Video Solution

122. A pendulum clock loses 12s a day if the temperature is $40\,^{\circ}C$ and gains 4s a day if the temperature is $20\,^{\circ}C$, The temperature at which the clock will show correct time, and the co-efficient of linear expansion (α) of the metal of the pendulum shaft are respectively:

A. $25\,^{\circ}C, \alpha = 1.85 \times 10^{-5}.\,^{\circ}C^{-1}$

B. $60\,^{\circ}C, \alpha = 1.85 \times 10^{-4}.\,^{\circ}C^{-1}$

C. $30\,^{\circ}C, \alpha = 1.85 \times 10^{-3}.\,^{\circ}C^{-1}$

D. $55\,^{\circ}C, \alpha = 1.85 \times 10^{-2}.\,^{\circ}C^{-1}$

Answer: A

Watch Video Solution

123. The specific heat capacity of a metal at low temperature (T) is given as

$$C_p\left(kJK^{-1}kg^{-1}\right) = 32\left(\frac{T}{400}\right)^3$$

A 100 gram vessel of this metal is to be cooled from $20\,^\circ K$ to $4\,^\circ K$ by a special refrigerator operating at room temperaturte $\left(27\,^\circ C\right)$. The amount of work required to cool the vessel is

A. equal to 0.002 kJ

B. greater than 0.148 kJ

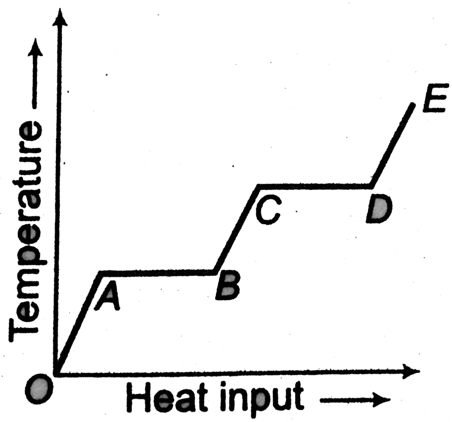
C. between 0.148 kJ and 0.028 kJ

D. less than 0.028 kJ

Answer: A

Watch Video Solution

124. A solid material is supplied heat at a constant rate. The temperature of material is changing with heat input as shown in the figure. What does the slope of DE represent ?



A. AB and CD of the graph represent phase changes

B. AB represents the change of state from solid to liquid

C. Latent heat of fusion is twice the latent heat of vaporisation

D. CD represents change of state from liquid to vapour

Answer: C

Watch Video Solution

125. The amount of heat energy required to raise the temperature of 1 g of Helium at NTP, from T_1 K to T_2 K is

:

A. $\frac{3}{4}N_a k_B\left(\frac{T_2}{T_1}\right)$

B. $\frac{3}{8}N_a k_b\left(T_2 - T_1\right)$

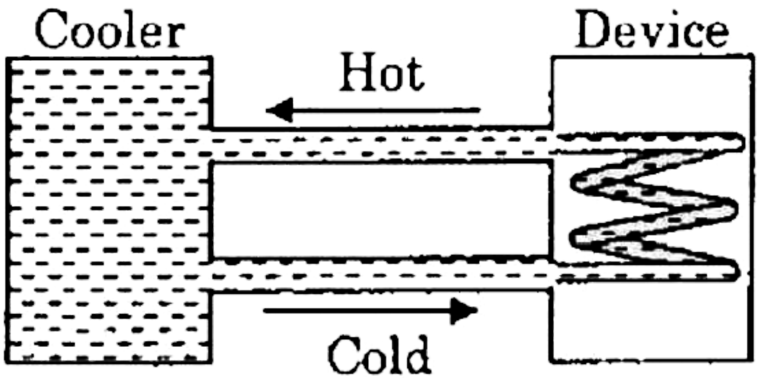
C. $\frac{3}{2}N_a k_B\left(T_2 - T_1\right)$

D. $\frac{3}{4}N_a k_B\left(T_2 - T_1\right)$

Answer: B

Watch Video Solution

126. A water cooler of storages capacity 120 liters can cool water at a constant rate of P watts. In a closed circulation system (as shown schematically in the figure), the water from the cooler is used to cool an external device that generates constantly 3kW of heat (thermal load). The temperature of water fed into the device cannot exceed $30\,^{\circ}C$ and the entire stored 120 liters of water is initially cooled to $10\,^{\circ}C$. The entire system is thermally insulated. The minimum value of P (in watts) for which the device can be operated for 3hours is



(Specific heat of water is $4.2kJkg^{-1}K^{-1}$ and the density of water is $1000kgm^{-3}$)

A. 1600

B. 2067

C. 2533

D. 3933

Answer: B

Watch Video Solution

127. A piece of ice falls from a hight h so that it melts completely. Only one quarter of the heat produced is absorbed by the ice and all energy of ice gets converted into heat during its fall. The value of h is : (Latent heat of ice is $3.4 \times 10^5 j/kg$ and $g = 10N/kg$)

A. 34 km

B. 544 km

C. 136 km

D. 68 km

Answer: C

Watch Video Solution

128. The value of coefficient of volume expansion of glycerin is $5 \times 10^4 K^{-1}$. The fractional change in temperature is :

A. 0.010

B. 0.015

C. 0.020

D. 0.025

Answer: C

Watch Video Solution

129. A ice box of styrofoam (thermal conductivity = 0.01 J $ms^{-1}K^{-1}$) is used to keep liquid cool. It has a total wall area, including lid, of $10.8m^2$ and wall thickness of 2.0 cm. A bottle of water is placed in the box and filled with ice. If the outside temperature is $30\,^{\circ}C$, the rate of flow of heat into the box is (in J/s)

A. 16

B. 14

C. 12

D. 10

Answer: C

Watch Video Solution

130. A beaker full of hot water is kept in a room and it cools from $80^{\circ} C$ to $75^{\circ} C$ in t_1 mminutes , from $75^{\circ} C$ to $65^{\circ} C$ in t_2 minutes and from $70^{\circ} C$ to $65^{\circ} C$ in t_3 min, then

A. $t_1 > t_2 > t_3$

B. $t_1 = t_2 = t_3$

C. $t_1 < t_2 = t_3$

D. $t_1 < t_2 < t_3$

Answer: D

Watch Video Solution

131. The rate of cooling at 600 K, if surrounding temperature is 300 K is R. The rate of cooling at 900 K is

A. $\frac{16}{3}R$

B. $2R$

C. $3R$

D. $\frac{2}{3}R$

Answer: A

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132. A cup of tea cools from 65.5°C to $62.55^{\circ}C$ in one minute is a room at $225.^{\circ}C$. How long will the same cup of tea take to cool from $46.5^{\circ}C$ to $40.5^{\circ}C$ in the same room ? (Choose the nearest value in min).

