9.MECHANICAL PROPERTIES OF SOLIDS

Single Correct Answer Type

1. The value of Poisson's ratio lies between

a) $-1 ¿ \frac{1}{2}$ b) $\frac{-3}{4} ¿ -\frac{1}{2}$ c) $\frac{-1}{2} ¿ 1$ d) 1 to 2

2. A $5\,metre$ long wire is fixed to the ceiling. A weight of $10\,kg$ is hung at the lower end and is $1\,metre$ above the floor. The wire was elongated by $1\,mm$. The energy stored in the wire due to stretching is

a) Zero b) $0.05\,joule$ c) $100\,joule$ d) $500\,joule$

3. 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) $F=\frac{k^2}{l}$

4. If in a wire of Young's modulus Y, longitudinal strain X is produced then the potential energy stored in its unit volume will be

a) $0.5\,YX^2$ b) $0.5\,Y^2 X$ c) $2\,YX^2$ d) YX^2

5. A steel wire of length 20 cm and uniform cross-section 1 mm^2 is tied rigidly at both the ends. The temperature of the wire is altered from $40\,℃ ¿ 20\,℃$. Coefficient of linear expansion of steel is $\alpha = 1.1\times10^{-5}\,℃^{-1}$ and Y for steel is $2.0\times10^{11}\,N\,m^{-2}$; the tension in the wire is

a) $2.2\times10^6\,N$ b) 16 N c) 8 N d) 44 N

6. 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) $2l$ c) $4l$ d) $\frac{l}{2}$

7. A and B are two wires. The radius of A is twice that of B. They are stretched by the same load. Then the stress on B is

a) Equal to that on A b) Four times that on A c) Two times that on A d) Half that on A

8. When the length of a wire having cross-section area $10^{-6}\,m^2$ is stretched by 0.1%, then tension in it is $100\,N$. Young's modulus of material of the wire is

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

9. 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) $\frac{L_1 M_2 - L_2 M_1}{M_2 + M_1}$

10. The ratio of two specific heats of gas C_p/C_v for argon is 1.6 and for hydrogen is 1.4. Adiabatic elasticity of argon at pressure P is E. Adiabatic elasticity of hydrogen will also be equal to E at the pressure

a) P b) $\frac{8}{7}P$ c) $\frac{7}{8}P$ d) $1.4\,P$

11. Two wires of same material and radius have their lengths in ratio 1:2. If these wires are stretched by the same force, the strain produced in the two wires will be in the ratio

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

12. 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

13. Minimum and maximum values of Poisson's ratio for a metal lies between

a) $-\infty$ to $+\infty$ b) 0 to 1 c) $-\infty$ to 1 d) 0 to 0.5

14. A cube is compressed at $0\,°C$ equally from all sides by an external pressure p. By what amount should be temperature be raise to bring to back to the size it had before the external pressure was applied ? (Given K is bulk modulus of elasticity of the material of the cube and α is the coefficient of linear expansion.)

a) $\frac{p}{K\alpha}$ b) $\frac{p}{3K\alpha}$ c) $\frac{3\pi\alpha}{p}$ d) $\frac{K}{3p}$

15. 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}

16. The force constant of a wire is k and that of another wire of the same material is $2k$. When both the wires are stretched, then work done is

a) $W_2=2W_1^2$ b) $W_2=2W_1$ c) $W_2=W_1$ d) $W_2=0.5W_1$

17. For a constant hydraulic stress on an object, the fractional change in the object's volume $\left(\frac{\Delta V}{V}\right)$ and its bulk modulus (B) are related as

a) $\frac{\Delta V}{V}\propto B$ b) $\frac{\Delta V}{V}\propto\frac{1}{B}$ c) $\frac{\Delta V}{V}\propto B^2$ d) $\frac{\Delta V}{V}\propto B^{-2}$

18. Two rods A and B of the same material and length have their radii $r_1 \wedge r_2$ 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) $\frac{r_1^2}{r_2^2}$

19. Young's modulus of the wire depends on

a) Length of the wire b) Diameter of the wire

c) Material of the wire d) Mass hanging from the wire

20. For most materials the Young's modulus is n times the rigidity modulus, where n is

a) 2 b) 3 c) 4 d) 5

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

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

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

22. Consider an iron rod of length 1 m and cross-section 1 cm^2 with a Young's modulus of 10^{12} dyne cm^{-2}. We wish to calculate the force with which the two ends must be pulled to produce an elongation of 1mm. It is equal to

a) 10^9 dyne b) 10^8 dyne c) 10^6 dyne d) 10^{17} dyne

23. The upper end of a wire 1 m log and 2 mm radius is clamped. The lower end is twisted through and angle of $45°$. The angle of shear is

a) $0.09°$ b) $0.9°$ c) $9°$ d) $90°$

24. 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 $=2.2\times10^9\,Nm^{-2}\wedge g=10\,ms^{-2}¿is$

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

25. A wire elongates by $l$mm when a load W is hanged from it. If the wire goes over a pulley and two weights W each are hung at the two ends, the elongation of the wire will be (in mm)

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

26. Bulk modulus of water is $2\times10^9\ N\,m^{-2}$. The change in pressure required to increase the density of water by 0.1% is

a) $2\times10^9\ N\,m^{-2}$ b) $2\times10^8\ N\,m^{-2}$ c) $2\times10^6\ N\,m^{-2}$ d) $2\times10^4\ N\,m^{-2}$

27. 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

28. The possible value of Poisson's ratio is

a) 1 b) 0.9 c) 0.8 d) 0.4

29. A metallic ring of radius r and cross-sectional area A is fitted into a wooden circular disc of radius *R(R>r).* If the Young's modulus of the material of the ring is Y, the force with which the metal ring expands is

a) $\frac{AYR}{r}$ b) $\frac{AY(R-r)}{r}$ c) $\frac{Y(R-r)}{Ar}$ d) $\frac{YR}{AR}$

30. 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

31. A $2\,m$ long rod of radius $1\,cm$ which is fixed from one end is given a twist of 0.8 radians. The shear strain developed will be

a) 0.002 b) 0.004 c) 0.008 d) 0.016

32. The upper end of a wire of radius 4 mm and length 100 cm is clamped and its other end is twisted through and angle of $30°$. Then angle of shear is

a) 0.012° b) $0.12°$ c) $1.2°$ d) $12°$

33. 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) $\frac{K}{2}(l_2^2-l_1^2)$

34. A wire suspended vertically from one of its ends is stretched by attaching a weight of 200 N to the lower end. The weight stretches the wire by 1mm. Then, the elastic energy stored in the wire is

a) 0.2 J b) 10 J c) 20 J d) 0.1 J

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

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

36. 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

37. Write copper, steel, glass and rubber in order of increasing coefficient of elasticity.

a) Steel, rubber, copper, glass b) Rubber, copper, steel, glass

c) Rubber, glass, steel, copper d) Rubber, glass, copper, steel

38. The Bulk modulus for an incompressible liquid is

a) Zero b) Unity c) Infinity d) Between 0 and 1

39. 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

40. On increasing the length by $0.5\,mm$ in a steel wire of length $2\,m$ and area of cross-section $2\,mm^2$, the force required is [Y for steel ¿$2.2\times10^{11}\,N/m^2$]

a) $1.1\times10^5\,N$ b) $1.1\times10^4\,N$ c) $1.1\times10^3\,N$ d) $1.1\times10^2\,N$

41. A copper wire 2 m long is stretched by 1 mm. If the energy stored in the stretched wire is converted to heat, calculate the rise in temperature of the wire. (Given, $Y=12\times10^{11}\,dyne\,cm^{-2}$,density of copper= $9\,gcm^{-3}$and specific heat of copper = $0.1\,cal\,g^{-1}\,°C^{-1}$¿

a) $252\,°C$ b) $(1/252)°C$ c) $1000\,°C$ d) $2000°C$

42. 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) $0.002\,m$

43. A copper wire and a steel wire of the same diameter and length are connected end to end and a force is applied, which stretches their combined length by 1 cm. The two wires will have

a) Different stresses and strains b) The same stress and strain

c) The same strain but different stresses d) The same stress but different strains

44. Two identical wires of rubber and iron are stretched by the same weight, then the number of atoms in the iron wire will be

a) Equal to that of rubber b) Less than that of the rubber

c) More than that of the rubber d) None of the above

45. A cube of side 10 cm is subjected to a tangential force of $5\times10^5\,N$ 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) $5\times10^{10}\,N\,m^{-2}$ b) $5\times10^{11}\,N\,m^{-2}$ c) $5\times10^{12}\,N\,m^{-2}$ d) $5\times10^{13}\,N\,m^{-2}$

46. If Poisson's ratio σ is $\frac{-1}{2}$ for a material, then the material is

a) Uncompressible b) Elastic fatigue c) Compressible d) None of the above

47. A material has Poisson's ratio 0.50. If a uniform rod of it suffers a longitudinal strain of 2×10^{-3}, then the percentage change in volume is

a) 0.6 b) 0.4 c) 0.2 d) Zero

48. 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) $10^9\,N/m^2$

49. To what depth below the surface of sea should a rubber ball be taken as to decrease its volume by 0.1%? [Take : density of sea water ¿$1000\,kg\,m^{-3}$, Bulk modulus of rubber ¿$9\times10^8\,N\,m^{-2}$; acceleration due to gravity ¿$10\,m\,s^{-2}$]

a) $9\,m$ b) $18\,m$ c) $180\,m$ d) $90\,m$

50. The radii and Young's modulii of two uniform wires A and B are in the ratio 2:1 and 1:2 respectively. Both wires

are subjected to the same longitudinal force. If the increase in length of the wire A is one percent, the percentage increase in length of the wire B is

a) 1.0 b) 1.5 c) 2.0 d) 3.0

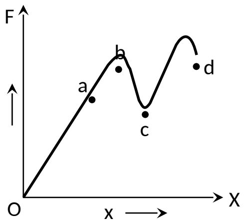
51. If a bar is made of copper whose coefficient of linear expansion is one and a half times that of iron, the ratio of the force developed in the copper bar to the iron bar of identical lengths and cross-sections, when heated through the same temperature range (Young's modulus for copper may be taken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

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

52. The breaking stress of a wire depends upon

a) Length of the wire
b) Radius of the wire
c) Material of the wire
d) Shape of the cross section

53. The graph is drawn between the applied force F and the strain (x) for a thin uniform wire. The wire behaves as a liquid in the part



a) ab b) bc c) cd d) oa

54. 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 $\omega\neq\sqrt{k/m}$

55. Two wires of copper having the length in the ratio 4:1 and their radii ratio as 1:4 are stretched by the same force. The ratio of longitudinal strain in the two will be

a) 1 : 16 b) 16 : 1 c) 1 : 64 d) 64 : 1

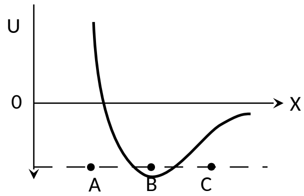
56. A copper bar of length L and area of cross-section A is placed in a chamber at atmospheric pressure. If the chamber is evacuated, the percentage change in its volume will be (compressibility of copper is $8\times10^{12}m^2N^{-1}\wedge1atm=10^5N\,m^2$¿

a) 8×10^{-7} b) 8×10^{-5} c) 1.25×10^{-4} d) 1.25×10^{-5}

57. 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) $3F/AY$

58. The potential energy U between two molecules as a function of the distance X between them has been shown in the figure. The two molecules are



a) Attracted when x lies between A and B and are repelled when X lies between B and C
b) Attracted when x lies between B and C and are repelled when X lies between A and B
c) Attracted when they reach B

d) Repelled when they reach B

59. Energy stored in stretching a string per unit volume is

a) $\frac{1}{2} \times stress \times strain$ b) $stress \times strain$ c) $Y(strain)^2$ d) $\frac{1}{2} Y(stress)^2$

60. 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 $\pm 0.05\,mm$ 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) $(2.0 \pm 0.05) \times 10^{11}\,N/m^2$

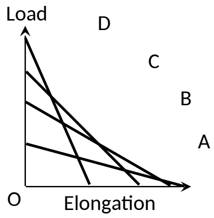
61. A body of mass m is suspended to an ideal spring of force constant k. The expected change in the position of the body due to an additional force F acting vertically downwards is

a) $\frac{3F}{2k}$ b) $\frac{2F}{k}$ c) $\frac{5F}{2k}$ d) $\frac{4F}{k}$

62. Stress to strain ratio is equivalent to

a) Modulus of elasticity b) Poission's Ratio c) Reynold number d) Fund number

63. 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

64. A rubber cord $10\,m$ long is suspended vertically. How much does it stretch under its own weight (Density of rubber is $1500\,kg/m^3, Y = 5 \times 10^8\,N/m^2, g = 10\,m/s^2$¿

a) $15 \times 10^{-4}\,m$ b) $7.5 \times 10^{-4}\,m$ c) $12 \times 10^{-4}\,m$ d) $25 \times 10^{-4}\,m$

65. Equal torsional torques act on two rods $x \wedge y$ having equal length. The diameter of rod y is twice the diameter of rod x. $If\ \theta_x \wedge \theta_y$ are the angles of twist, then $\frac{\theta_x}{\theta_y} =$¿

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

66. 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) $12.2 \times 10^{-1}\,J$

67. The elastic energy stored in a wire of Young's modulus Y is

a) $\frac{1}{2} Y \times stress \times strain \times volume$ b) $\frac{(stress)^2 \times volume}{2Y}$

c) $stress \times strain \times volume$ d) $Y \times \frac{(stress)^2}{volume}$

68. According to Hooke's law of elasticity, if stress is increased, them the ratio of stress to strain

a) Becomes zero b) Remains constant c) Decreases d) Increases

69. When a force is applied on a wire of uniform cross-sectional area $3\times10^{-6}m^2$ and length 4 m, the increase in length is 1mm. Energy stored in it will be
$(Y=2\times10^{11}N/m^2)$.
a) 6250J b) 0.177J c) 0.075J d) 0.150J

70. The Young's modulus of the material of a wire is $6\times10^{12}\,N\,m^{-2}$ and there is no transverse strain it, then its modulus of rigidity will be
a) $3\times10^{12}\,N\,m^{-2}$ b) $2\times10^{12}\,N\,m^{-2}$ c) $10^{12}\,N\,m^{-2}$ d) None of these

71. A weight of $200\,kg$ is suspended by vertical wire of length $600.5\,cm$. The area of cross-section of wire is $1\,mm^2$. When the load is removed, the wire contracts by $0.5\,cm$. The Young's modulus of the material of wire will be
a) $2.35\times10^{12}\,N/m^2$ b) $1.35\times10^{10}\,N/m^2$ c) $13.5\times10^{11}\,N/m^2$ d) $23.5\times10^{9}\,N/m^2$

72. 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

73. A thick rope of rubber of density $1.5\times10^3 kg\,m^{-3}$ and Young's modulus $5\times10^6\,N\,m^{-2}$, 8m in length is hung from the ceiling of a room, the increase in ϕ its length due to its own weight is
a) $9.6\times10^{-2}m$ b) $19.2\times10^{-2}m$ c) $9.6\times10^{-3}m$ d) $9.6\,m$

74. A load suspended by a massless spring produces an extension of x cm in equilibrium. When it is cut into two unequal parts, the same load produces an extension of 7.5 cm when suspended by the larger part of length 60 cm. When it is suspended by the smaller part, the extension is 5.0 cm. Then
a) $x=12.5$ b) $x=3.0$
c) The length of the original spring is 90 cm d) The length of the original spring is 80 cm

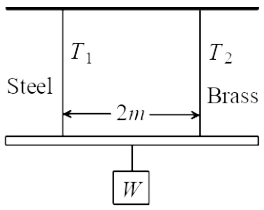
75. If the force constant of a wire is K, the work done in increasing the length of the wire by l is
a) $K/2$ b) Kl c) $Kl^2/2$ d) Kl^2

76. Mark the wrong statement
a) Sliding of molecular layer is much easier than compression or expansion
b) Reciprocal of bulk modulus of elasticity is called compressibility
c) It is difficult to twist a long rod as compared to small rod
d) Hollow shaft is much stronger than a solid rod of same length and same mass

77. A pan with set of weights is attached with a light spring. When disturbed, the mass-spring system oscillates with a time period of $0.6\,s$. When some additional weights are added then time period is $0.7\,s$. The extension caused by the additional weights is approximately given by
a) $1.38\,cm$ b) $3.5\,cm$ c) $1.75\,cm$ d) $2.45\,cm$

78. To break a wire, a force of $10^6\,N/m^2$ is required. If the density of the material is $3\times10^3\,kg/m^3$, 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) $3\,m$

79. A light rod of length $2\,m$ suspended from the ceiling horizontally by means of two vertical wires of equal length. A weight W is hung from a light rod as shown in figure. The rod hung by means of a steel wire of cross-sectional area $A_1=0.1\,cm^2$ and brass wire of cross-sectional area $A_2=0.2\,cm^2$. To have equal stress in both wires, $T_1/T_2=¿$



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

80. A stretched rubber has

a) Increased kinetic energy
b) Increased potential energy
c) Decreased kinetic energy
d) Decreased potential energy

81. A brass rod of cross-sectional area $1\, cm^2$ and length $0.2\, m$ 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 $g = 10\, m/sec^2$, 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) $2.5 \times 10^{-4}\, J$

82. Which one of the following statements is wrong

a) Young's modulus for a perfectly rigid body is zero
b) Bulk modulus is relevant for solids, liquids and gases
c) Rubber is less elastic than steel
d) The Young's modulus and shear modulus are relevant for solids

83. There are two wires of the same length. The diameter of second wire is twice that of the first. On applying the same load to both the wires, the extension produced in them will be in ratio of

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

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

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

85. A rope 1cm in diameter breaks, if the tension in it exceeds 500 N. The maximum tension that may be given to similar rope of diameter 3 cm is

a) 500 N b) 3000 N c) 4500 N d) 2000 N

86. The increase in length on stretching a wire is 0.05%. If its Poisson's ratio is 0.4, the diameter is reduced by

a) 0.01% b) 0.02% c) 0.03% d) 0.04%

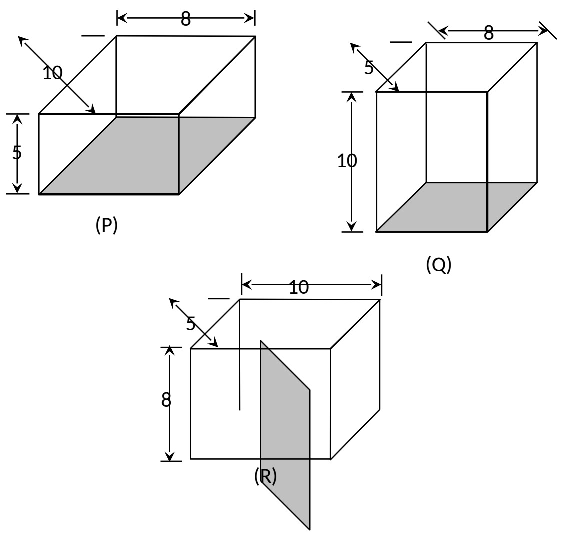
87. A cube is subjected to a uniform volume compression. If the side of the cube decreases by 1% the bulk strain is

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

88. Two wires of length l, radius r and length $2l$, radius $2r$ respectively having some Young's modulus are hung with a weight mg. Net elongation is

a) $\frac{3mgl}{\pi r^2 Y}$ b) $\frac{2mgl}{3\pi r^2 Y}$ c) $\frac{3mgl}{2\pi r^2 Y}$ d) $\frac{3mgl}{4\pi r^2 Y}$

