MECHANICAL PROPERTIES OF SOLIDS

Single Correct Answer Type

1. If a spring is extended to length l, then according to Hooke's law

a) $F = kl$ b) $F = \frac{k}{l}$ c) $F = k^2 l$ d) $F = \frac{k^2}{l}$

2. 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 extension produced in another wire of the same material of length $2L$ and radius $2r$ by a force $2F$, is

a) l b) $2\,l$ c) $4\,l$ d) $\frac{l}{2}$

3. A wire of length L is hanging from a fixed support. The length changes to L_1 and L_2 when masses M_1 and M_2 are suspended respectively from its free end. Then L is equal to

a) $\frac{L_1 + L_2}{2}$ b) $\sqrt{L_1 L_2}$ c) $\frac{L_1 M_2 + L_2 M_1}{M_1 + M_2}$ d) $\frac{L_1 M_2 - L_2 M_1}{M_2 + M_1}$

4. A wire extends by 1 mm when a force is applied. Double the force is applied to another wire of same material and length but half the radius of cross-section. The elongation of the wire in mm will be

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

5. When a pressure of 100 atmosphere is applied on a spherical ball, then its volume reduces to 0.01%. The bulk modulus of the material of the rubber in $dyne/cm^2$ is

a) 10×10^{12} b) 100×10^{12} c) 1×10^{12} d) 20×10^{12}

6. Two rods A and B of the same material and length have their radii r_1 and r_2 respectively. When they are rigidly fixed at one end and twisted by the same couple applied at the other end, the ratio of the angle of twist at the end of A and the angle of twist at the end of B is

a) $\frac{r_2^4}{r_1^4}$ b) $\frac{r_1^4}{r_2^4}$ c) $\frac{r_2^2}{r_1^2}$ d) $\frac{r_1^2}{r_2^2}$

7. The elastic energy stored per unit volume in a stretched wire is

a) $\frac{1}{2}(\text{Young modulus})(\text{Strain})^2$ b) $\frac{1}{2}(\text{Stress})(\text{Strain})^2$

c) $\frac{1}{2}\frac{\text{Stress}}{\text{Strain}}$ d) $\frac{1}{2}(\text{Young modulus})(\text{Stress})$

8. The average depth of Indian ocean is about 3000 m. The fractional compression, $\frac{\Delta V}{V}$ of water at the bottom of the ocean (given that the bulk modulus of the water $=2.2\times 10^9$ Nm^{-2} and g $= 10$ ms^{-2}) is

a) 0.82% b) 0.91% c) 1.36% d) 1.24%

9. If longitudinal strain for a wire is 0.03 and its Poisson's ratio is 0.5, then its lateral strain is

a) 0.003 b) 0.0075 c) 0.015 d) 0.4

10. A uniform wire, fixed at its upper end, hangs vertically and supports a weight at its lower end. If its radius is r, its length L and the Young's modulus for the material of the wire is E, the extension is

1. directly proportional to E
2. inversely proportional to r
3. directly proportional to L

a) If only 3 is correct b) If 1, 2 are correct c) If 2, 3 are correct d) If only 1 correct

11. K is the force constant of a spring. The work done in increasing its extension from l_1 to l_2 will be

a) $K(l_2 - l_1)$ b) $\frac{K}{2}(l_2 + l_1)$ c) $K(l_2^2 - l_1^2)$ d) $\frac{K}{2}(l_2^2 - l_1^2)$

12. A height spring extends 40 mm when stretched by a force of 10 N, and for tensions up to this value the extension is proportional to the stretching force. Two such springs are joined end-to-end and the double- length spring is stretched 40 mm beyond its natural length. The total strain energy in (joule), stored in the double spring is

a) 0.05 b) 0.10 c) 0.80 d) 0.40

13. Which one of the following quantities does not have the unit of force per unit area

a) Stress b) Strain

c) Young's modulus of elasticity d) Pressure

14. A wire is stretched by 0.01 m by a certain force F. Another wire of same material whose diameter and length are double to the original wire is stretched by the same force. Then its elongation will be

a) 0.005 m b) 0.01 m c) 0.02 m d) 0.002 m

15. A cube of side 10 cm is subjected to a tangential force of 5×10^5 N at the upper face, keeping lower face fixed. The upper face is displaced by 0.001 radian relative to the lower face along the direction of tangential force. The shear modulus of the material of the cube is

a) 5×10^{10} Nm^{-2} b) 5×10^{11} Nm^{-2} c) 5×10^{12} Nm^{-2} d) 5×10^{13} Nm^{-2}

16. A wire of area of cross-section $10^{-6} m^2$ is increased in length by 0.1%. The tension produced is 1000 N. The Young's modulus of wire is

a) $10^{12} N/m^2$ b) $10^{11} N/m^2$ c) $10^{10} N/m^2$ d) $10^9 N/m^2$

17. If a bar is made of copper whose coefficient of linear expansion is one and a half times that of iron, the ratio of the force developed in the copper bar to the iron bar of identical lengths and cross-sections, when heated through the same temperature range (Young's modulus for copper may be taken equal to that of iron) is

a) 3/2 b) 2/3 c) 9/4 d) 4/9

18. A particle of mass m is under the influence of a force F which varies with the displacement x according to the relation $F = -kx + F_0$ in which k and F_0 are constants. The particle when disturbed will oscillate

a) About $x = 0$, with $\omega \neq \sqrt{k/m}$ b) About $x = 0$, with $\omega = \sqrt{k/m}$

c) About $x = F_0/k$, with $\omega = \sqrt{k/m}$ d) About $x = F_0/k$, with $\omega \neq \sqrt{k/m}$

19. A uniform plank of Young's modulus Y is moved over a smooth horizontal surface by a constant 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

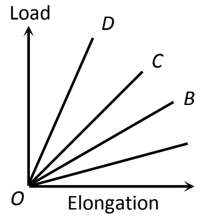
a) F/AY b) $2F/AY$ c) $\frac{1}{2}(F/AY)$ d) $3F/AY$

20. A student performs an experiment to determine the Young's modulus of a wire, exactly 2 m long, by Searle's method. In a particular reading, the student measures the extension in the length of the wire to be 0.8 mm with an uncertainty of ± 0.05 mm at a load of exactly 1.0 kg. The student also measures the diameter of the wire to be 0.4 mm with an uncertainty of $\pm 0.01 mm$. Take $g = 9.8\ m/s^2$ (exact). The Young's modulus obtained from the reading is

a) $(2.0 \pm 0.3) \times 10^{11} N/m^2$ b) $(2.0 \pm 0.2) \times 10^{11} N/m^2$

c) $(2.0 \pm 0.1) \times 10^{11} N/m^2$ d) $(2.0 \pm 0.05) \times 10^{11} N/m^2$

21. The load versus elongation graph for four wires of the same material is shown in the figure. The thickest wire is represented by the line



a) OD b) OC c) OB d) OA

22. When a spring is stretched by a distance x, it exerts a force, given by $F = (-5x - 16x^3)N$. The work done, when the spring is stretched from 0.1 m to 0.2 m is

a) $8.7 \times 10^{-2}J$ b) $12.2 \times 10^{-2}J$ c) $8.7 \times 10^{-1}J$ d) $12.2 \times 10^{-1}J$

23. When a force is applied on a wire of uniform cross-sectional area $3 \times 10^{-6}\text{m}^2$ and length 4 m, the increase in length is 1mm. Energy stored in it will be
$(Y = 2 \times 10^{11}\text{N/m}^2)$.

a) 6250J b) 0.177J c) 0.075J d) 0.150J

24. Two wires of the same material and length but diameters in the ratio 1 : 2 are stretched by the same force. The potential energy per unit volume for the two wires when stretched will be in the ratio

a) 16 : 1 b) 4 : 1 c) 2 : 1 d) 1 : 1

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

a) $K/2$ b) Kl c) $Kl^2/2$ d) Kl^2

26. To break a wire, a force of $10^6 N/m^2$ is required. If the density of the material is $3 \times 10^3 kg/m^3$, 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

27. A brass rod of cross-sectional area $1cm^2$ and length $0.2m$ is compressed lengthwise by a weight of 5 kg. If Young's modulus of elasticity of brass is $1 \times 10^{11} N/m^2$ and $g = 10m/sec^2$, then increase in the energy of the rod will be

a) $10^{-5}\,J$ b) $2.5 \times 10^{-5}\,J$ c) $5 \times 10^{-5}\,J$ d) $2.5 \times 10^{-4}\,J$

28. Which of the following substances has the highest elasticity?

a) Sponge b) Steel c) Rubber d) Copper

29. A cube is subjected to a uniform volume compression. If the side of the cube decreases by 1% the bulk strain is

a) 0.01 b) 0.02 c) 0.03 d) 0.06

30. A spring of constant k is cut into parts of length in the ratio 1 : 2. The spring constant of larger on is

a) $\frac{k}{2}$ b) $\frac{k}{3}$ c) $\frac{2k}{3}$ d) $\frac{3k}{2}$

31. The reason for the change in shape of a regular body is

a) Volume stress b) Shearing strain c) Longitudinal strain d) Metallic strain

32. A substance breaks down by a stress of 10^6 Nm^{-2}. If the density of the material of the wire is 3×10^3 kgm^{-3}, then the length of the wire of the substance which will break under its own weight when suspended vertically is

a) 66.6 m b) 60.0 m c) 33.3 m d) 30.0 m

33. When a wire of length 10m is subjected to a force of 100 N along its length, the lateral strain produced is 0.01×10^{-3}m. The Poisson's ratio was found to be 0.4. If the area of cross-section of wire is 0.025 m^2, its Young's modulus is

a) 1.6×10^8 Nm^{-2} b) 2.5×10^{10} Nm^{-2} c) 1.25×10^{11}Nm^{-2} d) 16×10^9Nm^{-2}

34. A wire whose cross-section is 4 mm^2 is stretched by 0.1 mm by a certain weight. How far will a wire of the same material and length stretch if its cross-sectional area is 8 mm^2 and the same weight is attached ?