A. 1

B. 2

C. 3

D. 4

Answer: D

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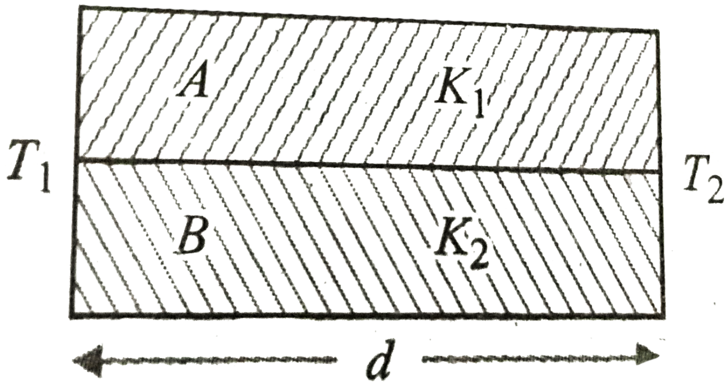
133. Two rods A and B of different materials are welded together as shown in figure. Their thermal conductivities are K_1 and K_2. The thermal conductivity of the composite rod will be



A. $\frac{K_1 + K_2}{2}$

B. $\frac{3(K_1 + K_2)}{2}$

C. $K_1 + K_2$

D. $2(K_1 + K_2)$

Answer: A

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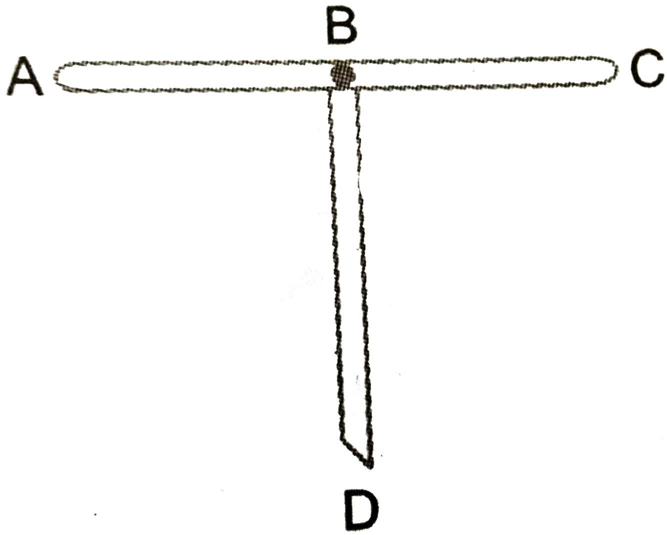
134. Three conducting rods of same material and cross-section are showm in Fig .7(CF).22. Temperatures of A, D and C are maintained at $20^{\circ} C, 90^{\circ} C$ and $0^{\circ} C$. The ratio of the lengths of BC and BD, if there is no flow in AB, is



A. $2/9$

B. $9/2$

C. $2/7$

D. $7/2$

Answer: C

Watch Video Solution

135. Two identical rods are connected between two containers. One of them is at $100\,^{\circ}C$ containing water and another is at $0\,^{\circ}C$ containing ice. If rods are connected in parallel then the rate of melting of ice is $q_1 g/s$. If they are connected in series then teh rate is $q_2 g/s$. The ratio q_2/q_1 is

A. $1/8$

B. $1/4$

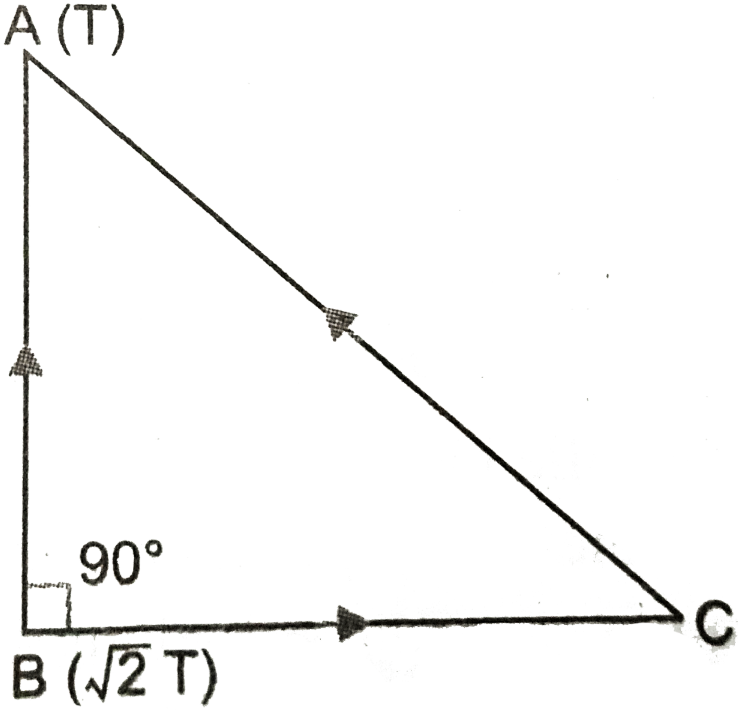
C. $1/2$

D. 4

Answer: B

Watch Video Solution

136. Three rods of identical cross-sectional area and made from the same metal, from the sides of an isosceles triangle ABC right angled at B, as shown in Fig .7(CF).23. The points A and B are maintained at temperature T and $\sqrt{2}T$ respectively in the steady. Assuming that only heat conduction takes place, temperature of point C will be



A. $\frac{T}{\sqrt{2} + 1}$

B. $\frac{T}{\sqrt{2} - 1}$

C. $\frac{3T}{\sqrt{2} + 1}$

D. $\frac{\sqrt{3}T}{\sqrt{2} + 1}$

Answer: C

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137. Three rods of copper, brass and steel are welded togeher to from a Y -shaped structure. Area of cross-section of each rod $= 4cm^2$. End of copper rod is maintained at $100\,^\circ C$ whereas the ends of brass and steel are at $0\,^\circ C$. Lengths of copper, brass and steel rods are 46, 13 and 12 cm respectively. The rods are thermally insulated from surroundings except at ends. Thermal conductivities of copper, brass and steel are $0.92, 0.26$ and 0.12 CGS units respectively. Rate of heat flow through copper rod is

A. $4.8 cal/s$

B. $6.0 cal/s$

C. $1.2 cal/s$

D. $2.4 cal/s$

Answer: A

Watch Video Solution

138. Consider a compound slab consisting of two different material having equal thickness and thermal conductivities K and $2K$ respectively. The equivalent thermal conductivity of the slab is

A. $(2/3)K$

B. $\sqrt{2}K$

C. $3K$

D. $(4/3)K$

Answer: D

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139. The ends Q and R of two thin wires, PQ and RS, are soldered (joined) together. Initially each of the of wire has a length of 1m at $10^\circ C$. Now the end P is maintained at $10^\circ C$, while the ends S is heated and maintained at $400^\circ C$. The system is thermally insultated from its surroundings. If the thermal conductivity of wire PQ is twice that of the wire RS and the coefficient of linear thermal expansion of PQ is $1.2 \times 10^{-5} K^{-1}$, the change in length of the wire PQ is

A. $0.78mm$

B. $0.90mm$

C. $1.56mm$

D. $2.34mm$

Answer: A

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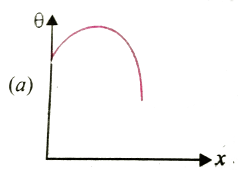
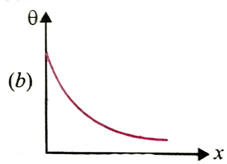
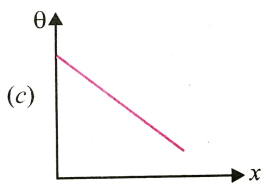
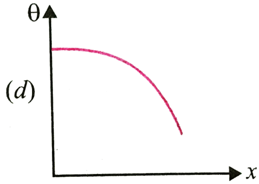
140. A long metallic bar is carrying heat from one of its ends to the other end under steady-state. The variation of temperature θ along the length x of the bar from its hot end is best described by which of the following figures?

A. 

B. 

C. 

D. 

