SIMPLE STRESS AND STRAIN

1. Hook'es law essentially defines **(P.M.T., M.P. 88)**
   (a) stress (b) strain
   (c) yield point (d) elastic limit
2. Bulk modulus was first defined by
   (a) Young (b) Bulk
   (c) none of the above (d) Maxwell
3. The dimensional formula for modulus of rigidity is
   (a) MLT (b) $ML^{-2}T^{3}$ (c) $ML^{-1}T^{-1}$
   (d) MLT^{-2} (d) $ML^{-1}T^{-2}$
4. The following four wires are made of the same material which of these will have the largest extension when the same tension is applied
   (a) length 50cm and diameter 0.5 mm.
   (b) length 100 cm and diameter 1 mm.
   (c) length 200 cm and diameter 2 mm.
   (d) length 300cm and diameter 3 mm.
5. An iron bar of length l cm and cross-section A cm^2 is pulled by a force of F dynes from ends so as to produce an elongation l cm. Which of the following stqatement is correct ?
   (a) elongation is inversely proportional to length.
   (b) elongation is directly proportional to cross section A.
   (c) elongation is inversely proportional to A.
   (d) elongation is directly proportional to Young's modulus.

6. Energy in a stretched wire is
(a) half of load × strain
(b) load × strain
(c) stress × strain
(d) half of stress × strain

7. An iron bar of length l and having cross-section A is heated from 0^0C to 100^0C. If this bar is held so that it is not permitted to expand or bend, the gigantic force that is developed is
(a) directly proportional to the length of the bar.
(b) inversely proportional to the length of the bar.
(c) independent of the length of the bar.
(d) inversely proportional to the cross-section of the bar.

8. If a gas is heated at constant pressure, its iso thermal compressibility
(a) remains constant
(b) increases linearly with temperature.
(c) decreases linearly with temperature.
(d) decreases inversely with temperature.

9. Theoretical value of Poisson's ratio lies between
(a) –1 and + 0.5 (b) –1 and –2
(c) –0.5 and +1 (d) –1 and 0.

10. On stretching a wire, the elastic energy stored per unit volume is,
(a) F dl/ 2 Al (b) FA / 2l
(c) Fl / 2 A (d) F l / 2

11. Which of the following relation is true
(a) $3\gamma = K(1-\sigma)$ (b) $\sigma = 0.5\gamma\eta$
(c) $K = \dfrac{9\gamma\eta}{\gamma+\eta}$ (d) $\sigma = (6k+\eta)\gamma$

12. A beam of metal supported at the two ends is loaded at the centre. The depression at the centre is proportional to
(a) γ^2 (b) γ (c) $1/\gamma$ (d) $1/\gamma^2$

13. The Young's modulus of a wire of length L and radius r is γ newton per square metre. If the length is reduced to L/2 and radius r/2, its Yound's modulus will be
(a) $\gamma/2$ (b) γ
(c) 2γ (d) 4γ

14. In a wire stretched by hanging a weight from its end, the elastic potential energy per unit volume in terms of the longitudinal strain σ and modulus of elasticity γ is
(a) $\gamma\sigma^2/2$ (b) $\gamma\sigma/2$
(c) $2\gamma\sigma^2/2$ (c) $\gamma^2\sigma/2$

15. When an elastic material with Young's modulus Y is subjected to a stretching stress s, the elastic energy stored per unit volume of the material is
(a) $\gamma s/2$ (b) $s^2\gamma/2$
(c) $s^2/2\gamma$ (d) $s/2\gamma$

16. A long string is stretched by 2cm and the potential energy is V. If the spring is strectched by 10 cm, its potential energy will be
(a) V / 25 (b) V / 5
(c) 5 V (d) 25 V

17. Two rods of different materials having coefficients of linear expansion α_1, α_2 and Young's module γ_1 and γ_2 respectively are fixed betweenn two rigid massive walls. The rods are heated such that they undergo the same increase in temperature. There is no bending of rods. If $\alpha_1 : \alpha_2 = 2:3$, the thermal stresses developed in the two rods are equal provided $\gamma_1 : \gamma_2$ is equal to
(a) 2 : 3 (b) 1 : 1 (c) 3 : 2 (d) 4 :9

18. A spherical ball contracts in volume by 0.01% when subjected to a normal uniform pressure of 100 atmospheres. The bulk modulus of its material in dyne/cm^2 is

(a) 10×10^{12} (b) 100×10^{12}

(c) 1×10^{12} (d) 2.0×10^{11}

19. Two wires A and B are of the same material. Their lengths are in the ratio 1:2 and the diameter are in the ratio 2:1. If they are pulled by the same force, their increase in length will be in the ratio

(a) 2 : 1 (b) 1 : 4 (c) 1 : 8 (d) 8 :1

20. A steel wire of length 20 cm and uniform cross-section 1 mm² is tied rigidly at both the ends. The temperature of the wire is altered from 40°c to 20°c coefficient of lonear expansion for steel $\alpha = 1.1\times10^{-5}/{}^0C$ and γ for steel is 2.0×10^{11} n/m². The change in tension of the wire is

(a) 2.2×10^6 Newton (b) 16 Newton

(c) 8 Newton (d) 44 Newton

21. An cron bar of length l, cross-section A and Young's modulus γ is pulled by a force F from both ends so as to produce an elongation e which of the following statement is correct ?

