IMPORTANT QUESTIONS CLASS – 11 PHYSICS CHAPTER – 8 MECHANICAL PROPERTIES OF SOLID

Question 1.
What are the factors due to which three states of matter differ from one's Other?

Answer:
Three states of-matter differ from each other due to the following two factors:
(a) The different magnitudes of tester atomic and intermolecular forces.
(b) The degree of random thermal motion of the atoms and molecules of a substance depends upon the temperature.

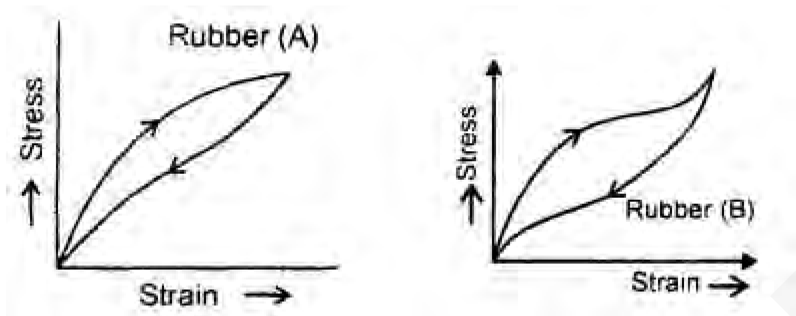
Question 2.
When we stretch a wire, we have to perform work Why? What happens to the energy given to the wire in this process?

Answer:
In a normal situation, the atoms of a solid are at the locations of minimum potential energy. When we stretch a wire, the work has to be done against interatomic forces. This work is stored in the wire in the form of elastic potential energy.

Question 3.
Why are the bridges declared unsafe after long use?

Answer:
A bridge during its use undergoes alternative strains a large number of times each day, depending upon the movement of vehicles on it. When a bridge is used for a long time it loses its elastic strength, due to which the number of strains in the bridge for given stress will become large and ultimately the bridge may collapse. Thus, !» to avoid this, the bridges are declared unsafe after long use..

Question 4 .
A heavy machine is to be installed in a factory. To absorb vibrations of the machine, a block of rubber is placed between the machinery and the floor. Which of the two rubbers (A) and (B) of Figure would you prefer to use for this purpose? Why?



Answer:
The area of this hysteresis loop measures the amount of heat energy dissipated by the material. Since the area of the loop B is more than that of A, therefore B can absorb more vibrations than that of Av Hence B is preferred.

Question 5.
Compare the densities of water at the surface and bottom of a lake 100 m deep, given that the compressibility is 10322 per atm and 1 atm = 1.015 × 10^5 Pa.
Answer:

Ans. Here, Compressibility $= \frac{1}{K} = \frac{10^{-3}}{22}$ per atm

$$\therefore \quad K = \frac{22}{10^{-3}} \text{ atm}$$
$$= 22 \times 10^{3} \times 1.015 \times 10^{5} \text{ Pa}$$
$$(\because 1 \text{ atm} = 1.015 \times 10^{5} \text{ Pa})$$
$$h = \text{depth of lake} = 100 \text{ m}$$

Let V = Volume of 1 kg water at the surface.
V’ = Volume of 1 kg water at the bottom of lake 100 m deep
= V – ΔV, where ΔV = decrease in volume, increase in pressure, P = hρg = 100 × 10^3 × 9.8 Nm^2

$$\therefore \quad \text{increase in pressure, } P = h\rho g = 100 \times 10^{3} \times 9.8 \text{ Nm}^{-2}$$

From the relation, $K = \frac{P}{\left(\frac{\Delta V}{V}\right)}$, we get

$$\therefore \quad \frac{\Delta V}{V} = \frac{P}{K}$$
$$= \frac{100 \times 10^{3} \times 9.8}{22 \times 1.015 \times 10^{8}}$$
$$= \frac{9.8}{22 \times 1.015} \times 10^{-3}$$

If ρ_s and ρ_b be the densities of water at the surface and at the bottom of the lake respectively, then

$$\rho_s = \frac{1}{V} \text{ and } \rho_b = \frac{1}{V'}.$$

$$\frac{\rho_s}{\rho_b} = \frac{\text{Density of water at the surface}}{\text{Density of water at the bottom}}$$

$$= \frac{1/V}{\frac{1}{V-\Delta V}} = \frac{V-\Delta V}{V}$$

$$= 1 - \frac{\Delta V}{V} = 1 - \frac{9.8\times10^{-3}}{22\times1.015}$$

$$= 0.99956.$$

Question 6.
A steel wire 2 mm in diameter is stretched between two clamps, when its temperature is 40° C. Calculate the tension in the wire, when its temperature falls to 30° C. Given, coefficient of linear
Answer:

Here, $Y = 21\times10^{11}$ dyne cm^{-2}

$\alpha = 11\times10^{-6}\,{}^\circ C^{-1}$

$\theta_1 = 30^\circ C, \theta_2 = 40^\circ C;$

$\therefore \Delta\theta = \theta_2 - \theta_1 = 40 - 30 = 10^\circ C$

$D = 2\text{ mm} = 0.2\text{ cm}$

$\therefore r = \frac{D}{2} = 0.10\text{ cm}$

$\therefore$ Area, $A = \pi r^2 = \pi (0.1)^2\text{ cm}^2$

$\therefore$ Tension $=$ Force $= F = ?$

Let $l =$ length of the wire

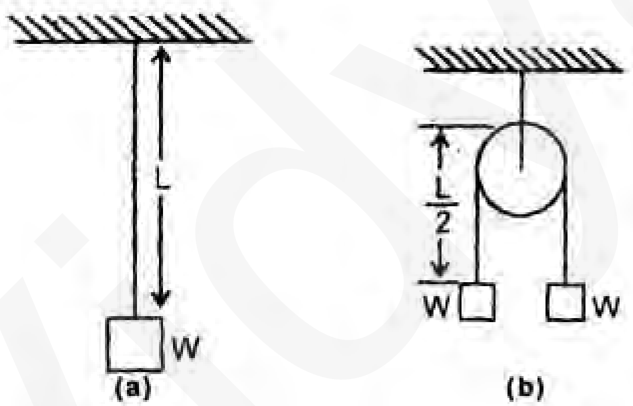
If Δl be the change n length of the wire, then

$$\Delta l = l \alpha \Delta\theta$$
$$= l \times (11 \times 10^{-6}) \times 10 \text{ cm}$$
$$= 11\, l \times 10^{-5} \text{ cm}$$

Using the relation $Y = \dfrac{F/A}{\frac{\Delta l}{l}}$, we get

$\therefore$
$$F = \frac{\Delta l}{l} YA = \pi r^2 Y \frac{\Delta l}{l}$$
$$= \frac{22}{7} \times (0.1)^2 \times 21 \times 10^{11} \times 11 \times 10^{-5}$$
$$= 726 \times 10^4 \text{ dyne} = 7.26 \times 10^6 \text{ dyne.}$$

Question 7.
When a weight W is hung from one end of a wire of length L (other end being fixed), the length of the wire increases by l fig. (a). If the wire is passed over a pulley and two weights W each is hung at the two ends fig. (b), what will be the total elongation in the wire?



Answer:
(a) Let Y = Young's modulus of the material of the wire. If 'a' be its area of cross-section, then

$$Y = \frac{F/a}{l/L} = \frac{WL}{al} \qquad (\because F = W)$$

or
$$l = \frac{WL}{aY} \qquad \text{.... (1)}$$

(b) When the wire is passed over the pulley, let l' be the increase in the length of each segment. Since L2 = length of each segment.

$$\therefore \quad Y = \frac{W\left(\frac{L}{2}\right)}{al'}$$

$$\text{or} \quad l' = \frac{1}{2}\frac{WL}{aY} = \frac{l}{2} \quad \text{.... (2)}$$

[by using (1)]

∴

Total increase in the length of the wire is given by
= l' + l' = 2l' = 2 × l2 = l.

Question 8.
A uniform cylindrical wire is subjected to longitudinal tensile stress of 5 × 10^7 Nm^{-2}. The Young's Modulus of the material of the wire is 2 × 10^{11} Nm^{-2}. The volume change in the wire is 0.02%. Calculate the fractional change in the radius of the wire.

Answer: Here,

$$\text{Stress} = 5 \times 10^7 \, Nm^{-2}$$
$$Y = 2 \times 10^{11} \, Nm^{-2}$$
$$\frac{\Delta V}{V} = 0.02\% = \frac{0.02}{100}$$

$$\therefore \quad Y = \frac{\text{Stress}}{\left(\frac{\Delta L}{L}\right)}$$

$$\text{or} \quad \frac{\Delta L}{L} = \frac{\text{Stress}}{Y} = \frac{5 \times 10^7}{2 \times 10^{11}} = 2.5 \times 10^{-4}$$