Answer: C

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141. Three identical rods A, B and C are placed end to end. A temperature difference is maintained between the free ends of A and C. The thermal conductitvity of B is thrice that of C and half that of A. The effective thermal conductivity of rod A)

A. $\frac{1}{3}K_A$

B. $3K_A$

C. $2K_A$

D. $\frac{2}{3}K_A$

Answer: A

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142. A spherical black body with a radius of 12 cm radiates 450 watt power at 500 K. If the radius were halved and the temperature doubled, the power radiated in watt would be

A. 225

B. 450

C. 1000

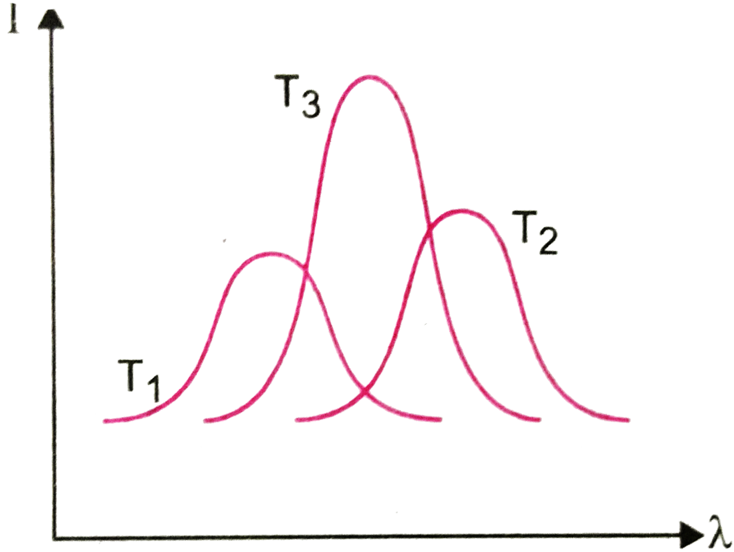
D. 1800

Answer: D

Watch Video Solution

143. The plots of intensity (I) of radiation versus wavelength (γ) of thee black bodies at temperatures

T_1, T_2 and T_3 are shown in Fig.7(CF).25. Then,



A. $T_3 > T_2 > T_1$

B. $T_1 > T_2 > T_3$

C. $T_2 > T_3 > T_1$

D. $T_1 > T_3 > T_2$

Answer: D

144. Certain quantity of water cools from $70^{\circ} C$ to $60^{\circ} C$ in the first 5 minutes and to $54^{\circ} C$ in the next 5 minutes. The temperature of the surrounding is

A. $45^{\circ} C$

B. $20^{\circ} C$

C. $42^{\circ} C$

D. $10^{\circ} C$

Answer: A

145. Hot water cools from $60^{\circ} C$ to $50^{\circ} C$ in the first 10 min and to $42^{\circ} C$ in the next 10 min. The temperature of the surrounding is

A. $10^{\circ} C$

B. $5^{\circ} C$

C. $15^{\circ} C$

D. $20^{\circ} C$

Answer: A

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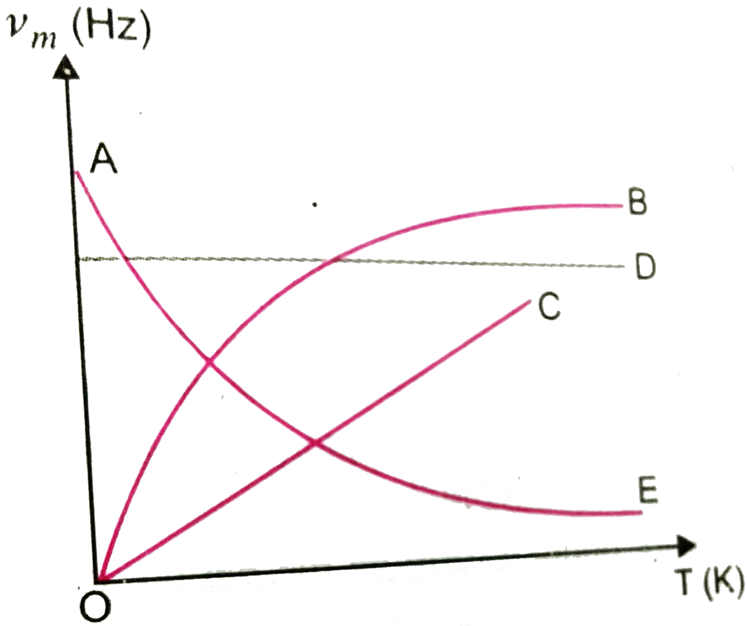
146. Which one of the following is ν_m - T graph for perfectly black body ? ν_m is the frequency of radition with maximum intensity. T is the absolute temperature



A. A

B. B

C. C

D. D

Answer: C

Watch Video Solution

147. Three very large plates of same area are kept parrallel and close to each other. They are considered as ideal black surfaces and have high thermal conductivity. The first and third plates are maintained at temperatures 2T and 3T respectively. The temperature of the middle (i.e., second) plate under steady state condition is

A. $\left(\frac{65}{2}\right)^{1/4}T$

B. $\left(\frac{97}{4}\right)^{1/4}T$

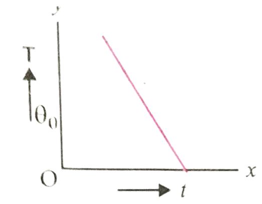
C. $\left(\frac{97}{2}\right)^{1/4}T$

D. $(97)^{1/4}T$

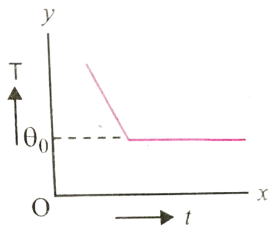
Answer: C

Watch Video Solution

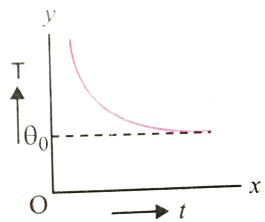
148. If a piece of metal is heated to temperature θ and the allowed to cool in a room which is at temperature θ_0, the graph between the temperature T of the metal and time t will be closet to

A. 

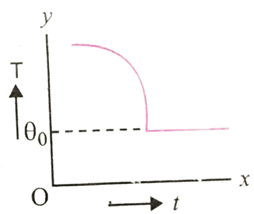
(a)

B. 

(b)

C. 

(c)

D. 

(d)

Answer: C

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149. A black body is at a temperature of 5760 K. The energy of radiation emitted by the body at wavelength 250 nm is U_1, at wavelength 500 nm is U_2 and at 1000 nm is U_3, Wien's constant, $b = 2.88 \times 10^6$ nm K, which of the following is correct ?

A. $U_1 = 0$

B. $U_3 = 0$

C. $U_1 > U_2$

D. $U_2 > U_1$

Answer: D

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150. On observing light from three different stars P, Q and R, it was found that intensity of violet colour is maximum in the spectrum of P, the intensity of green colour is maximum in the spectrum of R and the intensity of red colour is maximum in the spectrum of Q. if T_P, T_Q and T_R are respective absolute temperature of P, Q and R. then it can be concluded from the above observation that

A. $T_P > T_R > T_Q$

B. $T_P < T_R < T_Q$

C. $T_P < T_Q < T_R$

D. $T_P < T_Q < T_R$

Answer: A

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151. The black body spectrum of an object O_1 is such that its radiant intensity (i.e. intensity per unit wavelength interval) is maximum at a wavelength of 200 nm. Another object O_2 has the maximum radiant intensity at 600 nm. The ratio of power emitted per unit area by source O_1 to that of source O_2 is

A. $1:81$

B. $1:9$

C. $9 : 1$

D. $81 : 1$

Answer: D

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152. When a wire is streched to duble its length

A. strain is unity

B. stress is equal to Young's modulus of elasticity

C. its radius is halved

D. Young's modulus is equal to twice the elastic energy per unit volume

Answer: A::B::D

Watch Video Solution

153. When an air bubble moves up from the bottom of a lake

A. its velocity decreases and becomes zero

B. its velocity increases and becomes constant

C. its ac celeration decreases and becomes zero

D. its ac celeration increases and becomes constant

Answer: B::C

Watch Video Solution

154. When a drop splits up into number of drops

A. Area increases

B. Volume increases

C. Energy is absorbed

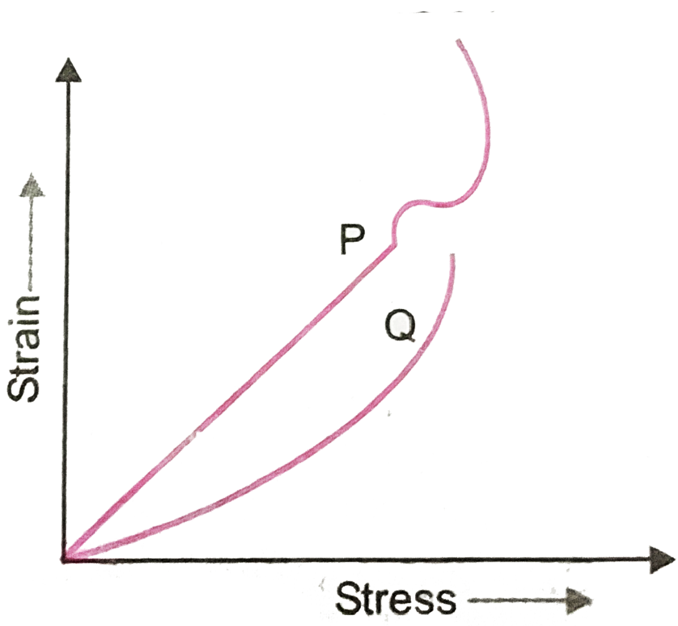
D. Energy is liberated

Answer: A::C

Watch Video Solution

155. In plotting stress versus strain curves for two material P and Q, a student by mistake puts strain on the y-axis stress on ther x-axis as shown in the figure.

