Mechanical Properties of Solids

1. 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 ?

[AIEEE-2009]

(1) $4F$ (2) $6F$

(3) $9F$ (4) F

2. A metal rod of Young's modulus Y and coefficient of thermal expansion α is held at its two ends such that its length remains invariant. If its temperature is raised by t°C, the linear stress developed in it is **[AIEEE-2011]**

(1) $\dfrac{1}{(Y\alpha t)}$ (2) $\dfrac{\alpha t}{Y}$

(3) $\dfrac{Y}{\alpha t}$ (4) $Y\alpha t$

3. A man grows into a giant such that his linear dimensions increase by a factor of 9. Assuming that his density remains same, the stress in the leg will change by a factor of **[JEE (Main)-2017]**

(1) 9 (2) $\dfrac{1}{9}$

(3) 81 (4) $\dfrac{1}{81}$

4. A solid sphere of radius r made of a soft material of bulk modulus K is surrounded by a liquid in a cylindrical container. A massless piston of area of a floats on the surface of the liquid, covering entire cross-section of cylindrical container. When a mass m is placed on the surface of the piston to compress the liquid, the fractional decrement in the radius of the sphere, $\left(\dfrac{dr}{r}\right)$, is **[JEE (Main)-2018]**

(1) $\dfrac{Ka}{mg}$ (2) $\dfrac{Ka}{3mg}$

(3) $\dfrac{mg}{3Ka}$ (4) $\dfrac{mg}{Ka}$

5. A rod, length L at room temperature and uniform area of cross section A, is made of a metal having coefficient of linear expansion α/°C. It is observed that an external compressive force F, is applied on each of its ends, prevents any change in the length of the rod, when its temperature rises by ΔTk. Young's modulus, Y, for this metal is

[JEE (Main)-2019]

(1) $\dfrac{F}{A\alpha(\Delta T - 273)}$ (2) $\dfrac{F}{A\alpha\Delta T}$

(3) $\dfrac{2F}{A\alpha\Delta T}$ (4) $\dfrac{F}{2A\alpha\Delta T}$

6. A load of mass M kg is suspended from a steel wire of length 2 m and radius 1.0 mm in Searle's apparatus experiment. The increase in length produced in the wire is 4.0 mm. Now th load is fully immersed in a liquid of relative density 2. The relative density of the material of load is 8.

The new value of increase in length of the steel wire is **[JEE (Main)-2019]**

(1) 4.0 mm (2) Zero

(3) 5.0 mm (4) 3.0 mm

7. A steel wire having a radius of 2.0 mm, carrying a load of 4 kg, is hanging from a ceiling. Given that g = 3.1 π ms^{-2}, what will be the tensile stress that would be developed in the wire? **[JEE (Main)-2019]**

(1) 4.8×10^6 Nm^{-2} (2) 3.1×10^6 Nm^{-2}

(3) 5.2×10^6 Nm^{-2} (4) 6.2×10^6 Nm^{-2}

8. A boy's catapult is made of rubber cord which is 42 cm long, with 6 mm diameter of cross-section and of negligible mass. The boy keeps a stone weighing 0.02 kg on it and stretches the cord by 20 cm by applying a constant force. When released, the stone flies off with a velocity of 20 ms^{-1}. Neglect the change in the area of cross-section of the cord while stretched. The Young's modulus of rubber is closest to **[JEE (Main)-2019]**

(1) 10^4 Nm^{-2} (2) 10^3 Nm^{-2}

(3) 10^8 Nm^{-2} (4) 10^6 Nm^{-2}

9. Young's moduli of two wires *A* and *B* are in the ratio 7 : 4. Wire *A* is 2 m long and has radius *R*. Wire *B* is 1.5 m long and has radius 2 mm. If the two wires stretch by the same length for a given load, then the value of *R* is close to **[JEE (Main)-2019]**
   (1) 1.3 mm (2) 1.9 mm
   (3) 1.5 mm (4) 1.7 mm

10. In an experiment, brass and steel wires of length 1 m each with areas of cross section 1 mm^2 are used. The wires are connected in series and one end of the combined wire is connected to a rigid support and other end is subjected to elongation. The stress required to produce a net elongation of 0.2 mm is,

    [Given, the Young's Modulus for steel and brass are, respectively, 120×10^9 N/m^2 and 60×10^9 N/m^2] **[JEE (Main)-2019]**
    (1) 1.8×10^6 N/m^2 (2) 1.2×10^6 N/m^2
    (3) 8.0×10^6 N/m^2 (4) 0.2×10^6 N/m^2

11. The elastic limit of brass is 379 MPa. What should be the minimum diameter of a brass rod if it is to support a 400 N load without exceeding its elastic limit? **[JEE (Main)-2019]**
    (1) 0.90 mm (2) 1.16 mm
    (3) 1.00 mm (4) 1.36 mm

12. Two steel wires having same length are suspended from a ceiling under the same load. If the ratio of their energy stored per unit volume is 1 : 4, the ratio of their diameters is **[JEE (Main)-2020]**
    (1) $\sqrt{2}:1$
    (2) 2 : 1
    (3) $1:\sqrt{2}$
    (4) 1 : 2

13. A cube of metal is subjected to a hydrostatic pressure of 4 GPa. The percentage change in the length of the side of the cube is close to

    (Given bulk modulus of metal, $B = 8 \times 10^{10}$ Pa)

    [JEE (Main)-2020]
    (1) 0.6
    (2) 20
    (3) 1.67
    (4) 5

14. A body of mass m = 10 kg is attached to one end of a wire of length 0.3 m. The maximum angular speed (in rad s^{-1}) with which it can be rotated about its other end in space station in (Breaking stress of wire = 4.8×10^7 Nm^{-2} and area of cross-section of the wire = 10^{-2} cm^2) is

    [JEE (Main)-2020]

❑ ❑ ❑