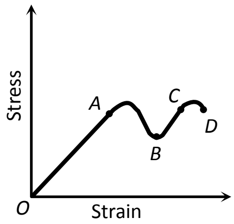
a) 0.1 mm b) 0.05 mm c) 0.025 mm d) 0.012 mm

35. What is the increase in elastic potential energy when the stretching force is increased by 200 kN?
a) 238.5 J b) 636.0 J c) 115.5 J d) 79. 5 J

36. A wire of length 50 cm and cross sectional area of 1 $sq. mm$ is extended by 1 mm. The required work will be ($Y = 2 \times 10^{10} Nm^{-2}$)
a) $6 \times 10^{-2}\, J$ b) $4 \times 10^{-2}\, J$ c) $2 \times 10^{-2}\, J$ d) $1 \times 10^{-2}\, J$

37. A wire of Young's modulus 1.5×10^{12} Nm^{-2} is stretched by a force so as to produce a strain of 2×10^4. The energy stored per unit volume is
a) 3×10^8 Jm^{-3} b) 3×10^3 Jm^{-3} c) 6×10^3 Jm^{-3} d) 3×10^4 Jm^{-3}

38. A graph is shown between stress and strain for a metal. The part in which Hooke's law holds good is



a) OA b) AB c) BC d) CD

39. A steel wire of cross-sectional area 3×10^{-6}m^2 can withstand a maximum strain of 10^{-3} . Young's modulus of steel is 2×10^{11}Nm^{-2}. The maximum mass the wire can hold is (take g = 10 ms^{-2})
a) 40 kg b) 60 kg c) 80 kg d) 100 kg

40. The Young's modulus of brass and steel are 10×10^{10} Nm^{-2} and 2×10^{11} Nm^{-2} respectively. A brass wire and a steel wire of the same length are extended by 1 mm under the same force. The radii of the brass and steel wires are R_B and R_S respectively. Then
a) $R_A = \sqrt{2}\, R_B$ b) $R_S = \dfrac{R_B}{\sqrt{2}}$ c) $R_S = 4\, R_B$ d) $R_S = \dfrac{R_B}{4}$

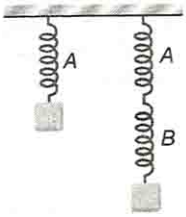
41. Two bars A and B of circular cross-section and of same volume and made of the same material are subjected to tension. If the diameter of A is half that of B and if the force applied to both the rods is the same and it is in the elastic limit, the ratio of extension of A to that of B will be
a) 16 b) 8 c) 4 d) 7

42. A force of 200 N is applied at one end of a wire of length 2m and having area of cross-section $10^{-2} cm^2$. The other end of the wire is rigidly fixed. If coefficient of linear expansion of the wire $\alpha = 8 \times 10^{-6}$/°C and Young's modulus $Y = 2.2 \times 10^{11}\, N/m^2$ and its temperature is increased by 5°C, then the increase in the tension of the wire will be
a) 4.2 N b) 4.4 N c) 2.4 N d) 8.8 N

43. Young's modulus of perfectly rigid body material is
a) Infinite b) Zero c) 10×10^{10} Nm^{-2} d) 1×10^{10} Nm^{-2}

44. A load of 4.0 kg is suspended from a ceiling through a steel wire of length 2.0 m and radius 2.0 mm. It is found that the length of the wire increase by 0.031 mm as equilibrium is achieved. Taking g =3.1 π ms^{-2}, the Young's modulus of steel is
a) 2.0×10^8 Nm^{-2} b) 2.0×10^9 Nm^{-2} c) 2.0×10^{11} Nm^{-2} d) 2.0×10^{13} Nm^{-2}

45. In the figure three identical springs are shown. From spring A, a mass of 4 kg is hung and spring shows elongation of 1 cm. But when a weight of 6 kg is hung on B, the Hook descends



a) 1 cm b) 2 cm c) 3 cm d) 4 cm

46. What among of work is done in increasing the length of a wire though unity ?

a) $\frac{YL}{2A}$ b) $\frac{YL^2}{2A}$ c) $\frac{YA}{2L}$ d) $\frac{YL}{A}$

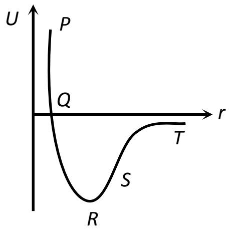
47. An iron bar of length L, cross-section A and Young's modulus Y is pulled by a force F from both ends so as to produce an elongation l. Which of the following statement is correct?

a) $l \propto Y$ b) $l \propto l/A$ c) $l \propto A$ d) $l \propto l/L$

48. 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

49. The points of maximum and minimum attraction in the curve between potential energy (U) and distance (r) of a diatomic molecules are respectively



a) S and R b) T and S c) R and S d) S and T

50. An elastic material of Young's modulus Y is subjected to a stress S. The elastic energy stored per unit volume of the material is

a) $\frac{SY}{2}$ b) $\frac{S^2}{2Y}$ c) $\frac{S}{2Y}$ d) $\frac{2S}{Y}$

51. When a weight of 5 kg is suspended from a copper wire of length 30 m and diameter 0.5 mm, the length of the wire increases by 2.4 cm. If the diameter is doubled, the extension produced is

a) 1.2 cm b) 0.6 cm c) 0.3 cm d) 0.15 cm

52. The diameter of a brass wire is 0.6 mm and Y is 9×10^6 Nm^{-2} . The force which will increase its length by 0.2% is about

a) 100 N b) 51 N c) 25 N d) None of these

53. A steel wire of 1m long and $1 mm^2$ cross section area is hang from rigid end. When weight of $1 kg$ is hung from it then change in length will be (given $Y = 2 \times 10^{11} N/m^2$)

a) 0.5 mm b) 0.25 mm c) 0.05 mm d) 5 mm

54. A wire can be broken by applying a load of 200 N. The force required to break another wire of the same length and same material, but double in diameter, is

a) 200 N b) 400 N c) 600 N d) 800 N

55. Shearing stress causes change in

a) Length b) Breadth c) Shape d) Volume

56. The increase in pressure required to decrease the 200 L volume of a liquid by 0.008% in kPa is (Bulk modulus of the liquid = 2100 MPa is)

a) 8.4 b) 84 c) 92.4 d) 168

57. 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) $2.026 \times 10^5 N/m^2$

58. A wire of cross-sectional area A is stretched horizontally between two clamps loaded at a distance $2l$ metres from each other. A weight $w$kg suspended from the mid point of the wire. The strain produced in the wire, (if the vertical distance through which the mid point of the wire moves down $x < l$) will be

a) x^2/l^2 b) $2x^2/l^2$ c) $x^2/2l$ d) $x/2l$

59. The compressibility of water is $6 \times 10^{-10} N^{-1} m^2$. If one litre is subjected to a pressure of $4 \times 10^7 N\ m^{-2}$, the decrease in its volume is
a) $2.4\ cc$ b) $10\ cc$ c) $24\ cc$ d) $15\ cc$

60. If the interatomic spacing in a steel wire is 3.0Å and $Y_{steel} = 20 \times 10^{10} N/m^2$ then force constant is
a) $6 \times 10^{-2} N/Å$ b) $6 \times 10^{-9} N/Å$ c) $4 \times 10^{-5} N/Å$ d) $6 \times 10^{-5} N/Å$

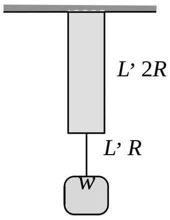
61. A force of 10^3 *newton* stretches the length of a hanging wire by 1 *millimetre*. The force required to stretch a wire of same material and length but having four times the diameter by 1 *millimetre* is
a) $4 \times 10^3 N$ b) $16 \times 10^3 N$ c) $\frac{1}{4} \times 10^3 N$ d) $\frac{1}{16} \times 10^3 N$

62. A uniform cube is subjected to volume compression. If each side is decreased by 1%, then bulk strain is
a) 0.01 b) 0.06 c) 0.02 d) 0.03

63. The Young's modulus of a wire of length L and radius r is $Y\ N/m^2$. If the length and radius are reduced to $L/2$ and $r/2$, then its Young's modulus will be
a) $Y/2$ b) Y c) $2Y$ d) $4Y$

64. The hollow shaft is….. than a solid shaft of same mass, material and length.
a) Less stiff b) More stiff c) Squally stiff d) None of these

65. Two wires of the same material (Young's modulus Y) and same length L but radii R and $2R$ respectively are joined end to end and a weight w is suspended from the combination as shown in the figure. The elastic potential energy in the system is



a) $\frac{3w^2L}{4\pi R^2 Y}$ b) $\frac{3w^2L}{8\pi R^2 Y}$ c) $\frac{5w^2L}{8\pi R^2 Y}$ d) $\frac{w^2L}{\pi R^2 Y}$

