PHYSICS

AIMED AT STUDENTS PREPARING FOR IIT JEE EXAMS

MECHANICAL PROPERTIES OF SOLIDS

Exercise

1. 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 $D=[U(r=\infty)-U_{\text{at equilibrium}}]$, D is

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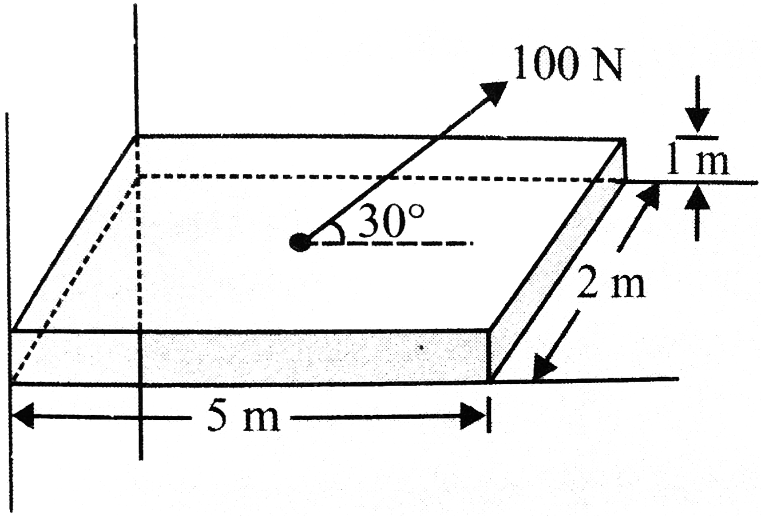
2. Find out longitudinal stress and tangential stress on a fixed block.



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3. A uniform rope of mass M and length L, on which a force F is applied at one end, then find stress in the ropw at a distance x form the end where force is applied?

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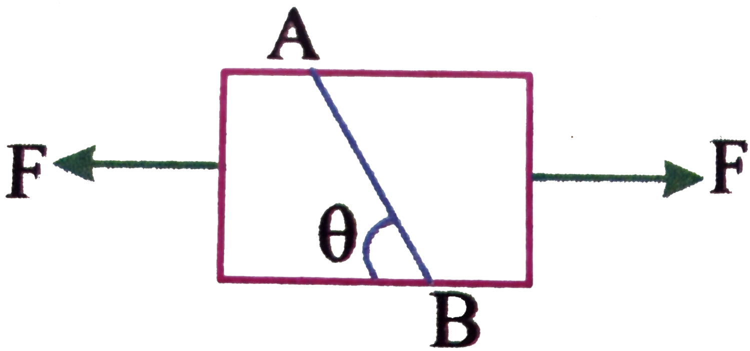
4. Two equal and opposite forces F and $-F$ act on a rod of unifrom cross-sectional ara A, as shown in the figure. Find the (i) shearing (ii) longitual stress on the section AB.



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5. A rubber rope of length $8m$ is hung from the ceiling of a room. What is the increase in length of the rope due to its own weight? (Given: Young's modulus of elasticity of rubber $= 5 \times 10^6 N/m^2$ and density of rubber $= 1.5 \times 10^3 kg/m^3$. Take $g = 10ms^{-2}$)

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6. The length of a metal wire is l_1 when the tension in it is F_1 and l_2 when the tension becomes F_2. Find the natural length of wire.

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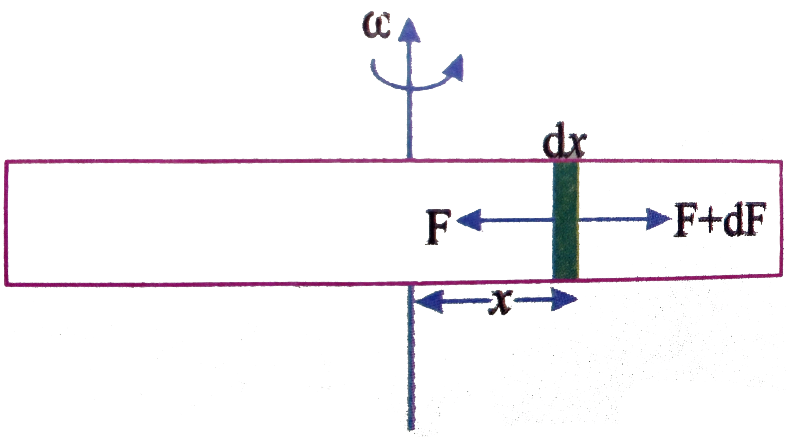
7. A horizontally orientied unifrom copper rod of length l is rotating about a vertical axis passing through its centre. Calculate the rotated frequency at which the rod ruptures. Breaking or rupture strength of copper is σ and density of copper is ρ.



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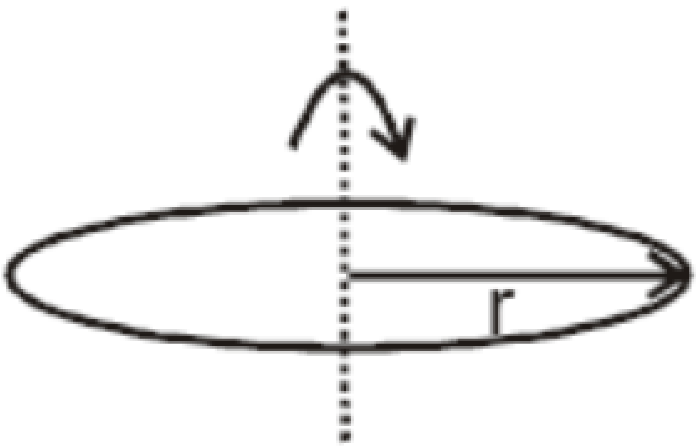
8. A ring of radius r made of wire of density ρ is rotated about a stationary vertical axis passing through its centre and perpendicular to the plane of the ring as shown in the figure. Determine the angular velocity (in rad/s) of ring at which the ring breaks. The wire breaks at tensile stress σ. Ignore gravity. Take $\sigma / \rho = 4$ and $r = 1m$.



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9. A body of mass m s connected to an inextensible thread of length L si whirled in horizontal circle. Find the maximum angular velocity with which it can be whirsted without breaking the thread (Breaking stress of thread $= S$)

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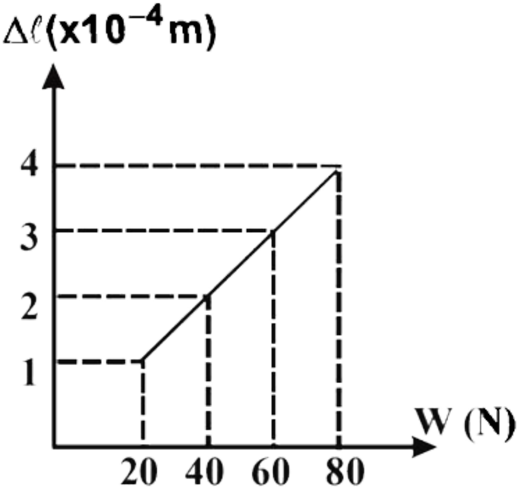
10. The adjacent graph shows the estension (Δl) of a wire of length 1m suspended from the top of a roof at one end and with a load W connected to the other end. If the cross-sectional area of the wire is $10^{-6}m^2$, calculate the Young's modulus of the material of the wire.



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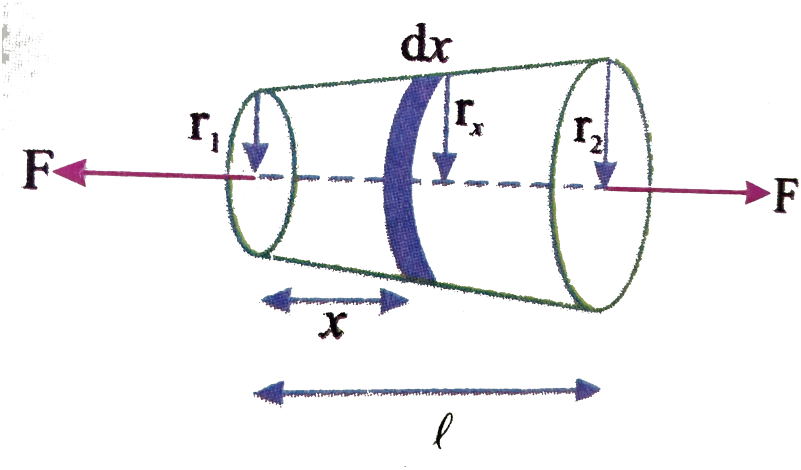
11. A slightly conical wire of length l and radii, r_1 and r_2 is strecthced by two forces each of magnitude F applied parallel to length in opposide directions and normal to end faces. If Y denotes the Young's modulus then find the elogation of the wire

$(r_2 > r_1)$.



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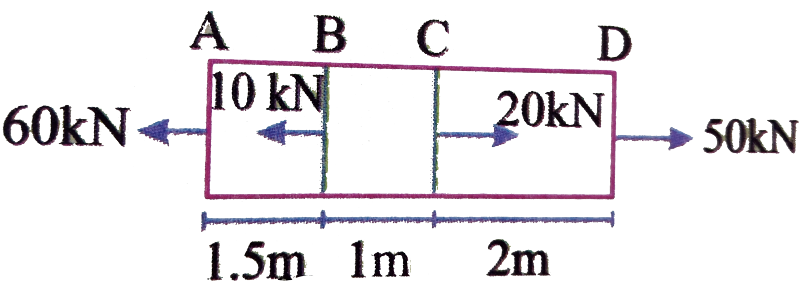
12. A steel rod of cross-sectional area $1m^2$ is acted upon by forces as shown in the Fig. Determine the total elongation of the bar. Take $Y = 2.0 \times 10^{11} N/m^2$



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13. A uniform rod of length l, mass m, cross-sectional area A and Young's modulus Y is rotated in horizontal plane about a fixed vertical axis passing through one end, with a constant angular velocity ω. Find the total extension in the rod due to the tension produced in the rod.

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14. A uniform rod of length L and mass M is pulled horizontally on a smooth surface with a force F. Determine the elongation of rod if Young's modulus of the material is Y.

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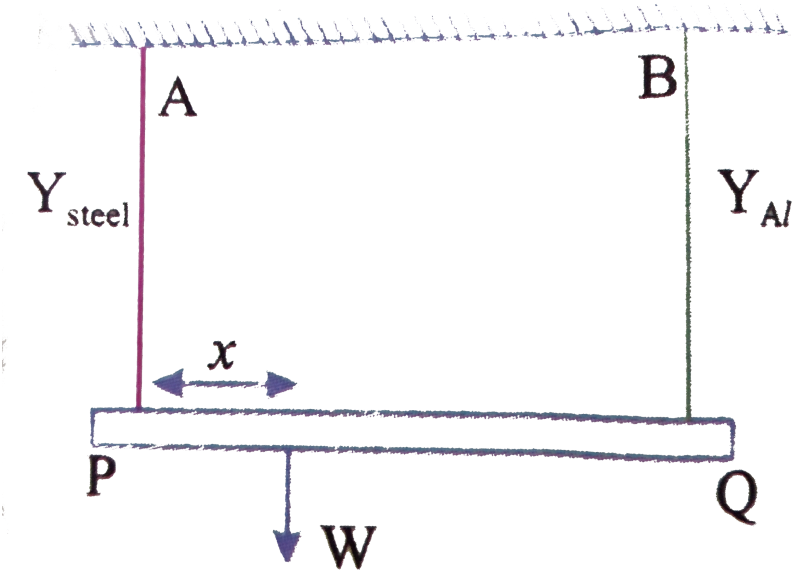
15. A rod PQ of length $1.05m$ having negligible mass is supported at its ends by two wires one of stell (wire A), and the other of aluminium (wire B) of equal lengths as shown in fig. The cross-sectional areas of wires A and B are $1.0mm^2$ and $2.0mm^2$ respectively. At what point along the rod a load W be suspended in order to produce

(a) equal stress, (b) equal strains in both steel an aluminium.

$(Y_{\text{steel}} = 200GPa, Y_{\text{aluminium}} = 70GPa)$



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16. A reinforced concrete column consists of concrete filled with iron bars. Assume that iron occupies one-twentieth of the total cross-section area and Young's modulus of concrete is one-tenth of that of iron. The concrete column is under a compressive load P. Determine the fraction of load on the concrete.

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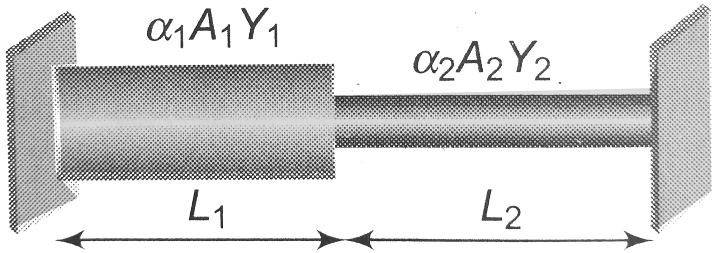
17. Two rods are joined between fixed supports as shown in the figure. Condition for no change in the length of individual rods with the increase of temperature will be

$(\alpha_1, \alpha_2 =$ linear expansion coefficient

$A_1, A_2 =$ Area of rods

$Y_1, Y_2 =$ Young modulus)



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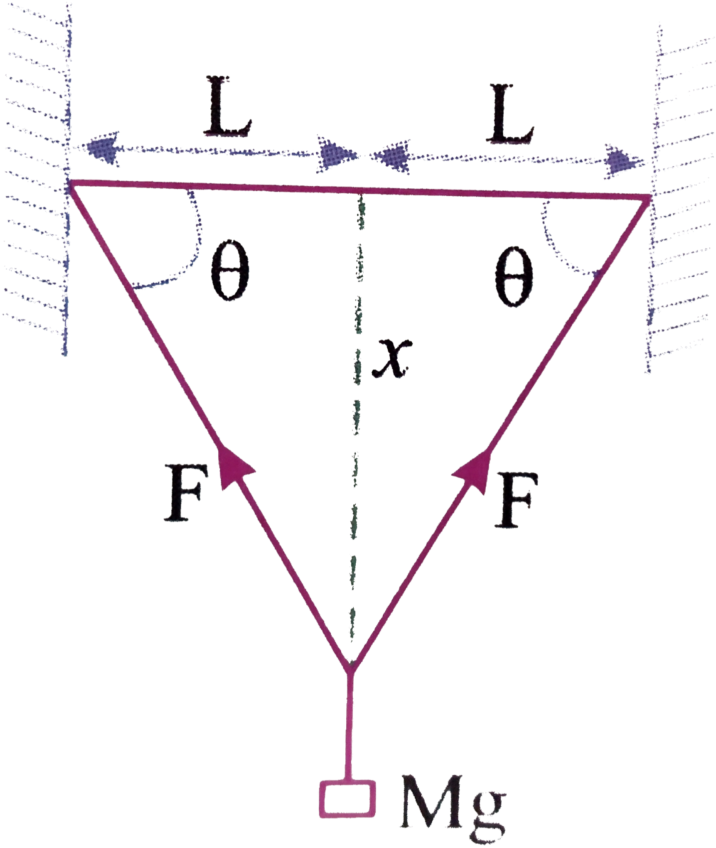
18. A steel of area of cross-section A and length $2L$ is calmped family between two rigid supports separated by a distance $'2L'$. A body is hung from the middle point sags by a distance x. Calculate the mass of the body body and the angle made by the string with the horizontal. (Young's modulus of Steel $= Y$)



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19. A mild steel wire of length $1.0 m$ and cross sectional area $5.0 \times 10^{-2} cm^2$ is stretched, within its elastic limit horizontally between two pillars. A mass of $100 g$ is suspended form the midpont of the wire. Calculate the depression at the midpoint $(Y_{steel} = 200GPa)$

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20. 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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21. 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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22. Two cylinders A and B of the same matieral have same length, their radii being in the ratio of $1:2$ repectively. They are joined end to end as shown in figure. The upper end of A is rigidly fixed. The lower end of B is twised through an angle θ, the angle of twist of the cylinder A is:

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23. 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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24. Determine the volume contraction of a solid copper cube, 10 cm on an edge when subjected to hydraulic pressure of $7 \times 10^6 Pa$. Bulk modulus of copper = 140 Gpa.

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25. A material has normal density ρ and bulk modulus K. The increase in the density of the material when it is subjected to an external pressure P from all sides is

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26. A copper wire of cross sectional asrea 0.01 cm is under a tension of 20 N. Find the decrease in the cross sectional area. Young modulus of copper $= 1.1 \times 10^{11} Nm^{-2}$ and Poisson ratio 0.32.

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27. When a wire of length $10m$ is subjected to a force of $100N$ along its length, the lateral strain produced is 0.01×10^{-3}. The poisson's ratio was found to be 0.4. If area of cross section of wire is $0.25m^2$, its young's modulus is

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28. 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 $1.1 \times 10^{-5} K - 1$)

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29. A 40 kg boy whose leg are $4cm^2$ in area and $50cm$ long falls through a height of $2m$ without breaking his leg bones. If the bones can stand a stress of $1.0 \times 10^8 \frac{N}{m^2}$, calculate the Young's modulus for the material of the bone.

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30. A copper wire $2m$ long is stretched by $1mm$. If the energy strored in the stretched wire is converted into heat, then calculate the rise in temperature of the wire.

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31. A catapult consists of two parallel rubber cords each of length $20cm$ and cross-sectional area $5cm^2$. When stretched by $8cm$, it can throw a stone of mass $4gm$ to a vertical height $5m$, the Young's modulus of elasticity of rubber is $\left[g = 10m/\sec^2\right]$

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32. 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:

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33. A spring of force constant $800N/m$ has an extension of 5cm. The work done in extending it from 5cm to 15cm is

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34. Two springs of spring constants $1500N/m$ and $3000N/m$ respectively are streched by the same force. The potential energy gained by the two springs will be in the ratio

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C.U.Q

1. Reason for the deforemation of a regular body is

A. bulk strain

B. shearing strain

C. linear strain

D. laterial strain

Answer: B

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2. For a gas elastic limit

A. exists

B. eoes not exist

C. exists only at absolute zero

D. exists for a perfect gas

Answer: B

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3. Which of the following affects the elasticity of a substance

A. hammering and annealing

B. change in temperature

C. impurity in substance

D. all of these

Answer: D

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4. A spring is stretched by applying a load to its free end. The strain produced in the spring is

A. volume strain

B. longitudinal strian

C. shearing strain

D. all the above

Answer: C

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5. Three wires A, B, C made of different materails elongated by $1.5, 2.5, 3.5 mm$, under a load of $5 kg$. If the diameters of the wires are the same, the most elastic material is that of

A. A

B. B

C. C

D. $A, B\&C$ are correct

Answer: A

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6. The modulus of elasticity is dimesionally equivalent to

A. stress

B. surface tension

C. strain

D. coefficient fo visocity

Answer: A

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7. For a perfectly rigid body

A. Zero

B. inifinity

C. 1

D. 2

Answer: B

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8. Statement-1 : $C_P - C(v) = R$ is true for monoatomic gases only.

Statement-2 : The relation applies equally to all gases.

A. young's modulus

B. bulk modulus

C. modulus of rigidity

D. all the above

Answer: B

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9. As temperture increases the Young's modulus of the material of a wire

A. increases

B. decreases

C. remains the same

D. becomes infinite

Answer: B

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10. If stress is numbercially equal to young's modulus, the elongation will be

A. $1/4$ the original length

B. $1/2$ the orginla length

C. equal to the orginal length

D. twice the original length

Answer: C

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11. A wire elongastes by 1.0 mm when a load W ils hung from it. If this wire goes over a pulley and two weights W each are hung at the two ends the elongation of the wire will be

A. $0.5mm$

B. $1mm$

C. $2mm$

D. $4mm$

Answer: B

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12. A uniform rod of length L and mass M is pulled horizontally on a smooth surface with a force F. Determine the elongation of rod if Young's modulus of the material is Y.

A. $l\alpha\frac{1}{L}$

B. $l\alpha A$

C. $l\alpha\frac{1}{A}$

D. $l\alpha Y$

Answer: C

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13. The bulk modulus for an incompresssible liquid is

A. infinity

B. unity

C. zero

D. between 0 and 1

Answer: A

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14. Shearing strain is expreseed by

A. angle of twist

B. angle of shear

C. decrease in volume

D. increases in volume

Answer: B

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15. Braking froce per unit area of cross section of a wire is called

A. yield point

B. tensile stress

C. ductility

D. breaking stress

Answer: D

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16. The property of metals where by they could be drawn into thin wires beyond their elastic limit without breaking is

A. ductiliy

B. malleabilty

C. elasticity

D. hardness

Answer: A

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17. The breaking stress of a wire depends on

A. material of the wire

B. length of the wire

C. radius of the wir

D. shape of the cross section

Answer: A

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18. A wire can sustain the weight of $40kg$ before breaking. If the wire is cut into $4-$n equal parts, each part can sustain a weight of $...kfg$

A. 40

B. 160

C. 10

D. 20

Answer: A

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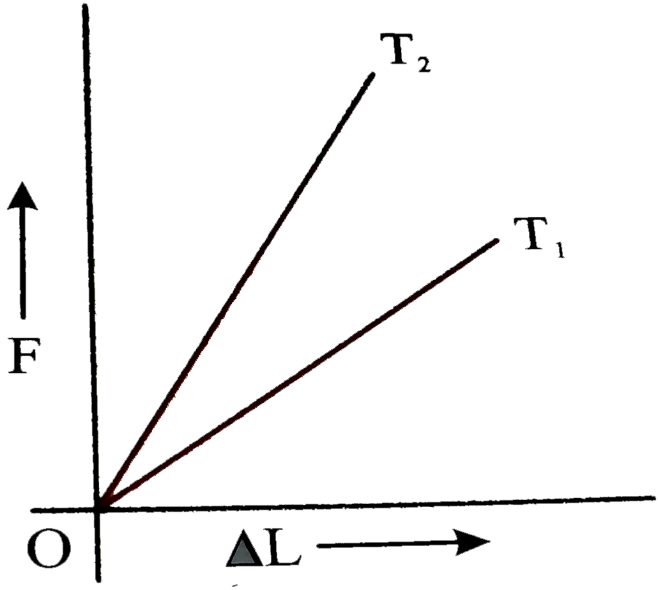
19. The graph shows the change $'\Delta l'$ in the length of a thin uniform wire used by the application of force F at different temperatures T_1 and T_2. The variation suggests that



A. $T_1 = T_2$

B. $T_1 < T_2$

C. $T_1 > T_2$

D. cannot be preidiced

Answer: B

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20. If the length of the wire is doubled the strain produced is

A. 0.5

B. 1

C. 0.25

D. 2

Answer: B

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21. 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 and strain

B. the same strain but different stresses

C. the same stress but different strains

D. different stress and strains

Answer: C

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22. An iron bar of length L. Cross section A and Young's modulus Y is heated from $o^{o}C$ to $100^{0}C$. If this bar is held so that it is not permitted to bend and to expand, the force F that is develop, is proportional to

A. l

B. $\sqrt{l}$

C. l^{0}

D. l^{-1}

Answer: C

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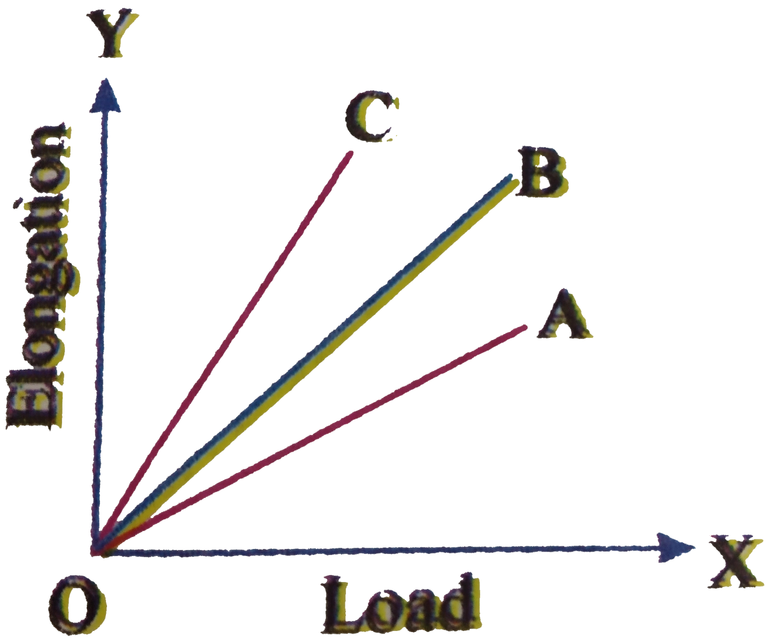
23. Three wires A, B, C made of the same material and radius have different lengths. The graph in the figures show the elongation-load variation. The longest wire is



A. A

B. B

C. C

D. All

Answer: C

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24. According to Hooke's law of elasticity the ratio of stress too strain

A. does not remain constant

B. remain constant

C. increases

D. decreases

Answer: B

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25. The law which governs the working of a spring balance is

A. Kepler's law

B. Robort Hooke's law

C. Newton's law

D. Young's law

Answer: B

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26. A body subjected to strain a number of times does not they Hook's law due to

A. yield point

B. breaking stress

C. elastic fatigue

D. permanent set

Answer: C

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27. A heavy mass is attached to a thin wire and is whirled in a vertical circle. The wire is most likely to break

A. when the mass is at the lowest point

B. when mass is at the highest point

C. when wire is horizontal

D. when mass is an angle of $\cos^{-1}\left(\frac{1}{\sqrt{2}}\right)$ from upward vertical

Answer: A

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28. Steel is preferred for making springs over copper because

A. Y of steel is more than that of copper.

B. steel is cheaper

C. Y of copper is more than steel

D. steel is less likely to be oxidised

Answer: A

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29. Elongation of a wire under its own weight is independent of

A. length

B. area of cross section

C. density

D. young's modulus

Answer: B

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30. The young's modulus of a wire of length (L) and radius (r) is Y. If the length is reduced to $\frac{L}{2}$ and radius $\frac{r}{2}$, then its young's modulus will be

A. $Y/2$

B. $2Y$

C. Y

D. $4Y$

Answer: C

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31. The dimensional formula for young's modulus is

A. $M^1L^{-1}T^{-2}$

B. $M^{1}L^{1}T^{2}$

C. $M^{-1}L^{3}T^{-2}$

D. $M^{-1}L^{3}T^{-2}$

Answer: A

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32. The modulus of rigidly of a liquid is

A. zero

B. 1

C. infinity

D. some other finite value

Answer: A

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33. The young's modulus of air is

A. infinity

B. more than 1 but not infinity

C. less than 1 but not zero

D. zero

Answer: C

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34. Young's modulus for perfectly plastic body is

A. zero

B. infinity

C. 1

D. some other finite value

Answer: A

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35. Young's modulus for a perfectly rigid body is

A. zero

B. 1

C. infinity

D. some other finite value

Answer: C

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36. Within elastic limit, which of the following graphs correctly represents the variation of extension in the length of wire with the external load?

