PHYSICS

BOOKS - DC PANDEY ENGLISH

ELASTICITY

Example

1. Determine the elongation of the steel bar $1m$ long and $1.5cm^2$ cross-sectional area when subjected to a pull of $1.5 \times 10^4 N$.

$\left(TakeY = 2.0 \times 10^{11} N/m^2\right)$.

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2. The bulk modulus of water is $2.3 \times 10^9 N/m^2$.

(a) Find its compressibility in the units atm^{-1}.

(b) How much pressure in atmospheres in needed to compress a sample of water by 0.1% ?

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

(a) the energy density of wire,

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

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4. A rubber cord has a cross -sectional area $1mm^2$and total unstretched length$10.0cm$. It is streched to $12.0cm$ and then released to project a missile of mass 5.0 g.Taking young's modulus Y for rubber as $5.0 \times 10^8 N/m^2$.Calculate the velocity of projection .

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5. Find the greatest length of steel wire that can hang vertically without breaking. Breaking stress of steel $= 8.0 \times 10^8 N/m^2$. Density of steel $= 8.0 \times 10^3 kg/m^3$. Take $g = 10 m/s^2$.

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6. A rod has a radius of 100 mm and a length of 10 cm. A 100 N force compresses along its length . Calculate the longitudinal stress developed in the rod.

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7. Consider a rod of steel having radius of 8 mm and the length of 2 m. If a force of 150 kN stretches it along its lengths , then calculated the stress, percentage strain in the rod if the elongation in length is 7.46 mm.

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8. If the angle of shear is 30° for a cubical body and the change in length is 250 cm, then what must be the volume of this cubical body.

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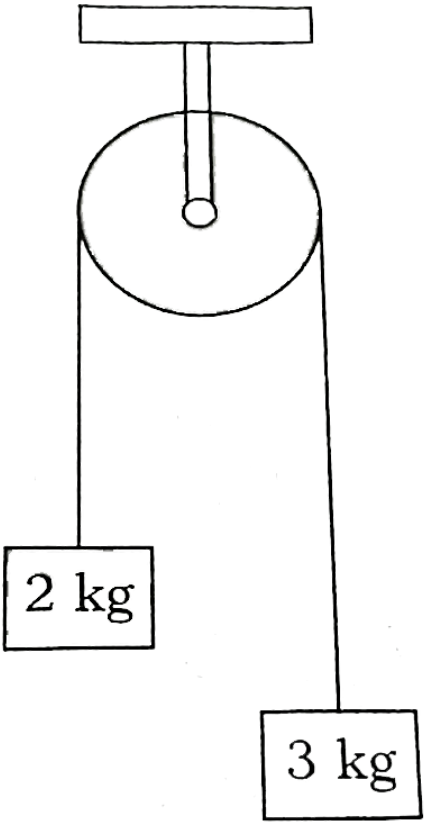
9. Two blocks of masses 2 kg and 3kg are connected by a metal wire going over a smoother pulley as shown in figure. The breaking stress of the steel is $2 \times 10^9 Nm^{-2}$. What would be the minimum radius of the wire

used if it not to break ? Take ,$g = 10ms^{-2}$



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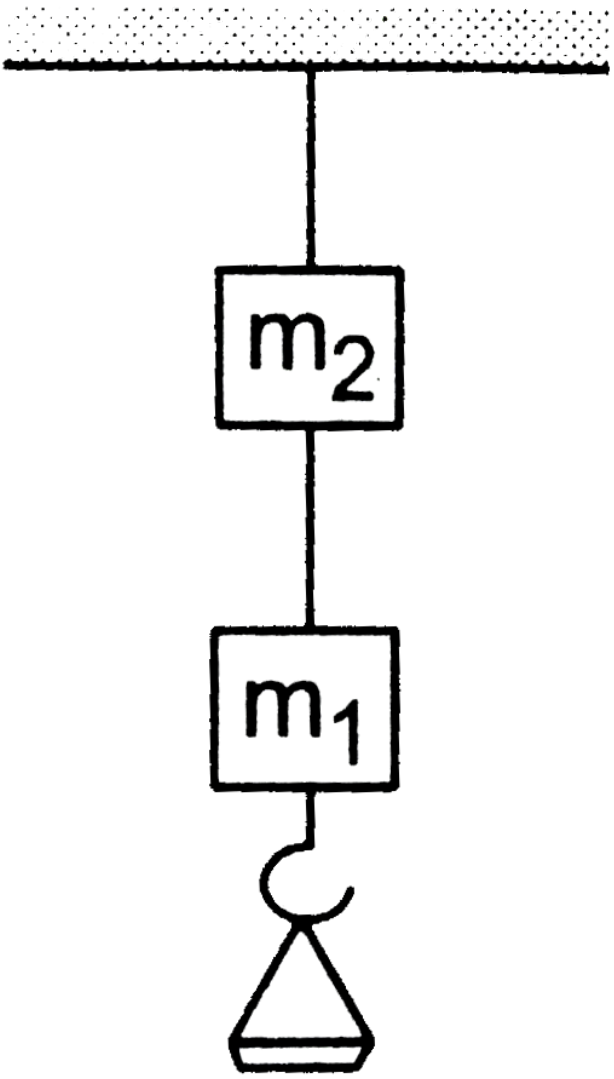
10. The two wires shown in figure are made of the same material which has a breaking stress of $8 \times 10^8 Nm^{-2}$. The area of cross section of the upper wire is $0.006cm^2$ and that of the lower wire is $0.003cm^2$. The mass

$m_1 = 10kg$, $m_2 = 20kg$ and the hanger is light. a. Find the maximum load that can be put on the hanger without breaking a wire. Which wire will break first if the load is increased? b. Repeat the above part $m_1 = 10kg$ and $m_2 = 36kg$.



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11. Consider a solid cube which is subjected to a pressure of $6 \times 10^5 Nm^{-2}$. Due to this pressure, the each side of the cube is shortened by 2% . Find out the volumetric strain of the cube.

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12. If a wire of length 4 m and cross-sectional area of $2m^2$ is stretched by a force of 3 kN, then determine the change in length due to this force . Given, Young's modulus of material of wire is $110 \times 10^9 Nm^{-2}$

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13. A steel wire of length 4 m and diameter 5 mm is strethed by 5 kg-wt. Find the increase in its length, if the Young's modulus of steel is 2×10^{12} dyne cm^2

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14. Determine the elongation of the steel bar $1m$ long and $1.5cm^2$ cross-sectional area when subjected to a pull of $1.5 \times 10^4 N$.

(Take $Y = 2.0 \times 10^{11} N/m^2$).

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15. A wire is replaced by another wire of same length and material but of twice diameter.

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

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

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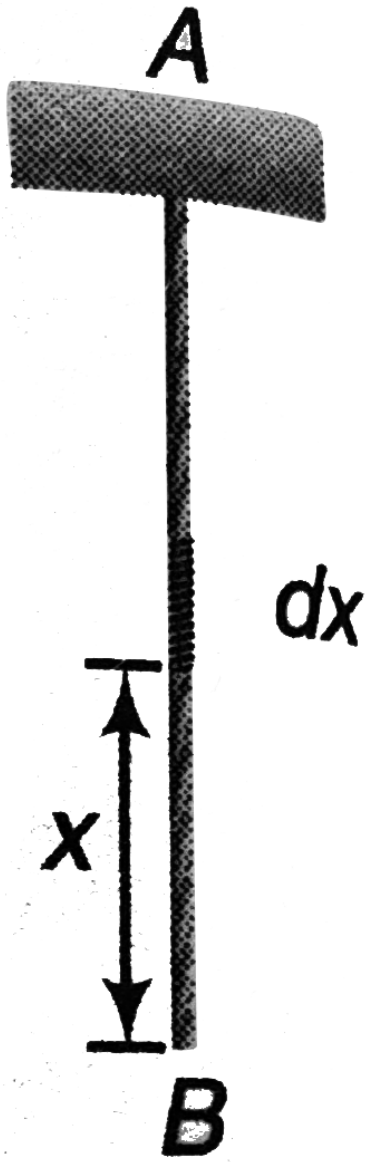
16. A bar of mass m and length l is hanging from point A as shown in figure.Find the increase in its length due to its own weight. The young's

modulus of elasicity of the wire is Y and area of cross-section of the wire is A.



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17. A rod AD consisting of three segments AB,BC and CD joined together is hanging vertically from a fixed support at A. The lengths of the segments are restectively 0.2 m , 0.3m and 0.15 m . The cross-section of the rod is uniformly $10^{-4}m^2$. A weight of 10 kg is hung from D.Calculate the displacement of points B,C and D if $Y_{AB} = 3.5 \times 10^{10} Nm^{-2}, Y_{BC} = 5 \times 10^{10}, Y_{CD} = 2 \times 10^{10} Nm^{-2}.$ (Neglect the weight of the rod)

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18. A block of weight 10 N is fastened to one end of wire of cross-sectional area $4mm^2$ and is rotated ina vertical circle of radius 30 cm. The speed of the block at the bottom of the circle is $3ms^{-1}$. Find the elongation of the wire when the block is at the bottom of the circle . Young's modulus of the material of the wire $= 2 \times 10^{11} Nm^{-2}. (g = 10ms^{-2})$

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19. A 2 kg mass is suspended by a rubber cord 2 m long and of cross-section 0.5 cm. It is made to describe a horizontal circle of radius 50cm in 4 times a second. Find the extension of the cord.(Young's modulus $Y = 7 \times 10^8 Nm^{-2}$)

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20. A light rod of length $2m$ 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 $0.1cm^2$. The other wire is a brass of cross section $0.2cm^2$. A weight is suspended from a certain point of the rod such that equal stress are produced in both the wires. Which of the following are correct?

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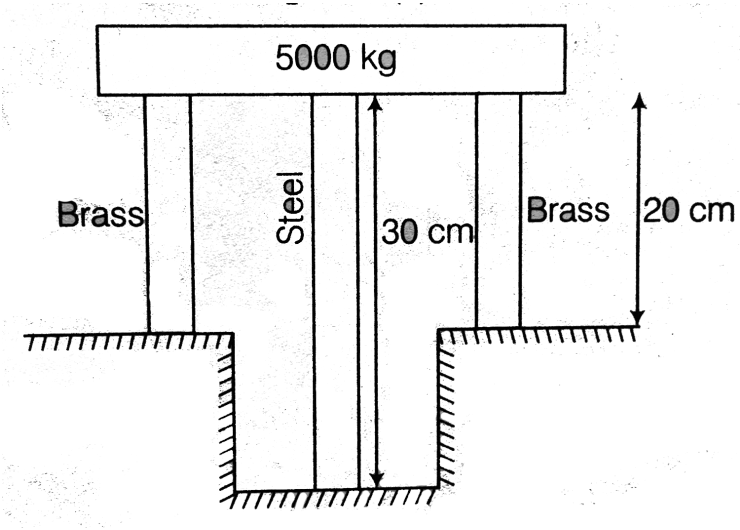
21. A steel rod of cross-sectional area $16cm^2$ and two brass rods each of cross-sectional area $10cm^2$ together support a load of $5000kg$ as shown in the figure. (Given, $Y_{steel} = 2 \times 10^6 kgcm^{-2}$ and $Y_{brass} = 10^6 kgcm^{-2}$). Choose the correct option(s).



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22. How much should the pressure on a litre of water be changed to compress it by 0.10%?

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23. What will be the decrease in volume of $100cm^3$ of water under pressure of 100 atm if the compressibility of water is 4×10^{-5} per unit atmosphere pressure ?

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24. Find the decrease in the volume of a simple of water from the following data. Initial volume $= 2000cm^{-2}$, initial pressure $= 10^5 Nm^{-2}$, final pressure $= 10^6 N^{-1}m^2$.

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25. What is the density of lead under a pressure of $2 \times 10^8 Nm^{-2}$, if the bulk modulus of lead is $8 \times 10^9 Nm^{-2}$ and initially the density of lead is $11.4gcm^{-3}$?

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26. The bulk modulus of water is $2.3 \times 10^9 Nm^{-2}$.

(i) Find its compressibility.

(ii) How much pressure in atmosphere is needed to compress a sample of water by 0.1%

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27. A 4 cm cube has its upper face displaced by 0.1 mm by a tangential force of 8 kN. Calculate the shear modulus of the cube.

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28. A square lead slab of side 50cm and thickness 5.0cm is subjected to a shearing force (on its narrow face) of magnitude 9.0×10^4 N. The lower edge is riveted to the floor. How much is the upper edge displaced, if the shear modulus of lead is 5.6×10^{90} Pa?

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29. Consider an Indian rubber cube having modulus of rigidity of 2×10^7 dyne cm^{-2} and of side 8 cm. If one side of the rubber is fixed, while a tangential force equal to the weight of 300 kg is applied to the opposite face, then find out the shearing strain produced and distance through which the strain side moves .

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30. The stress-strain graph for a metallic wire is shown at two different temperature, T_1 and T_2 which temperature is high T_1 or T_2 ?

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31. Determine the poisson's ratio of the material of a wire whose volume remains constant under an external normal stress.

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32. A solid sphere of radius $2.45m$ is rotating with an angular speed of $10rad/s$. When this rotating sphere is placed on a rough horizontal surface then after sometime it starts pure rolling. Find the linear speed of the sphere after it starts pure rolling.

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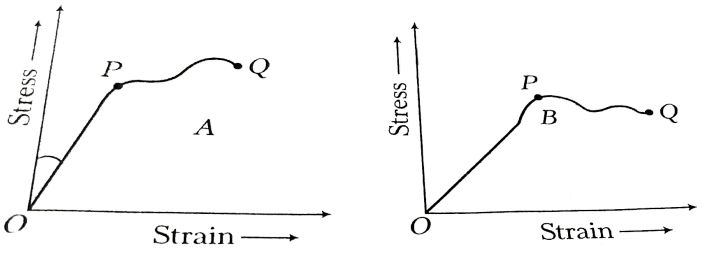
33. The stress-strain graphs for two materials A and B are shown in the figure. The graphs are drawn to the same scale.



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

(b) Which material is more ductile ?

(c) Which material is more brittle?

(d) Which of the two is the stronger material ?

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34. Calculate the work done in streching a steel wire of Young's modulus of $2 \times 10^{11} Nm^{-2}$ mass of 40kg,length of 200 cm and area of cross-section is 0.06 cm^2 slowly applied without the elastic limit being reached.

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35. A steel wire of 4.0 m is stretched through 2.0 mm. The cross - sectional area of the wire is $2.0mm^2$. If young's modulus of steel is $2.0 \times 10^{11} Nm^{-2}$ find (i) the energy density of the wire, (ii) the elastic potential energy stored in the wire.

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

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37. A rubber cord has a cross -sectional area $1mm^2$and total un-stretched length$10.0cm$. It is stretched to $12.0cm$ and then released to project a missile of mass 5.0 g. Taking young's modulus Y for rubber as $5.0 \times 10^8 N/m^2$.Calculate the velocity of projection .

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38. (a) A wire 4 m long and 0.3mm in diameter is stretched by a force of 100 N. If extension in the wire is 0.3 mm, calculate the potential energy stored in the wire.

(b) Find the work done is stretching a wire of cross-section $1mm^2$ and length 2 m through 0.1 mm. Young's modulus for the material of wire is $2.0 \times 10^{11} Nm^{-2}$.

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

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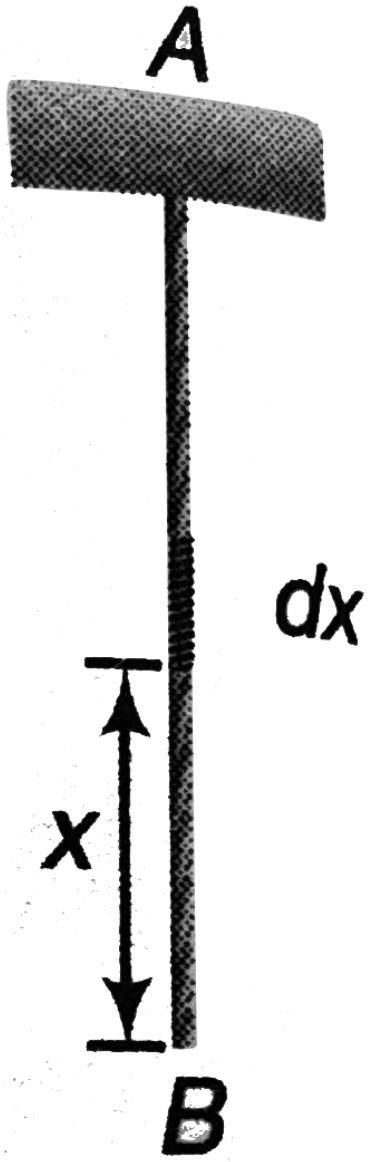
Solved Examples

1. A bar of mass m and length l is hanging from point A as shown in figure.Find the increase in its length due to its own weight. The young,s modulus of elasicity of the wire is Y and area of cross-section of the wire

is A.



