PHYSICS

BOOKS - S CHAND PHYSICS (ENGLISH)

PROPERTIES OF MATTER

Module 1 Solved Examples

1. A wire 10m long has a cross-sectional area $1.25 \times 10^{-4} m^2$. It is subjected to a load of 5kg. Wt. If Y for the material is $4 \times 10^{10} Nm^{-2}$,

calculate the elongation produced in the wire. Take g = $10ms^{-2}$.

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2. The length of a wire increase by 8mm when a weight of 5 kg is hung. If all conditions are the same but the radius of the wire is doubled, find the increase in length.

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3. Determine the force required to double the length of the steel wire of area of cross-section $5 \times 10^{-5} m^2$. Give Y for steel $= 2 \times 10^{11} Nm^{-2}$.

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4. A metal cube of side 1m is subjected to a uniform force acting normally on the whole surface of the cube. If the volume changes by $1.5 \times 10^{-5} m^3$ and if the pressure is $10^6 Pa$, find the bulk modulus of the metal.

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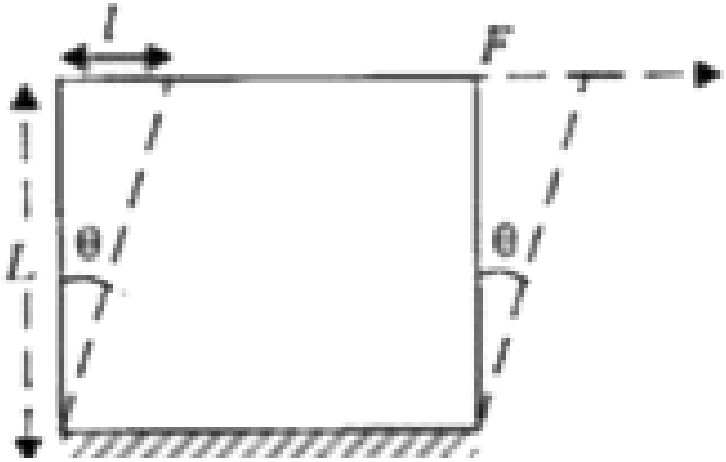
5. A metal cube of side 20cm is subjected to a shearing force of 4000N. The top face is displaced through 0.50 cm with respect to the bottom. Find the rigidity modulus of the metal.



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6. A sphere contracts in volume by 0.01 % , when taken to the bottom of sea 1 km deep. The bulk modulus of the material of the sphere is (Given density of sea water may be taken as $1.0 \times 10^3 kgm^{-3}$)

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7. A mass of 20kg is attached to one end of a steel wire 50cm long and is rotated in a horizontal circle. The area of cross-section of the wrie is $10^{-6} m^2$ and the breaking stress for it is 4.8×10^7

Pa. Calculate the maximum velocity with which the mass can be rotated.

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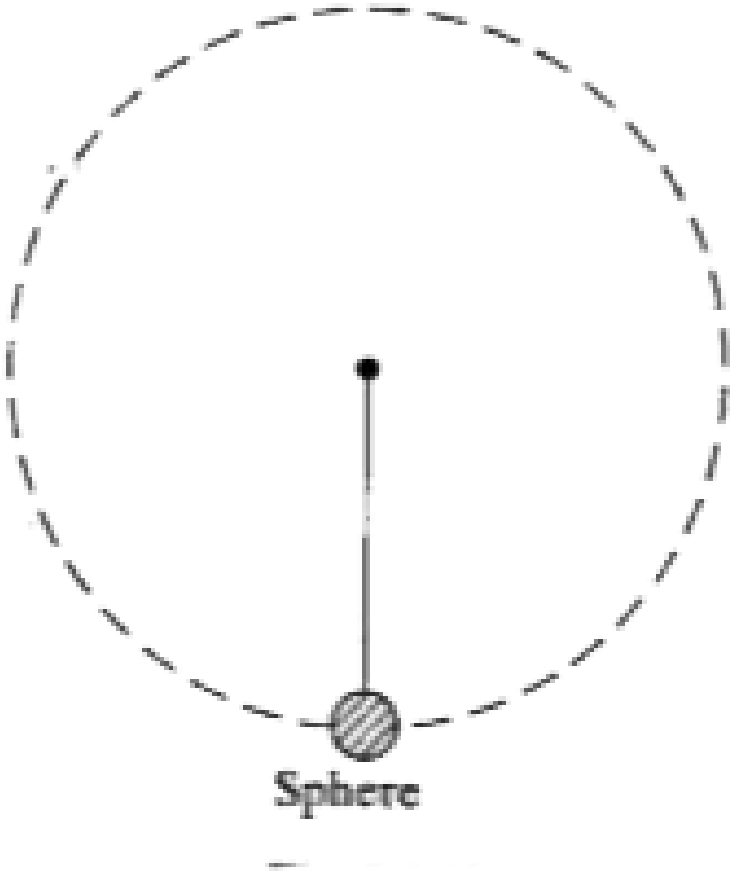
8. A sphere of mass 3 kg is attached to one end of a steel wire of length 1 m and radius 1mm. It is whirled in a vertical circle with an angular velocity of 2 rev / s. What is the elongation of the wire, when the weight is at the lowest point of its path?

Y for steel $= 20 \times 10^{10} N/m^2$.



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9. When a wire is stretched by a mass of 5 kg the wire elongates by 0.5mm. Calculate the work done in stretching the wire.

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10. When a wire of length 5m and diameter 1mm was stretched by a load of 5kg the elongation produced in the wire was 1mm. Find the energy stored in per unit volume of the wire?

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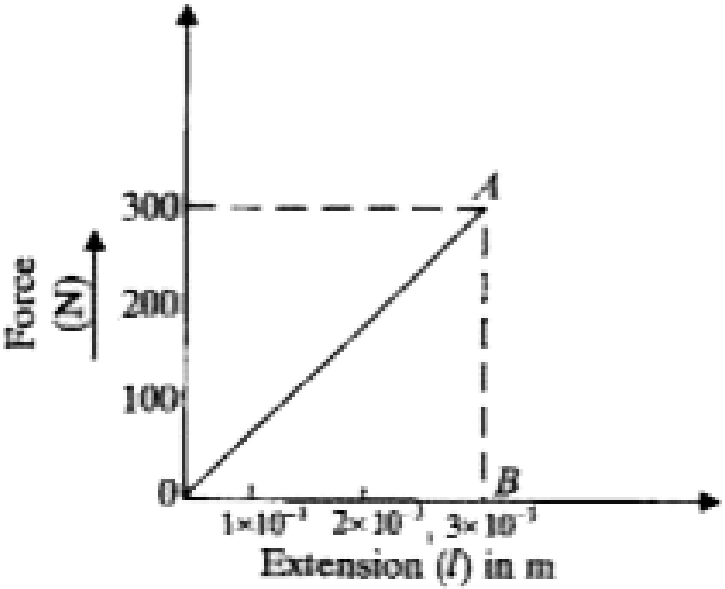
11. The force-extension graph of an elastic wire subjected to a certain force is as shown in Figure. From the graph calculate the work done in stretching the wire.



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12. A uniform wire of length 8m and diameter 0.6mm stretched by 4mm under a certain force. If the Poisson's ratio of the material of the wrie is 0.3, calculate the change in diameter of the wire.

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13. The Young's modulus of brass is $9.1 \times 10^{10} N/m^2$and its rigidity modulus is $3.5 \times 10^{10} N/m^2$. Calculate its Poisson's ratio ?

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14. The bulk modulus of quartz is $2.70 \times 10^{10} Nm^{-2}$. Calculate its Young's modulus if the Poisson's ratio of quartz is 0.154.

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15. A steel wire of length 1m and diameter 0.8 mm is kept stretched between two rigid supports. What additional stretching force the wire will experience when its temperature falls by 30K? Linear expansivity of steel $\alpha = 12 \times 10^{-6}/k$. Young's modulus of steel $Y = 20 \times 10^{10} N/m^2$.

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16. A steel wire of length L and diameter d is placed over a massless, frictionless pulley with one end of the wire connected to a mass m_1 and other end to a mass m_2. When the masses move, by how much does the wire stretch ?

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17. A steel wire of length 4.7m and cross-section $3.0 \times 10^{-5} m^2$ stretched by the same amount as a copper wire of length 3.5m and cross-section

$4.0 \times 10^{-5} m^2$ under a given load. What is the ratio of Young's modulus of steel to that of copper ?

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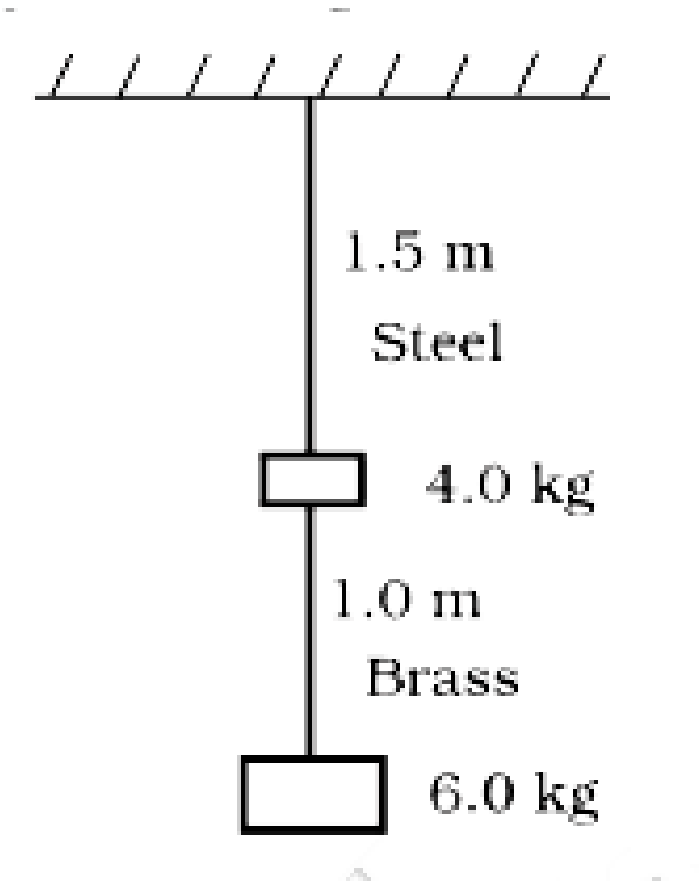
18. Two wires of diameter 0.25 cm, one made of steel and the other made of brass are loaded as shown in Fig. 9.13. The unloaded length of steel wire is 1.5 m and that of brass wire is 1.0 m. Compute the elongations of the steel and the

brass wires.