(a) 2 α $1/l$ (b) e α A

(c) e α 1/A (d) e α γ

22. A wire of length L and radius r fixed at one end and a force F applied to the other end produces an extension l. The extention produced in another wire of the same material of length 2L and radius 2r by a force 2F is

(a) l (b) $2l$ (c) $l/2$ (d) $4l$

23. A thick copper rope of density 1.5×10^6 N/m², 8m in length when hung from the ceiling of a room, the increase in its length due to its own weight is

(a) 9.6×10^{-5} m (b) 19.2×10^{-7} m

(c) 9.6×10^{-2} m (d) 9.6 m

24. Two rods A and B of the same material and length have their radii r_1 and r_2 respectively. Whent hey are rigidly fixed at one end and twisted by the same couple aplied at the other end, the ratio $\left(\frac{\text{theangleof twistat theendof A}}{\text{theangleof twistat theendof B}}\right)$ is

(a) r_1^2/r_2^2 (b) r_1^3/r_2^3

(c) r_2^4/r_1^4 (d) r_1^4/r_2^4

25. The following four wires of length L and radius r are made of the same material. which of these will have the largest extension when the same tension is applied ?

(a) L = 50 cm r = 0.25 mm

(b) L = 100 cm r = 0.5 mm

(c) L = 200 cm r = 1 mm

(d) L = 300 cm r = 1.5 mm

26. If the work done in stretching a wire by 1 mm is 2J, the work necessary for stretching another wire of the same material but with double radius of cross-section and half the length by 1 mm is in joules

(a) 16 (b) 8 (c) 4 (d) 1 / 4

27. What is relation between γ, k, η for some isotropic solid material

(a) $\eta = \frac{3k\gamma}{Ak+\gamma}$ (b) $\eta = \frac{3k\gamma}{Ak-\gamma}$

(c) $\eta = \frac{3\gamma k}{Ak-\gamma}$ (d) $\gamma = \frac{Ak\eta}{3k-\eta}$

28. Two pieces of wire A and B of the same material have their lengths in the ratio of 1:2 and their diameters in the ratio of 2:1. If they are stretched by the same force, their elongations will be in the ratio of

(a) 2 : 1 (b) 1 : 4

(c) 1 : 8 (d) 8 : 1

29. A wie of length l and cross-sectional area A is made of a material of Young's modulus γ. If the wire is stretched by an amount x, the worddone is

(a) $\frac{\gamma Ax^2}{2L}$ (b) $\frac{\gamma Ax}{2L^2}$

(c) $\frac{\gamma Ax}{2L}$ (d) $\frac{\gamma Ax^2}{L}$

30. A steel ring of radius r and cross sectional area. A i filled on to a wooden disc of radius R (R > r). If Young's modlulus be γ, then the force with which the steel ring is expanded is

(a) $A\gamma(R/r)$ (b) $A\gamma\left(\frac{R-r}{r}\right)$

(c) $\frac{\gamma}{A}\left(\frac{R-r}{r}\right)$ (d) $\frac{\gamma r}{AR}$

31. The upper end of a wire 1 metre long and 2 mm radius is clamped. The lower end is twisted through an angle of 45^0. The angle of shear is

(a) 0.09^0 (b) 0.9^0 (c) 9^0 (d) 90^0

32. The compressibility of water is 4×10^{-5} per unit atmospheric pressure. The decrease in volume of 100 cm^3 of water under a pressure of 100 atmosphere will be

(a) 0.4 cm^3 (b) 4×10^{-5} cm^3
(c) 0.02 cm^3 (d) 0.004 cm^3

34. The magnitude of the force developed by raising the temperature from 0^0c to 100^0c of the iron bar 1.00m long and 1cm^2 cross-section when it is held so that it is not permitted to expand or bend is $(\alpha=10^{-5}/^0c \text{ and } \gamma=10^{11}\,N/m^2)$

(a) 10^3 N (b) 10^4 N
(c) 10^5 N (d) 10^9 N

35. One end of a uniform wire of length L and of weight W is attached rigidly to a point in the roof and a 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) W_1/S (b) $\left(W_1+\frac{W}{4}\right)S$

(c) $\left(W_1+\frac{3W}{4}\right)S$ (d) $(W_1+W)/S$

ANSWERS

1.(d) 2.(c) 3.(e) 4.(a) 5.(c) 6.(d)
7.(a) 8.(a) 9.(a) 10.(a) 11.(b) 12. (c)
13.(b) 14.(a) 15.(c)
16.(d)

$$V=\frac{1}{2}k(x)^2=\frac{1}{2}k(2)^2$$

$$\Rightarrow k=\frac{2v}{4}=\frac{v}{2}$$

$$v'=\frac{1}{2}k(10)^2=\frac{1}{2}\times\left(\frac{v}{2}\right)(10)^2=25v.$$

17.(c)