89. A rectangular block of size $10\, cm \times 8\, cm \times 5\, cm$ is kept in three different positions P, Q and R in turn as shown in the figure. In each case, the shaded area is rigidly fixed and a definite force F is applied tangentially to the opposite face to deform the block. The displacement of the upper face will be



a) Same in all the three cases
b) Maximum in P position
c) Maximum in Q position
d) Maximum in R position

90. 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) $\frac{3k}{2}$

91. When a certain weight is suspended from a long uniform wire, its length increases by 1 cm. If the same weight is suspended from another wire of the same material and length but having a diameter half of the first one, the increase in length will be

a) 0.5 cm
b) 2 cm
c) 4 cm
d) 8 cm

92. The rubber cord catapult has a cross-sectional area 1 mm^2 and total unsaturated length 10.0 cm. It is stretched to 12.0 cm and then released to project a miscible of mass 5.0 g. Taking Young's modulus for rubber as, the tension in the cord is

a) 1000 N
b) 100 N
c) 10 N
d) 1 N

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

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

94. The general form of potential energy curve for atoms or molecules can be represented by the following equation $U(R)=\frac{A}{R^n}-\frac{B}{R^m}$. Here, R is the interatomic or molecular distance, A and B are coefficients, n and m are the exponents. In the above equation

a) First term represents the attractive part of the potential
b) Second term represents the attractive part of the potential
c) Both terms represents the attractive part of the potential
d) Second term represents the repulsive part of the potential

95. A wire $\left(Y=2\times 10^{11}\,N\,m^{-2}\right)$ has length 1 m and area of cross-section 1 mm^2. The work required to increase its length by 2 mm is

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

96. A substance breaks down by a stress of $10^6\,N\,m^{-2}$. If the density of the material of the wire is $3\times 10^3\,kg\,m^{-3}$, 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

97. Identify the incorrect statement.

a) Young's modulus and shear modulus are relevant only for solids

b) Bulk modulus is relevant for solids, liquids and gases

c) Alloys have larger values of Young's modulus than metals

d) Metals have larger values of Young's modulus than elastomers

98. 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_pC_v d) $1/C_pC_v$

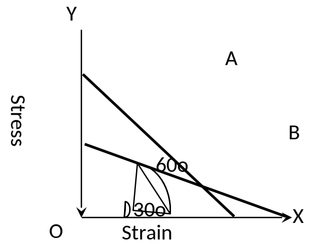
99. When a wire of length 10m is subjected to a force of 100 N along its length, the lateral strain produced is 0.01×10^{-3}m. The Poisson's ratio was found to be 0.4. If the area of cross-section of wire is $0.025\,m^2$, its Young's modulus is

a) $1.6\times10^{8}\,Nm^{-2}$ b) $2.5\times10^{10}\,Nm^{-2}$ c) $1.25\times10^{11}\,Nm^{-2}$ d) $16\times10^{9}\,Nm^{-2}$

100. The Poisson's ratio of a material is 0.4. If a force is applied to a wire of this material, there is decrease of cross-sectional area by 2%. The percentage increase in its length is

a) 3% b) 2.5% c) 1% d) 0.5%

101. The stress versus strain graphs for wires of two materials A and B are as shown in the figure. If Y_A and Y_B are the Young's modulii of the materials, then



a) $Y_B=2Y_A$ b) $Y_A=Y_B$ c) $Y_B=3Y_A$ d) $Y_A=3Y_B$

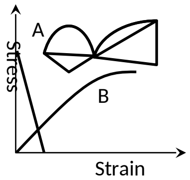
102. A wire whose cross-section is 4 mm^2 is stretched by 0.1 mm by a certain weight. How far will a wire of the same material and length stretch if its cross-sectional area is 8 mm^2 and the same weight is attached ?

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

103. A uniform metal rod of $2\,mm^2$ cross-section is heated from 0^0C ¿ 20^0C. The coefficient of the linear expansion of the rod is $12\times10^{-6}/°C$. Its Young's modulus of elasticity is $10^{11}\,Nm^{-2}$. The energy stored per unit volume of the rod is

a) $1440\,Jm^{-3}$ b) $15750\,Jm^{-3}$ c) $1500\,Jm^{-3}$ d) $2880\,Jm^{-3}$

104. The diagram shows stress v/s strain curve for the materials A and B. From the curves we infer that



a) A is brittle but B is ductile

b) A ductile and B is brittle

c) Both A and B are ductile

d) Both A and B are brittle

105. 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

106. The energy stored per unit volume in copper wire, which produces longitudinal strain of 0.1% is $(Y = 1.1 \times 10^{11}\, Nm^{-2})$

a) $11 \times 10^{3}\, Jm^{-3}$ b) $5.5 \times 10^{3}\, Jm^{-3}$ c) $5.5 \times 10^{4}\, Jm^{-3}$ d) $11 \times 10^{4}\, Jm^{-3}$

107. The length of an elastic string is a metre when the tension is 44 N, and b metre when the tension is 5 N. The length in metre when the tension is 9 N, is

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

108. A wire of length $50\, cm$ and cross sectional area of $1\, sq.mm$ is extended by $1\, mm$. The required work will be $(Y = 2 \times 10^{10}\, N\, m^{-2})$

a) $6 \times 10^{-2}\, J$ b) $4 \times 10^{-2}\, J$ c) $2 \times 10^{-2}\, J$ d) $1 \times 10^{-2}\, J$

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

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

110. The force required to stretch a steel wire of 1 cm^2 cross-section to 1.1 times its length would be $(Y = 2 \times 10^{11}\, N\, m^{-2})$

a) $2 \times 10^{6}\, N$ b) $2 \times 10^{3}\, N$ c) $2 \times 10^{5}\, N$ d) $2 \times 10^{-6}\, N$

111. A wire of Young's modulus $1.5 \times 10^{12}\, N\, m^{-2}$ is stretched by a force so as to produce a strain of 2×10^{4}. The energy stored per unit volume is

a) $3 \times 10^{8}\, J\, m^{-3}$ b) $3 \times 10^{3}\, J\, m^{-3}$ c) $6 \times 10^{3}\, J\, m^{-3}$ d) $3 \times 10^{4}\, J\, m^{-3}$

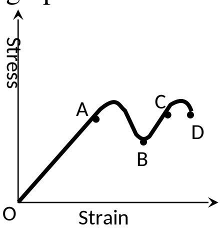
112. The relationship between Young's modulus Y, Bulk modulus K and modulus of rigidity η is

a) $Y = \frac{9\eta K}{\eta + 3K}$ b) $\frac{9YK}{Y + 3K}$ c) $Y = \frac{9\eta K}{3 + K}$ d) $Y = \frac{3\eta K}{9\eta + K}$

113. A rod elongated by l when a body of mass M is suspended from it. The work done is

a) Mgl b) $\frac{1}{2} Mgl$ c) $2Mgl$ d) zero

114. 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

115. For a given material, the Young's modulus is 2.4 times that of rigidity modulus. Its Poisson's ratio is

a) 2.4 b) 1.2 c) 0.4 d) 0.2

116. The lower surface of a cube is fixed. On its upper surface, force is applied at an angle of $30°$ from its surface. The change will be of the type

a) Shape b) Size c) None d) Shape and size

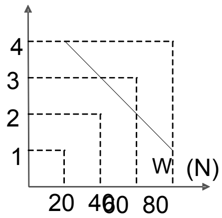
117. A steel wire of cross-sectional area $3 \times 10^{-6} m^2$ can withstand a maximum strain of 10^{-3}. Young's modulus of steel is $2 \times 10^{11}\, Nm^{-2}$. The maximum mass the wire can hold is $(take\ g = 10\, ms^{-2})$

a) 40 kg b) 60 kg c) 80 kg d) 100 kg

118. A force F is needed to break a copper wire having radius R. The force needed to break a copper wire of radius $2R$ will be

a) $F/2$ b) $2F$ c) $4F$ d) $F/4$

119. The adjacent graph shows the extension (l) of a wire of length 1m suspended from the top of a roof at one end and with a load W connected to the other end. If the cross-sectional area of the wire is $10^{-6} m^2$, calculate the Young's modulus of the material of the wire.



a) $2\times10^{11}\,Nm^{-2}$ b) $2\times10^{-11}\,Nm^{-2}$ c) $3\times10^{12}\,Nm^{-2}$ d) $2\times10^{13}\,Nm^{-2}$

120. The Young's modulus of brass and steel are $10\times10^{10}\,N\,m^{-2}\wedge2\times10^{11}\,N\,m^{-2}$ 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 $R_B\wedge R_S$respectively. Then

a) $R_A=\sqrt{2}R_B$ b) $R_S=\frac{R_B}{\sqrt{2}}$ c) $R_S=4R_B$ d) $R_S=\frac{R_B}{4}$

121. The length of a wire is $1.0\,m$ and the area of cross-section is $1.0\times10^{-2}\,c\,m^2$. If the work done for increase in length by $0.2\,cm$ is $0.4\,joule$, then Young's modulus of the material of the wire is

a) $2.0\times10^{10}\,N/m^2$ b) $4.0\times10^{10}\,N/m^2$ c) $2.0\times10^{11}\,N/m^2$ d) $4.0\times10^{11}\,N/m^2$

122. X linear strain is produced in a wire of elasticity coefficient Y. The stored potential energy in unit volume of this wire is

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

123. Two bars $A\wedge B$ 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 Bwill be

a) 16 b) 8 c) 4 d) 7

124. Find the extension produced in a copper of length 2 m and diameter 3 mm, when a force of 30 N is applied. Young's modulus for copper = $1.1\times10^{11}\,N\,m^{-2}$

a) 0.2 mm b) 0.04 mm c) 0.08 mm d) 0.68 mm

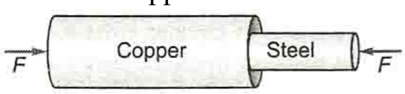
125. Which is the most elastic

a) Iron b) Copper c) Quartz d) Wood

126. A force of $200\,N$ is applied at one end of a wire of length $2\,m$ and having area of cross-section $10^{-2}\,c\,m^2$. The other end of the wire is rigidly fixed. If coefficient of linear expansion of the wire $\alpha=8\times10^{-6}/°C$ and Young's modulus $Y=2.2\times10^{11}\,N/m^2$ 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) $8.8\,N$

127. Two wires, one made of copper and other of steel are joined end to end (as shown in figure). The area of cross-section of copper wire is twice that of steel wire.



They are placed under compressive force of magnitudes F. The ratio for their lengths such that change in lengths of both wires are same is $(Y_s=2\times10^{11}\,N\,m^{-2}\wedge Y_c=1.1\times10^{11}\,N\,m^{-2}$¿

a) 2.1 b) 1.1 c) 1.2 d) 2

128. A rubber cord catapult has cross-sectional area $25\,mm^2$ and initial length of rubber cord is $10\,cm$. It is stretched to $5\,cm$ and then released to project a missile of mass $5\,gm$. Taking $Y_{rubber} = 5 \times 10^8\,N/m^2$ velocity of projected missile is

a) $20\,m\,s^{-1}$ b) $100\,m\,s^{-1}$ c) $250\,m\,s^{-1}$ d) $200\,m\,s^{-1}$

129. Young's modulus of perfectly rigid body material is

a) Infinite b) Zero c) $10 \times 10^{10}\,Nm^{-2}$ d) $1 \times 10^{10}\,Nm^{-2}$

130. The Poisson's ratio of a material is 0.1. If the longitudinal strain of a rod of this material is 10^{-3}, then the percentage change in the volume of the rod will be

a) 0.008% b) 0.08% c) 0.8% d) 8%

131. If a spring extends by x on loading, then the energy stored by the spring is (if T is tension in the spring and k is spring constant)

a) $\frac{T^2}{2x}$ b) $\frac{T^2}{2k}$ c) $\frac{2x}{T^2}$ d) $\frac{2T^2}{k}$

132. 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 $= 3.1\pi\,m\,s^{-2}$, the Young's modulus of steel is

a) $2.0 \times 10^8\,N\,m^{-2}$ b) $2.0 \times 10^9\,N\,m^{-2}$ c) $2.0 \times 10^{11}\,N\,m^{-2}$ d) $2.0 \times 10^{13}\,N\,m^{-2}$

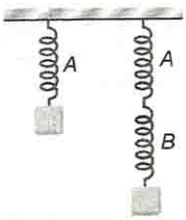
133. A cube is shifted to a depth of 100 m in a lake. The change in volume is 0.1%. The bulk modulus of the material is nearly

a) 10 Pa b) $10^4\,Pa$ c) $10^7\,Pa$ d) $10^6\,Pa$

134. Calculate the work done, if a wire is loaded by $'Mg'$ weight and the increase in length is $'l'$

a) Mgl b) Zero c) $Mgl/2$ d) $2\,Mgl$

135. 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

136. A steel wire has length 2 m, radius 1 mm and $Y = 2 \times 10^{11}\,N\,m^{-2}$. A 1 kg sphere is attached to one end of the wire and whirled in a vertical circle with an angular velocity of 2 revolutions per second. When the sphere is at the lowest point of the vertical circle, the elongation of the wire is nearly (Take g = $10\,m\,s^{-2}$¿

a) 1 mm b) 2 mm c) 0.1 mm d) 0.01 mm

137. Which of the following statements is correct

a) Hooke's law is applicable only within elastic limit

b) The adiabatic and isothermal elastic constants of a gas are equal

c) Young's modulus is dimensionless

d) Stress multiplied by strain is equal to the stored energy

138. 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) $\frac{YL}{A}$

139. After effects of elasticity are maximum for

a) Glass b) Quartz c) Rubber d) Metal

140. The upper end of a wire of radius 4 mm length 100 cm is clamped and its other end is twisted through an angle of 30°. Then angle of shear is

a) 12° b) 0.12° c) 1.2° d) 0.012°

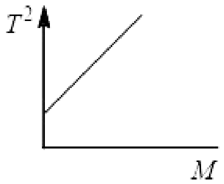
141. An iron bar of length L, cross-section A and Young's modulus Y is pulled by a force F from both ends so as to produce an elongation l. Which of the following statement is correct?

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

142. Compressibility of water is $5 \times 10^{10} m^2 N^{-1}$. The change in volume of 100 mL water subjected to 15×10^6 Pa pressure will

a) No change b) Increase by 0.75 mL c) Decrease by 1.50 mL d) Decrease by 0.75 mL

143. The graph shown was obtained from the experimental measurements of the period of oscillation T for different masses M placed in the scale on the lower end of the spring balance. The most likely reason for the line not passing through the origin is that



a) Spring did not obey Hook's law b) Amplitude of oscillation was too large

c) Clock used needed regulation d) Mass of the pan was not neglected

144. 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

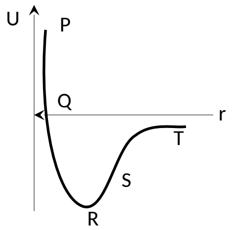
145. A beam of metal supported at the two ends is loaded at the centre. The depression at the centre is proportional to

a) Y^2 b) Y c) $1/Y$ d) $1/Y^2$

146. To break a wire of one metre length, minimum 40 $kg\,wt$, is required. Then the wire of the same material of double radius and 6 m length will require breaking weight

a) 80 kg-wt b) 240 kg-wt c) 200 kg-wt d) 160 kg-wt

147. 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

148. Two spring P and Q of force constants k_p and $k_Q \left(k_Q = \frac{k_p}{2}\right)$ are stretched by applying forces of equal magnitude

if the energy stored in Q is E, then the energy stored in P is

a) E b) $2E$ c) $E/8$ d) $E/2$

149. The material which practically does not show elastic after effect is

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

150. 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) $\frac{2S}{Y}$

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

a) $Fl/2AL$ b) $FA/2L$ c) $FL/2A$ d) $FL/2$

152. The bulk modulus of a metal is $8\times10^9 N m^{-2} \wedge ¿$ its density is 11 $gc m^{-2}$. The density of this metal under a pressure of 20,000 N $c m^{-2}$ will be (in $gc m^{-3}¿$

a) $\frac{440}{39}$ b) $\frac{431}{39}$ c) $\frac{451}{39}$ d) $\frac{40}{39}$

153. 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

154. When a weight w is hung from one and of the wire other end being fixed, the elongation produced in it be l. If this wire goes over a pulley and two weights w each are hung at the two ends, the elongation of the wire will be

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

155. A particular force (F) applied on a wire increases its length by $2\times10^{-3} m$. To increase the wire's length by $4\times10^{-3} m$ the applied force will be

a) $4F$ b) $3F$ c) $2F$ d) F

156. The diameter of a brass wire is 0.6 mm and Y is $9\times10^6 N m^{-2}$.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

157. An aluminium rod, Young's modulus $7.0\times10^9 N m^{-2}$, has a breaking strain of 0.2%. The minimum cross-sectional area of the rod in m^2in order to support a load of $10^4 N is$

a) 1×10^{-2} b) 1.4×10^{-3} c) 1.0×10^{-3} d) 7.1×10^{-4}

158. In the above graph, point D indicates

a) Limiting point b) Yield point c) Breaking point d) None of the above

159. 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 $Y=2\times10^{11} N/m^2$)

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

160. Hooke's law defines

a) Stress b) Strain c) Modulus of elasticity d) Elastic limit

161. In the Young's experiment, If length of wire and radius both are doubled then the value of Y will become

a) 2 times b) 4 times c) Remains same d) Half

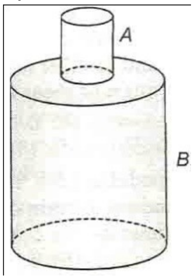
162. A wire can be broken by applying a load of 200 N. The force required to break another wire of the same length and same material, but double in diameter, is

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

163. The temperature of a wire of length 1 m and area of cross section 1 $cm^2$is increased from$0\,°C ¿ 100\,°C$. If the rod is not allowed to increased in length, the force required will be ¿ and $Y=10^{11}\,N/m^2$ ¿

a) $10^3\,N$ b) $10^4\,N$ c) $10^5\,N$ d) $10^9\,N$

164. Two cylinders of same material and of same length are joined to end as shown in figure. The upper end of A is rigidly fixed. Their radii are in ratio of 1 : 2, If the lower end of B is twisted by an angle θ ,the angle of twist of cylinder A is



a) $\frac{15}{16}\theta$ b) $\frac{16}{15}\theta$ c) $\frac{16}{17}\theta$ d) $\frac{17}{16}\theta$

165. Shearing stress causes change in

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

166. There are two wires of same material and same length while the diameter of second wire is 2 times the diameter of first wire, then ratio of extension produced in the wires by applying same load will be

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

167. A rod is fixed between two points at $20\,°C$. The coefficient of linear expansion of material of rod is $1.1\times10^{-5}/°C$ and Young's modulus is $1.2\times10^{11}\,N/m^2$. Find the stress developed in the rod if temperature of rod becomes $10\,°C$

a) $1.32\times10^7\,N/m^2$ b) $1.10\times10^{15}\,N/m^2$ c) $1.32\times10^8\,N/m^2$ d) $1.10\times10^6\,N/m^2$

168. 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

169. In solids, inter-atomic forces are

a) Totally repulsive b) Totally attractive

c) Combination of (a) and (b) d) None of these

170. A stress of $3.18\times10^8\,N\,m^{-2}$ is applied to a steel rod of length $1\,m$ along its length. Its Young's modulus is $2\times10^{11}\,N\,m^{-2}$. Then the elongation produced in the rod in mm is

a) 3.18 b) 6.36 c) 5.18 d) 1.59

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

a) $1\,mm$ of Hg b) $13.6\,mm$ of Hg c) $1.013\times10^5\,N/m^2$ d) $2.026\times10^5\,N/m^2$

