1. The elastic limit for a gas
(a) Exists
(b) Exists only at absolute zero
(c) Exists for a perfect gas
(d) Does not exist

2. Two wires of the same material have lengths in the ratio 1 : 2 and their radii are in the ratio $1:\sqrt{2}$. If they are stretched by applying equal forces, the increase in their lengths will be in the ratio
(a) $2:\sqrt{2}$ (b) $\sqrt{2}:2$
(c) $1:1$ (d) $1:2$

3. Two wires '*A*' and '*B*' of the same material have radii in the ratio 2 : 1 and lengths in the ratio 4 : 1. The ratio of the normal forces required to produce the same change in the lengths of these two wires is
(a) 1 : 1 (b) 2 : 1
(c) 1 : 4 (d) 1 : 2

4. A fixed volume of iron is drawn into a wire of length *L*. The extension *x* produced in this wire by a constant force *F* is proportional to
(a) $\frac{1}{L^2}$ (b) $\frac{1}{L}$
(c) L^2 (d) L

5. In which case there is maximum extension in the wire, if same force is applied on each wire
(a) $L = 500\ cm, d = 0.05\ mm$
(b) $L = 200\ cm, d = 0.02\ mm$
(c) $L = 300\ cm, d = 0.03\ mm$
(d) $L = 400\ cm, d = 0.01\ mm$

6. A load *W* produces an extension of 1*mm* in a thread of radius *r*. Now if the load is made 4*W* and radius is made 2*r* all other things remaining same, the extension will become
(a) 4 *mm* (b) 16 *mm*
(c) 1 *mm* (d) 0.25 *mm*

7. A 5 *m* long aluminium wire ($Y = 7\times10^{10}\ N/m^2$) of diameter 3 *mm* supports a 40 *kg* mass. In order to have the same elongation in a copper wire $(Y = 12\times10^{10}\ N/m^2)$ of the same length under the same weight, the diameter should now be, in *mm*.
(a) 1.75 (b) 1.5
(c) 2.5 (d) 5.0

8. A uniform plank of Young's modulus *Y* is moved over a smooth horizontal surface by a constant horizontal force *F*. The area of cross section of the plank is *A*. The compressive strain on the plank in the direction of the force is
(a) F/AY (b) $2F/AY$
(c) $\frac{1}{2}(F/AY)$ (d) $3F/AY$

9. The area of cross section of a steel wire $(Y = 2.0\times10^{11}\ N/m^2)$ is $0.1\ cm^2$. The force required to double its length will be
(a) $2\times10^{12}\ N$ (b) $2\times10^{11}\ N$
(c) $2\times10^{10}\ N$ (d) $2\times10^{6}\ N$

10. A wire of diameter 1*mm* breaks under a tension of 1000 *N*. Another wire, of same material as that of the first one, but of diameter 2 *mm* breaks under a tension of

(a) 500 *N* (b) 1000 *N*

(c) 10000 *N* (d) 4000 *N*

11. The Poisson's ratio cannot have the value

(a) 0.7 (b) 0.2

(c) 0.1 (d) 0.5

12. The specific heat at constant pressure and at constant volume for an ideal gas are C_p and C_v and its adiabatic and isothermal elasticities are E_ϕ and E_θ respectively. The ratio of E_ϕ to E_θ is