A. straight line with negative slope

B. straight line with zero slope

C. Straight line with positive slope

D. None of the above

Answer: C

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37. Which of the folliwing substances has the highest elastictiy

A. Rubber

B. Steel

C. Copper

D. Wood

Answer: B

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38. A steel wire is stretched by $5kwt$. If the radius of the wire is doubled its Young's modulus

A. remains unchanged

B. becomes double

C. becomes half

D. becomes $1/4$ times

Answer: A

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39. A stone is suspended in a tub of water with copper wire. Another stone of equal mass is suspended in kerosene with equal length of copper wire then

A. Young's modulus is more in the first case

B. Young's modulus is more in the second case

C. elongatin will be less in the former case

D. elongation will be more in the former case

Answer: C

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40. A given quantity of a ideal gas is at pressure P and absolute temperature T. The isothermal bulk modulus of the gas is

A. $\frac{P}{2}$

B. P

C. γP

D. $\frac{PdP}{dV}$

Answer: B

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41. K is the force constant of a spring. The work done in increasing its extension from l_1 to l_2 will be

A. $K(l_2 - l_1)$

B. $K/2(l_2 + l_1)$

C. $K(l_2^2 - l_1^2)$

D. $\frac{K}{2}(l_2^2 - l_1^2)$

Answer: D

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42. 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. $\frac{Yax}{2L}$

B. $\frac{YAx^2}{L}$

C. $\frac{YAx^2}{2L}$

D. $\frac{2YAx^2}{L}$

Answer: C

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43. The following substances which posses rigidity modulus

A. only Solids

B. only liquids

C. liquids and Gases

D. solids, Liquids and Gases

Answer: A

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44. The poisson's ratio cannot have the value

A. 0.7

B. 0.2

C. 0.1

D. 0.3

Answer: A

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45. When a rubber cord is streched, the changed in volume in neglible compared to the change in its linear dimension. Then Posisson's ratio for rubber is

A. infinite

B. Zero

C. 0.5

D. -1

Answer: C

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

A. $-1 < \sigma < 0.5$

B. $-0.5 < \sigma < 1.0$

C. $0.5 < \sigma < 1.0$

D. $-10. \; < \sigma < 0.5$

Answer: A

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

A. 1

B. 0.9

C. 0.8

D. 0.4

Answer: D

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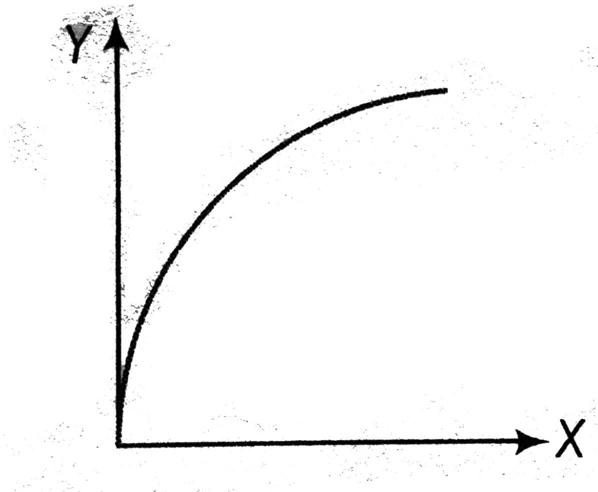
48. The graph shows the behaviour of a steel wire in the region for whoch the wire obeys Hooke's law. The graph is a parabola. The variables X and Y -axes, respectively can be [stress (σ)

,strain (ε) and elastic potential energy(U)]



A. X = stress, Y = strain

B. X = strain, Y = stress

C. X = stress, Y = elastic energy

D. X = elastic energy, Y = stress

Answer: D

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49. The elastic after effect show that the

A. strain in a material is lagging behind stress

B. strain produced is quick

C. elasticity of the material vanishes

D. strain is develop very slowly

Answer: A

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50. A student plots a graph from hs readings on the determination of Young modulus of a metal wire but forgets to put the labels figure. The quantities on X and Y axes may be respectively

A. weight hund and extension

B. stress applied and extension

C. stress applied and strain produced

D. stress appleid and energy stored.

Answer: D

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51. A wire extends by $'l'$ on the application of load $'mg'$. Then the energy stored in it is

A. mgl

B. $mgl/2$

C. mg/l

D. mgl^2

Answer: D

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52. A metallic rod of length $'L'$ and cross-section $'A'$ has Young's modulus $'Y'$ and coeffcient of linear expansion $'\alpha'$. If the rod is heated to a temperature. 'T'` the energy stored per unit volume is:

A. $\frac{1}{2}Y\alpha^2T^2$

B. $\frac{1}{2}YA\alpha^2T^2$

C. $\frac{1}{2}YA\alpha T$

D. $\frac{1}{2}YA^2\alpha^2T^2$

Answer: A

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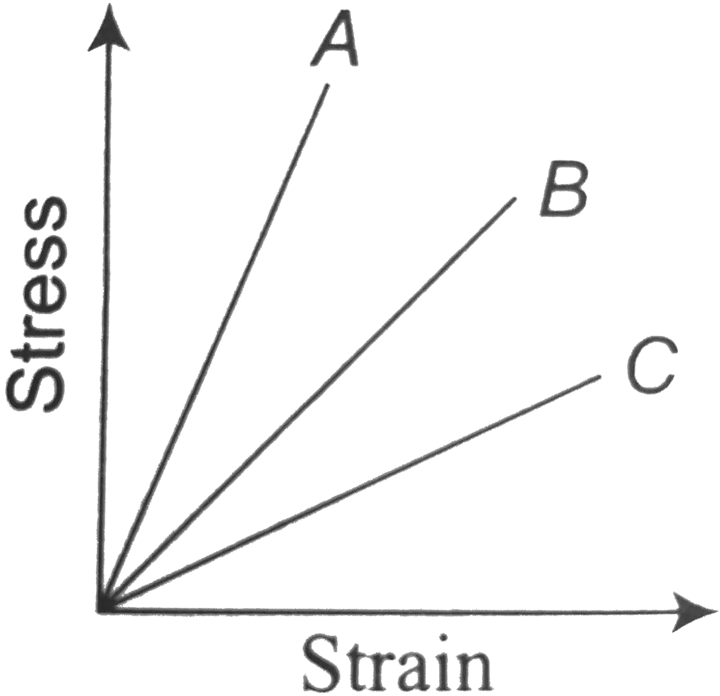

53.

The stress strain curves for brass, steel and rubber are shown in the figure. The lines A, B and C are for

A. rubber, brass and steel respectively

B. brass, Steel and rubber respectively

C. steel, brass and rubber respectively

D. steel, rubber and brass respectively.

Answer: C

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54. When a small block is suspended at the lower end of an elastic steel wire hanging form the celling, there is a loss in gravitational potential energy (U) of earth-block system then

A. the lost energy is irrecoverable

B. the entire can be recovered

C. the lost energy which is irrecoverable is $'U'$

D. the lost energy which is irrecoverable is $U/2$

Answer: D

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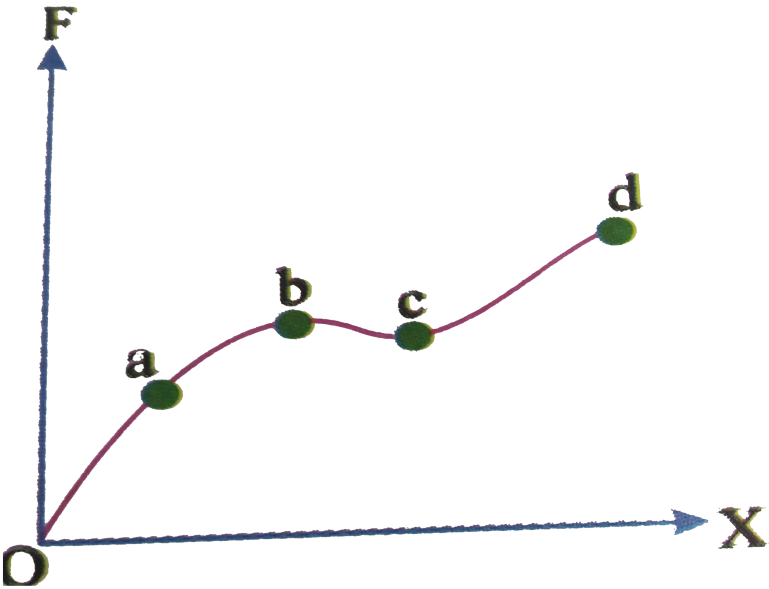
55. The diagram represents the applied force per unit area (F) with the strain (X) produced in a thin wire of uniform



cross-section in the curve shown. The region in which the wire behaves like a viscous liquid is

A. ab

B. bc

C. cd

D. oa

Answer: B

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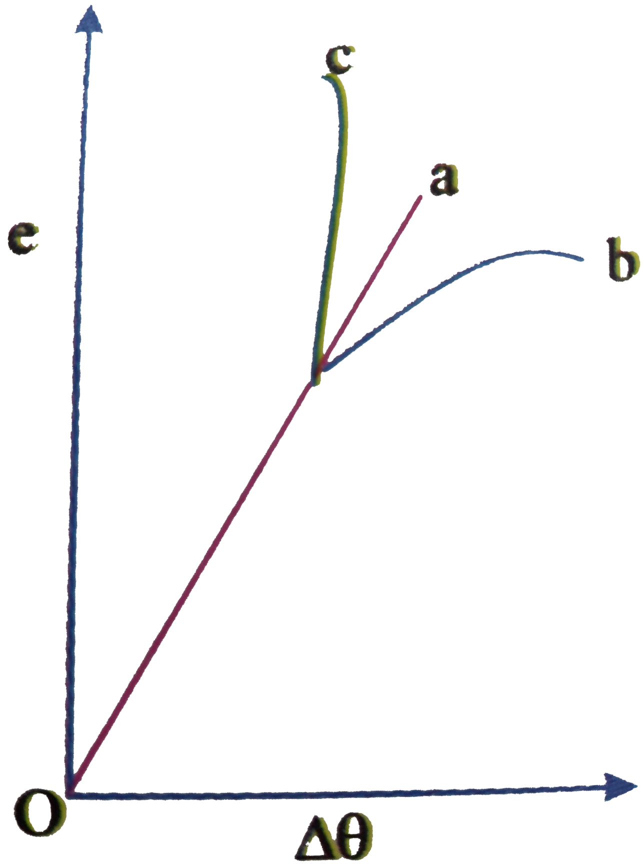
56. A unifrom rod is fixed at one end to a rigid support, its temperture is gradually increased the representaion of graph strain (e) versus increment in temperature $\Delta\theta$ is



A. d

B. a

C. C

D. b

Answer: B

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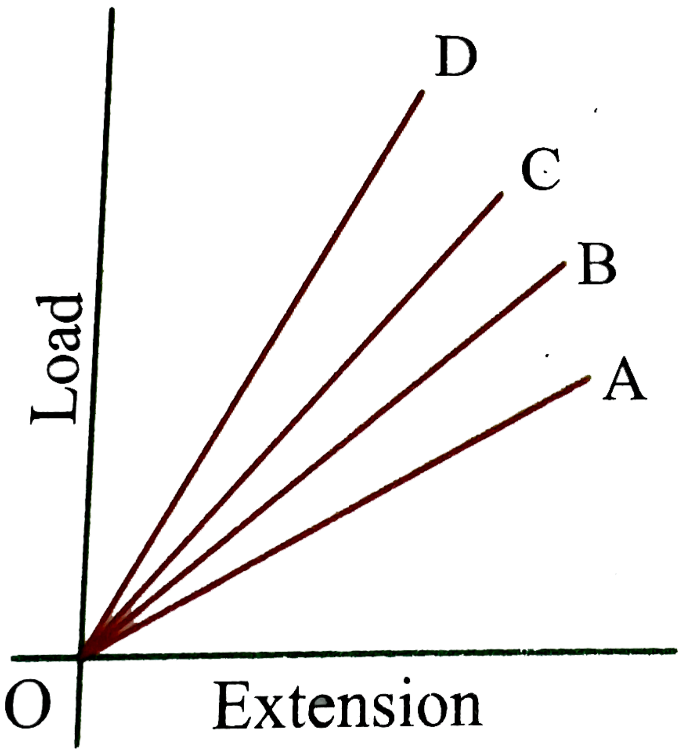
57. The load versus extension graph for four wires of same material is shown.

The thinnest wire is represented by the line



A. OA

B. OB

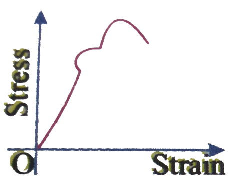
C. OC

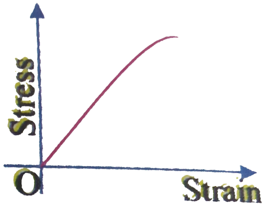
D. OD

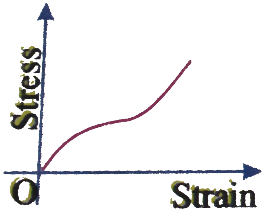
Answer: A

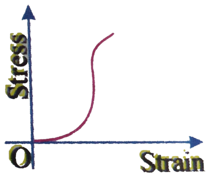
Watch Video Solution

58. Which of the following stress versus strain curve representes cast iron?

A. 

B. 

C. 

D. 

Answer: B

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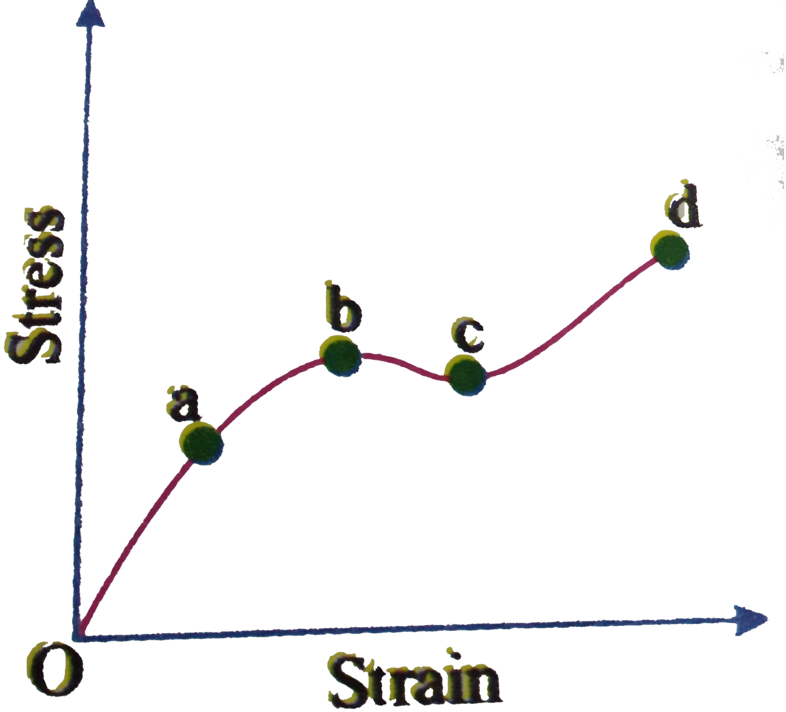
59. A graph is shown between stress and strain for a metal. The part in which Hooke's law holds good is



A. OA

B. AB

C. BC

D. OD

Answer: A

Watch Video Solution

60. In the above graph, point B indicates

A. Breaking point

B. Limiting Pooint

C. Yield point

D. Elastic limit

Answer: C

Watch Video Solution

61. In the above graph, point D indicates

A. Limiting Pooint

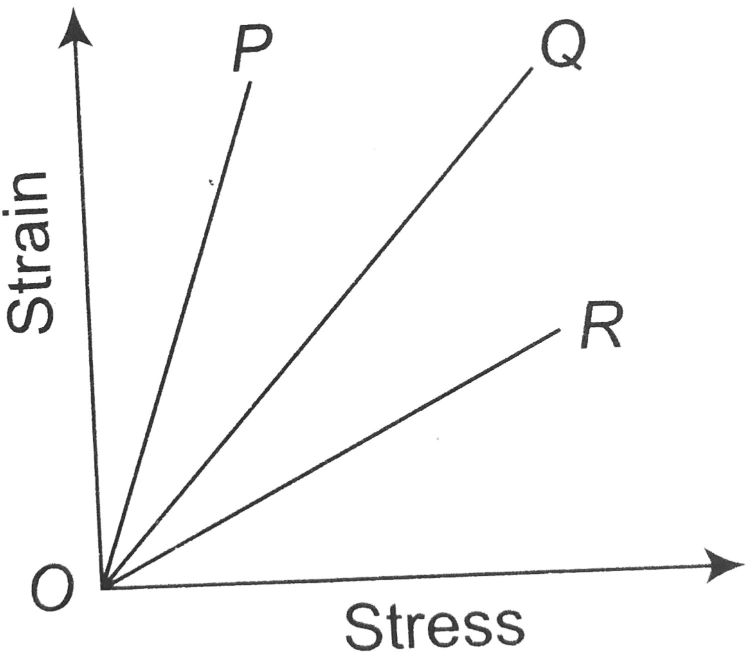
B. Yield point

C. Breaking point

D. Elastic limit

Answer: C

Watch Video Solution



62.

The strain stress curves of three wires of different materials are shown in the figure. P, Q and R are the elastic limits of the wires. The figure shown that

A. Elasticity of wire $'P'$ is maximum

B. Elasticity fo wire $'Q'$ is maximum

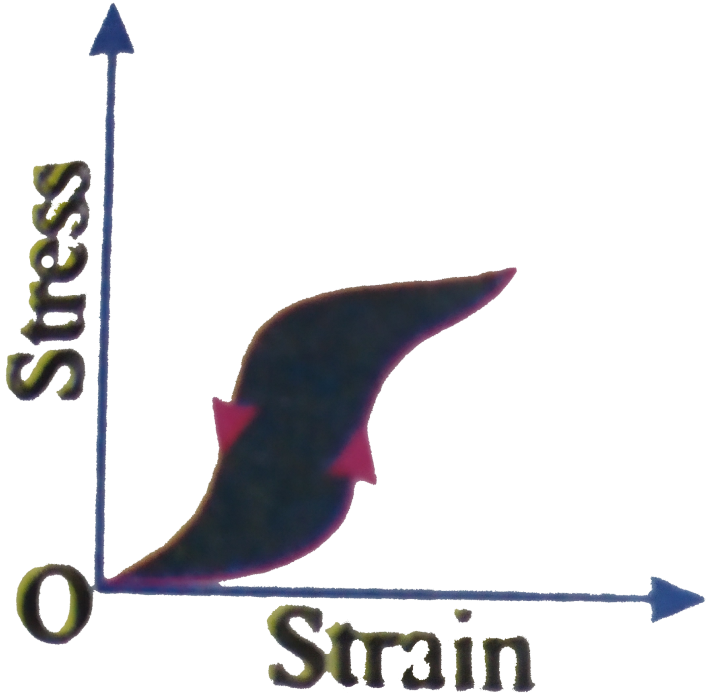
C. Tensile strength of R' is maximum

D. Elasticity $P, Q\&R$ are same

Answer: A

Watch Video Solution

63. The diagram shows a forc-extension graph for a rubber band. Consider of the following statements



I. It will be easier to compress this rubber than expand it

II. Rubber does not return to its original length after it is streched

III. The rubber band will get heated id it is streched and realeased

Which of these can be deduced from the graph

A. II only

B. II and III

C. I and III

D. I only

Answer: A

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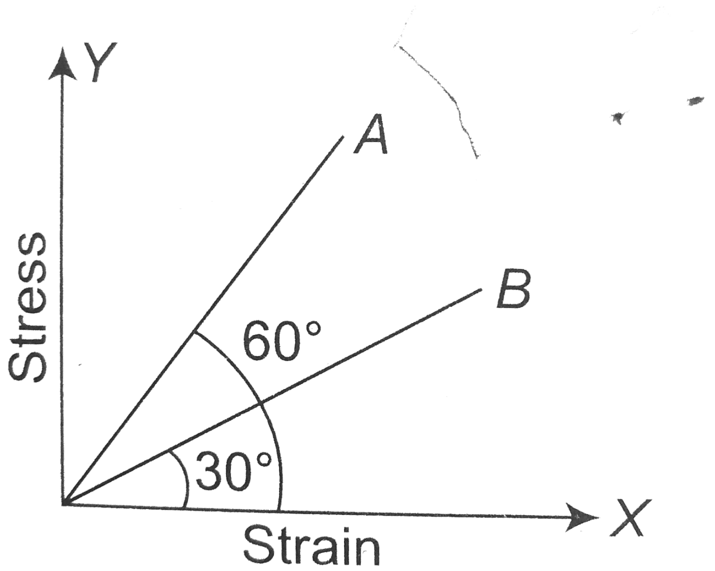


64.

The stress versus strain graphs for wires of two materials A and B are as shown in the figure. If YA and YB are the Young's moduli of the materials then

A. $Y_B = 2Y_A$

B. $Y_A = Y_B$

C. $Y_B = 3Y_A$

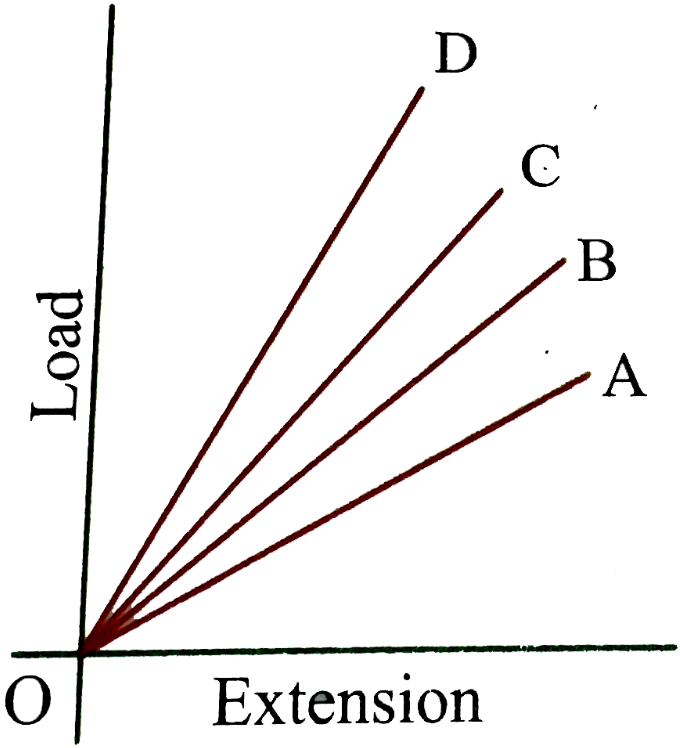
D. $Y_A = 3Y_B$

Answer: D

Watch Video Solution

65. The load versus extension graph for four wires of same material is shown.

The thinnest wire is represented by the line



A. OD

B. OC

C. OB

D. OA

Answer: A

Watch Video Solution

66. When does an elastic metal rod change its length?

A. If it fall vertically under its weight

B. If it is pulled along its length by a force acting at one end

C. If it si rotated about its own axis.

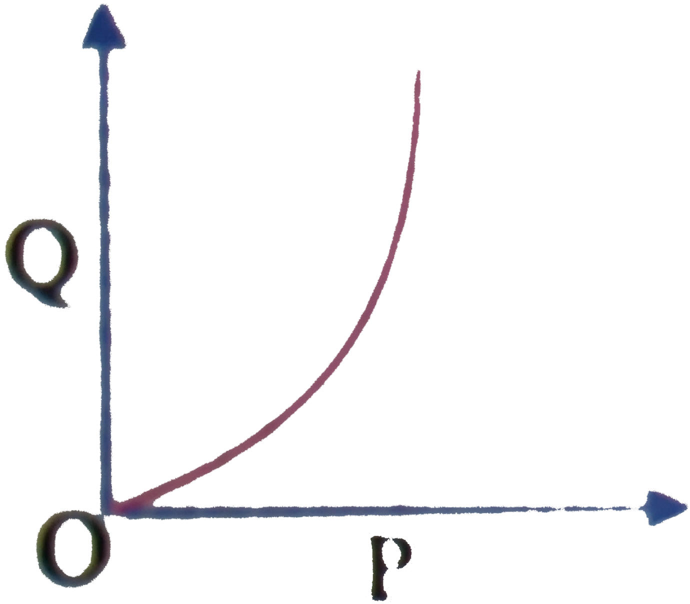
D. If it is slidses on a smooth surface

Answer: B

Watch Video Solution

67. The graph show the behaviour of a length of wire in the region for which the substances obeys Hooke's law. P and Q

represent



A. P = applied force, Q = extension

B. extension, applied force

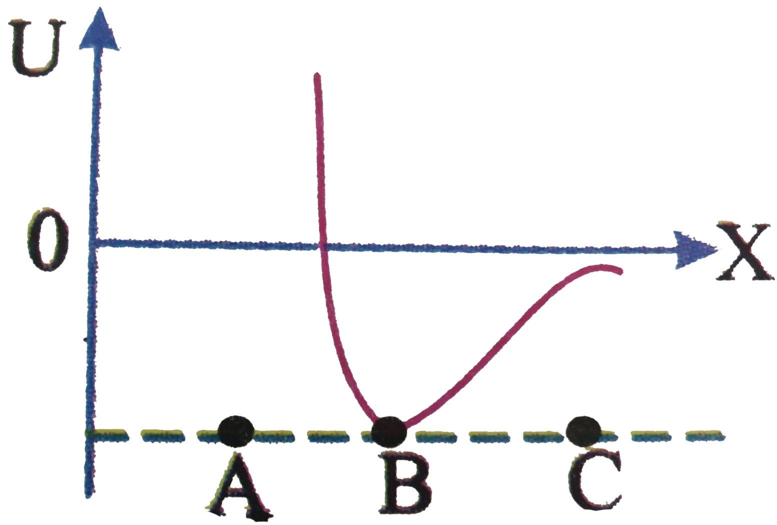
C. extension, stored elastic energy

D. stored elastic energy, extension

Answer: C

Watch Video Solution

68. The potential energy U between two molecules as a function of the distance X between them has been shown in the figure. The two moleucles are



