



## PHYSICS

### BOOKS - NCERT PHYSICS (HINGLISH)

### MECHANICAL PROPERTIES OF SOLIDS

Mcq

1. Modulus of rigidity of a liquid

A. infinity

B. zero

C. unity

D. some finite small non-zero constant value

**Answer: B**



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

- A. be double
- B. be half
- C. be four times
- D. remain same

**Answer: D**



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

- A. will also double
- B. will become four times
- C. will remain same
- D. will decrease

**Answer: D**



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

- A. volumetric

B. shear

C. longitudinal and shear

D. longitudinal

**Answer: C**



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5. A rigid bar of mass  $M$  is supported symmetrically by three wires each of length  $l$ . Those at each end are of copper and the middle one is of iron. The ratio of their diameters, if each is to have the same tension, is equal to

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

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

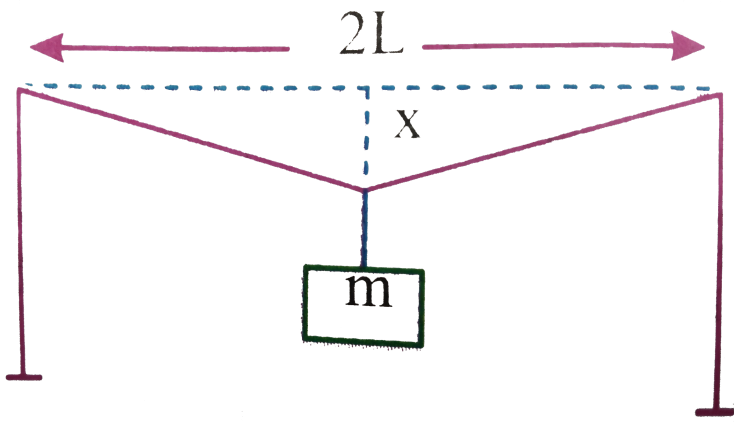
C.  $\frac{Y_{\text{iron}}^2}{Y_{\text{copper}}^2}$

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

Answer: B

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6. A mild steel wire of length  $1.0\text{m}$  and cross sectional area  $2L$  is stretched, within its elastic limit horizontally between two pillars (figure). A mass of  $m$  is suspended from the midpoint of the wire. Strain in the wire is



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

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

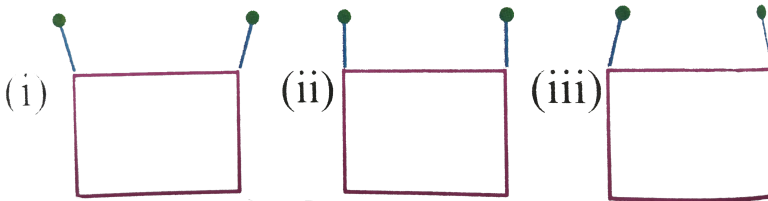
C.  $x^2 / L$

D.  $x^2 / 2L$

**Answer: A**

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7. A 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:



A. the same in all cases

B. least in (a)

C. least in (b)

D. least in (c)

**Answer: C**

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8. Consider two cylindrical rods of 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 elongate but there shall be no perceptible change in shape

B. The steel rod will elongate and change shape but the rubber rod will only elongate

- C. The steel rod will elongate without any perceptible change in shape, but the 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

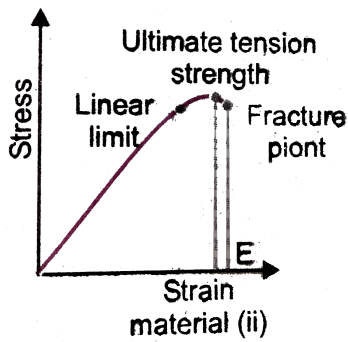
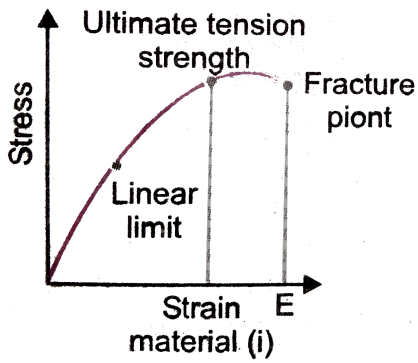
**Answer: D**



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**9.** The stress-strain graphs for two materials are shown in Fig. 7(EP).3 (assume scale).