Thermal stress $=\gamma\alpha(\Delta T)$

(Thermal stress)$_1$ $=\gamma_1\alpha_1\,\Delta T$,

(Thermal stress)$_2$ $=\gamma_2\alpha_2\,\Delta T$

$\therefore \gamma_2\alpha_2\,\Delta T=\gamma_2\alpha_2\,\Delta T$

$$\Rightarrow\frac{\gamma_1}{\gamma_2}=\frac{\alpha_2}{\alpha_1}=\frac{3}{2}.$$

18. (c)

19.(c) We know that $\gamma=\frac{F}{\pi r^2}\times\frac{L}{l}$

Since γ, F are same for both the wires, we have

$$\frac{1}{r_1^2}\frac{L_1}{l_1}=\frac{1}{r_2^2}\frac{L_2}{l_2}$$

$$\Rightarrow\frac{l_1}{l_2}=\frac{4_2^{\,2}\times L_1}{r_1^2\times L_2}=\frac{(D_2/2)^2\times L_1}{(D_1/2)^2\times L_2}$$

$$\Rightarrow l_1:l_2=1:8$$

20.(d)

$F=\gamma A\alpha t$
$=(2.0\times10^{11})\,(10^{-6})\,(1.1\times10^{-5})\,(20)$
= 44 Newton

21.(c)

since the same force acts on both ends and hence the stress will be due to the force F and not by 2F. Hence

$$\gamma = \frac{\text{Stress}}{\text{Strain}} = \frac{F/A}{e/l} = \frac{Fl}{Ae}$$

$$\therefore e = \frac{Fl}{A\gamma} \Rightarrow e \alpha l/A$$

22.(a)

$$\gamma = \frac{F/\pi r^2}{l/L} = \frac{Fl}{\pi r^2 l} \Rightarrow l = \frac{FL}{\pi r^2 \gamma}$$

Let l be the extension produced when a force 2F is applied. Then

$$l' = \frac{(2F)(2L)}{\pi (2r)^2 \gamma} = \frac{FL}{\pi r^2 \gamma} = l$$

23. (c)

$$\Delta L = \left(\frac{1}{2}\rho g L^2\right)/\gamma$$

$$= \frac{1}{2} \times \frac{1.5\times10^3\times64}{5\times10^6}$$

$= 9.6 \times 10^{-2}$

24. (c)

Couple per unit angle of twist

$$C = \frac{\pi\eta r^4}{2l}$$

$\therefore$ Angle of twist $= C\theta = \frac{\pi\eta r^4\theta}{2l}$

Here, η, l and c are same. Hence

$r^4\theta = \text{constant}$

$$\therefore \frac{\theta_1}{\theta_2} = \left(\frac{r_2^4}{r_1^4}\right)$$

25.(a)

We know that $\gamma = \frac{F}{\pi r^2} \times \frac{L}{l}$

Here γ, F and π are same for a the four wires. So L will be maximum for a wire which L/r^2 is maximum.

26. (a) $\gamma = \frac{FL}{Al}$

In both the case γ and l are the same

$$\therefore \frac{F_1 L}{\pi r^2} = \frac{F_2(L/2)}{\pi(2r)^2} \Rightarrow F_2 = 8F_1 = 1\theta$$

27.(c)

28.(c) $l_1 = \frac{FL_1}{\pi r_1^2 \gamma}$ and $l_2 = \frac{FL_1}{\pi r_2^2 \gamma}$

$$\therefore \frac{l_1}{l_2} = \frac{L_1}{L_2} \times \frac{r_2^2}{r_1^2} = \frac{1}{2} \times \frac{1}{4} = \frac{1}{8} = 1:8$$

29.(a) $\gamma = \frac{FL}{AL} \Rightarrow F = \frac{\gamma AL}{L}$

$$dW = Fdl = \frac{\gamma A}{L} l dl$$

$$\therefore W = \int \frac{\gamma A}{L} l dl = \frac{\gamma A}{L}\left[\frac{l^2}{2}\right]_0^x = \frac{\gamma A x^2}{2L}$$

30.(b)

31.(a) $\theta = \frac{r \times \varphi}{L} = \frac{(2/1000)45^\circ}{1} = 0.09^\circ$

32.(c) $\theta = \frac{r \times \varphi}{L} = \frac{(4/1000)\times 30^\circ}{1} = \frac{120}{100} = 0.12^\circ$

33.(a)

34. (b) $F = \gamma A \alpha t = 10^{11} \times (10^{-4}) \times 10^{-5} \times 100 = 10^4 N$

35.(c)

Force at a height 3L/4 fromits lower end = weight suspended + weight of $\left(\frac{3}{4}\right)$ of the chain

$$= W_1 + \left(\frac{3w}{4}\right)$$

Stress $= \left(W_1 + \frac{3w}{4}\right)/S$.