$$\text{Now} \quad V = \pi r^2 L$$

$$\therefore \quad \frac{\Delta V}{V} = \frac{\pi \Delta (r^2 L)}{\pi r^2 L} = \frac{r^2 \Delta L + L \times 2r\Delta r}{r^2 L}$$

$$\text{or} \quad \frac{\Delta V}{V} = \frac{\Delta L}{L} + 2\left(\frac{\Delta r}{r}\right)$$

$$\text{or} \quad 2\frac{\Delta r}{r} = \frac{\Delta V}{V} - \frac{\Delta L}{L}$$

$$= \frac{0.02}{100} - 2.5 \times 10^{-4}$$
$$= 2 \times 10^{-4} - 2.5 \times 10^{-4}$$
$$= -0.5 \times 10^{-4}$$

$$\therefore \quad \frac{\Delta r}{r} = -\frac{0.5}{2} \times 10^{-4} = -0.25 \times 10^{-4}.$$

Question 9.
A wire loaded by the weight of density 7.6 g cm^{-3} is found to measure 90 cm. On immersing the weight in water, the length decreases by 0.18 cm. Find the original length of the wire.

Answer:
Let L = original length of the wire =?
A = be its area of cross-section.
W = load attached to the wire.
Then Young's Modulus of the wire is given by

$$Y = \frac{W/A}{\frac{\Delta L}{L}} = \frac{W}{A} \times \frac{L}{\Delta L}$$

Here, ΔL = 90 – L = Change in the length of wire.

$$\therefore \quad Y = \frac{W \times L}{A(90 - L)} \quad \text{.... (i)}$$

Volume of weight attached,

$$V = \frac{W}{\text{density of weight}} = \frac{W}{7.6} \text{ cm}^3.$$

∴ Mass of water displaced = V × density of water
= W7.6 × l = W7.6

∴ Net weight after immersing in water is
W' = W – W7.6 = 6.67.6 W

Length of wire after immersing in water
= 90 – 0.18 = 89.82 cm.

∴ Increase in length on immersing in water,

$$\Delta L' = (89.82 - L) \text{ cm}$$

$$\therefore \quad Y = \frac{W'L}{A\Delta L'}$$

$$= \frac{6.6W \times L}{7.6 \times A \times (89.82 - L)} \quad \text{.... (ii)}$$

∴ from (*i*) and (*ii*), we get

$$\frac{W \times L}{A(90 - L)} = \frac{6.6W \times L}{7.6 \times A \times (89.82 - L)}$$

$$7.6\,(89.82 - L) = 6.6\,(90 - L)$$
$$682.632 - 7.6\,L = 594 - 6.6\,L$$
or $$L = 88.632 \text{ cm.}$$

Question 10.
Two exactly similar wires of steel and copper are stretched by equal forces. If the total elongation is 1 cm, find by how much each wire is elongated. Given Y for steel = 20×10^{11} dyne cm^{-2}, Y for copper = 12×10^{11} dyne cm^{-2}.

Answer:
Let Δl_S and Δl_C be the elongation produced in steel and copper wires respectively.
L_S, L_C be their respective lengths,
$L_S = L_C$ ($\because$ wires are similar)
$Y_S = 20 \times 10^{11}$ dyne cm^{-2}
$Y_C = 12 \times 10^{11}$ dyne cm^{-2}
$\Delta l_S + \Delta l_C = 1$ cm
A = area of cross-section of each wire.
F = equal force applied.

$\therefore$ Using the relation, $$Y = \frac{F}{A} \times \frac{L}{\Delta l}, \text{ we get}$$

$$\Delta l_c = \frac{F\,L_c}{A\,Y_c} \quad \ldots (i)$$

and $$\Delta l_s = \frac{F\,L_s}{A\,Y_s} = \frac{F\,L_c}{A\,Y_s} \quad \ldots (ii)$$

Dividing (ii) by (i), we get

$$\therefore \quad \frac{\Delta l_s}{\Delta l_c} = \frac{Y_c}{Y_s} = \frac{12 \times 10^{11}}{20 \times 10^{11}}$$
$$= \frac{3}{5} = 0.6 \quad \ldots (iii)$$

Also $$\Delta l_s + \Delta l_c = 1 \text{ cm}$$
or $$0.6\,\Delta l_c + \Delta l_c = 1 \text{ cm}$$
or $$1.6\,\Delta l_c = 1 \text{ cm}$$

$$\therefore \quad \Delta l_c = \frac{1}{1.6} = 0.625 \text{ cm}$$

From (*iii*)
$$\therefore \quad \Delta l_s = 0.6 \times 0.625 = 0.375 \text{ cm.}$$