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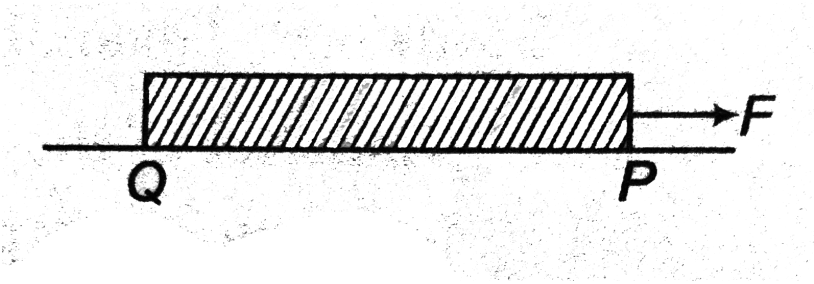
2. A rod PQ of mass, area of cross section A, length l and young's modulus of elasticity Y is lying on a smooth table as shown in figure. A force Fis applied at P. Find

(a) tension at a distance x from end P,

(b) longitudinal stress at this point,

(c) total change in length and

(d) total strain the rod.



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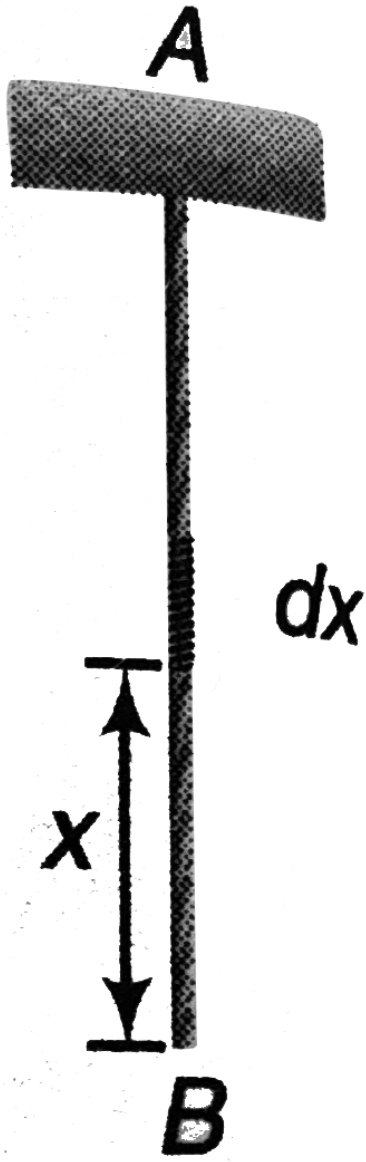
3. A steel rod of length $6.0m$ and diameter $20mm$ is fixed between two rigid supports . Determine the stress in the rod, when the temperature increases by 80° C if

(a)the ends do not yield (b) the ends yield by 1mm

Take $Y = 2.0 \times 10^6 kg/cm^2$ and $\alpha = 12 \times 10^{-6} per^\circ C$.



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4. If the elastic limit of copper is $1.5 \times 10^8 N/m^2$,determine the minimum diameter a copper wire can have under a load of$10.0kg$ force , if its elastic limit is not to be exceeded.

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5. Find the greatest length of steel wire that can hang vertically without breaking. Breaking stress of steel $= 8.0 \times 10^8 N/m^2$. Density of steel $= 8.0 \times 10^3 kg/m^3$. Take $g = 10m/s^2$.

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6. Bulk modulus of water is $\left(2.3 \times 10^9 N/m^2\right)$.Taking average density of water$\rho = 10^3 kg/m^3$,find increases in density at a depth of $1km$. Take $g = 10m/s^2$

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Miscellaneousexamples

1. The presssure of a medium is changed from $1.01 \times 10^5 Pa$ to $1.165 \times 10^5 Pa$ and change in volume is $10\,\%$ keeping temperature constant . The bulk modulus of the medium is

(a) $204.8 \times 10^5 Pa$ (b) $102.4 \times 10^5 Pa$ (c) $5.12 \times 10^5 Pa$

(d) $1.55 \times 10^5 Pa$

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2. A light rod of length of length $2m$ is suspended from a 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 $2 \times 10^{-3} m^2$. x is the distance from the steel wire end, at which a weight may be hung. $Y_{steel} = 2 \times 10^{11} Pa$ and $Y_{brass} = 10^{11} Pa$

Which of the following statement(s) is /are correct ?

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3. 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}. 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 $\left(1.994 \times 10^{11} N/m^2\right)$.

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4. A thin ring of radius R is made of a material of density ρ and Young's modulus Y. If the ring is rotated about its centre in its own plane with angular velocity ω , find the small increase in its radius.

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Exercise 15 1

1. Two wires A and B of same dimensions are stretched by same amount of force .Young's modulus of A is twice that of B. Which wire will get more elongation?

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2. A rod 100 cm long and of $2cm \times 2cm$ cross-section is subjected to a pull of 1000 kg force. If the modulus of elasticity of the materials is $2.0 \times 10^6 kg/cm^2$, determine the elongation of the rod.

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3. A cast iron column has internal diameter of 200 mm. What sholud be the minimum external diameter so that it may carry a load of $1.6MN$ without the stress exceeding $90N/mm^2$?

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4. Find the dimensions of stress, strain and modulus of elasticity.

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Exercise 15 2

1. Find the dimensions of energy density.

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2. (a) A wire $4m$ long and 0.3 mm, calculate the potential energy stored in the wire.

Young's modulus for the material of wire is $2.0 \times 10^{11} N/m^2$.

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Assertion And Reason

1. Assertion : steel is more elastic than rubber.

Reason : For same strain , steel requires more stress to be produced in it.

A. (a) If both Assertion and Reason are true and the Reason is correctn explanation of the Assertion.

B. (b) If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

C. If Assertion is true, but the Reason is false.

D. If Assertion is false but the Reason is true.

Answer: A

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2. Assertion : If pressure is increased , bulk modulus of gases will increase.

Reason : With increase in pressure , temperature of gases also increases .

A. (a) If both Assertion and Reason are true and the Reason is correctn explanation of the Assertion.

B. (b) If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

C. If Assertion is true, but the Reason is false.

D. If Assertion is false but the Reason is true.

Answer: C

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3. Assertion: From the relation $Y = \frac{Fl}{A\Delta l}$, we can say that, if length of a wire is doubled, its young's modulus of elasticity will also becomes two times.

Reason : Modulus of elasticity is a material property.

A. (a) If both Assertion and Reason are true and the Reason is correctn explanation of the Assertion.

B. (b) If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

C. If Assertion is true, but the Reason is false.

D. If Assertion is false but the Reason is true.

Answer: A

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4. Assertion : Bulk modulus of elasticity can be defined for all three states of matter, solid liquid and gas.

Reason: Young's modulus is not defined for liquids and gases.

A. (a) If both Assertion and Reason are true and the Reason is correctn explanation of the Assertion.

B. (b) If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

C. If Assertion is true, but the Reason is false.

D. If Assertion is false but the Reason is true.

Answer: C

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5. Assertion: Every wire is like a spring, whose spring constant ,$K \propto \frac{1}{l}$, where l is length of wire.

Reason : It follows from the relation

$K = \frac{YA}{l}$

A. (a) If both Assertion and Reason are true and the Reason is correctn explanation of the Assertion.

B. (b) If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

C. If Assertion is true, but the Reason is false.

D. If Assertion is false but the Reason is true.

Answer: A

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6. Assertion: Ratio of stress and strain is always constant for a substance.

Reason : This ratio is called modulus of elasticity .

A. (a) If both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

B. (b) If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

C. (c) If Assertion is true, but the Reason is false.

D. (d) If Assertion is false but the Reason is true.

Answer: D

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7. Assertiobn : Ratio of isothermal bulk modulus and adiabatic bulk modulus for a monoatomic gas at a given pressure is $\frac{3}{5}$.

This ratio is equal to $\gamma = \frac{C_p}{C_v}$.

A. (a) If both Assertion and Reason are true and the Reason is correctn explanation of the Assertion.

B. (b) If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

C. If Assertion is true, but the Reason is false.

D. If Assertion is false but the Reason is true.

Answer: C

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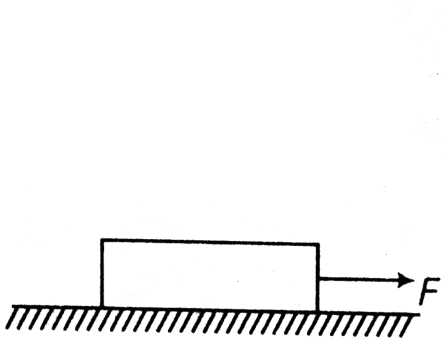
8. Assertion: A uniform elastic rod lying on smooth horizontal surface is pulled by a constant horizontal force of magnitude F as shown in the figure. Another identical elastic rod is pulled vertically upwards by a

constant vertical force of magnitude F as shown in the figure . the extensions in both the rods will be same.

Reason : In a uniform elastic rod, the extension depends only on forces acting at the ends of rods.



A. (a) If both Assertion and Reason are true and the Reason is correctn explanation of the Assertion.

B. (b) If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

C. If Assertion is true, but the Reason is false.

D. If Assertion is false but the Reason is true.

Answer: C

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9. Assertion : identical springs of steel and copper are equally stretched. More work will be done on the steel spring.

Reason : Steel is more elastic than copper.

A. (a) If both Assertion and Reason are true and the Reason is correctn explanation of the Assertion.

B. (b) If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

C. If Assertion is true, but the Reason is false.

D. If Assertion is false but the Reason is true.

Answer: A

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10. Assertion Young's modulus of elasticity is not defined for liquids.

Reason Liquids cannot be stretched as wires.

A. If both Assertion and Reason are true and Reason is the correct explanation of Assertion.

B. If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

C. If Assertion is true but Reason is false.

D. If both Assertion and Reason are false.

Answer: A

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11. Assertion Stress and modulus of elasticity have the same dimensions

Reason Strain is dimensionless.

A. If both Assertion and Reason are true and Reason is the correct explanation of Assertion.

B. If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

C. If Assertion is true but Reason is false.

D. If both Assertion and Reason are false.

Answer: A::B

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12. Assertion Modulus of elasticity does not depend upon the dimensions of material

Reason Modulus of elasticity is a material property.

A. If both Assertion and Reason are true and Reason is the correct explanation of Assertion.

B. If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

C. If Assertion is true but Reason is false.

D. If both Assertion and Reason are false.

Answer: A

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13. Assertion Upto the elastic limit, strain $\propto$ stress.

Reason Upto elastic limit, material returns to its original shape and size, when external force is removed.

A. If both Assertion and Reason are true and Reason is the correct explanation of Assertion.

B. If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

C. If Assertion is true but Reason is false.

D. If both Assertion and Reason are false.

Answer: D

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14. Assertion Incompressible liquids have finite value of bulk modulus of elasticity.

Reason Compressibility is inverse of bulk modulus of elasticity.

A. If both Assertion and Reason are true and Reason is the correct explanation of Assertion.

B. If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

C. If Assertion is true but Reason is false.

D. If Assertion is false but Reason is true.

Answer: D

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15. Assertion If length of a wire is halved, its Young's modulus of elasticity will become two times.

Reason The ratio of longitudinal stress and longitudinal strain is called Young's modulus of elasticity.

A. If both Assertion and Reason are true and Reason is the correct explanation of Assertion.

B. If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

C. If Assertion is true but Reason is false.

D. If Assertion is false but Reason is true.

Answer: D

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16. Assertion If a wire is stretched, only half of the work done in stretching the wire remains stored as elastic potential energy.

Reason Potential energy stored in the wire is 1/2 (stress) $\times$ (strain)

A. If both Assertion and Reason are true and Reason is the correct explanation of Assertion.

B. If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

C. If Assertion is true but Reason is false.

D. If both Assertion and Reason are false.

Answer: C

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17. Assertion The materials having low value of Young's modulus of elasticity are more ductile.

Reason If Young's modulus is less, they can be easily stretched as wires.

A. If both Assertion and Reason are true and Reason is the correct explanation of Assertion.

B. If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

C. If Assertion is true but Reason is false.

D. If both Assertion and Reason are false.

Answer: A

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18. Assertion Bulk modulus of elasticity of gases is pressure dependent.

Reason More the pressure of gas, more is the Bulk modulus of elasticity of gas.

A. If both Assertion and Reason are true and Reason is the correct explanation of Assertion.

B. If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

C. If Assertion is true but Reason is false.

D. If both Assertion and Reason are false.

Answer: A

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19. Assertion : Bulk modulus of an incompressible liquid is infinite.

Reason : Compressibility is inverse of bulk modulus.

A. If both Assertion and Reason are true and Reason is the correct explanation of Assertion.

B. If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

C. If Assertion is true but Reason is false.

D. If both Assertion and Reason are false.

Answer: B

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20. Assertion Upto elastic limit of a stress-strain curve, the steel wire tends to regain its original shape when stress is removed.

Reason Within elastic limit, the wire follows Hooke's law.

A. If both Assertion and Reason are true and Reason is the correct explanation of Assertion.

B. If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

C. If Assertion is true but Reason is false.

D. If both Assertion and Reason are false.

Answer: C

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21. Assertion A diabatic bulk modulus of an ideal gas in more than its isothermal bulk modulus.

Reason Both the modulii aer proportional to the pressure of gas at that moment.

A. If both Assertion and Reason are true and Reason is the correct explanation of Assertion.

B. If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

C. If Assertion is true but Reason is false.

D. If both Assertion and Reason are false.

Answer: B

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22. Assertion If radius of cylinderical wire is doubled, then this wire can bear four times stress.

Reason By doubling the radius, area of cross-section will become four times.

A. If both Assertion and Reason are true and Reason is the correct explanation of Assertion.

B. If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

C. If Assertion is false but Reason is true.

D. If both Assertion and Reason are false.

Answer: D

Watch Video Solution

Level 1 Single Correct

1. The bulk modulus for an incompresssible liquid is

A. zero

B. unity

C. infinity

D. between 0 and 1

Answer: C

Watch Video Solution

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

B. Y

C. $2Y$

D. $4Y$

Answer: B

Watch Video Solution

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

A. W

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

C. $\frac{W}{4}$

D. $2W$

Answer: A

Watch Video Solution

4. Identify the case when an elastic metal rod does not undergo elongation

A. it is pulled with a constant acceleration on a smooth horizontal surface

B. it is pulled with constant acceleration on a smooth horizontal surface

C. it is allowed to fall freely

D. All of the above

Answer: C

Watch Video Solution

5. Vessel of $1 \times 10^{-3} m^3$ volume contains an oil. If a pressure of $1.2 \times 10^5 N/m^2$ is applied on it , then volume decreases by $0.3 \times 10(-3) m^3$. The bulk modulus of oil is

A. (a) $6 \times 10^{10} N/m^2$

B. (b) $4 \times 10^5 N/m^2$

C. (c) $2 \times 10^7 N/m^2$

D. (d) $1 \times 10^6 N/m^2$

Answer: B

Watch Video Solution

6. 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. (A) 2×10^{12}

B. (B) 4×10^{11}

C. (C) 2×10^{11}

D. (D) 0.02×10^9

Answer: A

Watch Video Solution

7. 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. A) $\left(\pi^2\right)\frac{x}{8}$