Then the correct statement is/are



A. P has more tensile sile strrength than Q

B. P is more ductile than Q

C. P is more brittle Q

D. The young's modulus of P is more than that of Q

Answer: A::B

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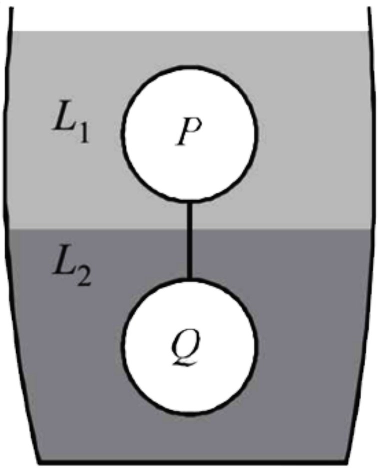
156. Two spheres P and Q of equal radii have densities ρ_1 and ρ_2, respectively. The spheres are connected by a massless string and placed in liquids L_1 and L_2 of densities σ_1 and σ_2 and viscosities η_1 and η_2, respectively. They float in equilibrium with the sphere P in L_1 and sphere Q in L_2 and the string being taut(see figure). If sphere P alone in L_2 has terminal velocity $\vec{V}_p$

and Q alone in L_1 has terminal velocity $\vec{V}_Q$, then



A. $\left|\frac{v_P}{v_Q}\right| = \frac{\eta_1}{\eta_2}$

B. $\frac{\vec{v}_P}{\vec{v}_Q} = \frac{\eta_2}{\eta_1}$

C. $\vec{v}_P \cdot \vec{v}_Q > 0$

D. $\vec{v}_P \cdot \vec{v}_Q < 0$

Answer: B::D

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157. Which of the following statement (s) is/are correct about a soap bubble ?

A. work done in forming the bubble of radius R and surface tension T is $8\pi R^2$ T

B. work done in doubling the radius of bubble of radius R and surface tension T is $12\pi R^2$ T

C. Pressure inside the bubble is double than inside the drop of same radius and liquid

D. pressure inside the bubble is lesser than outside it

Answer: A::C

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158. Viscous force is somewhat like friction as it opposes the motion and is non-conservative but not exactly so because

A. it is velocity independent while friction depends on velocity

B. it is veloctiy dependent while friction is not

C. it is independent of area like surface tension while friction depends on area

D. it is temerature dependent while friction does not depend on temperature

Answer: B::D

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159. If for a liquid in a vessel force of cohesion is twice of adhesion

A. the liquid will wet the solild

B. the liquid will not wet the solid

C. the miniscus will be convex upwards

D. the angle of contact will be obtuse

Answer: B::C::D

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160. With the rise in temperature, which of the following forces can never increase

A. friction

B. elastic

C. viscous

D. surface tension force

Answer: A::B::D

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161. A human body has a surface area of approximately 1 m^2. The normal body temperature is 10 K above the surrounding room temperature T_0. Take the room temperature to be $T_0 = 300K$. For $T_0 = 300K$, the value of $\sigma T_0^4 = 460 Wm^{-2}$ (where σ is the Stefan-Boltzmann constant). Which of the following options is/are correct?

A. The amount of energy radiated by the body in/second is close to 60 joules.

B. If the surrounding temperature reduces by a small amount $\Delta T_0 < < T_0$, then to maintain the same body temperature the same (living) human being needs to radiate $\Delta W = 4\sigma T_0^3 \Delta T_0$ more energy per unit times.

C. Reducing the exposed surface area of the body (e.g., by curbing up) allows humans to maintain the same body temperature while reducing the energy lost by radiation.

D. If the body temperature rises significantly then the peak in the spectrum of electromagnetic radiation emitted by the body would shift to longer wavelengths.

Answer: A::B::C

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162. The velocity of efflux of an ideal liquid does not depend on

A. the area of orifice

B. the density of liquid

C. the area of cross-section of the vessel

D. the depth of point below the free surface of the liquid

Answer: A::B::C

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163. A piece of wood is floating in water kept in a bottle. The bottle is connected to an air pump. Neglect the compressibility of water. When more air is pushed into the bottle from the pump, the piece of wood will float with

A. the thrust of air will increase

B. the total thrust will remain unchanged

C. the thrust of water will decrease

D. the wood pices will rise a little

Answer: A::B::C::D

Watch Video Solution

164. A spherical body of radius R consists of a fluid of constant density and is in equilibrium under its own gravity. If P(r) is the pressure at r(rltR), then the correct option(s) is (are)

A. $P(r = 0) = 0$

B. $\frac{P(r = 3R/4)}{P(r = 2R/3)} = \frac{63}{80}$

C. $\frac{P(r = 3R/5)}{P(r = 2R/5)} = \frac{16}{21}$

D. $\frac{P(r = R/2)}{P(r = R/3)} = \frac{20}{27}$

Answer: B::C

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165. A structural steel rod has a radius r(=10 mm) and a length l(=1 m). When a force F(= 100 kN) is applied, it stretches it along its length. Young's modulus of elasticity of the structural steel is $2.0 \times 10^{11} Nm^{-2}$.

What is the stress produced ?

A. 1.59×10^9 Pa

B. 3.18×10^9 Pa

C. 3.18×10^8 Pa

D. 1.59×10^8 Pa

Answer: C

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166. A structural steel rod has a radius r(=10 mm) and a length l(=1 m). When a force F(= 100 kN) is applied, it stretches it along its length. Young's modulus of elasticity of the structural steel is $2.0 \times 10^{11} Nm^{-2}$. What is the elongation produced ?

A. 1.59 mm

B. 2.32 mm

C. 0.159 mm

D. 3.18 mm

Answer: A

Watch Video Solution

167. A structural steel rod has a radius r(=10 mm) and a length l(=1 m). When a force F(= 100 kN) is applied, it stretches it along its length. Young's modulus of elasticity of the structural steel is $2.0 \times 10^{11} Nm^{-2}$. What is the elastic energy density of the steel rod ?

A. $6.12 \times 10^{4} Jm^{-3}$

B. $1.25 \times 10^{4} Jm^{-3}$

C. $2.5 \times 10^{4} Jm^{-3}$

D. $2.5 \times 10^{5} Jm^{-3}$

Answer: D

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168. Let n number of little droplets of water of surface tension S (dyne/cm), all of the same radius r cm combine to from a single drop of radius R heat, while using cgs system of units answer the following questions.

The energy released is

A. $S \times 4\pi nr^2$

B. $S \times 4\pi R^2$

C. $S4\pi R^2\left[n^{1/3} - 1\right]$

D. $S4\pi R^2\left[n^{2/3} - 1\right]$

Answer: C

Watch Video Solution

169. Let n number of little droplets of water of surface tension S (dyne/cm), all of the same radius r cm combine to from a single drop of radius R heat, while using cgs system of units answer the following questions.