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19. A composite wire of uniform diameter 3mm consisting of copper wire of length 2.2 m and a steel wire of length 1. 6m stretches under a load by 0.7mm. Calcualte the load, given that the Young's modulus of copper is $1.1 \times 10^{11} Pa$ and for steel is $2.0 \times 10^{11} Pa$.

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20. Compute the bulk modulus of water from the following data : Initial volume 100.0 litre, final volume = 100.5 litre (1 atm = $1.013 \times 10^5 Pa$).

Change in pressure 100 atm. Compare the bulk modulus of water with that of air (at constant temperature). Explain in simple terms why is the ratio so large.

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21. What is the density of ocean water at a depth, where the pressure is $80.0atm$, given that is density at the surface is $1.03 \times 10^3 kgm^{-3}$ (compressibility of water $= 45.8 \times 10^{-11} Pa^{-1}$) ?

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22. A square lead slab of sides 50cm and thickness 5.0cm is subjected to a shearing force (on its narrow face) of magnitude $9.0 \times 10^4 N$. The lower edge is riveted to the floor. How much is the upper edge displaced if the shear modulus of lead is $5.6 \times 10^9 Pa$?

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23. A load of 2 kg produces a certain extension in a wire of length 6m and diameter 1mm. What is the lateral contraction produced if $\sigma = 0.25$ and $Y = 7.48 \times 10^{10} N/m^2$?

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24. A wire 2 mm in diameter is just stretched in between two fixed points at a temperature of $50^{\circ}C$. Calculate the tension in the wire, when the temperature falls to $30^{\circ}C$. Coefficient of linear expansion is $11 \times 10^{-4} l^{\circ} C$ and Young modulus is $2.1 \times 10^{11} Nm^2$

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25. A steel wire of length 600cm and diameter 1.2 mm is stretched through 4 mm by a load. Calculate the work done. Young's modulus of steel $= 2 \times 10^{11} Nm^{-2}$.

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26. Two masses 7 kg and 12 kg are connected at the two ends of a metal wire that goes ove a frictionless puulley. What should be in the minimum radius of the wire in order that the wire

does not break,if the breaking stess of the metal is $1.3 \times 10^8 N/m^2$?

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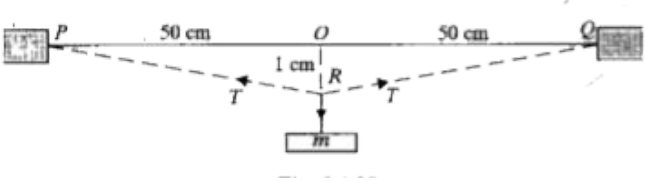
27. A steel wire of diameter 0.8 mm and length 1m is clamped firmly at two points P and Q which are one metre apart and in the same horizontal plane. A body is hung from the middle point of the wire, such that the middle point sags one cm lower from the original position as shown in figure. Calculate the mass of the body.

$Y = 2 \times 10^{11} N/m^2$.



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28. A rectangular metallic bar one metre long, one cm deep and one cm broad is placed on a smooth table. The Young's modulus and modulus of rigidity of metal of the bar are $2 \times 10^{11} N/m^2$ and $8 \times 10^{10} N/m^2$ respectively.

If the bar is rigidity clamped at one end is pulled at the other end with a force 5000 N applied

normaly to its end cross-section, calculate the elongation of the bar and the work done in elongating the bar.

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29. A rectangular metallic bar one metre long, one cm deep and one cm broad is placed on a smooth table. The Young's modulus and modulus of rigidity of metal of the bar are $2 \times 10^{11} N/m^2$ and $8 \times 10^{10} N/m^2$ respectively.

If now the base of the bar is rigidly clamped to the table, how will you apply a force of 500N, to

produce shearing strain in the bar? Calculate the angle of deformation and the horizontal displacement produced in the top layer of the bar.

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30. A wire of area of cross -section 3mm^2 breaks under a force of 225N. Find the rise in temperature of the wire at the time of breaking. Given $Y = 117Gpa$. Density of the wire = 8930 kg/m^3 .Specific heat capacity $= 380Jkg^{-1}k^{-1}$

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31. Show that the maximum possible value of poisson's ratio is 0.5.

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Module 2 Solved Examples

1. The surface tension of water is 72 dyne/cm. convert it in SI unit.

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2. A wire of mass 5 gm is kept horizontally on the surface of water. What ist he minimum length of the wire so that it does not break the surface film.Surface tension $= 72 \times 10^{-3} N/m$

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3. A liquid of diameter D breaks up into 64 tiny drops. If the surface tension of the liquid is σ what is the change in energy?

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4. Two mercury drops each of radius r merge to form a bigger drop. Calculate the surface energy released.

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5. What is the excess pressure inside (i) a drop (ii) a bubble of water of diameter 2mm. If the atmospheric pressure is 1.01×10^5Pa, calculate the total pressure inside them $= \sigma = 72 \times 10^{-3} N/m.$

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6. What should be the radius of a water drop so that the excess pressure inside it is 0.2 atm? Surface tension of water is $72 \times 10^{-3} N/m$?

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7. A vessel containing mercury has a hole at its bottom. The diameter of the hole is $60 \times 10^{-6} m$. Find the maximum height of mercury in the vessel so that it does not flow out through the hole. Surface tension of mercury is $54 \times 10^{-2} N/m$.

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8. At one end of capillary tube of radius r and length l, there is a soap bubble of radius R. The bubble is connected to the atmosphere though ccapillary tube. After how long the radius of the bubble will be reduced to zero? Coefficient of viscosity of air in η.

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9. A capillary tube of inside diameter 1 mm is dipped vertically in a liquid of surface tension $63 \times 10^{-3} N/m$ and density $1262 \frac{kg}{m^3}$. Find the

height of the capillary rise if the angle of contact is 10°.

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10. A capillary tube of inside diameter 1mm is dipped vertically into water, so that the length of its part protruding over the water surface is 20mm.What is the radius of curvatur of the meniscus ? Surface tension of water is $72 \times 10^{-3} N/m.$

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11. A capillary tube of length 12 cm and inside diameter 0.033m is dipped vertically into water. The top end of the capillary is sealed. If the outside pressure is $1.01 \times 10^5 N/m^2$. Find the length to which the capillary tube should be submerged in water so that the levels inside the outside coincide. $\sigma = 72 \times 10^{-3} N/m$.

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12. Calculate the work done to increase the radius of a soap bubble from 4 cm to 5cm. $\sigma = 25 \times 10^{-3} Nm^{-1}$.

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13. Find the work done in spraying a drop of water of 2mm diameter into a million droplets all of the same size. Surafce tension of water is 72 dyne cm^{-1}.

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14. What is the excess pressure inside a bubble of soap solution of radius 500 mm, given that the surface tension of soap solution at the

temperature $(20^{\circ}C)$ is $2.50 \times 10^{-2} Nm^{-1}$? If an air bubble of the same dimension were formed at 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? (1 atmospheric pressure is $1.01 \times 10^{5} Pa$).

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15. The excess pressure inside a soap bubble of radius 6mm is balanced by 2mm column of all of density 800 kgm^{-3}. Find the surface tension of soap solution.

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16. Two soap bubbles one of radius 3cm and other of radius 4cm each coaless in vacuum under isothermal conditons. Calculate the radius of the bubble formed ?

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17. A small drop of water kept pressed between two glass plates spreads as a circle of diameter 10cm. If the distance between the plates is 0.005 mm, and surface tension of water is $0.072Nm^{-1}$,

what force will be required to separate the plates

?

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18. Two identical spherical soap bubbles collapses. If V is consequent change in volume of the contained air, S is the chage in the total surface area and T is the surface tension of the soap solution. Then (ifp_0 is atmospheric pressure and assume temperature to remain same in all the bubbles).

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19. Mercury has an angle of contact equal to 140^0 with soda lime glass. A narrow tube of radius 1 mm made of the glass is dipped in a trough containing mercury. The surface tension of mercury at the temperature of the experiment is $0.465 Nm^{-1}$. The distance by which the mercury dip down in the tube relative to the mercury surface outside is (Density of mercury = $13.6 \times 10^3 kgm^{-3}$)

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20. Find the heights to which water will in a capillary tube of radius 0.3mm, $\sigma = 7.2 \times 10^{-2} Nm^{-1}$. What will happen if the tube is raised till the upper end is 3cm above the water surface?

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21. A liquid can rise to a height of h in a capillary tube of length l $(l > h)$. The tube filled with the liquid is kept horizontal with its two ends open. Now the tube is kept vertical with the liquid in it. Some liquid flows out. Find the height of the

liquid remaining in the tube if the surface tension of the liquid is σ.