- A. Material (ii) is more elastic than material (i) and hence material (ii) is more brittle
- B. Material (i) and (ii) have the same elasticity and the same brittleness
- C. Material (ii) is elastic over a larger region of strain as compared to (i)
- D. Material (ii) is more brittle than material (i)

Answer: C::D



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10. A wire is suspended from the ceiling and stretched under the action of weight  $F$  suspended from its other end. The force exerted by the ceiling on it is equal and opposite to the weight.

- A. Tensile stress at any cross-section  $A$  of the wire is  $F/A$
- B. Tensile stress at any cross-section is zero
- C. Tensile stress at any cross-section  $A$  of the wire is  $2F/A$
- D. Tensile at any cross-section  $A$  of the wire is  $F$

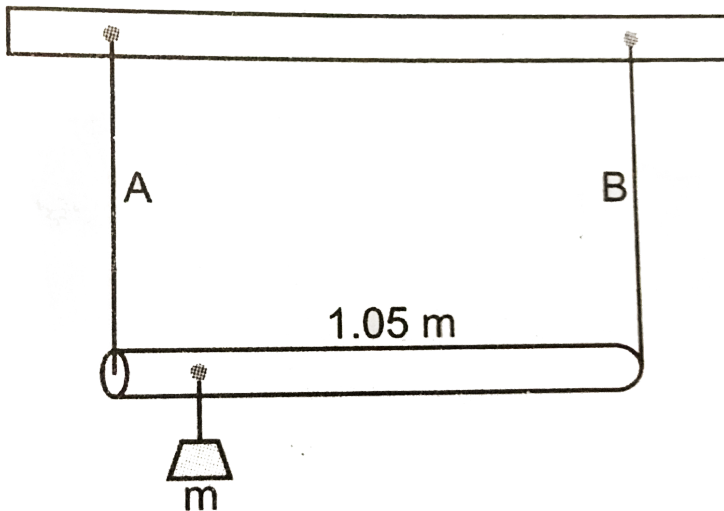
**Answer: A::D**

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11. A rod of length 1.05 m having negligible mass is supported at its ends by two wires of steel (wire A) and aluminium (wire B) of equal lengths as shown in fig. The cross-sectional area of wire A

and B are  $1\text{mm}^2$  and  $2\text{mm}^2$ , respectively. At what point along the rod should a mass  $m$  be suspended in order to produce (a) equal stresses and (b) equal strains in both steel and aluminium wires. Given,

$$Y_{\text{steel}} = 2 \times 10^{11} \text{Nm}^{-2} \text{ and } Y_{\text{aluminium}} = 7.0 \times 10^{10} \text{Nm}^{-2}$$



- A. Mass  $m$  should be suspended close to wire A to have equal stresses in both the wires
- B. Mass  $m$  should be suspended close to B to have equal stresses in both the wires

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

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

**Answer: B::D**



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**12.** For an ideal liquid

A. the bulk modulus is infinite

B. the bulk modulus is zero

C. the shear modulus is infinite

D. the shear modulus is zero

**Answer: A::D**



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**13.** A Copper wire and steel of the same diameter and length are connected end to end and a force is applied, which stretches their combined length by 1 cm. The two wires will have

- A. the same stress
- B. different stress
- C. the same strain
- D. different strain

**Answer: A::D**



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## Long Short Answer Type Question

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

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2. Is stress a vector quantity ?

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

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



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5. what is the Bulk modulus for a perfect rigid body ?