If the whole energy released is taken by water drop fromed, then rise in temperature in .^(@)C` is

A. $\frac{S}{J}\left[\frac{1}{r}-\frac{1}{R}\right]$

B. $\frac{4S}{J}\left[\frac{n}{r}-\frac{1}{R}\right]$

C. $\frac{3S}{J}\left[\frac{1}{r}-\frac{1}{R}\right]$

D. $\frac{S}{J}\left[\frac{n}{r}-\frac{1}{R}\right]$

Answer: C

Watch Video Solution

170. Let n number of little droplets of water of surface tension S (dyne/cm), all of the same radius r cm combine to from a single drop of radius R heat, while using cgs system of units answer the following questions.

If the radius of the big drop formed is made two times without any change in temperature then the work done is

A. $4\pi R^2 S$

B. $8\pi R^2 S$

C. $12\pi R^2 S$

D. $16\pi R^2 S$

Answer: C

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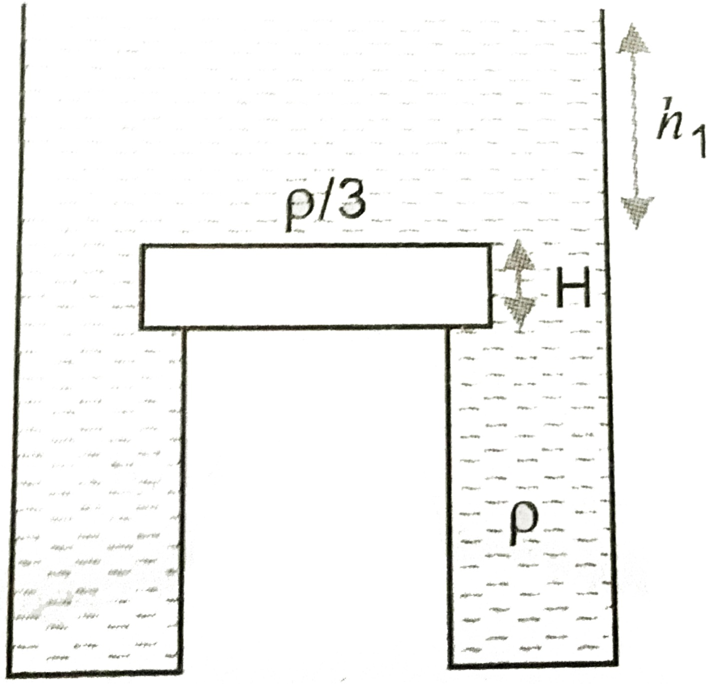
171. A wooden cylinder of diameter 4 r, height H and density $\rho/3$ is kept on a hole of diameter 2 r of a tank, filled with water of density ρ as shown in the



If level of liquid starts decreasing slowly, when the level of liquid is at a height h_1 above the cylinder, the block just start moving up. Then the value of h_1 is

A. $4H/9$

B. $5H/9$

C. $5H/3$

D. remains same

Answer: C

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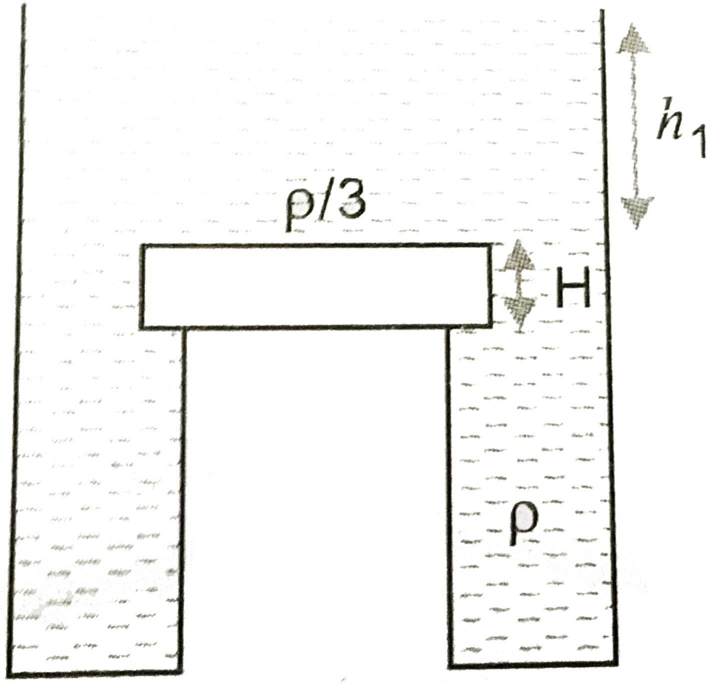
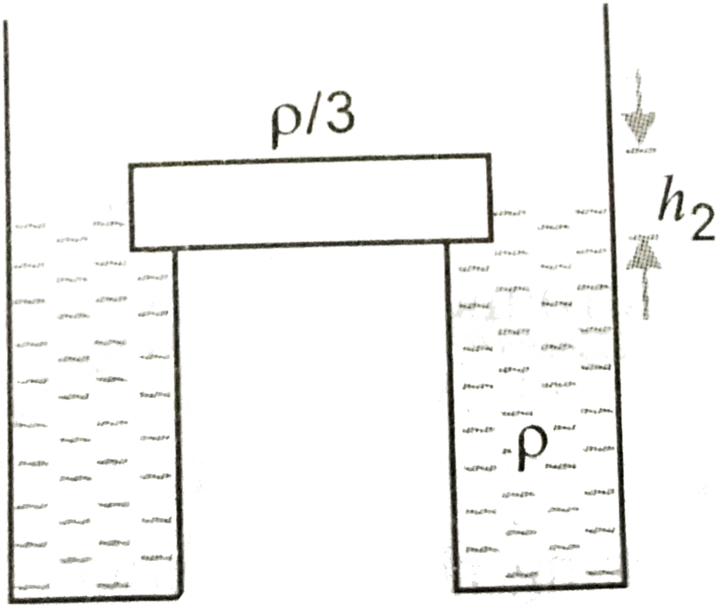
172. A wooden cylinder of diameter 4 r, height H and density $\rho/3$ is kept on a hole of diameter 2 r of a tank, filled with water of density ρ as shown in the



The block in the above question is maintained by external means and the level of liquid is lowered. The height h_2 when this external force reduces to zero is



A. $4H/9$

B. $5H/9$

C. remains same

D. $2H/3$

Answer: A

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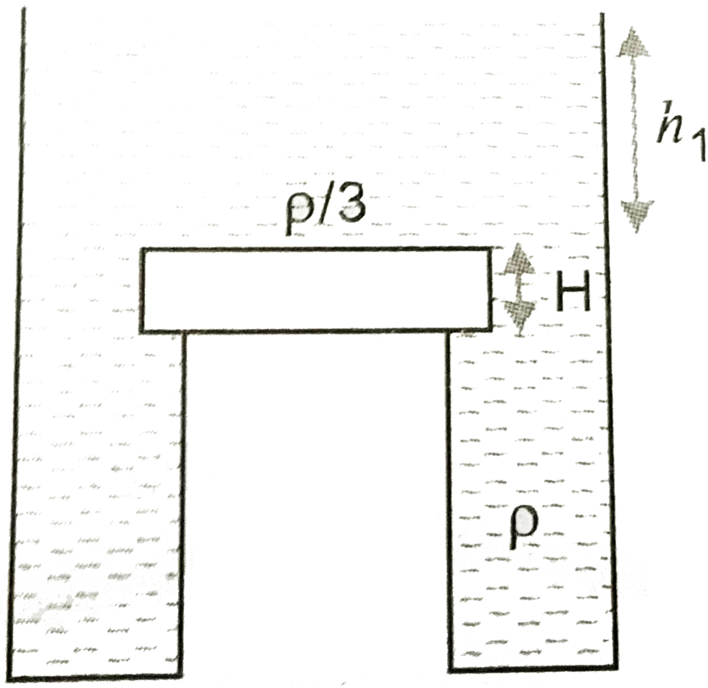
173. A wooden cylinder of diameter 4 r, height H and density $\rho/3$ is kept on a hole of diameter 2 r of a tank, filled with water of density ρ as shown in the