66. On applying a stress of $20 \times 10^8 N/m^2$ the length of a perfectly elastic wire is doubled. Its Young's modulus will be
a) $40 \times 10^8 N/m^2$ b) $20 \times 10^8 N/m^2$ c) $10 \times 10^8 N/m^2$ d) $5 \times 10^8 N/m^2$

67. According to Hooke's law force is proportional to
a) $\frac{1}{x}$ b) $\frac{1}{x^2}$ c) x d) x^2

68. A metal bar of length L and area of cross-section A is clamped between two rigid supports. For the material of the rod, its Young's modulus is Y and coefficient of linear expansion is α. If the temperature of the rod is increased by Δt°C, the force exerted by the rod on the supports is
a) $Y\ AL\ \Delta t$ b) $Y\ A\ \alpha\ \Delta t$ c) $\frac{YL\ \alpha\Delta t}{A}$ d) $Y\ \alpha\ AL\ \Delta t$

69. One end of a uniform rod of mass m_1, uniform area of cross section A is suspended from the roof and mass m_2 is suspended from the other end. What is the stress at the mid point of the rod?
a) $(m_1 + m_2)\ g/A$ b) $(m_1 - m_2)\ g/A$ c) $\left[\frac{(m_1/2)+m_2}{A}\right] g$ d) $\left[\frac{m_1+(m_2/2)}{A}\right] g$

70. In steel, the Young's modulus and the strain at the breaking point are $2 \times 10^6 \text{Nm}^{-2}$ and 0.15 respectively. The stress at the break point for steel is
a) $1.33 \times 10^{11} \text{Nm}^{-2}$ b) $1.33 \times 10^{12}\ \text{Nm}^{-2}$ c) $2 \times 10^{10}\ \text{Nm}^{-2}$ d) $3 \times 10^{10}\ \text{Nm}^{-2}$

71. The twisting couple per unit twist for a solid cylinder of radius 3 cm is 0.1 N-m. The twisting couple per unit twist, for a hollow cylinder of same material with outer and inner radius 5 cm and 4 cm respectively will be
a) 0.1 N-m b) 0.455 N-m c) 0.91 N-m d) 1.82 N-m

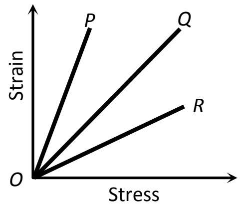
72. A solid sphere of radius r made of a material of bulk modulus K is surrounded by a liquid in a cylindrical container. A massless piston of area a floats on the surface of the liquid. When a mass m is placed on the piston to compress the liquid, the fractional change in the radius of the sphere (dr/r) is

a) Ka/mg b) $Ka/3mg$ c) $Mg/3Ka$ d) Mg/Ka

73. Coefficient of isothermal elasticity E_θ and coefficient of adiabatic elasticity E_ϕ are related by $(\gamma = C_p/C_v)$

a) $E_\theta = \gamma E_\phi$ b) $E_\phi = \gamma E_\theta$ c) $E_\theta = \gamma/E_\phi$ d) $E_\theta = \gamma^2 E_\phi$

74. The strain-stress curves of three wires of different materials are shown in the figure. P, Q and R are the elastic limits of the wires. The figure shows that



a) Elasticity of wire P is maximum b) Elasticity of wire Q is maximum

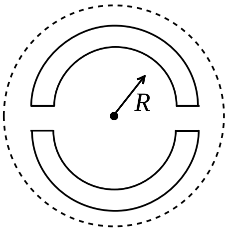
c) Tensile strength of R is maximum d) None of the above is true

75. Why the spring is made up of steel in comparison of copper

a) Copper is more costly than steel b) Copper is more elastic than steel

c) Steel is more elastic than copper d) None of the above

76. A wooden wheel of radius R is made of two semicircular parts (see figure). The two parts are held together by a ring made of a metal strip of cross sectional area S and length L. L is slightly less than $2\pi R$. To fit the ring on the wheel, it is heated so that its temperature rises by ΔT and it just steps over the wheel. As it cools down to surrounding temperature, it presses the semicircular parts together. If the coefficient of linear expansion of the metal is α, and its Young's modulus is Y, the force that one part of the wheel applies on the other part is



a) $2\pi SY\alpha\Delta T$ b) $SY\alpha\Delta T$ c) $\pi SY\alpha\Delta T$ d) $2SY\alpha\Delta T$

77. 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

78. 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) 0.025 m^3 c) 4×10^5 cm^3 d) 0.04 cm^3

79. Forces of 100 N each are applied in opposite directions on the upper and lower faces of a cube of side 20 cm. The upper face is shifted parallel to itself by 0.25 cm. If the side of the cube were 10 cm, then the displacement would be

a) 0.25 cm b) 0.5 cm c) 0.75 cm d) 1 cm

80. In a wire stretched by hanging a weight from its end, the elastic potential energy per unit volume in terms of longitudinal strain σ and modulus of elasticity Y is

a) $\frac{Y\sigma^2}{2}$ b) $\frac{Y\sigma}{2}$ c) $\frac{2Y\sigma^2}{2}$ d) $\frac{Y^2\sigma}{2}$

81. A 1m long steel wire of cross-sectional area 1 mm^2 is extended by 1 mm. If $Y = 2 \times 10^{11} \text{N m}^{-2}$, then the work done is

a) 0.1 J b) 0.2 J c) 0.3 J d) 0.4 J

82. Young's modulus of the material of a wire is Y. On pulling the wire by a force F, the increase in its length is x. The potential energy of the stretched wire is

a) $\frac{1}{2}Fx$ b) $\frac{1}{2}Yx$ c) $\frac{1}{2}Fx^2$ d) None of these

83. A substance breaks down by a stress of 10^6 Nm^{-2}. If the density of the material of the wire is 3×10^3 kgm^{-3}, then the length of the wire of that substance which will break under its own weight when suspended vertically is nearly

a) 3.4 m b) 34 m c) 340 m d) 3400 m

84. Modulus of rigidity of a liquid

a) Non zero constant b) Infinite c) Zero d) Can not be predicted

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

a) $\frac{3}{4}$ b) $\frac{4}{3}$ c) 1 d) $\frac{5}{3}$

86. In above question, the work done in the two wires is

a) 0.5 J, 0.03 J b) 0.25 J, 0 J c) 0.03 J, 0.25 J d) 0 J, 0 J

87. 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) $\sqrt{2}:2$ b) $2:\sqrt{2}$ c) 1 : 1 d) 1 : 2

88. When the tension in a metal wire is T_1, its length is l_1. When the tension is T_2 its length is l_2. The natural length of wire is

a) $\frac{T_2}{T_1}(l_1 + l_2)$ b) $T_1 l_1 + T_2 l_2$ c) $\frac{l_1 T_2 - l_2 T_1}{T_2 - T_1}$ d) $\frac{l_1 T_2 + l_2 T_1}{T_2 + T_1}$

89. The pressure of a medium is changed from 1.01×10^5 Pa to 1.165×10^5 Pa and change in volume is 10% keeping temperature constant. The Bulk modulus of the medium is

a) 204.8×10^5Pa b) 102.4×10^5Pa c) 51.2×10^5Pa d) 1.55×10^5Pa

90. How much force is required to produce an increase of 0.2% in the length of a brass wire of diameter 0.6 mm

(Young's modulus for brass = $0.9 \times 10^{11} N/m^2$)

a) Nearly 17 N b) Nearly 34 N c) Nearly 51 N d) Nearly 68 N

91. Which of the following is true for elastic potential energy density

a) Energy density = 1/2 × strain × stress b) Energy density = $(\text{strain})^2$ × volume

c) Energy density = (strain) × volume d) Energy density = (stress) × volume

92. Which statement is true for a metal

a) $Y < \eta$ b) $Y = \eta$ c) $Y > \eta$ d) $Y < 1/\eta$

93. 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) $L = 400$ cm, $r = 0.8$ mm b) $L = 300$ cm, $r = 0.6$ mm

c) $L = 200$ cm, $r = 0.4$ mm d) $L = 100$ cm, $r = 0.2$ mm

94. A 100 N force stretches the length of a hanging wire by 0.5 mm. The force required to stretch a wire, of the same material and length but having four times the diameter, by 0.5 mm is

a) 100 N b) 400 N c) 1200 N d) 1600 N

95. Which of the following relations is true

a) $3Y = K(1 - \sigma)$ b) $K = \frac{9\eta Y}{Y + \eta}$ c) $\sigma = (6K + \eta)Y$ d) $\sigma = \frac{0.5Y - \eta}{\eta}$