A. attracted when X lies between A and B and are replled when X lies between B and C

B. attracted when X lies between B and C and are repelled when X lies between A and B

C. attracted when they reach B

D. repelled when they reach B

Answer: B

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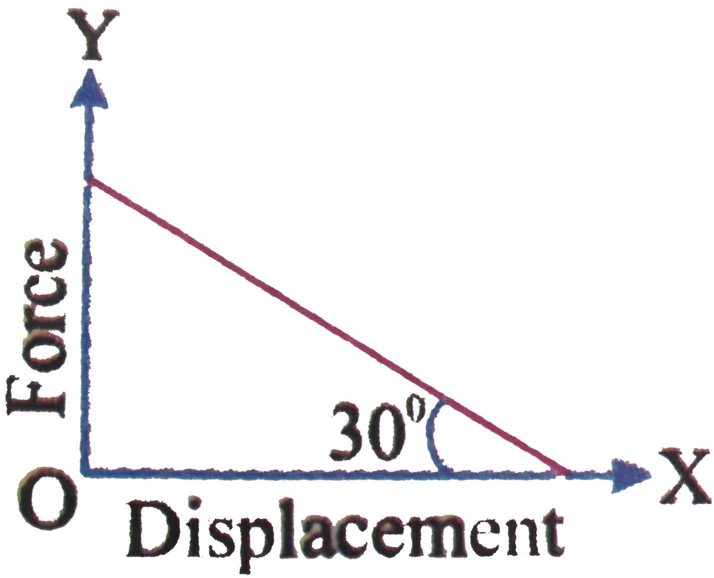
69. The value of force constant between the applied elastic force F and displacement will be



A. $\sqrt{3}$

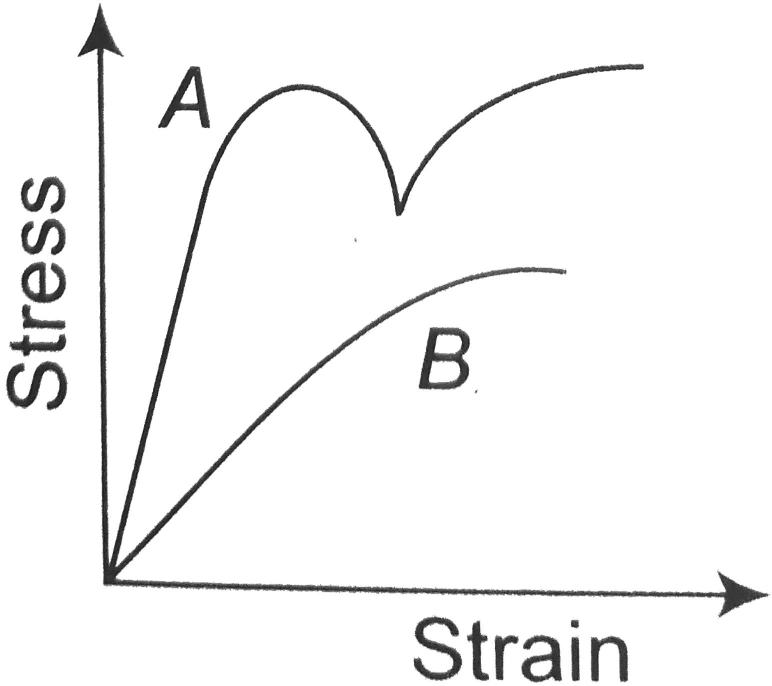
B. $\frac{1}{\sqrt{3}}$

C. $\frac{1}{2}$

D. $\frac{\sqrt{3}}{2}$

Answer: B

Watch Video Solution



70.

The diagram shoes stress v/s strain curve for the materials A and B. From the curves we infer that

A. A is brittle but B is ductie

B. A is ductile and B is britte

C. both A and B are ductile

D. both A and B are brittle

Answer: B

Watch Video Solution

71. What happens to the elastic property of a substance after annealing (cooling slowly after heating)

A. increases

B. decreases

C. remains constant

D. become zero

Answer: B

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72. If a metal wire of length L, having area of cross-section A and Young's modulus Y, behaves as a spring constant K. The value of K is

A. $\frac{YA}{L}$

B. $\frac{YA}{2L}$

C. $\frac{2YA}{L}$

D. $\frac{YL}{A}$

Answer: A

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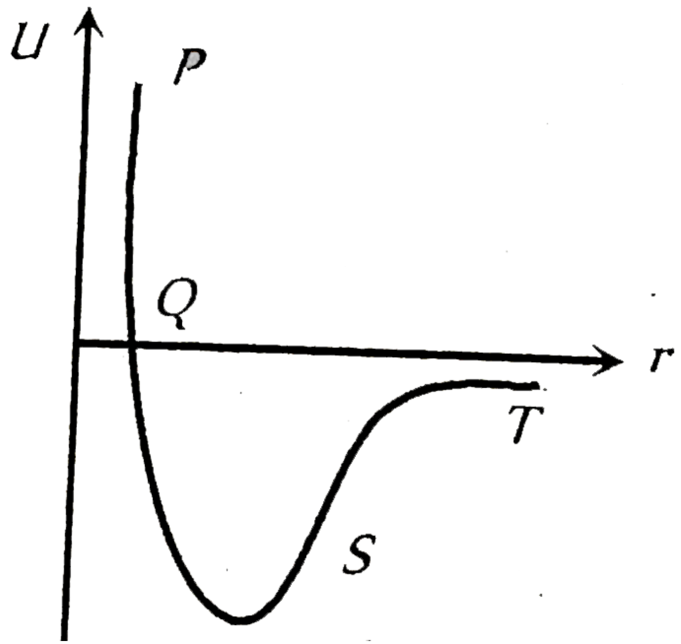
73. the points of maximum and minimum attraction in the curve between potential energy (U) and distance (r) of a diatomic molecules aree respectively.



A. S and R

B. T and R

C. R and S

D. S and T

Answer: D

Watch Video Solution

74. The linear strain in x, y and z direction are e_x, e_y and e_z respectively. Then the volumetric strain is givne by

A. $e_x e_y e_z$

B. $e_x + e_y + e_z$

C. $e_z = e_x e_y$

D. $e_z = \frac{e_x + e_y}{2}$

Answer: B

Watch Video Solution

LEVEL-I (C.W)

1. A $20kg$load is suspended by a wire of cross section $0.4mm^2$. The stress produced in N/m^2 is

A. 4.9×10^{-6}

B. 4.9×10^8

C. 49×10^8

D. 2.45×10^{-6}

Answer: B

Watch Video Solution

2. The length of a wire is $4m$. Its length is increased by $2mm$ when a force acts on it. The strain is

A. 0.5×10^{-3}

B. 5×10^{-3}

C. 2×10^{-3}

D. 0.05

Answer: A

Watch Video Solution

3. An air filled balloon is at a depth of $1km$ below the water level in an ocean . The normal stress of the balloon (in Pa) is

(Given,$\rho_{\text{water}} = 10^3 kgm^{-3}, g = 9.8ms^{-2}$ and $P_{atm} = 10^5 Pa)$

A. $98 \times 10^5 N/m^2$

B. $99 \times 10^5 N/m^2$

C. $98 \times 10^3 N/m^2$

D. $99 \times 10^3 N/m^2$

Answer: B

Watch Video Solution

4. In the Searle's method to determine the Young's modulus of a wire, a steel wire of length $156cm$

and diameter $0.054cm$ is taken as experinmental wire. The average increases in length for $1.5kgwt$ is found to be $0.50cm$. Then the Young's modulus of the wire is

A. $3.002 \times 10^{11} N / m^2$

B. $1.002 \times 10^{11} N / m^2$

C. $2.002 \times 10^{11} N / m^2$

D. $2.5 \times 10^{11} N / m^2$

Answer: C

Watch Video Solution

5. An elongation of 0.1% in a wire of cross-sectional $10^{-6}m^2$ casues a tension of $100N$. Y for the wire is

A. $10^{12}N/m^2$

B. $10^{11}N/m^2$

C. $10^{10}N/m^2$

D. $100N/m^2$

Answer: B

Watch Video Solution

6. The length of two wires are in the ratio $3:4$. Ratio of the determeters is $1:2$, young's modulus of the wires are in the

ratio $3:2$. If they are subjected to same tensile force, the ratio of the elogation produced is

A. $1:1$

B. $1:2$

C. $2:3$

D. $2:1$

Answer: D

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7. The ratio of diameters of two wires of same material is $n:1$. The length of each wire is $4m$. On applying the same load, the increases in the length of the thin wire will be $(n > 1)$

A. n^2 tiems

B. n times

C. $2n$ times

D. $(2n+1)$ times

Answer: A

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8. An aluminium rod has a breaking strain 0.2%. The minimum cross-sectional area of the rod in m^2 in order to support a load of $10^4 N$ is fi (Young's modulus is $7 \times 10^9 Nm^{-2}$)

A. 1.7×10^{-4}

B. 1.7×10^{-3}

C. 7.1×10^{-4}

D. 1.4×10^{-4}

Answer: C

Watch Video Solution

9. A metallic rod of radius $2cm$ and cross sectional area $4cm^2$ is fitted into a wooden circular disc of radisu $4cm$. If the Young's modulus of the materail of the ring is $2 \times 10^{11} N/m^2$, the force with which the metal ring expands is:

A. $2 \times 10^7 N$

B. $8 \times 10^7 N$

C. $4 \times 10^7 N$

D. $6 \times 10^7 N$

Answer: B

Watch Video Solution

10. The length of a metal wire is $10cm$ when the tension in it is $20N$ and $12cm$ when the tension is $40N$. Then natural length of the wire is in cm

A. 6

B. 4

C. 8

D. 9

Answer: C

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11. A solid sphere hung at the lower end of a wier is suspended from a fixed point so as to give an elongation of $0.4mm$. When the first solid sphere is replaced by another one made of same material but twice the radius, the new elongation is

A. $0.8mm$

B. $1.6mm$

C. $3.2mm$

D. $1.2mm$

Answer: C

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12. The extension of a wire by application of load is $0.3cm$. The extension in a wire of same material but of double the length and half the radius of cross section by the same load will be in (cm)

A. 0.3

B. 0.6

C. 0.2

D. 2.4

Answer: D

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13. Two steel wires have equal volumes. Their diameters are in the ratio $2:1$. When the same force is applied on them, the elongation produced will be in the ratio of

A. $1:8$

B. $8:1$

C. $1:16$

D. $16 : 1$

Answer: C

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14. An iron wire an copper wire having same length and cross-section are suspended form same roof Young's modulus of copper is $1/3rd$ that of iron. Then the ratio of the weighs to be added at their ends so that their ends are at the same level is

A. $1 : 3$

B. $1 : 9$

C. $3 : 1$

D. $9 : 1$

Answer: C

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15. A steel wire of unifrom cross-section $1mm^2$ is heated to $70^\circ C$ and strechted by tying it two ends rigidly. Calculate the change in tension on the wire when temperature falls form $70^\circ C$ to $35^\circ C$

A. $70N$

B. $72N$

C. $74N$

D. $77N$

Answer: D

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16. A wire elongastes by 1.0 mm when a load W ils hung from it. If this wire goes over a pulley and two weights W each are hung at the two ends the elongation of the wire will be

A. zero

B. $l/2$

C. l

D. $2l$

Answer: C

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17. A wire is made of a material of density $10g/cm^3$ and breaking stress $5 \times 10^9 Nm^{-2}$. If `g = 10ms^(-2) the length of the wire that will break under its own weight when suspended vertically is

A. $2 \times 10^4 m$

B. $3 \times 10^4 m$

C. $4 \times 10^4 m$

D. $5 \times 10^4 m$

Answer: D

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18. A metal cube of side length $8.0 cm$ has its upper surface displacement with respect to the bottom by $0.10 mm$ when a tangential force of $4 \times 10^9 N$ is applied at the top with bottom surface fixed. The rigidity modulus of the material of the cube is

A. $4 \times 10^{14} N/m^2$

B. $5 \times 10^{14} N/m^2$

C. $8 \times 10^{14} N / m^2$

D. $1 \times 10^{14} N / m^2$

Answer: B

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19. 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. 0.12°

B. 1.2°

C. 12^2

D. 0.012°

Answer: A

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20. A ball falling in a lake of depth $200m$ shows a decrease of 0.1% in its volume at the bottom. The bulk modulus of elasticity of the material of the ball is (take $g = 10ms^{-2}$)

A. $19.6 \times 10^{8} N/m^{2}$

B. $19.6 \times 10^{-10} N/m^{2}$

C. $19.6 \times 10^{10} N/m^{2}$

D. $19.6 \times 10^{-8} N/m^{2}$

Answer: A

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21. A hydraulic press contains $0.25m^3(250L)$ of oil. Find the decrease in volume of the oil when it is subjected to a pressure increase $\triangle p = 1.6 \times 10^7 Pa$. The bulk modulus of the oil is $B = 5.0 \times 10^9 Pa$.

A. $-0.8lit$

B. $-0.5lit$

C. $-0.6lit$

D. $-0.9lit$

Answer: B

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22. A material has normal density ρ and bulk modulus K. The increase in the density of the material when it is subjected to an external pressure P from all sides is

A. $\frac{p}{\rho K}$

B. $\frac{KP}{\rho}$

C. $\frac{P\rho}{K}$

D. $\frac{K\rho}{P}$

Answer: C

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23. The stress required to double the length of wire (r) to produce 100% longitudinal strain is

A. Y

B. $\frac{Y}{2}$

C. $2Y$

D. $3Y$

Answer: A

Watch Video Solution

24. A $3cm$ long copper wire is strechted to increases its length by $.3cm$. Find the laterial strain in the wire, if the possion's ratio for copper is 0.26

A. 0.013

B. 0.018

C. 0.026

D. 0.016

Answer: C

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Watch Video Solution

25. A unifrom bar of Length $'L'$ and cross sectional area $'A'$ is subjected to a tesnile load $'F'$, $'Y'$ be the Young's modulus and $'\sigma'$ be the Poisson's ratio then volumeteric strain is

A. $\frac{F}{AY}(1-\sigma)$

B. $\frac{F}{AY}(2-\sigma)$

C. $\frac{F}{AY}(1-2\sigma)$

D. $\frac{F}{AY}\sigma$

Answer: C

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26. A rod has Poisson's ratio 0.2. If a rod suffers a longtudinal strain of 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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27. A metallic rod undergoes a strain of 0.5% . The energy stroed per unit volume is

A. $0.5 \times 10^4 Jm^{-3}$

B. $0.5 \times 10^5 Jm^{-3}$

C. $2.5 \times 10^5 Jm^{-3}$

D. $2.5 \times 10^4 Jm^{-3}$

Answer: D

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28. A brass rod of cross sectional area $1cm^2$ and length $0.2m$ is compressed lengthwise by a weight of $5kg$. If Young's modulus of elasticity of brass is $1 \times 10^{11} \frac{N}{m^2}$ and $g = 10 \frac{m}{\sec^2}$ Then increase in the energy of the ro will be

A. increases by $2.4 \times 10^{-5} J$

B. decreases by $2.4 \times 10^{-5} J$

C. increases by $2.4 \times 10^{7} J$

D. increases by $2.4 \times 10^{7} J$

Answer: A

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29. A uniform wire of length $4m$ and area of cross section but with lengths in the ratio $5:3$ are strechted by the same force. The ratio of work done in two cases is

A. $0.5J$

B. $0.05J$

C. $0.005J$

D. $5.0J$

Answer: C

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30. Two wires of same material and area of cross section but with lengths in the ratio $5:3$ are strechted by the same force. The

ratio of work done in two cases is

A. $5:8$

B. $8:5$

C. $5:3$

D. $3:5$

Answer: C

Watch Video Solution

31. An elastic spring of unstretched length L and force constant K is stretched by amoun t x .It is further stretched by another length y The work done in the second streaching is

A. $\frac{1}{2}Ky^2$

B. $\frac{1}{2}K(x^2+y^2)$

C. $\frac{1}{2}Ky(2x+y)$

D. $\frac{1}{2}K(x+y)^2$

Answer: C

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32. A spring of spring constant $5 \times 10^3 N/m$ is stretched initially by 5 cm from the unstretched position. The work required to further stretch the spring by another 5 cm is .

A. $6.25Nm$

B. $12.50Nm$

C. $18.75Nm$

D. $25.00Nm$

Answer: C

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33. Young's modulus of a metal is $15 \times 10^{11} Pa$. If its Poisson's ratio is 0.4. The bulk modulus of the metal in Pa is

A. 25×10^{11}

B. 2.5×10^{11}

C. 250×10^{11}

D. 0.25×10^{11}

Answer: A

Watch Video Solution

34. Y, K, η represent the Young's modulus, bulk modulus and rigidily modulus for a body respectively. If rigidity modulus is twice the Bulk Modulus, then,

A. $Y = 5K/18$

B. $Y = 5\eta/9$

C. $Y = 9K/5$

D. $Y = 18K/5$

Answer: D

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35. For a given material the Young's modulus is 2.4 times that of its rigidity modulus. Its Possion's ratio is

A. 2.4

B. 1.2

C. 0.4

D. 0.2

Answer: D

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36. For a material $Y = 6.6 \times 10^{10} Nm^2$ and bulk modulus $K = 11 \times 10^{10} N/m^2$, then its Poisson's ratio is

A. 0.8

B. 0.35

C. 0.7

D. 0.4

Answer: D

Watch Video Solution

37. If the Possion's ratio of a solid is $2/5$, then the ratio of its young's modulus to the rigidity modulus is

A. $5/4$

B. $7/15$

C. $14/9$

D. $14/5$

Answer: D

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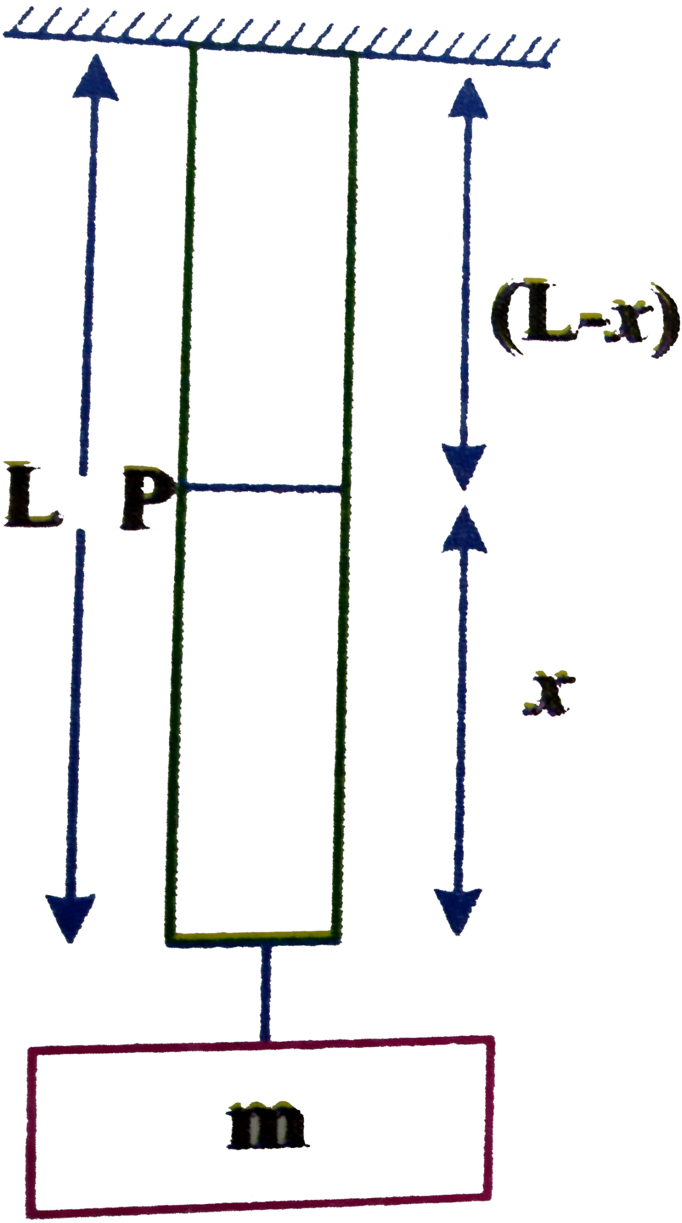
LEVEL-II (C.W)

1. One end of a uniform wire of length $'L'$ and mass $'M'$ is attached rigidly to a point in the roof and a load of a mass $'m'$ is suspended from its lower end. If A is the area of cross-section of the wire then the stress in the wire at height $'x'$ from its lower end $(x < L)$ is



A. $\dfrac{Mg}{A} + \dfrac{mxg}{AL}$

B. $\frac{mg}{A} - \frac{Mxg}{AL}$

C. $\frac{mg}{A} + \frac{Mxg}{AL}$

D. $\frac{mg}{AL} + \frac{Mxg}{A}$

Answer: C

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2. A load of $4kg$ is suspended from a ceiling through a steel wire of length $20m$ and radius $2mm$. It is found that the length of the wire increases by $0.031mm$, as equilibrium is achieved. If $g = 3.1 \times \pi\, ms^{-2}$, the value of young's modulus of the material of the wire (in Nm^{-2}) is

A. 2.0×10^{12}

B. 4.0×10^{11}

C. 2.0×10^{11}

D. 0.02×10^{9}

Answer: A

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3. 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 $= 1.1 \times 10^{1} Nm^{-2}$

A. $20 : 11$

B. $11 : 20$

C. $5:4$

D. $4:5$

Answer: A

Watch Video Solution

4. If young's modulus of iron be $2 \times 10^{11} Nm^{-2}$ and interatomic distance be $3 \times 10^{-10} m^{-2}$, the intertomic force constant will be (in N/m)

A. 60

B. 120

C. 30

D. 180

Answer: A

Watch Video Solution

5. Two wires A and B of the same dimensions are under loads of $4kg$ and $5.5kg$ respectively. The ratio of Young's moduili of the materials of the wire for the same elongation is

A. $64:121$

B. $\sqrt{11}:\sqrt{8}$

C. $11:8$

D. $8:11$

Answer: D

Watch Video Solution

6. A load of $1kg$ weight is attacheed to one end of a steel wire of cross sectional area $3mm^2$ and Young's modulus $10^{11}N/m^2$. The other end is suspended vertically form a hook on a wall, then load is pulled horizonatally and relased. When the load passes through its lowest position the fractional change in length is $(g = 10m/s^2)$

A. 10^{-4}

B. 10^{-3}

C. 10^3

D. 10^4

Answer: A

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7. The radii and Young's moduli of two uniform wires A and B are in the ratio $2:1$ and $1:2$ respectively. Both wires are subjected to the same longitudinal force. If the increase in leangth of the wire A is one percent, the percentage increae in length of the wire B is

A. 1

B. $1:5$

C. 2

D. 3

Answer: C

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8. 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 $2.0 \times 10^{11} Pa.$

A. 2.78×10^{-6}

B. 3.78×10^{-6}

C. 2.78×10^{-4}

D. 3.78×10^{-4}

Answer: A

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9. A wire of length $1m$ and radius $1mm$ is subjected to a load. The extension is x.The wire is melted and then drawn into a wire of square cross - section of side $2mm$ Its extension under the same load will be

A. $\pi^2 x$

B. πx^2

C. πx

D. π / x

Answer: A

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10. 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. $20 / 7$

B. $400/9$

C. $7/20$

D. $49/400$

Answer: C

Watch Video Solution

11. What percent of length of a wire will increses by applying a stress fo $1kg. Wt/mm^2$ on it.

$[Y = 1 \times 10^{11} Nm^{-2} \text{and} 1 kgwt = 9.8N]$

A. 0.0078%

B. 0.0088%

C. 0.0098%

D. 0.0067%

Answer: C

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12. A lift is tied with thick iron wire and its mass is $1000kg$. If the maximum acceleration of the lift is $1.2ms^2$ and the maximum stress of the wire is $1.4 \times 10^8 Nm^2$ what should be the minimum diameter of the wire?

A. $10^{-2}m$

B. $10^{-4}m$

C. $10^{-6}m$

D. $0.5 \times 10^{-2}m$

Answer: A

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13. Two wires are made of the same material and have the same volume. However wire 1 has cross-sectional area A and wire 2 has cross-sectional area 3A. If the length of wire 1 increases by Δx on applying force F, how much force is needed to stretch wire 2 by the same amount?

