DPP

DAILY PRACTICE PROBLEMS

CLASS : XITH

DATE :

Solutions

SUBJECT : PHYSICS

DPP NO. : 5

Topic :- MECHANICAL PROPERTIES OF SOLIDS

1 **(b)**

$$U = \frac{1}{2} \times \frac{(\text{stress})^2}{Y} \times \text{volume} = \frac{1}{2} \times \frac{F^2 \times A \times L}{A^2 \times Y}$$

$$= \frac{1}{2} \times \frac{F^2 L}{AY} = \frac{1}{2} \times \frac{(50)^2 \times 0.2}{1 \times 10^{-4} \times 1 \times 10^{11}} = 2.5 \times 10^{-5} J$$

3 **(d)**

Young's modulus, $Y = \frac{\text{Stress}}{\text{Strain}} = \frac{\frac{\text{Force}}{\text{Area}}}{\frac{l}{L}}$

Where, l is change in length and L the original length.

Force $= mg$, Area $= A = \pi r^2$

$$\therefore Y = \frac{FL}{\pi r^2 l}$$

$$\therefore \frac{Y_1}{Y_2} = \frac{F_1 L_1}{\pi r_1^2 l_1} \times \frac{\pi r_2^2 l_2}{F_2 L_2}$$

$$\Rightarrow \frac{l_1}{l_2} = \frac{r_2^2}{r_1^2}$$

(as all other quantities remain same for both the wires)

Given, $r_2 = 2r_1$

$$\therefore \frac{l_1}{l_2} = \frac{(2r_1)^2}{r_1^2} = \frac{4}{1}$$

4 **(b)**

Out of the given substances, steel has greater value of Young's modulus. Therefore, steel has highest elasticity.

5 **(c)**

Breaking stress for both ropes would be same.

$$\frac{T_{\max_1}}{\pi \times \left(\frac{1}{2}\right)^2} = \frac{T_{\max_2}}{\pi\left(\frac{3}{2}\right)^2}$$

$$\Rightarrow T_{\max_2} = 9 \times T_{\max_2} = 4500 \text{ N}$$

6 **(b)**

$$\sigma = \frac{\text{Lateral strain}}{\text{Longitudinal strain}}$$

Or Lateral strain $= \sigma \times$ longitudial strain

$= 0.4 \times \frac{0.5}{100} = \frac{0.02}{100}$

So, percentage reduction in diameter is 0.02.

7 **(c)**

Let L be the length of each side of cube. Initial volume = L^3. When each side decreases by 1%.

New length $L' = L - \frac{1}{100} = \frac{99L}{100}$

New volume = $L'^3 = \left(\frac{99L}{100}\right)^3$, change in volume,

$$\Delta V = L^3 - \left(\frac{99L}{100}\right)^3$$

$= L^3\left[1 - \left(1 - \frac{3}{100} + \cdots\right)\right] = L^3\left[\frac{3}{100}\right] = \frac{3L^3}{100}$

$$\therefore Bulk\ strain = \frac{\Delta V}{V} = \frac{3L^3/100}{L^3} = 0.03$$

8 **(c)**

Young's modulus $Y = \frac{mgl}{a_1 l_1}$

$l_1 = \frac{mgl}{Y\pi r^2}$ ....(i)

and $Y = \frac{mg(2l)}{a_2 l_2} = \frac{mg(2l)}{\pi(2\,r)^2 l_2}$

Or $l_2 = \frac{mg\,l}{2Y\ \pi r^2}$ ....(ii)

From Eqs. (i) and (ii), we have

$$\therefore\ l_1 + l_2 = \frac{mgl}{Y\ \pi r^2} + \frac{mgl}{2Y\pi r^2} = \frac{3}{2}\ \frac{mgl}{Y\ \pi r^2}$$

9 **(c)**

$$\eta = \frac{F/A}{x/L} \Rightarrow x = \frac{L}{\eta} \times \frac{F}{A}$$

If η and F are constant then $x \propto \frac{L}{A}$

For maximum displacement area at which force applied should be minimum and vertical side should be maximum, this is given in the Q position of rectangular block