96. If x longitudinal strain is produced in a wire of Young's modulus y, then energy stored in the material of the wire per unit volume is

a) yx^2 b) $2\ yx^2$ c) $\frac{1}{2}y^2x$ d) $\frac{1}{2}yx^2$

97. The length of a wire is increased by 1 mm on the application of a given load. In a wire of the same material, but of length and radius twice that of the first, on the application of the same load, extension is

a) 0.25 cm b) 0.5 cm c) 2 mm d) 4 mm

98. Two similar wires under the same load yield elongation of 0.1 mm and 0.05 mm respectively. If the area of cross-section of the first wire is 4 mm^2, then the area of cross section of the second wire is

a) 6 mm^2 b) 8 mm^2 c) 10 mm^2 d) 12 mm^2

99. Two wires of equal lengths are made of the same material. Wire A has a diameter that is twice as that of wire B. If identical weights are suspended from the ends of these wires, the increase in length is

a) Four times for wire A as for wire B b) Twice for wire A as for wire B

c) Half for wire A as for wire B d) One-fourth for wire A as for wire B

100. A wire ($Y = 2 \times 10^{11}$ Nm^{-2}) has length 1 m and cross-sectional area 1 mm^{-2}. The work required to increase the length by 2 mm is

a) 0.4 J b) 4 J c) 40 J d) 400 J

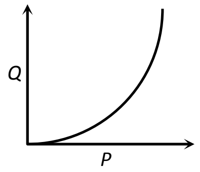
101. The increases in length is l of a wire of length L by the longitudinal stress. Then the stress is proportional to

a) L/l b) l/L c) $l \times L$ d) $l^2 \times L$

102. A gas has Bulk modulus K and natural density ρ. If pressure p is applied, what is change in density?

a) $\frac{K}{p\rho}$ b) $\frac{pK}{\rho}$ c) $\frac{p\rho}{K}$ d) $\frac{K\rho}{p}$

103. The graph shows the behaviour of a length of wire in the region for which the substance obeys Hooke's law. P and Q represent



a) $P =$ applied force, $Q =$ extension b) $P =$ extension, $Q =$ applied force

c) $P =$ extension, $Q =$ stored elastic energy d) $P =$ stored elastic energy, $Q =$ extension

104. A steel ring of radius r and cross-section area 'A' is fitted on to a wooden disc of radius $R (R > r)$. If Young's modulus be E, then the force with which the steel ring is expanded is

a) $AE\frac{R}{r}$ b) $AE\left(\frac{R-r}{r}\right)$ c) $\frac{E}{A}\left(\frac{R-r}{A}\right)$ d) $\frac{Er}{AR}$

105. A 5 m long aluminium wire $Y = 7 \times 10^{10}$ Nm^{-2}) of diameter 3 mm supports a 40 kg mass. In order to have the same elongation in the copper wire($Y = 12 \times 10^{2}$Nm $^{-2}$) of the same length under the same weight, the diameter should now be (in mm)

a) 1.75 b) 1.5 c) 2.3 d) 5.0

106. A solid block of silver with density 10.5 $\times 10^3$ kg m^{-3} is subjected to an external pressure of 10^7 Nm^{-2}. If the bulk modulus of silver is 17 $\times 10^{10}$ Nm^{-2}, the change in density of silver (in kg m^{-3}) is

a) 0.61 b) 1.7 c) 6.1 d) 17×10^3

107. When a rubber cord is stretched, the change in volume with respect to change in its linear dimensions is negligible. The Poisson's ratio for rubber is

a) 1 b) 0.25 c) 0.5 d) 0.75

108. The mean distance between the atoms of iron is $3 \times 10^{-10} m$ and interatomic force constant for iron is $7 N/m$. The Young's modulus of elasticity for iron is

a) $2.33 \times 10^{5} N/m^{2}$ b) $23.3 \times 10^{10} N/m^{2}$ c) $233 \times 10^{10} N/m^{2}$ d) $2.33 \times 10^{10} N/m^{2}$

109. Which is correct relation

a) $Y < \sigma$ b) $Y > \sigma$ c) $Y = \sigma$ d) $\sigma = +1$

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

a) $2 \times 10^{12} N$ b) $2 \times 10^{11} N$ c) $2 \times 10^{10} N$ d) $2 \times 10^{6} N$

111. One end of steel wire is fixed to ceiling of an elevator moving up with an acceleration 2 ms^{-2} and a load of 10 kg hangs from other end. Area of cross-section of the wire is 2 cm^{2}. The longitudinal strain in the wire is

(Take $g = 10 \text{ ms}^{-2}$ and $Y = 2 \times 10^{11} \text{ Nm}^{-2}$)

a) 4×10^{11} b) 3×10^{-6} c) 8×10^{-6} d) 2×10^{-6}

112. The length of an elastic spring is a metres when a force of 4 N is applied, and b metres when the 5 N force is applied. Then the length of the spring when the 9 N force is applied is

a) $a + b$ b) $9b - 9a$ c) $5b - 4a$ d) $4a - 5b$

113. A solid sphere of radius R made up of a material of bulk modulus K is surrounded by a liquid in a cylindrical container. A massless piston of area A floats on the surface of the liquid. When a mass M is placed on the piston to compress the liquid, the fractional change in the radius of the sphere is

a) $\frac{Mg}{AK}$ b) $\frac{Mg}{3AK}$ c) $\frac{3Mg}{AK}$ d) $\frac{Mg}{2AK}$

: ANSWER KEY :

1)	a	2)	a	3)	d	4)	a	5)	c	6)	a	7)	a	8)	c
9)	c	10)	a	11)	d	12)	b	13)	b	14)	a	15)	a	16)	a
17)	a	18)	c	19)	a	20)	b	21)	a	22)	a	23)	c	24)	a
25)	c	26)	a	27)	b	28)	b	29)	c	30)	d	31)	b	32)	c
33)	a	34)	b	35)	b	36)	c	37)	d	38)	a	39)	b	40)	b
41)	a	42)	d	43)	a	44)	c	45)	c	46)	c	47)	b	48)	c
49)	d	50)	b	51)	b	52)	b	53)	c	54)	d	55)	c	56)	b
57)	c	58)	c	59)	c	60)	b	61)	b	62)	d	63)	b	64)	a
65)	c	66)	b	67)	c	68)	b	69)	c	70)	d	71)	b	72)	c
73)	b	74)	d	75)	c	76)	d	77)	b	78)	a	79)	b	80)	a
81)	a	82)	a	83)	b	84)	c	85)	b	86)	a	87)	c	88)	c
89)	d	90)	c	91)	a	92)	c	93)	d	94)	d	95)	d	96)	d
97)	b	98)	b	99)	d	100)	a	101)	b	102)	c	103)	c	104)	b
105)	c	106)	a	107)	c	108)	d	109)	b	110)	d	111)	b	112)	c
113)	b														

: HINTS AND SOLUTIONS :

2 **(a)**

When strain is small, the ratio of the longitudinal stress to the corresponding longitudinal strain is called the Young's modulus (Y) of the material of the body.

$$Y = \frac{\text{stress}}{\text{strain}} = \frac{F/A}{l/L}$$

Where F is force, A the area, l the change in length and L the original length.

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

r being radius of the wire.

Given $r_2 = 2r_1,\ L_2 = 2L_1, F_2 = 2F_1$

Since, Young's modulus is a property of material, we have

$Y_1 = Y_2$

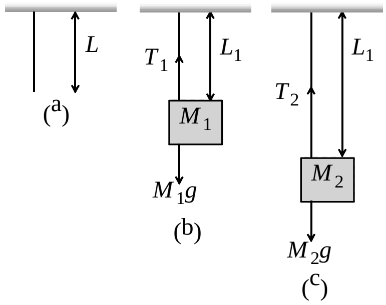
$$\therefore \frac{F_1 L_1}{\pi r_1^2 l_1} = \frac{2F_1 \times 2L_1}{\pi (2r_1)^2 l_2}$$

$l_2 = l_1 = l$

Hence, extension produced is same as that in the other wire.

3 **(d)**

L be original length of the wire



When a mass M_1 is suspended from the wire, change in length of wire is $\Delta L_1 = L_1 - L$

When a mass M_2 is suspended from it, change in length of wire is $\Delta L_2 = L_2 - L$

From figure (b), $T_1 = M_1 g$ ...(i)

From figure (c), $T_2 = M_2 g$ ...(ii)

As young's modulus, $Y = \frac{T_1 L}{A \Delta L_1} = \frac{T_2 L}{A \Delta L_2}$

$$\frac{T_1}{\Delta L_1} = \frac{T_2}{\Delta L_2} \Rightarrow \frac{T_1}{L_1 - L} = \frac{T_2}{L_2 - L}$$

$\frac{M_1 g}{L_1 - L} = \frac{M_2 g}{L_2 - L}$ [Using (i) and (ii)]

$M_1(L_2 - L) = M_2(L_1 - L)$

$M_1 L_2 - M_1 L = M_2 L_1 - M_2 L$

$$L(M_2 - M_1) = L_1 M_2 - L_2 M_1 \Rightarrow L = \frac{L_1 M_2 - L_2 M_1}{M_2 - M_1}$$

4 **(a)**

$$Y = \frac{Fl}{A \Delta l} \text{ or } \Delta l \propto \frac{F}{r^2}$$

Or $\frac{\Delta l_2}{\Delta l_1} = \frac{F_2}{F_1} \times \frac{r_1^2}{r_2^2}$

Or $\frac{\Delta l_2}{\Delta l_1} = 2 \times 2 \times 2 = 8$

Or $\Delta l_2 = 8 \Delta l_1 = 8 \times 1\text{ mm} = 8\text{ mm}$

5 **(c)**

$$K = \frac{100}{0.01/100} = 10^6 atm = 10^{11} N/m^2 = 10^{12} dyne/cm^2$$

6 **(a)**

$$\tau = \frac{\pi\eta r^4}{2l}\,\theta$$

In the given problem, $r^4\theta = \text{constant}$

$$\therefore \frac{\theta_A}{\theta_B} = \frac{r_2^4}{r_1^4}$$

8 **(c)**

$$B = \frac{P}{\Delta V/V}$$

$$\frac{\Delta V}{V} = \frac{P}{B}$$

$$= \frac{\rho g h}{B} = 1.36\%$$

9 **(c)**

$$\sigma = \frac{\text{lateral strain}}{\text{longitudinal strain}} \Rightarrow 0.5 = \frac{\text{lateral strain}}{0.03}$$