If height h_2 of water level is further decreased, then

A. cylinder will not move up and remains at its original position

B. for $h_2 = H/3$, cylinder again starts moving up

C. for $h_2 = H/4$, cylinder again starts moving up

D. for $h_2 = H/5$, cylinder again starts moving up

Answer: A

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Integer Type Questions

1. During Searle's experiment, zero of the Vernier sacle lies between 3.20×10^{-2}, and $3.25 \times 10^{-2} m$ of the main scale. The 20^{th} division of the Vernier scale exactly coincides with one of the main scale divisions. When an additional load of $2kg$ is applied to the wire, the zero of the vernier scale still lies between 3.20×10^{-2}, and $3.25 \times 10^{-2}m$ of the main scale but now the 45^{th} division of Vernier scale coincide with one of the main scale divisions. the length of the thin metallic wire is $2m$ and its cross-sectional ares is $8 \times 10^{-7}m^2$. the least count of the Vernier scale is $1.0 \times 10^{-5}m$. the maximum percentage error in the Young's modulus of the wire is

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2. When equal volumes of two metals are mixed together the specific gravity of alloy is 4. When equal masses of the same two metals are mixed together the specific gravity of the alloy becomes 3. find specific gravity of each metal?

(specific gravity $= \frac{\text{density of substance}}{\text{density of water}}$)

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3. There is a soap bubble of radius $2.4 \times 10^{-4}m$ in air cylinder at a pressure of $10^5 N/m^2$. The air in the cylinder is compressed isothermal until the radius of the bubble is halved. Calculate the new pressure of air in the cylinder. Surface tension of soap solution is $0.08 Nm^{-1}$.

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4. A drop of liquid of radius $R = 10^{2}$m having surface tension $S = \frac{0.1}{4\pi} N/m^{-1}$ divides itself into K identical drop. In this process the total change in the surface energy $\Delta U = 10^{-3}$ J. If $K = 10^{\alpha}$, then the value of α is :

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5. A liquid flows through two capillary tubes A and B connected in series. The length and radius of B are twice that of A. What is the ratio of the pressure difference across A to that across B ?

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6. Water flows through a tapering horizontal tube whose radii of cross-section of the ends $r_1 = 20\text{cm}$ and $r_2 = 10\text{cm}$. The velocity of water at the points for the radius of cross-section r_1 is $v_1 = 2ms^{-1}$. The force imparted by the emergiang water at the other end of teh tube is nearly 2×10^nN. What is the value of n ?

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7. Water flowing steadily through a horizontal pipe of non-unifrom cross-section. If the pressure of water is $4 \times 10^4 N/m^2$ at a point where cross-section is $0.02m^2$ and velocity of flow is $2ms^{-1}$. The pressure at a point where cross-section reduces to $0.01m^2$ is 3.4×10^n Pa.

What is the value of n ?

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8. A piece of ice (heat capacity $= 2100 Jkg^{-1}.^\circ C^{-1}$ and latent heat $= 3.36 \times 10^5 Jkg^{-1}$) of mass m grams is at $-5.^\circ C$ at atmospheric pressure. It is given 420 J of heat so that the ice starts melting. Finally when the ice . Water mixture is in equilibrium, it is found that 1 gm of ice has melted. Assuming there is no other heat exchange in the process, the value of m in gram is

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9. 0.75 gram of petroleum was burnt in a bomb calorimeter which contains 2 kg of water and has a water equivalent 500 gram. The rise in temperature was $3\,^{\circ}C$. The calorific value of petroleum is 10^{n} cal/g. Determine the value of n.

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10. Consider two solid spheres P and Q each of density $8gmcm^{-3}$ and diameters 1cm and 0.5cm, respectively. Sphere P is dropped into a liquid of density $0.8gmcm^{-3}$ and viscosity $\eta = 3$ poiseulles. Sphere Q is dropped into a liquid of density $1.6gmcm^{-3}$ and viscosity $\eta = 2$ poiseulles. The ratio of the terminal velocities of P and Q is

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11. A metal is heated in a furnace where a sensor is kept above the metal surface to read the power radiated (P) by the metal. The sensor has scale that displays $\log_2, (P/P_0)$, where P_0 is constant. When the metal surface is at a temperature of $487\,^\circ C$, the sensor shows a value 1. Assume that the emissivity of the metallic surface remains constant. What is the value displayed by the sensor when the temperature of the metal surface is raised to $2767\,^\circ C$?

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12. Two spherical starts A and B emit black body radiation. The radius of A is 400 times that of B and A emits 10^4 times the power emitted from B. The ratio $\left(\lambda_A/\lambda_B\right)$ of their wavelengths λ_A and λ_B at which the peaks oc cur in their respective radiation curves is :

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Asseration - Reason Type Question

1. STATEMENT-1: The stream of water flowing at high speed from a garden hose pipe tends to spread like a fountain when held vertically up, but tends to narrow down when held vertically down.

STATEMENT-2: In any steady flow of an incompressible fluid, the volume flow rate of the fluid remains constant.

A. both Assertion and Reason are true and the Reason in the correct explanation of the Assertion.

B. both Assertion and Reason are true but Reason is not a correct explanation of the Assertion.

C. Assertion is true but the Reason is false.

D. both Assertion and Reason are false.

Answer: A

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2. Assertion. A bubble comes from the bottom of a lake to the top.

Reason. Its radius increases.

A. both Assertion and Reason are true and the Reason in the correct explanation of the Assertion.

B. both Assertion and Reason are true but Reason is not a correct explanation of the Assertion.

C. Assertion is true but the Reason is false.

D. both Assertion and Reason are false.

Answer: B

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3. Assertion : At critical temperature, surface tension of liquids becomes zero.

Reason : At critical temperature, intermolecular forces for liquids and gases become equal. Liquids can expand without restriction.

A. both Assertion and Reason are true and the Reason in the correct explanation of the Assertion.

B. both Assertion and Reason are true but Reason is not a correct explanation of the Assertion.

C. Assertion is true but the Reason is false.

D. both Assertion and Reason are false.

Answer: A

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4. Assertion : The angle of contact of a lilquid with a solid decreases with increase in temperature.

Reason : With increase in temperature, the surface tension of the liquid increases.

A. both Assertion and Reason are true and the Reason in the correct explanation of the Assertion.

B. both Assertion and Reason are true but Reason is not a correct explanation of the Assertion.

C. Assertion is true but the Reason is false.

D. both Assertion and Reason are false.

Answer: D

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5. Assertion : A given mass of a gas is subjected to an external pressure of $0.5 \times 10^{10} N/m^2$, the bulk modulus of the gas is $0.5 \times 10^{10} N/m^2$. The ratio of the density of the gas before and after applying the external pressure is $1:1$

Reason : Pressure is inversely proportional to density of gas and bulk modulus is inversely proportional to change in volume

A. both Assertion and Reason are true and the Reason in the correct explanation of the Assertion.

B. both Assertion and Reason are true but Reason is not a correct explanation of the Assertion.

C. Assertion is true but the Reason is false.

D. both Assertion and Reason are false.

Answer: D

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6. Statement I: A needle placed carefully on the surface of water may float, whereas the ball of the same material will always sink.

Statement II: The buoyancy of an object depends both on the material and shape of the object.

A. both Assertion and Reason are true and the Reason in the correct explanation of the Assertion.

B. both Assertion and Reason are true but Reason is not a correct explanation of the Assertion.

C. Assertion is true but the Reason is false.

D. both Assertion and Reason are false.

Answer: C

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7. Statement I: A hydrogen-filled balloon stops rising after it has attained a certain height in the sky.

Statement II: The atmospheric pressure decreases with height and becomes zero when the maximum height is attained.