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22. A tube of conical bore is dipped into water with apex upwards. The length of the tube is 20cm and radii at the upper and lower ends are 0.1 and 0.3 cm. Find the height to which the liquid rises in the tube (Surface tension of water = 80 dyne / cm).

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Module 3 Solved Examples

1. A tank of capacity 20 litre contains air at a pressure of $4.0 \times 10^5 Pa$. Calculate the pressure that must be applied in order that the volume is reduced to 10 litres, keeping the temperature constant.

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2. A narrow tube 50 cm length is closed at one end contains air trapped by a certain column of Hg. When the tubes is held horizontally, the air

column in if has a length of 10cm. What is the pressure exerted by air when the tube is held vertically with the open end at the bottom and the length of the air column is 15cm? Also find the vertical height of the mercury column inside the tube.

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3. The volume of a given mass of gas is 20 litre at 300K and 1 atmosphere pressure .At what pressure will the volume of the gas be 1 litre at the same temperature ?

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4. The pressure exerted by a certain mass of gas is 100cm of Hg at $30^{\circ}C$. The gas is heated at constant volume. At what temperaute will the pressure exerted by the gas be 200cm of Hg?

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5. A certain mass of gas in a cylinder at $27^{\circ}C$ has a volume of 10 litre and pressure 100 N/m^2. (i) The gas is first compressed at constant temperature and the pressure is raised to 150

N/m^2 . Find the change in volume. (ii) If the gas is then heated at constant volume and if the temperature is raised to $127^\circ C$, find the new pressure.

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6. What is the volume occupied bythe 64 gm of oxygen at standard pressure and at a temperature 27°. R $= 8.31 J/mol/K$? Molar mass of oxygen = 32 gm.

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7. Air contained in a cylinder at $20.0^{\circ}C$ is compressed froma n initial pressure of 1.00 atm, and volume of $700cm^3$ to a volume of $70.0cm^3$. If the final pressure is 15.0 atm then what is the final temperature?

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8. A certain mass of gas occupies a volume of $500cm^3$ at 0.9 atm and at a temperature 320K. What is its volume at NTP ?

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9. The density of hydrogen at NTP is $8.9 \times 10^{-5} kg/$ litre . Find the universal gas constant.

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10. 56.0 g of nitrogen and 48.0 g of O_2 are mixed together in a vessel at a temperature of 300K and a pressure of one atmosphere . Assuming the gases to be ideal, find the density of the mixture.

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11. A vessel of capacity 3 litres contains 22g of CO_2 and 28 g of nitrogen at $30^\circ C$. Calculate the partial pressure and hence the total pressure exerted by the gas mixture. R = 8.31 J $mol^{-1}K^{-1}$.

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12. A vessel of capacity 10 litres contains 0.5 moles of CO_2, 1.3 moles ofnitrogen and 0.20 mole of oxygen at $30^\circ C$. Assuming the gases to be ideal, find the pressure of the mixture , R $= 8.31 Jmol^{-1}K^{-1}$.

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13. The speeds of ten particles are (in m/s) 6.00, 5.00, 8.00, 10.0, 10.0, 14.0, 14.0, 18.0, and 20.0 m/s (i) What is the average speed, (ii) What is the rms speed and (iii) What is the most probable speed of the particles?

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14. Calculate the pressure exerted by hydrogen if the density of hydrogen is 0.09 kgm^{-3} and rms

speed of hydrogen molecule at that presure is $1.84 kms^{-1}$.

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15. The rms velocity of oxygen at 353 K is 524.8 m/s. Find the value of universal gas constant. The molecular weight of oxygen is 32.

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16. Find the value of Avogadro number. Given the mean value of kinetic energy of a molecule of

hydrogen at 273K is 5.64×10^{-21}J and $R = 8.31 Jmol^{-1}K^{-1}$.

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17. What is the K.E. of one mole of a gas at $237^{\circ}C$? Given Boltzamann's constant k $= 1.38 \times 10^{-23} J/k$, Avogadro number $= 6.033 \times 10^{23}$.

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18. A vessel of capacity 0.30 m^3 contains 3.00 mol of helium gas at $20^\circ C$. (i) Find the total thermal energy of the system. (ii) Find the average kinetic energy per molecule.

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19. Calculate the internal pressure for CO_2. Given the value of van der Waals constant for CO_2 is a = 0.37 N - m^4/mol^2 and $V = 22.4$litre / mol.

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20. Assume that the van der Waals constant for oxygen b to be equal to four times the volume of one mole of oxygen find the radius of one molecule of oxygen. Given b = $32cm^3$ / mole.

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21. The van der Waals constants for CO_2 are a = 0.37 N- m^4/mol^2 and $b = 43 \times 10^{-6} m^3/mol$. What is the pressure exerted by the gas at $0^\circ C$, for a specific volume of 0.55 litre / mole, assuming Van der Waals equation to be strictly

true? Also calculate the pressure under the same condition, assuming CO_2 as an ideal gas.

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22. Calculate the critical volume for one mole of hydrogen if the critical temperature is 240 K and its critical pressure is 12.8 atm. R = $8.31 Jmol^{-1}K^{-1}$.

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23. Calculate the r.m.s velocity of air molecules at S.T.P. Density of air at S.T.P. is 1.29 kg m^{-3}

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24. The initial gauge pressure of hydrogen contained in a cylinder of volume 50 litres is 20atm and its initial temperature is $30^{\circ}C$. Afte some hydrogen is withdrawn from the cylinder, the gauge pressure drops to 15 atom and its temperature drops to $25^{\circ}C$. Find the mass of hydrogen flown out of the cylinder.

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25. A vessel of volume V is divided into two parts by a partition. The pressure of the gas in one part is p_1 and that in the other part is p_2. If the partition is removed find the pressure of the gas in the vessel.

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26. A metre long narrow bore held horizontally (and closed at one end) contains a 76 cm long mercury thread, which traps a 15 cm column of air.

What happens if the tube is held vertically with the open end at the bottom ?

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27. The atmosphere of Jupiter contains methane gas at $-130^{\circ} C$. What is the rms velocity?

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28. Calculate the temperature at which the rms velocity of a gas doubles its value at S.T.P.

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29. At what temperature is the rms speed of an atom in an argon gas cylinder is equal to the rms speed of helium gas atom at $-20^{\circ}C$? (atomic mass of Ar = 39.9, of He = 4.0)

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30. Estimate the mean free path and collison frequency of a nitrogen molecule in a cylinder containing nitrogen at 2.0 atm and temperature $17^{\circ}C$. Take the radius of a nitrogen molecule to

be roughtly 1.0 $\mathring{A}$. Compare the collision time with the time the molecule moves freely between two successive collision (molecular mass of $N_2 = 28.0$) . [Optional]

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31. A thin tube sealed at both ends is 90 cm long. It is kept horizontally, the middle 10cm containing mercury and the two equal ends containing air at standard atmospheric pressure. The tube is turned and kept in vertical position. By what amount will the mercury be displaced?

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Module 4 Solved Examples

1. The melting point of gold is $1064^{\circ}C$. Express this in $^{\circ}F$ and K.

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2. A constant volume gas thermometer record a pressure of 20.0 k Pa at the triple point of water

and a pressure of 35.0 k Pa at an unknown tempeature . Find the unknown temperature.

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3. A substance is heated from $30^{\circ}C$ to $85^{\circ}C$. What is the change in its temperature on the Kelvin Scale and on the Fahrenheit scale?

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4. When a constant volume gas thermometer is placed in melting ice, boiling water and in an

unknown hot bath, the pressure of the gas at constant volume are found to be 1m,1.3m and 1.8m of Hg respectively. Calculate the unknown temperature.

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5. A constant volume gas thermometer is calibrated in dry ice and in boiling ethyl alcohol at temperature $78^{\circ}C$. The corresponding pressure ar 0.90 atm and 1.63 atm. What is the pressure at the boiling of water ?

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6. A constant volume gas thermometer using helium records a pressure of 20.0k Pa at the triple point of water, and a pressure of 14.3 k Pa at the temperature of 'dry ice' (solid CO_2) . What is the temperature of dry ice?

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7. The triple points of neon and carbon dioxide are 24.57 K and 216.55 K respectively. Express these temperatures on the Celsius and Fahrenheit scales.

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8. At what temperature do the Celsius and Fahrenheit readings have the same numerical value ?

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

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10. The length of the mercury column in a mercury thermometer was 15mm when it was placed in melting ice, 200mm when it was placed in steam and 100mm when it was placed in a hot liquid. What is the temperature of the liquid?

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11. When a constant volume gas thermometer is placed in melting ice, boiling water and in an unknown hot bath, the pressure of the gas at constant volume are found to be 1m,1.3m and 1.8m

of Hg respectively. Calculate the unknown temperature.

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Module 1 Elasticity

1. The curve in the diagram shows a potential energy U of two molecules for different values of intermolecular separation r. Which part of the curve represent that the intermolecular force is (i) repulsive, (ii) attractive ?

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2. The graph showing the relation of the distance between two molecules with the inter molecular potential energy (U) is given in Figure. Find with the help of the graph.

(i) the distance between the molecule in their state of stable equilibrium.

(ii) the minimum and maximum distance between the molecules when the potential energy is $-U_1$.

(iii) the energy required for the molecules to be free from each other when the distance between them is r_2.