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



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

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

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9. A truck is pulling a car out of a ditch by means fo a steel cable that is  $9.1m$  long and has a radius of  $5mm$ . When the car just beings to move, the tension in the cable is  $800N$ . If Young's



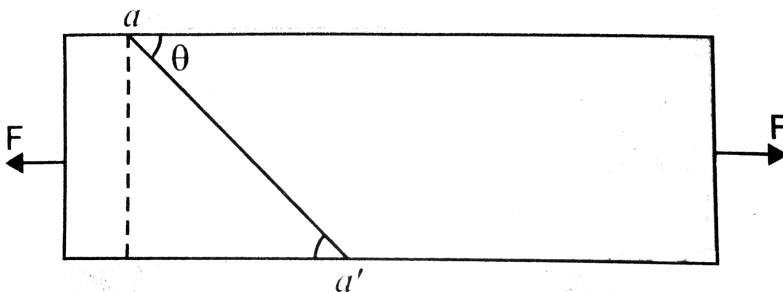
modulus for steel is  $2 \times 10^{11} \text{ N/m}^2$  then the stretch in the cable is (nearly)

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

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



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

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

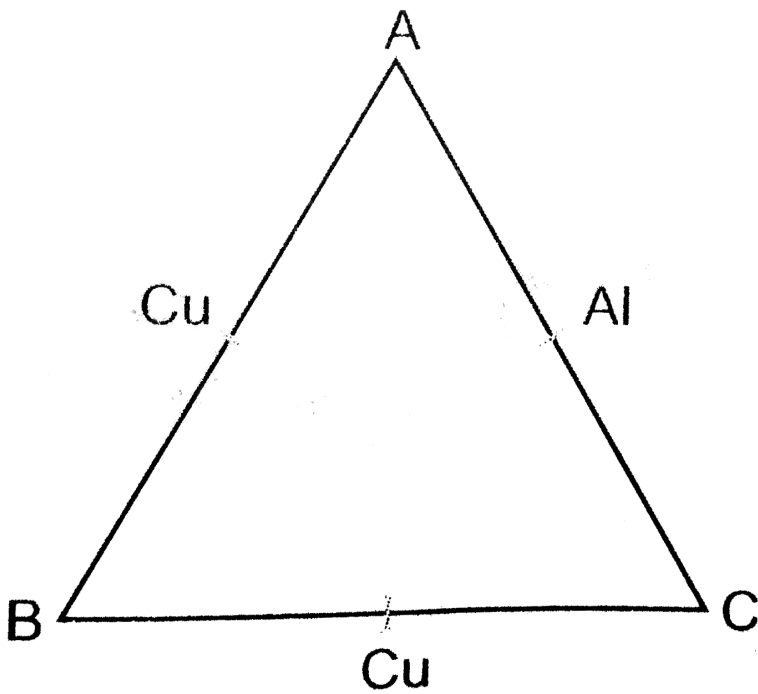
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13. A steel rod of length  $2l$  cross sectional area  $A$  and mass  $M$  is set rotating in a horizontal plane about an axis passing through its centre and perpendicular to its length with constant angular velocity  $\omega$ . If  $Y$  is the Young's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



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14. An equilateral triangle  $ABC$  is formed by two Cu rods  $AB$  and  $BC$  and one Al rod



it is heated in such a way that temperature of each rod increases by  $\Delta T$ . Find change in the angle ABC. [Coeff. Of linear expansion for Cu. is  $\alpha_1$ , Coeff. of linear expansion for Al is  $\alpha_2$ ]

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15. In nature, the failure of structural members usually result from large torque because of twisting or bending rather than

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



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**16.** A stone of mass m is tied to an elastic string of negligible mass and spring constant k. The unstretched length of the string is L and has negligible mass. The other end of the string is fixed to a

nail at a point p. Initially the stone is at the same level as the point P. The stone is dropped vertically from point P.

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

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

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



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