A. F

B. $4F$

C. $6F$

D. $9F$

Answer: D

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14. An aluminum wire and a steel wire of the same length and cross-section are joined end to end. The compoiste wire is hung from a rigid support and a load is suspended from the free end. If the length of the composite wire is $2.7mm$ then the increases in the length of wire is (in mm)

$(Y_{Al} = 2 \times 10^{11} Nm^2, Y_{\text{Steel}} = 7 \times 10^{11} Nm^{-2})$

A. $1.7, 1$

B. $1.3, 4$

C. $1.5, 1.2$

D. $2.1, 0.6$

Answer: D

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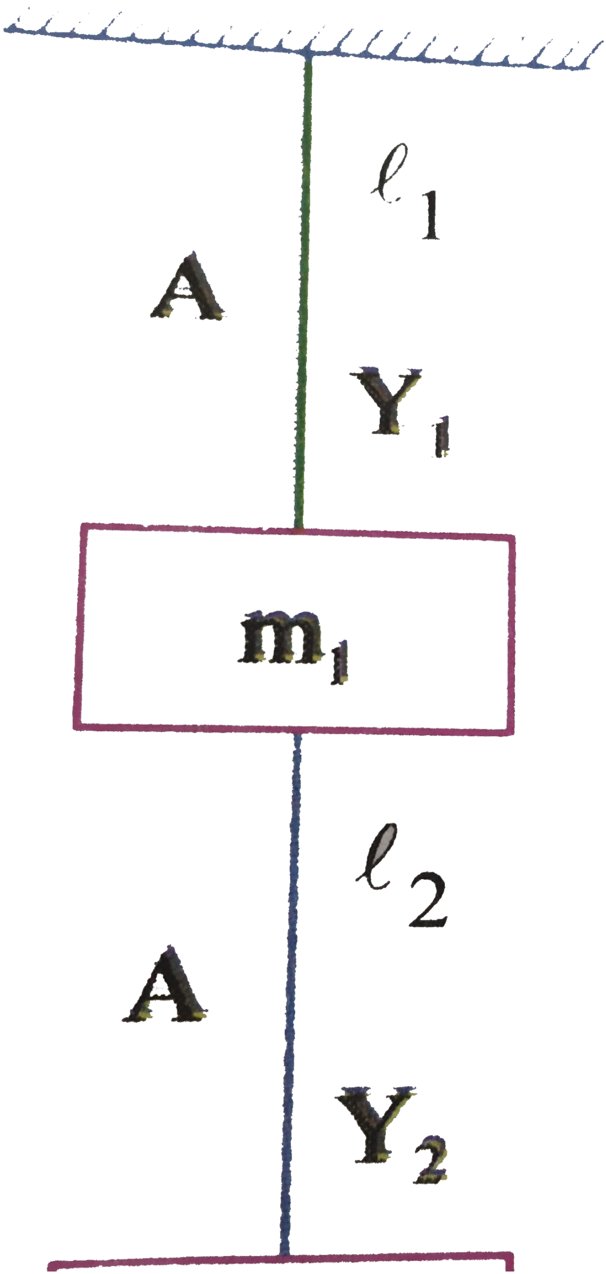
15. Two wires are arranged as shown in the figure. The elongation in upper and lower wire are respectively



A. $\frac{(m_1+m_2)gl_1}{AY_1}, \frac{m_2gl_2}{AY_2}$

B. $\frac{(m_1-m_2)gl_1}{AY_1}, \frac{m_2gl_2}{AY_2}$

C. $\frac{\left(\frac{m_1}{m_2}+1\right)gl_1}{AY_1}, \frac{m_2gl_2}{AY_2}$

D. $\frac{\left(\frac{m_1}{m_2}-1\right)gl_1}{AY_1}, \frac{m_2gl_2}{AY_2}$

Answer: A

Watch Video Solution

16. Calculate the force $'F'$ needed to punch a $1.46cm$ diameter hole in a steel plate $1.27cm$ thick. The ultimate shear strength of steel s $345MN/m^2$ (Approx).

A. $300KN$

B. $400KN$

C. $200KN$

D. $100KN$

Answer: C

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17. A block of weight $15N$ slides on a horizontal table the co-efficient of siliding fricition is 0.4. The area of the block in contact with the table is $0.5m^2$. The shearing stress will be

A. $120Nm^{-2}$

B. $140Nm^{-2}$

C. $160Nm^{-2}$

D. $180Nm^{-2}$

Answer: A

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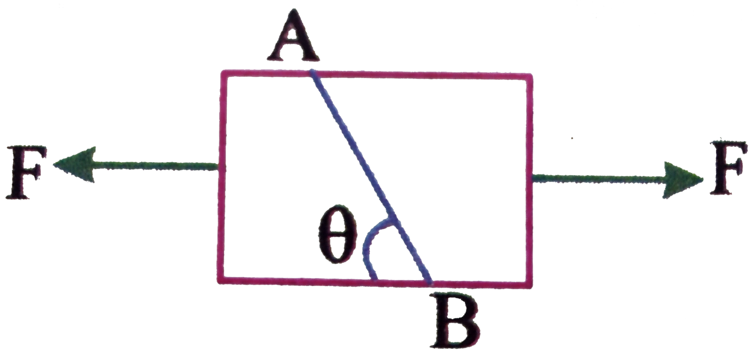
18. Two equal and opposite forces F and $-F$ act on a rod of unifrom cross-sectional ara A, as shown in the figure. Find the (i) shearing (ii) longitual stress on the section AB.



A. $\dfrac{F\sin x\cos x}{A}$

B. $\dfrac{F\sin x}{A}$

C. $\frac{F \cos x}{A}$

D. $\frac{F \sin^2 x}{A}$

Answer: A

Watch Video Solution

19. A cubical ball is taken to a depth in volume observed to be 0.1% the bulk modulus of the ball is $\left(g = 10m/s^2\right)$

A. $2 \times 10^7 Pa$

B. $2 \times 10^6 Pa$

C. $2 \times 10^9 Pa$

D. $1.2 \times 10^9 Pa$

Answer: C

Watch Video Solution

20. Compressibility of water is $5 \times 10^{-10} m^2 / N$. Find the decrease in volume of $100 mL$ of water when subjected to a pressure of $15 MPa$.

A. 7.5×10^{-3}

B. 5×10^{-3}

C. 2.5×10^{-3}

D. 1.25×10^{-3}

Answer: A

21. 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

A. $0\,\%$

B. $10\,\%$

C. $20\,\%$

D. $5\,\%$

Answer: A

Watch Video Solution

22. A steel wire of mass $3.16kg$ is streached to a tensite strain of 1×10^{-3}. What is the elastic deforemaiton energy if density $\rho = 7.9g/$ and $Y = 2 \times 10^{11} N/m^2$

A. $4KJ$

B. $0.4KJ$

C. $0.04KJ$

D. $4J$

Answer: C

Watch Video Solution

23. A brass wire of cross-sectional area $2mm^2$ is suspended from a rigid support and a body of volume $100cm^2$ is attached to its other end. If the decrases in the length of the wire is $0.11mm$, when the body is completely immersed in water, find the natural length of the wire.

A. $20.43m$

B. $10.43m$

C. $40.43m$

D. $30.43m$

Answer: A

Watch Video Solution

24. The young's modulus of the material of a rod is 20×10^{10} pascal. When the longitudal strain is 0.04%. The energy stored per unit volume is

A. $4 \times 10^{-3} J/m^3$

B. $8 \times 10^3 J/m^3$

C. $16 \times 10^{-3} J/m^3$

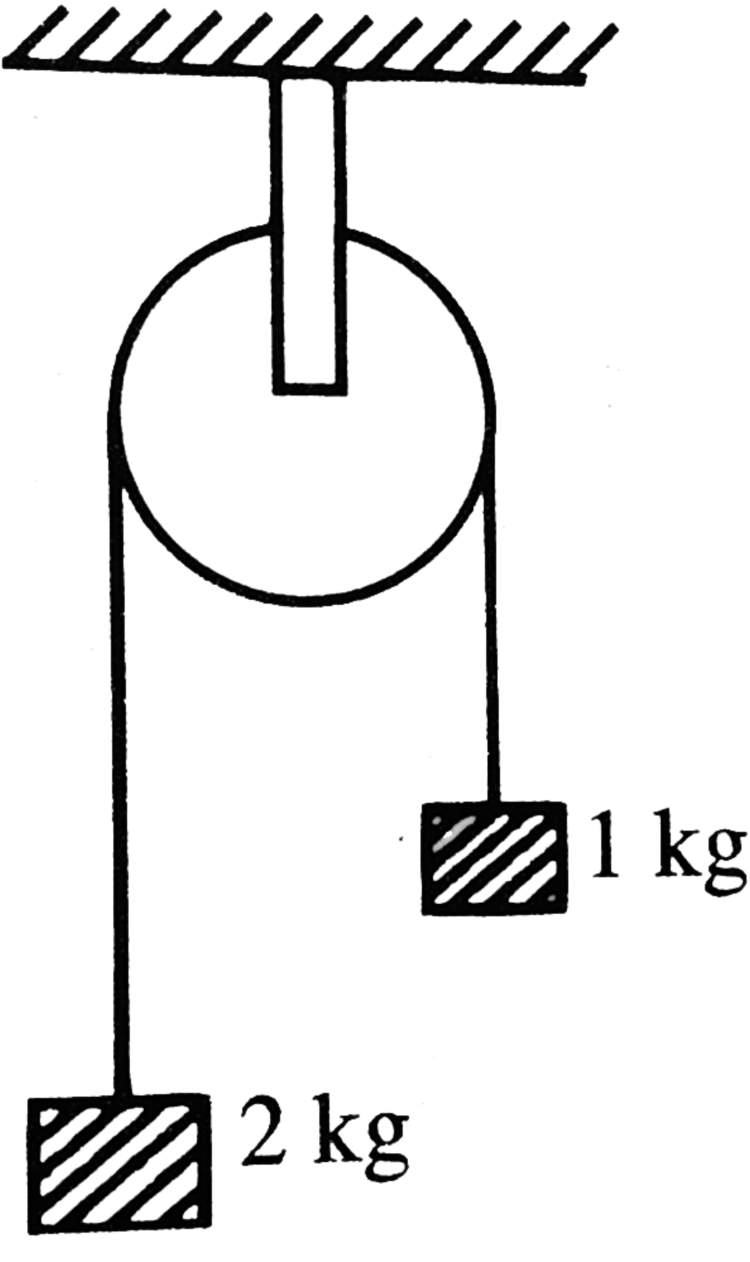
D. $16 \times 10^3 J/m^3$

Answer: D

Watch Video Solution

25. Two blocks of masses $1kg$ and $2kg$ are connected by a metal wire going over a smooth pulley as shown in figure.

The breaking stress of the metal is $(40/3\pi) \times 10^6 N/m^2$. If $g = 10ms^{-2}$, then what should be the minimum radius of the wire used if it is not to break?



A. $0.5mm$

B. $1mm$

C. $1.5mm$

D. $2mm$

Answer: B

Watch Video Solution

26. A copper wire of cross sectional asrea 0.01 cm is under a tension of 20 N. Find the decrease in the cross sectional area. Young modulus of copper $= 1.1 \times 10^{11} Nm^{-2}$ and Poisson ratio 0.32.

A. $1.28 \times 10^{-6} cm^2$

B. $1.6 \times 10^{-6} cm^2$

C. $2.56 \times 10^{-6} cm^2$

D. $0.64 \times 10^{-6} cm^2$

Answer: A

Watch Video Solution

27. An Aluminum and Copper wire of same cross sectional area but having lengths in the ratio $2:3$ are joined end to end. This composite wire is hung form a rigid support and a load is suspended form the free end. If the increases in length of the composite wire is $2.1mm$ the increses in lenghts of Aluminimum and Copper wirs are

A. $0.7mm, 1.4mm$

B. $0.9mm, 1.2mm$

C. $1.0mm, 1.1mm$

D. $1.6mm, 1.5mm$

Answer: D

Watch Video Solution

28. A copper wire and a steel wire of the same length and same cross-section are joined end to end to form a composite wire. The composite wire is hung form a rigid support and a load is suspended form the other end. If the increses in length of the composite wire is $2.4mm$. then the increases in lenghts of steel and copper wires are

A. $0.1mm, 2.0mm$

B. $1.2mm, 1.2mm$

C. $0.6mm, 1.8mm$

D. $0.8mm, 1.6mm$

Answer: D

Watch Video Solution

29. Force constant of two wires A and B of the same material are K and $2K$ respectively. If the two wires are strechted equally, then the ratio of work done in streching $\left(\frac{W_A}{W_B}\right)$ is

A. $\frac{1}{3}$

B. $\frac{1}{2}$

C. $\frac{3}{2}$

D. $\frac{1}{4}$

Answer: B

Watch Video Solution

30. Two wires of same material and length but diameters in the ratio $1:2$ are streached by the same force, the elastic potential energy per unit volume for the two wires then strechted by the same force will be in the ratio

A. $16:1$

B. $1:1$

C. $1:4$

D. $4:1$

Answer: A

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31. A $4m$ long copper wire of cross sectional are a$1.2cm^2$ is strechted by a force of $4.8 \times 10^3 N$.

if Young's modulus for copper is $Y = 1.2 \times 10^{11} M / m^2$, the increases in length of wire and strain energy per unit volume are

A. $1.32 \times 10^{-4} m, 66 \times 10^3 J$

B. $132 \times 10^{-4} m, 66 \times 10^2 J$

C. $1.32 \times 10^{-4} m, 6.6 \times 10^3 J$

D. $0.132 \times 10^{-4} m, 66 \times 10^4 J$

Answer: C

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32. When a wire subjected to a froce along its length, its length increases by 0.4% and its radius decreases by 0.2% then the

Poisson's ratio of the material of the wire is

A. 0.8

B. 0.5

C. 0.2

D. 0.1

Answer: B

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LEVEL-III

1. A wire of length $1m$ fixed at one end has a sphere attached to it at the other end. The sphere is projected hroizonatally with a veloicity of $\sqrt{9g}$. When it decribes a vertical circle the ratio of elongations of the wire when the sphere is at top and bottom of the circle is

A. $2:5$

B. $5:2$

C. $3:5$

D. $5:3$

Answer: A

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2. A bob of mass $10kg$ is attached to a wire $0.3m$ long. Its breaking stress is $4.8 \times 10^7 N/m^2$. Then area of cross-section of the wire is $10^{-6}m^2$. What is the maximum angular velocity with which it can be rotated in a horizontal circle?

A. $2\text{rad} / s$

B. $4\text{rad} / s$

C. $6\text{rad} / s$

D. $8\text{rad} / s$

Answer: B

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3. A mass $'m' kg$ is whirled in a verticle plane by tying it at the end of a flexible wire of length $'L'$ and area of cross-section $'A'$ such that it just completes the verticle circle. When the mass is a its lowest positon, the strain produced in the wire is (Young's modulus of the wire is $'Y'$)

A. $AY / 6mg$

B. $6mg / AY$

C. $5mg / Ay$

D. $AY / 5mg$

Answer: B

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4. When a mass is suspended from the end of wire the top end of which is attached to the roof of the lift, the extension is $'e'$ when the lift is stationary . If the lift moves up with constant acceleartion $g / 2$ the extension of the wire would be

A. $\frac{2e}{3}$

B. $\frac{3e}{2}$

C. $2e$

D. $3e$

Answer: B

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5. A block of mass $1Kg$ is fastened to one each of a wire of cross-sectional area of $2mm^2$ and is rotated in verticle circle of radius $20cm$. The speed of the block at the bottom of the circle is $3.5ms^{-1}$. The elongation of the wire when the block is at top of the circle

A. $0.6125 \times 10^{-5}m$

B. $0.6125 \times 10^{-4}m$

C. $0.6125 \times 10^{-3}m$

D. $0.6125 \times 10^{-2}m$

Answer: A

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6. As shown in adjacent figure if a load of mass (m) is attached at lower end of wire. Then find the displacement of the points B, C and D are as shwon in figure.

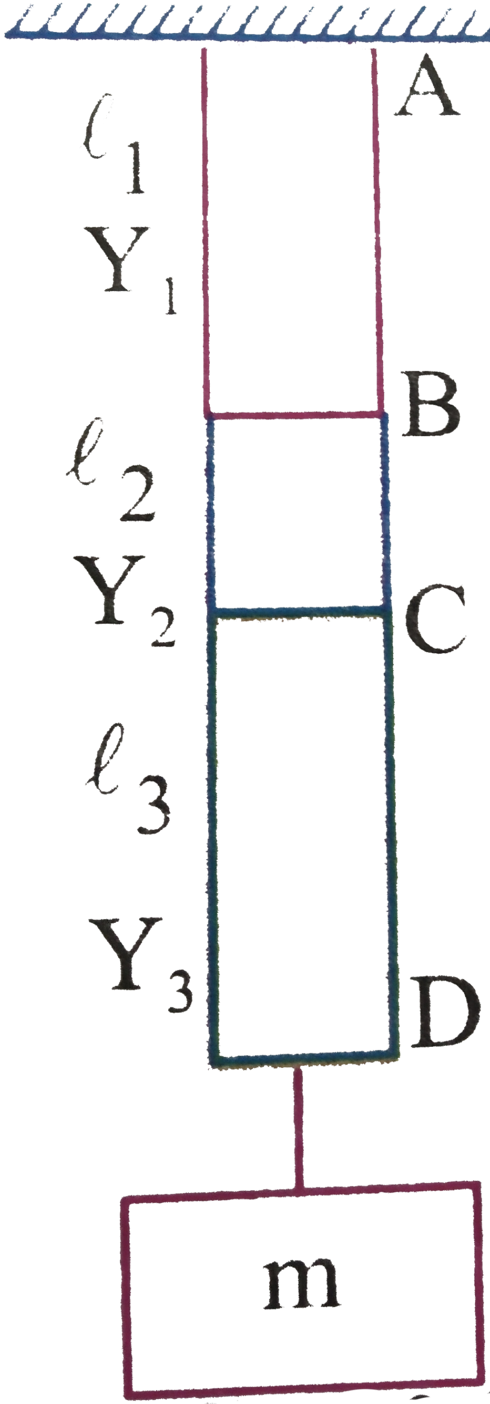
(i) elongation of first wire $e_1 = \frac{(mg)l_1}{AY_1}$

(ii) elongation of $2nd$ wire

$$e_2 = \frac{(mg)l_2}{AY_2} + \frac{(mg)l_1}{AY_1}$$

(iii) elongation of $3rd$ wire

$$e_3 = \frac{(mg)l_3}{AY_3} + \frac{(mg)l_2}{AY_2} + \frac{(mg)l_1}{AY_1}$$



A
ℓ_1
Y_1
B
ℓ_2
Y_2
C
ℓ_3
Y_3
D
m

A. (i) is correct

B. (i)&(ii) is correct

C. (iii) is correct

D. All are correct.

Answer: D

View Text Solution

7. A copper wire of negligilble mas, length (l) and cross-sectional area (A) is kept on a smooth horizontal table with one end fixed, a ball of mass $'m'$ is attached at the other end. The wire and the ball are rotated with angular velocity $'\omega'$. If wire elongates by Δl then the Young's modulus of wire and if on incresing the angular velocity from ω to ω^1 when the wire breaks-down, then the brekaing stress $(\Delta l < \ < l)$ are respectivley.

A. $\frac{(ml^2\omega^2)}{A\Delta l}, \frac{ml\omega^2}{A}$

B. $\frac{ml}{A\Delta l\omega^2}, \frac{ml\omega^2}{A}$

C. $\frac{ml\omega^2}{A\Delta l}, \frac{m\omega^2}{Al}$

D. $\frac{ml\omega^2}{A\Delta l}, \frac{ml\omega^2}{Al}$

Answer: A

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8. A stone of mass m tied to one end of a wire of length L. the diameter of the wire is D and it is suspended vertically. The stone is now rotated in a horizontal plane and makes an angle 6 with the vertical. If Young's modulus of the wire is Y, Then the increase in the length of the wire is

A. $\frac{mgl\cos\theta}{AY}$

B. $\frac{mgl}{AY \cos \theta}$

C. $\frac{mglY}{A \cos \theta}$

D. $\frac{mglA}{Y \cos \theta}$

Answer: B

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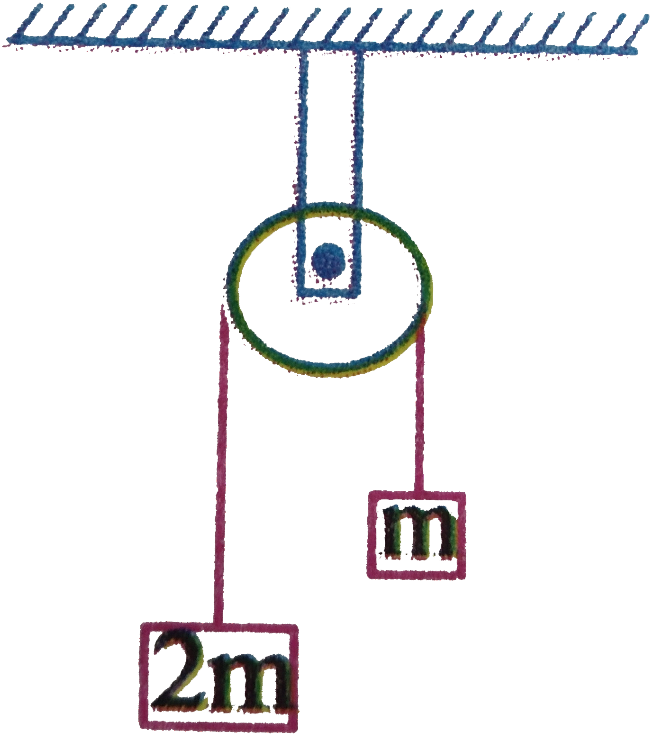
9. Two blocks of masses m and $2m$ are connected through a wire fo breakig stress S passing over a frictionless pulley. The maximum radius of the wire to be used so that the wire may not break is



A. $\sqrt{\frac{3}{4}\frac{mg}{\pi S}}$

B. $\sqrt{\frac{4}{3}\frac{mg}{S}}$

C. $\sqrt{\frac{4}{3}\frac{3g}{\pi S}}$

D. $\sqrt{\frac{1}{2}\frac{mg}{\pi S}}$

Answer: C

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10. One end of a long metallic wire of length (L) is tied to the ceiling. The other end is tied to a massless spring of spring constant . (K.A) mass (m) hangs freely from the free end of the spring. The area of cross- section and the Young's modulus of the wire are (A) and (Y) respectively. If the mass is slightly pulled down and released, it will oscillate with a time period (T) equal to :

A. $2\pi\sqrt{\frac{m}{K}}$

B. $2\pi\sqrt{\frac{mYA}{KL}}$

C. $2\pi\sqrt{\frac{mK}{KL}}$

D. $2\pi\sqrt{\frac{m(KL+YA)}{KLA}}$

Answer: D

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11. A wire of cross section A is stretched horizontally between two clamps located $2lm$ apart. A weight Wkg is suspended from the mid-point of the wire. If the mid-point sags vertically through a distance $x < l$, the strain produced is

A. $\frac{2x^2}{l^2}$

B. $\frac{x^2}{l^2}$

C. $\frac{x^2}{2l^2}$

D. $\frac{x}{2l^2}$

Answer: C

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12. If in the above question the Young's modulus of the material is Y, the value of extension x is:

A. $\left(\frac{Wl}{YA}\right)^{1/3}$

B. $\left(\frac{YA}{Wl}\right)^{1/3}$

C. $\frac{l}{l}\left(\frac{WA}{Y}\right)^{1/3}$

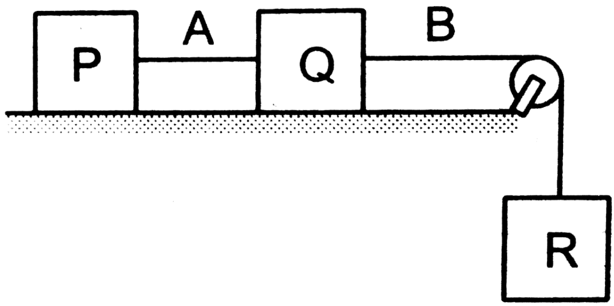
D. $l\left(\frac{W}{YA}\right)^{1/3}$

Answer: D

Watch Video Solution

13. Each of the three blocks P, Q and R shown in figure has a mass of 3 kg. Easch of the wires A and B has cross sectional area 0.005 cm^2 and Young modulus $2x10^{11}Nm^{-2}$. Neglect friction. Find the longitudinal strain developed ineach of the wires. Take

$g = 10ms^{-2}$



A. 500

B. 1000

C. 2000

D. 3000

Answer: B

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14. A sphere of radius $0.1m$ and mass $8\pi\ kg$ is attached to the lower end of a steel wire of length $5.0m$ and diameter $10^{-3}m$. The wire is suspended from $5.22m$ high ceiling of a room . When the sphere is made to swing as a simple pendulum, it just grazes the floor at its lowest point. Calculate the velocity of the sphere at the lowest position . Young's modulus of steel is $\left(1.994 \times 10^{11} N/m^2\right)$.