B. B) $\left(\pi^2\right)\frac{x}{16}$

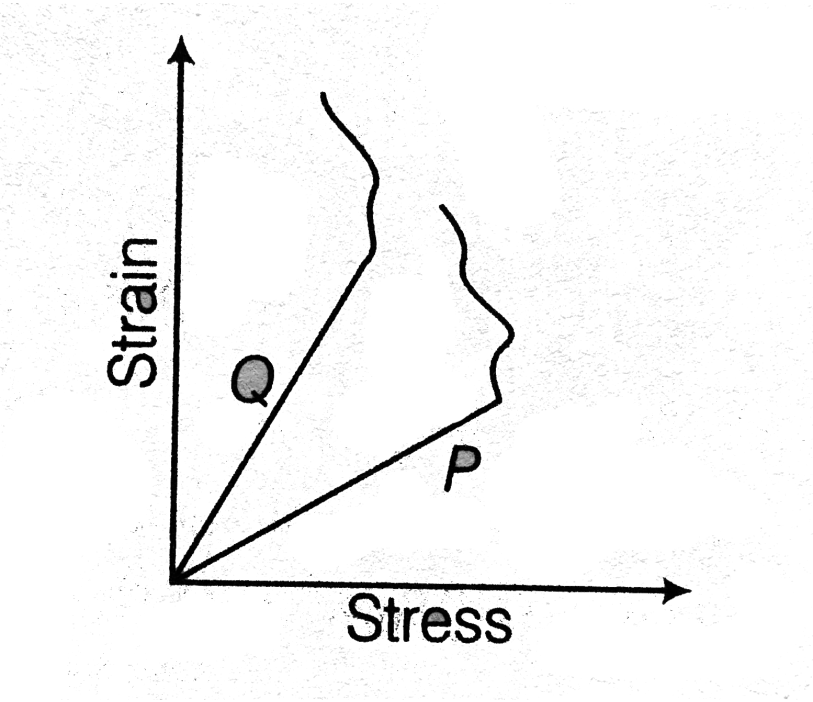
C. C) $\left(\pi^2\right)\frac{x}{2}$

D. D) $\frac{x}{2\pi}$

Answer: B

Watch Video Solution

8. Figure shows the stress-strain curve of two metals P and Q . From the graph, it can be concluded that



A. (A) P has greater young's modulus and lesser ductility

B. (B) Q has greater young's modulus and lesser ductility

C. (C) P has greater young's modulus and greater ductility

D. (D) Q has greater young's modulus and greater ductility

Answer: A

Watch Video Solution

9. The bulk modulus of water is $2.0 \times 10^9 N/m^2$. The pressure required to increase the density of water by $0.1\ \%$ is

A. $2.0 \times 10^3 N/m^2$

B. $2.0 \times 10^6 N/m^2$

C. $2.0 \times 10^5 N/m^2$

D. $2.0 \times 10^7 N/m^2$

Answer: B

Watch Video Solution

10. If the work done in stretching a wire by $1mm$ is $2J$, then work necessary for stretching another wire of same material but with double radius of cross -section and half of the length by $1mm$ is

A. (A) $8J$

B. (B) $16J$

C. (C) $4J$

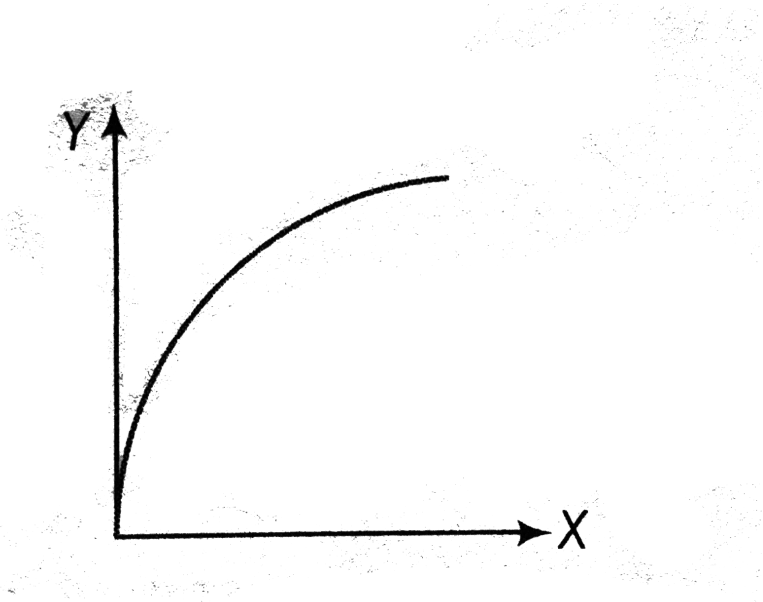
D. (D) $32J$

Answer: B

Watch Video Solution

11. 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. A) U, σ

B. B) U, ε

C. C) σ, ε

D. D) `None of these

Answer: B

Watch Video Solution

12. Depth of sea is maximum at Mariana Trench in West Pacific Ocean. Trench has a maximum depth of about $11km$. At bottom of trench water column above it exerts $1000atm$pressure. Percentage change in density of sea water at such depth will be around

(Given , B $= 2 \times 10^9 Nm^{-2}$ and $P_{atm} = 1 \times 10^{5Nm^{-2}}$)

A. about 5%

B. about 10%

C. about 3%

D. about 7%

Answer: A

Watch Video Solution

13. One end of a horizontal thick copper wire of length $2L$ and radius $2R$ is weded to an end of another horizontal thin copper wire of length 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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14. 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. 10^6

B. 9.9×10^5

C. $9.9 \times 10(7)$

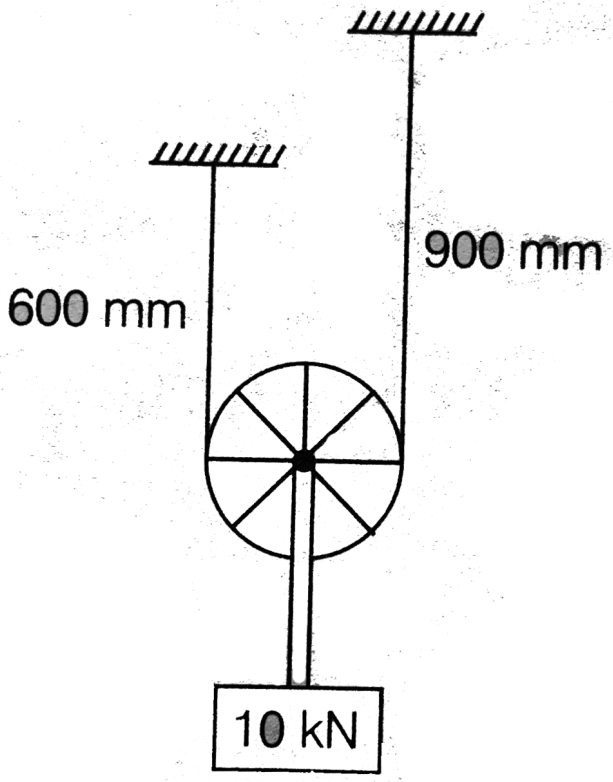
D. 9.9×10^6

Answer: D

Watch Video Solution

15. A load of $10KN$ is supported from a pulley , which in turn is supported by a rope of cross-sectional area $10^3 mm^2$ and modulus of elasticity $10^3 Nmm^{-2}$ as shown in the figure. Neglecting friction at the

pulley , then downward deflection of the load (in mm) is



A. 3.75

B. 4.25

C. 2.75

D. 4.00

Answer: A

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16. A body of mass $3.14kg$ is suspended from one end of a wire of length $10m$. The radius of cross-section of the wire is changing uniformly from $5 \times 10^{-4}m$ at the top (i.e. point of suspension) to $9.8 \times 10^{-4}m$ at the bottom . Young's modulus of elasticity is $2 \times 10^{11}N/m^2$. The change in length of the wire is

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

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

C. $10^{-3}m$

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

Answer: C

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Level 1 Subjective

1. What is the density of lead under a pressure of $2 \times 10^8 Nm^{-2}$, if the bulk modulus of lead is $8 \times 10^9 Nm^{-2}$ and initially the density of lead is $11.4 gcm^{-3}$?

Watch Video Solution

2. A cylindrical steel wire of $3m$ length is to stretch no more than $0.2cm$ When a tensile force of $400N$ is applied to each end of the wire ? What minimum diameter is required for the wire ?? $Y_{steel} = 2.1 \times 10^{11} N/m^2$

Watch Video Solution

3. The elastic limit of a steel cable is $3.0 \times 10^8 N/m^2$ and the cross-section area is $4cm^2$. Find the maximum upward acceleration that can be given to a $900kg$ elevator supported by the cable if the stress is not to exceed one - third of the elastic limit.

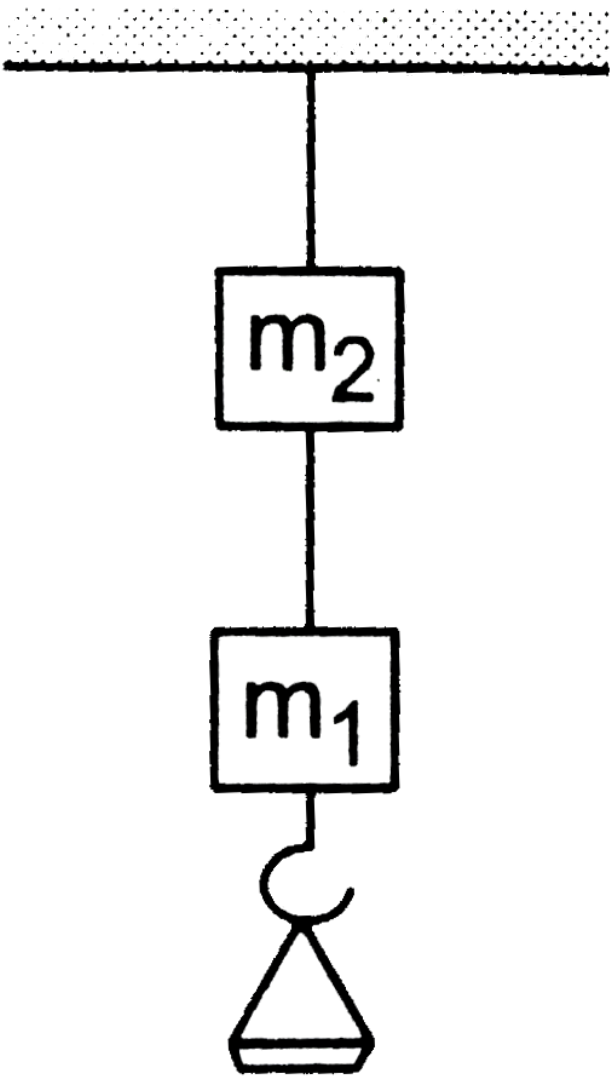
Watch Video Solution

4. Find the increment in the length of a steel wire of length $5m$ and radius $6mm$ under its own weight. Density of steel $= 8000kg/m^3$ and young's modulus of steel $= 2 \times 10^{11} N/m^2$. What is the energy stored in the wire ? (Take g $= 9.8m/s^2$)

Watch Video Solution

5. The two wires shown in figure are made of the same material which has a breaking stress of $8 \times 10^8 Nm^{-2}$. The area of cross section of the upper wire is $0.006cm^2$ and that of the lower wire is $0.003cm^2$. The mass $m_1 = 10kg$, $m_2 = 20kg$ and the hanger is light. a. Find the maximum load that can be put on the hanger without breaking a wire. Which wire will break first if the load is increased? b. Repeat the above part

$m_1 = 10kg$ and $m_2 = 36kg$.



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6. A steel wire and a copper wire of equal length and equal cross-sectional area are joined end to end and the combination is subjected to a tension. Find the ratio of

copper/steel

(a) the stresses developed . In the two wires,

(b) the strains developed. (Y of steel $= 2 \times 10^{11} N/m^2$)

Watch Video Solution

7. Calculate the apprroximate change in density of water in a lake at a depth of $400m$ below the surface. The density of water at the surface id $1030kg/m^3$ and bulk modulus of water is $2 \times 10^9 N/m^2$.

Watch Video Solution

8. In taking a solid ball of rubber from the surface to the bottom of a lake of $180m$ depth, reduction in the volume of the ball is $0.01\ \%$. The density

of water of the lake is $1 \times 10^3 kg/m^3$. Determine the value of the bulk modulus of elasticity of rubber . $\left(g = 9.8m/s^2\right)$

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Level 2 Single Correct

1. A wire elongates by l units, when a load w is suspended from it . If the wire gets over a pulley (equally on both the sides) and two weights w each are hung at the two ends, the elongation of wire (in units) will be

A. $(a)\, Zero$

B. $(b)\, \frac{1}{2}$

C. $(c)\, l$

D. $(d)\, 2l$

Answer: C

Watch Video Solution

2. Maximum stress that can be applied to a wire which supports on elevator is σ. Mass of elevator is m and it is moved upwards with an acceleration of $g/2$. Minimum diameter of wire (Neglecting weight of wire) must be

A. $\frac{\sqrt{2mg}}{\pi\sigma}$

B. $\frac{\sqrt{3mg}}{2\pi\sigma}$

C. $\frac{\sqrt{5mg}}{2\pi\sigma}$

D. $\sqrt{\frac{6mg}{\pi\sigma}}$

Answer: D

Watch Video Solution

3. 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. $8rad/s$

B. $4rad/s$

C. $2rad/s$

D. $1rad/s$

Answer: B

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4. A uniform steel rod of cross- sectional area A and L is suspended so that it hangs vertically. The stress at the middle point of the rod is

A. $\frac{1}{2}\rho gL$

B. $\frac{1}{4}\rho gL$

C. ρgL

D. None of these

Answer: A

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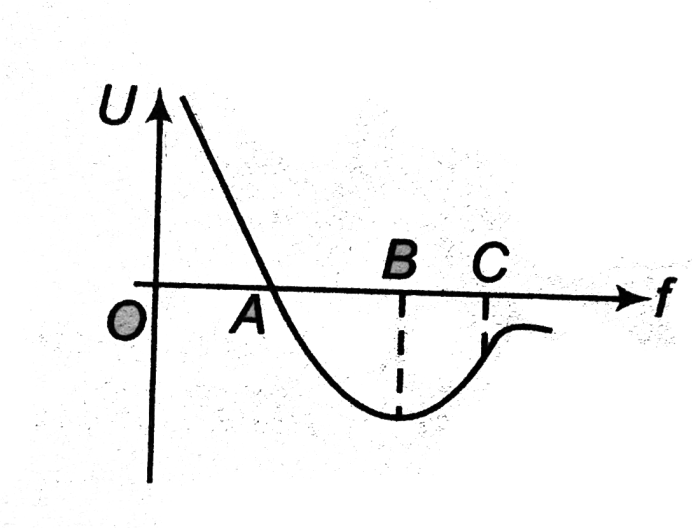
5. The potential energy U of diatomic molecules as a function of separation r is shown in figure. Identify the correct stateement.



A. The atoms are in equilibrium if $r = OA$

B. The force is repulsive only if r lies between A and B

C. The force is attractive if r lies between A and B

D. The atoms are in equilibrium if $r = OB$

Answer: D

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

A. $\frac{l_1T_1 + l_2T_2}{T_1 + T_2}$

B. $\frac{l_2T_1 + l_1T_2}{T_1 + T_2}$

C. $\frac{l_2T_1 - l_1T_2}{T_1 - T_2}$

D. $\frac{l_1T_1 - l_2T_2}{T_1 - T_2}$

Answer: C

Watch Video Solution

7. A mass m is suspended from a wire . Change in length of the wire is Δl. Now the same wire is stretched to double its length and the same mass is suspended from the wire. The change in length in this case will become

(it is suspended that elongation in the wire is within the proportional limit)

A. Δl

B. $2\Delta l$

C. $4\Delta l$

D. $8\Delta l$

Answer: C

Watch Video Solution

8. A uniform metal rod fixed at its ends of $2mm^2$ cross-section is cooled from $40\ {}^{\circ}C$ to $20^{\circ}C$. The coefficient of the linear expansion of the rod is 12×10^{-6} per degree celsius and its young's modulus of elasticity is $10^{11} N/m^2$. The energy stored per unit volume of the rod is

A. $2880 J/m^3$

B. $1500 J/m^3$

C. $5760 J / m^3$

D. $1440 J / m^3$

Answer: A

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9. A rod of length $1000 mm$ and co-efficient of linear expansion $\alpha = 10^{-4}$ per degree Celsius is placed in horizontal smooth surface symmetrically between fixed walls separated by $1001 mm$. The young's modulus of rod is $10^{11} N / m^2$. If the temperature is increased by $20^\circ C$, then the stress developed in the rod is (in N / m^2)

A. $(a) 10^5$

B. $(b) 10^8$

C. $(c) 10^7$

D. $(d) 10^6$

Answer: B

Watch Video Solution

10. 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. $\frac{F_o}{2SY}$

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

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

D. $\frac{\sqrt{2F_0}}{SY}$

Answer: A

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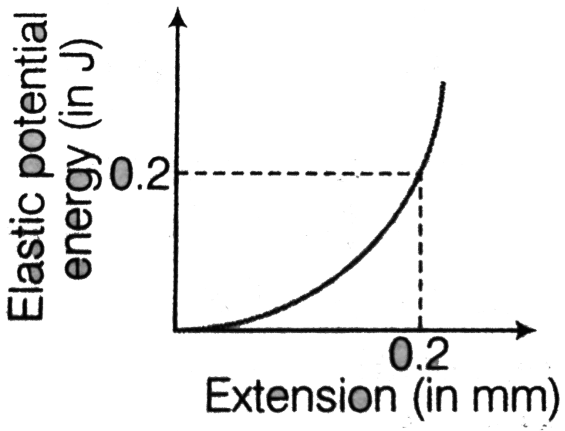
Level 2 More Than One Correct

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



A. $(a) A = 10^{-4} m^2$

B. $(b) A = 10^{-3} m^2$

C. $(c) L = 1.5m$

D. $(d) L = 2m$

Answer: A::D

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2. A metal wire of length L, area of cross-section A and young's modulus Y is stretched by a variable force F such that F is always slightly greater than the elastic forces of resistance in the wire. When the elongation of the wire is l

A. (a)the work done by F is $\frac{YAl^2}{2L}$

B. (b)the work done by F is $\frac{YAl^2}{L}$

C. (c)the elastic potential energy stored in the wire is $\frac{Yal^2}{2L}$

D. (d)the elastic potential energy stored in the wire is $\frac{Yal^2}{4L}$

Answer: A::C

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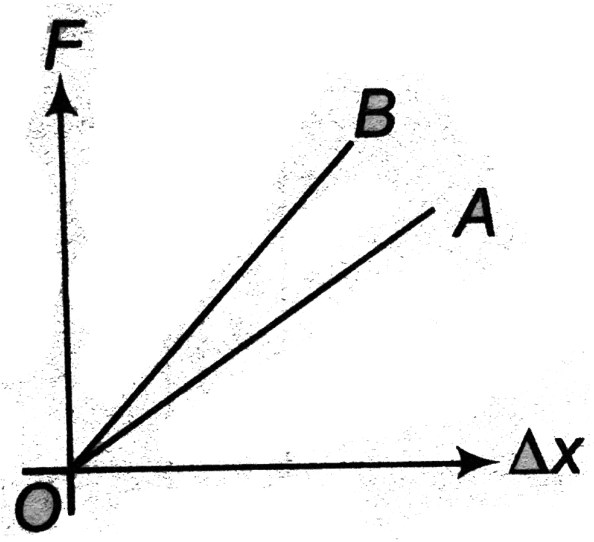
3. Two wires A and B of same length are made of same material . The figure represents the load F versus extension Δx graph for the wires.