$\Rightarrow$ Lateral strain$= 0.5 \times 0.03 = 0.015$

10 **(a)**

$$E = \frac{FL}{\pi r^2 \Delta L} \text{ or } \Delta L = \frac{FL}{\pi r^2 E}$$

Clearly , $\Delta L \propto L$

11 **(d)**

At extension l_1, the stored energy $= \frac{1}{2}Kl_1^2$

At extension l_2, the stored energy $= \frac{1}{2}Kl_2^2$

Work done in increasing its extension from l_1 to l_2

$$= \frac{1}{2}K(l_2^2 - l_1^2)$$

12 **(b)**

$$\text{k} = \frac{10\text{ N}}{40 \times 10^{-3}\text{m}} = \frac{1000}{4}\text{ Nm}^{-1} = 250\text{ Nm}^{-1}$$

Spring constant of combination

$$= \frac{250}{2}\text{ Nm}^{-1} = 125\text{ Nm}^{-1}$$

Energy $= \frac{1}{2} \times 125 \times (40 \times 10^{-3})^2\text{ J} = 0.1\text{ J}$

13 **(b)**

Because strain is a dimensionless and unitless quantity

14 **(a)**

$l = \frac{FL}{\pi r^2 Y} \therefore l \propto \frac{L}{r^2}$ [Y and F are constant]

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

$$\Rightarrow l_2 = \frac{l_1}{2} = \frac{0.01m}{2} = 0.005m$$

15 **(a)**

$$\eta = \frac{F}{A\theta} = \frac{5 \times 10^5}{100 \times 10^{-4} \times 0.001} = 5 \times 10^{10}\text{Nm}^{-2}$$

16 **(a)**

$$Y=\frac{FL}{Al}=\frac{1000\times 100}{10^{-6}\times 0.1}=10^{12}N/m^2$$

17 **(a)**

$F=YA\alpha T$;

$$\frac{F_{Cu}}{F_{Fe}}=\frac{\alpha_{Cu}}{\alpha_{Fe}}=\frac{3}{2}$$

18 **(c)**

Restoring force is zero at mean position

$$F=-Kx+F_0\Rightarrow 0=-Kx+F_0\Rightarrow x=\frac{F_0}{K}$$

$i.e.$ the particle will oscillate about $x=\frac{F_0}{K}$

$$\Rightarrow F_0=Kx\Rightarrow ma=Kx\Rightarrow a=\frac{K}{m}n\therefore W=\sqrt{\frac{K}{m}}$$

19 **(a)**

$$Y=\frac{F/A}{\text{Strain}}\Rightarrow \text{strain}=\frac{F}{AY}$$

20 **(b)**

$$Y=\frac{FL}{Al}=\frac{4FL}{\pi l^2 l};F=mg$$

Where L = length of the wire

l = elongation of the wire

d = diameter of the wire

substituting the values, we get $Y=2\times 10^{11}N/m^2$

$$\Rightarrow\frac{\Delta Y}{Y}=2\frac{\Delta d}{d}+\frac{\Delta l}{l}=2\left(\frac{0.01}{0.4}\right)+\frac{0.05}{0.8}=\frac{9}{80}$$

$$\Rightarrow\Delta Y=\frac{9}{80}\times Y=\frac{9}{80}\times 2\times 10^{11}=0.2\times 10^{11}N/m^2$$

21 **(a)**

$l=\frac{FL}{AY}\therefore l\propto\frac{1}{r^2}$ [Y, L and F are constant]

$i.e.$ for the same load, thickest wire will show minimum elongation. So graph D represent the thickest wire

22 **(a)**

$$F=-5x-16x^3=-(5+16x^2)x=-kx$$

$$\therefore k=5+16x^2$$

Work done, $W=\frac{1}{2}k_2x_2^2-\frac{1}{2}k_1x_1^2$

$$=\frac{1}{2}[5+16(0.2)^2](0.2)^2-\frac{1}{2}[5+16(0.1)^2](0.1)^2$$

$$=2.82\times 4\times 10^{-2}-2.58\times 10^{-2}=8.7\times 10^{-2}J$$

23 **(c)**

Work done is stretching a wire,

$$U=\frac{1}{2}\times\frac{YAl^2}{L}$$

$$=\frac{1}{2}\times\frac{2\times 10^{11}\times 3\times 10^{-6}\times(1\times 10^{-3})^2}{4}$$

= 0.075 J

24 **(a)**

Energy density $= \frac{1}{2}$ stress $\times$ strain

$= \frac{1}{2}\text{stress} \times \frac{\text{stress}}{Y} = \frac{(\text{stress})^2}{2Y} \propto \frac{1}{D^4}$

Now , $\frac{u_A}{u_B} = \frac{D_B^4}{D_A^4} = (2)^4 = 16$

25 **(c)**

$K = \frac{F}{l}$ and $W = \frac{1}{2}Fl = \frac{1}{2}Kl \times l = \frac{1}{2}Kl^2$

26 **(a)**

$$L = \frac{P}{dg} = \frac{10^6}{3 \times 10^3 \times 10} = \frac{100}{3} = 34m$$

27 **(b)**

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

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

28 **(b)**

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

29 **(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,

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

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

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

30 **(d)**

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

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

32 **(c)**

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

33 **(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

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

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

34 **(b)**

$$Y = \frac{Fl}{A\Delta l}$$

$Y, F\ and\ l$ are constants.

$$\therefore \frac{\Delta l_2}{\Delta_1} = \frac{a_1}{a_2} = \frac{4}{8} = \frac{1}{2}$$

Or $\Delta l_2 \ = \frac{\Delta l_1}{2} = \frac{0.1}{2} \text{mm} = 0.5 \text{ mm}$

35 **(b)**

Initial elastic potential energy

$$U_1 = \frac{1}{2}\ F\Delta l = \frac{1}{2} = \frac{1}{2} \times (100 \times 1000) \times (1.59 \times 10^{-3}) = \ 79.5 \text{ J}$$

Let Δl_1, be the elongation in the rod when stretching force is increased by, 200N, Since, $\Delta l = \frac{F}{\pi r^2} \times \frac{l}{Y}\ ; so, \Delta l\ \propto F$

$$\therefore \qquad \frac{\Delta l_1}{\Delta l} = \frac{F_1}{F} = \frac{100 + 200}{100} = 3$$

Or $\qquad \Delta l_1 = 3\Delta l = 3\ \times 1.59\ \times 10^{-3}\text{m} = 4.77 \times 10^{-3} \text{ m}$

Final elastic potential energy is

$$U_1 = \frac{1}{2} F_1 \Delta l_1 = \frac{1}{2} \times (300 \times 10^3) \times (4.77 \times 10^{-3}) = 715.5 \text{ J}$$

Increase in elastic potential energy

$= 715.5\text{-}79.5 = 636.0$ J

36 **(c)**

$$W = \frac{YAl^2}{2L} = \frac{2 \times 10^{10} \times 10^{-6} \times (10^{-3})^2}{2 \times 50 \times 10^{-2}} = 2 \times 10^{-2} J$$

37 **(d)**

Energy stored per unit volume

$$= \frac{1}{2} Y\ (\text{strain})^2 = \frac{1}{2} \times 1.5\ \times 10^{12} \times (2 \times 10^{-4})^2$$

$= 3\ \times 10^4 \text{ Jm}^{-3}$

38 **(a)**

In the figure OA, stress ∝ strain $i.e.$ Hooke's law hold good

39 **(b)**

Young's modulus $Y = \frac{\text{Stress}}{\text{Strain}} = \frac{\frac{F}{A}}{\text{Strain}}$

or $Y \frac{mg}{A \times \text{strain}}$

or $m = \frac{Y \times A \times \text{strain}}{\text{g}}$

$$= \frac{2 \times 10^{11} \times 10^{-3} \times 10^{-6}}{10} = 60\text{kg}$$

40 **(b)**

$$Y = \frac{F}{\pi R^2} \times \frac{l}{\Delta l}$$

$F, l\ and\ \Delta l$ are constants.

$$\therefore \ R^2 \ \propto \frac{1}{Y}$$

$$\frac{R_S^2}{R_B^2} = \frac{Y_B}{Y_S} = \frac{10^{11}}{2\ \times 10^{11}} = \frac{1}{2}$$

Or $\frac{R_S}{R_B} = \frac{1}{\sqrt{2}}$ or $R_S = \frac{R_B}{\sqrt{2}}$

41 **(a)**

$$Y = \frac{FV}{A^2 \Delta l}$$

$$\Delta l \propto \frac{1}{A^2} \text{ or } \Delta l \propto \frac{1}{D^4}$$

$$\therefore \frac{\Delta l_A}{\Delta l_B} = \frac{D_B^4}{D_A^4} = \frac{1^4}{\left(\frac{1}{2}\right)^4} = 16$$

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

Now, $V = Al$ or $l \frac{V}{A}$ $\therefore$ $Y = \frac{FV}{A^2 \Delta l}$

42 **(d)**

Increase in tension of wire $= YA\alpha\Delta\theta$

$= 8 \times 10^{-6} \times 2.2 \times 10^{11} \times 10^{-2} \times 10^{-4} \times 5 = 8.8\ N$

43 **(a)**

Young's modulus of a material is given by

$$Y = \frac{F \times L}{A \times l}$$

For a perfectly rigid body,

$l = 0$

$\therefore$ $Y = \infty$ (infinite)

44 **(c)**

$$Y = \frac{Mgl}{\pi r^2 \times l} = \frac{4 \times (3.1\pi) \times 2.0}{\pi \times (2 \times 10^{-3})^2 \times 0.031 \times 10^{-3}}$$

$= 2 \times 10^{11}\ \text{Nm}^{-2}$

45 **(c)**

$$x = \frac{F}{k}$$

If spring constant is k for the first case, it is $\frac{k}{2}$ for second case.