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Module 1 Elasticity Conceptual Short Answer Questions With Answers

1. Which is more elastic, steel or rubber? Why?

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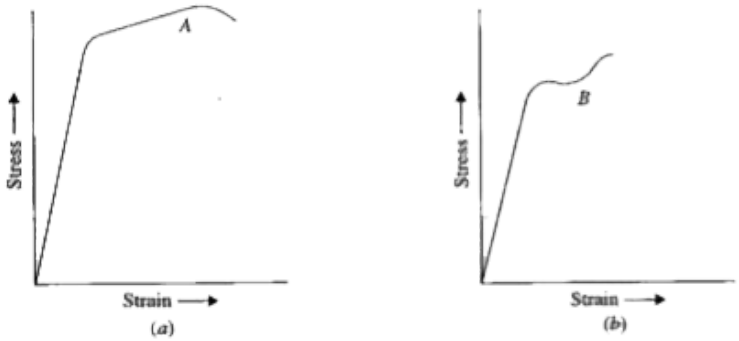
2. The stress versus strain graphs for two materials A and B are shown in Figure. (The graphs are drawn to the same scale) (a) Which material has greater Young's modulus ? (b) Which

material is more ductile ? (c) Which is more brittle ? (d) Which of the two is the strong material?



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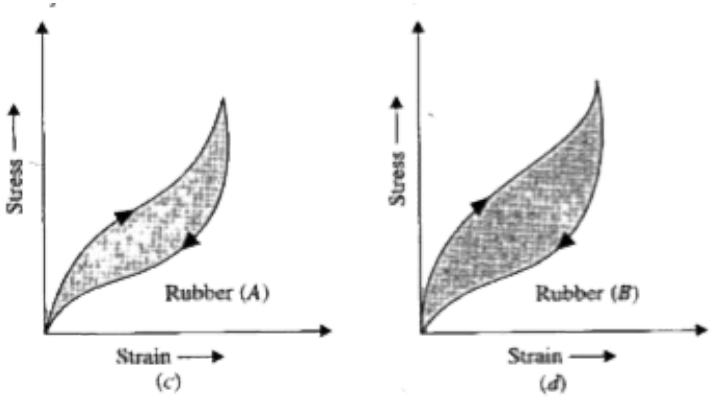
3. Two different types of rubbers are found to have the stress -strain curve of a metal wire .

(a) In which significant way do these curves differ from the stress-strain curve of a metal wire shown in Figure.

(b) A heavy machine is to be installed in a factory. To absorb vibrations of the machine, a block of you preferr to use for his purrpose ? Why?

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



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4. Which modulus determines the stretching of a coiled spring?

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5. What is elastic after-effect?

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6. What is the effect of temperature on elasticity?

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7. A spring is made of steel and not of copper because

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8. What is elastic fatigue?

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9. A spring balance shows wrong reading after using for a long time. Why?

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10. Modulus of rigidity of ideal liquids is

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11. What happens to the (i) extension (ii) maximum load, a wire can bear, when the wire is cut into half?

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12. Where does the work done go during the stretching of a wire ?

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Module 1 Elasticity Long Answer Questions

1. State Hooke's law. A metallic wire of Young's modulus Y is stretched by suspending a load from it. If the linear strain produced in it is μ, obtain an expression for the elastic potential energy, in

terms of Y and μ , stored in unit volume of the wire.

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2. (i) State Hook's law.

(ii) Draw a labelled graph of tensile stress against tensile strain for a metal wire upto the breaking point. Shhow on your graph the region in which Hooke's law is obeyed.

What is the significance of the area between the graph and the strain axis withing the Hooke's law region?

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3. State Hooke's law and describe with the help of a diagram, the behaviour of a copper wire which hangs vertically and is loaded with a gradually increasing load until it finally breaks. On the diagram mark the points (i) elastic limit (ii) yield point.

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4. Distinguish between Young's modulus,bulk modulus and the modulus of rigidity.

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5. Define stress, strain and Young's modulus of an elastic material. Describe an experiment for measuring the Young's modulus of a material in the form of a wire.

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Module 1 Elasticity Short Answer Questions

1. Distinguish between elasticity and plasticity.

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2. Explain elasticity using intermolecular force.

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3. Define strain. Name the three types of strain.

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4. Define stress. Give its dimensional formula.

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5. What is the difference between tensile stress and volume stress?

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6. How should we apply a force on a body to produce shearing stress?

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7. What is the condition under which Hooke's law holds goods?

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8. What is compressibility?

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9. What is an elastomer?

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10. Which is more elastic, steel or rubber? Why?

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11. What is the effect of temperature on elasticity?

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12. What happens to the (i) extension (ii) maximum load, a wire can bear, when the wire is cut into half?

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13. Define energy density?

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14. Write down the expression for the elastic potential energy of a stretched wire.

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15. Define Poisson's ratio.

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16. What are elastic constants?

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17. Write down the relation connecting elastic constants.

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18. What is thermal stress?

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19. Why gases have two elasticities?

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20. A steel wire and a copper wire, identical in all respects are to be stretched equally. On which wire more work has to be done.

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1. "Water is more elastic than air". Why?

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2. What is the Young's modulus for a perfect rigid body?

Watch Video Solution

3. Bridges are declared unsafe after a long use'. Why?

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4. Is it possible that the restoring force is not equal and opposite to the applied force?

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5. A spring balance shows wrong reading after using for a long time. Why?

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6. Arrange the following materials in the order of increasing elasticity : steel , copper , glass and rubber.

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7. The breaking force for a wire is F N. What is the breaking force for two parallel wire of this size?

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8. A cable is cut to half of its original length. Why does this change has no effect on the maximum load that it can support?

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Module 1 Elasticity From Young S Modulus

1. A wire of length 15m and diameter 4 mm elongates 0.3mm when stretched by weigth of 2.20kg. Calulate the Young's modulus of the material of the wire.

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2. A wire one square centimeter area of cross-section is stretched by a force to double its original length. Calculate the force. Young's modulus = 90 GPa. Assume that the wire does not break.

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3. How much will a 30m steel tape 1 cm wide and 0.05 cm thick stretch unde a pull of a force of

300N if Young's modulus of steel is $2 \times 10^{11} Nm^{-2}$

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4. Find the stress to be applied to a steel wire to stretched it by 0.025% of its original length. Y for steel is 90 GPa.

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5. A uniform wire 6m long weighing 0.04 kg elongates by 0.8 mm when stretched by a load of 1

kg . If its density is 8.9 gm / cc, find the Young's modulus of the material.

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6. The breaking stress of a material is $10^8 Nm^{-2}$. Find the greatest length of a wire that could hang vertically without breaking? Density of material $= 3000 kgm^{-3}$.

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7. Find the percentage increase in length of a wire subjected to a stress of 1 gm. Wt $/mm^2$. Young's modulus of the material of the wire = 100 Gpa.

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8. A steel wire of length 1m and diameter 0.8 mm is kept stretched between two rigid supports. What additional stretching force the wire will experience when its temperature falls by 30K? Linear expansivity of steel $\alpha = 12 \times 10^{-6}/k$. Young's modulus of steel $Y = 20 \times 10^{10} N/m^2$.

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9. How much a hollow cylindrical piller of height 6m and external diameter 28cm and internal diameter 22cm will contract under a load of 60,000 kg? Given Young's modulus of the material to be $21 \times 10^{10} N/m^2$.

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10. Two wire mode of the same material are subjected to force in the ratio of $1:2$. Their

lengths are in the ratio $8:1$ and diameters in the raio $2:1$. Find the ratio of their extension.

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11. A wire longates by 9 mm when a load of 10kg is suspended from it. What is the elongation when its radius is doubled, iff all other quantities are same as before ?

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12. Four identical hollow cylindrical columns of mild steel support a big structure of mass 50,000 kg. The inner and outer radil of each column are 30 and 60 cm respectively. Assuming the load distribution to be uniform, calculate the compressional strain of each column.

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13. To one end of a steel wire of unstretched length 3m and cross-section area $1mm^2$ a small ball of mass 150 gm is attached. The other end of

the wire is fixed and the ball is allowed to revolved in a horizontal circle. If the ball makes 600 revolutions per minute find the radius of the uniform circular motion. Y for steel $= 2 \times 10^{11} Pa.$

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14. A uniform wire of steel of length 2.5m and of density $8000 kgm^{-3}$ weigths 0.05kg. When stretched by a force of 10kg wt the length increases by 2mm. Calculate the Young's modulus for steel.

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15. Two parallel wires A and B are fixed to a right support at the upper ends and are subjected to the same load at the lower ends. The lengths of the wire are in the ratio $4:5$ and their radius are in the ratio $4:3$. The increase in length of the wire A is 1mm.Calculate the increase in length of the wire B.

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16. Calculate the force required to incrase the length of wire of cross-sectional area $10^{-6}m^2$ by 50% if the Young's modulus of the material of the wire is $90 \times 10^9 Pa$.

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17. A uniform wire of length 6m and a cross-sectional area 1.2 cm^2 is stretched by a force of 600N . If the Young's modulus of the material of the wire $20 \times 10^{10} Nm^{-2}$, calculate (i) stress (ii) strain and (iii) increase in length of the wire.

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18. A steel wire and copper wire of the same diameter and of length 1m and 2m respectively are connected end to end and a force is applied. The increase in length of the combination is 0.01m.Calculate the elongation produced in the individual wires. Given that Y of copper is $12 \times 10^{10} Nm^2$ and that of steel is $20 \times 10^{10} Nm^{-2}$.

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19. The maximum stress that can be applied to the material of a wire used to suspend an elevator is $1.3 \times 10^8 Nm^{-2}$. If the mass of the elevator is 900 kg and it moves up with an acceleration of $2.2ms^{-2}$, what is the minimum diameter of the wire?