Then



A. (A) The cross sectional area of A is greater than that of B

B. (B) The elasticity of B is greater than that of A

C. (C) The cross-sectional area of B is greater than that of A

D. (D) The elasticity of A is greater than that of B

Answer: C

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4. 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 gravitational potential energy of$M$ is Mgl

B. The elastic potential energy stored in the wire is Mgl

C. The elastic potential energy stored in the wire is $\frac{1}{2}Mgl$

D. Heat produced is $\frac{1}{2}Mgl$

Answer: A::C::D

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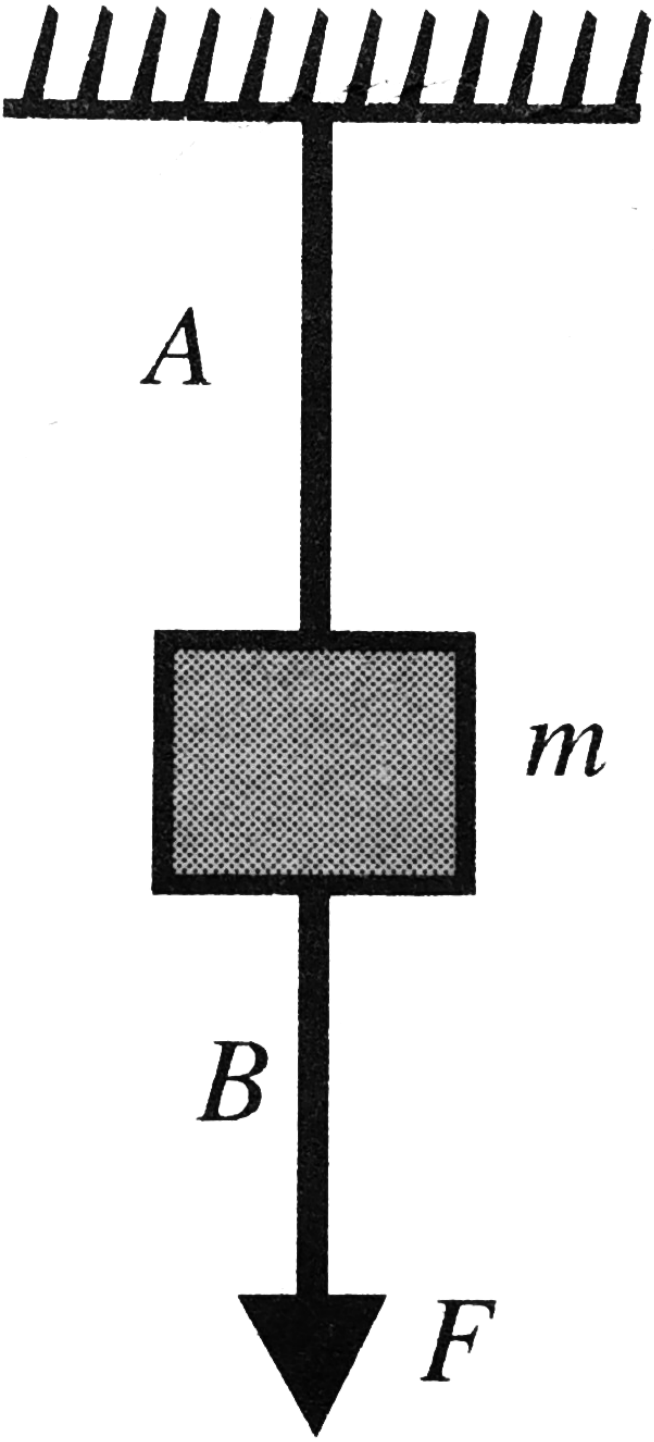
5. The wires A and B shown in Fig. are made of the same material and have radii r_A and r_B, respectively. The block between them has a mass m.

When the force F is $mg/3$, one of the wires breaks. Then


A
m
B
F

A. P breaks, if $r_p = r_Q$

B. P breaks, if $r_p < 2r_Q$

C. Either P or Q may break , if $r_p = 2r_Q$

D. To predict , which wire will break, the lengths of P and Q may break,

the lengths of p and Q must be known

Answer: A::B::C

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6. Two wires A and B have equal lengths and aremade of the same material , but diameter of wire A is twice that of wire B. Then, for a given load,

A. (A) the extension of B will be four times that of A

B. (B) the extensions of A and will be equal

C. (C) the strain in B is four times that in A

D. (D) the strains in A and B will be equal

Answer: A::C

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7. A light rod of length of length $2m$ is suspended from a 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 $2 \times 10^{-3}m^2$. x is the distance from the steel wire end, at which a weight may be hung. $Y_{steel} = 2 \times 10^{11}Pa$ and $Y_{brass} = 10^{11}Pa$

Which of the following statement(s) is /are correct ?

A. (A) $x = 1.2m$, if the strains of both the wires are to be equal

B. (B) $x = 1.42m$, if the stresses of the wires are to be equal

C. (C) $x = 1m$, if the stains of both the wires are to be equal

D. (D) $x = 1.33m$, if the stresses of the wires are to be equal

Answer: C::D

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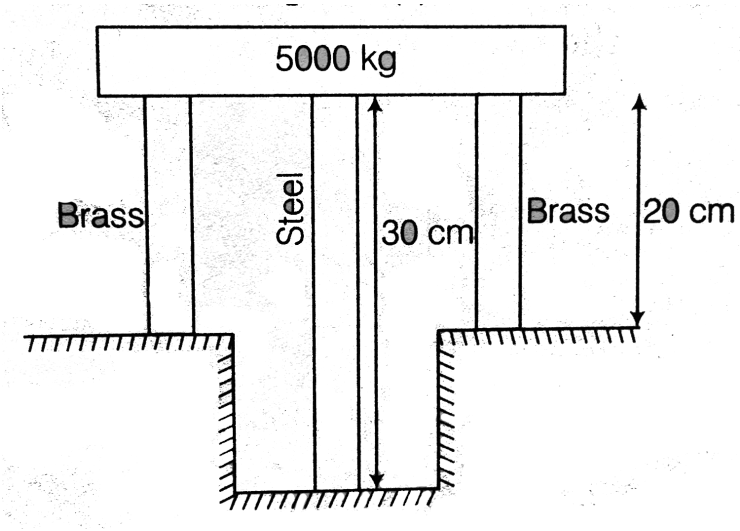
8. A steel rod of cross-sectional area $16cm^2$ and two brass rods each of cross-sectional area $10cm^2$ together support a load of $5000kg$ as shown in the figure. (Given, $Y_{steel} = 2 \times 10^6 kgcm^{-2}$ and $Y_{brass} = 10^6 kgcm^{-2}$). Choose the correct option(s).



A. Stress in brass rod $= 121kgcm^{-2}$

B. Stress in steel rod $= 161kgcm^{-2}$

C. Stress in brass rod $= 141kgcm^{-2}$

D. Stress in steel rod $= 141 kgcm^{-2}$

Answer: A::B

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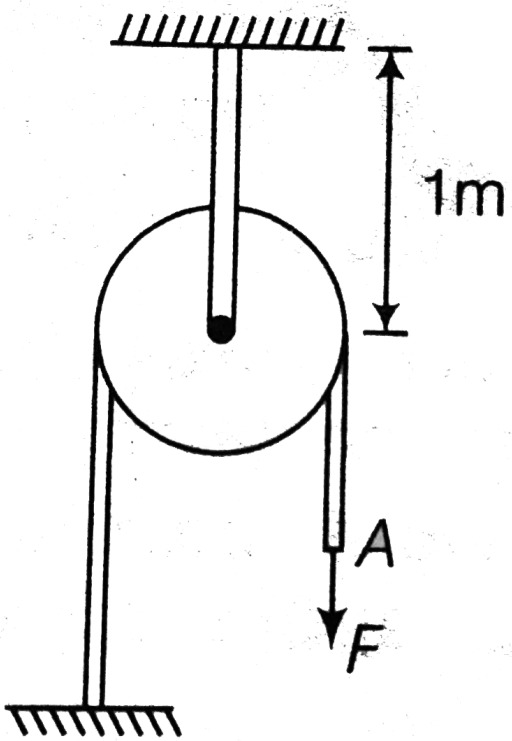
Level 2 Comprehension Based

1. The axle of a pulley of mass $1kg$ is attached to the end of an elastic string of length $1m$, cross- sectional area $10^{-3}m^2$ and young's modulus $2 \times 10^5 Nm^{-2}$,whose other end is fixed to the ceiling. A rope of negligible mass is placed on the pulley such that its left end is fixed to the ground and its right end is hanging freely , from the pulley which is at rest in equilibrium . Now, the rope and the pulley can be neglected. (Given, $g = 10ms^{-2}$)



The elongation of the string before applying force is

A. $(a) 50cm$

B. $(b) 5cm$

C. $(c) 0.5cm$

D. $(d) 0.05cm$

Answer: B

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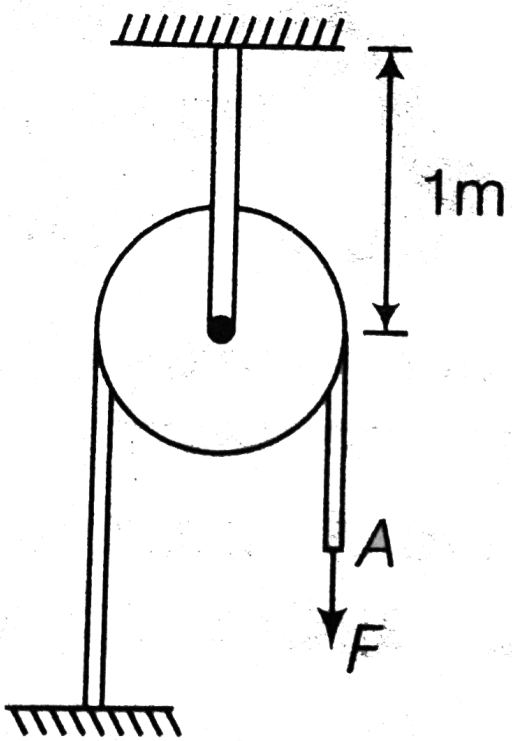
2. The axle of a pulley of mass $1kg$ is attached to the end of an elastic string of length $1m$, cross- sectional area $10^{-3}m^2$ and young's modulus $2 \times 10^5 Nm^{-2}$,whose other end is fixed to the ceiling. A rope of negligible mass is placed on the pulley such that its left end is fixed to the ground and its right end is hanging freely , from the pulley which is at rest in equilibrium . Now, the rope and the pulley can be neglected. (Given, $g = 10ms^{-2}$)



The elongation of the string before applying force is

A. (a)$35cm$

B. (b)$5cm$

C. (c)$0.5cm$

D. (d)$0.05cm$

Answer: C

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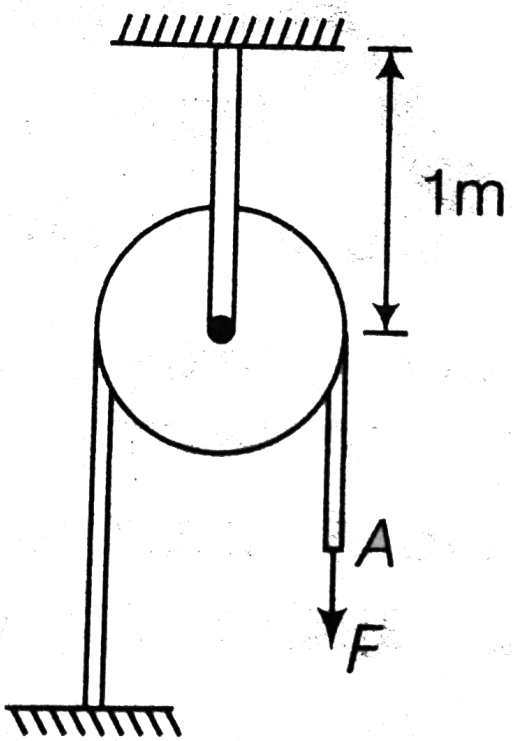
3. The axle of a pulley of mass $1kg$ is attached to the end of an elastic string of length $1m$, cross- sectional area $10^{-3}m^2$ and young's modulus $2 \times 10^5 Nm^{-2}$,whose other end is fixed to the ceiling. A rope of negligible mass is placed on the pulley such that its left end is fixed to the ground and its right end is hanging freely , from the pulley which is at rest in equilibrium . Now, the rope and the pulley can be neglected. (Given, $g = 10ms^{-2}$)



The elongation of the string before applying force is

A. $50cm$

B. $60cm$

C. $40cm$

D. $50cm$

Answer: D

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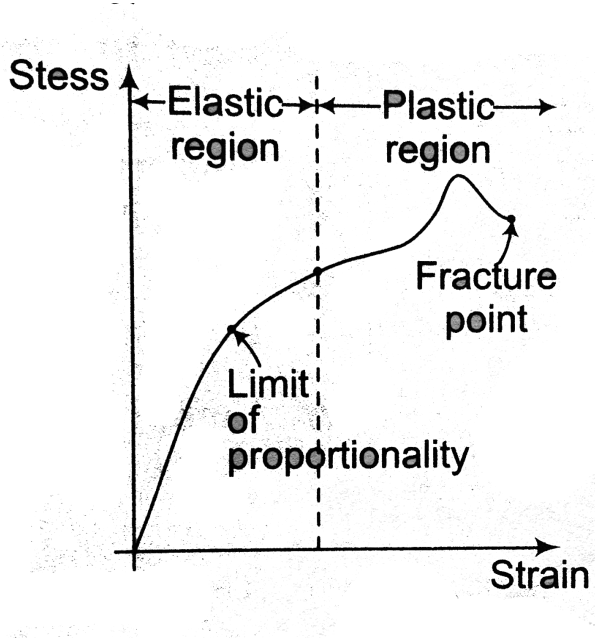
4. On gradual loading , stress - strain relationship for a metal wire is as follows . Within proportionality limit , stress $\propto$ strain or, $\frac{\text{Stress}}{\text{strain}}$ = a constant for the material of wire.