For first case, $1 = \frac{4}{k}$ ....(i)

For second case, $x' = \frac{6}{k/2} = \frac{12}{k}$ ....(ii)

Dividing Eq. (ii) by Eq. (i), we get

$$x' = \frac{12/k}{4/k} = 3\ \text{cm}$$

46 **(c)**

Work done $= \frac{1}{2}F \times$ extension

$$= \frac{1}{2} \times \frac{YA}{L} \times 1 \qquad \left| \; Y = \frac{F \times L}{A \times 1} \right.$$

$$= \frac{YA}{2L} \qquad \left| \; F = \frac{YA}{L} \right.$$

47 **(b)**

$$Y = \frac{F}{A} \times \frac{L}{l} \text{ or } l = \frac{FL}{AY} \text{ or } l \propto 1/A$$

48 **(c)**

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

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

49 **(d)**

Attraction will be minimum when the distance between the molecule is maximum

Attraction will be maximum at that point where the positive slope is maximum because $F = -\frac{dU}{dx}$

50 **(b)**

Energy per unit volume $= \frac{1}{2} \times$ stress $\times$ strain

$$= \frac{1}{2} \times \text{stress} \times \frac{\text{strain}}{Y} \qquad \mid Y = \frac{\text{stress}}{\text{strain}} = \frac{S^2}{2Y}$$

51 **(b)**

$$Y = \frac{mg \times 4 \times l}{\pi D^2 \times \Delta l} \text{ or } \Delta l \propto \frac{1}{D^2}$$

When D is doubled, Δl becomes on- fourth, *ie*, $\frac{1}{4} \times 2.4$ cm, *ie*, 0.6 cm.

52 **(b)**

$$F = \frac{YA\Delta l}{l}$$

$$= 9 \times 10^{10} \times \frac{22}{7} \times \frac{(0.6\times10^{-3})^2}{4} \times \frac{0.2}{100} \text{N} \approx 51 \text{ N}$$

53 **(c)**

$$l = \frac{MgL}{YA} = \frac{1 \times 10 \times 1}{2 \times 10^{11} \times 10^{-6}} = 0.05\ mm$$

54 **(d)**

Young's modulus $\quad Y = \frac{FL}{Al}$

or $F = \frac{YAl}{L}$

or $F \propto A$ or $F \propto r^2$ or $F \propto d^2$

$\therefore \quad \frac{F_1}{F_2} = \frac{d_1^2}{d_2^2}$

Given, $d_1 = d,\ d_2 = 2d, F_1 = 200$N

$\therefore \quad \frac{200}{F_2} = \frac{(d)^2}{(2d)^2} = \frac{1}{4}$

or $\quad F_2 = 4 \times 200 = 800$N

56 **(b)**

Bulk modulus $K = \frac{\Delta p}{\Delta V} V$

$$\Delta p = \frac{K\Delta V}{V}$$

$$\Delta p = \frac{2100 \times 10^6 \times 0.008}{200} = 84 \text{ kPa}$$

57 **(c)**

Isothermal elasticity $K_i = P = 1atm = 1.013 \times 10^5\ N/m^2$

58 **(c)**

From figure the increase in length $\Delta l = (PR + RQ) - PQ$

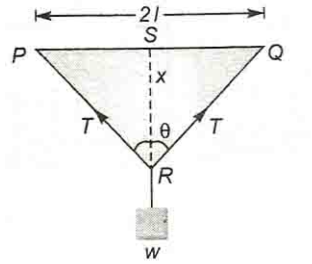
$= 2PR - PQ$

$$= 2(l^2 + x^2)^{1/2} - 2l = 2l\left(1 + \frac{x^2}{l^2}\right)^{1/2} - 2l$$

$$= 2l\left[1 + \frac{1}{2}\frac{x^2}{l^2}\right] - 2l$$

$= x^2/l$ (By Binomial theorem)

$\therefore \quad$ Strain $= \Delta l/2l = x^2/2l^2$



59 **(c)**

Bulk modulus, $B = -\frac{P}{\left(\frac{\Delta V}{V}\right)}$

$-$ve sign shows that with an increase in pressure, a decrease in volume occurs

Compressibility, $k = \frac{1}{B} = -\frac{\Delta V}{PV}$

Decrease in volume, $\Delta V = PVk$

$= 4 \times 10^7 \times 1 \times 6 \times 10^{-10} = 24 \times 10^{-3}$ litre

$= 24 \times 10^{-3} \times 10^3 cm^3 = 24\ cc$

60 **(b)**

$K = Yr_0 = 20 \times 10^{10} \times 3 \times 10^{-10} = 60\ N/m$

$= 6 \times 10^{-9} N/\text{Å}$

61 **(b)**

$$F = Y \times A \times \frac{l}{L}$$

$\Rightarrow F \propto r^2 [Y, l$ and L are constant]

If diameter is made four times then force required will be 16 times, $i.e.$ $16 \times 10^3 N$

62 **(d)**

If side of the cube is L then $V = L^3 \Rightarrow \frac{dV}{V} = 3\frac{dL}{L}$

$\therefore$ % change in volume $= 3 \times$ (% change in length)

$= 3 \times 1\% = 3\%$

$\therefore$ Bulk strain, $\frac{\Delta V}{V} = 0.03$

63 **(b)**

Young's modulus of wire does not vary with dimension of wire. It is the property of given material

65 **(c)**

$$k_1 = \frac{Y\pi(2R)^2}{L}, k_2 = \frac{Y\pi(R)^2}{L}$$

Equivalent $\frac{1}{k_1} + \frac{1}{k_2} = \frac{L}{4Y\pi R^2} + \frac{L}{Y\pi R^2}$

Since, $k_1 x_1 = k_2 x_2 = w$

Elastic potential energy of the system

$$U = \frac{1}{2}k_1 x_1^2 + \frac{1}{2}k_2 x_2^2$$

$$U = \frac{1}{2}k_1\left(\frac{w}{k_1}\right)^2 + \frac{1}{2}k_2\left(\frac{w}{k_2}\right)^2$$

$$= \frac{1}{2}w^2\left\{\frac{1}{k_1} + \frac{1}{k_2}\right\} = \frac{1}{2}w^2\left(\frac{5L}{4Y\pi R^2}\right)$$

$$U = \frac{5w^2 L}{8\pi Y R^2}$$

66 **(b)**

Young's modulus $= \frac{\text{stress}}{\text{strain}}$

As the length of wire get doubled therefore strain = 1

$\therefore Y = \text{strain} = 20 \times 10^8 N/m^2$

69 **(c)**

Stress = (weight due to mass m_2 + half of the weight of rod)/area

$= (m_2 g + m_1 g/2)/A = [(m_1/2) + m_2]g/A$

70 **(d)**

Stress = Strain

$= 2 \times 10^{11} \times 0.15 \text{ Nm}^{-2} = 3 \times 10^{10} \text{ Nm}^{-2}$

71 **(b)**

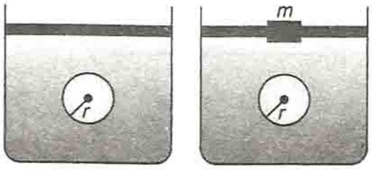
Twisting coupler per unit twist for solid cylinder, for hollow cylinder, $C_1 = \frac{\pi \eta r^4}{2l}$

$$\therefore \quad C_2 = C_1 \frac{r_2^4 - r_1^4}{r^4} = \frac{0.1 \times (5^4 - 4^4)}{\partial^4} = \frac{36.9}{81}$$

$= 0.455 \text{ Nm}$

72 **(c)**

In volume of sphere in liquid,



(a) (b)

$V = \frac{4}{3}\pi r^3$ ....(i)

When mass m is placed on the piston, the increased pressure $p = \frac{mg}{a}$. since this increased pressure is equally applicable to all directions on the sphere, so there will be decrease in volume of sphere, due to decrease in its radius. From Eq.(i), change in volume is

$$\Delta V = \frac{4}{3}\pi \times 3r^2 \,\Delta r = 4\pi \,\Delta r$$

$$\therefore \quad \frac{\Delta V}{V} = \frac{4\pi r^2 \Delta r}{(4/3)\pi r^3} \frac{3\Delta r}{r}$$