A. both Assertion and Reason are true and the Reason in the correct explanation of the Assertion.

B. both Assertion and Reason are true but Reason is not a correct explanation of the Assertion.

C. Assertion is true but the Reason is false.

D. both Assertion and Reason are false.

Answer: B

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8. Statement I: Smaller drops of liquid resist deforming forces better than the larger drops.

Statement II: Excess pressure inside a drop is directly proportional to its surface area.

A. both Assertion and Reason are true and the Reason in the correct explanation of the Assertion.

B. both Assertion and Reason are true but Reason is not a correct explanation of the Assertion.

C. Assertion is true but the Reason is false.

D. both Assertion and Reason are false.

Answer: C

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9. Assertion: The shape of an automobile is so designed that its front resembles the stream line pattern of the fluid through which it moves.

Reason: The resistance offered by the fluid is maximum.

A. both Assertion and Reason are true and the Reason in the correct explanation of the Assertion.

B. both Assertion and Reason are true but Reason is not a correct explanation of the Assertion.

C. Assertion is true but the Reason is false.

D. both Assertion and Reason are false.

Answer: C

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10. Assertion: Aeroplanes are made to run on the runway before take off, so that they acquire the necessary lift.

Reason: This is as per Bernoulli's theorem.

A. both Assertion and Reason are true and the Reason in the correct explanation of the Assertion.

B. both Assertion and Reason are true but Reason is not a correct explanation of the Assertion.

C. Assertion is true but the Reason is false.

D. both Assertion and Reason are false.

Answer: A

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11. Assertion : Water is flowing through a horizontal tube, the static pressure and total pressure at any point are 1.20×10^5 P and 1.28×10^5 P . If the density of water is $1000 kg / m^3$, the velocity of liquid flow is 4 m/s.

Reason : Work done on the liquid by difference in pressure is equal to gain in K.E. of liquid

A. both Assertion and Reason are true and the Reason in the correct explanation of the Assertion.

B. both Assertion and Reason are true but Reason is not a correct explanation of the Assertion.

C. Assertion is true but the Reason is false.

D. both Assertion and Reason are false.

Answer: A

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12. Statement -1 : A large soap bubble expands while a small bubble shrink, when they are connecteed to each other by a capillary tube.

Statement -2 : The excess pressure (due to surface tension) inside a spherical bubble increasesee, as its volume decreases.

A. Statement -1 is true , Statement -2 is true , Statement -2 is a correct explanation of Statement -1.

B. Statement -1 is true , Statement -2 is true , Statement -2 is not a correct explanation of Statement -1.

C. Statement -1 is true, Statement -2 is false.

D. Statement -1 is false , Statement -2 is true.

Answer: A

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13. Statement -1 : A block of wood is floating in a tank containing water. The apparent weight of the floating block is equal to zero.

Statement -2 : Because the entire weight of the block is supported by the buoyant force (the upward thrust) due to water.

A. Statement -1 is true , Statement -2 is true , Statement -2 is a correct explanation of Statement -1.

B. Statement -1 is true , Statement -2 is true , Statement -2 is not a correct explanation of Statement -1.

C. Statement -1 is true, Statement -2 is false.

D. Statement -1 is false , Statement -2 is true.

Answer: A

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14. Statement -1 : All the raindrops hit the surface of the earth with the same constant velocity.

Statement -2 : An object falling through a viscous medium eventually attains a teerminal velocity.

A. Statement -1 is true , Statement -2 is true , Statement -2 is a correct explanation of Statement -1.

B. Statement -1 is true , Statement -2 is true , Statement -2 is not a correct explanation of Statement -1.

C. Statement -1 is true, Statement -2 is false.

D. Statement -1 is false , Statement -2 is true.

Answer: D

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15. Statement -1 : A rain drop after fallling through some height attains a constant velocity.

Statement -2 : At constant velocity, the viscous drag is just to its weight.

A. Statement -1 is true , Statement -2 is true , Statement -2 is a correct explanation of Statement -1.

B. Statement -1 is true , Statement -2 is true , Statement -2 is not a correct explanation of Statement -1.

C. Statement -1 is true, Statement -2 is false.

D. Statement -1 is false , Statement -2 is true.

Answer: A

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16. Statement -1 : Aeroplanes always fly at low altitudes.

Statement -2 : Ac cording to Newton's third law of motion, for every action there is an equal and opposite reaction.

A. Statement -1 is true , Statement -2 is true , Statement -2 is a correct explanation of Statement -1.

B. Statement -1 is true , Statement -2 is true , Statement -2 is not a correct explanation of

Statement -1.

C. Statement -1 is true, Statement -2 is false.

D. Statement -1 is false , Statement -2 is true.

Answer: A

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17. Statement -1 : When temperature is incrteased, viscosity of the gas decreases.

Statement -2 : With the increase in temperature, the gas becomes lighter.

A. Statement -1 is true , Statement -2 is true , Statement -2 is a correct explanation of Statement -1.

B. Statement -1 is true , Statement -2 is true , Statement -2 is not a correct explanation of Statement -1.

C. Statement -1 is true, Statement -2 is false.

D. Statement -1 is false , Statement -2 is true.

Answer: D

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18. Statement -1 : A tiny shere of mass m and density ρ is dropped in a tall jar of glycerine of density ρ_0 . When the sphere acquires terminal velocity v, the magnitude of viscous force is $mg\left(1 - \rho_0/\rho\right)$.

Statement -2 : Viscous force on the body falling in a medium is $F = 6\pi\eta rv$, where η is the coeff. of viscosity of medium and r is the radius of body

A. Statement -1 is true , Statement -2 is true , Statement -2 is a correct explanation of Statement -1.

B. Statement -1 is true , Statement -2 is true , Statement -2 is not a correct explanation of

Statement -1.

C. Statement -1 is true, Statement -2 is false.

D. Statement -1 is false , Statement -2 is true.

Answer: B

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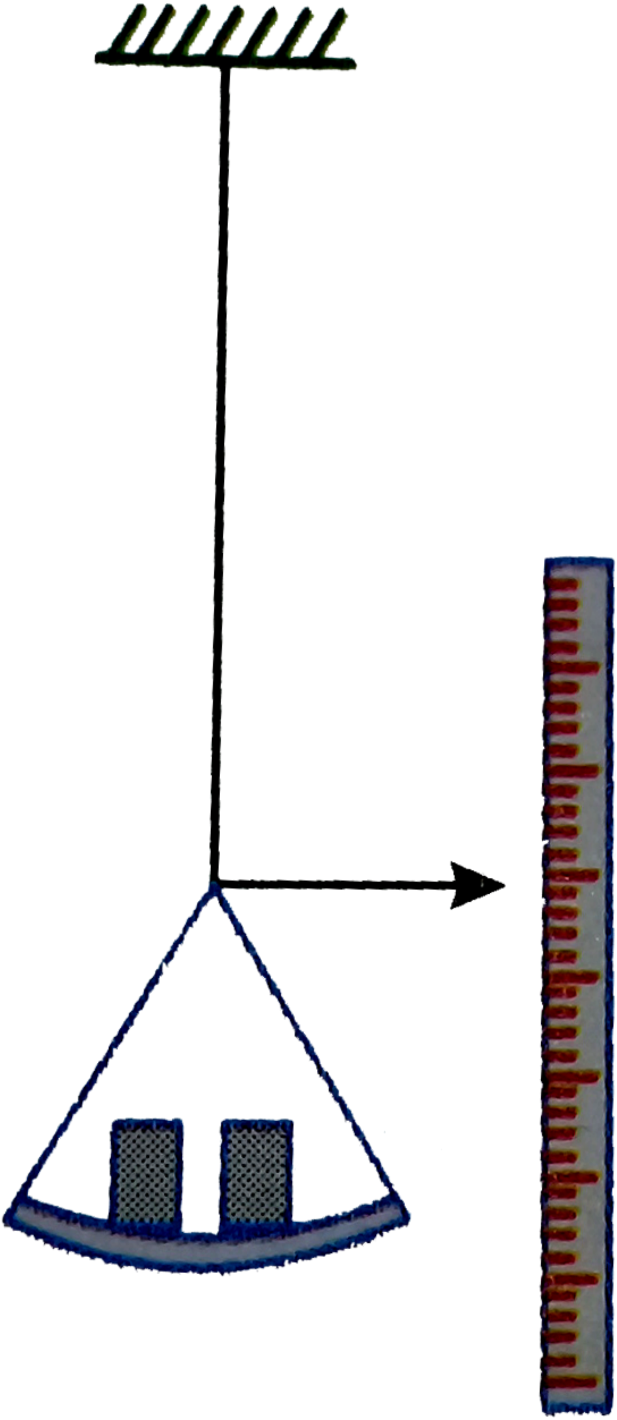
Multiple choice questions