Two wires of same material have length and radius (L, r) and $\left(2L, \frac{r}{2}\right)$. The ratio of their young's modulii is



A. $1:2$

B. $2:3$

C. $2:1$

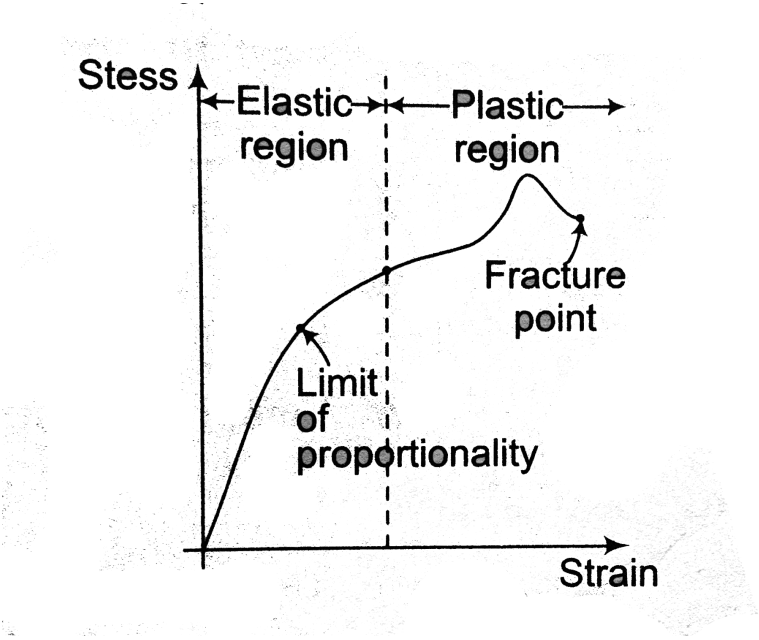
D. $1:1$

Answer: D

Watch Video Solution

5. On gradual loading , stress - strain relationship for a metal wire is as follows . Within proportionality limit , stress prop strain or, $\frac{\text{Stress}}{\text{strain}}$ = a constant for the material of wire.

Just on crossing the yield region, the material will have



A. increased and breaking stress

B. reduced and breaking stress

C. constant stress

D. None of these

Answer: B

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6. On gradual loading , stress - strain relationship for a metal wire is as follows . Within proportionality limit , stress $\propto$ strain or, $\frac{\text{Stress}}{\text{strain}}$ = a constant for the material of wire.

If $\frac{\text{Stress}}{\text{Strain}}$ is x in elastic region and y in the region of yield , then

A. $x > y$

B. $x = y$

C. $x < y$

D. $x = 2y$

Answer: A

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Level 2 Subjective

1. A solid sphere of radius R made of a material of bulk modulus B is surrounded by a liquid in a cylindrical container. A massless piston of area A (the area of container is also A) floats on the surface of the liquid. When a mass M is placed on the piston to compress the liquid , fractional change in radius of the sphere is $\frac{Mg}{\alpha AB}$. Find the value of α.

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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 cross - sectional area is $4.9 \times 10^{-7}m^2$. If the mass is pulled a little in the vertically downward direction and released , it performs SHM with angular frequency $140rads^{-1}$. If the young's modulus of the material of the wire is $p \times 10^9 Nm^{-2}$, find the value of p.

Watch Video Solution

3. A wire havinga 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 vqalue of α

Watch Video Solution

4. A wire of length $3m$ diameter $0.4mm$ and young's modulus $8 \times 10^{10} N/m^2$ is suspended from a point and supports a heavy cylinder of volume $10^{-3} m^3$ at its lower end . Find the decrease in length when the metal cylinder is immersed in a liquid of density $800 kg/m^3$.

Watch Video Solution

5. A sphere of radius $10cm$ and mass 25 kg is attached to the lower end of a steel wire of length $5m$ and diameter $4mm$ which is suspended from the ceiling of a room . The point of support is $521cm$ above the floor. When the sphere is set swinging as a simple pendulum, its lowest point just grazes the floor. Calculate the velocity of the ball at its lowest position $\left(Y_{steel} = 2 \times 10^{11} N/m^2\right)$.

Watch Video Solution

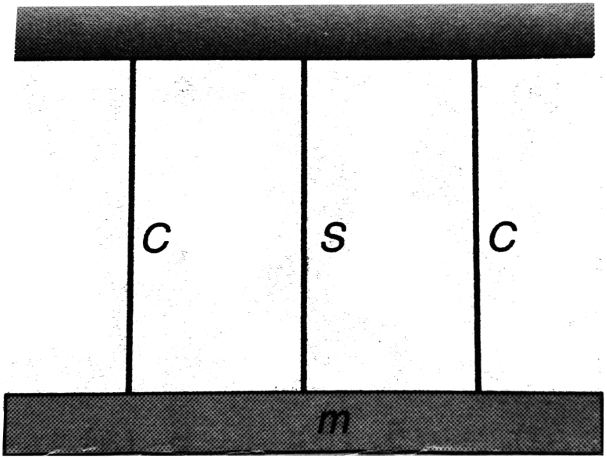
6. A uniform ring of radius R and made up of a wire of cross - sectional radius r is rotated about its axis with a frequency f. If density of the wire is ρ and young's modulus is Y . Find the fractional change in radius of the ring .

Watch Video Solution

7. A $6kg$ weight is fastened to the end of a steel wire of un stretched length $60cm$. It is whirled in a vertical circle and has an angular velocity of $2rev/s$ at the bottom of the circle. The area of cross - section of the wire is $0.05cm^2$. Calculate the elongation of the wire when the weight is at the lowest point of the path . Young's modulus of steel $= 2 \times 10^{11} N/m^2$.

Watch Video Solution

8. A homogeneous block with a mass m hangs on three vertical wires of equal length arranged symmetrically . Find the tensions of the wires if the middle wire is of steel and the other two are of copper . All the wires have the same cross - section . Consider the modulus of elasticity of steel to be double than that of copper .



Watch Video Solution

9. A uniform copper bar of density ρ , length L , cross - sectional area S and young's modulus Y is moving horizontally on a frictionless surface

with constant acceleration a_0. Find

(a) the stress at the center of the wire ,

(b) total elongation of the wire .

Watch Video Solution

10. A $5m$ long cylindrical steel wire with radius $2 \times 10^{-3} m$ is suspended vertically from a rigid support and carries a bob of mass $100kg$ at the other end . If the bob gets snapped , calculate the change in temperature of the wire ignorning radiation looses. (Take $g = 10m/s^2$)

(For the steel wire , young's modulus $= 2.1 \times 10^{11} N/m^2$, Density $= 7860kg/m^3$, Specific heat $= 420 \frac{J}{k} g - \circ C$) .

Watch Video Solution

Check Point 12 1

1. In solids interatomic forces are

A. totally repulsive

B. totally attractive

C. Both (a) and (b)

D. None of these

Answer: C

Watch Video Solution

2. Name the property of an object by virtue of which it opposes or tends to oppose any change in its state.

A. plasticity

B. elasticity

C. elastic fatigue

D. None of these

Answer: A

Watch Video Solution

3. The breaking stress of a wire depends on

A. length of wire

B. area of cross-section of wire

C. Both (a) and (b)

D. independent of length and area of cross-section

Answer: D

Watch Video Solution

4. The maximum deforming force upto which a body retains its property of elasticity is called

A. elastic limit of the material

B. elastic force

C. elastic after effect

D. None of these

Answer: A

Watch Video Solution

5. The internal restoring force acting per unit area of cross-section of the deformed body is called

A. strain

B. stress

C. elastic limit

D. volumetric strain

Answer: B

Watch Video Solution

6. The ratio of change in configuration to the original configuration is called

A. stress

B. force

C. strain

D. volumetric strain

Answer: C

Watch Video Solution

7. The deforming force produces a change in the shape of the body without changing its volume, strain produced is called

A. longitudinal strain

B. shearing strain

C. volumetic strain

D. normal strain

Answer: B

Watch Video Solution

8. The property of matter by virtue of which it does not regain its original shape and size after the removal of deforming force is called

A. deforming force

B. plasticity

C. elasticity

D. electricity

Answer: B

Watch Video Solution

9. The lower surface of a cube is fixed. On its upper surface, force is applied at an angle of 30° from its surface. The change will be the type

A. shape

B. size

C. volume

D. Both shape and size

Answer: D

Watch Video Solution

10. Which type of strain is there, when a spiral spring is stretched by a force?

A. longitudinal strain

B. volumetric strain

C. shear strain

D. Both (a) and (c)

Answer: D

Watch Video Solution

11. A metallic cube whose each side is 10 cm is subjected to a shearing force of 100 kgf. Calculate the shearing produced.

A. $9.8 \times 10^4 Nm^{-2}$

B. $10Nm^{-2}$

C. $9.8Nm^{-2}$

D. $9.8 \times 10^2 Nm^{-2}$

Answer: A

Watch Video Solution

12. In a wire of length L, the increase in its length is l. If the length is reduced to half, the increase in its length will be

A. Reduced by half

B. Increase by half

C. Remains same

D. None of these

Answer: B

Watch Video Solution

13. A wire of length 2.5 m has a percentage strain of 0.012% under a tensile force. The extension produce in the wire will be

A. 0.03 mm

B. 0.3 mm

C. 0.3 mm

D. 0.03 m

Answer: B

Watch Video Solution

14. A uniform cube is subjected to volume compression. If each side is decreased by 2% , then bulk strain is

A. 0.02

B. 0.03

C. 0.04

D. 0.06

Answer: D

Watch Video Solution

15. A metallic cube of side 10 cm is subjected to a shearing force of 300 kgf. The top force is displaced through 0.25 cm with respect ot the bottom ? Calculate the shearing strain produced .

A. 0.25

B. 2.5

C. 0.025

D. 0.08

Answer: C

Watch Video Solution

Check Point 12 2

1. Write Copper , Steel , Glas and Rubber in order at increasing coefficient of elasticity

A. Steel, Rubber, Copper, Glass

B. Rubber, Copper, Glass, Steel

C. Rubber , Glass , Steel, Copper

D. Rubber , Glass , Copper, Steel

Answer: D

Watch Video Solution

2. The Young's modulus of the material of a wire is equal ot the

A. stress required to increase its length four times

B. stress required to produce unit strain

C. strain produced in it

D. half the strain produced in it

Answer: B

Watch Video Solution

3. Which one of the following statements is wrong ?

A. Young's modulus for a perfectly rigid body is zero.

B. Bulk moludus is relevent for solids, liquids and gases

C. Rubber is less elastic than steel

D. The Young's modulus and shear modulus are relevant for solids

Answer: A

Watch Video Solution

4. 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: B

Watch Video Solution

5. A rubber cord $10m$ long is suspended vertically. How much does it stretch under its own weight (Density of rubber is $1500kg/m, Y = 5 \times 10N/m, g = 10m/s$)

A. $15 \times 10^{-4}m$

B. $7.5 \times 10^{4}m$

C. $12 \times 10^{-4}m$

D. 25×10^{-4} m

Answer: C

Watch Video Solution

6. Two similar wires under the same load yield elongation of $0.1mm$ and $0.05mm$ respectively. If the area of cross-section of the first wire is $4mm^2$, then the area of cross-section of the second wire is

A. $6mm^2$

B. $8mm^2$

C. $10mm^2$

D. $12mm^2$

Answer: C

Watch Video Solution

7. A 5 m long aluminium wire $\left(Y = 7 \times 10^{10} \frac{N}{m^2}\right)$ of diameter 3 mm supprts a 40 kg mass. In order to have the same elongation in a copper

wire $\left(Y = 12 \times 10^{10} \frac{N}{m^2}\right)$ of the same length under the same weight, the diameter should now, in mm

A. 1.75

B. 1.65

C. 2.5

D. 5.0

Answer: C

Watch Video Solution

8. Choose the wrong statement

A. The bulk modulus for solids is much larger than for liquids.

B. Gases are least compressible

C. The incompressibility of the solids is due to the tight coupling.

D. The reciprocal of the bulk modulus is called compressibility.

Answer: B

Watch Video Solution

9. The bulk modulus of an ideal gas at constant temperature

A. is equal to its volume V

B. is equal to p/2

C. is equal to its pressure p

D. Cannot be determined

Answer: C

Watch Video Solution

10. A uniform cube is subjected to volume compression. If each side is decreased by 1 % then bulk strain is

A. 0.01

B. 0.06

C. 0.02

D. 0.03

Answer: C

Watch Video Solution

11. The average depth of indian ocean is about 3000 m. The fractional compression, $\frac{\Delta V}{V}$ of water at the bottom of the ocean is

(Given: Bulk moculus of the water $= 2.2 \times 10^9 Nm^{-2}$ and $g = 10ms^{-2}$

)

A. 0.0082

B. 0.0091

C. 0.0136

D. 0.0124

Answer: D

Watch Video Solution

12. To what depth must a rubber ball be taken in deep sea so that its volume is decreased by 0.1 %.

(Take, density of sea water $= 10^3 kgm^{-3}$, bulk modulus of rubber $= 9x10^8 Nm^{-2}$, $g = 10ms^{-2}$)

A. 9 m

B. 18 m

C. 180 m

D. 90 m

Answer: D

Watch Video Solution

13. A 2 m long rod of radius 1 cm which is fixed from one end is given a twist of 0.8 radius. The shear strain developed will be

A. 0.002

B. 0.004

C. 0.008

D. 0.016

Answer: A

Watch Video Solution

14. Modulus of rigidity of a liquid

A. Non-zero constant

B. Infinite

C. Zero

D. Cannot be predicted

Answer: B

Watch Video Solution

15. Mark the wrong statement

A. Sliding of molecular layer is much easier than compression or expansion.

B. Reciprocal of bulk modulus of elasticiy is called compressibility

C. It is difficult to twist a long rod as compared to small rod.

D. Hollow shaft is much stronger than a solid rod of same length and same mass.

Answer: C

Watch Video Solution

Check Point 12 3

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

A. $+0.50$

B. -0.50

C. 0.25

D. -0.25

Answer: A

Watch Video Solution

2. Which statement is true for a metal

A. $Y < \eta$

B. $Y = \eta$

C. $Y > \eta$

D. $Y < 1/\eta$

Answer: C

Watch Video Solution

3. For a given material, the Young's modulus is 2.4 times that of rigidity modulus . Its poission's ratio is

A. 2.4

B. 1.2

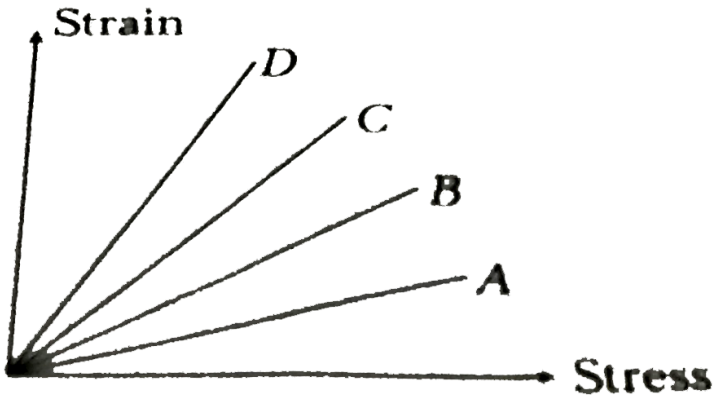
C. 0.4

D. 0.2

Answer: D

Watch Video Solution

4. Stress-strain curve for four metals are shown in figure. The maximum Young's modulus of elasticity is for metal



A. A

B. B

C. C

D. D

Answer: A

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5. Substances which can be elastically stretched to large value of strain are called

A. Isomers

B. Isodiapheres

C. Plastomers

D. Elastomers

Answer: D

Watch Video Solution

6. A stretched rubber has

A. increased kinetic energy

B. increased potential energy

C. decreased kinetic energy

D. decreased potential energy

Answer: B

Watch Video Solution

7. A metallic rod of length l and cross-sectional area A is made of a material of Young's modulus Y. If the rod is elongated by an amount y,then the work done is proportional to

A. Y

B. 1/Y

C. Y^2

D. $1/Y^2$

Answer: C

Watch Video Solution

8. The work per unit volume to stretch the length by 1% of a wire with cross sectional area of $1mm^2$ will be. $\left[Y = 9 \times 10^{11} \frac{N}{m^2}\right]$

A. $9 \times 10^{11} J$

B. $4.5 \times 10^7 J$

C. $9 \times 10^7 J$

D. $4.5 \times 10^{11} J$

Answer: B

Watch Video Solution

9. When a load of 10 kg is hung from the wire, then extension of 2m is produced. Then work done by restoring force is

A. 200 J

B. 100 J

C. 50 J

D. 25 J

Answer: B

Watch Video Solution

10. 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. 0.1 J

B. 0.2 J

C. 10 J

D. 20 J

Answer: A

Watch Video Solution

11. If a spring extends by x on loading, then the energy stored by the spring is (if T is tension in the spring and k is spring constant)

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

B. $\frac{T^2}{2K}$

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

D. $\frac{2T^2}{2k}$

Answer: B

Watch Video Solution

12. Two wires A and B are made of same material. The wire A has a length l and diameter r while the wire B has a length 2l and diameter r/2. If the two wires are stretched by the same force the elongation in A divided by the elongation in B is

A. $2:3$

B. $3:4$

C. $3:2$

D. $6:1$

Answer: C

Watch Video Solution

13. A wire of length $50cm$ and cross sectional area of 1 sq. mm is extended by $1mm$. The required work will be $\left(Y = 2 \times 10^{10} Nm^{-2}\right)$