A. $7.5ms$

B. $8.2ms$

C. $8.8ms^{-1}$

D. $6.5ms^{-1}$

Answer: C

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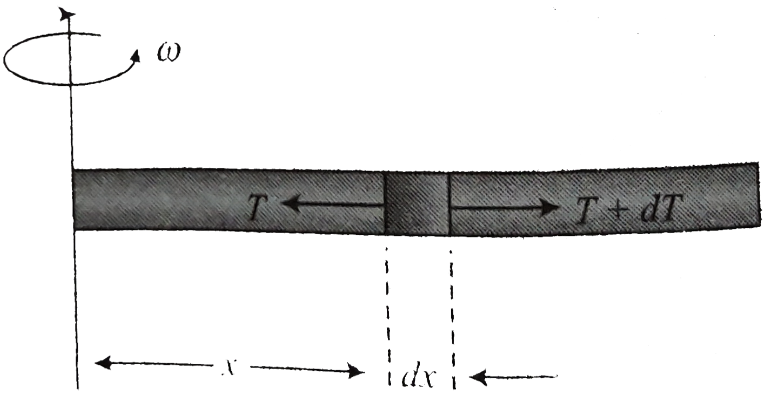
15. A thin uniform rod of length l and masses m rotates uniformly with an angularly velocity ω in a horizontal plane about a verticle axis passing through one of its ends determine the tension in the rot as a funtion of the distance x from the rotation axis



A. $\frac{1}{2}ML\omega^2$

B. $\frac{1}{4}ML\omega^2$

C. $\frac{1}{8}ML\omega^2$

D. $\frac{3}{8}ML\omega^2$

Answer: D

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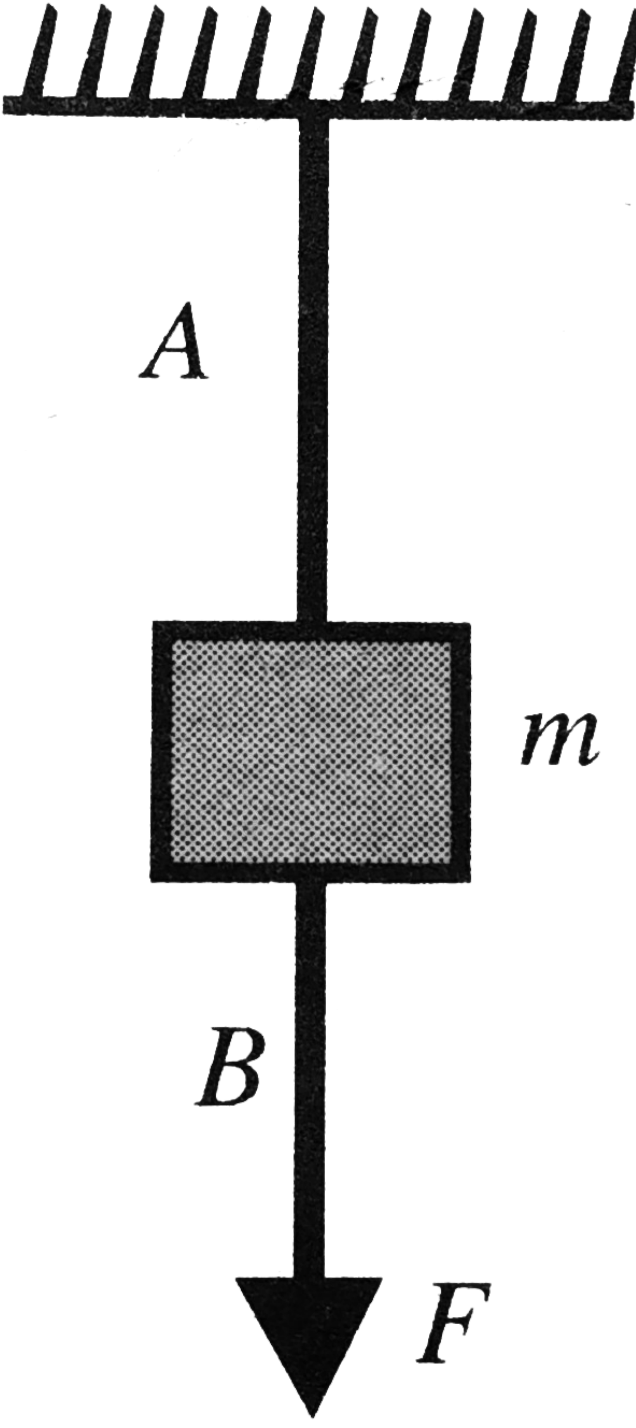
16. The wires A and B shown in Fig. are made of the same material and have radii r_A and r_B, respectively. The block between them has a mass m. When the force F is $mg/3$, one of the wires breaks. Then


A
m
B
F

A. for $r_1 = r_2$, 2 should be broken before 1.

B. for r_1 less than $2r_2$, 2 should be broken before 1

C. data is indufiicent

D. for $r_1 = 2r_2$, any of the two may break

Answer: D

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17. A wire of radius r, Young's modulus Y and length l is hung from a fizxed point and support a heavty metal cycliner of volume V at its own lowest end. The change in length of the wire when cyclinder is immersed in a liquid of density ρ, is in fact

A. decreases by $\frac{Vl\rho g}{Y\pi r^2}$

B. increses by $\frac{Vr\rho g}{Y\pi l^2}$

C. decreaes by $\frac{V\rho g}{Y\pi r}$

D. increaes by $\frac{V\rho g}{\pi r l}$

Answer: A

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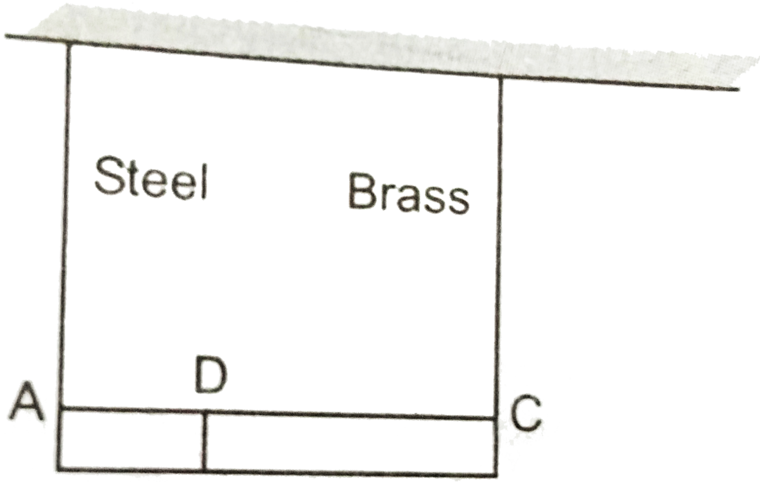
18. A light rod AC of length 2.00 m is suspended from the ceiling horizontally by means of two vertical wires of equal length tied to its ends. One of the wires is made of steel and is of cross-section $10^{-3}m^2$ and the other is of brass of cross-section $2 \times 10^{-3}m^2$. The position of point 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. $1.33m, 1m$

B. $1m, 1.33m$

C. $1.5m, 1.33m$

D. $1.33m, 1.5m$

Answer: A

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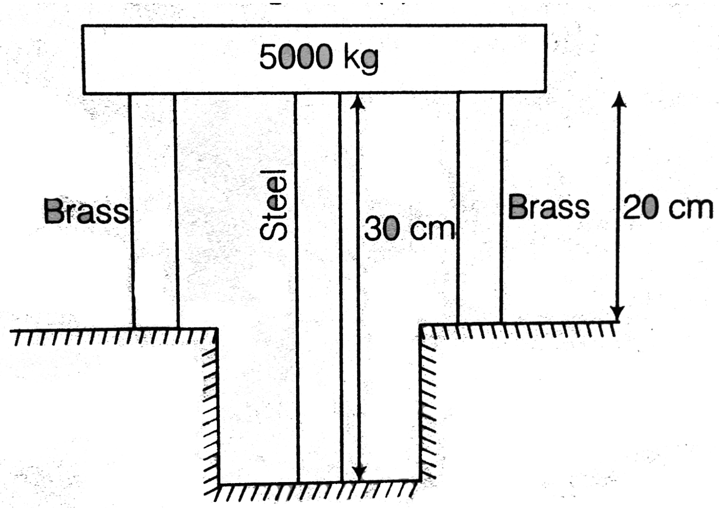
19. A steel rod of cross-sectional area $16cm^2$ and two brass rods each of cross-sectional area $10cm^2$ together support a load of $5000kg$ as shown in the figure. (Given, $Y_{steel} = 2 \times 10^6 kgcm^{-2}$ and $Y_{brass} = 10^6 kgcm^{-2}$). Choose the correct option(s).



A. $120, 161$

B. $161, 120$

C. $120, 140$

D. $141, 120$

Answer: A

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20. If the ratio of lenghts, radi and Young's moduli of steel and brass wires are a, b and c respectively their respective loads are in the ratio $3:2$ then the corresponding ratio of increases in their lenghts would be

A. $\frac{2a^2c}{b}$

B. $\frac{3a}{2b^2c}$

C. $\frac{3ac}{b^2}$

D. $\frac{3c}{2ab^2}$

Answer: B

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21. A uniform rod of length L, has a mass per unit length λ and area of cross section A. The elongation in the rod is l due to its own weight, if it suspended form the celing of a room. The Young's modulus of the rod is

A. $\dfrac{3\lambda g L^2}{Al}$

B. $\dfrac{\lambda g L^2}{2Al}$

C. $\dfrac{2\lambda g L}{Al}$

D. $\dfrac{\lambda g L^2}{Al}$

Answer: B

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22. The torque required to produce a unit twist in a solide bar of length L and radius r is

A. $\tau_1 = \tau_2$

B. $\tau_1 < \tau_2$

C. $\tau_1 > \tau_2$

D. $1 \& 2$ are correct

Answer: C

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23. 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?

A. $\frac{P\gamma}{B}$

B. $\frac{PB}{\gamma}$

C. $\frac{\gamma}{PB}$

D. $\frac{P}{\gamma B}$

Answer: D

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24. The density of water at the surface of ocean is ρ . If the bulk modulus of water is B, then the density of ocean water at depth, when the pressure at a depth is αp_0 and p_0 is the atmospheric pressure is

A. $\dfrac{\rho B}{B-(n-1)P_0}$

B. $\dfrac{\rho B}{B+(n-1)P_0}$

C. $\dfrac{\rho B}{B-nP_0}$

D. $\dfrac{\rho B}{B+nP_0}$

Answer: A

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25. 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. $12.89 gm/cm^3$

B. $14 gm/cm^3$

C. $11.69 gm/cm^3$

D. zero

Answer: C

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26. How does the density of sea water change with depth?

A. $\frac{B\rho^2}{gh}$

B. $B\rho gh$

C. $\frac{\rho^2 gh}{B}$

D. $\frac{\rho gh}{B}$

Answer: C

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27. 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 .

A. $10m/s$

B. $15m/s$

C. $20m/s$

D. $25m/s$

Answer: C

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28. On loading a metal wire of cross section $10^{-6}m^2$ and length $2m$ by a mass of $210kg$, it extends by $16mm$ and suddenly broke form the point of support . If denstiy of that metal is $8000 Kgm^{-3}$ and its specific heat is $420 JKg^{1} K^{-1}$ the ride in temperature of wire is

A. $2.5^{\circ} C$

B. $5^{\circ} C$

C. $6^{\circ} C$

D. $10^{\circ} C$

Answer: A

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29. A long wire hangs vertically with its upper end clamped. A torque of $8 Nm$ applied to the free end that twists it through45°. The potential energy of the twisted wire is

A. πJ

B. $\frac{\pi}{2}J$

C. $\frac{\pi}{4}J$

D. $\frac{\pi}{8}J$

Answer: A

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NCERT BASED QUESTIONS

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

A. Infinity

B. zero

C. unity

D. some finite small non-zero constant value

Answer: B

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2. 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

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 becomes four times

C. will remain same

D. will decreases

Answer: C

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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. $Y_{\text{copper}} / Y_{\text{iron}}$

B. $\sqrt{\dfrac{Y_{\text{iron}}}{Y_{\text{copper}}}}$

C. $\dfrac{Y_{\text{iron}}^2}{Y_{\text{copper}}^2}$

D. $\frac{Y_{\text{iron}}}{Y_{\text{copper}}}$

Answer: B

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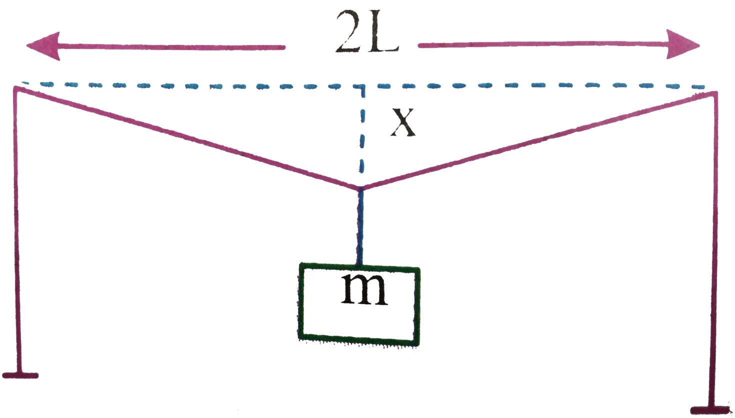
6. A mild steel wire of length $1.0m$ and cross sectional area $2L$ is strethched, within its elastic limit horizontally between two pillars(figure). A mass of m is suspended form the midpont of the wire. Strain in the wire is



A. $\frac{x^2}{2L^2}$

B. $\frac{x}{L}$

C. x^2 / L

D. $x^2 / 2L$

Answer: A

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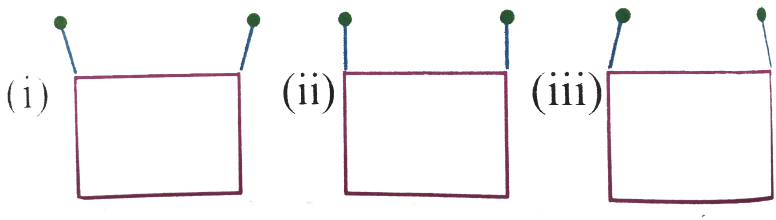
7. A recantangular frame is to be suspended symmetrically by two strings of equal length on two supports (figure).It can be done in one of the following three ways:



A. the same in all cases

B. least in (i)

C. least in (ii)

D. least in (iii)

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 rubbe rrod will elongate and the shape of the bottom edge will change to an ellipse.

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 taperd to a tip at the centre.

Answer: D

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9. 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)

A. $5 \times 10^{-3} m$

B. $0.5 \times 10^{-3} m$

C. $3 \times 10^{-3} m$

D. $0.3 \times 10^{-3} m$

Answer: B

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10. A wire of length L and radius r is fixed at one end. When a stretching force F is applied at free end, the elongation in the wire is l. When another wire of same material but of length $2L$ and radius $2r$, also fixed at one end is stretched by a force $2F$ applied at free end, then elongation in the second wire will be

A. $\frac{l}{2}$

B. l

C. $2l$

D. $4l$

Answer: B

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11. A steel rod $\left(Y = 2.0 \times 10^{11} N/m^2\right.$ and $\alpha = 10^{-50.0} C^{-1})$ 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

A. $4 \times 10^4 N$

B. $3 \times 10^4 N$

C. $2 \times 10^4 N$

D. $1 \times 10^4 N$

Answer: A

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12. Bulk modulus for rubber is $9.8 \times 10^8 Nm^{-2}$. To what depth should a rubber ball be taken in a lake so that its volume is decreased by 0.1%

A. $0.1m$

B. $1m$

C. $10m$

D. $100m$

Answer: D

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13. 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 $25 kg$ 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 $7860 kgm^{-3}$ and Young's modulus is $2 \times 10^{11} N/m^2$ then the extension in the length fo the wire is

A. $1 \times 10^{-3} m$

B. $2 \times 10^{-3} m$

C. $3 \times 10^{-3} m$

D. $4 \times 10^{-3} m$

Answer: D

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14. In the above problem if the the yield strength of steel is $2.5 \times 10^{8} N / m^{2}$, then the maximum mass that can be hung at the lower end of the wire is

A. $785 kg$

B. $78.75 kg$

C. $78.25 kg$

D. $78.50 kg$

Answer: C

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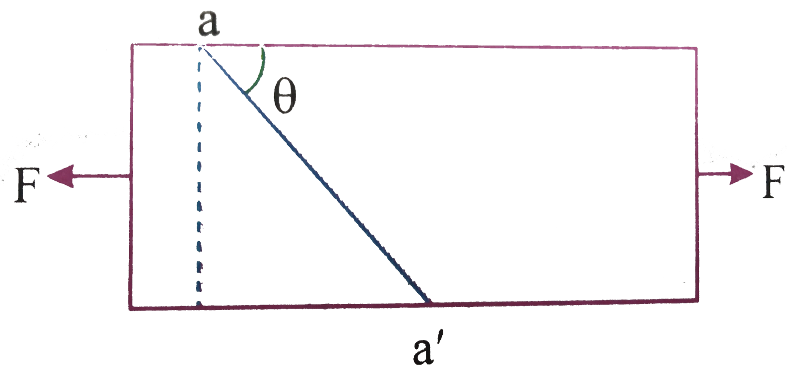
15. Consider a long steel bar under a tensille due to force F acting at the edges along the length of the bar (figure). Consider a plane making an angle θ with the length. For what angle is the tensile stress a maximum?



A. 30°

B. 45°

C. 60°

D. 90°

Answer: D

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16. In the above problem, for what angle is the shearing stress a maximum?

A. 30°

B. 45°

C. 60°

D. 90°

Answer: B

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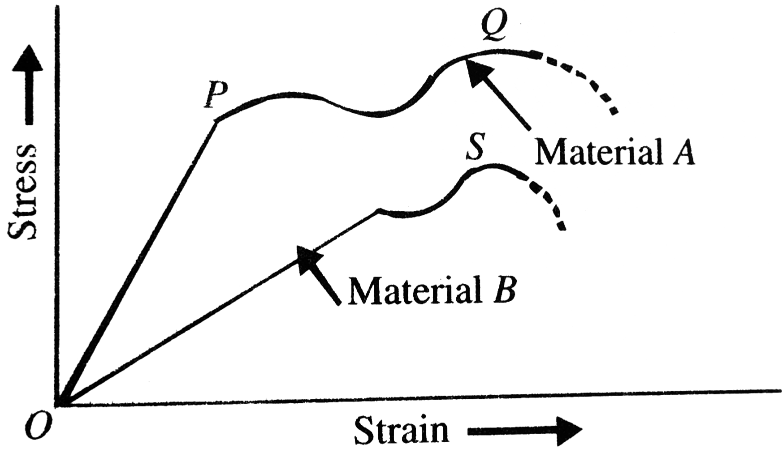
17. Figure shows the stress-strain graphs for materials $.A$ and B. From the graph it follows that



A. Material (ii) is more elasitc than material (i) and hence material (ii) is more brittle

B. Materials (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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18. 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 fo the wrie is $2F/A$

D. Tension at any cross-section A fo the wire is F.

Answer: A::D

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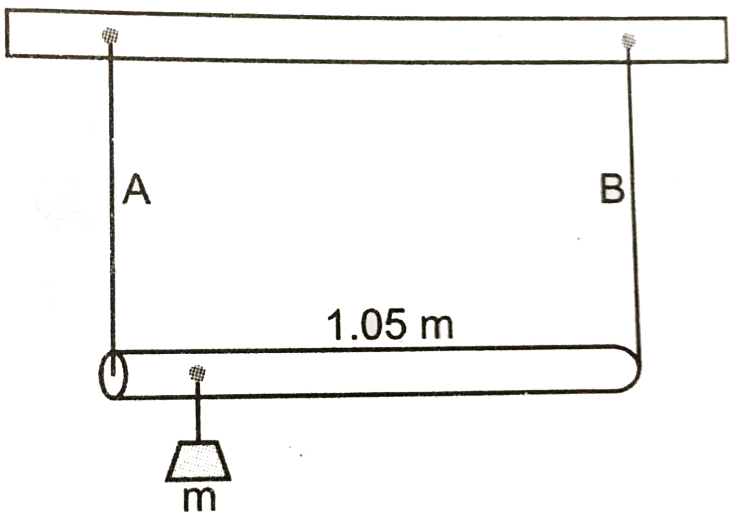
19. A rod of length 1.05 m having negliaible mass is supported at its ends by two wires of steel (wire A) and aluminium (wire B) of equal lengths as shown in fig. The cross-sectional area of wire A and B are $1mm^2$ and $2mm^2$, respectively . At what point along the rod should a mass m be suspended 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 $Y - (aluminium) = 7.0 \times 10^{10} N^{-2}$



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 in both wires.

Answer: B::D

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20. What are the qualities of an ideal liquid?

A. the bulk modulus is infinite

B. the bulk modulus is zero

C. the shear modulus is inifite

D. the shear modulus is Zero

Answer: A::D

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21. 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

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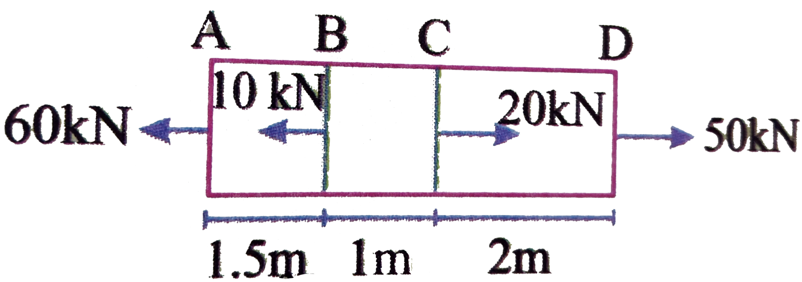
SINGLE ANSWER TYPE

1. A steel rod of cross-sectional area Im^2 is acted upon by forces as shown in the Fig. Determine the total elongation of the bar. Take $Y = 2.0 \times 10^{11} N/m^2$



A. $13 \times 10^{-7}m$

B. $4.5 \times 10^{-7}m$

C. $5 \times 10^{-7}m$

D. $3.5 \times 10^{-7} m$

Answer: D

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2. A $30.0 kg$ hammer, moving with speed a $20.0 ms^{-1}$ strikes a steel spike $2.30 cm$ in diameter. The hammer rebounds with speed $10.0 ms^{-1}$ after $0.110 s$. What is the average strain in the spike during the impact.?

A. $1.97 \times 10^7 N/m^2$

B. $3.2 \times 10^7 N/m^2$

C. $4.6 \times 10^7 N/m^2$

D. $8.2 \times 10^7 N/m^2$

Answer: A

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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?

A. l

B. $2l$

C. $3l$

D. $\frac{l}{2}$

Answer: A

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4. A uniform heavy rod of weight W, cross sectional area a and length L is hanging from fixed support. Young modulus of the material of the rod is Y. Neglect the lateral contraction. Find the elongation of the rod.

A. $\frac{1}{2}\frac{WL}{YA}$

B. $\frac{1}{3}\frac{WL}{YA}$

C. $2\frac{WL}{YA}$

D. $3\frac{WL}{YA}$

Answer: A

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5. A uniform elastic plank moves due to a constant force F_0 applied at one end whose area is S. The Young's modulus of the plank is Y. The strain produced in the direction of force is

A. $\frac{F_0 Y}{S}$

B. $\frac{F_0}{SY}$

C. $\frac{F_0}{2SY}$

D. $\frac{F_0 Y}{2S}$

Answer: C

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6. A pendulum bob of mass m hangs form a massless elastic string. The potential energy (elastic + gravitational) of the system (bob + string + earth) measured relative to the position of the

bob corresponding to the normal length of the string is: (where x = static deformation (elongation) of the string.)

A. mgx

B. $-\frac{1}{2}mgx$

C. $2mgx$

D. $-mgx$

Answer: B

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7. The elastic limit of an elevator cable is $2 \times 10^9 N/m^2$. The maximum upward acceleration that an elevator of amss $2 \times 10^3 kg$ can have been supported by a cable would not exceed half of the elastic limit would be

A. $10m/s^2$

B. $50m/s^2$

C. $40m/s^2$

D. Not possible to move up

Answer: C

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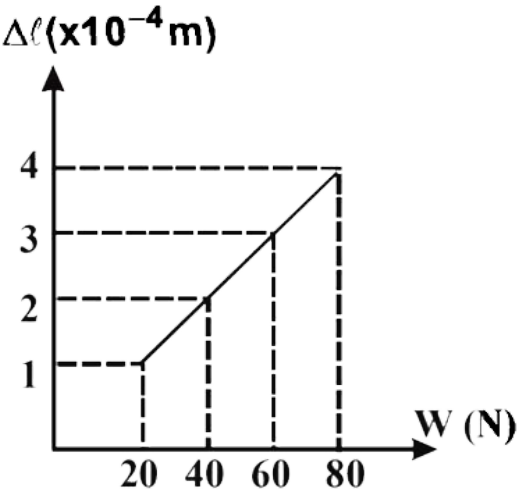
8. The adjacent graph shows the estension (Δl) of a wire of length 1m suspended from the top of a roof at one end and with a load W connected to the other end. If the cross-sectional area of the wire is $10^{-6}m^2$, calculate the Young's modulus of the material of the wire.



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

B. $2 \times 10^{-11} N/m^2$

C. $3 \times 10^{-12} N/m^2$

D. $2 \times 10^{-13} N/m^2$

Answer: A

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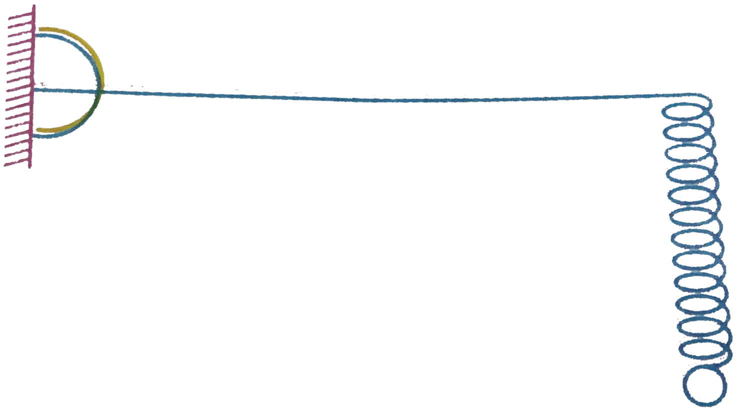
9. A horizongal rod fixed at one of its ends has lengtht l, rigidly modulus η and area of cross-sectional A. A bob of mass m hangs from the freee end of the rod by a light spring of stiffness constant k, Find the small displacement of the free end of the rod.