(a) C_v / C_p (b) C_p / C_v

(c) $C_p C_v$ (d) $1 / C_p C_v$

13. The ratio of the adiabatic to isothermal elasticities of a triatomic gas is

(a) 3/4 (b) 4/3

(c) 1 (d) 5/3

14. The compressibility of a material is

(a) Product of volume and its pressure

(b) The change in pressure per unit change in volume strain

(c) The fractional change in volume per unit change in pressure

(d) None of the above

15. In the three states of matter, the elastic coefficient can be

(a) Young's modulus

(b) Coefficient of volume elasticity

(c) Modulus of rigidity

(d) Poisson's ratio

16. The isothermal bulk modulus of a gas at atmospheric pressure is

(a) $1\,mm$ of Hg (b) $13.6\,mm$ of Hg

(c) $1.013 \times 10^5\ N/m^2$ (d) $2.026 \times 10^5\ N/m^2$

17. The Bulk modulus for an incompressible liquid is

(a) Zero (b) Unity

(c) Infinity (d) Between 0 to 1

18. Which statement is true for a metal

(a) $Y < \eta$ (b) $Y = \eta$

(c) $Y > \eta$ (d) $Y < 1/\eta$

19. When a spiral spring is stretched by suspending a load on it, the strain produced is called

(a) Shearing (b) Longitudinal

(c) Volume (d) Transverse

20. Shearing stress causes change in

(a) Length (b) Breadth

(c) Shape (d) Volume

21. If the force constant of a wire is K, the work done in increasing the length of the wire by l is

(a) $Kl/2$ (b) Kl

(c) $Kl^2/2$ (d) Kl^2

22. The ratio of Young's modulus of the material of two wires is 2 : 3. If the same stress is applied on both, then the ratio of elastic energy per unit volume will be

(a) 3 : 2 (b) 2 : 3

(c) 3 : 4 (d) 4 : 3

23. On stretching a wire, the elastic energy stored per unit volume is

(a) $Fl/2AL$ (b) $FA/2L$

(c) $FL/2A$ (d) $FL/2$

24. When a 4 kg mass is hung vertically on a light spring that obeys Hooke's law, the spring stretches by 2 cms. The work required to be done by an external agent in stretching this spring by 5 cms will be $(g = 9.8\ metres\ /\ sexc^{2})$

(a) 4.900 $joule$ (b) 2.450 $joule$

(c) 0.495 $joule$ (d) 0.245 $joule$

25. Wires A and B are made from the same material. A has twice the diameter and three times the length of B. If the elastic limits are not reached, when each is stretched by the same tension, the ratio of energy stored in A to that in B is

(a)2 : 3 (b) 3 : 4

(c) 3 : 2 (d) 6 : 1

26. Two rods of different materials having coefficients of linear expansion α_1, α_2 and Young's moduli Y_1 and Y_2 respectively are fixed between 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 equally provided $Y_1 : Y_2$ is equal to

(a) 2 : 3 (b) 1 : 1

(c) 3 : 2 (d) 4 : 9

27. Two wires A and B of same length, same area of cross-section having the same Young's modulus are heated to the same range of temperature. If the coefficient of linear expansion of A is 3/2 times of that of wire B. The ratio of the forces produced in two wires will be

(a) 2/3 (b) 9/4

(c) 4/9 (d) 3/2

28. The breaking stress of a wire of length L and radius r is 5 $kg-wt/m^2$. The wire of length 2l and radius 2r of the same material will have breaking stress in $kg-wt/m^2$

(a) 5 (b) 10

(c) 20 (d) 80

29. If the thickness of the wire is doubled, then the breaking force in the above question will be

(a) 6F (b) 4F

(c) 8F (d) F

30. The mass and length of a wire are M and L respectively. The density of the material of the wire is d. On applying the force F on the wire, the increase in length is l, then the Young's modulus of the material of the wire will be

(a) $\frac{Fdl}{Ml}$ (b) $\frac{FL}{Mdl}$

(c) $\frac{FMl}{dl}$ (d) $\frac{FdL^2}{Ml}$

1. (a)

2. (c) $l = \frac{FL}{\pi r^2 Y} \Rightarrow l \propto \frac{L}{r^2}$ (*F* and *Y* are constant)

$\frac{l_1}{l_2} = \frac{L_1}{L_2}\left(\frac{r_2}{r_1}\right)^2 = \frac{1}{2}\left(\sqrt{2}\right)^2 \therefore \frac{l_1}{l_2} = 1:1$

3. (a) $F = Y \times A \times \frac{l}{L} \Rightarrow F \propto \frac{r^2}{L}$ (*Y* and *l* are constant)

$\therefore \frac{F_1}{F_2} = \left(\frac{r_1}{r_2}\right)^2\left(\frac{L_2}{L_1}\right) = \left(\frac{2}{1}\right)^2\left(\frac{1}{4}\right) = 1 \Rightarrow \frac{F_1}{F_2} = 1:1$

4. (c) $l = \frac{FL}{AY} = \frac{FL^2}{(AL)Y} = \frac{FL^2}{VY}$.

If volume is fixed then $l \propto L^2$

5. (d) $l \propto \frac{L}{r^2}$ (*Y* and *F* are constant)

Maximum extension takes place in that wire for which the ratio of $\frac{L}{r^2}$ will be maximum.