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

B. $4 \times 10^{-2} J$

C. $2 \times 10^{-2} J$

D. $1 \times 10^{-2} J$

Answer: C

Watch Video Solution

14. When a force is applied on a wire of uniform cross-sectional area $3 \times 10^{-6} m^2$ and length 4 m, the increase in length is 1mm. Energy stored

in it will be $\left(Y = 2 \times 10^{11} \frac{N}{m^2}\right)$

A. 6250 J

B. 0.177 J

C. 0.075 J

D. 0.150 J

Answer: A

Watch Video Solution

15. When a 4 kg mass is hung vertically on a light string that obeys Hooke's law, the spring stretches by 2 cm. The work required to be done by an external agent in stretching this spring by 5 cm will be ($g = 9.8 \frac{metrs}{\sec^2}$)

A. 4.9 J

B. 2.4 J

C. 0.495 J

D. 0.24 J

Answer: B

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Chapter Exercise

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

A. is zero

B. is unity

C. is infinity

D. may have any finite non-zero value

Answer: C

Watch Video Solution

2. The valve of Poisson's ratio lies between

A. $\infty \text{to} + \infty$

B. 0 and $+\infty$

C. 0 and 0.5

D. 0.5 and 1.0

Answer: C

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3. The only elastic modulus that applies to fluids is

A. Young's modulus

B. Shear modulus

C. Modulus of rigidity

D. Bulk modulus

Answer: D

Watch Video Solution

4. Modulus it rigidity of ideal liquids is

A. infinity

B. zero

C. unity

D. some finite small non-zero constant value

Answer: B

Watch Video Solution

5. The work done in stretching an elastic wire per unit volume is or strain energy in a stretched string is

A. $\frac{1}{2}$ stress $\times$ strain

B. stress $\times$ strain

C. $(\text{stress} \times \text{strain})^2$

D. stress/strain

Answer: A

Watch Video Solution

6. The maximum load a wire can withstand without breaking, when its length is reduced to half of its original length, will

A. be double

B. be half

C. be four times

D. remain same

Answer: D

Watch Video Solution

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

A. $2 \times 10^7 N$

B. $2 \times 10^6 N$

C. $2 \times 10^8 N$

D. $2 \times 10^5 N$

Answer: A

Watch Video Solution

8. Longitudinal stress of $1kg/mm^2$ is applied on a wire. The percentage increase in length is $\left(Y = 10^{11} N/m^2\right)$

A. 0.002

B. 0.001

C. 0.003

D. 0.01

Answer: B

Watch Video Solution

9. The Young's modulus of a wire Y. If the energy per unit volume is E, then the strain will be

A. $\sqrt{\frac{2E}{Y}}$

B. $E\sqrt{2Y}$

C. EY

D. $\frac{E}{Y}$

Answer: A

Watch Video Solution

10. When a force is applied at one end of an elastic wire, it produce a strain E in the wire. If Y is the Young's modulus of the material of the wire, the amount of energy stored per unit volume of the wire is given by

A. $Y \times E$

B. $\frac{1}{2}(Y \times E)$

C. $Y \times E^2$

D. $\frac{1}{2}(Y \times E^2)$

Answer: D

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11. 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

B. 2Y

C. $\frac{Y}{4}$

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

Answer: A

Watch Video Solution

12. The Young's modulus of a wire is numerically equal

A. not change the length of the wire

B. double the length of the wire

C. increase the length by 50%

D. change the radius of the wire to half

Answer: A

Watch Video Solution

13. The length of an iron wire is L and area of cross-section is A. The increase in length is l on applying the force F on its two ends. Which of the statement is correct

A. increase in length is inversely proportional to its length L

B. Increase in length is proportional to area of cross-section A

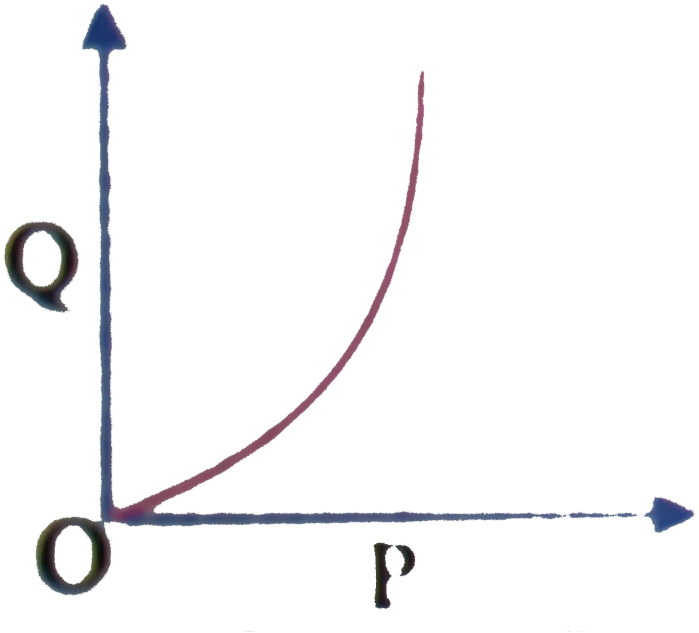
C. Increase in length is inversely proportional to A

D. Increase in length is proportional to Young's modulus

Answer: C

Watch Video Solution

14. 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. P=extension, Q=applied force

C. P=extension, Q=stored elastic energy

D. P=stored elastic energy, Q=extension

Answer: C

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15. A metal block is experiencing an atmospheric pressure of $1 \times 10^5 N/m^2$, when the same block is placed vacuum chamber, the freactional change in its volume is (the bulk modulus of metal is $1.25 \times 10^{11} N/m^2$)

A. 4×10^{-7}

B. 2×10^{-7}

C. 8×10^{-7}

D. 1×10^{-7}

Answer: C

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16. The bulk modulus of water is $2.1 \times 10^9 Nm^{-2}$. The pressure required ot increase the density of water by 0.1% is

A. $2.1 \times 10^3 Nm^{-2}$

B. $2.1 \times 10^6 Nm^{-2}$

C. $2.1 \times 10^5 Nm^{-2}$

D. $2.1 \times 10^7 Nm^{-2}$

Answer: B

Watch Video Solution

17. If the Young's modulus of the material is 3 times its modulus of rigidity, then its volume elasticity will be

A. zero

B. infinity

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

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

Answer: B

Watch Video Solution

18. For a given material, the Young's modulus is 2.4 times that of the modulus of rigidity. Its Poisson's ratio is

A. 2.4

B. 1.2

C. 0.4

D. 0.2

Answer: D

Watch Video Solution

19. Mark the wrong statement

A. Sliding of molecular layer is much easier than compression or expansion.

B. Reciprocal of bulk modulus of elasticiy is called compressibility

C. It is difficult to twist a long rod as compared to small rod.

D. Hollow shaft is much stronger than a solid rod of same length and same mass.

Answer: C

Watch Video Solution

20. The increase in length on stretching a wire is 0.05%. If its poisson's ratio is 0.4, then its diameter

A. reduce by 0.02%

B. reduce by 0.1%

C. increase by 0.02%

D. decrease by 0.4%

Answer: A

Watch Video Solution

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

A. volumetic

B. shear

C. longitudinal and shear

D. longitudinal

Answer: C

Watch Video Solution

22. An elastic material of Young's modulus Y is subjected to a stress S. The elastic energy stored per unit volume of the material is

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

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

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

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

Answer: C

Watch Video Solution

23. The temperature of a wire is doubled. 'The Young's modulus of elasticity will

A. (a)will also doubled

B. (b)will bercome four times

C. (c)will remain same

D. (d)will decrease

Answer: D

Watch Video Solution

24. When a pressure of 100 atmosphere is applied on a spherical ball, then its volume reduces to $0.01\ \%$. The bulk modulus of the material of the rubber in dyne/cm^2 is

A. 10×10^{12}

B. 100×10^{12}

C. 1×10^{12}

D. 20×10^{12}

Answer: C

Watch Video Solution

25. A 5 metre long wire is fixed to the ceiling. A weight of $10kg$ is hung at the lower end and is $1metre$ above the floor. The wire was elongated by $1mm$. The energy stored in the wire duw to streching is

A. 0.01J

B. 0.05 J

C. 0.02 J

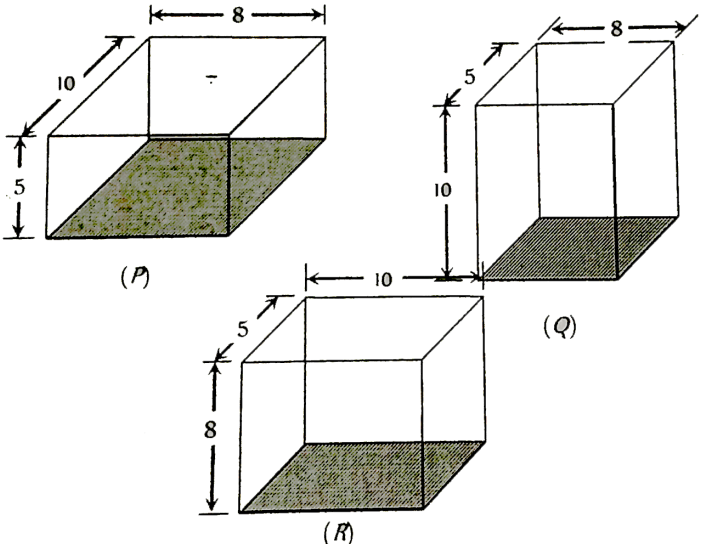
D. 0.04J

Answer: B

Watch Video Solution

26. A rectangular block of size $10cm \times 8cm \times 5cm$ is kept in three different positions P,Q and R in turns as shown in the figure. In each case, the shaded area is rigidly fixed and a definite force F is applied tangentially to the opposite face to deform the black. The displacement

of the upper face will be



A. same in all the three cases

B. maximum in p position

C. maximum in Q position

D. miximum in R position

Answer: C

Watch Video Solution

27. A uniform cube is subjected to volume compression. If each side is decreased by 1% , then bulk strain is

A. 0.01

B. 0.03

C. 0.02

D. 0.06

Answer: D

Watch Video Solution

28. The longitudinal extention of any elastic material is very small.In order to have an appericiable change ,the material must be in the form of

A. long thick wire

B. short thick wire

C. long thin wire

D. short thin wire

Answer: C

Watch Video Solution

29. 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. $\frac{W}{4}$

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

C. W

D. 2W

Answer: C

Watch Video Solution

30. when a metal wire elongates by hanging a load Mg on it , the gravitational poyential energy of mass M decreases by Mgl. This energy appears

A. as elastic potential energy completely

B. as thermal energy completely

C. half as potential energy and half as thermal energy

D. as kinetic energy of the load completely

Answer: C

Watch Video Solution

31. A ball falling in a lake of depth 200m shown 0.1% decrease in its volume at the bottom .What is the bulk modulus of the materialof the ball

A. $19.6 \times 10^8 Nm^{-2}$

B. $19.6 \times 10^{9} Nm^{-2}$

C. $19.6 \times 10^{10} Nm^{-2}$

D. $19.6 \times 10^{12} Nm^{-2}$

Answer: A

Watch Video Solution

32. 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 highest point

B. when the mass is at the lowest point

C. when the wire is horizontal

D. at an angle of $\cos^{-1}(1/3)$ from the upward vertical

Answer: B

Watch Video Solution

33. Two wires of copper having the length in the ratio $4:1$ and their radii ratio as $1:4$ are stretched by the same force. The ratio of longitudinal strain in the two will be

A. $1:16$

B. $16:1$

C. $1:64$

D. $64:1$

Answer: B

Watch Video Solution

34. The interatomic distance for a metal is 3×10^{-10} m. If the interatomic force constant is $3.6 \times 10^{-9} N/\text{Å}$. The the Young's modulus in N/m^2 will be

A. 1.2×10^{11}

B. 4.2×10^{11}

C. 10.8×10^{8}

D. 2.4×10^{10}

Answer: A

Watch Video Solution

35. Young's modulus of rubber is $10^4 N/m^2$ and area of cross section is $2cm^2$. If force of $2 \times 10^5 dyn$ is applied along its length, then its final length becomes

A. 3L

B. 4L

C. 2L

D. None of these

Answer: C

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36. Two wires of same diameter of the same material having the length l and $2l$ If the force F is applied on each, the ratio of the work done in two wires will be

A. $1:2$

B. $1:4$

C. $2:1$

D. $1:1$

Answer: A

Watch Video Solution

37. A force of 200 N is applied at one end of a wire of length 2m and having area of cross-section $10^{-2}cm^2$. The other end of the wire is rigidly fixed. If coefficient of linear expansion of the wire $\alpha = 8 \times 10^{-6}/.^{\circ} C$ and Young's modulus $Y = 2.2 \times 10^{11} N/m^2$ and its temperature is increased by $5^{\circ} C$, then the increase in the tension of the wire will be

A. 4.2 N

B. 4.4 N

C. 2.4 N

D. 8.8 N

Answer: D

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38. A beam of electrons moving with a momentum p enters a uniform magnetic field of flux density B perpendicular to its motion. Which of the following statement(s) is (are) true?

A. work done by the external force is FL.

B. some heat is produced in the wire in the process

C. the elastic potential energy of the wire is $\frac{FL}{2}$

D. the heat produced is equal to the half of the elastic potential energy stored in the wire

Answer: D

Watch Video Solution

39. The temperature of a wire of length 1 metre and area of cross-section $1cm^2$ is increased from $0^\circ C$ to $100^\circ C$. If the rod is not allowed to increased in length, the force required will be $\left(\alpha = 10^{-5}/.^\circ C \text{ and } Y = 10^{11} N/m^2\right)$

A. $10^3 N$

B. 10^4 N

C. $10^5 N$

D. $10^9 N$

Answer: B

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40. Calculate the apprroximate change in density of water in a lake at a depth of $400m$ below the surface. The density of water at the surface id $1030kg/m^3$ and bulk modulus of water is $2 \times 10^9 N/m^2$.

A. $4kgm^{-3}$

B. $2kgm^{-3}$

C. $6kgm^{-3}$

D. $8kgm^{-3}$

Answer: B

Watch Video Solution

41. A load suspended by a massless spring produces an extention of xcm in equilibrium.When it is cut into two unequal parts ,the same load produces an extention of 7.5cm when suspended by the larger part of length 60cm .When it is suspended by the smaller part,the extention is 5cm.Then

A. x=12.5cm

B. x=3.0cm

C. the length of the original spring is 90cm

D. the length of the original spring is 80cm

Answer: A

Watch Video Solution

42. A steal wire of cross-section area $3 \times 10^{-6} m^2$ can withstand a maximum strain of 10^{-3} .Young's modulus of steel is $2 \times 10^{11} Nm^{-2}$ .The maximum mass this wire can hold is

A. 40kg

B. 60kg

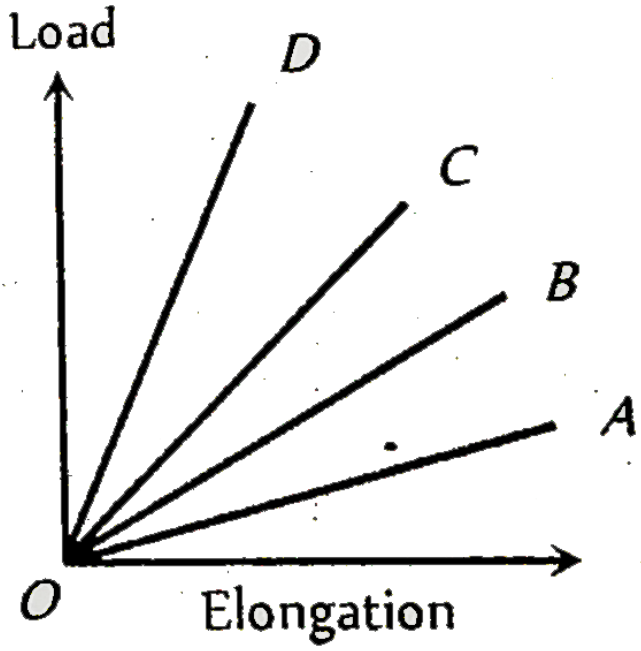
C. 80kg

D. 100kg

Answer: B

Watch Video Solution

43. The load versus elongation graph for four wires of the same material is shown in the figure. The thickest wire is represented by



A. OD

B. OC

C. OB

D. OA

Answer: A

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44. Two wires of the same material and length but diameter in the ratic 1: 2 are stretched by the same load. The ratio of elastic potential energy per unit volume for the two wires is

A. $16:1$

B. $4:1$

C. $2:1$

D. $1:1$

Answer: A

Watch Video Solution

45. 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 $\left(g = 10m/s^2\right)$

A. 10 m

B. 33.3 m

C. 5 m

D. 66.6 m

Answer: B

Watch Video Solution

46. A cable is replaced by another cable of the same length and material but of double the diameter.

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

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

A. half

B. double

C. four times

D. one-fourth

Answer: C

Watch Video Solution

47. A uniform steel rod of cross- sectional area A and L is suspended so that it hangs vertically. The stress at the middle point of the rod is

A. $\frac{L}{2A}\rho g$

B. $\frac{L\rho g}{2}$

C. $\frac{LA}{\rho g}$

D. $L\rho g$

Answer: B

Watch Video Solution

48. A rubber pipe of density $1.5 \times 10^3 N/m^2$ and Young's modulus $5 \times 10^6 N/m^2$ is suspended from the roof. The length of the pipe is 8m. What will be the change in length due to its own weight.