A. $\frac{A\eta}{mgl}$

B. $\frac{mgA}{\eta l}$

C. $\frac{mgl}{A\eta}$

D. $\frac{\eta l}{mgA}$

Answer: C

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10. The following four wires are made of the same material. Which of these will have the largest extension when the same tension is applied

A. Length $= 50cm$, diameter $= 0.5mm$

B. Length $= 100cm$, diameter $= 1mm$

C. Length $= 200cm$, diameter $= 2mm$

D. Length $= 300cm$, diameter $= 3mm$

Answer: A

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11. When temperature of a gas is $20^{\circ}C$ and pressure is changed from $p_1 = 1.01 \times 10^5 Pa$ to $p_2 = 1.165 \times 10^5 Pa$, the volume changes by 10% . The bulk modulus is

A. $1.55 \times 10^5 Pa$

B. $0.115 \times 10^5 Pa$

C. $1.4 \times 10^5 Pa$

D. $1.01 \times 10^5 Pa$

Answer: A

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12. Two rods of equal cross-sections, one of copper and the other of steel are joined to from a composite rod of length $2.0m$ at $20^{\circ}C$ the length of the copper rod is $0.5m$. When the tempertuare is raised to $120^\circ C$, the length of composite rod increases to $2.002m$. If the composite rod is fixed between two rigid walls and thus not allowed to expand, it is foundthat the length fo the component rod also do not change with increase in temperature. Calcualte the Young's modulus of steel. Given Young's modulus of copper $= 1.3 \times 10^{11} N/m^2$ the coefficent of linear expansion of copper $\alpha_C = 1.6 \times 10^{-5} / .^\circ c$

A. $2.6 \times 10^{11} Pa$

B. $1.6 \times 10^{10} Pa$

C. $1.3 \times 10^{10} Pa$

D. $0.9 \times 10^{10} Pa$

Answer: A

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13. 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. $\sqrt{\frac{M}{\eta L}}$

Answer: B

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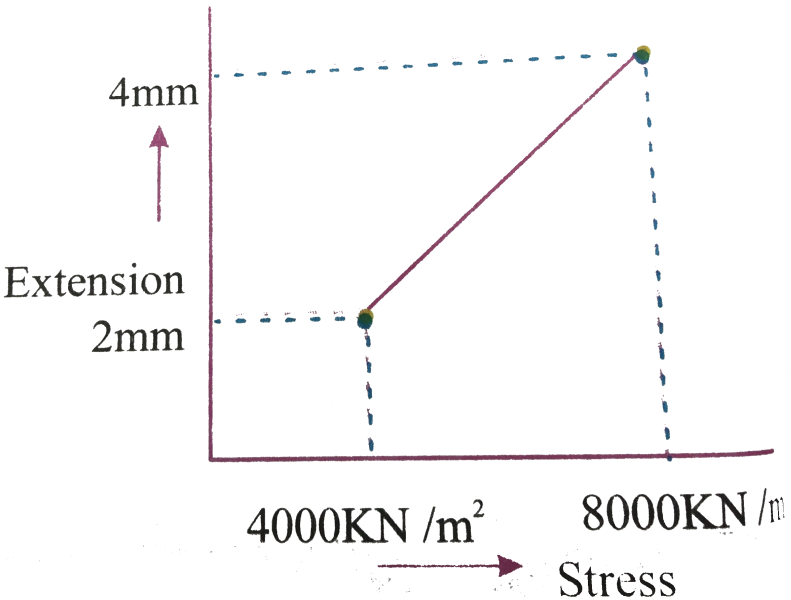
14. In determine of youggn modulus of ealsticity of wire, a force is applied and extension is recoreded. Initial length of wire $'1m'$. The curce between extension and stress is depicted then young modulus of wire will be:



A. $2 \times 10^9 N / m^2$

B. $1 \times 10^9 N / m^2$

C. $2 \times 10^{10} N / m^2$

D. $1 \times 10^{10} N / m^2$

Answer: A

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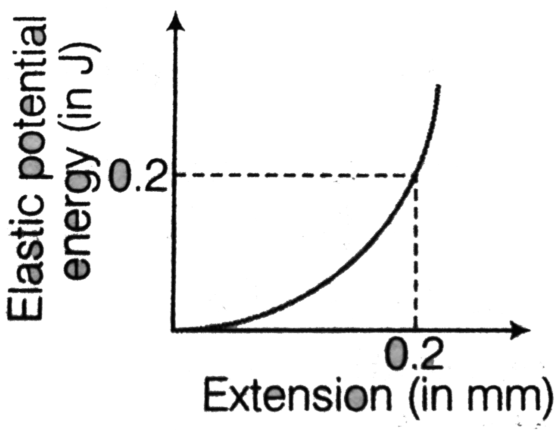
15. Figure shows the graph of elastic potential energy (U) stored versus extension, for a steel wire $(Y = 2 \times 10^{11} Pa)$ of volume $200cc$. If area of cross- section A and original length L, then



A. $4m$

B. $2m$

C. $4cm$

D. $2cm$

Answer: B

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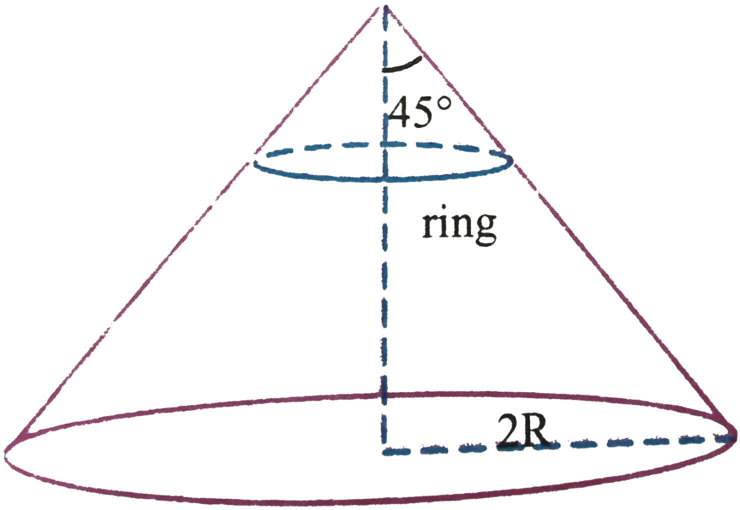
MULTIPLE ANSWER TYPE

1. A unifrom metallic ring of mass m, radisus R, cross sectional area $'a'$ and young'/s modulus Y kis kept on a smooth cone of radius $2R$ and semivertex angle 45° as shown. [Assume that extension in the ring is small]



A. The tension in the ring will be same through out

B. The tension in the ring will be independent of radius of ring.

C. The extension in the ring will be $\frac{mgR}{aY}$

D. Elastic potential energy should in the ring will be $\frac{m^2g^2R}{8\pi Ya}$

Answer: A::B::C

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2. The torque required to produce a unit twist in a solide bar of length L and radius r is

A. directly proportional to r^2

B. directly proportional to r^4

C. inversely proportional to l

D. inversely proportional to r^2

Answer: B::C

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3. A small cube of liquid of surface area A ias considered at a depth of $'h'$ form the surface of liquid. If the density is ρ bulk modulus is B, the elastic energy density inside the cube is proportional to:"

A. h^2

B. A

C. $\frac{1}{B}$

D. ρ

Answer: A::C

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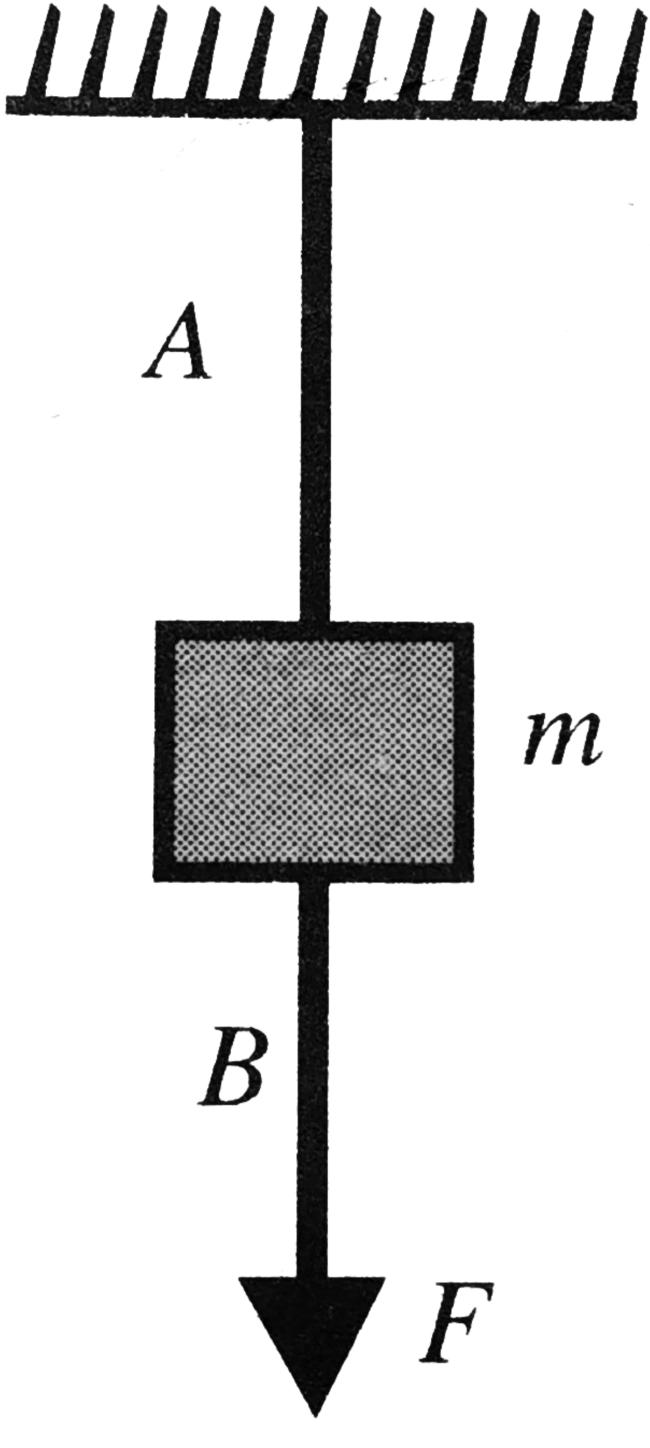
4. The wires A and B shown in Fig. are made of the same material and have radii r_A and r_B, respectively. The block between them has a mass m. When the force F is $mg/3$, one of the wires breaks. Then



A
m
B
F

A. A will break before B if $r_A = r_B$

B. A will break before B if $r_A < 2r_B$

C. Either A or B may break if $r_A = 2r_B$

D. The lengths of A and B must be known to predict which wire will break.

Answer: A::B::C

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5. A uniform plank is resting over a smooth horizontal floor and is pulled by applying a horizontal force at its one end. Which of the following statements are not correct?

A. Stress developed in plank material is maximum at the end at which force is applied and decreases linearly to zero at the other end.

B. A unifrom tensile is developed in the plank material.

C. since plank is a pulled at one only plank starts to accelerate along direction of the force. Hence no stress is developed in the plank material.

D. Stress at the ends is the same but it changes in between.

Answer: B::C::D

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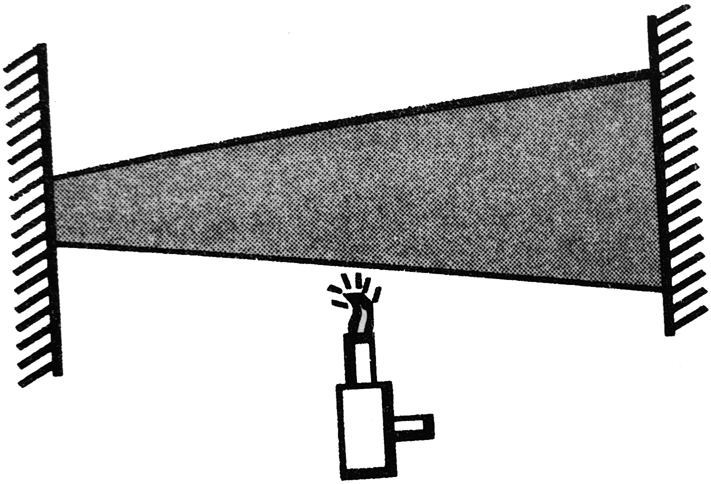
6. A rod is made of uniform material and has non-uniform cross section. It is fixed at both the ends as shown and heated at mid-section. Which of the following are not correct?



A. Force of compression in the rod will be maximum at mid-section.

B. Compressive stress in the rod will be maximum at left end.

C. Since rod is fixed at both the ends, its length will remain unchanged. Hence, no strain will be induced in it.

D. Force of compression is the same throughout the rod.

Answer: A::C

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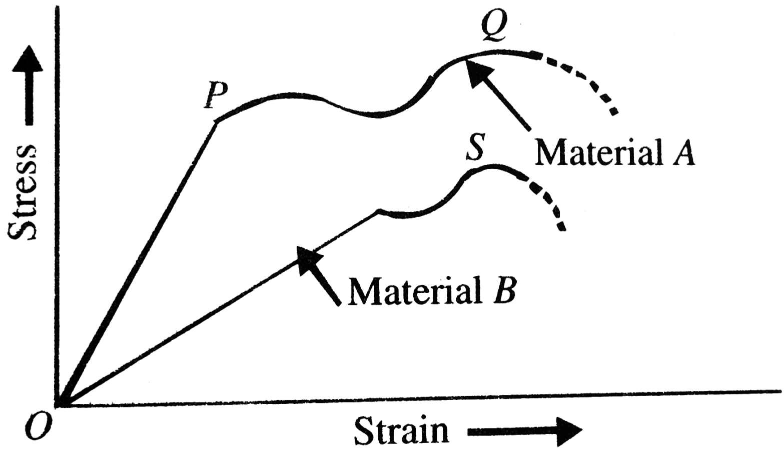
7. Figure shows the stress-strain graphs for materials .A and B.

From the graph it follows that



A. material A has a higher Young's modlus

B. material B is more ductile

C. material A can withstand greater stress

D. material B can withstand greater stress

Answer: A::C

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8. Which of the following are correct?

A. For a small deformation fo a material, the ratio (stress/strain) constant.

B. for a large deformaition fo a material, the ratio (stress/strian) decreases.

C. Two wires made of differnet materials, having the same diameter and length are connected aedn to end A force is applied. This strethces their combined length by $2mm$ Now they have same strenght but different stress

D. none

Answer: A::B

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9. Which of the following are correct?

A. The shear modulus of a liquid is infinite

B. Bulk modulus of a perfectly rigid body is infinite.

C. When length fo a bar is increased by strechtingh it, it's volume must decreases.

D. When length of a bar is increased by streching it, its volume must remain same.

Answer: A::B

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10. A body of mass M is attached to the lower end of a metal wire, whose upper end is fixed . The elongation of the wire is l.

A. Loss in gravitinal potential energy of M is Mgl

B. Elastic potential energy stored in the wire is $\frac{Mgl}{2}$

C. Elastic potential energy stored in the wire is Mgl

D. Elastic potential energy stored in the wire is $Mgl/3$

Answer: A::B

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COMPREHENSION TYPE

1. A stationlay unifrom sting of modlulus Y, density ρ and length $'I'$ is hanging from a rigid support.

The stress at a distance x from the point of tis suspension.

A. $\rho x g$

B. $\rho(l - x)g$

C. $\rho l g$

D. $\frac{\rho x^2 g}{l}$

Answer: B

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2. A wire of length L and density ρ and Young's modulus Y is hanging from a support. Find the elongation in the length of wire at which wire will break:

A. $\Delta l = \frac{\rho g l^2}{2Y}$

B. $\Delta l = \frac{\rho g l^2}{3Y}$

C. $\Delta l = \dfrac{2\rho g l^2}{Y}$

D. $\Delta l = \dfrac{3\rho g l^2}{Y}$

Answer: A

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3. A homogeneous rod of length L is acted upon by two forces F_1 and F_2 applied to its ends and directed opposite to each other. With what force F will the rod be stretched at the cross section at a distance l from the end where F_1 is applied?

A. $\left(F_1 + (F_1 - F_2)\dfrac{x}{l}\right) = T$

B. $\left(F_1 - (F_1 + F_2)\dfrac{x}{l}\right) = T$

C. $\left(F_1 + (F_1 + F_2)\dfrac{x}{l}\right) = T$

D. $\left(F_1 - (F_1 - F_2)\dfrac{x}{l}\right) = T$

Answer: D

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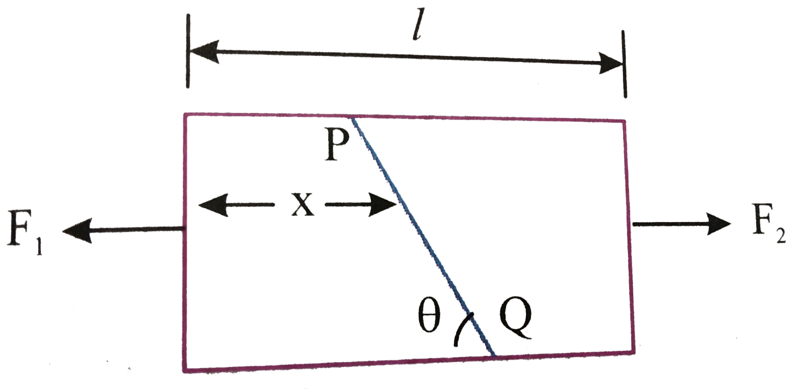
4. Two forces F_1 and F_2 are applied at the ends of a metal rod of Yougn's Modulus Y, length l as shown.



Longitudinal stress at the given cross-section PQ if the cross-section of the rod is A_0 and tension is T

A. $\dfrac{T\sin^2\theta}{A_0}$

B. $\dfrac{T\sin\theta}{A_0}$

C. $\frac{T \sin \theta}{2A_0}$

D. $\frac{2T \sin \theta}{2A_0}$

Answer: A

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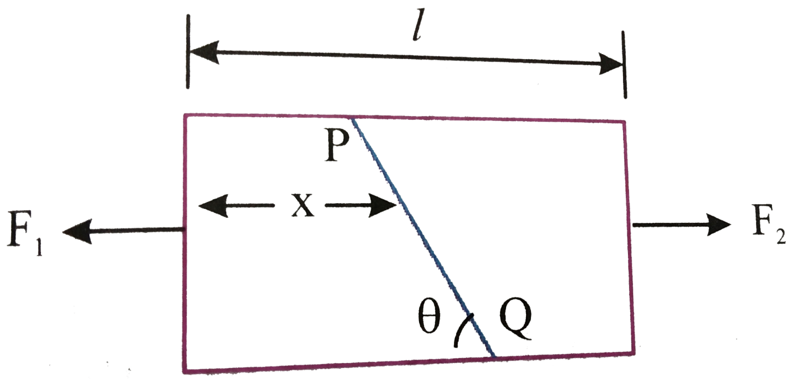
5. Two forces F_1 and F_2 are applied at the ends of a metal rod of Yougn's Modulus Y, length l as shown.



Longitudinal stress at the given cross-section PQ if the cross-section of the rod is A_0 and tension is T

A. $\dfrac{T\sin 2\theta}{A_0}$

B. $\dfrac{T\sin\theta\cos\theta}{A_0}$

C. $\dfrac{T\cos 2\theta}{A_0}$

D. $\dfrac{T\sin\theta\cos\theta}{2A_0}$

Answer: B

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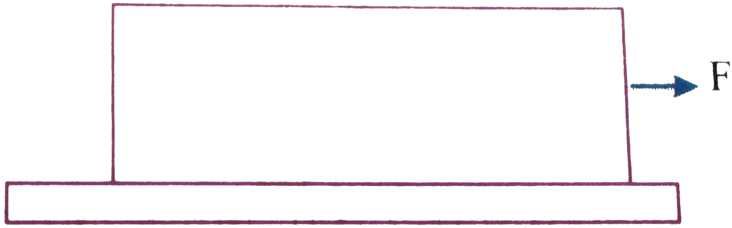
6. A rod of length l, mass M, cross section area A is placed on a rough horizonatal surface. A horizonatal force F is applied to rod as shwon in figure. The coefficient of fricition between rod and surface is μ, the Young, modulus of material of rod is Y. [Assume that fricition force is distributed uniformly on rod]



The elongation in the rod if $F < \mu Mg$ is

A. Zero

B. $\left[\frac{F - \frac{\mu Mg}{2}}{2AY}\right]l$

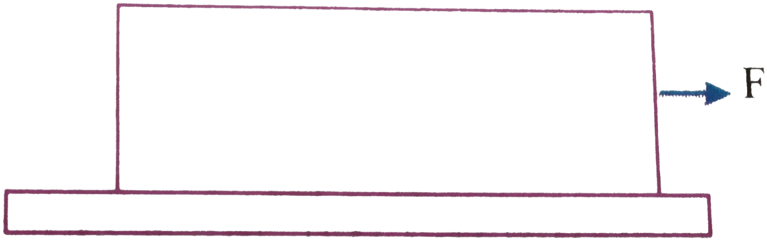
C. $\frac{Fl}{2AY}$

D. None

Answer: C

Watch Video Solution

7. A rod of length l, mass M, cross section area A is placed on a rough horizonatal surface. A horizonatal force F is applied to rod as shwon in figure. The coefficient of fricition between rod and surface is μ, the Young, modulus of material of rod is Y. [Assume that fricition force is distributed uniformly on rod]



Teh elongation in rod if $F > \mu Mg$ is

A. $\dfrac{(F - \mu Mg)l}{2AY}$

B. $\left[\dfrac{F - \frac{\mu Mg}{2}}{2AY}\right]l$

C. $\dfrac{Fl}{2AY}$

D. None

Answer: C

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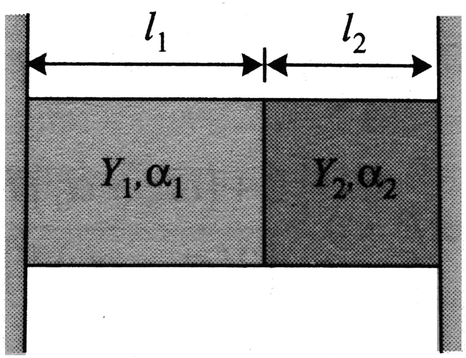
8. Two rods of different metals having the same area of cross section A are placed between the two massive walls as shown is Fig. The first rod has a length l_1, coefficient of linear expansion α_1 and Young's modulus Y_1. The correcsponding quantities for second rod are l_2, α_2 and Y_2. The temperature of both the rods is now raised by $t^\circ C$.

i. Find the force with which the rods act on each other (at higher temperature) in terms of given quantities.

ii. Also find the length of the rods at higher temperature.



A. $F = \dfrac{A(L_1\alpha_1 + L_2\alpha_2)T}{\left[\dfrac{L_1}{Y_1} + \dfrac{L_2}{Y_2}\right]}$

B. $F = A(Y_1\alpha_1 + Y_2\alpha_2)T$

C. $F = \dfrac{A(Y_1\alpha_1 + Y_2\alpha_2)T}{2}$

D. $F = \dfrac{A\left(\frac{L_1}{Y_1} + \frac{L_2}{Y_2}\right)T}{L_1\alpha_1 + L_2\alpha_2}$

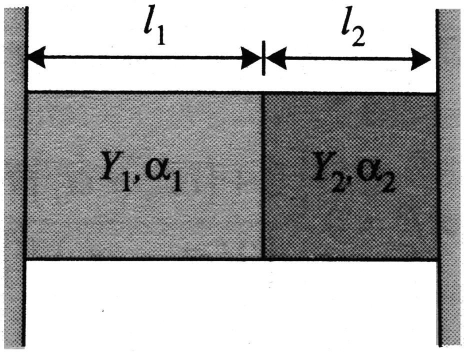
Answer: A

Watch Video Solution

9. Two rods of different metals having the same area of cross section A are placed between the two massive walls as shown is Fig. The first rod has a length l_1, coefficient of linear expansion α_1 and Young's modulus Y_1. The correcsponding quantities for second rod are l_2, α_2 and Y_2. The temperature of both the rods is now raised by $t^\circ C$.

i. Find the force with which the rods act on each other (at higher temperature) in terms of given quantities.

ii. Also find the length of the rods at higher temperature.



A. $L_2^1 = L_2\left[1 + \alpha_2 T - \frac{F}{AY_2}\right]$

$L_1^1 = L_1\left(1 + \alpha_1 T - \frac{F}{AY_1}\right)$

B. $L_2^1 = L_1\left[1 - \alpha_2 T + \frac{F}{AY_2}\right]$

$L_1^1 = L_1\left(1 - \alpha_1 T - \frac{F}{AY_1}\right)$

C. $L_2^1 = L_1\left[1 + \alpha_2 T + \frac{F}{AY_2}\right]$

D. $L_2^1 = L_1\left[1 - \alpha_2 T - \frac{F}{AY_2}\right]$

Answer: A

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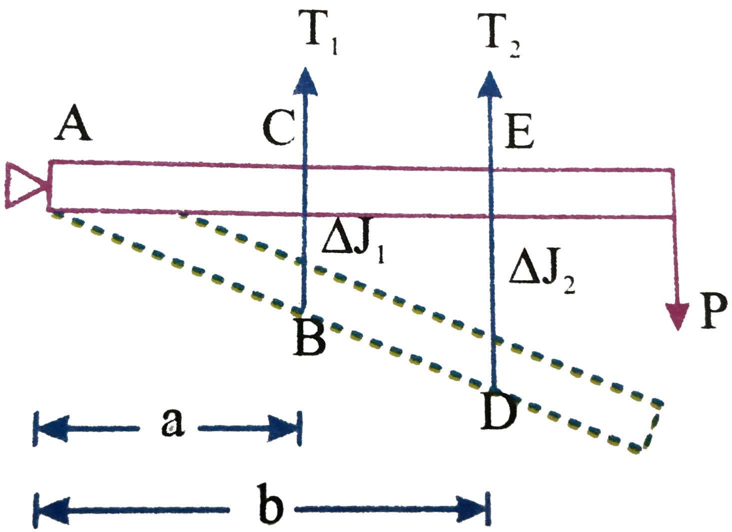
10. A massless rod of length l is hinged at one end and is held horizontal by two identical vertical wires, which are tied at distances a and b form the hinged end. A load P si applied at the free end of the rod.



The tension in the first is

A. $\dfrac{Pl}{a^2 + b^2}a$

B. $\dfrac{Pl}{a^2 + b^2}b$

C. $\frac{Pl}{a+b}a$

D. $\frac{Pl}{a+b}b$

Answer: A

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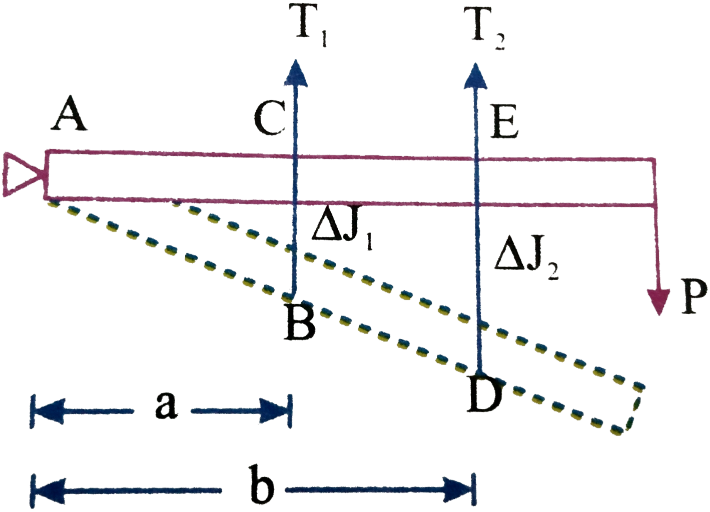
11. A massless rod of length l is hinged at one end and is held horizontal by two identical vertical wires, which are tied at distances a and b form the hinged end. A load P si applied at the free end of the rod.



The tension in the secound wire is

A. $\frac{Pl}{a^2+b^2}a$

B. $\frac{Pl}{a^2+b^2}b$

C. $\frac{Pl}{a+b}a$

D. $\frac{Pl}{a+b}b$

Answer: B

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SINGLE ANSWER TYPE QUESTIONS

1. A rubber ball of bulk modulus B is taken to a depth h of a liquid of density ρ. Find the fractional change in the radius of the ball.