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Module 1 Elasticity From Bulk Modulus

1. Artificial diamond is made by subjected carbon in the form of graphite to a pressure of $1.55 \times 10^{10} N/m^2$ at a high temperature. Assuming that the natrual diamond formed at similar high presssure within the earth, calcualte its original volume if the mass of the diamond before cutting was 150g. The density of diamond = 3000 kg/m^2.Bulk modulus $= 6.2 \times 10^{111} N/m^2$.

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2. A sphere contract in volume by 0.1% when taken to bottom of the sea 1 km deep. Find the bulk modulus of the material of the sphere. Density of sea water $= 10^3 kg/m^3$.

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3. When a body having a volume of $10^{-3} m^3$ is pressed by a pressure of $4 \times 10^4 N/m^2$, its volume decreases by $0.2 \times 10^{-6} m^3$. Calculate the bulk modulus of the body.

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4. The volume of a solid is $6 \times 10^{-3} m^3$ under 2 atm pressure. Find the change in volume when subjected to a pressure of 102 atm. Bulk modulus of the material $= 10^{11} Nm^{-2}$.

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5. What pressure is required to prevent the expansion of a copper block, if it is heated from $30^\circ C$ to $40^\circ C$. Coefficient fo linear expansion of copper α is $15 \times 10^{-6}/K$ and bulk modulus $= 12 \times 10^{10} Nm^{-2}$.

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6. On taking a solid ball of rubber from the surface to the bottom of a lake of 200m depth, the reduction in the volume of ball is 0.1%. The density of water of the lakes is $10^3 kgm^{-3}$. Calculate the value off bulk modulus elasticity of rubber, $g = 10ms^{-2}$.

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7. What is the decrease in volume of one litre of water when a pressure of 10 atm is applied ? Given that the compressibility of water is $5 \times 10^{-10} m^2 N^{-1}$

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8. Find the pressure requried to prevent the expansion of a copper block if it is heated from $40^\circ C$ to $50^\circ C$. Coefficient of linear expansion of copper is $15 \times 10^{-6} / ^\circ C$ and bulk modulus $= 12 \times 10^{10} N / m^2$

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Module 1 Elasticity From Rigidity Modulus And Poisson S Ratio

1. A cube of soft rubber of face area $0.02m^2$ whose lower face is fixed is sheared through an angle 2° by a force of $10^4 N$ acting tangential to the upper face. Calculate the rigidity modulus of the material.

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2. A square aluminium of side 50cm and thickness 5cm is subjected to a shearing force of magnitude $10^4 N$. The lower edge is revetted to the floor. How much is the upper edge displaced if shear modulus of aluminium is $2.5 \times 10^{10} Nm^{-2}$?

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3. A metalic cube whose side is 10cm is subjected to a shearing force of 100 N. The top face is displaced through 0.25cm with respect to the

bottom . Calculate the shearing stress, strain and shear modulus.

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4. A tangential force equal to the weight of 500kg is applied to the opposite face of a cube of aluminium of side 10cm has its one face fixed. Find the shearing strain produced. Rigidity modulus of aluminium is $2.5 \times 10^{10} Nm^{-2}$

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5. A uniform wire of length 10m and diameter 0.8 mm stretched 5 mm under a certain force . If the change in diameter is $10 \times 10^{-8} m$, calculate the Poissson's ratio.

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6. The Youngg's modulus of a material is $6 \times 10^{10} Nm^{-2}$ and its bulk modulus is $2.8 \times 10^{10} Nm^{-2}$. What is its Poisson's ratio ?

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7. Calculate the Poisson's ratio for steel. Given that Young's modulus is $2 \times 10^{11} Nm^{-2}$ and rigidity modulus is $8 \times 10^{10} Nm^{-2}$.

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Module 1 Elasticity From Work Done In Stretching A Wire

1. A wire 4m long 0.3 mm diameter is streteched by a force of 8 kg.wt. If the extension in the length amounts to 1.5 mm, calcualte the energy stored in the wire?

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2. Find the maximum energy per unit volume that can be stored in a metal wire when stretched, if its breaking stress is $1.3 \times 10^8 Nm^{-2}$ and Young's modulus of the material is $2.2 \times 10^{11} Nm^{-2}$.

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3. A weight of 110N is suspended from the cceiling by an aluminium wire of lenth 2m and radius 1 mm. Calculate (i) the extension produced and (ii)

the elastic energy stored in the wire. [The Young's modulus of aluminium is $7 \times 10^{10} Nm^{-2}$

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4. A 94.2 cm long sitar string of 1mm diameter is tuned by stretching it 1.0 cm. Calculate (i) the tension (ii) the work done in stretching the wire (Young's modulus of the material of the wire is $6 \times 10^{10} N/m^2$).

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Module 2 Surface Tensions Short Answer Questions With Answers

1. Which earthen pot keep water cooler, a new one or an oldd used one?

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2. Why there is a split in the nib of a pen?

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3. A steel blade floats on the surface of pure water. When detergent is added it sinks , why?

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4. Why is sand drier than clay?

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5. Why does sharp glass edge become smooth on heating it upto its melting point in a flame ?

Explain which property of liquids is responsible for this phenomenon.

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6. Explain how rain-coats become water-proof.

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7. When a chalk-pieve is immersed in water, bubble are emitted, why?

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8. The pressure given by a mercury barometer is always less than actual pressure. Why?

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9. "The angle of contact of mercury with glass is obtus, while the water with glass is acute." Why?

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10. Water on a clean glass surface, tends to spread out, while mercury on the same surface, tends to

form drops. Why?

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11. Surface tension of a liquid is independent of the area of surface. Why?

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12. A drop of liquid unde no external force, is always spherical in shape. Why?

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13. What is the effect of temperature on surface tension?

Watch Video Solution

14. Particles of comphor move around on the sruface of water. Why?

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Module 2 Surface Tensions Long Answer Questions

1. Give two experiments to illustrate the phenomenon of surface tension.

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2. Explain surface tension on the basis of molecular theory.

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3. Define surface tension and surface energy. How are they related?

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4. Describe Laplace law for a spherical membrane.

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5. Describe an experiment to demonstrate the excess pressure inside a soap bubble.

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6. What do you understand by the term surface of a liquid?

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7. What is the force of surface tension on a light ring of radius r floating on a liquid of surface tension γ ?

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8. When a capillary tube is dipped in a liquid, it rises in the tube to a height h above the outside level . What would happen it the tube is dipped such that its length outside the liquid is less then h? Explain your answer briefly.

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9. Describe the method of determination of surface tension of a liquid by capillary rise. Derive the formula used.

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Module 2 Surface Tensions Short Anwer Questions

1. A steel blade placed gently on the surface of water floats on it. If the same blade is kept well inside the water, it sinks. Explain.

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2. Why the surface of a liquid act like a stretched membrane?

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3. Droplets of a liquid are usually more spherical in shape than larger drops of the same liquid because the force of

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4. Distinguish between cohesive and adhesive forces.

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5. Explain the terms (i) molecular range (ii) sphere of influence.

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6. Define surface tension and surface energy. How are they related?

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7. Which of the following statements is not true about angle of contact ?

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8. What are water proofing agents?

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9. "The shape of water meniscus is concave, whereas the shape of mercury menisscus is convex" Why?

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10. Why there is an excess pressure on the concave side of a liquid surface?

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11. Draw labelled diagram to show contact between (i) water and glass (ii) mercury and glass.

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12. "Oil rises in lamp wick". Why?

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13. "Water stick to the walls of a glass tube, but mercury does not." Why?

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14. If the capillary tube is dipped in water is of insufficient length $(l < h)$,will water overflow?

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15. If a capillary tube in dipped in a state of weightlessness how will the rise of water in it be different to that observed in nomal conditions?

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16. "Tenis are coated with a thin layer of aluminium hydroxide." Why?

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17. Is it possible for water to have an angle of contact as high as 160° ? If so, when ?

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18. What are surfactants?

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19. "Camphor particles do not dance about in water contaminated with oil." Why?

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20. "On cold water oil spreads, but on hot water it remains in the form of drops." Why?

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21. What are the characteristics of detergent solution?

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22. Name the factors affecting the surface tension of a liquid.

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23. Give practical application of spreading of liquid over solid.

[Hint. Resin is used with solder is a tin-lead alloy)in soldering etc.]

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Module 2 Surface Tensions Very Short Answer Questions

1. "Water can be sprayed easily when soap is added to it" Why?

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2. When the temperture is increased the angle of contact of a liquid ?

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3. (a) When wax is rubbed on cloth, the cloth becomes water proof. Explain why ?

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4. Mercury does not wet glass. This is the property of liquid known as

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5. What happens to the pressure inside a soap bubble when air is blown into it?

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6. What type of clothes should we wear in summer?

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7. If a capillary tube in dipped in a state of weightlessness how will the rise of water in it be different to that observed in nomal conditions?

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8. "Soldering becomes easy due to the addition of flux". Why?

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9. A water-alcohol mixture is prepared such that its density is exactly equal to the density of some oil. What would be the shape of a drop of that oil in the given mixture and why?

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10. The rise of a liquid in a capillary tube depends on

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11. "A drop of oil placed on the surface of water spreads out. But a drop of water placed on oil contracts to a spherical shape". Why?

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12. What will be the shape of a bigger dop of mercury on a glass plate (a) on the surface of the earth (b) at the centre of the earth?

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13. When droplets of mercury are brought in contact, they immediately combine to form a bigger drop. Why ? Is the temperature of the bigger drop the same, or more, or less than the temperature of the droplets?

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Module 2 Surface Tensions Selected Problems From The Definition Of Surface Tension

1. A wire ring of diameter 0.03m is dipped in a liquid and pulled out gently. If a force of 0.1N is required to break the film, then what is the surface tension of the liquid?