A. $96 \times 10^{-3} m$

B. $19.2 \times 10^{-5} m$

C. 9.4 cm

D. 9.6 mm

Answer: C

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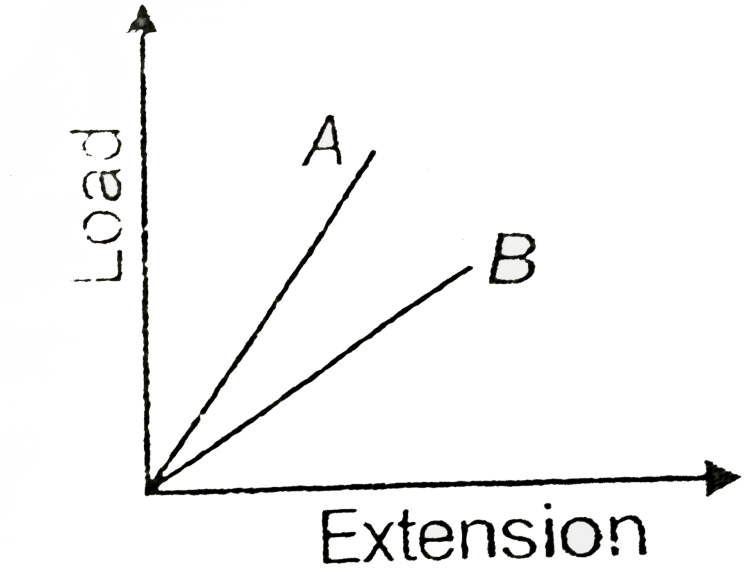
49. In the given figure, if the dimensions of the two wires are same but materials are different, then Young's modulus is



A. A

B. B

C. Both

D. None of these

Answer: A

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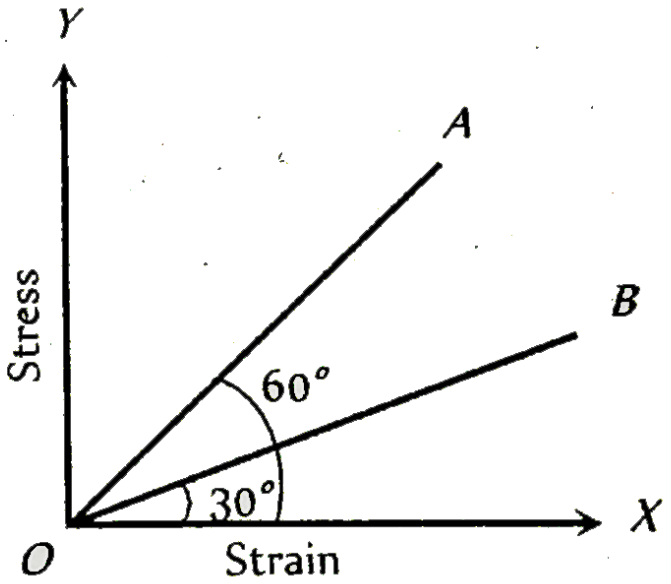
50. The stress versus strain graphs for wires of two materials A and B are as shown in the figure. If Y_A and Y_B are the younng's moduli of the materials, then



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

51. An elevator cable is to have a maximum stress of $7 \times 10^7 Nm^{-2}$ to allow for appropriate safety factors. Its maximum upward acceleration is $1.5ms^{-2}$. If the cable has to support the total weight of 2000 kg of a loaded elevator , the area of cross-section of the cable should be

A. $3.22cm^2$

B. $2.38cm^2$

C. $0.32cm^2$

D. $8.23cm^2$

Answer: A

Watch Video Solution

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

A. diameter 1 mm and length 1 m

B. diameter 2 mm and length 2 m

C. diameter 0.5 mm and length 0.5m

D. diameter 3 mm and length 3 m

Answer: C

Watch Video Solution

53. A copper wire $\left(Y = 10^{11} Nm^{-2}\right)$ of length 8 m and a steel wire $\left(Y = 2 \times 10^{11} Nm^{-2}\right)$ of length 4 m, each of $0.5 cm^2$ cross-section are fastened end to end and stretched with a tension of 500 N. choose the correct option.

A. Elongation in copper wire is 0.8 mm

B. Elongation in steel is $\frac{1}{4} th$ the elongation in copper wire.

C. Total elongation is 1.0 m

D. All of above

Answer: D

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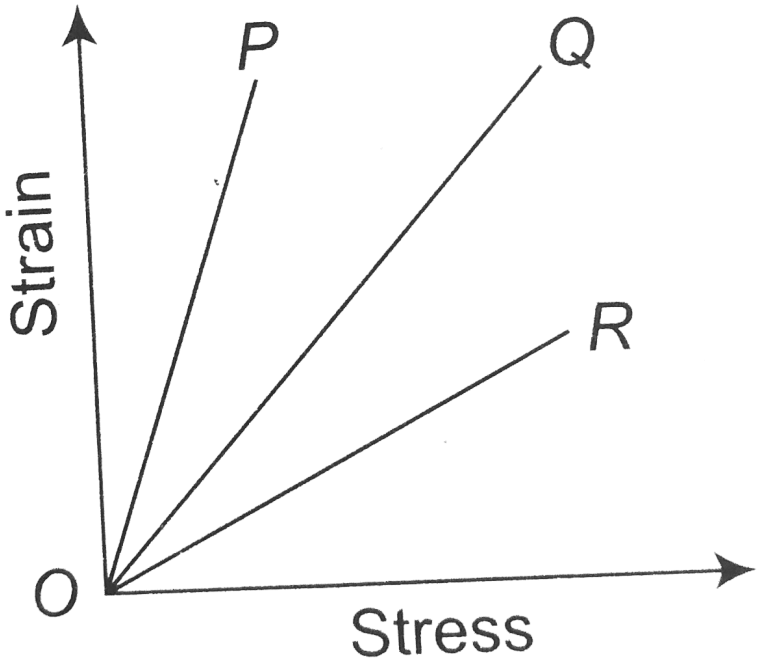

54.

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

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55. A string 1m long is drawn by a 300 Hz vibrator attached to its end. The string vibrates in three segments. The speed of transverse waves in the string is equal to

A. 1.22v

B. 0.61v

C. 1.50v

D. 0.75v

Answer: A

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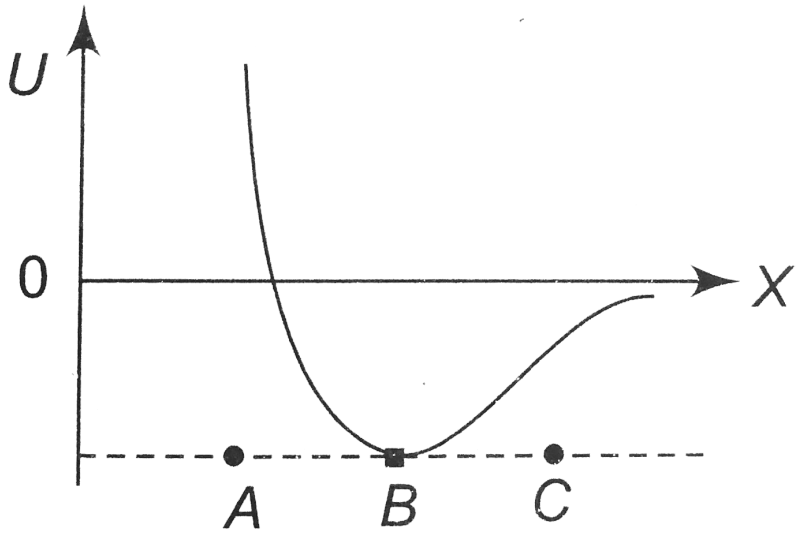

56.

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

A. attracted when x lies between A and B are repelled 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 hey reach B

Answer: B

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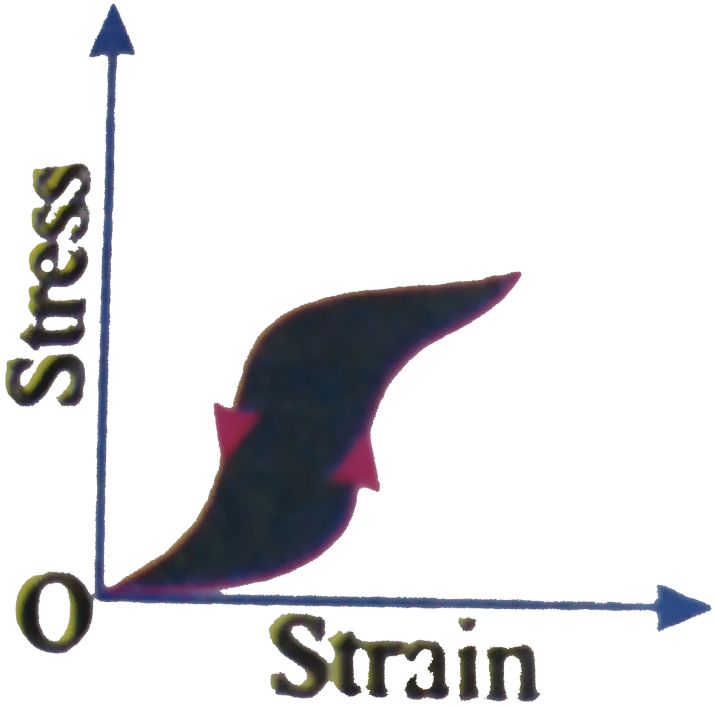
57. The diagram shows a force-extension graph for a rubber band. Consider of the following statements



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. only III

B. II and III

C. I and III

D. only I

Answer: A

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58. Consider two cylindrical rods of identical dimensions, one of rubber and the other of steel. Both the rods are fixed rigidly 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 elongates 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 rubber rod 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 tapered to a tip at the centre

Answer: D

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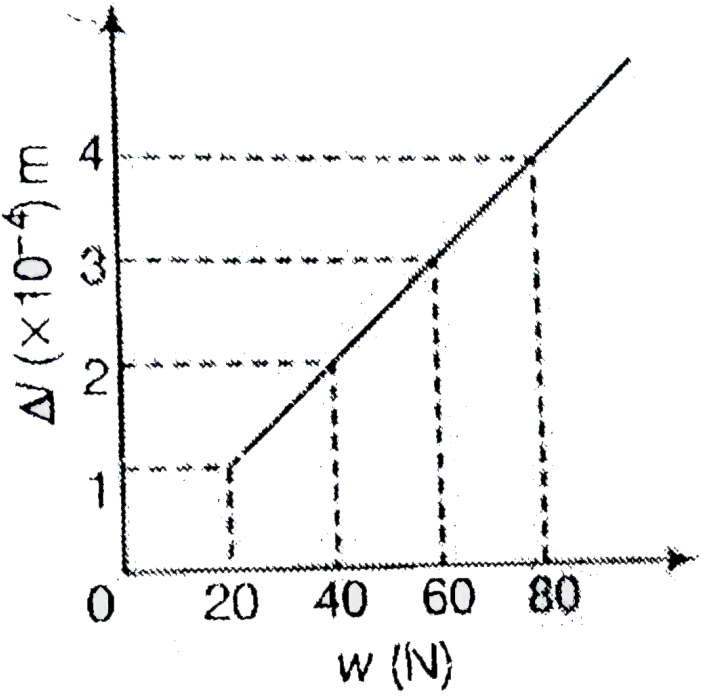
59. The adjacent graph shows the extension Δl of a wire of length 1m, suspended from the f top of a roof at one end and with a loaf w connected to the other end. If the cross-sectional area of the wire is

$10^6 m^2$ 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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60. A brass of length $2m$ and cross-sectional area $2.0cm^2$ is attached end to end to a steel rod of length and cross-sectional area $1.0cm^2$. The compound rod is subjected to equal and oppsite pulls of magnitude $5 \times 10^4 N$ at its ends. If the elongations of the two rods are equal, the length of the steel rod (L) is

$\{Y_{Brass} = 1.0 \times 10^{11} N/m^2$ and $Y_{steel} = 2.0 \times 10^{11} N/m^2$

A. 1.5 m

B. 1.8 m

C. 1 m

D. 2 m

Answer: D

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61. 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. $\frac{w_1 + \frac{w}{4}}{S}$

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

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

Answer: C

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62. The wire of a Young's modules appartus is elongated by 2 mm when a brick is suspended from .it When the brick is immersed in water the wire contracts by 0.6mm Calculate the density of the brick given that the density of water is $1000kgm^{-3}$

A. $3333 kgm^{-3}$

B. $4210 kgm^{-3}$

C. $5000 kgm^{-3}$

D. $2000 kgm^{-3}$

Answer: A

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63. 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 iron. The ratio of their diameters, if each is to have the same tension, is equal to

A. $\frac{\sqrt{Y_{\text{copper}}}}{Y_{\text{iron}}}$

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

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

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

Answer: B

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64. A wire of leng:h L has a linear mass density μ and area of cross-section A and the Youngs modulus Y is susperded vertically from a rigid support. The extension produced in the wire due to its own weight is

A. zero

B. $\frac{mgL}{2AY}$

C. $\frac{mgL}{AY}$

D. $\frac{2mgL}{AY}$

Answer: B

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

A. $\frac{1}{1-\frac{p}{B}}$

B. $1+\frac{B}{P}$

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

D. $1+\frac{p}{B}$

Answer: A

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66. One end of a long metallic wire of length L is tied to the ceiling. The other end is tied to massless spring of spring constant k. A mass m hangs freely from the free end of the spring . The area of cross-section and Young's modulus of the wire are A and Y respectively . If the mass is

slighty pulled down and released , it will oscillate with a time period T equal to

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

B. $2\pi\sqrt{\frac{m(YA+kL)}{YAK}}$

C. $2\pi\sqrt{\frac{mYA}{kL}}$

D. $2\pi\sqrt{\frac{mL}{YA}}$

Answer: B

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67. The length of a rubber cord is l_1 m when the tension is 4 N and l_2 m when the tension is 6 N.The length when the tension is 9 N, is

A. $(a+b)$

B. $(4b-5a)$

C. $(5b-4a)$

D. $(9b - 9a)$

Answer: C

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68. 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. $\frac{F}{SE}$

B. $\frac{F}{2SE}$

C. $\frac{F}{4SE}$

D. Zero

Answer: B

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

A. $\frac{p\alpha}{\beta}$

B. $\frac{3p\alpha}{\beta}$

C. $\frac{p}{\alpha\beta}$

D. $\frac{p}{3\alpha\beta}$

Answer: D

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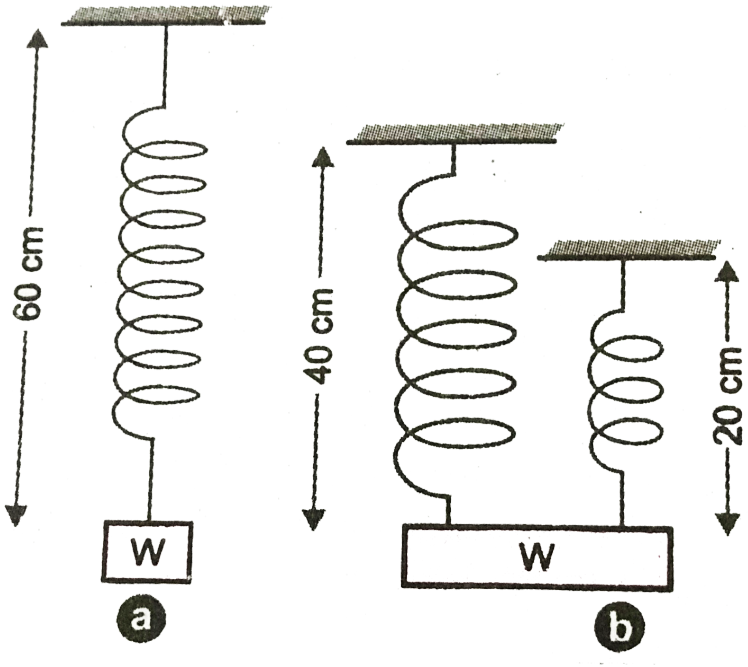
70. A block of weight W produces an extension of $9cm$ when it is hung by an elastic spring of length of $60cm$ and is in equilibrium. The spring is cut into two parts, one of length $40cm$ and the other of length $20cm$. The same load W hangs in equilibrium supported by both parts as shwon in

figure. The extension in cm noe is



A. 9

B. 6

C. 5

D. 2

Answer: D

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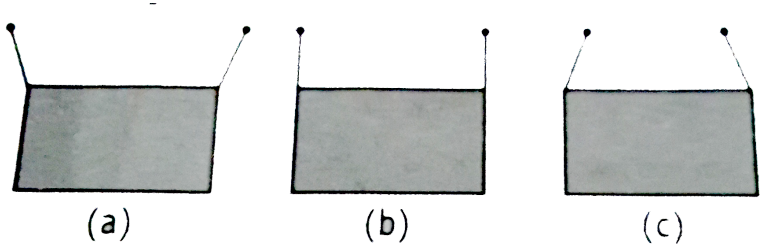
71. A rectangular frame is to be suspended symmetrically by two strings of equal length on two supports (figure). It can be done in one of the following three ways,