A. $\frac{\delta r}{r} = \frac{\rho g h}{3B}$

B. $\frac{\delta r}{r} = \frac{\rho g h}{2B}$

C. $\frac{\delta r}{r} = \frac{3\rho g h}{B}$

D. $\frac{\delta r}{r} = \frac{2\rho g h}{B}$

Answer: A

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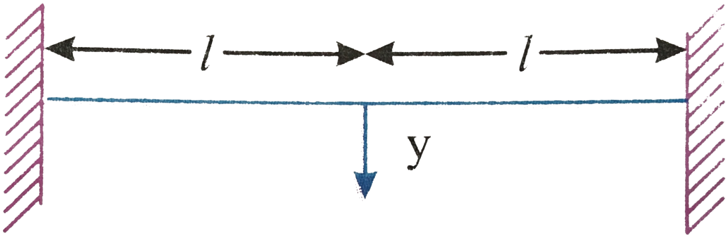
2. A wire is length $2l$, radius r and Young's modulus Y pulled perpendicular to its mid point by a distance y. Fina the tesnion in the wire



A. $=\dfrac{\pi r^2 y^2 Y}{l^2}$

B. $=\dfrac{\pi r^2 y^2 Y}{2l^2}$

C. $=\dfrac{r^2 y^2 Y}{2l^2}$

D. $=\dfrac{r^2 y^2 Y}{l^2}$

Answer: B

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3. A smooth uniform string of natural length L_0, cross-sectional area A and Young's modulus Y is pulled along its length by a force F on a horizontal smooth surface. The elastic potential energy stored in the string is

A. $U = m\frac{F^2 l}{AY}$

B. $U = \frac{F^2 l}{3AY}$

C. $U = \frac{F^2 l}{6AY}$

D. $U = \frac{F^2 l}{2AY}$

Answer: C

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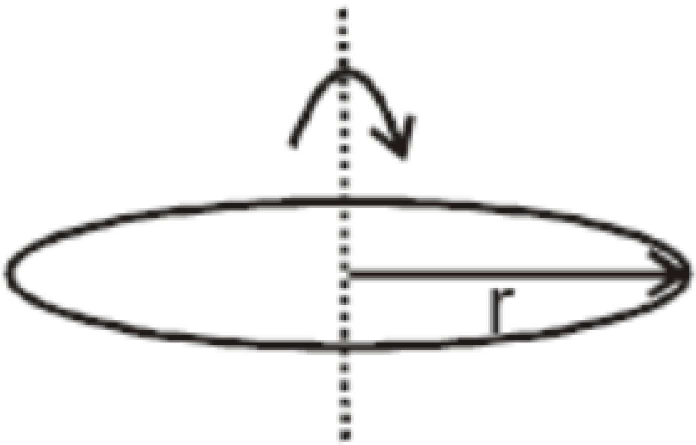
4. A ring of radius r made of wire of density ρ is rotated about a stationary vertical axis passing through its centre and perpendicular to the plane of the ring as shown in the figure.

Determine the angular velocity (in rad/s) of ring at which the ring breaks. The wire breaks at tensile stress σ. Ignore gravity. Take $\sigma / \rho = 4$ and $r = 1m$.



A. $n = \frac{1}{2\pi R}\sqrt{\frac{\sigma}{\delta}}$

B. $n = \frac{1}{\pi R}\sqrt{\frac{\sigma}{\delta}}$

C. $n = \frac{1}{2R}\sqrt{\frac{\sigma}{\delta}}$

D. $n = \frac{1}{R}\sqrt{\frac{\sigma}{\delta}}$

Answer: A

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5. Two vertical rods of equal lengths, one of steel and the other of copper, are suspended from the ceiling at a distance l apart and are connected rigidly to a rigid horizontal bar at their lower ends. If A_S and A_C be their respective cross-sectional areas, and Y_S and Y_C,their respective Young's moduli of elasticities, where should a vertical force F be applied to the horizontal bar in order that the bar remains horizontal?`

A. $\dfrac{l}{1-(A_S/A_C)(Y_S/Y_C)}$

B. $\dfrac{2l}{1+(A_S/A_C)(Y_S/Y_C)}$

C. $\dfrac{l}{(A_S/A_C)(Y_S/Y_C)}$

D. $\dfrac{l}{1+(A_S/A_C)(Y_S/Y_C)}$

Answer: D

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6. A circular ring of radius R and mass m made of a uniform wire of cross sectional area A is rotated about a stationary vertical axis passing through its center and perpendicular to the plane of the ring. If the breaking stress of the material of the ring is σ_b, then determine the maximum angular speed $\omega_{\max}$ at which the ring may be rotated without failure.

A. $\sqrt{\dfrac{2\pi\sigma A}{mR}}$

B. $\sqrt{\dfrac{2\pi\sigma A}{mR}}$

C. $\dfrac{3\pi\sigma A}{mR}$

D. $\dfrac{\pi\sigma A}{2mR}$

Answer: A

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7. A wire having a length L and cross- sectional area A is suspended at one of its ends from a ceiling . Density and young's modulus of material of the wire are ρ and Y, respectively. Its strain energy due to its own weight is $\frac{\rho^2 g^2 A L^3}{\alpha Y}$. Find the value of α

A. $\frac{\rho^2 g^2 L^3 \times \pi r^2}{3Y}$

B. $\frac{\rho^2 g^2 L^3 \times \pi r^2}{6Y}$

C. $\frac{\rho^2 g^2 L^3 \times \pi r^2}{2Y}$

D. $\frac{\rho^2 g^2 L^3 \times \pi r^2}{5Y}$

Answer: B

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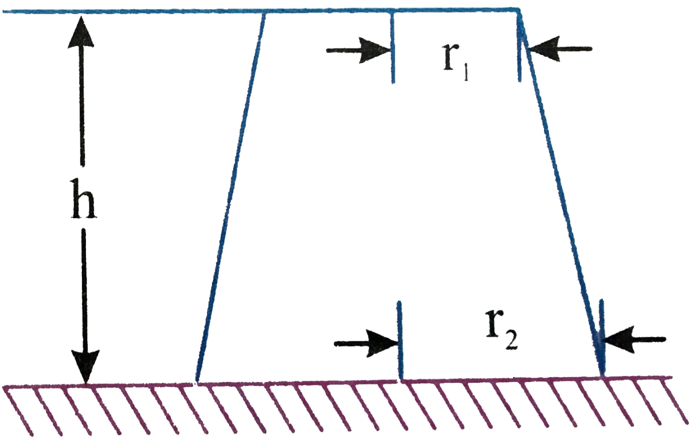
8. A truncated cone of solid rubber of a mass M is placed verticle. If its linear dimensions are given and Y = Young's modulus of the cone, find the deformation of the cone.



A. $\Delta l = \frac{FH}{2\pi r_1 r_2 Y}$

B. $\Delta l = \frac{FH}{6\pi r_1 r_2 Y}$

C. $\Delta l = \frac{FH}{3\pi r_1 r_2 Y}$

D. $\Delta l = \frac{FH}{\pi r_1 r_2 Y}$

Answer: D

9. A uniform ring of mass M of outside radius r_2 is fitted tightly with a shaft of radius r_1. If the shaft is rotated with a constant angular acceleration. About it's axis, the moment of the elastic force in the ring about the axes of rotation is

A. $\dfrac{M\left(r_2^4 - r_1^4\right)\alpha}{2\left(r_2^2 - r_1^2\right)}$

B. $\dfrac{M\left(r_2^4 + r_1^4\right)\alpha}{2\left(r_2^2 + r_1^2\right)}$

C. $\dfrac{M\left(r_2^4 - r_1^4\right)\alpha}{2\left(r_2^2 + r_1^2\right)}$

D. $\dfrac{M\left(r_2^4 + r_1^4\right)\alpha}{2\left(r_2^2 - r_1^2\right)}$

Answer: A

10. Estimate the pressure deep inside the sea at a depth h below the surface. Assume that the density fo water is ρ_0 at sea level and its bulk modulus is B. P_0 is the atmosphere pressure at sea level P is the pressure at depth $'h'$

A. $P = P_0 - BIn\left(1 - \frac{\rho_0 gh}{B}\right)$

B. $P = P_0 + BIn\left(1 - \frac{\rho_0 gh}{B}\right)$

C. $P = P_0 - BIn\left(1 + \frac{\rho_0 gh}{B}\right)$

D. $P = P_0 + BIn\left(1 + \frac{\rho_0 gh}{B}\right)$

Answer: A

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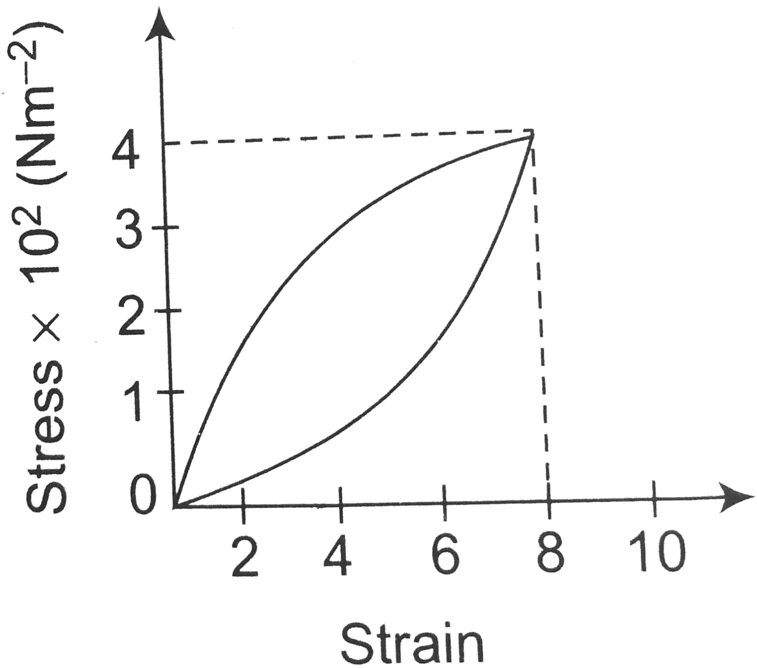
11.



A rubber of volume 2000 cc is alternately subjected to tension and released. The figure shown the stress-strain curve of rubber. Each curve is a quadrant of an ellipse. The amount of energy lost as heat per cycle per unit volume will be

A. $\left(\frac{\pi}{2}-1\right) \times 16 \times 10^2 J$

B. $\left(\frac{\pi}{4}-1\right) \times 8 \times 10^2 J$

C. $\left(\frac{\pi}{4}-1\right) \times 32 \times 10^2 J$

D. $\left(\frac{\pi}{2} - 1\right) \times 32 \times 10^2 J$

Answer: D

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12. One end of a horizontal thick copper wire of length 2L and radius 2R is welded to an end fo another horizontal thin copper wire of lenth L and radius R. When the arrangement is stretched by applying forces at two ends, the ratio of the elongation in the thin wire to that in the thick wire is

A. 0.25

B. 0.50

C. 2.00

D. 4.00

Answer: C

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13. Maximum excess pressure inside a thin-walled steel tube of radius r and thickness $\triangle r(< < r)$, so that the tube would not rupture would be (breaking stress of steel is $\sigma_{\max}$

A. $\sigma_{\max} \times \frac{r}{\Delta r}$

B. $\sigma_{\max} \times \frac{\Delta r}{r}$

C. $\sigma_{\max}$

D. $\sigma_{\max} \times \frac{2\Delta r}{r}$

Answer: B

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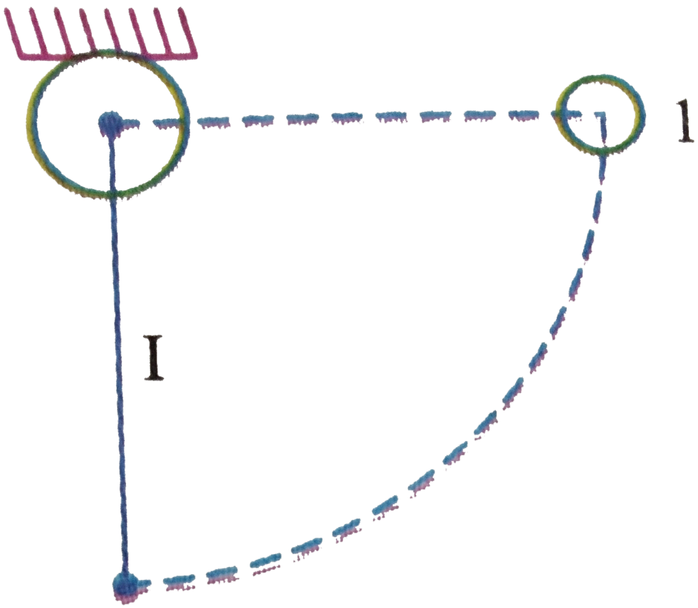
Comprehension-1:

1. A sphere of mass m attached with the free end of a steel wire of length l swings in the veritical plane form the horizontal positon.



Elongation of the wire in the vericle positon is

A. $\frac{mgl}{Y(\pi r^2)}$

B. $\frac{2mgl}{Y(\pi r^2)}$

C. $\dfrac{mgl}{3Y(\pi r^2)}$

D. $\dfrac{3mgl}{Y(\pi r^2)}$

Answer: D

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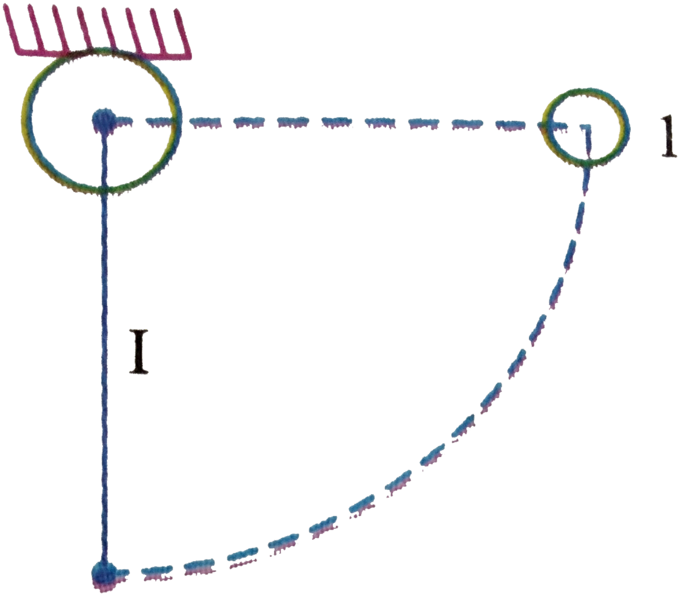
2. A sphere of mass m attached with the free end of a steel wire of length l swings in the veritcle plane form the horizontal positon.



Elastic energy should in the wire in the vericle positon is

A. $\dfrac{9m^2g^2l}{2Y\pi r^2}$

B. $\dfrac{7m^2g^2l}{2Y\pi r^2}$

C. $\dfrac{9m^2g^2l}{Y\pi r^2}$

D. $\dfrac{9m^2g^2l}{4Y\pi r^2}$

Answer: A

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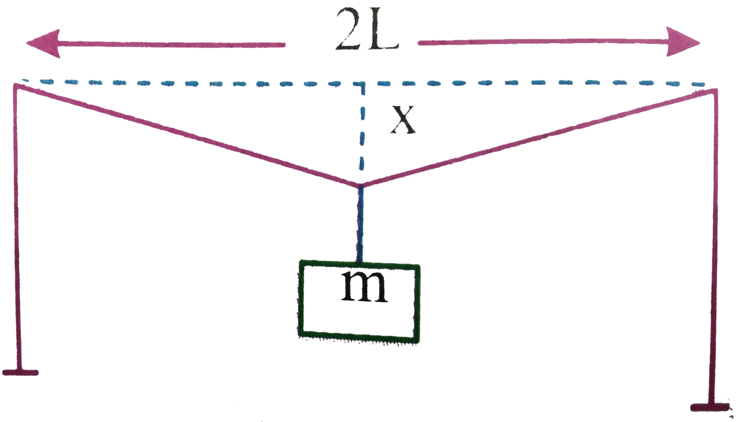
Comprehension-2:

1. 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. $\frac{y^2}{l}$

B. $\frac{y^2}{3l}$

C. $\frac{y^2}{4l}$

D. $\frac{2y^2}{l}$

Answer: A

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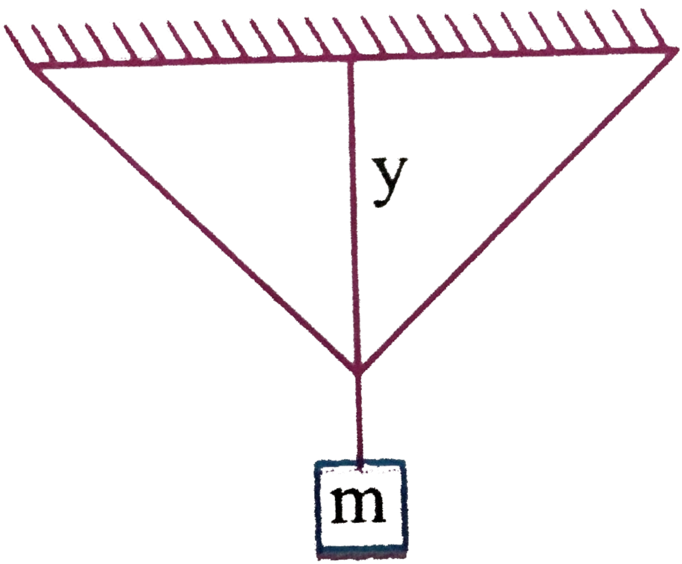
2. A body hangs form the mid-point of a light wire of length $2l$ and cross-sectional area A such that the wire sags through a verticle distance $(y < < l)$. If the youngs's modulus of the wire is Y.



What is the elastic energy stored?

A. $\frac{YA\Delta l^2}{2l}$

B. $\frac{YA\Delta l^2}{6l}$

C. $\frac{YA\Delta l^2}{4l}$

D. $\frac{YA\Delta l^2}{l}$

Answer: C

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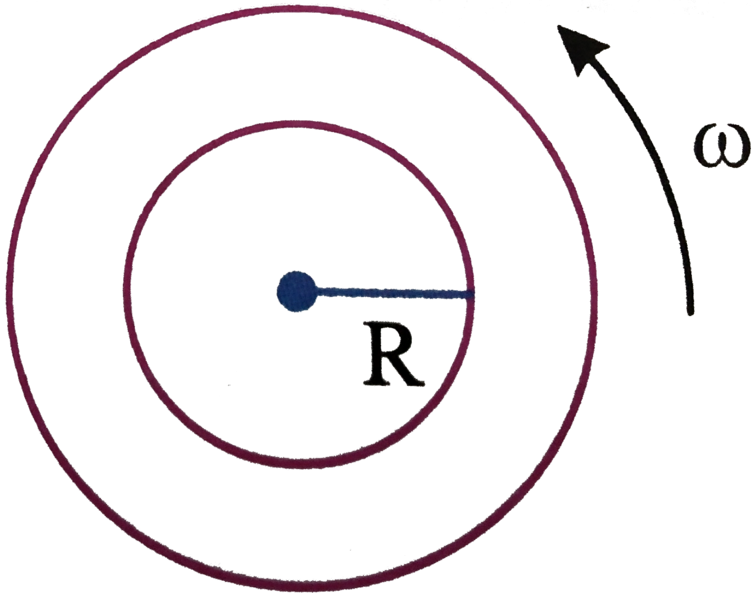
Comprehension-3:

1. A thin wire of cross section a is made to from a flexible circular loop of radius R. If the loop spins with angular speed ω, the (Assume ρ = density and y = Young's modulus fo wire)



Tension in the wire is

A. $\frac{mR\omega^2}{2\pi}$

B. $\frac{2mR\omega^2}{\pi}$

C. $\frac{mR\omega^2}{4\pi}$

D. $\frac{1}{2}mR\omega^2$

Answer: A

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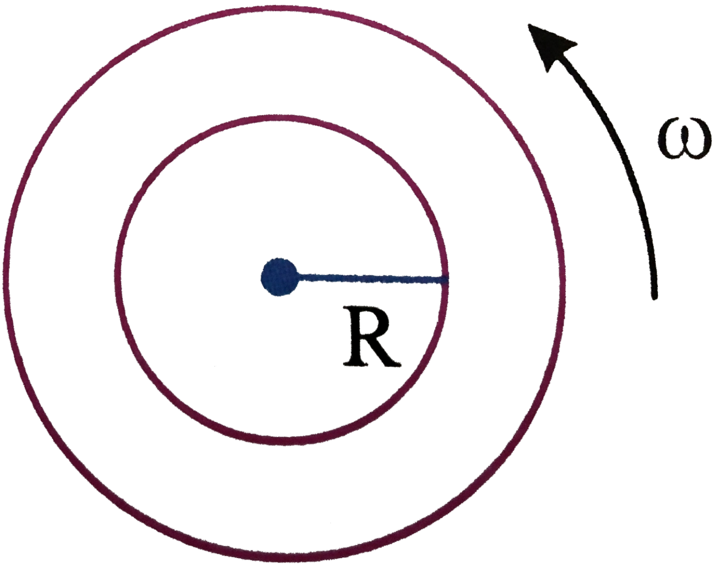
2. A thin wire of cross section a is made to from a flexible circular loop of radius R. If the loop spins with angular speed ω, the (Assume ρ = density and y = Young's modulus fo wire)



Stress in the wire is

A. $\rho R^2 \omega^2$

B. $\rho R \omega$

C. $\frac{R^2 \omega^2}{\rho}$

D. $\frac{R^2\omega^2}{2\rho}$

Answer: A

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Comprehension-4:

1. In the figure shown, A and B are two short steel rods each of cross-sectional area $5cm^2$. The lower ends of A and B are welded to a fixed plate CD. The upper end of A is welded to the L-shaped piece EFG, which can slide without friction on upper end of B. A horizontal pull of $1200N$ is exerted at G as shown. Neglect the weight of EFG.

Mark out the correct statement(s).

A. Shearing stress in A is zero

B. Shearing stress in B is zero

C. Shearing stress in both A and B is zero

D. Shearing stress in both A and B is non-zero.

Answer: B

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2. In the figure shown, A and B are two short steel rods each of cross-sectional area $5cm^2$. The lower ends of A and B are welded to a fixed plate CD. The upper end of A is welded to the L-shaped piece EFG, which can slide without friction on upper end of B. A horizontal pull of $1200N$ is exerted at G as shown. Neglect the weight of EFG.

Longitudinal stress in B is

A. Tensile in nature and having magntitude $180N/cm^2$

B. Tensile in nature and having magnitude $240N/cm^2$

C. Compressive in nature and having magnitude $180N/cm^2$

D. Compressive in nature and having magnitude $240N/cm^2$

Answer: A

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3. In the figure shown, A and B are two short steel rods each of cross-sectional area $5cm^2$. The lower ends of A and B are welded to a fixed plate CD. The upper end of A is welded to the L-shaped piece EFG, which can slide without friction on upper end of B. A horizontal pull of $1200N$ is exerted at G as shown.

Neglect the weight of EFG.

Longitudinal stress in B is

A. Tensile in nature and having magntitude $180N/cm^2$

B. Tensile in nature and having magnitude $240N/cm^2$

C. Compressive in nature and having magnitude $180N/cm^2$

D. Compressive in nature and having magnitude $240N/cm^2$

Answer: C

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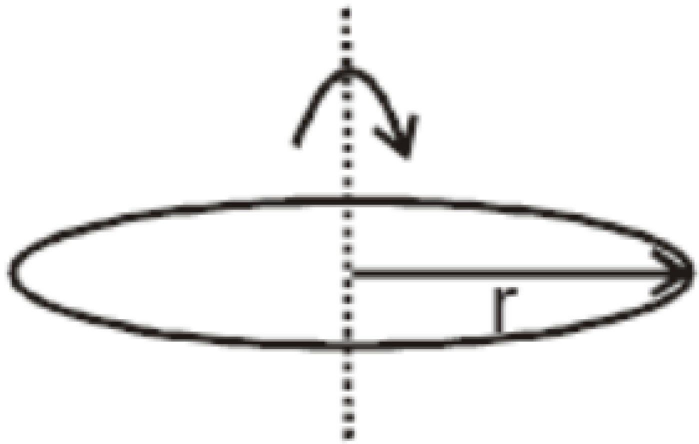
INTERGET TYPE QUESTIONS

1. A ring of radius r made of wire of density ρ is rotated about a stationary vertical axis passing through its centre and perpendicular to the plane of the ring as shown in the figure. Determine the angular velocity (in rad/s) of ring at which the ring breaks. The wire breaks at tensile stress σ. Ignore gravity. Take $\sigma / \rho = 4$ and $r = 1m$.