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2. A square wire fram of size L is dipped in a liquid. On taking out a membrane is formed. Ifthe surface

tension of the liquid is T, the force acting on the frame will be

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

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4. A wire 0.1m long is placed horizontally on the surface of water and is gently pulled up with a force of $1.456 \times 10^{-2} N$ to keep the wire in equilibrium. Calculate the surface tension of water.

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5. Calculate the force required to take away a flat circular plate of radius 0.02m from the surface of water. The surface tension of water is $0.07 Nm^{-1}$

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6. A ring of internal and external diameters $8.5 \times 10^{-2} m$ and $8.7 \times 10^{-2} m$ is supported horizontally from the pan of a physical balance such that it comes in contact with a liquid. An extra force of 40N is required to pull it away from the liquid . Determine the surface tension of the liquid?

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7. There is a soap film on a rectangular frame of wire of area $4 \times 4 cm^2$. If the area of the frame is

increased to $4 \times 5cm^2$,find the work done in the process. Given surface tension of soap films $= 3 \times 10^{-2} Nm^{-1}$.

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8. Calculate the work done in blowing a soap bubble of radius 0.1m surface tension being 0.03 Nm^{-1}. What additional work will be performed in further blowing it so that its radius is doubled ?

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9. Assume that 64 water droplets combine to form a large drop. Determine the ratio of the total surface energy of 64 droplets to that of large drop. Given, surface tension of water $= 0.072 Nm^{-1}$.

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10. A spherical mercury drop of $10^{-3} m$ radius is sprayed into million drops of the same size. Calculate the energy used in doing so. Given surface tension of mercury $= 0.55 Nm^{-1}$

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11. Calculate the amount of energy evolved when 8 droplets of water (surface tension of water =0.072 Nm^{-1}) of radius $1/2$mm each combine into one.

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12. 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

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13. If a number of small droplets off water each of radius r coalesce to form a single drop of radius R, show that the rise in temperature is given by $T = \frac{3\sigma}{\rho c}\left[\frac{1}{r} - \frac{1}{R}\right]$ where σ is the surface tension of water, ρ its density and c is its specific heat capacity.

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14. Workdone to blow a bubble of volume V is W. The workdone is blowing a bubble of volume 2 V

will be

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15. The work done in blowing a bubble of radius R is W. What is the work done in making a bubble of radius 2R? Given both the bubble are to be made with the same solution.

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16. A film of water is formed between two straight parallel wires each 10cm long and at a separation

0.5cm. Calculate the work required to increase 1 mm distance between them. Surface tension of water $= 72 \times 10^{-3} N/m$

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17. What is the difference of pressure between the inside and outside of a spherical drop of water of radius 1mm? Surface tension of water $= 7.2 \times 10^{-2} Nm^{-1}$

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18. Find the difference of pressure between inside and outside of a soap bubble 5mm in diameter . Surface tension of soap solution is $3.2 \times 10^{-2} Nm^{-1}$

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19. What should be the diameter of a soap bubble in order that the excess pressure inside it is $20 Nm^{-1}$. Surface tension $= 25 \times 10^{-3} Nm^{-1}$

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20. What is the pressure inside the drop of mercury of radius 3.00 mm at room temperature? Surface tension of mercury at that temperature $(20^\circ C)$ is 4.65×10^{-1} N m^{-1}. The atmospheric pressure is $1.01 \times 10^5 Pa$. Also give the excess pressure inside the drop.

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21. Calculate the pressue inside air bubble of diameter 0.2 mm situated just below the surface of water. Surface tension of water is $72 \times 10^{-3} Nm^{-1}$.

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22. Find the difference in excess pressure on the inside and outside of a rain drop, if its diameter changes from 1.003 cm to 1.002 cm by evaporation ? Surface tension of water is $72 \times 10^{-3} Nm^{-1}$.

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23. An air bubble of radius 0.6mm may remain in equilibrium at a depth in water. If the surface

tension of water is $72 \times 10^{-3} N/m$ then calculate the depth.

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24. A spherical air bubble is formed in water at a depth of 1.2 m from the surface. The diameter of the bubble is 0.6 mm and surface tension of water is $0.073 Nm^{-1}$. Calculate the pressure inside . Atmospheric pressure $= 10.3m$ of water.

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25. A small hollow sphere having a small hole in it is immersed in water to a depth of 50cm, before any water penetrates into it. Calculate the radius of the hole, if the surface tension of water is $7.2 \times 10^{-2} Nm^{-1}$.

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26. The pressure inside a soap bubble of radius 1 cm balances a 1.5 mm column of oil of density 800 kgm^{-3}. Find the surface tension of the soap solution.

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27. Calculate the height of liquid column required to balance the excess pressure inside a soap bubble of radius $3 \times 10^{-3} m$ .The density of liquid is $900 kgm^{-3}$ and the surface tension of soap solution is $30 \times 10^{-3} Nm^{-1}$.

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Module 2 Surface Tensions From Capillary

1. A capillary tube of radius 0.6 mm is dipped vertically in a liquid of surface tension $0.04Nm^{-1}$ and relative density 0.8 . Calculate the height of capillary rise if the angle of contact is 15°.

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2. A capillary tube whose inside radius is 0.5 mm is dipped in water having surface tension $7.0 \times 10^{-2}Nm^{-1}$. To what height is the water raised above the normal water level ? Angle of

contact of water with glass is 0°. Density of water is $10^3 kgm^{-3}$ and $g = 9.8ms^{-2}$.

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3. The tube of a mercury barometer is 4.5 mm in diameter . What error does surface tension introduce in the reading? Given angle of contact of mercury and glass is 140°. Surface tension of mercury $54 \times 10^{-2} Nm^{-1}$ and density 13.6 g m / cc .

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4. Water rises in a capillary tube to a height 4 cm. If the tube is inclined at an angle of 45° with the vertical , find the position of the water in the tube.

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5. Find the heights to which water will in a capillary tube of radius 0.3mm, $\sigma = 7.2 \times 10^{-2} Nm^{-1}$. What will happen if the tube is raised till the upper end is 3cm above the water surface?

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6. Mercury in a capillary tube is depressed by 1.16cm. The diameter of the capillary tube is 1mm. Calculate the angle of contact of mercury with the glass if the surface tension of mercury is $54 \times 10 N m^{-1}$ and its density is $13.6 \times 10^3 kgm^{-3}$.

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7. When a capillary tube of radius $2.8 \times 10^{-4} m$ is dipped vertically in alcohol , alcohol rises by $0.02m$ above the outer level. Calculate the surface

tension of alcohol, given density of alcohol is $790kg - m^{-3}$.

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8. Calculate the radius of the capillary tube if, when it is dipped vertially into a beaker of water, the water stands 35 cm higher in capillary tube than in the beaker. Surface of water is $0.073Nm^{-1}$.

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9. Mercury in a capillary tube is depressed by 1.16cm. The diameter of the capillary tube is 1mm. Calculate the angle of contact of mercury with the glass if the surface tension of mercury is $54 \times 10 N m^{-1}$ and its density is $13.6 \times 10^3 kgm^{-3}$.

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10. Water rises to a height of 4cm in a certain capillary tube. Find the height to which water will

rise in another tube whose radius is one-half of the first tube.

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11. 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 $1.0 \times 10^3 kg/m^3$.

$(g = 9.8ms^{-2})$

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12. Water rises to a height of 9cm in a certain capillary tube. In the same tube the level of mercury surface is depressed by 3 cm . Compute the ratio of surface tension of water and mercury . Density of mercury $13.6 \times 10^3 kgm^{-3}$. Angle of contact of water is zero and that for mercury is 135°.

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13. A spherical drop of mercury of radius 3mm falls to the ground and breaks into 27 smaller drops of equal size. Calculate the amount of work done. Surfae tension of mercury $= 0.472Nm^{-1}$

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14. A glass tube of radius $0.4mm$ is dipped vertically in water. Find upto what height the water will rise in the capillary? If the tube in inclined at an angle of 60° with the vertical, how much length of the capillary is occupied by water?

Suface of water $= 7.0 \times 10^{-2} N/m$,density of water $= 10^3 kg/m^3$.

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15. The lower end of a clean glass capillary tube of internal radius $2 \times 10^{-4} m$ is dippled into a beaker containing water . The water rise up the tube to a vertical height of $7 \times 10^{-2} m$ above its level in the beaker. Calculate the surface tension of water. Density of water = $1000 kgm^{-3}$, $g = 10 ms^{-2}$.

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Module 3 Kinetic Theory Of Gases Conceptual Short Answer Questions With Answers

1. "Hydrogen escapes from the earth's atmosphere more readily than oxygen " why?

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2. Why does the temperature of a gas increase when it is suddenly compressed?

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3. A closed vessel contains equal number of molecule of hydrogen and oxygen. A fine hole is made in the vessel. Which gas will leak rapidly?

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4. Which oen of the following has larger number of molecules ?

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5. If the number of molecules of a gas in a closed vessel is doubled what happens to (i) the pressure of the gas, (ii) the total kinetic energy and (iii) the r.m.s. velocity of the gas?

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Module 3 Kinetic Theory Of Gases Long Answer Questions

1. On the basis of the kinetic theory explain why the pressure of a gas at constant volume increases with rise in temperature?

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2. A cylinder fitted with a piston is filled with a gas at a given temperature and pressure. Explain on the basis of the kinetic theory the increase in pressure of the gas as its temperature is increased.