Now, $K = \frac{p}{dV/V} = \frac{mg}{a} \times \frac{r}{3\Delta r}$

$$\therefore \quad \frac{\Delta r}{r} = \frac{mg}{3Ka}$$

74 **(d)**

As stress is shown on x-axis and strain on y-axis

So we can say that $Y = \cot\theta = \frac{1}{\tan\theta} = \frac{1}{\text{slope}}$

So elasticity of wire P is minimum and of wire R is maximum

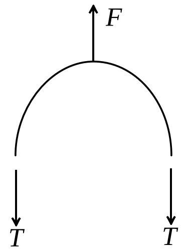
76 **(d)**

If temperature increases by ΔT,

Increase in length $L, \Delta L = L\alpha\Delta T$

$$\therefore \frac{\Delta L}{L} = \alpha \Delta T$$

Let tension developed in the ring is T



$\therefore \frac{T}{S} = Y\frac{\Delta L}{L} = Y\alpha\Delta T$

$\therefore T = SY\alpha\Delta T$

$F = 2T$ (From figure)

Where, F is the force that one part of the wheel applies on the other part

$\therefore F = 2SY\alpha\Delta T$

78 **(a)**

$K = \frac{\Delta p}{\Delta V/V}$ or $\frac{1}{K} = \frac{\Delta p}{V\Delta p}$

Or $\Delta V = \frac{1}{K} V\Delta p$

$= 4 \times 10^{-5} \times 100 \times 100 \text{ cm}^3$

$= 4 \times 10^{-1}\text{cm}^3 = 0.4 \text{ cm}^3$

79 **(b)**

$\eta = \frac{Fl}{A\Delta l} = \frac{Fl}{l^2\Delta l} = \frac{F}{l\,\Delta l}$ or $\Delta l \propto \frac{1}{l}$

If l is halved, then Δl is doubled.

80 **(a)**

Energy density $= \frac{1}{2} \times$ stress $\times$ strain

$Y = \frac{\text{stress}}{\sigma}$ or stress $= Y\sigma$

$\therefore$ energy density $= \frac{1}{2} Y\sigma \times \sigma = \frac{Y\sigma^2}{2}$

81 **(a)**

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

Work done $= \frac{1}{2} F\Delta l$

$= \frac{1}{2}\frac{FA(\Delta l)^2}{l} = \frac{YA(l)^2}{2l}$

$= \frac{2\times10^{11}\times10^{-6}\times10^{-6}}{2\times1} = 0.1 \text{ J}$

82 **(a)**

When a wire is stretched through a length, then work has to be done, this work is stored in the wire in the form of elastic potential energy

Potential energy of stretched wire is

$U = \frac{1}{2} \times \text{stress} \times \text{strain}$

$\therefore U = \frac{1}{2} \times F \times s \Rightarrow U = \frac{1}{2} Fx$

83 **(b)**

$10^6 = \frac{LAdg}{A}$

$$\therefore\ L=\frac{10^6}{3\times10^3\times9.8}\text{m}=\frac{1000}{3\times9.8}=34.01\text{m}$$

85 **(b)**

For triatomic gas $\gamma=\frac{4}{3}$

86 **(a)**

$$W=\frac{F^2l}{2\left(\frac{\pi D^2}{4}\right)Y}$$

Y, l and F are constants.

$$\therefore\ W\ \propto\frac{1}{D^2}$$

$\therefore\ \frac{W_1}{W_2}=\frac{D_2^2}{D_1^2}=16$ ....(i)

Now, $W_1=\frac{1}{2}\times10^3\times1\times10^{-3}=0.5\text{ J}$

$$W_2=\frac{1}{2}\times10^3\times\frac{10^{-3}}{16}=\frac{1}{32}=0.03125$$

Again, $\frac{W_1}{W_2}=\frac{0.5}{0.03125}=16$ ....(ii)

Answer is confirmed by comparing Eqs. (i) and (ii) .

87 **(c)**

$$Y=\frac{Fl}{\pi r^2\Delta l}\text{ or }\Delta l=\frac{F}{\pi r^2Y}$$

$$\Delta l\ \propto\frac{1}{r^2},\Delta l'\propto\frac{2l}{\left(\sqrt{2}r\right)^2}\text{ or }\Delta l'\propto\frac{1}{r^2}$$

$$\therefore\frac{\Delta l}{\Delta l'}=1$$

88 **(c)**

$$Y=\frac{Fl}{A\Delta l}$$

Y, l *and* A are constants.

$$\therefore\ \frac{F}{\Delta l}=\text{constant}\quad\text{or }\Delta l\ \propto\ F$$

Now, $l_1-l\ \propto T_1$ and $l_2-l\ \propto T_2$

Dividing, $\frac{l_1-l}{l_2-l}=\frac{T_1}{T_2}$

Or $l_2T_2-lT_2=l_2T_1$ or $l(T_1-T_2)=l_2T_1-l_1T_2$

Or $l=\frac{l_2T_1-l_1T_2}{T_1-T_2}$ or $l=\frac{l_1T_2-l_2T_1}{T_2-T-1}$

89 **(d)**

From the definition of Bulk modulus,

$$B=-\frac{dp}{(dV/V)}$$

Substituting the values we have,

$$B=\frac{(1.165-1.01)\times10^5}{\left(\frac{10}{100}\right)}$$

$\text{Pa}=1.55\times10^5\text{ Pa}$

90 **(c)**

$$F=\frac{YAl}{L}=0.9\times10^{11}\times\pi\times(0.3\times10^{-3})^2\times\frac{0.2}{100}=51\ N$$

92 **(c)**

$Y = 2\eta(1+\sigma)$

93 **(d)**

Young's modulus $Y = \frac{F}{A} \times \frac{L}{l}$

$$Y = \frac{F}{\pi r^2} \times \frac{L}{l}$$

$$Y \propto \frac{L}{r^2}$$

Option (d) has the largest extension when the same tension is applied.

94 **(d)**

$$Y = \frac{F \times 4 \times 1}{\pi D^2\, \Delta l}$$

In the given problem, $F \propto D^2$. Since, D is increased by a factor of, 4, therefore, F is increased by a factor of 16.

95 **(d)**

$$Y = 2\eta(1+\sigma) \Rightarrow \sigma = \frac{0.5Y - \eta}{\eta}$$

96 **(d)**

Energy stored per unit volume $= \frac{1}{2} \times$ Stress $\times$ Strain

$$= \frac{1}{2} \times \text{Young's modulus} \times (\text{Strain})^2 = \frac{1}{2} \times Y \times x^2$$

97 **(b)**

$$Y = \frac{Fl}{A\Delta l} \text{ or } \Delta l = \frac{Fl}{AY} = \frac{Fl}{\pi r^2 Y}$$

In the given problem, $\Delta l = \frac{1}{r^2}$; when both l and r are double, Δl is halved.

98 **(b)**

$l = \frac{FL}{AY} \therefore l \propto \frac{1}{A}$ $[F, L \text{ and } Y \text{ are constant}]$

$$\frac{A_2}{A_1} = \frac{l_1}{l_2} \Rightarrow A_2 = A_1\left(\frac{0.1}{0.05}\right) = 2A_1 = 2 \times 4 = 8mm^2$$

99 **(d)**

$$l = \frac{FL}{AY} \Rightarrow l \propto \frac{1}{r^2} [F, L \text{ and } Y \text{ are same}]$$

$$\frac{l_A}{l_B} = \left(\frac{r_B}{r_A}\right)^2 = \left(\frac{r_B}{2r_B}\right)^2 = \frac{1}{4} \Rightarrow l_A = 4l_B \text{ or } l_B = \frac{l_A}{4}$$

100 **(a)**

Work done $= \frac{1}{2}\, F\Delta l$

$= \frac{1\,YA\Delta l^2}{2\quad l}$

$\frac{2\times10^{11}\times10^{-6}(2\times10^{-3})^2}{2\times1}$

$Y = \frac{Fl}{A\Delta l}$

or $F = \frac{YA\Delta l}{l}$

$= 4\times 10^{-1}$ J $= 0.4$ J

101 **(b)**

Stress $\propto$ Strain $\Rightarrow$ Stress $\propto \frac{1}{L}$

103 **(c)**

Graph between applied force and extension will be straight line because in elastic range

Applied force $\propto$ extension

But the graph between extension and stored elastic energy will be parabolic in nature

As $U = 1/2\, kx^2$ or $U \propto x^2$

104 **(b)**

Initial length (circumference) of the ring $= 2\pi r$

Final length (circumference) of the ring $= 2\pi R$

Change in length $= 2\pi R - 2\pi r$

$$\text{strain} = \frac{\text{change in length}}{\text{original length}} = \frac{2\pi(R-r)}{2\pi r} = \frac{R-r}{r}$$

Now Young's modulus $E = \frac{F/A}{l/L} = \frac{F/A}{(R-r)/r}$

$$\therefore F = AE\left(\frac{R-r}{r}\right)$$

105 **(c)**

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

$r^2 \propto \frac{1}{Y}$ $(F, L$ and l are constants)

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

$$r_2 = 1.5 \times \left(\frac{7}{12}\right)^{\frac{1}{2}} = 1.145 \text{ mm}$$

$\therefore$ Diameter $= 2.29$ mm.