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2. A $0.1kg$ mass is suspended from a wire of negligible mass. The length of the wire is 1m and its crosssectional are is $4.9 \times 10^{-7} m^2$. If the mass is pulled a little in the vertically downward direction and released, it performs simple harmonic motion of angular frequency $140 rads^{-1}$. If the Young's modulus of the material of the wire is $n \times 10^9 Nm^{-2}$, the value of n is

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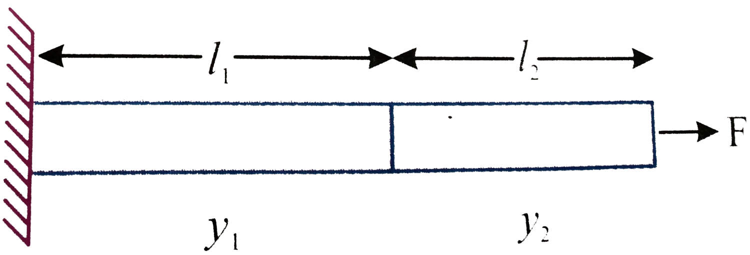
3. Find the

(i) Net elongation rod approximately. $(x \times 10^{-11} m)$ then $x =$

(ii) Y_{eq} of the composite rod $(x \times 0^{11} N. . m^2)$ (assume A = area of cross section of each rod),. Then $x =$

$l_1 = l(2) = 1m, F = 2N/m^2, A = 1sq. m^2$

$y_1 = 2 \times 10^{11} N/m^2 n, y_2 = 3 \times 10^{11} N/m^2$ ltbr4gt



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MUTI CORRECT ANSWER TYPE

1. A student plots a graph from hs readings on the determination of Young modulus of a metal wire but forgets to put the labels figure. The quantities on X and Y axes may be respectively

A. Weight hung and length increased

B. Stress applied and length increased

C. stress applied and strain develop

D. length increased and the weight hung

Answer: A::B::C::D

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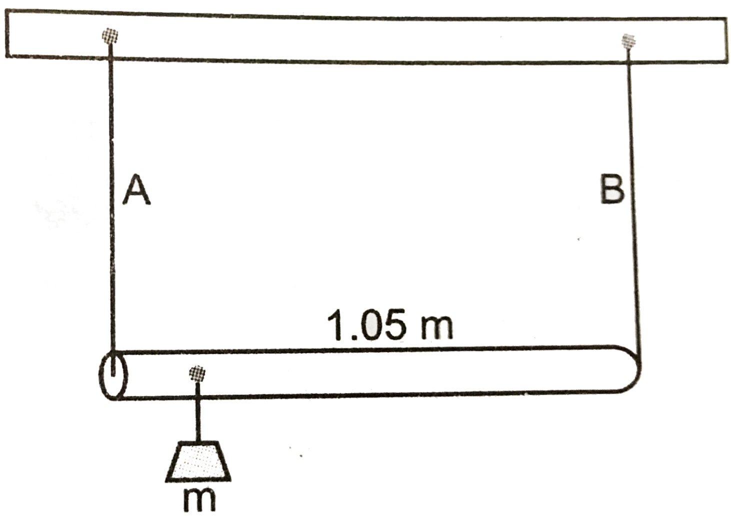
2. A rod of length 1.05 m having negliaible mass is supported at its ends by two wires of steel (wire A) and aluminium (wire B) of equal lengths as shown in fig. The cross-sectional area of wire A and B are $1mm^2$ and $2mm^2$, respectively . At what point along the rod should a mass m be suspended in 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 $Y - (aluminium) = 7.0 \times 10^{10} N^{-2}$



A. Masss m should be suspended close to wire A to have equal stresses in bothe the wires

B. Mass m should be suspended close to B to have equal

C. Mass m should be suspended at the middle of the wires to have equal stress in both the wires

D. Mass m should be suspended close to wire A to have equal strain in both wires

Answer: B::D

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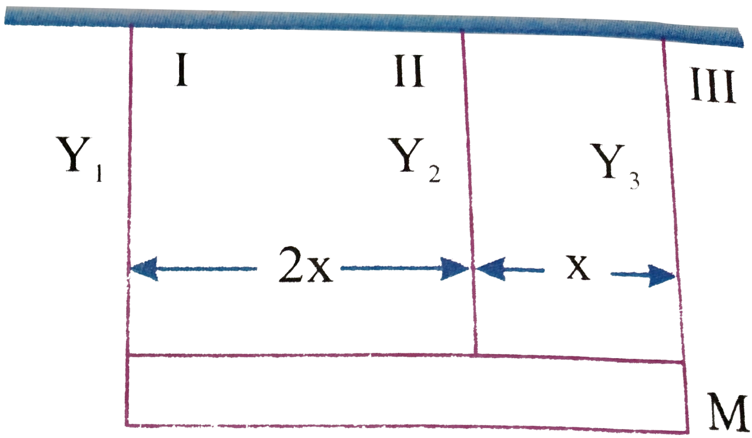
3. Three vertical wires, I, II and III are supporting a block of mass M in horizontal positon. The wires are to equal length and cross-sectional area. It is given that Young's modulus of wire

$II, Y_2 = Y_3$ (Yong's modulus of wire III). The wire I and III and attached at extreme ends of the block.



A. $T_1 = 2T_3$

B. $2T_1 = T_3$

C. $T_2 = T_3$

D. $T_1 = Mg/5$

Answer: B::C::D

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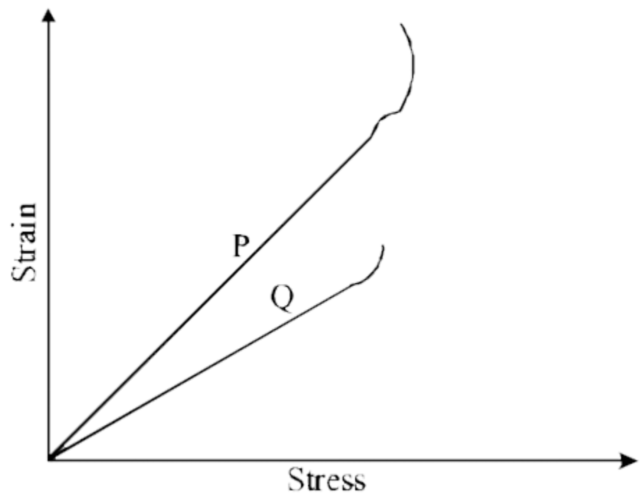
4. In plotting stress versus strain curves for two materials P and Q, a student by mistake puts strain on the y-axis and stress on the x-axis as shown in the figure. Then the correct statement(s) is (are)



A. P has more tensile than Q

B. P is more ducite than Q

C. P is more brittle than Q

D. The young's modulus of P is more than that of Q.

Answer: A::B

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LEVEL-I (H.W)

1. A steel wire of $2mm$ in diameter is stretched by applying a force of $72N$. Stress in the wire is

A. $2.29 \times 10^7 N / m^2$

B. $1.7 \times 10^7 N / m^2$

C. $3.6 \times 10^7 N / m^2$

D. $0.8 \times 10^7 N / m^2$

Answer: A

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2. The length of a wire under stress changes by 0.01% .The strain produced is

A. 1×10^{-4}

B. 0.01

C. 1

D. 10^{4}

Answer: B

Watch Video Solution

3. An air filled balloon is at a depth of $1km$ below the water level in an ocean . The normal stress of the balloon (in Pa) is

(Given,$\rho_{\text{water}} = 10^{3} kgm^{-3}, g = 9.8ms^{-2}$ and $P_{atm} = 10^{5} Pa)$

A. $190 \times 10^5 Pa$

B. $196 \times 10^5 pa$

C. $190 \times 10^7 Pa$

D. $196 \times 10^7 Pa$

Answer: B

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4. A wire of $10m$ long and $1mm^2$ area of cross section is strechted by a force of $20N$. If the elongation is $2mm$ the young's modulus of the material of the wire (in Pa) is

A. 1×10^9

B. 2×10^{-9}

C. 1×10^{11}

D. 1×10^{12}

Answer: C

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5. The area of cross-section of a wire is $10^{-5}m^2$ when its length is increased by 0.1% a tension of $1000N$ is produced. The Young's modulus of the wire will be (in Nm^{-2})

A. 10^{12}

B. 10^{11}

C. 10^9

D. 10^{10}

Answer: B

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6. There are two wires of same material. Their radii and lengths are both in the ratio $1:2$ If the extensions produced are equal, the ratio of the loads is

A. $1:2$

B. $2:1$

C. $1:4$

D. $4:1$

Answer: A

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7. If stress is numbercially equal to young's modulus, the elongation will be

A. $1/4$ the original length

B. $1/2$ the orginal length

C. Equal to the orginal length

D. twice the original length

Answer: C

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8. Two wires of the same length and same material but radii in the ratio of $1:2$ are stretched by unequal forces to produce equal elongation. The ratio of the two forces is

A. $1:1$

B. $1:2$

C. $1:3$

D. $1:4$

Answer: D

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9. A steel wire fo length $5m$ and cross-sectional area $2 \times 10^{-6} m^2$ streches by the same amount as a copper wire of length $4m$ and cross sectional area of $3 \times 10^{-6} m^2$ under a given load. The ratio of young's mouduls of steel to that of copper is

A. $8:15$

B. $15:8$

C. $5:3$

D. $3:5$

Answer: B

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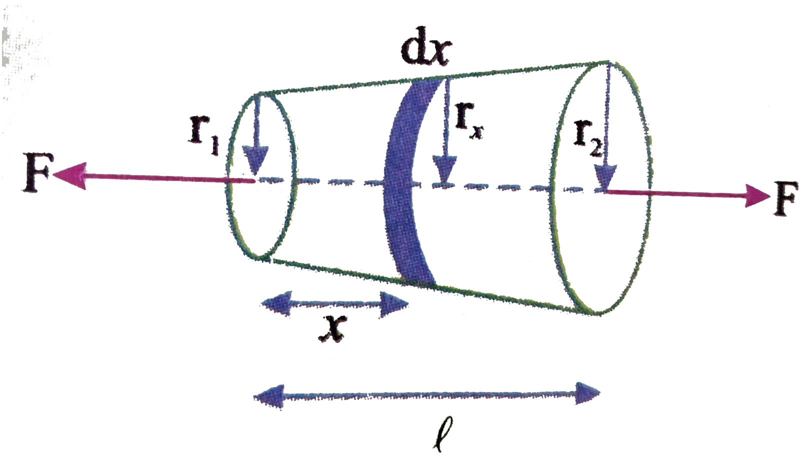
10. A slightly conical wire of length l and radii, r_1 and r_2 is strecthced by two forces each of magnitude F applied parallel to length in opposide directions and normal to end faces. If Y denotes the Young's modulus then find the elogation of the wire $(r_2 > r_1)$.



A. $\frac{Ayr_2}{r_1}$

B. $\frac{AY(r_2 - r_1)}{r_1}$

C. $\frac{Y(r_2 - r_1)}{Ar_1}$

D. $\frac{Yr_1}{Ar_2}$

Answer: B

Watch Video Solution

11. When the tension on a wire is $4N$ its length is l_1. When the tension on the wire is $4N$ length is l_1. When the tension on the wire is $5N$ its length is l_2. Find its natural length.

A. $5l_1 - 4l_2$

B. $4l_1 - 5l_2$

C. $10l_1 - 8l_2$

D. $8l_1 - 10l_2$

Answer: A

Watch Video Solution

12. A wire whose cross-sectional area is $4mm^2$ is streched by $0.1mm$ by a certain load. If a similar wire of double the area of cross-section is under the same load, then the elongation would be

A. $0.5mm$

B. $0.05mm$

C. $0.005mm$

D. $5mm$

Answer: B

Watch Video Solution

13. Two wires A and B have Young moduli in the ratio $1:2$ and ratio of lenghts is $1:1$. Under the application of same stress the ratio of elonagations is

A. $1:1$

B. $1:2$

C. $2:1$

D. $1:4$

Answer: C

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14. A wire is strected by $0.1mm$ by a certain force F' another wire of same material whose diameter and lengths are double to original wire is streched by the same force then its elongation will be

A. $0.05mm$

B. $0.01mm$

C. $0.02mm$

D. $0.04mm$

Answer: A

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15. A brass wire of length $300cm$ when subjected to a force F produces an elongation a. Another wire of twice the diameter and of same length and material, when subjeceted to the force F produces and elongation b. Then the value of a/b is

A. $1:1$

B. $4:1$

C. $1:3$

D. $1:2$

Answer: B

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16. Two bars A and B of circular cross section, same volume and made of the same material, are subjected to tension. If the diameter of A is half that of B and if the force applied to both the rod is the same and it is in the elastic limit, the ratio of extension of A to that of B will be

A. 16

B. 8

C. 4

D. 2

Answer: A

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17. Two wires of the same material have masses in the ratio of their extenisons under the same load if their lenghts are in the ratio $9:10$ is

A. $5:3$

B. $27:40$

C. $6:5$

D. $27:25$

Answer: D

Watch Video Solution

18. Two rods of different materials are clamped at their ends rigidy. When they are heated for the same rise in temperature, same thermal stresses are prouded in them. If their Young's modulll are in the ratio $x : y$ then ratio fo coefficients of their linear expanison is

A. $x : y$

B. $y : x$

C. $x^2 : y^2$

D. $y^2 : x^2$

Answer: B

19. A tungsten wire, $0.5mm$ in diameter, is just strechted between two fixed points at a temperture of $40^\circ C$. Determine the tension in the wire when the temperature falls to $20^\circ C$. (coefficant of linear expansion of tungsten $= 4.5 \times 10^{-6} / .^0 C$, Young's modulus of tungsten $= 3.4 \times 10^{10} Nm^{-2}$)

A. $0.609N$

B. $3.097N$

C. $5.097N$

D. $7.094N$

Answer: A

20. A unifrom steel rod of length $1m$ and area of cross-section $20cm^2$ is hanging from a fixed support. Find the increases in the length of the rod.

A. $1.923 \times 10^{-5} cm$

B. $2.923 \times 10^{-5} cm$

C. $1.123 \times 10^{-5} cm$

D. $3.123 \times 10^{-5} cm$

Answer: A

Watch Video Solution

21. A rope 1 cm in diameter breaks if the tension in it exceeds 500 N. The maximum tension that any be given to a similar rope of diameter 2 cm is

A. 500

B. 250

C. 1000

D. 2000

Answer: D

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22. A cabe breaks if strethced by more than $2mm$. It is cut into two equal parts. By how much eitther part can be streched without breaking

A. $0.25mm$

B. $0.5mm$

C. $1mm$

D. 2000

Answer: C

Watch Video Solution

23. A metal cube of side $10cm$ is subjected to a shearing stress of $10^6 N/m^2$. Calculate the modulus of rigidity if the edge of the cube is displaced by $0.05cm$ with respect to its bottom.

A. 20×10^8

B. 15×10^8

C. 2×10^8

D. 0.2×10^8

Answer: C

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24. The upper end of a wire of radius $4mm$ and lengh $100cm$ is clamped and its other end if twiced through an angle of 60° the angle of shear si

A. 0.024°

B. 0.24°

C. 2.4°

D. 24°

Answer: B

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25. A thin cylindrical rod of length $2.5m$ and radius $5mm$ is firmly fixed at upper end when lower end is twiced, the shear angle is found to be 0.06° then angle of twising is

A. 10°

B. 20°

C. 30°

D. 40°

Answer: C

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26. A spherical ball of volume $1000 cm^3$ is subjected to a pressure of 10 atomosphere. The change in volume is $10^{-2} cm^{-3}$. IF the ball is made of iron find its bulk modulus.

(Atmospheric pressure $= 1 \times 10^5 Nm^{-2}$)

A. $1 \times 10^{11} N/m^2$

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

C. $3 \times 10^{11} N / m^2$

D. $4 \times 10^{11} N / m^2$

Answer: A

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27. On taking a solid rubber ball from the surface to the bottom of a lake $100m$ deep, the reduction in volume is found to eb 0.5% if the density of water si $10^3 kgm^{-3}$ and $g = 10ms^{-1}$, find the bulk modulus of rubber.

A. $1 \times 10^8 Pa$

B. $2 \times 10^8 Pa$

C. $4 \times 10^8 Pa$

D. $6 \times 10^8 Pa$

Answer: B

Watch Video Solution

28. Estimate the change in the density of water in ocean at a depth fo $500m$ below the surface. The density of water at the surface $= 1030 kgm^{-3}$ and the bulk modulus of water $= 2.2 \times 10^9 Nm^{-2}$

A. $2.363 kg / m^3$

B. $1.363 kg / m^3$

C. $4.363 kg / m^3$

D. $3.363 kg / m^3$

Answer: A

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29. A material has Poisson's ratio 0.3, If a uniform rod of it suffers a longtiudinal strain of 25×10^{-3} then the percentage increases in its volume is

A. 1%

B. 2%

C. 3%

D. 4%

Answer: A

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30. A metal rod fo Young's modulus $2 \times 10^{10} Nm^2$ undergoes an elastic strain of $0.02\,\%$ the energy per unit volume stored in the rod in joule/m^3 is

A. 400

B. 800

C. 1200

D. 1600

Answer: A

Watch Video Solution

31. 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

A. $0.2J$

B. $10J$

C. $20J$

D. $0.1J$

Answer: D

Watch Video Solution

32. Two wire of same radius and lengh the are subjected to the same load. One wire is of steel and the other is of copper. If the Young's modulus of steel is twice that of copper, the ratio the energy stored per unit volume in steel to that of copper wire is

A. $1:2$

B. $2:1$

C. $1:4$

D. $4:1$

Answer: A

Watch Video Solution

33. The potential energy of a spring when stretched by $2cmisU$ if the spring is stretched by $8cm$ the potential energy in it is

A. $8U$

B. $16U$

C. $4U$

D. U

Answer: B

Watch Video Solution

34. If bulk modulus of the metal is $2 \times 10^{12} Pa$ and Poisson's ratio is 0.4 then young's modulus of the metal is

A. $1.2 \times 10^{12} Pa$

B. $3 \times 10^{12} Pa$

C. $3.2 \times 10^{12} Pa$

D. $4.2 \times 10^{12} Pa$

Answer: A

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35. Y, K and η respectively the young's Bulk and rigidly modulus of a body, if $\eta = \frac{K}{2}$ then correct relation is

A. $Y = \frac{3K}{7}$

B. $Y = \frac{9K}{7}$

C. $Y = \frac{7}{3}K$

D. $Y = \frac{7K}{7}$

Answer: B

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36. Find poisson's ratio of a metal if young's modulus is 2.8 times rigidly modulus.

A. 0.2

B. 0.4

C. 0.6

D. 0.5

Answer: B

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37. For a metal $Y = 1.1 \times 10^{10} N/m^2$ and Bulk modulus is $K = 11 \times 10^{10} N/m^2$ then Poisson's ratio is (nearly)

A. 0.5

B. 0.7

C. 0.2

D. 0.9

Answer: A

Watch Video Solution

38. If the Possion's ratio of a solid is $1/4$. Then the ratio of its Rigidity Modulus to the Young's modulus is

A. $2/5$

B. $5/2$

C. $7/5$

D. $5/7$

Answer: A

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LEVEL-II (H.W)

1. One end of uniform wire of length L and of weight W is attached rigidly to a point in the roof and a weight W_1 is suspended from its lower end. If s is the area of cross section of the wire, the stress in the wire at a height $(3L/4)$ from its lower end is

A. $\frac{W_1}{S}$

B. $\frac{\left(w_1 + \frac{w}{4}\right)}{S}$

C. $\frac{\left(w_1 + \frac{3w}{4}\right)}{S}$

D. $\frac{(w_1 + w)}{S}$

Answer: C

Watch Video Solution

2. A $20kg$ load is suspended from the lower end of a wire $10cm$ long and $1mm^2$ in cross-sectional area. The upper half of the wire is made of iron and the lower half with aluminium. The total elongation in the wire is

$\left(Y_{\text{iron}} = 20 \times 10^{10} N/m^2, Y_{Al} = 7 \times 10^{10} N/m^2\right)$

A. $18.9 \times 10^{-3} m$

B. $17.8 \times 10^{-3} m$

C. $1.78 \times 10^{-3} m$

D. $1.89 \times 10^{-4} m$

Answer: D

Watch Video Solution

3. A Steel wire is $1m$long and $1mm^2$ in area of cross-section. If it takes $200N$ to streach this wire by $1mm$, the forces that will be required to stretch the wrie of the same material and cross-sectional area form a length of $10m$ to $1002cm$

A. $100N$

B. $200N$

C. $400N$

D. $2000N$

Answer: C

Watch Video Solution

4. A wire of length $1m$ and radius $1mm$ is subjected to a load. The extension is x.The wire is melted and then drawn into a wire of square cross - section of side $2mm$ Its extension under the same load will be

A. $\frac{\pi^2 x}{16}$

B. πx^2

C. $\frac{\pi^2 x}{3}$

D. $\frac{\pi}{x}$

Answer: A

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5. A stress of $10^6 N/m^2$ is required for breaking a material. If the density of the material is $3 \times 10^3 Kg/m^3$, then what should be the minimum length of the wire made of the same material so that it breaks by its own weight $(g = 10m/s^2)$

A. $33.4m$

B. $3.4m$

C. $34cm$

D. $3.4cm$

Answer: A

Watch Video Solution

6. A wire can be broken by $400kg. wt$. The load required to break the wire of double the thickness of the same material will be (in $kgwt$.)

A. 800

B. 1600

C. 3200

D. 6400

Answer: B

Watch Video Solution

7. A copper wire and an aluminium wire has lenghts in the ratio $3:2$ diameter in the ratio $2:3$ and froce applied in the ratio $4:5$ find the ratio of the increase in length of the two wires

$TY_{AT} = 7 \times 10^{10} N/m^2, Y_{Cu} = 11 \times 10^{10} N/m^2$

A. $110, 89$

B. $180:110$

C. $189:110$

D. $80:11$

Answer: C

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8. There are two wires of same material. Their radii and lengths are both in the ratio $1:2$ If the extensions produced are equal, the ratio of the loads is

A. $1:2$

B. $2:1$

C. $1:4$

D. $4:1$

Answer: A

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9. 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. $41 : 9$

B. $3 : 2$

C. $9 : 4$

D. $2 : 2$

Answer: B

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10. A piece of copper wire has twice the radius of a piece of steel wire. Young's modulus for steel is twice that of the copper. One end of the copper wire is joined to one end of the steel wire so that both can be subjected to the same longitudinal force. By what fraction of its length will the steel have stretched when the length of the copper has increased by 1% ?

A. 2% of its orignal length

B. 1% of its orignal length

C. 4% of its orignal length

D. 0.5% of its orignal length

Answer: A

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11. A tangential force of $2100N$ is applied on a surface area $3 \times 10^{-6} m^2$ which is $0.1m$ form fixed surface. The force produces a shift of $7m$ of upper surface with respect to bottom. Calcualte the modulus of rigidity fo the material.

A. $2 \times 10^{10} N / m^2$

B. $1 \times 10^{10} N / m^2$

C. $3 \times 10^{10} N / m^2$

D. $4 \times 10^{10} N / m^2$

Answer: B

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12. 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?

A. $\frac{3P}{K\alpha}$

B. $\frac{P}{2\alpha K}$

C. $\frac{P}{3\alpha K}$

D. $\frac{P}{\alpha K}$

Answer: C

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13. 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 ....

A. $\frac{mg}{AK}$

B. $\frac{mg}{3AK}$

C. $\frac{mg}{A}$

D. $\frac{3mg}{AK}$

Answer: B

Watch Video Solution

14. Find the change in density of water in ocean at depth of $700m$ below the surface. The denity of water at the surface is $1000kg / m^3$ and the bulk modulus of water is $4.9 \times 10^9 Nm^{-2}$

A. $2.4kg / m^3$

B. $3.4kg/m^3$

C. $1.4kg/m^3$

D. $4.4kg/m^3$

Answer: C

Watch Video Solution

15. When a rubber ball of volume v, bulk modulus K is at a depth h in water then decreases in its volume is

A. $\frac{h\rho gv}{K}$

B. $\frac{h\rho gv}{2K}$

C. $\frac{h\rho gv}{3K}$

D. $\frac{h\rho gv}{4K}$

Answer: A

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16. A fractinal change in volume of oil is i percent . When a pressure f $2 \times 10^7 N/m^2$ is applied. Caluclate the bulk modulus and its compressibiliyt.

A. $3 \times 10^8 N/m^2, 0.33 \times 10^{-9} m^2/N$

B. $5 \times 10^9 N/m^2, 2 \times 10^{-10} m^2/N$

C. $2 \times 10^9 N/m^2, 5 \times 10^{-10} m^2/N$

D. $2 \times 10^9 N/m^2, 5 \times 10^{-9} m^2/N$

Answer: C

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17. When a wire of length $10m$ is subjected to a force of $100N$ along its length, the lateral strain produced is 0.01×10^{-3}. The poisson's ratio was found to be 0.4. If area of cross section of wire is $0.25m^2$, its young's modulus is

A. $1.6 \times 10^8 N/m^2$

B. $2.5 \times 10^{10} N/m^2$

C. $12.5 \times 10^{11} N/m^2$

D. $16 \times 10^9 N/m^2$

Answer: A

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18. The posisson's ratio of material is 0.4. If a force is applied to a wire of this material, then therre si a decreases of cross-sectional area by 2% . The percentage incrases in its length is

A. 3%

B. 2.5%

C. 1%

D. 0.5%

Answer: B

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19. A wire having a length L and cross- sectional area A is suspended at one of its ends from a ceiling . Density and young's modulus of material of the wire are ρ and Y, respectively. Its strain energy due to its own weight is $\frac{\rho^2 g^2 A L^3}{\alpha Y}$. Find the value of α

A. $\dfrac{d^2g^2Al^3}{6Y}$

B. $\dfrac{dgAl^3}{6Y}$

C. $\dfrac{d^2g^2Al^3}{3Y}$

D. $\dfrac{d^2g^2A^2l^3}{3Y}$

Answer: A

Watch Video Solution

20. Two wires of same material and same diameter have lenghts in the ratio $2:5$. They are strechted by same force. The ratio of work done in strechting them is

A. $5:2$

B. $2:5$

C. $1:3$

D. $3:1$

Answer: B

Watch Video Solution

21. A wire fixed at the upper end stretches by length l by applying a force F. The work done in stretching is

A. $F/2l$

B. Fl

C. $2Fl$

D. $Fl/2$

Answer: D

Watch Video Solution

22. If 'S' is stress and 'Y' is young's modulus of material of a wire, the energy stored in the wire per unit volume is

A. $\frac{S}{2Y}$

B. $\frac{2Y}{S^2}$

C. $\frac{S^2}{2Y}$

D. $2S^2Y$

Answer: C

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23. A simple pendulum is made by attaching $1Kg$ bob to $5m$ long copper wire of diameter $0.08cm$ and it has a certatin period of oscillation and $10kgbob$ is replaced by kg the change in time period is $\left(Y = 12.4 \times 10^{10} Nm^{-2}\right)$

A. 0.0035 sec

B. 4.4915 sec

C. 4.488 sec

D. 0.0021 sec

Answer: A

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24. A metal wire $4m$ long and $2 \times 10^{-7} sq. m$ in cross-section is streched by a force of $30N$. If the work done in streching that wire is $4.5 \times 10^{-2} J$ the young's modulus of the wire is

A. $2 \times 10^{11} Pa$

B. $4 \times 10^{11} Pa$

C. $2 \times 10^{12} Pa$

D. $4 \times 10^{12} Pa$

Answer: A

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