172. A load of 1 kg weight is a attached to one end of a steel wire of area of cross-section 3 mm^2 and Young's modulus $10^{11}\,N\,m^{-2}$. The other end is suspended vertically from a hook on a wall, then the load is pulled horizontally and released. When the load passes through its lowest position the fractional change in length is $(g=10\,ms^{-2})$

a) 0.3×10^{-4} b) 0.3×10^{-3} c) 0.3×10^3 d) 0.3×10^4

173. For a given material, the Young's modulus is 2.4 times that of modulus of rigidity. Its Poisson's ratio is

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

174. 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) $x/2l$

175. A wire is stretched under a force. If the wire suddenly snaps the temperature of the wire

a) Remains the same b) Decrease

c) Increase d) First decrease then increase

176. To keep constant time, watches are fitted with balance wheel made of

a) Invar b) Stainless steel c) Tungsten d) Platinum

177. The compressibility of water is $6\times10^{-10}\,N^{-1}m^2$. If one litre is subjected to a pressure of $4\times10^7\,N\,m^{-2}$, the decrease in its volume is

a) $2.4\,cc$ b) $10\,cc$ c) $24\,cc$ d) $15\,cc$

178. A cube of side 40 mm has its upper face displaced by 0.1 mm by a tangential force of 8 kN. The shearing modulus of cube is

a) $2\times10^9\,Nm^{-2}$ b) $4\times10^9\,Nm^{-2}$ c) $8\times10^9\,Nm^{-2}$ d) $16\times10^9\,Nm^{-2}$

179. A wire of length L and area of cross-section A is stretched through a certain length l. If Y is Young's modulus of the material of the wire, then the force constant of the wire is

a) $\frac{YL}{A}$ b) $\frac{Yl}{A}$ c) $\frac{YA}{l}$ d) $\frac{YA}{L}$

180. If the interatomic spacing in a steel wire is $3.0\,Å$ and $Y_{steel}=20\times10^{10}\,N/m^2$ then force constant is

a) $6\times10^{-2}\,N/Å$ b) $6\times10^{-9}\,N/Å$ c) $4\times10^{-5}\,N/Å$ d) $6\times10^{-5}\,N/Å$

181. $Y=\frac{mgl}{\pi r^2 L}$ formula would give Y if mg is doubled

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

182. The Poisson's ratio cannot have the value

a) 0.7 b) 0.2 c) 0.1 d) 0.3

183. 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) $4\times10^3\,N$ b) $16\times10^3\,N$ c) $\frac{1}{4}\times10^3\,N$ d) $\frac{1}{16}\times10^3\,N$

184. Two wires of the same length and same material but radii in the ratio of 1 : 2 are stretched by unequal forces to produce equal elongation. The ratio of the two forces is

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

185. One litre of a gas is maintained at pressure 72 cm of mercury. It is compressed isothermally so that its volume becomes $900\,c\,m^3$. The value of stress and strain will be respectively

a) $0.106\,N\,m^{-2}\wedge 0.1$ b) $1.106\,N\,m^{-2}\wedge 0.1$

c) $106.62\,N\,m^{-2}\wedge 0.1$ d) $10662.4\,N\,m^{-2}\wedge 0.1$

186. 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

187. A wire of length L and cross-section A is made of material of Young's modulus Y. It is stretched by an amount x, the work done is

a) $\frac{YxA}{2L}$ b) $\frac{Yx^2A}{L}$ c) $\frac{Yx^2A}{2L}$ d) $\frac{2Yx^2A}{L}$

188. 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

189. 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) $4Y$

190. The ratio of diameters of two wires of same materials is n: 1. The length of each wire is 4 m. On applying the same load, the increase in length of thin wire will be $(n>1)$

a) $n^2\times$¿ b) $n\times$¿ c) $2n\times$¿ d) $(2n+1)\times$¿

191. The coefficient of linear expansion of brass and steel are α_1 and α_2. If we take a brass rod of length l_1 and steel rod of length l_2 at 0 ℃, their difference in length (l_2-l_1) will remain the same at a temperature if

a) $\alpha_1 l_2=\alpha_2 l_1$ b) $\alpha_1 l_2^2=\alpha_2 l_1^2$ c) $\alpha_1^2 l_1=\alpha_2^2 l_2$ d) $\alpha_1 l_1=\alpha_2 l_2$

192. 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

193. A wire is stretched 1 mm by a force of 1 k N. How far would a wire of the same material and length but of four times that diameter be stretched by the same force ?

a) $\frac{1}{2}mm$ b) $\frac{1}{4}mm$ c) $\frac{1}{8}mm$ d) $\frac{1}{16}mm$

194. Two exactly similar wires of steel and copper are stretched by equal forces. If the difference in their elongations is $0.5\,cm$, the elongation (l) of each wire is

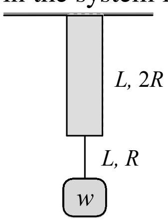
$Y_s(steel)=2.0\times10^{11}\ N/m^2$

$Y_c(copper)=1.2\times10^{11}\ N/m^2$

a) $l_s=0.75\,cm, l_c=1.25\,cm$ b) $l_s=1.25\,cm, l_c=0.75\,cm$

c) $l_s=0.25\,cm, l_c=0.75\,cm$ d) $l_s=0.75\,cm, l_c=0.25\,cm$

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

196. Two wires are made of the same material and have the same volume. However, wire 1 has cross-sectional area A and wire 2 has cross-sectional area $3A$. If the length of wire 1 increases by Δx on applying force F, how much

force is needed to stretch wire 2 by the same amount?

a) F b) $4F$ c) $6F$ d) $9F$

197. A spring is extended by 30 mm when a force of 1.5 N is applied to it. Calculate the energy stored in the spring when hanging vertically supporting a mass of 0.20 kg if the spring was instructed before applying the mass.

a) 0.01 J b) 0.02 J c) 0.04 J d) 0.08 J

198. 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) $5 \times 10^8 N/m^2$

199. On increasing the length by 0.5 mm in a steel wire of length 2 m and area of cross-section 2 mm^2, the force required is $[Y \text{ for steel} = 2.2 \times 10^{11} N m^{-2}]$

a) $1.1 \times 10^5 N$ b) $1.1 \times 10^4 N$ c) $1.1 \times 10^3 N$ d) $1.1 \times 10^2 N$

200. Which one of the following statements is correct? In the case of

a) Shearing stress there is change in volume

b) Tensile stress there is no change in volume

c) Shearing stress there is no change in shape

d) Hydraulic stress there is no change in volume

201. According to Hooke's law force is proportional to

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

202. An area of cross-section of rubber string is $2 cm^2$. Its length is doubled when stretched with a linear force of $2 \times 10^5 dynes$. The Young's modulus of the rubber in $dyne/cm^2$ will be

a) 4×10^5 b) 1×10^5 c) 2×10^5 d) 1×10^4

203. If the Young's modulus of the material is 3 times its modulus of rigidity, then its volume elasticity will be

a) Zero b) Infinity c) $2 \times 10^{10} N m^{-2}$ d) $3 \times 10^{10} N m^{-2}$

204. 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) $Y \alpha AL \Delta t$

205. A steel wire is of length 1m, area of cross-section 2 mm^2 $(Y = 2 \times 10^{11} N m^{-2})$. How much energy is required for increasing its length by 2 mm.

a) 0.08 J b) 0.8 J c) 80 J d) 800 J

206. A 0.1 kg mass is suspended from a wire of negligible mass. The length of the wire is 1 m and its cross-sectional area is $4.9 \times 10^{-7} m^2$. If the mass is pulled a little in the vertically downward direction and released, it performs simple harmonic motion of angular frequency $140 rad s^{-1}$. If the Young's modulus of the material of the wire is $n \times 10^9 Nm^{-2}$, the value of n is

a) 4 b) 2 c) 4.5 d) 5

207. 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) $\left[\frac{m_1+(m_2/2)}{A}\right] g$

208. A wire suspended vertically from one of its ends is stretched by attaching a weight of 200 N to the lower end. The

weight stretches the wire by 1 mm. Then the elastic energy stored in the wire is

a) 0.2 J b) 10 J c) 20 J d) 0.1 J

209. A ball falling in a lake of depth 200 m shows a decrease of 0.1% in its volume at the bottom. The bulk modulus of elasticity of the material of the ball is (Take g=$10\,m\,s^{-2}$¿

a) $10^9\,N\,m^{-2}$ b) $2\times10^9\,N\,m^{-2}$ c) $3\times10^9\,N\,m^{-2}$ d) $4\times10^9\,N\,m^{-2}$

210. In steel, the Young's modulus and the strain at the breaking point are $2\times10^6\,N\,m^{-2}$ ¿0.15 respectively. The stress at the break point for steel is

a) $1.33\times10^{11}\,N\,m^{-2}$ b) $1.33\times10^{12}\,N\,m^{-2}$ c) $2\times10^{10}\,N\,m^{-2}$ d) $3\times10^{10}\,N\,m^{-2}$

211. Two wires of same diameter of the same material having the length l and $2l$. If the force F is applied on each, the ratio of the work done in the two wires will be

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

212. When a weight of $10\,kg$ is suspended from a copper wire of length $3\,metres$ and diameter $0.4\,mm$, its length increases by $2.4\,cm$. If the diameter of the wire is doubled, then the extension in its length will be

a) $9.6\,cm$ b) $4.8\,cm$ c) $1.2\,cm$ d) $0.6\,cm$

213. 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

214. A tensile force of $2\times10^3\,N$ doubles the length of a rubber band of cross-sectional area $2\times10^{-4}\,m^2$. The Young's modulus of elasticity of the rubber band is

a) $4\times10^7\,N\,m^{-2}$ b) $2\times10^2\,N\,m^{-2}$ c) $10^7\,N\,m^{-2}$ d) $0.5\times10^7\,N\,m^{-2}$

215. Which of the following rods of same material undergoes maximum elongation when subjected to a given force?

a) L= 1m, d = 2 mm b) L= 1m, d = 1 mm c) L= 2m, d = 1 mm d) L= 2m, d = 2 mm

216. 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

217. If S is stress and Y is Young's modulus of material of a wire, the energy stored in the wire per unit volume is

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

218. 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) $4000\,N$

219. 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) $E_\theta=\gamma^2 E_\phi$

220. The length of a rubber cord is l_1 metre when the tension is 4 N and l_2 metre when the tension is 6N. The length when the tension is 9 N, is

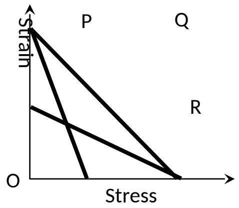
a) $(2.5\,l$¿¿$2-1.5\,l_1)\,m$¿ b) $(6\,l$¿¿$2-1.5\,l_1)\,m$¿ c) $(3\,l$¿¿$2-2\,l_1)\,m$¿ d) $(3.5\,l$¿¿$1-2.5\,l_1)\,m$¿

221. On all the six surfaces of a unit cube, equal tensile force of F is applied. The increase in length of each side will be ¿ Young's modulus, $\sigma=$¿ Poisson's ratio)

a) $\frac{F}{Y(1-\sigma)}$ b) $\frac{F}{Y(1+\sigma)}$ c) $\frac{F(1-2\sigma)}{Y}$ d) $\frac{F}{Y(1+2\sigma)}$

222. 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

223. The Young's modulus of a rubber string $8\,cm$ long and density $1.5\,kg/m^3$ is $5\times10^8\,N/m^2$, is suspended on the ceiling in a room. The increase in length due to its own weight will be

a) $9.6\times10^{-5}\,m$ b) $9.6\times10^{-11}\,m$ c) $9.6\times10^{-3}\,m$ d) $9.6\,m$

224. Two wires of the same material and length are stretched by the same force. Their masses are in the ratio 3:2. Their elongations are in the ratio

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

225. 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

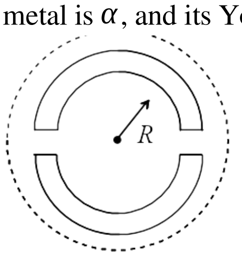
226. If the compressibility of water is σ per unit atmospheric pressure, then the decrease in volume (V) due to atmospheric pressure p will be

a) $\sigma\,p/V$ b) $\sigma\,pV$ c) σ/pV d) $\sigma\,V/p$

227. The isothermal elasticity of a gas is equal to

a) Density b) Volume c) Pressure d) Specific heat

228. 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) $2\,SY\alpha\,\Delta T$

229. 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 $2r$ all other things remaining same, the extension will become

a) $4\,mm$ b) $16\,mm$ c) $1\,mm$ d) $0.25\,mm$

230. A body of mass $m=10$ kg is attached to a wire of length 0.3 m. The maximum angular velocity with which it can be rotated in a horizontal circle is (Breaking stress of wire $=4.8\times10^7\,N\,m^{-2}$and area of cross-section of a wire = $10^{-2}\,m^2$¿

a) $4\,rad\,s^{-1}$ b) $8\,rad\,s^{-1}$ c) $1\,rad\,s^{-1}$ d) $2\,rad\,s^{-1}$

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

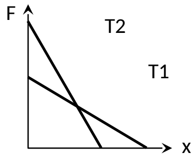
a) Young's modulus | b) Coefficient of volume elasticity

c) Modulus of rigidity | d) Poisson's ratio

232. If the volume of a block of aluminium is decreased by 1%, the pressure (stress) on its surface is increased by (Bulk modulus of $A1 = 7.5 \times 10^{10}\, Nm^{-2}$¿

a) $7.5 \times 10^{10}\, Nm^{-2}$ b) $7.5 \times 10^{8}\, Nm^{-2}$ c) $7.5 \times 10^{6}\, Nm^{-2}$ d) $7.5 \times 10^{4}\, Nm^{-2}$

233. The diagram shows the change x in the length of a thin uniform wire caused by the application of stress F at two different temperatures T_1 and T_2. The variation shown suggest that



a) $T_1 > T_2$ b) $T_1 < T_2$ c) $T_1 = T_2$ d) None of these

234. 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) $4 \times 10^{5}\, cm^3$ d) $0.04\, cm^3$

235. Which of the following substance has the highest elasticity?

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

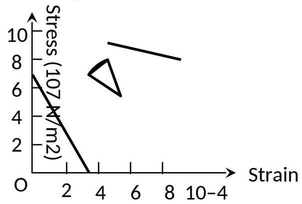
236. The mass and length of a wire are M and L respectively. The density of the material of the wire is d. On applying the force F on the wire, the increase in length is l, then the Young's modulus of the material of the wire will be

a) $\frac{Fdl}{Ml}$ b) $\frac{FL}{Mdl}$ c) $\frac{FMl}{dl}$ d) $\frac{FdL^2}{Ml}$

237. 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

238. Which one of the following is the Young's modules (in N/m^2¿ for the wire having the stress-strain curve shown in the figure



a) 24×10^{11} b) 8.0×10^{11} c) 10×10^{11} d) 2.0×10^{11}

239. A steel wire is stretched with a definite load. If the Young's modulus of the wire is Y. For decreasing the value of Y

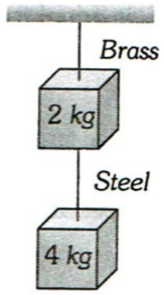
a) Radius is to be decreased | b) Radius is to be increased

c) Length is to be increased | d) None of the above

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

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

241. If the ratio of lengths, radii and Young's modulus of steel and brass wires shown in the figure are a, b and c, respectively. The ratio between the increase in lengths of brass and steel wires would be



a) $\frac{b^2 a}{2c}$ b) $\frac{bc}{2a^2}$ c) $\frac{ba^2}{2c}$ d) $\frac{a}{2b^2 c}$

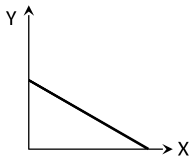
242. A metallic rod of length l and cross-sectional area A is made of a material of Young modulus Y. If the rod is elongated by an amount y, then the work done is proportional to

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

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

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

244. A student plots a graph from his reading on the determination of Young's modulus of a metal wire but forgets to label. The quantities on X and Y axes may be respectively



a) Weight hung and length increased b) Stress applied and length increased

c) Stress applied and strain developed d) Length increased and weight hung

245. A spherical ball contract in volume by 0.01% when subjected to normal uniform pressure of 100 atmosphere. What is the bulk modulus of elasticity of the material of the ball ? (Take 1 atmosphere = $10^6 \, dyne \, cm^{-3}$ ¿

a) $10^9 \, dyne \, cm^{-2}$ b) $10^{10} \, dyne \, cm^{-2}$ c) $10^{12} \, dyne \, cm^{-2}$ d) $10^{14} \, dyne \, cm^{-2}$

246. 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) $\frac{1}{2} F x^2$ d) None of these

247. There is no change in the volume of a wire due to change in its length on stretching. The Poisson's ratio of the material of wire is

a) +0.50 b) -0.50 c) +0.25 d) -0.25

248. A rectangular bar 2 cm in breadth and 1 cm in depth and 100 cm in length is supported at its ends and a load of 2 kg is applied at its middle. If Young's modulus of the material of the bar is $20 \times 10^{11} \, dyne \, cm^{-2}$, the depression in the bar is

a) 0.2450 cm b) 0.3675 c) 0.1225 cm d) 0.9800 cm

249. A substance breaks down by a stress of $10^6 \, N m^{-2}$. If the density of the material of the wire is $3 \times 10^3 \, kg \, m^{-3}$, 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

250. A wire is loaded by 6 kg at its one end, the increase in length is $12 \, mm$. If the radius of the wire is doubled and all other magnitudes are unchanged, then increase in length will be

a) $6 \, mm$ b) $3 \, mm$ c) $24 \, mm$ d) $48 \, mm$

251. Bulk modulus was first defined by

a) Young b) Bulk c) Maxwell d) None of the above

252. Modulus of rigidity of a liquid

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

253. The work done in stretching an elastic wire per unit volume is or strain energy in a stretched string is

a) Stress × Strain b) $1/2 \times$ Stress × Strain c) 2 × Strain × Stress d) Stress/Strain

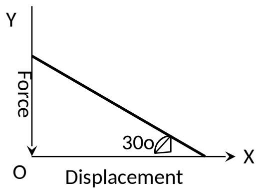
254. The bulk modulus of an ideal gas at constant temperature

a) Is equal to its volume V b) Is equal to $p/2$
c) Is equal to its pressure p d) Can not be determined

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

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

256. The value of force constant between the applied elastic force F and displacement will be



a) $\sqrt{3}$ b) $\frac{1}{\sqrt{3}}$ c) $\frac{1}{2}$ d) $\frac{\sqrt{3}}{2}$

257. A wire fixed at the upper end stretches by length by applying a force F. The work done in stretching is

a) $\frac{F}{2\Delta l}$ b) $F\Delta l$ c) $2F\Delta l$ d) $\frac{F\Delta l}{2}$

258. 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

259. A copper rod of length L and radius r is suspended from the ceiling by one of its ends. What will be elongation of the rod due to its own weight when $\rho \wedge Y$ are the density and Young's modulus of the copper respectively?

a) $\frac{\rho^2 g L^2}{2Y}$ b) $\frac{\rho g L^2}{2Y}$ c) $\frac{\rho^2 g^2 L^2}{2Y}$ d) $\frac{\rho g L}{2Y}$

260. If work done in stretching a wire by 1 mm is 2 J, the work necessary for stretching another wire of same material, but wire double the radius and half length 1 mm joule is

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

261. 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

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

a) $\frac{1}{4}J$ b) $4\,J$ c) 8 J d) 16 J

263. Under elastic limit the stress is

a) Inversely, proportional to strain b) Directly proportional to strain

c) Square root of strain | d) Independent of strain

264. 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) $\frac{l_1 T_2+l_2 T_1}{T_2+T_1}$

265. A wire of natural length l, Young's modulus Y and area of cross-section A is extended by x. Then the energy stored in the wire is given by

a) $\frac{1}{2}\frac{YA}{l}x^2$ b) $\frac{1}{3}\frac{YA}{l}x^2$ c) $\frac{1}{2}\frac{Yl}{A}x^2$ d) $\frac{1}{2}\frac{YA}{l^2}x^2$

266. A rubber rope of length 8 m is hung from the ceiling of a room. What is the increase in length of the rope due to its own weight ? (Given Young's modulus of elasticity of rubber = $5\times10^6\,N\,m^{-2}$ and density of rubber = $1.5\times10^6\,kg\,m^{-3}$.