106 **(a)**

Decrease in volume, $\Delta V = \frac{\Delta p \times V}{K}$

Final volume $V' = V - \Delta V = V - \frac{V\Delta p}{K} = V(1 - \Delta p/K)$

Or $\frac{m}{\rho'} = \frac{m}{\rho}\left(1 - \frac{\Delta p}{K}\right)$

Or $\rho' = \frac{\rho}{(1-\frac{\Delta \rho}{K})}$

Or $\rho = \frac{10.5 \times 10^3}{(1-10^7/17\times 10^{10})}$

$= 10500.61 \text{ kg m}^{-3}$

So $\rho' - \rho = 10500.61 - 10500 = 0.61 \text{ kg m}^{-3}$

107 **(c)**

$V = \pi r^2 l$

$$\frac{\Delta V}{V} = \frac{\Delta(\pi r^2 l)}{\pi r^2 l} \text{ or } \frac{\Delta V}{V} = \frac{r^2 \Delta l + 2rl\Delta r}{r^2 l}$$

$$\frac{\Delta V}{V} = \frac{\Delta l}{l} + \frac{2\Delta r}{r}$$

But $\sigma = -\frac{\Delta r/r}{\frac{\Delta l}{l}} = -\frac{\Delta r/r}{-2\frac{\Delta r}{r}} = 0.5$

108 **(d)**

$$Y = \frac{k}{r_0} = \frac{7}{3 \times 10^{-10}} = 2.33 \times 10^{10} N/m^2$$

110 **(d)**

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

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

111 **(b)**

$T = m\,(\text{g} + a_0) = 10\,(10 + 2) = 120 \text{ N}$

$\therefore$ Stress $= \dfrac{T}{A}$

$= \frac{120}{2 \times 10^{-4}} = 60 \times 10^4\ \mathrm{Nm}^{-2}$

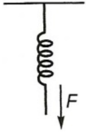
$\therefore\ Y = \dfrac{\text{stress}}{4\text{strain}}$

$\therefore$ strain $= \dfrac{\text{stress}}{Y}$

$= \frac{60 \times 10^4}{2 \times 10^{11}} = 30 \times 10^{-7} = 3 \times 10^{-6}$

112 **(c)**

From Hooke's law, restoring force F is $F = kl$ where k is spring constant. When L is original length of spring, and k the spring constant, then



$L + \left(\dfrac{5}{k}\right) = b$

Also $L + \left(\frac{4}{k}\right) = a$

$\therefore\ \frac{5}{k} - \frac{4}{k} = b - a$

$\Rightarrow\ k = \frac{1}{b-a}$

$\therefore\ L = b - \frac{5}{k}$

$\Rightarrow\ L = b - 5(b-a) = 5a - 4b$

When tension is 9 N.

Length of spring $= L + \frac{9}{k}$

Length of spring $= (5a - 4b) + 9(b - a)$

Length of spring $= 5b - 4a$

113 **(b)**

Change in pressure due to placing of mass on piston is,

$\Delta p = \dfrac{Mg}{A}$

From Bulk modulus definition

$K = \dfrac{-dp}{\frac{dV}{V}}$

$\Rightarrow\ \left|\frac{dV}{V}\right| = \frac{\Delta p}{K} = \frac{Mg}{AK}$

From $V = \dfrac{4}{3}\pi r^3$

$\dfrac{dV}{V} = \dfrac{3dR}{R}$

$\Rightarrow\ \dfrac{dR}{R} = \dfrac{1}{3}\dfrac{dV}{V}$

$= \dfrac{Mg}{3AK}$

Assertion - Reasoning Type

This section contain(s) 16 questions numbered 1 to 16. Each question contains STATEMENT 1(Assertion) and STATEMENT 2(Reason). Each question has the 4 choices (a), (b), (c) and (d) out of which **ONLY ONE** is correct.

a) Statement 1 is True, Statement 2 is True; Statement 2 **is** correct explanation for Statement 1

b) Statement 1 is True, Statement 2 is True; Statement 2 **is not** correct explanation for Statement 1

c) Statement 1 is True, Statement 2 is False

d) Statement 1 is False, Statement 2 is True

1 **Statement 1:** Ductile metals are used to prepare thin wires.

Statement 2: In the stress-strain curve of ductile metals, the length between the points representing elastic limit and breaking point is very small.

2 **Statement 1:** Young's modulus for a perfectly plastic body is zero.

Statement 2: For a perfectly plastic body, restoring force is zero.

3 **Statement 1:** The stretching of a coil is determined by its shear modulus

Statement 2: Shear modulus change only shape of a body keeping its dimensions unchanged

4 **Statement 1:** The unit of stress is same as that of pressure.

Statement 2: Stress has the same meaning as that pressure.

5 **Statement 1:** The restoring force $F$and a stretched string for extension x is related to potential energy Uas, $F = -\frac{dU}{dx}$

Statement 2: $F = -kx \text{ and } U = \frac{1}{2}kx^2$, where k is a spring constant for the given stretched string.

6 **Statement 1:** Spring balances show correct readings even after they had been used for a long time interval

Statement 2: On using for long time, spring balances losses its elastic strength

7 **Statement 1:** Steel is more elastic than rubber

Statement 2: Under given deforming force, steel is deformed less than rubber

8 **Statement 1:** A hollow shaft is found to be stronger than a solid shaft made of same material

Statement 2: The torque required to produce a given twist in hollow cylinder is greater than that required to twist a solid cylinder of same size and material

9 **Statement 1:** Glassy solids have sharp melting point

Statement 2: The bonds between the atoms of glassy solids get broken at the same temperature

10 **Statement 1:** Stress is the internal force per unit area of a body

Statement 2: Rubber is less elastic than steel

11 **Statement 1:** A solid shaft is found to be stronger, than a hollow shaft of same material.

Statement 2: The torque required to produce a given twist in solid cylinder is smaller than that required to twist a hollow cylinder of the same size and material.

12 **Statement 1:** Bulk modulus of elasticity (K) represents incompressibility of the material

Statement 2: Bulk modulus of elasticity is proportional to change in pressure

13 **Statement 1:** Two identical springs of steel and copper are equally stretched. More work will be done on steel than copper.

Statement 2: Steel is more elastic than copper.

14 **Statement 1:** Two identical solid balls, one of ivory and the other of wet-clay are dropped from the same height on the floor. Both the balls will rise to same height after bouncing

Statement 2: Ivory and wet-clay have same elasticity

15 **Statement 1:** The bridges are declared unsafe after a long use.

Statement 2: The bridges lose their elastic strength with time.

16 **Statement 1:** Force constant $k = \frac{YA}{l}, where\ Y$ is Young's modulus, A is area and l is original length of the given spring.

Statement 2: Force constant in the case of a given spring is called spring constant.

: ANSWER KEY :

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

: HINTS AND SOLUTIONS :

2 **(a)**

Young's modulus of a material, $Y = \frac{\text{stress}}{\text{strain}}$

Here Stress $= \frac{\text{Restoring force}}{\text{Area}}$

As restoring force is zero

$\therefore \quad Y = 0$

3 **(a)**

Because, the stretching of coil simply changes its shape without any change in the length of the wire used in coil. Due to which shear modulus of elasticity is involved

4 **(a)**

Stress $= \frac{\text{force}}{\text{area}} =$ pressure. Hence, both Assertion and Reason are true and Reason is the correct explanation of Assertion.

5 **(a)**

Here, both Assertion and Reason are true and Reason is the true explanation of Assertion.

6 **(d)**

When a spring balance has been used for a long time, the spring in the balance gets fatigued and there is loss of strength of the spring. In such a case, the extension in the spring is more for a given load and hence the balance gives wrong readings

7 **(a)**

Elasticity is a measure of tendency of the body to regain its original configuration. As steel is deformed less than rubber therefore steel is more elastic than rubber

9 **(d)**

In a glassy solid ($i.e.$ amorphous solid) the various bonds between the atoms or ions or molecules of a solid are not equally strong. Different bonds are broken at different temperatures. Hence there is no sharp melting point for a glassy solid

10 **(b)**

Stress is defined as internal force (restoring force) per unit area of a body. Also, rubber is less elastic than steel, because restoring force is less for rubber than steel

11 **(d)**

A hollow shaft is found to be stronger than solid shaft of the given size and material. Hence, Assertion-1 is false. Torque required to produce a given twist in hollow cylinder is greater than that required to twist a solid cylinder. Hence, Reason is true.

12 **(a)**

Bulk modulus of elasticity measures how good the body is to regain its original volume on being compressed. Therefore, it represents incompressibility of the material

$K = \frac{-PV}{\Delta V}$ where P is increase in pressure, ΔV is change in volume

13 **(a)**

Work done in stretching a spring of spring constant k is $W = \frac{1}{2}kx^2$ or $W \propto k$ where x is constant.

Since, k for steel is more than for copper, hence more work will be done on steel than copper.

14 **(d)**

Ivory is more elastic than wet-day. Hence the ball of ivory will rise to a greater height. In fact the ball of wet-day will not rise at all, it will be somewhat flattened permanently

15 **(a)**

A bridge during its use undergoes alternating strains for a large number of times each day, depending upon the movement of vehicles on it when a bridge is used for long time, if losses its elastic strength. Due to which the amount strain in the bridge for a given stress will become large and ultimately, the bridge may collapse. This may not happen's if the bridges are declared unsafe after long use.

16 **(b)**

Here, both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

As $k = \frac{F}{A}\frac{F}{\Delta l}$ and $Y = \frac{F}{A}\frac{l}{\Delta l}$ or $\frac{F}{\Delta l} = \frac{YA}{l} = k$

* * *