6. (c) $l = \frac{FL}{AY} \therefore l \propto \frac{F}{r^2}$

$\frac{l_1}{l_2} = \frac{F_2}{F_1}\left(\frac{r_1}{r_2}\right)^2 = (4) \times \left(\frac{1}{2}\right)^2 = 1 \therefore l_2 = l_1 = 1mm$

7. (c) $l = \frac{FL}{\pi r^2 Y} \Rightarrow r^2 \propto \frac{1}{Y}$ (*F*,*L* and *l* are constant)

$\frac{r_2}{r_1} = \left(\frac{Y_1}{Y_2}\right)^{1/2} = \left(\frac{7 \times 10^{10}}{12 \times 10^{10}}\right)^{1/2}$

$\Rightarrow r_2 = 1.5 \times \left(\frac{7}{12}\right)^{1/2}$ = 1.145 *mm* $\therefore$ dia = 2.29 *mm*

8. (a) $Y = \frac{F/A}{\text{Strain}} \Rightarrow \text{strain} = \frac{F}{AY}$

9. (d) When the length of wire is doubled then $l = L$ and strain = 1 $\therefore$ Y = strain = $\frac{F}{A}$

$\therefore$ Force = $Y \times A$ $= 2 \times 10^{11} \times 0.1 \times 10^{-4} = 2 \times 10^6 N$

10. (d) Breaking force $\propto r^2$

If diameter becomes double then breaking force will become four times *i.e.* 1000 × 4 = 4000 *N*

11. (a) Value of Poisson's ratio lie in range of -1 to $\frac{1}{2}$

12. (b) Ratio of adiabatic and isothermal elasticities

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

13. (b) For triatomic gas $\gamma = \frac{4}{3}$

14. (c) $\frac{1}{K}$ = compressibility $= \left(\frac{-\Delta V/V}{\Delta P}\right)$

15. (b)

16. (c) Isothermal elasticity $K_i = P = 1 atm = 1.013 \times 10^5\ N/m^2$

17. (c)

18. (c) $Y = 2\eta(1+\sigma)$

19. (a) A small part of the spring bear tangential stress, causing straining strain.

20. (c)

21. (c) $K = \frac{F}{l}$ and $W = \frac{1}{2}Fl = \frac{1}{2}Kl \times l = \frac{1}{2}Kl^2$

22. (a) Energy per unit volume = $\frac{(\text{stress})^2}{2Y}$

$\frac{E_1}{E_2} = \frac{Y_2}{Y_1}$ (Stress is constant) $\therefore$ $\frac{E_1}{E_2} = \frac{3}{2}$

23. (a) Energy stored per unit volume = $\frac{1}{2}\left(\frac{F}{A}\right)\left(\frac{l}{L}\right) = \frac{Fl}{2AL}$

24. (b) $K = \frac{F}{x} = \frac{40}{2\times 10^{-2}} = 0.2\ N/m$

Work done $= \frac{1}{2}Kx^2 = \frac{1}{2}\times(0.2)\times(0.05)^2 = 2.5\ J$

25. (b) $U = \frac{1}{2}Fl = \frac{F^2L}{2AY}$. $U \propto \frac{L}{r^2}$ (F and Y are constant)

$\therefore \frac{U_A}{U_B} = \left(\frac{L_A}{L_B}\right)\times\left(\frac{r_A}{r_B}\right)^2 = (3)\times\left(\frac{1}{2}\right)^2 = \frac{3}{4}$

26. (c) Thermal stress = $Y\alpha\Delta\theta$.

If thermal stress and rise in temperature are equal then $Y \propto \frac{1}{\alpha} \Rightarrow \frac{Y_1}{Y_2} = \frac{\alpha_2}{\alpha_1} = \frac{3}{2}$

27. (d) $F = YA\alpha\Delta\theta$

If Y, A and $\Delta\theta$ are constant then $\frac{F_A}{F_B} = \frac{\alpha_A}{\alpha_B} = \frac{3}{2}$

28. (a) Breaking stress depends on the material of wire.

29. (b) Breaking force $\propto \pi r^2$

If thickness (radius) of wire is doubled then breaking force will become four times.

30. (d) $Y = \frac{F}{A}\frac{L}{l} = \frac{FdL^2}{Ml}$

As M = volume × density $= A \times L \times d \quad \therefore \quad A = \frac{M}{Ld}$