Take g = 10 $m\,s^{-2}$¿

a) 1.5 mm b) 6 mm c) 24 mm d) 96 mm

267. 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

268. In the above graph, point B indicates

a) Breaking point b) Limiting point c) Yield point d) None of the above

269. Which of the following relation is true?

a) $Y=2\eta(1-2\sigma)$ b) $Y=2\eta(1+2\sigma)$ c) $Y=2\eta(1-\sigma)$ d) $(1+\sigma)2\eta=Y$

270. 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 ¿$0.9\times10^{11}\,N/m^2$)

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

271. A stress of 1 kg mm^2 is applied on a wire. If the modulus of elasticity of the wire is $10^{10}\,dyne\,cm^{-2}$, then the percentage increase in the length of the wire will be

a) 0.0098% b) 0.98% c) 9.8% d) 98%

272. The dimensions of four wires of the same material are given below. In which wire the increase in length will be maximum ?

a) Length 100 cm, Diameter 1 mm | b) Length 200 cm, Diameter 2 mm

c) Length 300 cm, Diameter 3 mm | d) Length 50 cm, Diameter 0.5 mm

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

a) Energy density ¿$1/2\times$ strain × stress | b) Energy density = $(strain)^2\times volume$

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

274. There is no change in the volume of a wire due to the change in its length on stretching. The Poisson's ratio of the material of the wire is

a) $\frac{+1}{2}$ b) $\frac{-1}{2}$ c) $\frac{+1}{4}$ d) $\frac{-1}{4}$

275. A cube is subjected to a uniform volume compression. It the side of the cube decreases by 2%, the bulk strain is

a) 0.02 b) 0.03 c) 0.04 d) 0.06

276. Which statement is true for a metal

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

277. If $E_\theta \wedge E_\phi$ denote the isothermal and adiabatic elasticities respectively of a gas, then $\frac{E_\theta}{E_\phi}$

a) ¿1 b) ¿1 c) = 1 d) = 3.2

278. Which of the following affects the elasticity of a substance

a) Hammering and annealing
b) Change in temperature
c) Impurity in substance
d) All of these

279. 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

280. When a 4 kg mass is hung vertically on a light spring that obeys Hook's law, the spring stretches by 2 cm. The work required to be done by an external agent in stretching this spring by 5 cm will be

a) 4.9 J b) 2.45 J c) 0.495 J d) 0.245 J

281. A work of 2×10^{-2}J is done on a wire of length 50 cm and area of cross-section $0.5 mm^2$. If the Young's modulus of the material of the wire is $2\times10^{10}\,Nm^{-2}$, then the wire must be

a) Elongated to 50.1414 cm
b) Contracted by 2.0 mm
c) Stretched by 0.707 mm
d) Of length changed to 49.293 cm

282. 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

283. Two identical wires are suspended from the same rigid support but one is of copper and the other is of iron. Young's modulus of iron is thrice that of copper. The weights to be added on copper and iron wires so that the ends are on the same level must be in the ratio of

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

284. One end of 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 (3L/4) from its lower end is

a) $\frac{w_1}{s}$ b) $\left[w_1+\frac{w}{4}\right]s$ c) $\left[w_1+\frac{3w}{4}\right]/s$ d) $\frac{w_1+w}{s}$

285. 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) $\sigma=\frac{0.5Y-\eta}{\eta}$

286. An iron rod of length $2\,m$ and cross section area of $50\,mm^2$, stretched by $0.5\,mm$, when a mass of $250\,kg$ is hung from its lower end. Young's modulus of the iron rod is

a) $19.6\times10^{10}\,N/m^2$ b) $19.6\times10^{15}\,N/m^2$ c) $19.6\times10^{18}\,N/m^2$ d) $19.6\times10^{20}\,N/m^2$

287. The following data were obtained when a wire was stretched within the elastic region Force applied to wire 100 N

Area of cross-section of wire $10^{-6}\,m^2$

Extensional of wire $2\times10^{-9}\,m$

Which of the following deductions can be correctly made from this data?

I. The value of Young's Modulus is $10^{11}\,N\,m^{-2}$

II. The strain is 10^{-3}

III. The energy stored in the wire when the load is applied is 10 J

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

288. 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) $y x^2$ b) $2 y x^2$ c) $\frac{1}{2} y^2 x$ d) $\frac{1}{2} y x^2$

289. A force F is required to break a wire of length l and radius r. What force is required to break a wire, of the same material, having twice the length and six times the radius ?

a) F b) $3F$ c) $9F$ d) $36F$

290. The Young's modulus of the material of a wire is $2 \times 10^{10}\,Nm^{-2}$. If the elongation strain is 1%, then the energy stored in the wire per unit volume in Jm^{-3} is

a) 10^6 b) 10^8 c) 2×10^6 d) 2×10^8

291. 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

292. The only elastic modulus that applies to fluids is

a) Young's modulus b) Shear modulus c) Modulus of rigidity d) Bulk modulus

293. 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

294. 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) $12\,mm^2$

295. A wire of length L and radius a rigidly fixed at one end. On stretching the other end of the wire with a force F, the increase in its length is l. If another wire of same material but of length $2L$ and radius $2a$ is stretched with a force $2F$, the increase in its length will be

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

296. The work per unit volume to stretch the length by 1% of a wire with cross sectional area of $1\,mm^2$ will be $[Y = 9 \times 10^{11}\,N/m^2]$

a) $9 \times 10^{11}\,J$ b) $4.5 \times 10^7\,J$ c) $9 \times 10^7\,J$ d) $4.5 \times 10^{11}\,J$

297. 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

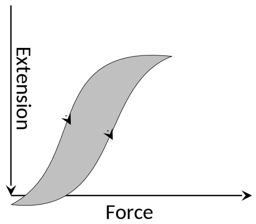
298. The diagram shows a force-extension graph for a rubber band. Consider the following statements

I. It will be easier to compress this rubber than expand it

II. Rubber does not return to its original length after it is stretched

III. The rubber band will get heated if it is stretched and released

Which of these can be deduced from the graph



a) III only b) II and III c) I and III d) I only

299. The extension in a string obeying Hooke's law is x. The speed of sound in the stretched string is v. If the extension in the string is increased to $1.5\,x$, the speed of sound will be

a) $1.22\,v$ b) $0.61\,v$ c) $1.50\,v$ d) $0.75\,v$

300. A wire $(Y = 2 \times 10^{11}\,N\,m^{-2})$ 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

301. The work done in increasing the length of a one metre long wire of cross-sectional area $1\,mm^2$ through 1 mm will be $(Y = 2 \times 10^{11}\,N\,m^{-2})$

a) 0.1 J b) 5 J c) 10 J d) 250 J

302. The pressure applied from all directions on a cube is P. How much its temperature should be raised to maintain the original volume? The volume elasticity of the cube is β and the coefficient of volume expansion is α

a) $\frac{P}{\alpha\beta}$ b) $\frac{P\alpha}{\beta}$ c) $\frac{P\beta}{\alpha}$ d) $\frac{\alpha\beta}{P}$

303. 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) $l^2 \times L$

304. A wire fixed at the upper end stretches by length l by applying a force F. The work done in stretching is

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

305. The Young's modulus of the material of a wire is equal to the

a) Stress required to increase its length four times
b) Stress required to produce unit strain
c) Strain produced in it
d) Half the strain produced in it

306. 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) $\frac{K\rho}{p}$

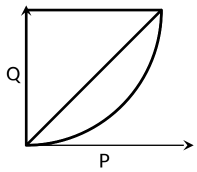
307. A rod of length l and radius r is joined to a rod of length $\frac{l}{2}$ and radius $r/2$ of same material. The free end of small rod is fixed to a rigid base and the free end of larger rod is given a twist of θ^0, the twist angle at the joint will be

a) $\frac{\theta}{4}$ b) $\frac{\theta}{2}$ c) $\frac{5\theta}{6}$ d) $\frac{8\theta}{9}$

308. If the shear modulus of a wire material is $5.9 \times 10^{11}\,dyne\,cm^{-2}$ then the potential energy of a wire of $4 \times 10^3\,cm$ in diameter and 5 cm long twisted through an angle of 10' , is

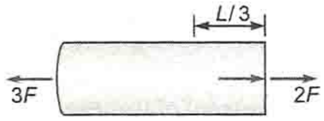
a) $1.253 \times 10^{-12}\,J$ b) $2.00 \times 10^{-12}\,J$ c) $1.00 \times 10^{-12}\,J$ d) $0.8 \times 10^{-12}\,J$

309. 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

310. A uniform slender rod of length L, cross-sectional area A and Young's modulus Y is acted upon by the forces shown in the figure. The elongation of the rod is

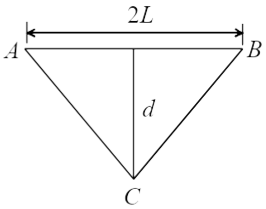


a) $\frac{3FL}{5AY}$
b) $\frac{2FL}{5AY}$
c) $\frac{3FL}{8AY}$
d) $\frac{8FL}{3AY}$

311. A cube of aluminium of sides 0.1 m is subjected to a sharing force of 100 N. The top face of the cube is displaced through 0.02 cm with respect to the bottom face. The shearing strain would be
a) 0.02
b) 0.1
c) 0.005
d) 0.002

312. 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) $\frac{Er}{AR}$

313. A wire of length $2L$ and radius r is stretched between A and B without the application of any tension. If Y is the Young's modulus of the wire and it is stretched like ACB, then the tension in the wire will be



a) $\frac{\pi r^2 Y d^3}{2L^2}$
b) $\frac{\pi r^2 Y d^2}{2L^2}$
c) $\frac{\pi r^2 Y .2L^2}{d^2}$
d) $\frac{\pi r^2 Y .2L}{d}$

314. The work done in deforming body is given by
a) $stress \times strain$
b) $\frac{1}{2}(stress \times strain)$
c) $stress/srain$
d) Strain/stress

315. 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

316. A copper wire of length $4.0\,m$ and area of cross-section $1.2\,cm^2$ is stretched with a force of $4.8\times 10^3 N$. If Young's modulus for copper is $1.2\times 10^{11} N/m^2$, the increase in the length of the wire will be
a) $1.33\,mm$
b) $1.33\,cm$
c) $2.66\,mm$
d) $2.66\,cm$

317. The relation between γ, η and K for a elastic material is
a) $\frac{1}{\eta}=\frac{1}{3\gamma}+\frac{1}{9K}$
b) $\frac{1}{K}=\frac{1}{3\gamma}+\frac{1}{9\eta}$
c) $\frac{1}{\gamma}=\frac{1}{3K}+\frac{1}{9\eta}$
d) $\frac{1}{\gamma}=\frac{1}{3\eta}+\frac{1}{9K}$

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

a) 0.61 b) 1.7 c) 6.1 d) 17×10^{3}

319. A 1 m long wire is stretched without tension at $30\,℃$ between two rigid supports. What strain will be produced in the wire if the temperature falls to $0\,℃$?
(Given : $\alpha = 12 \times 10^{-6} K^{-1}$¿
a) 36×10^{-5} b) 64×10^{-5} c) 0.78 d) 0.32

320. Two wires of equal cross-section but one made of steel and the other of copper are joined end to end. When the combination is kept under tension, the elongations in the two wires are found to be equal. What is the ratio of the lengths of the two wires? (Given : steel = $2 \times 10^{11} N m^{-2}$¿
a) 2 : 11 b) 11 : 2 c) 20 : 11 d) 11 : 20

321. 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

322. A metal rod of Young's modulus $2 \times 10^{10} N m^{-2}$ undergoes an elastic strain of 0.06%. The energy per unit volume stored in J m^{-3} *is*
a) 3600 b) 7200 c) 10800 d) 14400

323. A copper wire of negligible mass, 1 m length and cross-sectional area 10^{-6} is kept on a smooth horizontal table with one end fixed. A ball of mass 1 kg is attached to the other end. The wire and the ball are rotated with an angular velocity 20 rad s^{-1}. If the elongation in the wire is $10^{-3} m$, then the Young's modulus is
a) $4 \times 10^{11} N m^{-2}$ b) $6 \times 10^{11} N m^{-2}$ c) $8 \times 10^{11} N m^{-2}$ d) $10 \times 10^{11} N m^{-2}$

324. 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) $2.33 \times 10^{10} N/m^{2}$

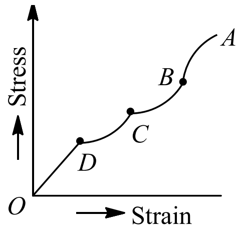
325. Two wires A and B of same length, same area of cross-section having the same Young's modulus are heated to the same range of temperature. If the coefficient of linear expansion of A is $3/2$ times of that of wire B. The ratio of the forces produced in two wires will be
a) 2/3 b) 9/4 c) 4/9 d) 3/2

326. Four wires of the same material are stretched by the same load. Which one of them will elongate most if their dimensions are as follows
a) $L = 100$ cm, $r = 1$mm b) $L = 200$ cm, $r = 3$mm
c) $L = 300$ cm, $r = 3$mm d) $L = 400$ cm, $r = 4$mm

327. Which is correct relation
a) $Y < \sigma$ b) $Y > \sigma$ c) $Y = \sigma$ d) $\sigma = +1$

328. A wire of length L and radius r is clamped rigidly at one end. When the other end of the wire is pulled by a force F its length increases by l. Another wire of the same material of length 4 L, radius $4r$ is pulled by a force $4F$. The increase in length will be
a) $\frac{l}{2}$ b) l c) $2l$ d) $4l$

329. The figure shows the stress-strain graph of a certain substance. Over which region of the graph is Hook's Law obeyed ?



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

330. 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) $2 \times 10^{6}\ N$

331. If a rubber ball is taken at the depth of $200\ m$ in a pool, its volume decreases by 0.1%. If the density of the water is $1 \times 10^3\ kg/m^3$ and $g = 10\ m/s^2$, then the volume elasticity in N/m^2 will be

a) 10^8 b) 2×10^8 c) 10^9 d) 2×10^9

332. If Young's modulus of elasticity Y for a material is one and half times its rigidity coefficient η, the Poisson's ratio σ will be

a) $\frac{+2}{3}$ b) $\frac{-1}{4}$ c) $\frac{+1}{4}$ d) $\frac{-2}{3}$

333. One end of steel wire is fixed to ceiling of an elevator moving up with an acceleration $2\ m s^{-2}$ 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 = $10\ m s^{-2} \wedge Y = 2 \times 10^{11}\ N m^{-2}$ ¿

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

334. A wire of length $2\ m$ is made from $10\ cm^3$ of copper. A force F is applied so that its length increases by $2\ mm$. Another wire of length $8\ m$ is made from the same volume of copper. If the force F is applied to it, its length will increase by

a) $0.8\ cm$ b) $1.6\ cm$ c) $2.4\ cm$ d) $3.2\ cm$

335. Steel and copper wires of same length are stretched by the same weight one after the other. Young's modulus of steel and copper are $2 \times 10^{11}\ N/m^2$ and $1.2 \times 10^{11}\ N/m^2$. The ratio of increase in length

a) $\frac{2}{5}$ b) $\frac{3}{5}$ c) $\frac{5}{4}$ d) $\frac{5}{2}$

336. 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) $4a-5b$

337. Longitudinal stress of $1\ N/mm^2$ is applied on a wire. The percentage increase in length is $(Y = 10^{11}\ N/m^2)$

a) 0.002 b) 0.001 c) 0.003 d) 0.01

338. If the length of a wire is reduced to half, then it can hold the ………. load

a) Half b) Same c) Double d) One fourth

339. 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) $\frac{Mg}{2AK}$

340. The modulus of elasticity is dimensionally equivalent to

a) Surface tension b) Stress c) Strain d) None of these

: ANSWER KEY :

1)	a	2)	b	3)	a	4)	a	169)	c	170)	d	171)	c	172)	a
5)	d	6)	a	7)	b	8)	d	173)	b	174)	c	175)	c	176)	a
9)	d	10)	b	11)	c	12)	a	177)	c	178)	a	179)	d	180)	b
13)	d	14)	b	15)	c	16)	b	181)	c	182)	a	183)	b	184)	d
17)	b	18)	a	19)	c	20)	b	185)	d	186)	d	187)	c	188)	b
21)	a	22)	a	23)	a	24)	c	189)	b	190)	a	191)	d	192)	a
25)	a	26)	c	27)	c	28)	d	193)	d	194)	a	195)	c	196)	d
29)	b	30)	a	31)	b	32)	b	197)	c	198)	b	199)	d	200)	b
33)	d	34)	d	35)	c	36)	b	201)	c	202)	b	203)	b	204)	b
37)	d	38)	c	39)	b	40)	d	205)	b	206)	a	207)	c	208)	d
41)	b	42)	a	43)	d	44)	c	209)	b	210)	d	211)	a	212)	d
45)	a	46)	a	47)	d	48)	a	213)	b	214)	c	215)	c	216)	c
49)	d	50)	c	51)	a	52)	c	217)	b	218)	d	219)	b	220)	a
53)	b	54)	c	55)	b	56)	b	221)	c	222)	d	223)	b	224)	c
57)	a	58)	b	59)	a	60)	b	225)	c	226)	b	227)	c	228)	d
61)	b	62)	a	63)	a	64)	a	229)	c	230)	a	231)	b	232)	b
65)	d	66)	a	67)	b	68)	b	233)	a	234)	a	235)	a	236)	d
69)	c	70)	a	71)	a	72)	a	237)	b	238)	d	239)	d	240)	a
73)	a	74)	a	75)	c	76)	c	241)	d	242)	c	243)	a	244)	c
77)	b	78)	a	79)	d	80)	b	245)	c	246)	a	247)	a	248)	c
81)	b	82)	a	83)	d	84)	b	249)	b	250)	b	251)	c	252)	c
85)	c	86)	b	87)	c	88)	c	253)	b	254)	c	255)	b	256)	b
89)	c	90)	d	91)	c	92)	b	257)	d	258)	a	259)	d	260)	d
93)	b	94)	b	95)	d	96)	c	261)	c	262)	d	263)	b	264)	c
97)	d	98)	b	99)	a	100)	b	265)	a	266)	d	267)	d	268)	c
101)	d	102)	b	103)	d	104)	b	269)	d	270)	c	271)	b	272)	d
105)	b	106)	c	107)	b	108)	c	273)	a	274)	b	275)	d	276)	c
109)	c	110)	a	111)	d	112)	a	277)	a	278)	d	279)	d	280)	b
113)	b	114)	a	115)	d	116)	d	281)	c	282)	d	283)	a	284)	c
117)	b	118)	c	119)	a	120)	b	285)	d	286)	a	287)	b	288)	d
121)	c	122)	d	123)	a	124)	c	289)	d	290)	a	291)	b	292)	d
125)	c	126)	d	127)	b	128)	c	293)	b	294)	b	295)	b	296)	b
129)	a	130)	b	131)	b	132)	c	297)	d	298)	a	299)	a	300)	a
133)	d	134)	c	135)	c	136)	a	301)	a	302)	a	303)	b	304)	d
137)	a	138)	c	139)	a	140)	b	305)	b	306)	c	307)	d	308)	a
141)	b	142)	d	143)	d	144)	c	309)	c	310)	d	311)	d	312)	b
145)	c	146)	d	147)	d	148)	d	313)	b	314)	b	315)	c	316)	a
149)	d	150)	b	151)	a	152)	a	317)	d	318)	a	319)	a	320)	c
153)	b	154)	c	155)	c	156)	b	321)	c	322)	a	323)	a	324)	d
157)	d	158)	c	159)	c	160)	c	325)	d	326)	a	327)	b	328)	b
161)	c	162)	d	163)	b	164)	c	329)	d	330)	d	331)	d	332)	b
165)	c	166)	d	167)	a	168)	b	333)	b	334)	d	335)	b	336)	c

337) b	**338) b**	**339) b**	**340) b**

: HINTS AND SOLUTIONS :

1 **(a)**

$Y=3K(1-2\sigma), Y=2\eta(1+\sigma)$

For $Y=0$, we get $1-2\sigma=0$, also $1+\sigma=0$

$\Rightarrow \sigma$ lies between $\frac{1}{2}$ and -1

2 **(b)**

$W=\frac{1}{2}\times F\times l=\frac{1}{2}mgl=\frac{1}{2}\times 10\times 10\times 1\times 10^{-3}=0.($

4 **(a)**

Elastic potential energy per unit volume is given as

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

From definition of Young's modulus of wire

$Y=\frac{stress}{strain}$

$\Rightarrow \quad stress=Y\times strain$

Given, $\quad strain=X$

Therefore, $U=\frac{1}{2}\times Y X^2$

$\Rightarrow \quad U=0.5\,Y X^2$

5 **(d)**

Increase in length due to rise in temperature

$\Delta L=aL\Delta T$

As

$Y=\frac{FL}{A\Delta L}, so, F=\frac{YA\Delta l}{L}=\frac{YA\times aL\Delta T}{L}=YAa\Delta T$

$\therefore F=2\times 10^{11}\times 10^{-6}\times 1.1\times 10^{-5}\times 20=44$N.

