ELASTICITY

Single Correct Answer Type:

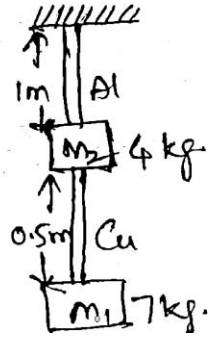
1. The diameter of a mass rod is 4 mm & Young's modulus of brass is $9\times10^{10}\ N/m^2$. Find the force required to stretch it by 0.1 % of its length

   (A) 360 πN (B) 280 πN (C) 340 πN (D) 380 πN

2. Calculate the elongation of the copper rod and Aluminium wire shown in figure. Diameters of copper & Al wires are 1.4 mm & 1 mm respectively. Given that $Y_{Cu}=11\times10^{10}\ N/m^2$ and $Y_{Al}=7\times10^{10}\ N/m^2$

   (A) 3 mm (B) 4 mm

   (C) 2 mm (D) 1 mm



3. A steel wire is suspended vertically from a rigid support. When it is loaded by a weight in air, it is elongated by 5 mm and when the weight is submerged in water elongation is changed to 4 mm. Find the relative density of the material of weight

   (A) 2 (B) 9 (C) 3 (D) 5

4. When a metal block is placed in vacuum chamber from normal atmosphere find the fractional change in its volume. Given that atmosphere pressure is $10^5\ N/m^2$ & bulk modulus of metal is $1.25\times10^{11}\ N/m^2$

   (A) 8×10^{-7} (B) 9×10^{-8} (C) 7×10^{-7} (D) 2×10^{-5}

5. A rubber ball is taken to a depth of 200 m in a lake. Its volume decreases by 0.1 %. If density of water is $1000\ kg/m^3$ and $g=10\ m/s^2$. Find Bulk modulus of material of ball

   (A) $3\times10^9\ N/m^2$ (B) $2\times10^{11}N/m^2$ (C) $2\times10^9\ N/m^2$ (D) $3\times10^{11}N/m^2$

6. A wire of cross sectional area A, Young's modulus Y and length 2L is stretched between two rigid poles. A weight of mass M is suspended at its middle. Find the angle made by string with horizontal.

   (A) $\theta=\sin^{-1}\left(\frac{mg}{YA}\right)^{1/3}$ (B) $\theta=\sin^{-1}\left(\frac{YA}{mg}\right)^{1/3}$ (C) $\theta=\sin^{-1}\left(\frac{mgA}{Y}\right)^{1/3}$ (D) $\theta=\sin^{-1}\left(\frac{Y}{mgA}\right)^{1/3}$

7. Calculate the elastic potential energy stored in a brass, rod of length 20 cm and area 1 cm^2 when it is elongated by a load of 5 kg mass. Given that Young's modulus of brass is $10^{11}\ N/m^2$, $g=10\ m/sec$

   (A) 2.5×10^{-5} J (B) 2.8×10^{-5} J (C) 2.5×10^{-10} J (D) 2.8×10^{10} J

8. A 4 m long cylindrical wire with cross section 1 cm^2 is suspended vertically from a rigid support and carries a bob of mass 100 kg at the other end. If the bob gets snapped, calculate the change in temperature of wire. Given that density of steel is $2\times10^{11}N/m^2$ and specific heat of steel is $420\ J/Kg-k$ and $g=10\ m/s^2$

   (A) $7.68\times10^{-9}K$ (B) $7.63\times10^{-5}K$ (C) $7.63\times10^{-7}K$ (D) $7.63\times10^{-10}K$

9. An elastic string of unstretched length L and force constant k is stretched by a small length x. It is further stretched by another small length 'Y'. The work done in the second stretching is

   (A) $\frac{1}{2}ky^2$ (B) $\frac{1}{2}k\left(x^2+y^2\right)$ (C) $\frac{1}{2}k\left(x+y\right)^2$ (D) $\frac{1}{2}ky\left(2x+y\right)$

10. The end of uniform wire of length 'L' and weight 'W' is attached rigidly to a point in the roof and 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 $\frac{3L}{4}$ from its lower end is

(A) $\frac{W_1}{S}$ (B) $\frac{W_1+\frac{W}{4}}{S}$ (C) $\frac{W_1+\frac{3W}{4}}{S}$ (D) $\frac{W_1+W}{S}$

11. A wire of length 'L' and cross-sectional area 'A' is made of a material of Young's modulus Y. If the wire is stretched by the amount x, the work done is

(A) $\frac{YAx^2}{2L}$ (B) $\frac{YAx^2}{L}$ (C) $\frac{YAx}{2L}$ (D) YAx^2L

12. When the pressure on a fluid is changed from 1.01×10^5 Pa to 1.165×10^5 Pa, the volume changes by 10%, the bulk modulus of fluid is

(A) 1.55×10^5 Pa (B) 0.015×10^5 Pa (C) 1.015×10^5 Pa (D) 1.55×10^6 Pa

13. If 'S' is stress & Y is Young's modulus of the material of a wire. The energy stored in the wire per unit volume is

(A) $\frac{S^2}{2Y}$ (B) $2S^2Y$ (C) $\frac{2Y}{C^2}$ (D) $\frac{1}{2}YS^2$

14. A wire elongates by ℓ mm when a load W is hanged from it. If the wire goes over a pulley & two weights W each are hung at the two ends, the elongation of the wire (in mm) will be