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3. According to the kinetic theory of gases, the pressure of a gas is expressed as $P = \frac{1}{3}\rho\bar{c}^2$

where ρ is the density of the gas, $\bar{c}^2$ is the mean square speed of gas molecules. Using this relation show that the mean kinetic energy of a gas molecule is directly proportional to its absolute temperature.

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4. Using the kinetic theory derive an expression for the pressure exerted by an ideal gas, stating clearly the assumption which you make.

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5. Explain (i) Boyle's law (ii) Charles's law

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6. Explain how gases derive from the ideal gas law.

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7. Derive the perfect gas equation.

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8. State the postulates of kinetic theory corrected by van der Waals.

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9. Using van der Waals equation $\left(P+\frac{a}{V^2}\right)(V-b)=RT$, answer the following questions:

The van der Waals equation explains the behaviour of

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Module 3 Kinetic Theory Of Gases Short Answer Questions

1. What is kinetic energy of matter ? Why is it called so?

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2. Why do real gases deviate from Boyle's law?

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3. What is meant by amu ?

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4. State Boyle's law in terms of pressure and density of a gas.

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5. While stating Boyle's law why should we use the phrase " at constant temperature"?

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6. Draw a graph to show the deviation of real gas from Boyle's law.

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7. How will you arrive at absolute zero using Charles's law?

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8. Write down the relation connecting the pressure and temperature of a gas if volume is

kept constant.

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9. Explain the symbols used in the equation of state.

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10. R is called the universal gas constant, why? Give its value in S.I.

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11. What is the difference between r and R ?

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12. What is the use of Dalton's law of partial pressure ?

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13. State Graham's law of diffusion.

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14. State the postulates of kinetic theory of gases. Why are they called so?

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15. Who is known as the father of kinetic theory?

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16. Define average speed and r.m.s. speed of a gas molecule.

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17. Define free path and mean free path.

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18. Explain the kinetic interpretation of temperature

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19. Derive an expression for the mean K.E. of a gas molecule.

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20. Starting from the pressure exerted by a gas derive (i) Boyle's law (ii) Charle's law.

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21. Obtain Graham's law of diffusion from the expression for the pressure exerted by a gas.

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22. State the law of equipartition of energy.

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23. Write down the gas equation applicable to real gases.

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Module 3 Kinetic Theory Of Gases Very Short Answer Questions

1. What is the physical significance of the universal gas constant R ?

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2. When an automobile moves for a long time, the air pressure in the tyres increases slightly. Why?

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3. Statement-1: In kinetic theory of gases, we do not take into account the change in gravitational

potential energy of the molecules.

Statement-2: The internal energy of a gas depends on the interaction between gas molecules. This interaction is not affected by the change in gravitational potential energy of the molecules.

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4. What is the mean translation kinetic energy of a perfect gas molecule at temperature T?

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5. What is the equation of state for 16kg of O_2 ?

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6. What is the volume of a gas at absolute zero of temperature ?

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7. Will the mean kinetic energy per mole of a mixture of two different gases in equilibrium be equal ?

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8. Assertion An actual gas behaves as an ideal gas most closely at low pressure and high temperature.

Reason At low pressure and high temperature, real gases obey the gasl laws.

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9. The velocity of air molecules is about 500 ms^{-1} . But still the smell of a scent speards very slowly.

Why?

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10. "If a container with porous wall filled with a mixture of two gases is placed in an evacuated space, the lighter of the two gases will escape out sooner. "Why?

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11. Does a single particle of a gas have temperature?

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Module 3 Kinetic Theory Of Gases From Gas Law And Equation Of State

1. An eletric bulb of volume $250cm^3$ was sealed off during manufacture at a pressure of 10^3mm of mercury at $27^\circ C$. Compute the number of air molecules contained in the bulb. Given that $R = 8.31J/mol - K$ and $N_A = 6.01 \times 10^{23}permol$

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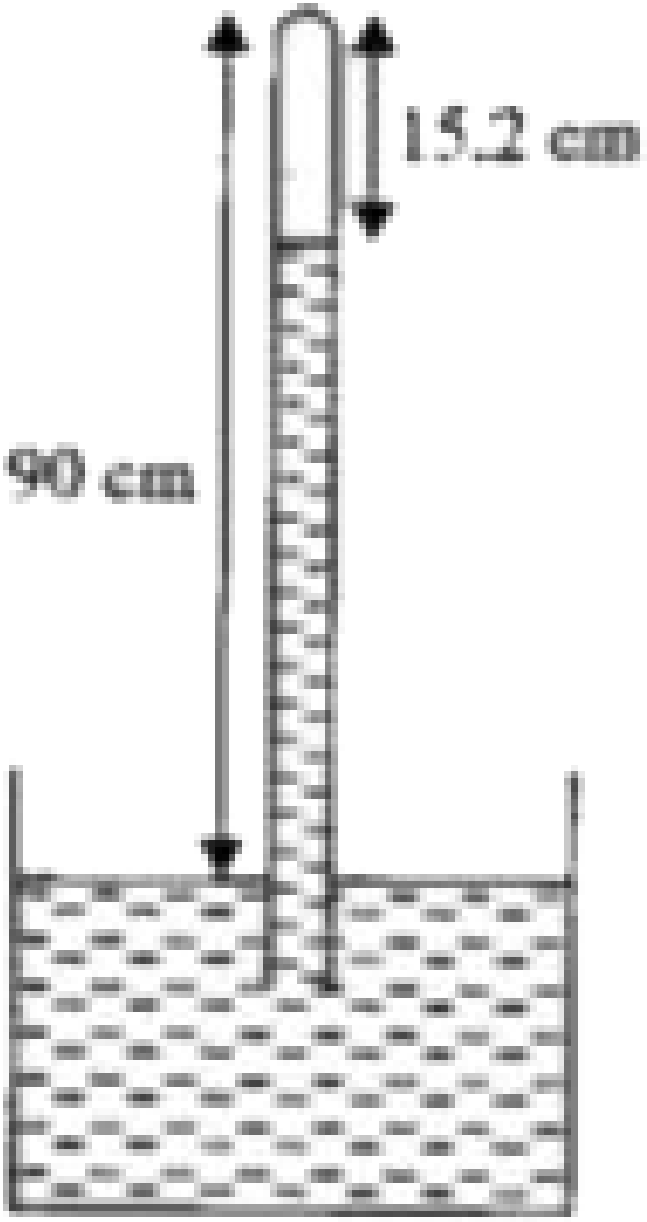
2. The length of a faulty barometer is 90 cm and there is a little air above the mercury. When the atmospheric pressure is 76cm of Hg it reads 74.8 cm. What will be the true atmospheric pressure if

the reading on the barometer is 74.3cm ?



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3. In a cubical vessel of side one metre a mixture of gases containing 22g of carbon dioxide, 8g of oxygen and 14g of nitrogen are taken. Find the pressure exerted by the mixture if the temperature is $30^{\circ} C$.

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4. Molar volume is the volume occupied by 1 mol of any (ideal) gas at standard temperature and pressure (STP : 1 atmospheric pressure, $0^{\circ} C$). Show that it is 22.4 litres.

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5. An air bubble of volume $1.0cm^3$ rises from the cottom of a lake 40 m deep at a temperature of $12^\circ C$. To what volume does it grow when it reaches the surface, which is of a temperature of $35^\circ C$?

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6. A bulb contains air at atmospheric pressure at $40^\circ C$ temperature. The maximum pressure bulb

can withstand is 2 atmosphere. Calculate the temperuatre of air when the bulb is on the point of bursting.

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7. Estimate the total number of air molecules (inclusive of oxygen, nitrogen, water vapour and other constituents) in a room of capacity $25.0m^3$ at a tempreature of 27° C and 1 atm pressure.

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8. The pressure inside an electric bulb is $10^{-3}mm$ of Hg at a temperature of $25^{\circ}C$. If the volume of the bulb is $10^{-4}m^3$, find the number of molecules contained in it.

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9. Two glass bulbs of same volume containing a gas at NTP are connected by a very narrow tube. The pressure is 88.46cm of mercury when one bulb is kept in ice and the other in hot water. Calculate the temperature of the hot water.

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10. A vessel is filled with a gas at a pressure of 76 cm of Hg at some temperature. The mass of the gas is increased by 50% by introducing more gas in the vessel at the same temperature. Calculate the new pressure of the gas.

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11. 1.5 mole of N_2 at $77^\circ C$ and at a pressure of 5 atmosphere is mixed with 0.5 mole of helium at $27^\circ C$ and at a pressure of 2 atmosphere. The

volume of the mixture is equal to the sum of their initial volume. What is the pressure of the mixture if the temperature of the mixture is $69^{\circ} C$.

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12. A container 11g of a CO_2 and 7g of N_2 at 290K . What is the density of the mixture if pressure of the mixture is 1 atmosphere . $R = 8.931 Jmole^{-1} K^{-1}$.

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Module 3 Kinetic Theory Of Gases From Kinetic Theory Rms Speed Temperature Pressure

1. Find the average value and rms value of the numbers 1,2,3,-1,-2 and -3

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2. Three gas molecules have velocities 0.3 kms^{-1}, $0.6kms^{-1}$, $1.5kms^{-1}$. Calculate rms velocity and average velocity?

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3. Calculate the rms velocity of oxygen at STP, density of oxygen is 1.44 kgm^{-3}

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4. A cubical vessel of side 15cm contains oxygen gas at $27^{\circ}C$. How long does it take a typical molecule to cross the container?

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5. The density of CO_2 gas at $0^\circ C$ and at a pressure of $1.0 \times 10^5 Nm^{-2}$ is 1.98 kgm^{-3}. Calculate the root mean square velocity of its molecules at $0^\circ C$ and $30^\circ C$. Assume the pressure to remain constant.