1. In the experiment to determine Young's modulus of the material of a wire under tension

used in the arrangement as shown. The percentage error in the measurement of length is a in the measurement of the radius of the wire is b and in the measurement of the change in length of the wire is c. Percentage error in the measurement of Young's modulus for a given load is



A. $a - 2b + c$

B. $a - 2b - c$

C. $a + 2b + c$

D. $a + 2b$

Answer: C

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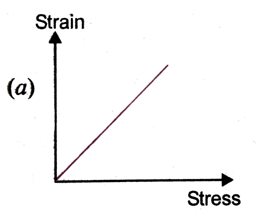
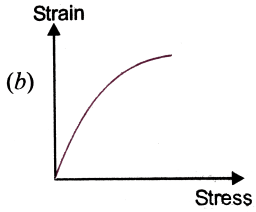
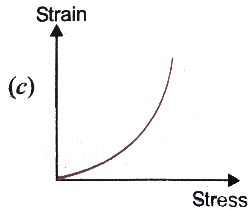
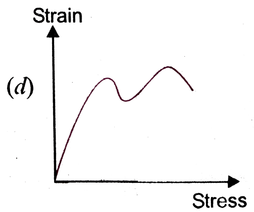
2. Which of the following is the graph showing stress-strain variation for elastomers ?

A. 

B. 

C. 

D. 

Answer: B

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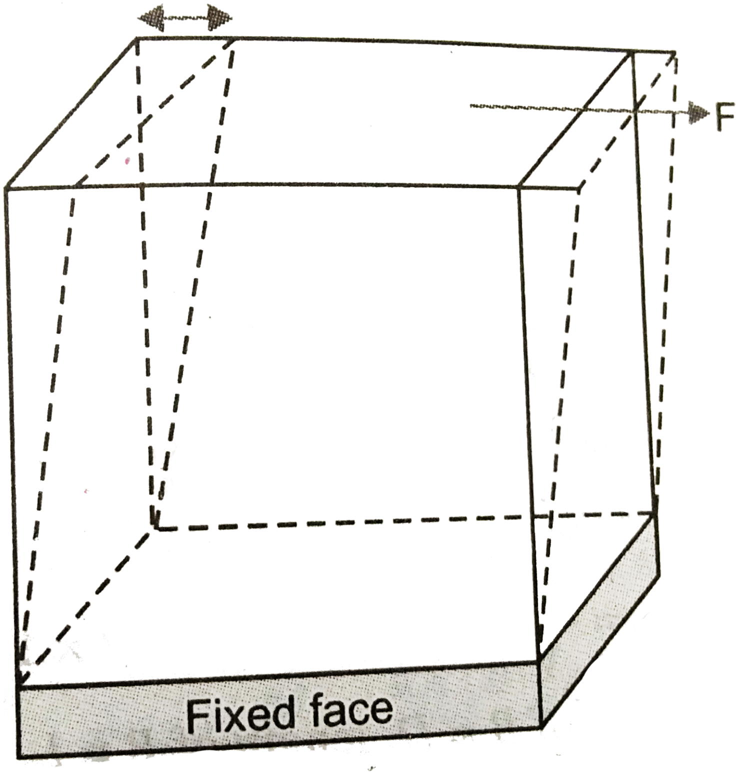
3. A square lead slab of side 50 cm and thickness 10 cm is subjected to a shearing force of $9.0 \times 10^4 N$. The lower edge of the slab is fixed to the floor. The upper edge of the slab is displaced by $0.16mm$. The Youn's modulus for the lead is



A. $1.9 \times 10^{9} N/m^{2}$

B. $1.7 \times 10^{10} N/m^{2}$

C. $1.1 \times 10^{10} N/m^{2}$

D. $5.6 \times 10^9 N/m^2$

Answer: B

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4. A steel wire of diameter 2 mm has a breaking strength of 4×10^5N. What is the breaking strength of similar steel wire of diameter $1.5mm$?

A. $2.3 \times 10^5 N$

B. $2.6 \times 10^5 N$

C. $3 \times 10^5 N$

D. $1.5 \times 10^5 N$

Answer: A

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5. What is the greatest length of copper wire that can hang without breaking ? Breaking stress $= 7.2 \times 10^{7} Nm^{-2}$. Density of copper $= 7.2 g/c.c.$, $g = 10 ms^{-2}$

A. $100m$

B. $1000m$

C. $150m$

D. $1500m$

Answer: B

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6. What is the percentage increase in length of a wire of diameter 2.5 mm, stretched by a force of 100 kg wt ? Young's modulus of elasticity of wire $= 12.5 \times 10^{11} dyne/cm^2$.

A. $0.16\ \%$

B. $0.32\ \%$

C. $0.08\ \%$

D. $0.12\ \%$

Answer: A

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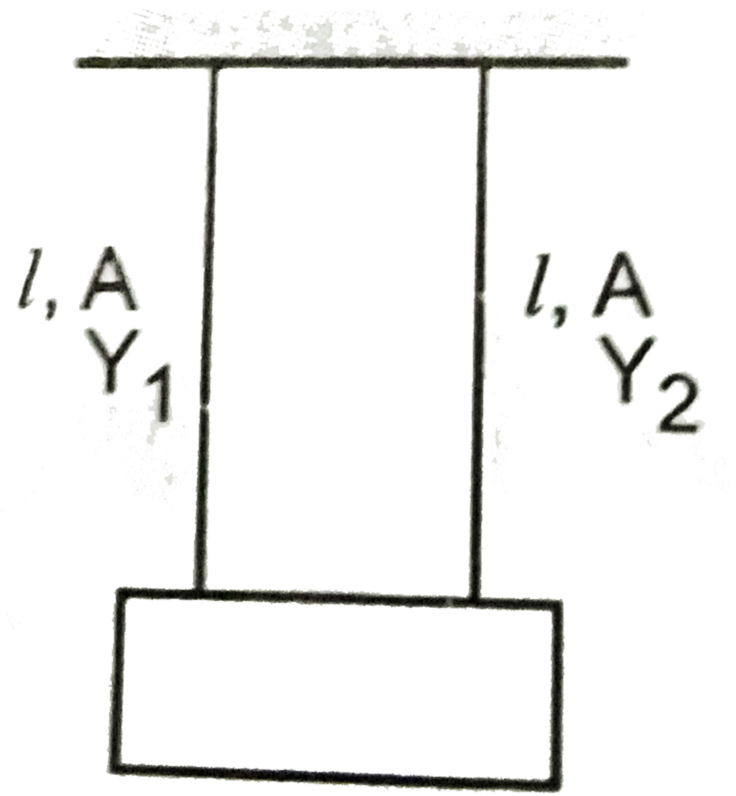
7. Two wires of equal length and cross sectional area suspended as shown in



Their Young's modulii are $Y_1 = 2 \times 10^{11}$ Pa and $Y_2 = 0.90 \times 10^{11}$ Pa respectively. What will be the equivalent Young's modulus of combination?

A. 2.90×10^{11} Pa

B. 1.45×10^{11} Pa

C. 1.34×10^{11} Pa

D. None of this above

Answer: B

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