6 **(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.

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

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

$Y_1=Y_2$

$\therefore \frac{F_1 L_1}{\pi r_1^2 l_1}=\frac{2F_1\times 2L_1}{\pi ¿¿}$

$l_2=l_1=l$

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

7 **(b)**

$Stress=\frac{force}{Area}\therefore Stress\propto\frac{1}{\pi r^2}$

$\frac{S_B}{S_A}=\left(\frac{r_A}{r_B}\right)^2=(2)^2\Rightarrow S_B=4S_A$

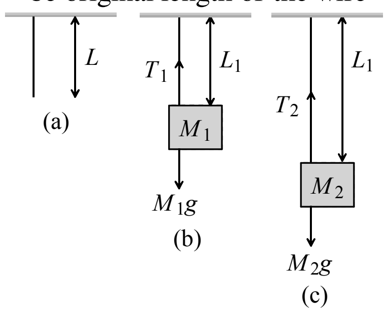
8 **(d)**

$A=10^{-6}m^2$

$Y=\frac{\left(\frac{T}{A}\right)}{\frac{\Delta l}{l}}=\frac{\left(\frac{100}{10^{-6}}\right)}{\left(\frac{0.1}{100}\right)}=\frac{100}{10^{-6}}\times\frac{100}{0.1}=\frac{10^4}{10^{-7}}=10^{11}N/m$

9 **(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)]

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

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

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

10 **(b)**

Adiabatic elasticity $E = \gamma P$

For argon $E_{Ar} = 1.6P$ ...(i)

For hydrogen $E_{H_2} = 1.4P'$ ...(ii)

As elasticity of hydrogen and argon are equal

$\therefore 1.6P = 1.4P' \Rightarrow P' = \frac{8}{7}P$

11 **(c)**

$l = \frac{FL}{AY} \Longrightarrow l \propto \frac{L}{r_2} \Longrightarrow \frac{l_1}{l_2} = \frac{L_1}{L_2} \times \frac{r_2^2}{r_1^2}$

or $\frac{l_1}{l_2} = \frac{1}{2}$

Therefore, strain produced in the two wires will be in the ratio 1:2.

12 **(a)**

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

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 $\Delta l_2 = 8 \Delta l_1 = 8 \times 1\, mm = 8\, mm$

14 **(b)**

$K = \frac{pV}{\Delta V} = \frac{pV}{\gamma \Delta T} = \frac{p}{3\alpha T} \vee T = \frac{p}{3K\alpha}$

15 **(c)**

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

16 **(b)**

Work done in stretching the wire

$W = \frac{1}{2} \times force\ constant \times x^2$

For first wire, $W_1 = \frac{1}{2} \times k x^2 = \frac{1}{2} k x^2$

For second wire, $W_2 = \frac{1}{2} \times 2k \times x^2 = k x^2$

Hence , $W_2 = 2W_1$

17 **(b)**

$B = \frac{\Delta P}{\Delta V / V} \Rightarrow \frac{1}{B} \propto \frac{\Delta V}{V}$ ¿ constant]

18 **(a)**

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

In the given problem, $r^4 \theta =$ ¿ constant

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

19 **(c)**

Young's modulus of wire depends only on the nature of the material of the wire

20 **(b)**

For most materials, the modulus of rigidity, G is one third of the Young's modulus, γ

$G = \frac{1}{3} \gamma$ or $\gamma = 3G$

$\therefore n = 3$

22 **(a)**

$L = 1\, m = 100\, cm$

$A = 1\, cm^2$

$Y = 10^{12}\, dyne\, cm^{-2}$

$l = 1 \times 10^{-1}\, cm$

Force, $F = \frac{AYl}{L} = \frac{1 \times 10^{12} \times 10^{-1}}{100}$

¿ $10^9\, dyne$

23 **(a)**

$strain = \frac{r}{l} \phi \frac{2 \times 10^{-3}}{1} \times 45° = 0.9$

24 **(c)**

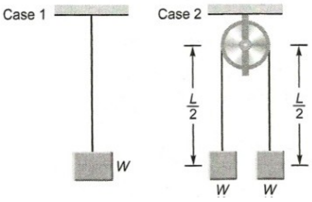
$B = \frac{P}{\Delta V / V}$

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

¿ $\frac{\rho g h}{B} = 1.36\%$

25 **(a)**

Let us consider the length of wire as L and cross-sectional area A, the material of wire has Young's modulus as Y.



Then for 1st case $Y = \frac{W/A}{l/L}$

For 2nd case, $Y = \frac{\frac{W}{A}}{\frac{2l'}{L}}$

$\therefore l' = \frac{l}{2}$

So, total elongation of both sides ¿ $2l' = l$

26 **(c)**
The density would increase by 0.1% if the volume decrease by 0.1%

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

$\Delta V = K\frac{\Delta V}{V} = 2\times10^9\times\frac{0.1}{100} = 2\times10^6\, N m^{-2}$

27 **(c)**

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

$\Rightarrow$ Lateral strain ¿ $0.5\times0.03 = 0.015$

28 **(d)**
Poisson's ratio varies between -1 and 0.5

29 **(b)**

Young's modulus Y ¿ $\frac{F}{A}\cdot\frac{L}{l}$

$\therefore$ Force F ¿ $\frac{AYl}{L} = \frac{AY[2\pi(R-r)]}{2\pi r}$

$\Rightarrow F = \frac{AY(R-r)}{r}$

30 **(a)**

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

Clearly , $\Delta L \propto L$

31 **(b)**

$r\theta = L\phi \Rightarrow 10^{-2}\times0.8 = 2\times\phi \Rightarrow \phi = 0.004$

32 **(b)**

Angle of shear $\phi = \frac{r}{l}\theta = \frac{0.4}{100}\times30 = 0.12°$

33 **(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

¿ $\frac{1}{2}K(l_2^2 - l_1^2)$

34 **(d)**
Elastic energy stored in the wire is

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

$= \frac{1}{2}\times\frac{F}{A}\times\frac{\Delta l}{l}\times Al$

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

$= \frac{1}{2}\times200\times1\times10^{-3} = 0.1\,J$

35 **(c)**

$Y = \frac{F}{\pi r^2}\times\frac{L}{\Delta L} = \frac{F\times2L}{x(r/2)^2\Delta L} \vee \frac{\Delta L}{\Delta L'} = \frac{1}{8}$

36 **(b)**

$k = \frac{10\,N}{40\times10^{-3}\,m} = \frac{1000}{4}\,N m^{-1} = 250\,N m^{-1}$

Spring constant of combination

$= \frac{250}{2}\,N m^{-1} = 125\,N m^{-1}$

Energy = $\frac{1}{2}\times125\times(40\times10^{-3})^2\,J = 0.1\,J$

37 **(d)**
Coefficient of elasticity in increasing order is given by Rubber<Glass<Copper<Steel.

38 **(c)**
The Bulk modulus is given by

$B = \frac{-pV}{\Delta V}$

If liquid is incompressible, so

$\Delta V = 0$

$Hence, B = \frac{-pV}{0} = \infty \Longrightarrow B = \infty(\infty)$

39 **(b)**
Because strain is a dimensionless and unitless quantity

40 **(d)**

$$F=\frac{YAl}{L}=\frac{2.2\times10^{11}\times2\times10^{-6}\times5\times10^{-4}}{2}=1.1\times1($$

41 **(b)**

$$E=\frac{1}{2}\frac{YA/\Delta l^2}{l}$$

But $m=Ald\vee A=\frac{m}{ld}$

$$\therefore E=\frac{Ym\Delta l^2}{2l^2d}$$

E in calorie = $\frac{Ym\Delta l^2}{2l^2d}$

Now, $mS\theta=\frac{Ym\Delta l^2}{2l^2dJ}\vee\theta=\frac{Y\Delta l^2}{2l^2dJS}$

Or $\theta=\frac{12\times10^{11}\times10^{-1}\times10^{-3}\times10^{-3}}{2\times2\times2\times9\times10^3\times4.2\times0.1\times10^3}$

$=\frac{12\times10^5}{72\times42\times10^5}=\frac{1}{252}\,°C$

42 **(a)**

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

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

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

43 **(d)**

$$Stress=\frac{Force}{area}$$

In the present case, force applied and area of cross-section of wires are same, therefore stress has to be the same

$$Strain=\frac{Stress}{Y}$$

Since the Young's modulus of steel wire is greater than the copper wire, therefore, strain in case of steel wire is less than that in case of copper wire

45 **(a)**

$$\eta=\frac{F}{A\theta}=\frac{5\times10^5}{100\times10^{-4}\times0.001}=5\times10^{10}\,Nm^{-2}$$

46 **(a)**

$$\frac{dV}{V}=(1+2\sigma)\frac{dL}{dL}$$

If $\sigma=\frac{-1}{2}$ then $\frac{dV}{V}=0\,i.e.K=\infty$

47 **(d)**

Poisson's ratio is 0.5 so there is no change in the volume.

48 **(a)**

$$Y=\frac{FL}{Al}=\frac{1000\times100}{10^{-6}\times0.1}=10^{12}\,N/m^2$$

49 **(d)**

$$K=\frac{p}{\frac{-\Delta V}{V}}\Rightarrow K=\frac{h\rho g}{0.1\times10^{-2}}$$

$$\Rightarrow h=\frac{K\times0.1\times10^{-2}}{\rho g}=\frac{9\times10^8\times10^3}{10^3\times10}=90\,m$$

50 **(c)**

Increase in length $l=\frac{FL}{AY}$

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

Percent increase in length

$$\Delta x=\frac{l}{L}\times100=\frac{F}{\pi r^2Y}$$

Here, same longitudinal force is applied.

So, $\frac{\Delta x_1}{\Delta x_2}=\left(\frac{r_2}{r_1}\right)^2\cdot\left(\frac{Y_2}{Y_1}\right)$

$$\frac{1}{\Delta x_2}=\left(\frac{1}{2}\right)^2\cdot\left(\frac{2}{1}\right)=\frac{1}{4}\times\frac{2}{1}$$

$$\frac{1}{\Delta x_2}=\frac{1}{2}$$

$$\Delta x_2=1\times2=2\%$$

51 **(a)**

$F=YA\alpha T\,;$

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

53 **(b)**

At point b, yielding of material starts

54 **(c)**

Restoring force is zero at mean position

$$F=-Kx+F_0\Rightarrow0=-Kx+F_0\Rightarrow x=\frac{F_0}{K}$$

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

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

55 **(b)**

Strain ∝ Stress ∝ $\frac{F}{A}$

Ratio of strain $¿\frac{A_2}{A_1}=\left(\frac{r_2}{r_1}\right)^2=\left(\frac{4}{1}\right)^2=\frac{16}{1}$

56 **(b)**

$\frac{1}{K}=\frac{\Delta V/V}{\Delta p} \vee \frac{\Delta V}{V}=\Delta p\left[\frac{1}{K}\right]$

Or $\frac{\Delta V}{V}\times 100=10^5\times 8\times 10^{-12}\times 100=8\times 10^{-5}$

57 **(a)**

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

58 **(b)**

$F=-\left(\frac{dU}{dx}\right)$

In the region BC slope of the graph is positive

$\therefore F=¿$ negative $i.e.$ force is attractive in nature

In the region AB slope of the graph is negative

$\therefore F=¿$ positive $i.e.$ force is repulsive in nature

59 **(a)**

Total work done in the stretching a string

$¿\frac{1}{2}\times stress\times strain\times volume$

Hence, the work done per unit volume is

$\frac{1}{2}(stress\times strain)$.

This work is stored as the potential energy in the string.

60 **(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 $Y=2\times 10^{11} N/m^2$

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

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

61 **(b)**

Let the change in position of the body due to additional force is x.

So, $F=\frac{1}{2}kx$

$\therefore x=\frac{2F}{k}$

63 **(a)**

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

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

64 **(a)**

$l=\frac{L^2 dg}{2Y}=\frac{(10)^2\times 1500\times 10}{2\times 5\times 10^8}=15\times 10^{-4} m$

65 **(d)**

$\tau_x=\frac{\pi\eta r^4}{2l}\theta_x\wedge\tau_y=\frac{\pi\eta(2r)^4}{2l}\theta_y$

Since, $\tau_x=\tau_y$,

$\therefore\theta_x=16\theta_y\vee\frac{\theta_x}{\theta_y}=16$

66 **(a)**

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

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

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

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

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

67 **(b)**

When a wire is stretched work is done against the interatomic forces. This work is stored in the wire in the form of elastic potential energy.

$W=\frac{1}{2}\times stress\times strain\times volume\,of\,wire$

Also, when strain in small, ratio of longitudinal stress to corresponding longitudinal strain is called Young's modulus of material of body.

$Y=\frac{longitudinal\,stress}{longitudinal\,strain}$

$\therefore W=\frac{1}{2}\times stress\times\frac{stress}{Y}\times volume$

$¿\frac{(stress)^2\times volume}{2Y}$

68 **(b)**

According the Hooke's law modulus of elasticity E.

$¿\frac{Stress}{Strain}=Constant$

Hence, if stress is increased, then the ratio of stress to strain remains constant.

69 **(c)**

Work done is stretching a wire,

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

$$¿\frac{1}{2} \times 2 \times 10^{11} \times 3 \times 10^{-6} \times ¿¿$$

$$¿0.075\,J$$

70 **(a)**

$$\eta = \frac{Y}{2(1+\sigma)}, \sigma = 0$$

$$\therefore \eta = \frac{Y}{2} = \frac{6 \times 10^{12}}{2} = 3 \times 10^{12}\,Nm^{-2}$$

71 **(a)**

$$F = 2000\,N, L = 6\,m, l = 0.5\,cm, A = 10^{-6}\,m^2$$

$$Y = \frac{FL}{Al} = \frac{2000 \times 6}{10^{-6} \times 0.5 \times 10^{-2}} = 2.35 \times 10^{12}\,N/m^2$$

72 **(a)**

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

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

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

73 **(a)**

If (A) is the area of cross-section and l is the length of rope, the mass of rope, $m = \frac{Al}{\rho}$. As the weight of the rope acts at the mid-point of the rope.

So, $Y = \frac{mg}{A} \times \frac{(I/2)}{\Delta l}$

$$\Delta l = \frac{mgl}{2AY} = \frac{Al\rho g l}{2AY} = \frac{g\rho l^2}{2AY}$$

Or $\Delta l = \frac{9.8 \times 1.5 \times 10^3 \times 8^2}{2 \times 5 \times 10^6} = 9.6 \times 10^2$m

74 **(a)**

Assume original length of spring $= l$

$mg = kx$

$k_1(60) = k_2(l-60) = kl$

$\therefore mg = k_1 = (7.5)$ according to question

And $mg = k_2 = (5.0)$

$$\therefore k_1 = \frac{kl}{60}, k_2 = \frac{kl}{l-60}$$

$$\frac{k_1}{k_2} = \frac{5.0}{7.5} = \frac{l-60}{60}$$

$$\Rightarrow \frac{2}{3} = \frac{l-60}{60}$$

$$\therefore l = 100\,cm$$

And $kx = k_1 \times 7.5$

$$kx = \left(\frac{5k}{3}\right) \times 7.5$$

$$\therefore x = 12.5\,cm$$

75 **(c)**

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

76 **(c)**

For twisting, Angle of shear $\phi \propto \frac{1}{L}$

$i.e.$ if L is more then ϕ will be small

77 **(b)**

$2\pi\sqrt{\frac{m}{k}} = 0.6$ …(i) and $2\pi\sqrt{\frac{m+m'}{k}} = 0.7$ …(ii)

Dividing (ii) by (i), we get $\left(\frac{7}{6}\right)^2 = \frac{m+m'}{m} = \frac{49}{36}$

$$\frac{m+m'}{m} - 1 = \frac{49}{36} - 1 \Rightarrow \frac{m'}{m} = \frac{13}{36}$$

$$\Rightarrow m' = \frac{13m}{36}$$

Also $\frac{k}{m} = \frac{4\pi^2}{(0.6)^2}$

Desired extension $¿\frac{m'g}{k} = \frac{13}{36} \times \frac{mg}{k}$

$$\frac{13}{36} \times 10 \times \frac{0.36}{4\pi^2} = 3.5\,cm$$

78 **(a)**

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

79 **(d)**

Equal stress

$$\frac{F_1}{A_1} = \frac{F_2}{A_2} \Rightarrow \frac{F_1}{F_2} = \frac{0.1}{0.2} = \frac{1}{2}$$

81 **(b)**

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

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

83 **(d)**

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

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

Force $=mg$, Area ¿ $A=\pi r^2$

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

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

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

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

Given, $r_2=2r_1$

$\therefore \frac{l_1}{l_2}=¿¿$

84 **(b)**

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

85 **(c)**

Breaking stress for both ropes would be same.

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

$\Longrightarrow T_{max_2}=9\times T_{max_2}=4500\,N$

86 **(b)**

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

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.

87 **(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,

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

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

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

88 **(c)**

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

$l_1=\frac{mgl}{Y\pi r^2}$ ……..(i)

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

Or $l_2=\frac{mgl}{2Y\pi r^2}$ ……..(ii)

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

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

89 **(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

90 **(d)**

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

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

91 **(c)**

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

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

92 **(b)**

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

$=$

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

94 **(b)**

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

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

95 **(d)**

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

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

$=\frac{1\times2\times10^{11}\times\left(10^{-6}\right)\times\left(2\times10^{-3}\right)^{2}}{2\times1}$= 0.4 J

96 **(c)**

$$L=\frac{p}{eg}=\frac{10^{6}}{3\times10^{3}\times10}=\frac{100}{3}=33.3\,m$$

97 **(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.