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6. Calculate the temperature to which a gas at $0^\circ C$ be heated so that the rms speed of its molecules be doubled, keeping other factors constant.

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7. What is the temperature at which rms velocity of a gas is half its value at $0^\circ c$, if the pressure is kept constant ?

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8. Find the temeprature at which the r.m.s. velocity is equal to the escape velocity from the surface of the earth for hydrogen. Escape velocity $= 11.2 km / s$

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9. The r.m.s. velocity of oxygen molecules at 273K is $460 m / s$. Find the r.m.s. velocity of argon at $40^{\circ} C$.

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10. The rms speed of helium on the surface of the sun is $6.01 km / s$. Make an estimate of the surface temperature of the sun.

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11. At what temperature is the rms speed of an atom in a nitrogen gas cylinder equals to the rms speed of an oxygen gas atom at $23^{\circ}C$. Atomic mass of nitrogen is 14 and that of oxygen is 16.

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12. Calculate the temperature at which the rms velocity of oxygen molecules will be $2km/s - R = 8.31Jm^{-1}K^{-1}$.

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13. Estimate the average thermal energy of a helium atom at (i) room temperature $27^{\circ}C$ and (ii) the temperature of the surface of the sun (6000K)

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14. The kinetic energy of translation of an oxygen molecule at a particular temperature of $6.27 \times 10^{-31} J$. Calculate the temperature . Boltzman's constant $= 1.38 \times 10^{-23} J/K$.

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15. Find the temeprature at which the r.m.s. velocity is equal to the escape velocity from the surface of the earth for hydrogen. Escape velocity $= 11.2 km / s$

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16. Calculate the frequency of revolution of a hydrogen molecule at $27^{\circ} C$ about it own axis, assuming it to be diatomic with distance between the atoms as $1.5 Å$. Mass of each atom is $1.67 \times 10^{-27} kg$. $k = 1.38 \times 10^{-23} JK^{-1}$

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17. Calculate the K.E. per mole of oxygen at $27^\circ C$. Given $N = 6.02 \times 10^{23}$, $k = 1.38 \times 10^{-23} JK^{-1}$.

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18. A flask contains hydrogen and helium in the ratio $2:1$ by mass. The temperature of the mixture is $27^\circ C$. Obtin the ratio of rms speeds of the molecules of the two gases. Atomic mass of hydrogen =2, molecular mass of helium =4

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19. Calculate the total kinetic energy of 0.002kg of helium at 200K.

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20. At certain pressure and $127^\circ C$ temperature the mean kinetic energy of hydrogen molecules is $8 \times 10^{-21} J$. What is the mean kinetic energy of hydrogen molecules at the same pressure and temperature $27^\circ C$?

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21. The root mean square speed of smoke particles each of mass 5×10^{-17} kg in their Brownian motion in air at N.T.P is

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22. A vessel is filled with a gas at a pressure of 76 cm of mercury at a certain temperature. The mass of the gas is increased by 50% by introducing more gas in the vessel at the same temperature. Find the resultant pressure of the gas. a) 76 cm of

mercury b) 108 cm of mercury c) 112 cm mercury d) 114 cm of mercury

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23. A gas molecule at the surface of earth happens to have the rms speed for the gas at $0^{\circ}C$. Suppose it went straight up without colliding with other molecules, how high it would rise? Mass of the molecule is $4.65 \times 10^{-26} kg$. Boltzmann's constant $= 1.38 \times 10^{-23} JK^{-1}$.

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24. Two perfect gases (1) and (2) are at temperatures T_1 and T_2 . If the number of molecules of the two gases are n_1 and n_2 and the masses of the molecules m_1 and m_2, find the resulting temperature when the two gases are mixed. Assume that there is no loss of energy on mixing the two gases.

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25. A vessel contains a mixture of helium and argon gas in equilibrium at 423K. Calculate the average kinetic energy of each gas molecule.

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26. If 10^{22} gas molecules each of mass $10^{-26}kg$ collide with a surface (perpendicular to it) elastically per second over an area $1m^2$ with a speed $10^2m/s$, the pressure exerted by the gas molecules will be of the order of :

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27. The van der Waals constant for hydrogen is $0.025N - m^4/mol^2$. What is the internal

pressure of hydrogen if $V = 22.4 \times 10^{-3} m^3$?

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28. Air consists mainly of nitrogen and oxygen molecules. Relative molecular masses of nitrogen and oxygen are 28 and 32 respectiely. Calculate :

(i) the ratio of the rms speed of nitrogen molecules to that of the oxygen molecules in air and

(ii) the ratio of the r.m.s. speed of oxygen molecules in air at $0^\circ C$ to that at $10^\circ C$.

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29. A cylinder containing 20kg of compressed nitrogen at pressure 9 times that of the atmosphere is kept in a store at $7^{\circ} C$. The safety valve allows nitrogen to escape when it pressure exceeds 10 times that of the atmosphere. How much nitrogen will escape if the temperature rises to $47^{\circ} C$?

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Module 4 Temperature Conceptual Short Answer Questions With Answers

1. The triple point of water is a standard fixed point in the modern thermometry, why? What is wrong in taking the melting point of ice and boiling point of water as standard fixed point?

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2. What is meant by a dynamical theory of heat?

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3. On the absolute scale triple point of water is one fixed temperature, what is the other?

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4. What is Joule's constant?

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5. The zero kelvin is called absolute zero, why?

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6. There is a slight temperature difference between the waterfall at the top and bottom, why?

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7. What is the temperature of the triple point of water on an absolute scale whose unit interval size is equal to that of Fahrenheit scale?

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8. Out of two thermometers one with spherical bulb and another with cylindrical bulb, which will respond quickly to temperature changes?

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9. Name various fixed points used in thermometry.

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10. What are the requistes of a theromemter.

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11. Compare the relative merits of mercury and alcohol as a thermometric liquid.

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12. Why is platinum used for making resistance thermometer?

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Module 4 Temperature Long Answer Questions

1. Name the different types of thermometers.

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2. Name the principle on which it works.

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3. Give the range of temperature that can be measured by using them.

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4. Why mercury is used as a thermometric liquid?

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5. Explain the construction of a mercury thermometer.

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6. Mention the errors and their correction.

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7. Describe with a labelled circuit diagram a platinum resistance thermometer. How is it used for measuring temperatures?

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8. Give the advantages and disadvantages of pesticides.

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9. Explain the working of the disappearing filament pyrometer.

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10. Give the advantages and disadvantages of pesticides.

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Module 4 Temperature Short Answer Questions

1. Name the most suitable thermometer for measuring the following temperatures.

$-250^\circ C, 250^\circ C, 80^\circ C, 780^\circ C, 2000^\circ C.$

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2. What type of a thermometer is recommended to measure accurately a temperature of 20K.

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3. Write the difference between heat and temperature .

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4. Why heat is called the disordered energy ?

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5. What is the difference between the calorie used in physics and Calorie used in nutrition?

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6. How will you explain temperature using kinetic theory?

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7. What is meant by thermal equilibrium?

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8. What is the difference between an adiabatic wall and a diathermic wall?

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9. State Zeroth law of thermodynamics. Why is it called so?

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10. Who invented the first thermometer?

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11. Why liquids are not used for measuring very high temperatures?

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12. Mention the advantages of a gas thermometer over liquid thermometer.

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13. Name the thermometer that can measure a temperature range from $-272^{\circ}C$ to $1600^{\circ}C$.

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14. What is the lowest temperature produced?

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15. What is the emipirical scales of temperature ?

Why are they called so?

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16. What is the difference in saying

(i) one degree Celsius and (ii) one Celsius degree?

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17. "Kelvin's scale is called an absolute scale of temperature." Why ?

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18. What is the superiority of Kelvin's scale over other scales?

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Module 4 Temperature Unsolved Problems

1. Room temperature is $30^{\circ}C$. Express this is degree Fahrenheit and Kelvin.

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2. The temperature of human body is $98.4^{\circ}F$. Calculate the temperature in $^{\circ}C$ and in Kelvin.

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3. The temperature of the surface of the sun is about 6000K. Express this on the Fahrenheit scale.

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4. Liquid oxygen freezes at $-218.4^{\circ}C$ and boils at $-183^{\circ}C$. Express these temperatures in Fahrenheit scale.

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5. At what temperature on the Fahrenheit scale will the reading be double of the reading on the Celsius scale?

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6. The pressure of air in a constant volume air thermometer is 80cm and 109.3cm at $0^\circ C$ and $100^\circ C$ respectively. When the bulb is placed in some hot water, the pressure is 100cm. Calculate the temperature of the hot water.

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7. The boiling point of liquid hydrogen is 20.2K . Express this is degree Rankine.

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8. A constant volume hydrogen thermometer was used to measure the temperature of a hot bath. The excess pressure in the bulb over the atmospheric pressure is found to be equal to 114cm of Hg. At $0^\circ C$ the pressure in the bulb is equal to that of the atmosphere. Find the temperature the hot bath. [Hint $\frac{P}{T} = \frac{P_0}{T_0}$]

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9. On Celsius scale two temperatures differ by 30°. What is the difference on Fahrenheit scale?

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10. The reading of a Fahrenheit thermometer is $132^\circ F$. The same temperature read by a faulty celsius thermometer is $54^\circ C$. Find the correction needed in the Celsius thermometer.

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11. The boiling point of liquid nitrogen is $-195.81^\circ C$ at atmospheric pressure. Express this temperature in (a) $^\circ F$ and (b) K.

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12. A body is heated from $-22^\circ F$ to $140^\circ F$. What is the change in temperature on (a) the Celsium scale and (b) the Kelvin scale?

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