The tension in the strings will be

A. the same in all cases

B. least in (a)

C. least in (b)

D. least in (c)

Answer: C

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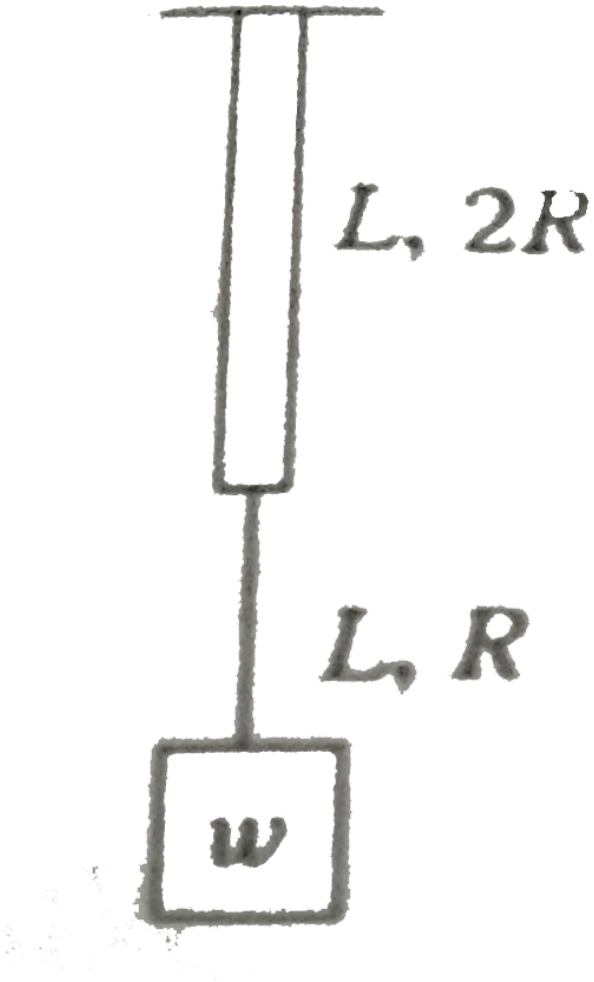
72. Two wires of the same material (Young's modulus=Y) and same length L but radii R and 2R respectively are joined end to end and a weight w is suspended from the combination as shown in the figure. The elastic potential energy in the system is



A. $\frac{3w^2L}{4\pi R^2Y}$

B. $\frac{3w^2L}{8\pi R^2Y}$

C. $\frac{5w^2L}{8\pi R^2Y}$

D. $\frac{w^2L}{\pi R^2Y}$

Answer: C

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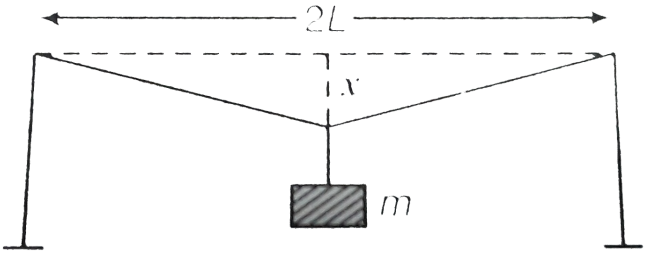
73. A mild steel wire of length 2L and cross-sectional area A is stretched, well within elastic limit, horizontally between two pillars (figure). A mass m is suspended from the mid-point of the wire. Strain in the wire is



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

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

C. x^2/L

D. $x^2/2L$

Answer: A

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Match The Columns

1. Match the following

Table-1		Table-2	
(A)	Steel	(P)	Young's modulus of elasticity
(B)	Water	(Q)	Bulk modulus of elasticity
(C)	Hydrogen gas filled in a chamber	(R)	sheer modulus of elasticity

A.

A	B	C
p	q	p

B.

A	B	C
p	p	q

C.

A	B	C
p	q	q

D.

A	B	C
p	r	r

Answer: c

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2. Match the following columns.

	Column I		Column II
(A)	Longitudinal stress	(p)	Volume changes
(B)	Shear stress	(q)	Shape change
(C)	Volumetric stress	(r)	Volume does not changes
(D)	Tensile stress	(s)	Shapes does not change

A.

A	B	C	D
p,s	q,r	p,s	p,s

B.

A	B	C	D
q,r	p,s	p,s	p,s

C.

A	B	C	D
p,s	p,s	q,r	p,s

D.

A	B	C	D
p,s	p,s	p,s	q,r

Answer: A

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3. Match the following

	Table-1		Table-2
(A)	Stress $\times$ Strain	(P)	J
(B)	$\frac{YA}{l}$	(Q)	N/m
(C)	Yl^3	(R)	J/m^3
(D)	$\frac{Fl}{AY}$	(S)	m

A. $\begin{matrix} A & B & C & D \\ r & q & p & s \end{matrix}$

B. $\begin{matrix} A & B & C & D \\ q & r & p & s \end{matrix}$

C. $\begin{matrix} A & B & C & D \\ p & r & r & q \end{matrix}$

D. $\begin{matrix} A & B & C & D \\ q & r & s & p \end{matrix}$

Answer: A

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4. With regard to dependence of quantities given in column I and II, match the following.

	Column I		Column II
(A)	Young's modulus of a substance	(p)	Depends on temperature
(B)	Bulk modulus of a substance	(q)	Depends on length
(C)	Modulus of rigidity of a substance	(r)	Depends on area of cross-sec
(D)	Volume of a substance	(s)	Depends on the nature of ma

A. A p,s B q,s C p,s D p,q

B. A p,s B p,s C p,s D p,q

C. A p,s B p,s C p,s D p,q,r

D. A p,q,r B p,s C p,s D p,r

Answer: a

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Medical Entrances S Gallery

1. The length of a metal wire is l_1 when the tension in it is T_1 and is l_2 when the tension is T_2. Then natural length of the wire is

A. $\frac{l_1 + l_2}{2}$

B. $\sqrt{l_1 l_2}$

C. $\frac{l_1 T_2 - l_2 T_1}{T_2 - T_1}$

D. $\frac{l_1 T_2 + l_2 T_1}{T_1 + T_2}$

Answer: C

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2. A load of 4 kg is suspended from a ceiling through a steel wire of length 2 m and radius 2 mm. It is found that the length of the wire increase by 0.032 mm as equilibrium is achieved. What would be the Young's modulus of steel ? (Take , $g = 3.1\pi ms^{-2}$)

A. $2.0 \times 10^{11} Nm^{-2}$

B. $2.82 \times 10^{11} Nm^{-2}$

C. $0.20 \times 10^{11} Nm^{-2}$

D. $0.028 \times 10^{11} Nm^{-2}$

Answer: A

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3. 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. $2:1$

D. $1:4$

Answer: D

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4. The elastic potential energy of a stretched wire is given by

A. $U = \frac{AL}{2Y} l^2$

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

C. $U = \frac{1}{2}\left(\frac{All}{Y}\right) l$

D. $U = \frac{1}{2} \cdot \frac{YL}{2A} \cdot l$

Answer: B

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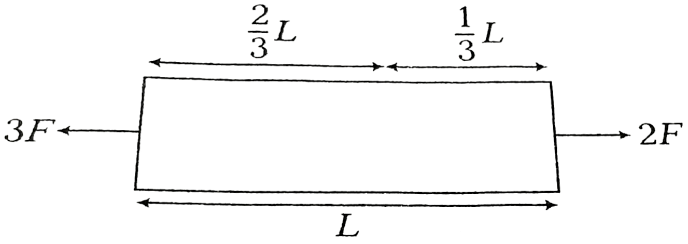
5. A uniform cylindrical rod of length L and cross-sectional area by forces as shown in figure.



The elongation produced in the rod is

A. $\frac{3FL}{8AY}$

B. $\frac{3FL}{5AY}$

C. $\frac{8FL}{3AY}$

D. $\frac{5FL}{3AY}$

Answer: C

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6. The ratio of hydraulic stress to the corresponding strain is known as

A. Young's modulus

B. compressibility

C. rigidity modulus

D. Bulk modulus

Answer: D

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7. The pressure on an object of bulk modulus B undergoing hydraulic compression due to a stress exerted by surrounding fluid having volume strain $\left(\frac{\Delta V}{V}\right)$

A. $B^2\left(\frac{\Delta V}{V}\right)$

B. $B\left(\frac{\Delta V}{V}\right)^2$

C. $\frac{1}{B}\left(\frac{\Delta V}{V}\right)$

D. $B\left(\frac{\Delta V}{V}\right)$

Answer: D

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8. For most of the material , Young's modulus (Y) and rigidity modulus (G) are related as

A. G=3Y

B. $G = \frac{Y}{3}$

C. $G = \frac{3}{2}Y$

D. $G = \frac{Y}{8}$

Answer: B

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9. The following four wires of length L and radius r are made of the same material. Which of these will have the largest extension, when the samne tersion is applied?

A. Length =50 cm, diameter =0.5 mm

B. Length =100 cm, diameter =1 mm

C. Length =200 cm, diameter =2 mm

D. Length =300 cm, diameter =3 mm

Answer: A

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10. The Young's modulus of a rope of 10 m length and having diameter of 2 cm is 20×10^{11} dyne cm^{-2} . If the elongation produced in the rope is 1 cm, the force applied on the rope is

A. $6.28 \times 10^5 N$

B. 6.28×10^4 N

C. 6.28×10^4 dyne

D. 6.28×10^5 dyne

Answer: B

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11. A steel wire of length l and cross sectional area A is stretched by 1 cm under a given load. When the same load is applied to another steel wire of double its length and half of its cross section area, the amount of stretching (extension) is

A. 0.5

B. 2 cm

C. 4 cm

D. 1.5 cm

Answer: C

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12. Theoretically the value of Poisson's ratio σ lies between

A. $0 < \sigma < 1$

B. $-1 < \sigma < 0.5$

C. $0.2 < \sigma < 0.4$

D. $-1 < \sigma < 1$

Answer: B

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13. A metal ring of initial radius r and cross-sectional area A is fitted onto a wooden disc of radius R > r. If Youngs modules of metal is Y then tension in the ring is

A. $\frac{AYr}{(R-r)}$

B. $\frac{Y(R-r)}{r}$

C. $\frac{AY(R-r)}{R}$

D. $\frac{AY(R-r)}{r}$

Answer: D

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14. An indian ruber cord L meter long and area of cross-secion A metre is suspended vertically. Density of rubber is ρ kg/ metre^3 and Young's modulus of rubber is Y newton/ metre^2. IF the cord extends by l metre under its own. Weight, then extension l is

A. $\frac{L^2Dg}{2E}$

B. $\frac{L^2Dg}{E}$

C. $\frac{L^2Dg}{4E}$

D. L

Answer: A

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15. The density of a metal at normal pressure is ρ. Its density when it is subjected to an excess pressure p is ρ' . If B is the bulk moldulus of the metal, the ratio $\frac{\rho'}{\rho}$ is

A. $1 + p/B$

B. $1 + B/p$

C. $\frac{1}{(1 - B/p)}$

D. $\frac{1}{(1 - p/B)}$

Answer: D

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16. To break a wire of one meter length, minimum 40 kg wt. is required. Then the wire of the same material of double radius and 6 m length will require breaking weight

A. 40 kg-wt

B. 80 kg -wt

C. 160 kg-wt

D. 320 kg-wt

Answer: C

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17. If Poission's ratio σ is $-\frac{1}{2}$ for a material, then the material is

A. elastic fatigue

B. incompressible

C. compressible

D. None of these

Answer: B

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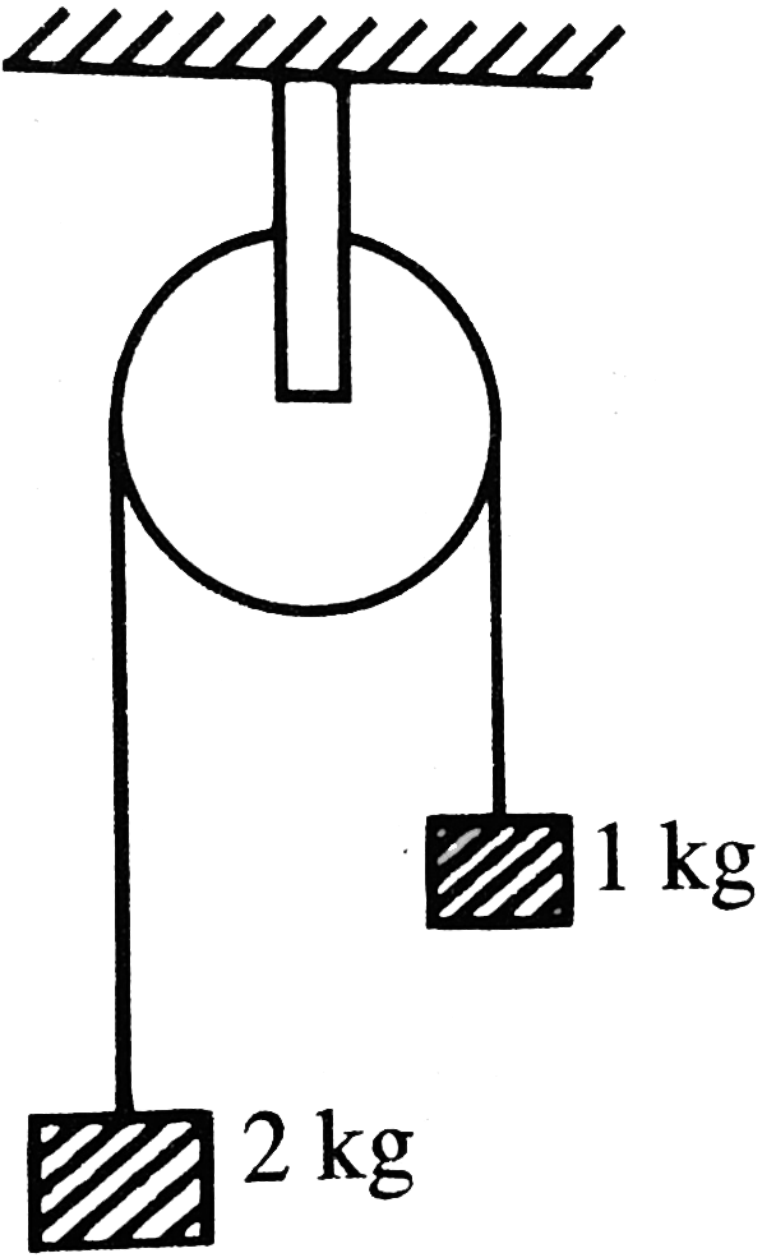
18. Two blocks of masses $1kg$ and $2kg$ are connected by a metal wire going over a smooth pulley as shown in figure.

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. 0.5 mm

B. 1 mm

C. 1.5 mm

D. 2 mm

Answer: C

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19. Which one the following is not a unit of Young's modulus ?

A. Nm^{-1}

B. Nm^{-2}

C. Dyne cm^{-2}

D. Mega pascal

Answer: A

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20. There is same change in length when a 33000 N tensile force is applied on a steel rod of area of cross-section $10^{-3}m^2$. The change of temperature reuired to produce the same elongation, if the steel rod is heated , if (The modulus of elasticitay is $3 \times 10^{11} N/m^2$ and the coefficient of linear expansion of steel is $1.1 \times 10^{-5}/^{\circ} C$).

A. 20° C

B. $15^{\circ} C$

C. $10^{\circ} C$

D. $0^{\circ} C$

Answer: C

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21. A beam of metal supported at the two ends is loaded at the centre. The depression at the centre is proportional to

A. Y^2

B. Y

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

D. $\frac{1}{Y^2}$

Answer: C

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