(A) ℓ (B) 2ℓ (C) Zero (C) $\ell/2$

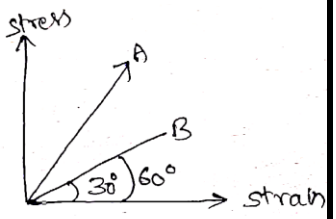
15. An elevator cable is to have a maximum stress of $7\times10^7\,N/m^2$ to allow for appropriate safety factors. Its maximum upward acceleration is $1.5\,m/s^2$. If the cable has to support the total weight of 2000 kg of a loaded elevator, the area of cross section of the cable should be

(A) 3.28 cm^2 (B) 2.38 cm^2 (C) 0.328 cm^2 (D) 8.23 cm^2

16. To break of wire, a force of $10^6\,N/m^2$ is required. If the density of the material is $3\times10^3\,kg/m^3$, then the length of the wire which will break by its own weight will be

(A) 34 m (B) 30 m (C) 300 m (D) 3 m

17. The stress versus strain graphs for wires of two materials A & B are as shown in the figure. If Y_A & Y_B are the young's module of the materials, then



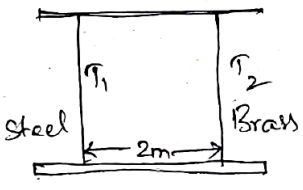
(A) $Y_B = 2Y_A$ (B) $Y_A = Y_B$

(C) $Y_B = 3Y_A$ (D) $Y_A = 3Y_B$

18. A rod of length ℓ and radius 'r' is joined to a rod of length $\ell/2$ and radius r/2 of same material. The free end of small rod is fixed to a rigid base and the free end of larger rod is given a twist of $\theta°$, the twist angle at the joint will be

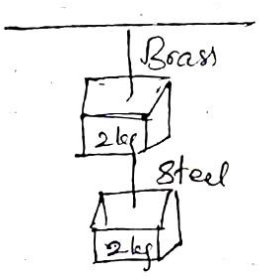
(A) $\theta/4$ (B) $\theta/2$ (C) $5\theta/6$ (D) $8\theta/9$

19. A light rod of length 2 m suspended from the ceiling horizontally by means of two vertical wires of equal lengths. A weight W is hung from a light rod as shown in figure. The rod hung by means of a steel wire of cross-section area $A_1 = 0.1\,cm^2$ & brass wire of cross-sectional area $A_2 = 0.2\,cm^2$. To have equal stress in both wires, $T_1/T_2 =$



(A) 1/3 (B) 1/4 (C) 4/3 (D) 1/2

20. If the ratio of lengths, radii & Young's modulus of steel & brass wires shown in the fig are a, b, c respectively. The ratio between the increase in length of steel and brass wires would be



(A) $\frac{b^2a}{2c}$ (B) $\frac{bc}{2a^2}$

(C) $\frac{ba^2}{2c}$ (D) $\frac{a}{2b^2c}$

Numerical Based:

21. Four identical hollow cylindrical columns of steel support a big structure of mass 50,000 kg. The inner and outer radii of each column are 30 cm and 40 cm respectively. Assuming the load distribution to be uniform, the compressional strain of each column is _____ $\times 10^{-6}$
(The Young's modulus of steel is 2.0×10^{11} Pa)

22. A steel wire of uniform cross-section 1 mm^2 is heated to $70°$ C and stretched by tying its two ends rigidly. Calculate the change in tension of the wire when the temperature falls from $70°$ C to $35°$ C co-efficient of linear expansion of steel is 1.1×10^{-5} /°C & the young's modulus is 2.0×10^{11} N/m^2

23. Compute the bulk modulus of water from the following data. Initial volume = 100.0 litre, Pressure increase = 100.0 atm, final volume = 100.5 litre (1 atm = 1.013×10^5 N/m^2) is _____ N/m^2

24. A light rod of length 2.00 m is suspended from the ceiling horizontally by means of two vertical wires of equal length tied to its ends. One of the wires is made of steel and is of cross-section 10^{-3} m^2 & the other is of brass of cross- section 2×10^{-3} m^2. Find out the position along the rod at which a weight may be hung to produce equal strains in both wires.
Young's modulus of brass $= 10^{11}$ N/m^2
Young's modulus of steel $= 2 \times 10^{11}$ N/m^2

25. 1 kg weight is suspended by a rubber cord 2.00 m long and of cross-section 0.5 cm^2. It is made to describe a horizontal circle of radius 50 cm in 4 times a second. Find the extension of the cord ($Y = 5 \times 10^8$ N/m^2) is _____ 10^{-2} m

KEY

1.	A	2.	C	3.	D	4.	A	5.	C
6.	A	7.	A	8.	B	9.	D	10.	C
11.	A	12.	A	13.	A	14.	A	15.	A
16.	A	17.	D	18.	D	19.	D	20.	D
21.	2.78	22.	2277	23.	2.026	24.	1	25.	2.53