98 **(b)**

Ratio of adiabatic and isothermal elasticities

$$\frac{E\phi}{E\theta}=\frac{\gamma P}{P}=\gamma=\frac{C_{p}}{C_{v}}$$

99 **(a)**

Poisson's ratio $¿\frac{Lateral\,strain}{Longitudinal\,strain}$

$$ie,0.4=\frac{0.01\times10^{-3}}{\frac{l}{L}}$$

or $\frac{L}{l}=\frac{0.4}{0.01\times10^{-3}}=4\times10^{4}$

Young's modulus

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

$¿\frac{100}{0.025}\times4\times10^{4}=1.6\times10^{8}\,Nm^{-2}$

100 **(b)**

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

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

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 $\frac{\Delta A}{A}\times100=2\%$

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

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 $\times1\%$

= 2.5%

101 **(d)**

$$\frac{Y_{A}}{Y_{B}}=\frac{\tan\theta_{A}}{\tan\theta_{B}}=\frac{\tan60}{\tan30}=\frac{\sqrt{3}}{1/\sqrt{3}}=3\Rightarrow Y_{A}=3Y_{B}$$

102 **(b)**

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

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

$$\therefore\frac{\Delta l_{2}}{\Delta_{1}}=\frac{a_{1}}{a_{2}}=\frac{4}{8}=\frac{1}{2}$$

Or $\Delta l_{2}=\frac{\Delta l_{1}}{2}=\frac{0.1}{2}mm=0.5\,mm$

103 **(d)**

Energy stored per unit volume is given by

$W=Y\times¿¿$

$¿\frac{10^{11}}{2}\times\left(\frac{change\in length}{original\,length}\right)^{2}$

where Y is Young's modulus

$¿\frac{10^{11}}{2}\left(\frac{\propto L\Delta\theta}{L}\right)^{2}$

$¿\frac{10^{11}}{2}¿$

104 **(b)**

In ductile materials, yield point exist while in Brittle material, failure would occur without yielding

105 **(b)**

Initial elastic potential energy

$U_{1}=\frac{1}{2}F\Delta l=\frac{1}{2}=\frac{1}{2}\times\left(100\times1000\right)\times\left(1.59\times10^{-3}\right)=$

Let Δl_{1}, be the elongation in the rod when stretching force is increased by, 200N, Since,

$$\Delta l = \frac{F}{\pi r^2} \times \frac{l}{Y}; so, \Delta l \propto F$$

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

Or

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

Final elastic potential energy is

$$U_1 = \frac{1}{2} F_1 \Delta l_1 = \frac{1}{2} \times (300 \times 10^3) \times (4.77 \times 10^{-3}) = 71$$

Increase in elastic potential energy

= 715.5-79.5 = 636.0 J

106 **(c)**

Elastic potential energy(U) is given by

$$U = \frac{1}{2} F \times l$$

$$¿ \frac{1}{2} \times \frac{F}{A} \times \frac{l}{L} \times AL \ldots (i)$$

where, L is length of wire, A is area of cross-section of wire, F is stretching force and l is increase in length.

Eq. (i) may be written as

$$U = \frac{1}{2} \times stress \times strain \times volume\, of\ the\ wire$$

$\therefore$Elastic potential energy per unit volume of the wire

$$u = \frac{U}{AL} = \frac{1}{2} \times stress \times srain$$

$$¿ \frac{1}{2} \times (Young' s\ modulus \times strain) \times strain$$

$$¿ \frac{1}{2} \times (Y) \times ¿$$

Hence,

$$u = \frac{1}{2} \times 1.1 \times 10^{11} \times \left(\frac{0.1}{100}\right)^2$$

$$¿ 5.5 \times 10^4 Jm^{-3}$$

107 **(b)**

$$T_1 = K(l - l_1)$$

$$T_2 = K(l - l_2)$$

So, $\dfrac{T_1}{T_2} = \dfrac{l - l_1}{(l - l_2)}$

$$\therefore T_1 l - T_1 l_2 = T_2 l - T_2 l_1$$

$$(T_1 - T_2) l = T_1 l_2 - T_2 l_1$$

$$l = \frac{T_1 l_2 - T_2 l_1}{(T_1 - T_2)}$$

$$l = (5a - 4b)$$

…….(i)

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

…….(ii)

So, length of wire when tension is 9 N

$9 = k l' ¿$ change in length)

$$9 = \frac{1}{(b-a)} \times l' \Rightarrow l' = 9b - 9a$$

Hence, final length = $l + l'$

$= 5a - 4a + 9a - 9a$

$l_0 = 5b - 4a$

108 **(c)**

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

109 **(c)**

Energy $U = \dfrac{1}{2} \times \dfrac{4Al^2}{L}$

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

= 0.075 J

110 **(a)**

$$F = YA\frac{\Delta L}{L} = 2 \times 10^{11} \times (10^{-4}) \times 0.1 = 2 \times 10^6 N$$

111 **(d)**

Energy stored per unit volume

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

$= 3 \times 10^4 J m^{-3}$

112 **(a)**

$Y = 3K(1 - 2\sigma)$ and $Y = 2\eta(1 + \sigma)$

Eliminating σ we get $Y = \dfrac{9\eta K}{\eta + 3K}$

113 **(b)**

Work done = $\dfrac{1}{2} F \times \Delta l = \dfrac{1}{2} M g l$

114 **(a)**

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

115 **(d)**

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

$$\Rightarrow 2.4\eta = 2\eta(1 + \sigma)$$

$$\Rightarrow 1.2 = 1 + \sigma$$

$$\Rightarrow \sigma = 0.2$$

116 **(d)**

There will be both shear stress and normal stress

117 **(b)**

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

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

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

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

118 **(c)**

Breaking Force ∝ Area of cross section of wire (πr^2) If radius of wire is double then breaking force will become four times

119 **(a)**

Extensions $\Delta l = \left(\frac{L}{YA}\right) \cdot W$

ie, graph is a straight line passing through origin (as shown in question also), the slope of which is $\frac{L}{YA}$

Slope$¿\left(\frac{L}{YA}\right)$

$Y = \left(\frac{L}{A}\right)\left(\frac{1}{slope}\right)$

$¿\left(\frac{1.0}{10^{-6}}\right)\frac{(80-20)}{(4-1) \times 10^{-4}}$

$¿ 2.0 \times 10^{11}\,Nm^{-2}$

120 **(b)**

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

$F, l \wedge \Delta l$ 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 $\frac{R_S}{R_B} = \frac{1}{\sqrt{2}} \vee R_S = \frac{R_B}{\sqrt{2}}$

121 **(c)**

$W = \frac{1}{2}\frac{YAl^2}{L} \Rightarrow 0.4 = \frac{1}{2} \times \frac{Y \times 1^{-6} \times (0.2 \times 10^{-2})^2}{1}$

$\therefore Y = 2 \times 10^{11}\,N/m^2$

122 **(d)**

Elastic potential energy per unit volume

$= \frac{1}{2}$ stress × strain = $\frac{1}{2}$¿strain) ×strain = $\frac{1}{2} Y x^2$

123 **(a)**

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

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

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

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

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

124 **(c)**

$\Delta l = \frac{4Fl}{\pi D^2 Y}$

$= \frac{4 \times 30 \times 2 \times 7}{22 \times (3 \times 10^{-3})^2 \times 1.1 \times 10^{11}}$

$= 7.7 \times 10^{-5} m = 0.077\,mm$

126 **(d)**

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

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

127 **(b)**

$Y_s = \frac{F l_s}{A_s \Delta L_s}$

And $Y_C = \frac{F L_C}{A_C \Delta L_C}$

$\therefore \frac{L_C}{L_S} = \frac{\frac{Y_C A_C \Delta L_C}{F}}{\frac{Y_S A_S \Delta L_S}{F}} = \left(\frac{Y_C}{Y_S}\right)\left(\frac{A_C}{A_S}\right)\left(\frac{\Delta L_C}{\Delta L_S}\right)$

Here, $\frac{A_C}{A_S} = 2, \frac{\Delta L_C}{\Delta L_S} = 1, \frac{Y_C}{Y_S} = \frac{1.1}{2}$

$\therefore \frac{L_C}{L_S} = \frac{1.1}{2} \times 2 \times 1 = 1.1$

128 **(c)**

Potential energy stored in the rubber cord catapult will be converted into kinetic energy of mass

$\frac{1}{2} m v^2 = \frac{1}{2}\frac{YAl^2}{L} \Rightarrow v = \sqrt{\frac{YAl^2}{mL}}$

$¿\sqrt{\frac{5\times10^{8}\times25\times10^{-6}\times(5\times10^{-2})^{2}}{5\times10^{-3}\times10\times10^{-2}}}=250\,m/s$

129 **(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)

130 **(b)**

Longitudinal strain $\alpha=\frac{l_2-l_1}{l_1}=10^{-3}$

$\frac{l_2}{l_1}=1.001$

Poisson's ratio, $\sigma=\frac{lateral\ strain}{longitudinal\,strai}=\frac{\beta}{\alpha}$

Or $\beta=\sigma\alpha=0.1\times10^{-3}=10^{-4}=\frac{r_1-r_2}{r_1}$

Or $\frac{r_2}{r_1}=1-10^{-4}=0.9999$

% increase in volume = $\left(\frac{V_2-V_1}{V_1}\right)\times100$

$=\left(\frac{\pi r_2^2 l_2-\pi r_1^2 l_1}{\pi r_1^2 l_1}\right)\times100=\left(\frac{r_2^2 l_2}{r_1^2 l_1}-1\right)\times100$

= $[(0.9999)^2\times1.001-1¿\times100=0.08\%$

131 **(b)**

$U=\frac{F^2}{2K}=\frac{T^2}{2K}$

132 **(c)**

$Y=\frac{Mgl}{\pi r^2\times l}=\frac{4\times(3.1\pi)\times2.0}{\pi\times(2\times10^{-3})^2\times0.031\times10^{-3}}$

= $2\times10^{11}\,N\,m^{-2}$

133 **(d)**

10 m column of water exerts nearly 1 atmosphere pressure. So, 100 m column of water exerts nearly 10 atmospheric pressure, $ie,10\times10^{5}Pa\vee10^{6}Pa$.

134 **(c)**

Work done $¿\frac{1}{2}Fl=\frac{Mgl}{2}$

135 **(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

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

136 **(a)**

$Y=\frac{(mg+ml\omega)l}{\pi r^2\Delta l}$

Or $\Delta l=\frac{m(g+ml\omega^2)l}{\pi r^2 Y}$

Or $\Delta l=\frac{1(10+2\times4\pi^2\times4)^2}{\pi(1\times10^{-3})^2\times2\times10^{11}}$

Or $\Delta l=\frac{(20+64\times9.88)7}{2\times22\times10^5}$

= $\frac{4566.24}{44\times10^5}\times10^3\,mm=1\,mm$

137 **(a)**

In accordance with Hook's law

138 **(c)**

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

$¿\frac{1}{2}\times\frac{YA}{L}\times1$ | $Y=\frac{F\times L}{A\times1}$

$¿\frac{YA}{2L}$ | $F=\frac{YA}{L}$

140 **(b)**

As $\pi\theta=l\phi;so\,\phi=\frac{0.4\times30°}{100}=0.12°$

141 **(b)**

$Y=\frac{F}{A}\times\frac{L}{l}\vee l=\frac{FL}{AY}\vee l\propto1/A$

142 **(d)**

Compressibility, $K=\frac{1}{B}=\frac{\Delta V}{V\Delta P}$

$\therefore\quad 5\times10^{-10}=\frac{\Delta V}{100\times10^{-3}\times15\times10^{6}}$

$\Rightarrow\ \Delta V=5\times10^{-10}\times100\times10^{-3}\times15\times10^{6}$

=0.175 mL

Since, pressure increases, so volume will decrease.

143 **(d)**

When no weight is placed in pan, and T^2 shows some value, it means, the pan is not weightless and hence, the mass of the pan cannot be neglected.

144 **(c)**

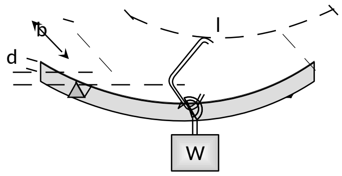
$l=\frac{FL}{AY}=\frac{F L^2}{(AL)Y}=\frac{F L^2}{VY}$

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

145 **(c)**

Depression in beam

$\delta=\frac{W L^3}{4 Yb\, d^3}$



$\therefore \delta \propto \frac{1}{Y}$

146 **(d)**

Breaking force = Breaking stress × Area of cross section of wire

∴ Breaking force $\propto r^2$ (Breaking stress is constant)

If radius becomes doubled then breaking force will become 4 times $i.e.\, 40 \times 4=160\, kg\, wt$

147 **(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 $F=\frac{-dU}{dx}$

148 **(d)**

Here, $k_Q=\frac{k_p}{2}$

According to Hooke's law

$\therefore F_p=-k_p x_p$

$F_Q=-k_Q x_Q \Rightarrow \frac{F_p}{F_Q}=\frac{k_p}{k_Q}\frac{x_p}{x_Q}$

$F_p=F_Q$ [Given]

$\therefore \frac{x_p}{x_Q}=\frac{k_Q}{k_p}$ ….(i)

Energy stored in a spring is $U=\frac{1}{2}k x^2$

$\therefore \frac{U_P}{U_Q}=\frac{k_p x_p^2}{k_Q x_Q^2}=\frac{k_p}{k_Q}\times\frac{k_Q^2}{k_p^2}=\frac{1}{2}\left[\because k_Q=\frac{k_p}{2}\right]$

$\Rightarrow U_p=\frac{U_Q}{2}=\frac{E}{2}[\because U_Q=E]$

150 **(b)**

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

$¿\frac{1}{2}\times stress \times \frac{strain}{Y} \vee Y=\frac{stress}{strain}=\frac{S^2}{2Y}$

151 **(a)**

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

152 **(a)**

Here, $p=20{,}000\, Nc\, m^{-2}=2\times 10^8\, N\, m^{-2}$

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

$\Delta V=\frac{pV}{k}$

$=\frac{2\times 10^8 \times V}{8\times 10^9}=\frac{V}{40}$

New volume of the metal,

$V'=V-\Delta V=V-\frac{V}{40}=\frac{39V}{40}$

New mass of the metal

$=V'\times \rho=\frac{39V}{40}\rho'=V\times 11$

Or $\rho'=\frac{440}{39}$ gcm^{-3}

153 **(b)**

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

When D is doubled, Δl becomes on- fourth,

$ie, \frac{1}{4}\times 2.4\, cm, ie, 0.6\, cm.$

154 **(c)**

$Y=\frac{w}{A}\times\frac{L}{l}\vee l=\frac{wL}{YA}$

When wire goes over a pulley and weight w is attached each free ad end of wire, then the tension in the wire is doubled, but the original length of wire is reduced to half, so extension in the wire is

$l'=\frac{2w\times(L/2)}{YA}=\frac{wL}{YA}=l$

155 **(c)**

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

(where Y is Young's modulus of elasticity Since, Y, L and A remain same.

$F\propto l$

$$\frac{F_1}{F_2}=\frac{l_1}{l_2}$$

$$\Rightarrow \frac{F}{F_2}=\frac{2\times10^{-3}}{4\times10^{-3}}$$

$F_2=2F$

156 **(b)**

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

$$=9\times10^{10}\times\frac{22}{7}\times\frac{(0.6\times10^{-3})^2}{4}\times\frac{0.2}{100}N\approx51N$$

157 **(d)**

$$Y=\frac{F/A}{Breaking\,strain}$$

Or $a=\dfrac{F}{Y\times Breaking\,strain}=\dfrac{10^4\times100}{7\times10\times0.2}$

$=0.71\times10^{-3}=7.1\times10^{-4}$

159 **(c)**

$$l=\frac{MgL}{YA}=\frac{1\times10\times1}{2\times10^{11}\times10^{-6}}=0.05\,mm$$

162 **(d)**

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

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

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

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

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

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

or $F_2=4\times200=800\,N$

163 **(b)**

$F=force\,developed$

$=YA\propto(\Delta\theta)$

$=10^{11}\times10^{-4}\times10^{-5}\times100=10^4\,N$

164 **(c)**

For cylinder A,

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

For cylinder B, $\tau=\dfrac{\pi\eta(2r)^4(\theta-\theta')}{2l}$

$$\frac{\pi\eta r^4\theta'}{2l}=\frac{\pi\eta(2r)^4(\theta-\theta')}{2l}$$

$$\theta'=\frac{16}{17}\theta$$

166 **(d)**

$l=\dfrac{FL}{AY}\therefore l\propto\dfrac{1}{r^2}$ ¿and$Y$ are constant]

$$\frac{l_1}{l_2}=\left(\frac{r_2}{r_1}\right)^2=(2)^2=4$$

167 **(a)**

Thermal stress $¿Y\alpha\Delta\theta$

$¿1.2\times10^{11}\times1.1\times10^{-5}\times(20-10)=1.32\times10^7\,N/r$

168 **(b)**

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

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

$$\Delta p=\frac{2100\times10^6\times0.008}{200}=84\,kPa$$

170 **(d)**

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

Given, $F/A=¿$ stress $¿3.18\times10^8\,N\,m^{-2}$

$l=1\,m, Y=2\times10^{11}\,N\,m^{-2}$

$\Delta l=\dfrac{lF/A}{Y}=\dfrac{1\times3.18\times10^8}{2\times10^{11}}=1.59\times10^{-3}m=1.59r$

171 **(c)**

Isothermal elasticity

$K_i=P=1\,atm=1.013\times10^5\,N/m^2$

172 **(a)**

Young's modulus, $Y=\dfrac{mgL}{Al}$

$\Rightarrow \dfrac{l}{L}=\dfrac{mg}{AY}$

$\therefore \dfrac{l}{L}=\dfrac{1\times10}{3\times10^{-6}\times10^{11}}$

$¿0.3\times10^{-4}$

173 **(b)**

$\eta = \frac{Y}{2(1+\sigma)} \vee \eta = \frac{2.4\eta}{2(1+\sigma)}$

Or $1+\sigma = 1.2 \vee \sigma = 0.2$

174 **(c)**

From figure the increase in length

$\Delta l = (PR + RQ) - PQ$

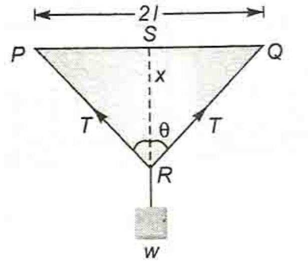
= $2PR - PQ$

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

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

= x^2/l (By Binomial theorem)

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



175 **(c)**

Work done on the wire to strain it will be stored as energy which is converted to heat. Therefore, the temperature increases.

176 **(a)**

Because dimension of invar does not vary with temperature

177 **(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

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

178 **(a)**

Shearing modulus of cube

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

$¿ \frac{8 \times 10^3 \times 40 \times 10^{-3}}{¿¿¿}$

179 **(d)**

$Y = \frac{F}{A} \times \frac{L}{l} \vee force\ constant = \frac{F}{l} = \frac{YA}{L}$

180 **(b)**

$K = Y r_0 = 20 \times 10^{10} \times 3 \times 10^{-10} = 60\, N/m$
¿$6 \times 10^{-9}\, N/Å$

182 **(a)**

We know that the Poisson's ratio have the theoretical value

$-1 < \sigma < \frac{1}{2}$

But practically the value of σ (Poisson's ratio) is

$0 < \sigma < \frac{1}{2}$

So the Poisson's ratio cannot have the value 0.7.