10 **(d)**

$Y = \frac{Fl}{A\Delta l} = \left(\frac{F}{\Delta l}\right)\frac{1}{A}$; $kl =$ constant;

$k \times 3 = k' \times 2$ or $k' = \frac{3k}{2}$

11 **(c)**

$Y = \frac{Fl}{\alpha\Delta L}$ or $\Delta L \propto \frac{1}{\alpha}$; $\Delta L \propto \frac{1}{D^2}$

$\frac{\Delta L_2}{\Delta L_2} = \frac{D_1^2}{D_2^2} = 4$ or $\Delta L_2 = 4\Delta L_1 = 4$cm

12 **(b)**

$Y = \frac{F}{A} \times \frac{l}{\Delta l}$ or $F = YA\frac{\Delta l}{l}$

$= \frac{(5.0 \times 10^8) \times 10^6) \times (2 \times 10^{-2})}{(10 \times 10^{-2})} = 100$ N

14 **(b)**

$U(R) = \frac{A}{R^n} - \frac{B}{R^m}$

The negative potential energy (2nd part) is the attractive

15 **(d)**

$Y = \frac{F}{A} \times \frac{l}{x}$ or $F = \frac{YAx}{l}$

Work done $W = \frac{1}{2}F \times x = \frac{1}{2}\frac{YAx'}{l}$

$= \frac{1 \times 2 \times 10^{11} \times (10^{-6}) \times (2 \times 10^{-3})^2}{2 \times 1} = 0.4$ J

16 **(c)**

$L = \frac{p}{eg} = \frac{10^6}{3 \times 10^3 \times 10} = \frac{100}{3} = 33.3$ m

17 **(d)**

Metals have larger values of Young's modulus than elastomers because the alloys having high densities, *ie,* alloys have larger values of Young's modulus than metals.

18 **(b)**

Ratio of adiabatic and isothermal elasticities

$\frac{E\phi}{E\theta} = \frac{\gamma P}{P} = \gamma = \frac{C_p}{C_v}$

19 **(a)**

Poisson's ratio $= \frac{\text{Lateral strain}}{\text{Longitudinal strain}}$

ie, $0.4 = \frac{0.01 \times 10^{-3}}{\frac{l}{L}}$

or $\frac{L}{l} = \frac{0.4}{0.01 \times 10^{-3}} = 4 \times 10^4$

Young's modulus

$Y = \frac{FL}{Al}$

$= \frac{100}{0.025} \times 4 \times 10^4 = 1.6 \times 10^8 \text{Nm}^{-2}$

20 **(b)**

Poisson's ratio, $\sigma = 0.4 = \frac{\Delta d}{d} / \frac{\Delta l}{l}$

Area $A = \pi r^2 = \frac{\pi d A^2}{4}$ or $d^2 = \frac{4A}{\pi}$

Differentiating

$2d\,\Delta d = \frac{4}{\pi}\Delta A$

As $A = \frac{\pi d^2}{4}$, so $\Delta A = \frac{2\pi d_\Delta d}{4}$

$\frac{\Delta A}{A} = \frac{\pi \frac{d}{2} \Delta d}{\pi d^2/4} = 2\frac{\Delta d}{d}$

Given $\frac{\Delta A}{A} \times 100 = 2\%$

= $2 = 2\frac{\Delta d}{d}$ or $\frac{\Delta d}{d} = 1\%$

Given $\sigma = \frac{\Delta d/d}{\Delta l/l} = 0.4$

Or $\frac{\Delta d}{d} = 0.4\frac{\Delta l}{l}$

$\frac{\Delta l}{l} = \frac{1}{0.4}\frac{\Delta l}{l}$

= $2.5 \times 1\%$

= 2.5%

ANSWER-KEY										
Q.	1	2	3	4	5	6	7	8	9	10
A.	B	A	D	B	C	B	C	C	C	D
Q.	11	12	13	14	15	16	17	18	19	20
A.	C	B	B	B	D	C	D	B	A	B