183 **(b)**

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

$\Rightarrow F \propto r^2$ ¿ and L are constant]

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

184 **(d)**

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

In the given problem, $Y, l \wedge \Delta l$ are constants .

$\therefore F \propto A$

Or $F = \pi^2 \vee F \propto r^2 \vee \frac{F_1}{F_2} = \frac{r_1^2}{r_2^2} = \frac{1}{4}$

185 **(d)**

According to Boyle's law, $p_2 V_2 = p_1 V_1$

Or $p_2 = p_1 \left(\frac{V_1}{V_2} \right)$

Or $p_1 = 72 \times 1000/900 = 80$ cm of Hg.

Stress = increase in pressure

= $p_2 - p_1 = 80 - 72 = 8$

= 1066.4 $N m^{-2}$

Volumetric strain = $\frac{V_1 - V_2}{V_1} = \frac{1000 - 900}{1000} = 0.1$

186 **(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, $\frac{\Delta V}{V} = 0.03$

187 **(c)**

Here, $\Delta l = x; Y = \frac{F/A}{\Delta l / L} \vee F = \frac{YA \Delta l}{L}$

The work is done from 0 to x (change in length), So the average distance = $\frac{0+\Delta l}{2}=\frac{\Delta l}{2}$

Work done = Force × distance

$=\frac{YA\Delta l}{L}\times\frac{\Delta l}{2}=\frac{YA(\Delta l)^2}{2L}=\frac{YAx^2}{2L}$

188 **(b)**

$U=\frac{1}{2}Fl=\frac{F^2L}{2AY}.U\propto\frac{L}{r^2}$¿ and Y are constant]

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

189 **(b)**

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

190 **(a)**

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

Or $Y=\frac{Fl\times 4}{\pi D^2\times\Delta l}\vee\Delta l\propto\frac{1}{D^2}\vee\frac{\Delta L_2}{\Delta L_1}=\frac{D_1^2}{D_2^2}=\frac{n^2}{1}$

191 **(d)**

$L_2=l_2(1+\alpha_2\Delta\theta)$ and $L_1=l_1(1+\alpha_1\Delta\theta)$

$\Rightarrow(L_2-L_1)=(l_2-l_1)+\Delta\theta(l_2\alpha_2-l_1\alpha_1)$

Now $(L_2-L_1)=(l_2-l_1)$ so, $l_2\alpha_2-l_1\alpha_1=0$

193 **(d)**

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

$Y, l\wedge F$ are constants.

$\therefore\Delta l\propto\frac{1}{D^2}$

$\frac{\Delta l_2}{\Delta l_1}=\frac{D_1^2}{D_2^2}=\frac{1}{16}$

$\therefore\Delta l_2=\frac{1}{16}mm$

194 **(a)**

$l\propto\frac{1}{Y}\Rightarrow\frac{Y_s}{Y_c}=\frac{l_c}{l_s}\Rightarrow\frac{l_c}{l_s}=\frac{2\times 10^{11}}{1.2\times 10^{11}}=\frac{5}{3}$ …(i)

Also $l_c-l_s=0.5$ …(ii)

On solving (i) and (ii) $l_c=1.25\,cm$ and $l_s=0.75\,cm$

195 **(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, $k_1x_1=k_2x_2=w$

Elastic potential energy of the system

$U=\frac{1}{2}k_1x_1^2+\frac{1}{2}k_2x_2^2$

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

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

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

196 **(d)**

$A_1l_1=A_2l_2$

$\Longrightarrow l_2=\frac{A_2l_1}{A_1}=\frac{A\times l_1}{3A}=\frac{l}{3}$

$\Longrightarrow\frac{l_1}{l_2}=3$

$\Delta x_1=\frac{F_1}{A\gamma}l_1...(i)$

$\Delta x_2=\frac{F_2}{3A\gamma}l_2$ …..(ii)

Here $\Delta x_1=\Delta x_2$

$\frac{F_2}{3A\gamma}l_2=\frac{F_1}{A\gamma}l_1$

$F_2=3F_1\times\frac{l_1}{l_2}$

¿$3F_1\times 3=9F$

197 **(c)**

$K=\frac{1.5N^2}{30\times 10^{-3}}=50\,Nm^{-1}$

$l=\frac{0.2\times 10}{50}m=0.04\,m$

Energy stored = $\frac{1}{2}\times 0.20\times 10\times 0.04\,J=0.04\,J$

198 **(b)**

Young's modulus ¿ $\frac{stress}{strain}$

As the length of wire get doubled therefore strain = 1

$\therefore Y=strain=20\times 10^8\,N/m^2$

199 **(d)**

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

Or $F=\frac{2.2\times10^{11}\times2\times10^{-6}\times0.5\times10^{-3}}{2}$

$= 1.1\times10^{2}N$

200 **(b)**

In case of shearing stress there is a change in shape without any change in volume. In case of hydraulic stress there is a change in volume without any change in shape. In case of tensile stress there is no change in volume

202 **(b)**

If length of the wire is doubled then strain = 1

$\therefore Y=Stress=\frac{Force}{Area}=\frac{2\times10^{5}}{2}=10^{5}\frac{dyne}{c\,m^{2}}$

203 **(b)**

$\frac{3}{\eta}+\frac{1}{K}=\frac{9}{Y}$

$\frac{1}{K}=\frac{9}{Y}=\frac{3}{\eta}\vee\frac{1}{K}=\frac{9}{3\eta}-\frac{3}{\eta}=0\Rightarrow K=\infty$

205 **(b)**

$U=\frac{1}{2}\times Y\times(strain)^{2}\times volume$

$=\frac{1}{2}\times2\times10^{11}\times(2\times10^{-3})^{2}\times2\times10^{-6}\times1=0.8J$

206 **(a)**

$\omega=\sqrt{\frac{K}{m}=¿\sqrt{\frac{YA}{lm}}¿}$

$¿\sqrt{\frac{(n\times10¿¿9)(4.9\times10^{-7})}{1\times0.1}}¿$

Given,$\omega=140\,rad\,s^{-1}\in above\,equation, we\,get,$
$n=4$

207 **(c)**

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

$=(m_2g+m_1g/2)/A=[(m_1/2)+m_2]g/A$

208 **(d)**

Elastic energy stored in the wire is

$U=\frac{1}{2}stess\times strain\times volume$

$¿\frac{1}{2}\frac{F}{A}\times\frac{l}{L}\times AL=\frac{1}{2}Fl$

$¿\frac{1}{2}\times200\times1\times10^{-3}=0.1J$

209 **(b)**

$\Delta p=h\rho g=200\times10^{3}\times10\,Nm^{-2}$

$=2\times10^{6}\,N\,m^{-2}$

$K\quad=$

$$\frac{\Delta p}{\frac{\Delta V}{V}} = \frac{2 \times 10^6}{\frac{0.1}{100}} = \frac{2 \times 10^8}{0.1} N\,m^{-2} = 2 \times 10^9 N\,m^{-2}$$

210 **(d)**

Stress = Strain

$= 2 \times 10^{11} \times 0.15 N\,m^{-2} = 3 \times 10^{10} N\,m^{-2}$

211 **(a)**

$$W=\frac{1}{2}\frac{(Stress)^2}{Y}\times Volume$$

As F, A and Y are same $\Rightarrow W\propto$ Volume [area is same]

$W\propto l \qquad (V=Al)$

$$\frac{W_1}{W_2}=\frac{l_1}{l_2}=\frac{l}{2l}=\frac{1}{2}$$

212 **(d)**

$l\propto\frac{FL}{\pi r^2 Y}\Rightarrow l\propto\frac{L}{r^2}$ ¿ and Y are constant]

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

213 **(b)**

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

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

= 0.455 Nm

214 **(c)**

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

$$\therefore Y=stress=\frac{2\times10^3 N}{2\times10^{-4}m^2}=10^7 N m^{-2}$$

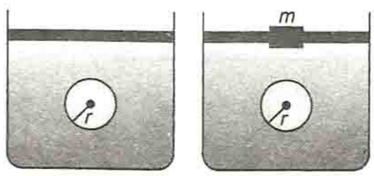
215 **(c)**

As $l=\frac{F}{\pi\left(\frac{d^2}{4}\right)}\times\frac{L}{Y}\, so, l\propto\frac{L}{d^2}$

$\frac{L}{d^2}$ *is maximum for option* (c).

216 **(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

$$\Delta V=\frac{4}{3}\pi\times3r^2\Delta r=4\pi\Delta r$$

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

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

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

217 **(b)**

Energy stored in the wire

¿ $\frac{1}{2}$ *stress* × *strain* × *volume*

and $Young's\, modulus=\frac{Stress}{Strain}$

$\Rightarrow\; strain=\frac{S}{Y}$

$$\frac{Energy\, stored\in wire}{Volume}=\frac{1}{2}\times stress\times strain$$

¿ $\frac{1}{2}S\times\frac{S}{Y}=\frac{S^2}{2Y}$

218 **(d)**

Breaking force $\propto r^2$

If diameter becomes double then breaking force will become four times $i.e. 1000\times4=4000\,N$

220 **(a)**

Let the original unstretched length be l.

$$Y=\frac{Stress}{Strain}=\frac{T/A}{\Delta l/l}=\frac{T}{A}\times\frac{l}{\Delta l}$$

Now, $\quad Y=\frac{4}{A}\frac{l}{(l_1-l)}=\frac{6}{A}\frac{l}{(l_2-l)}=\frac{9}{A}\frac{l}{(l_3-l)}$

$\therefore\; 4(l_3-l)=9(l_1-l)$

$\Longrightarrow 4l_3+5l=9l_1\ldots(i)$

Again, $6(l_3-l)=9(l_2-l)$

$\Rightarrow 2l_3+l=3l_2\ldots(ii)$

Solving Eqs. (i) and (ii), we obtain

$l_3=(2.5l_2-1.5l_1)$

221 **(c)**

Tensile strain on each face ¿ $\frac{F}{Y}$

Lateral strain due to the other two forces acting on perpendicular faces $¿\frac{-2\sigma F}{Y}$

Total increase in length $¿(1-2\sigma)\frac{F}{Y}$

222 **(d)**

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

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

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

223 **(b)**

$$l=\frac{L^2 dg}{2Y}=\frac{(8\times10^{-2})^2\times1.5\times9.8}{2\times5\times10^8}=9.6\times10^{-11}m$$

224 **(c)**

$Y=\frac{Fl}{A\Delta l}\vee\Delta l\propto\frac{1}{A}$

Again , $m=Alp, m\propto A$

$\therefore\Delta l\propto\frac{1}{m}$

$\therefore\frac{\Delta l_1}{\Delta l_2}=\frac{m_2}{m_1}=\frac{2}{3}$

226 **(b)**

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

Or $\sigma=\frac{\Delta V}{pV}\vee\Delta V=\sigma pV$

227 **(c)**

Isothermal elasticity $K_i=P$

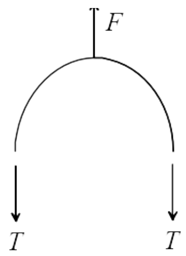
228 **(d)**

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

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

229 **(c)**

$$l=\frac{FL}{AY}\therefore l\propto\frac{F}{r^2}$$

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

230 **(a)**

Breaking strength = tension in the wire = $mr\,\omega^2$

$4.8\times10^7\times10^{-6}=10\times0.3\times\omega^2$

$$\omega^2=\frac{48}{0.3\times10}=16$$

$\omega=4\,rad\,s^{-1}$

232 **(b)**

Given $\frac{\Delta V}{V}\times100=1\%=\frac{1}{100}$

Bulk modulus,

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

or $p=\frac{B\Delta V}{V}=7.5\times10^{10}\times\frac{1}{100}$

¿$7.5\times10^8\,Nm^{-2}$

233 **(a)**

Elasticity of wire decreases at high temperature $i.e.$ at higher temperature slope of graph will be less

So we can say that $T_1>T_2$

234 **(a)**

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

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

$=4\times10^{-5}\times100\times100\,c\,m^3$

$=4\times10^{-1}\,c\,m^3=0.4\,c\,m^3$

235 **(a)**

Steel has the highest elasticity.

236 **(d)**

$$Y=\frac{F}{A}\frac{L}{l}=\frac{Fd\,L^2}{Ml}$$

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

237 **(b)**

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

If l is halved, then Δl is doubled.

238 **(d)**

Young's modulus is defined only in elastic region and

$$Y=\frac{Stress}{Strain}=\frac{8\times10^7}{4\times10^{-4}}=2\times10^{11}\,N/m^2$$

239 **(d)**

It is the specific property of a particular metal at a given temperature which can be changed only by temperature variations

240 **(a)**

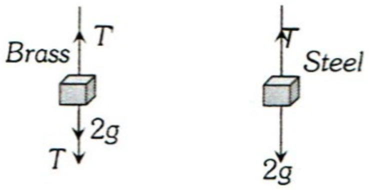
Energy density = $\frac{1}{2} \times stress \times strain$

$Y = \frac{stress}{\sigma} \vee stress = Y\sigma$

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

241 **(d)**

Given, $\frac{l_1}{l_2} = a, \frac{r_1}{r_2} = b, \frac{Y_1}{Y_2} = c$



Let Young's modulus of steel be Y_1, and that of brass be Y_2

$\therefore Y_1 = \frac{F_1 l_1}{A_1 \Delta l_1}$ …(i)

and $Y_2 = \frac{F_2 l_2}{A_2 \Delta l_2}$ …(ii)

Dividing Equation (i) by Equation (ii), we get

$\frac{Y_1}{Y_2} = \frac{F_1 . A_2 . l_1 . \Delta l_2}{F_2 . A_1 . l_2 . \Delta l_1}$ …(iii)

Force on steel wire from free body diagram

$T = F_1 = (2g)$ Newton

Force on brass wire from free body diagram

$F_2 = T_1'' = T + 2g = 4g$ Newton

Now, putting the value of F_1, F_2, in Equation (iii), we get

$\frac{Y_1}{Y_2} = \left(\frac{2g}{4g}\right) . \left(\frac{\pi r_2^2}{\pi r_1^2}\right) . \left[\frac{l_1}{l_2}\right] . \left(\frac{\Delta l_2}{\Delta l_1}\right) = \frac{1}{2}\left(\frac{1}{b_2}\right) . a \left(\frac{\Delta l_2}{\Delta l_1}\right)$

242 **(c)**

Volume $V =$ ¿ cross sectional $A \times$ length l or $V = Al$

Strain ¿ $\frac{Elongation}{Original\ length} = \frac{v}{l}$

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

Work done, $W = \frac{1}{2} \times stress \times strain \times volume$

$W = \frac{1}{2} \times Y \times (strain)^2 \times Al$

¿ $\frac{1}{2} \times Y \times \left(\frac{y}{l}\right)^2 \times Al = \frac{1}{2}\left(\frac{YA}{l}\right) y^2 \Rightarrow W \propto y^2$

243 **(a)**

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

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

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

$= \frac{2 \times 10^{11} \times 10^{-6} \times 10^{-6}}{2 \times 1} = 0.1\,J$

245 **(c)**

$\Delta p = 100\,atm = 100 \times 10^6 dyne\,cm^2$

$= 10^8\,dyne\,cm^{-2}$

$\frac{\Delta V}{V} = \frac{0.01}{100} = 10^{-4}$

$K = \frac{10^8}{10^{-4}} dyne\,cm^{-2} = 10^{12} dyne\,cm^{-2}$

246 **(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

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

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

247 **(a)**

The Poisson's ratio of the material of the wire is

$\sigma = \frac{\frac{\Delta D}{D}}{\frac{\Delta l}{l}}$

The relation for volume of wire is

$V = \pi r^2 l \left(But, r = \frac{D}{2}\right)$

$V = \pi \left(\frac{D}{2}\right)^2 l = \frac{\pi D^2 l}{4} \ldots (i)$

Differentiating both sides of Eq. (i)

$dV = \frac{\pi l}{4} \cdot 2D \cdot dD + \pi D^2 \times \frac{l}{4} dl$

As volume remains constant hence, we get

$$0=\pi\frac{l}{2}DdD+\pi\frac{D^2}{4}dl$$

or $-\pi\frac{l}{2}D\,dD=\frac{\pi D^2}{4}dl$

or $\frac{-dD}{D}\frac{l}{dl}=\frac{2}{4}=0.5$

Therefore, Poisson's ratio, $\sigma=0.5$

248 **(c)**

Here,

$w=2\times1000\times980\,dyne;l=100\,cm,b=2\,cm,d=1$
,

Now, $\delta=\frac{wl^3}{4Ybd^3}=\frac{(2\times1000\times980)\times(100)^3}{4\times(20\times10^{11})\times2\times(1)^3}$

= 0.1225 cm.

249 **(b)**

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

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

250 **(b)**

$l\propto\frac{1}{r^2}$, if radius of the wire is doubled then increment in length will become $\frac{1}{4}$ times $i.e.\frac{12}{4}=3\,mm$

254 **(c)**

Isothermal bulk modulus = Pressure of gas

255 **(b)**

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

256 **(b)**

Force constant, K $¿\tan30°=1/\sqrt{3}$

257 **(d)**

Work done in stretching the wire

= potential energy stored

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

= $\frac{1}{2}\times\frac{F}{A}\times\frac{\Delta l}{l}\times Al$

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

258 **(a)**

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

$Y,l\wedge F$ 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 , $W_1=\frac{1}{2}\times10^3\times1\times10^{-3}=0.5\,J$

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

Again , $\frac{W_1}{W_2}=\frac{0.5}{0.03125}=16$

………..(ii)

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

259 **(d)**

The weight of the rod can be assumed to act at its mid-point.

Now, the mass of the rod is

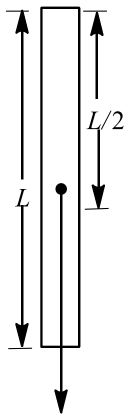
$M=V\rho$

$\Rightarrow M=AL\rho$

Here, $A=area\,of\,cross-sections,$

L= length of the rod.

Now, we know that the Young's modulus



$Y=\frac{\frac{MgL}{2}}{A\cdot l}\left(Here,L=\frac{L}{2},l=extension\right)$

$\Rightarrow l=\frac{\frac{MgL}{2}}{AY}$

or $l=\frac{MgL}{2AY}$

On putting the value of M from Eq.(i), we get

$$l=\frac{AL\rho\cdot g\,L}{2\,AY}$$

or $l=\frac{\rho g\,L^2}{2\,Y}$

260 **(d)**

Work done = $\frac{1}{2}\times Y\times(strain)^2\times volume$

$2 \;=\frac{1}{2}\times Y\times\left(\frac{\Delta L}{L}\right)^2=\frac{YA\,\Delta\,L^2}{2\,L}$

New work done, $W'=\frac{Y(4\,A)\Delta L^2}{2(L/2)}$

= $8\left[\frac{YA\,\Delta\,L^2}{2L}\right]8\times 2=16\,J$

261 **(c)**

$$Y=\frac{Fl}{\pi\,r^2\Delta\,l}\vee\Delta\,l=\frac{F}{\pi\,r^2\,Y}$$

$$\Delta\,l\propto\frac{1}{r^2},\Delta\,l'\propto\frac{2l}{(\sqrt{2}\,r)^2}\vee\Delta\,l'\propto\frac{1}{r^2}$$

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

262 **(d)**

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

$$W=\frac{1}{2}\times\frac{Y\pi\,r^2\Delta\,l}{l}\Delta l \quad\Bigg|\quad Y=\frac{Fl}{\pi\,r^2\Delta\,l}$$

$$¿W=\frac{Y\pi\,r^2\Delta l}{2l} \quad\Bigg|\quad F=\frac{Y\pi\,r^2\Delta\,l}{l}$$

$Or \quad W\propto\frac{r^2}{l},W\propto\frac{(2\,r^2)^2 2}{l}$

$$\frac{W'}{W}=8\vee W'=8\times 2\,J=16\,J$$

264 **(c)**

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

$Y\,,l\wedge A$ are constants.

$$\therefore\frac{F}{\Delta\,l}=constant\vee\Delta\,l\propto F$$

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

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

Or $l_2 T_2-l\,T_2=l_2 T_1\vee l(T_1-T_2)=l_2\,T_1-l_1\,T_2$

Or $l=\frac{l_2 T_1-l_1 T_2}{T_1-T_2}\vee l=\frac{l_1 T_2-l_2 T_1}{T_2-T-1}$

265 **(a)**

Energy stored in the wire

$U=\frac{1}{2}Y\times¿$

or $U=\frac{1}{2}Y\times\left(\frac{x}{l}\right)^2\times Al$

or $U=\frac{1}{2}\frac{Yx^2}{l}\times A$

or $U=\frac{1}{2}\frac{YA}{l}x^2$

266 **(d)**

$$Y=\frac{M\,g}{A}\times\frac{L/2}{\Delta\,L}$$

(Length is taken as $\frac{L}{2}$ because weight acts as CG)

Now, $M=AL\rho$

(For the purpose of calculation of mass, the whole of geometrical length L is to be considered.)

$$\therefore Y=\frac{ALp\,g\,L}{2\,A\,\Delta\,L}$$

Or $\Delta\,L=\frac{p\,g\,L^2}{2\,Y}=\frac{1.5\times 10^3\times 10\times 8\times 8}{2\times 5\times 10^6}$

= $9.6\times 10^{-2}m=9.6\times 10^{-2}\times 10^3\,mm$

= 96 mms

267 **(d)**

From the definition of Bulk modulus,

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

Substituting the values we have,

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

$$Pa=1.55\times 10^5\,Pa$$

269 **(d)**

We know that $Y=(1+\sigma)2\eta$

270 **(c)**

$$F=\frac{YAl}{L}=0.9\times 10^{11}\times\pi\times(0.3\times 10^{-3})^2\times\frac{0.2}{100}=51\,l$$

271 **(b)**

$$\frac{\Delta\,l}{l}=\frac{stress}{Y}=1000\times 980¿/(10^{-1})^2\frac{¿}{10^{10}}=0.0098$$

% increase in length of wire

= $\frac{\Delta\,l}{l}\times 100=0.0098\times 100=0.98\,\%$

272 **(d)**

$Y=\frac{F}{A}\frac{L}{l} \Rightarrow l \propto \frac{L}{A} \propto \frac{L}{\pi d^2}$

$\therefore l \propto \frac{L}{d^2}$

The ratio of $\frac{L}{d^2}$is maximum for case (d).

274 **(b)**

Volume of cylindrical wire, $V=\frac{\pi r^2 L}{4}$,

where x is the diameter of wire
Differentiating both sides

$\frac{dV}{dx}=\frac{\pi}{4}\left[2xL+x^2\cdot\frac{dL}{dx}\right]$

Also, volume remains constant

$\therefore \frac{dV}{dx}=0$

$\therefore 2xL+x^2\frac{dL}{dx}=0$

$\Longrightarrow 2xL=-x^2\frac{dL}{dx}$

$\Longrightarrow \frac{\frac{dx}{x}}{\frac{dL}{L}}=\frac{-1}{2}$

Poisson's ratio ¿$-\frac{1}{2}$.

275 **(d)**

Let L be the length of each side of cube. Initial volume of cube ¿L^3. When each side of cube decreases by 2%, the new length

$L'=L-\frac{2L}{100}=\frac{98L}{100}$

New volume¿$L'^3=$¿

$\therefore Change \in volume$

$\Delta V=L^3-$¿

¿$L^3 [1-\left(1-\frac{2}{100}\right)^3]$

¿$L^3 [1-\left(1-\frac{6}{100}+\dots\right)]$

(from binomial expension)

¿$L^3\left[\frac{6}{100}\right]=\frac{6L^3}{100}$

$\therefore Bulk\, strain=\frac{\Delta V}{V}=\frac{6L^3/100}{L^3}=0.06$

276 **(c)**

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

277 **(a)**

Isothermal elasticity = p, Adiabatic elasticity = γP

$\therefore \frac{E_\theta}{E_\phi}=\frac{1}{Y}, Y>1$

$\therefore \frac{E_\theta}{E_\phi}<1$

279 **(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.

280 **(b)**

$K=\frac{4\times 9.8}{2\times10^{-2}} \vee K=19.6\times10^2\, N\, m^{-1}$

Work done = $\frac{1}{2}\times19.6\times10^2\times\left(5\times10^{-2}\right)^2 J=2.45\, J$

281 **(c)**

The work done by wire is stored as potential energy in the wire

$U=\frac{1}{2}\times Young's\, modulus \times$¿

Given, $Y=2\times10^{10}\, Nm^{-2}$

Strain¿$\frac{l}{L}=\frac{l}{50\times10^{-2'}}U=2\times10^{-2}J$

$\therefore\ 2\times10^{-2}=\frac{1}{2}\times2\times10^{10}\times\left(\frac{l}{50\times10^{-2}}\right)^2$

$\Rightarrow l\approx0.707\, mm$ (stretched)

282 **(d)**

$Y=\frac{F\times4\times1}{\pi D^2\Delta l}$

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.

283 **(a)**

$Y\propto F$

$\therefore \frac{F_{Cu}}{F_{Fe}}=\frac{Y_{Cu}}{Y_{Ee}}=\frac{1}{3}$

284 **(c)**

Force = weight suspended + weight of $\frac{3L}{4}$ of wire

$w_1 + \frac{3w}{4}$

Stress = $\frac{force}{area} = \frac{W_1 + \frac{3}{4}w}{5}$

285 **(d)**

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

286 **(a)**

$Y = \frac{MgL}{Al} = \frac{250 \times 9.8 \times 2}{50 \times 10^{-6} \times 0.5 \times 10^{-3}}$

¿ $19.6 \times 10^{11} N/m^2$

287 **(b)**

Stress = $\frac{100N}{10^{-6}m^2} = 10^8 N m^{-2}$

Strain ¿ $\frac{2 \times 10^{-3}}{2} = 10^{-3}$

Young modulus

= $\frac{10^8}{10^{-3}} N m^{-2} = 10^{11} N m^{-2}$

Energy stored = $\frac{1}{2} \times 100 \times 2 \times 10^{-3} J$

= 10−¿1H = 0.1J

288 **(d)**

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

¿ $\frac{1}{2} \times Youn\,g's\,modulus \times (Strain)^2 = \frac{1}{2} \times Y \times x^2$

289 **(d)**

Breaking force does not depend upon length.

Breaking force = breaking stress × area of cross-section for a given material, breaking stress in constant.

$\therefore \frac{F_2}{F_1} = \frac{A_2}{A_1} = \frac{\pi(6r)^2}{\pi r^2} = 36$

Or $F_2 = 36F_1 = 36F$s

290 **(a)**

Per unit volume energy stored

¿ $\frac{1}{2} \times Y \times$ ¿

given $l = L \times 1\%$

or $l = \frac{L}{100} \times stored\,energy$

$Y = \frac{1}{2} \times 2 \times 10^{10} \times \left(\frac{L}{100L}\right)^2$ ¿ $10^6 Jm^{-3}$

291 **(b)**

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

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

293 **(b)**

Breaking force $\propto \pi r^2$

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

294 **(b)**

$l = \frac{FL}{AY} \therefore l \propto \frac{1}{A}$ ¿ and Y are constant]

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

295 **(b)**

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

¿ $\frac{FL}{\pi a^2 l}$

Since for same material Young's modulus is same, *ie*,

$Y_1 = Y_2$

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

or $l' = l$

296 **(b)**

$U = \frac{1}{2} \times Y \times (Strain)^2 = \frac{1}{2} \times 9 \times 10^{11} \times \left(\frac{1}{100}\right)^2$

¿ $4.5 \times 10^7 J$

297 **(d)**

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

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

298 **(a)**

Area of hysterisis loop gives the energy loss in the process of stretching and unstretching of rubber band and this loss will appear in the form of heating

299 **(a)**

Speed of sound in a stretched string $v = \sqrt{\frac{T}{\mu}}$ …(i)

Where T is the tension in the string and μ is mass per unit length

According to Hooke's law, $F \propto x \therefore T \propto x$ …(ii)

From (i) and (ii), $v \propto \sqrt{x}$

$\therefore v' = \sqrt{1.5}\, v = 1.22\, v$

300 **(a)**

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

¿ $\frac{1}{2} \frac{YA \Delta l^2}{l}$

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

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

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

¿ $F = \frac{YA \Delta l}{l}$

301 **(a)**

Work done, W

¿ $\frac{1}{2} F \times l = \frac{1}{2} \times stress \times strain \times volume$

Or $W = \frac{1}{2} Y \times (stress)^2 \times volume$

= $\frac{1}{2} Y \left(\frac{\Delta l}{l}\right)^2 \times Al = \frac{1}{2} Y \frac{\Delta l^2 A}{l}$

= $\frac{2 \times 10^{11} \times 10^{-6} \times 10^{-6}}{2 \times 1} = 0.1 J$

302 **(a)**

If coefficient of volume expansion is α and rise in temperature is $\Delta \theta$ then $\Delta V = V \alpha \Delta \theta \Rightarrow \frac{\Delta V}{V} = \alpha \Delta \theta$

Volume elasticity $\beta = \frac{P}{\Delta V / V} = \frac{P}{\alpha \Delta \theta} \Rightarrow \Delta \theta = \frac{P}{\alpha \beta}$

303 **(b)**

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

304 **(d)**

Work done in stretching the wire

¿ $potential\, energy\, stored$

¿ $\frac{1}{2} \times stress \times strain \times volume$

¿ $\frac{1}{2} \times \frac{F}{A} \times \frac{l}{L} \times AL = \frac{1}{2} Fl$

305 **(b)**

Young's modulus of material

$Y = \frac{Linear\ stress}{Longitudinal\ strain}$

If longitudinal strain is equal unity, then

$Y =$ ¿ Linear stress produced

307 **(d)**

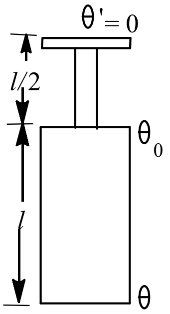
$\tau = C\theta$

¿ $\frac{\pi \eta r^4 \theta}{2L} = constant$

$$\Rightarrow \frac{\pi \eta r^4 (\theta - \theta_0)}{2l} = \frac{\pi \eta \left(\frac{r}{2}\right)^4 (\theta_0 - \theta')}{2(l/2)}$$

$$\Rightarrow \frac{(\theta - \theta_0)}{2} = \frac{\theta_0}{16}$$

$$\Rightarrow \theta_0 = \frac{8}{9}\theta$$



308 **(a)**

To twist the wire through the angle $d\theta$, it is necessary to do the work

$dW = \tau d\theta$

And $\theta = 10' = \frac{10}{60} \times \frac{\pi}{180} = \frac{\pi}{1080} rad$

$$W = \int_0^\theta \tau \, d\theta = \int_0^\theta \frac{\eta \pi r^4 \theta \, d\theta}{2l} = \frac{\eta \pi r^4 \theta}{4l}$$

$$W = \frac{5.9 \times 10^{11} \times 10^{-5} \times \pi (2 \times 10^{-5})^4 \pi^2}{10^{-4} \times 4 \times 5 \times 10^{-2} \times (1080)^2}$$

$W = 1.253 \times 10^{-12} J$

309 **(c)**

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

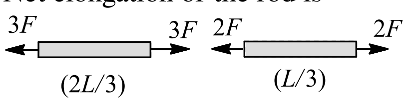
Applied force ∝ extension

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

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

310 **(d)**

Net elongation of the rod is



$$l = \frac{3F\left(\frac{2L}{3}\right)}{AY} + \frac{2F\left(\frac{L}{3}\right)}{AY}$$

$$l = \frac{8FL}{3AY}$$

311 **(d)**

Shearing strain = $\frac{0.02 \times 10^{-2}}{0.1} = 0.002$

312 **(b)**

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

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

Change in length ¿ $2\pi R - 2\pi r$

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

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

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

313 **(b)**

$$T = \frac{YAl}{L}$$

Increase in length of one segment of wire

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

So, $T = \frac{Y\pi r^2 . d^2}{2L^2}$

314 **(b)**

Let L be length of body, A the area of cross-section and l the increase in length.

$$Stress = \frac{F}{A}, strain = \frac{l}{L}$$

Force necessary to deform the body is

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

If body is deformed by a distance, then

$$Work\ done = F \times dl = \frac{YA}{L} l dl$$

$$W = \int_0^1 \frac{YA}{L} l dl = \frac{YA}{L}\left[\frac{l^2}{2}\right]_0^l = \frac{1}{2} YA \frac{l^2}{L}$$

¿ $\frac{1}{2}\left(Y \frac{l}{L}\right)\left(\frac{l}{L}\right)(AL)$

¿ $\frac{1}{2}(stress \times strain) \times volume$

Hence, work done for unit volume is

$$W = \frac{1}{2} stress \times srain.$$

315 **(c)**

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

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

$$\frac{r_2}{r_1}=\left[\frac{Y_1}{Y_2}\right]^{1/2}=\left[\frac{7\times10^{10}}{12\times10^{10}}\right]^{1/2}$$

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

$\therefore$ Diameter = 2.29 mm.

316 **(a)**

$$l=\frac{FL}{AY}=\frac{4.8\times10^3\times4}{1.2\times10^{-4}\times1.2\times10^{11}}=1.33\,mm$$

318 **(a)**

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

Final volume $V'=V-\Delta V=V-\frac{V\Delta p}{K}=V¿)$

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

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

Or $\rho=\frac{10.5\times10^3}{\left(1-10^7/17\times10^{10}\right)}$

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

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

319 **(a)**

Strain = $\frac{\Delta l}{l}=\frac{l\alpha t}{l}=\alpha t=12\times10^{-6}\times30=36\times10^{-5}$

320 **(c)**

$Y=\frac{stress}{strain}\vee strain=\frac{stress}{Y}\vee\frac{\Delta L}{L}=\frac{stress}{Y}$

Since, cross-sections are equal and same tension exists in both the wires, therefore, the stresses developed are equal.

Also, ΔL is given to be the same for both the wires.

$\therefore L\propto Y$

$\therefore\frac{L_s}{L_{Cu}}=\frac{2\times10^{11}}{1.1\times10^{11}}=\frac{20}{11}$

321 **(c)**

$V=\pi r^2 l$

$\frac{\Delta V}{V}=\frac{\Delta\left(\pi r^2 l\right)}{\pi r^2 l}\vee\frac{\Delta V}{V}=\frac{r^2\Delta l+2rl\Delta r}{r^2 l}$

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

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

322 **(a)**

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

= $\frac{1}{2}Y\times strain\times strain=\frac{1}{2}Y\times strain^2$

= $\frac{1}{2}\times2\times10^{10}\times0.06\times10^{-2}\times0.06\times10^{-2}$

= $3600\,J\,m^{-3}$

323 **(a)**

$Y=\frac{Fl}{A\Delta l}=\frac{\left(ml\omega^2\right)l}{A\Delta l}\vee Y=\frac{ml^2\omega^2}{A\Delta l}$

Or $Y=\frac{1\times1\times1\times20\times20}{10^{-6}\times10^{-3}}=4\times10^{11}\,N\,m^{-2}$

324 **(d)**

$$Y=\frac{k}{r_0}=\frac{7}{3\times10^{-10}}=2.33\times10^{10}\,N/m^2$$

325 **(d)**

$F=YA\alpha\Delta\theta$

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

326 **(a)**

$\Delta L=\frac{FL}{AY}$

Because, wires of the same material are stretched by the same load. So, F and Y will be constant.

$\therefore\Delta L\propto\frac{L}{\pi r^2}$

$\Delta L_1=\frac{100}{\pi\times¿¿}$

$¿\frac{100}{\pi}\times10^{-6}$

$\therefore\Delta L_2=\frac{200}{\pi\times¿¿}$

$¿\frac{22.2}{\pi}\times10^6$

$\therefore\Delta L_3=\frac{300}{\pi\times¿¿}$

$¿\frac{33.3}{\pi}\times10^6$

$\therefore\Delta L_4=\frac{400}{\pi\times¿¿}$

$¿\frac{25}{\pi}\times10^6$

We can see that, L=100 cm and r= 1mm will elongate most.

328 **(b)**

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

$\frac{l_1}{l_2}=\frac{F \times L}{r^2} \times \frac{(4r^2)}{4F \times 4L}$

Or $l_1=l_2=l$

So, l remain unchanged.

329 **(d)**

For Hook's law, stress $\propto strain\, ie$, the graph between stress and strain is a straight line, which is so for portion $O ¿ D$.

330 **(d)**

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

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

331 **(d)**

$K=\frac{\Delta P}{\Delta V/V}=\frac{h\rho g}{\Delta V/V}=\frac{200\times 10^3\times 10}{0.1/100}=2\times 10^9$

332 **(b)**

Young's modulus, $Y=\frac{3\eta}{2}$

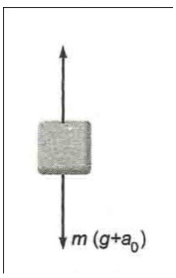
We know that $Y=2\eta(1+\sigma)$

$\therefore \frac{3\eta}{2}=2\eta(1+\sigma)$

$\Rightarrow \sigma=\frac{-1}{4}$

333 **(b)**

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



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

$=\frac{120}{2\times 10^{-4}}=60\times 10^4\,N\,m^{-2}$

$\therefore Y=\frac{stress}{4\,strain}$

$\therefore strain=\frac{stress}{Y}$

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

334 **(d)**

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

$\therefore l\propto L^2$ if volume of the wire remains constant

$\frac{l_2}{l_1}=\left(\frac{L_2}{L_1}\right)^2=\left(\frac{8}{2}\right)^2=16$

$\therefore l_2=16\times l_1=16\times 2=32\,mm=3.2\,cm$

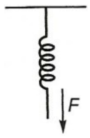
335 **(b)**

$l=\frac{FL}{AY}\Rightarrow \frac{l_S}{l_{cu}}=\frac{Y_{cu}}{Y_S}[F, L \wedge Y\, are\, constant]$

$\therefore \frac{l_s}{l_{cu}}=\frac{1.2\times 10^{11}}{2\times 10^{11}}=\frac{3}{5}$

336 **(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



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

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 $¿ 5b-4a$

337 **(b)**

Longitudinal strain $\frac{l}{L}=\frac{stress}{Y}=\frac{10^6}{10^{11}}=10^{-5}$

Percentage increase in length $¿ 10^{-5}\times 100=0.001\%$

338 **(b)**

Breaking force $\propto$ Area of cross section of wire $i.e.$ load hold by the wire does not depend upon the length of the wire

339 **(b)**

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

$\Delta p = \frac{M g}{A}$

From Bulk modulus definition

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

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

¿ $V = \frac{4}{3}\pi r^3$

$\frac{dV}{V} = \frac{3\,dR}{R}$

$\Longrightarrow \frac{dR}{R} = \frac{1}{3}\frac{dV}{V}$

¿ $\frac{Mg}{3\,AK}$