INDRUCTION

1. Solids which beak above the elastic limit are called
   a) brittle b) ductile
   c) malleable d) elastic
2. Out of the following the most plastic material is
   a) iron b) wood
   c) rubber d) plasticine
3. Match the Column I with Column II

Column I		Column II	
(A)	A body which regains its original shape after the removal of external forces	(p)	Elasticity
B)	A body which does not regain its original shape after the removal of external forces	q)	Elastic body
C)	A body which does not show any deformation on applying external forces	r)	Plastic body
D)	The property of the body to regain its original configuration when the deforming forces are removed	s)	Rigid body

   a) $A-q, B-r, C-s, D-p$
   b) $A-p, B-q, C-r, D-s$
   c) $A-r, B-s, C-p, D-q$
   d) $A-s, B-p, C-q, D-r$
4. The substance which shows practically no elastic after effect is
   a) copper b) silver
   c) rubbed d) quartz

ELASTIC BEHAVIOUR OF SOLIDS

5. Two identical solid balls, one of ivory and the other of wet day are dropped from the same height on the floor . After striking the floor ,
   a) ivory ball will rise to a greater height than wet clay ball,
   b) ivory ball will rise to a lesser height than wet clay ball.
   c) both balls will rise to the same height
   d) data is insufficient.
6. The potential energy U of two atoms of a diatomic molecules as function of distance r between the atoms as shown in the given figure

   Read the following statements carefully.
   1. The equilibrium separation distance between the atoms is equal to r_2
   2. At the force between the atom is repulsive
   3) For the force between the atoms is attractive

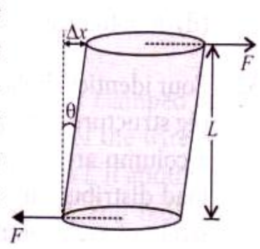
   Which of the above statements is true?
   1) 1 only 2) 2 only
   3) 3 only d) 2 and 3

STRESS AND STRAIN

7. Which of the following statements is incorrect?
   a) When a material is under tensile stress, the restoring forces are caused by interatomic attraction while under compress ional stress , the restoring force is due to interacomic repulsion
   b) The stretching of a coil is determined by its shear modulus
   c) Rubber is more elastic than steel
   d) Shearing stress plays an important role in the buckling of shafts
8. Shear stress is related to
   a) length b) area
   c) volume d) shape
9. If the volume of a wire remains constant when subjected to tensile stress, the value of Poisson's ratio of the ratio of the material of the wire is
   a) 0.1 b) 0.2
   c) 0.4 d) 0.5
10. Fluids can develop
    a) longitudinal strain only
    b) longitudinal and shearing strain
    c) longitudinal, shearing and volumetric strain
    d) volumetric strain only
11. Which of the following statements is correct regarding Poisson's ratio?
    a) It is the ratio of the longitudinal strain to the lateral strain.
    b) Its value is independent of the nature of the material

c) It is untiless and dimensionless quantity.
d) The practical value of Poisson's ratio lies between 0 and 1.

12. If two equal and opposite deforming forces are applied parallel to the cross-sectional are of the cylinder as shown in the figure, there is a relative displacement between the opposite faces of the cylinder.
The ratio of Δx to L is known as



a) longitudinal strain
b) volumetric strain
c) shearing strain
d) Poisson's ratio

13. Stress is a … quantity.
a) scalar b) vector
c) tensor d) dimensionless

14. The breaking stress of wire depends upon
a) length of the wire
b) radius of the wire
c) material of the wire
d) shape of the cross section

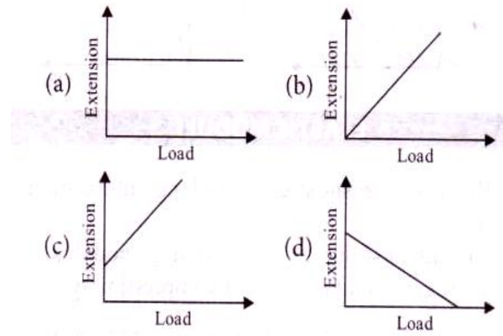
15. A wire is suspended from the ceiling and stretched under the action of a weight F suspended form its other end. The force exerted by the ceiling on its equal and opposite to the weight.
a) Tensile stress at any cross section A of the wire is $\frac{F}{A}$
b) Tensile stress at any cross section is zero
c) Tensile stress at any cross section is zero
d) Tension at any cross section A of the wire is 2F

HOOKE'S LAW

16. In which year Robert Hooke presented his law of elasticity?
a) 1672 b) 1674
c) 1676 d) 1678

17. According to Hooke's laws of elasticity, if stress is increased, the ratio of stress to strain
a) decreases b) increases
c) becomes zero
d) remains constant

18. Within elastic limit, which of the following graphs correctly represents the variation of extension in the length of a wire with the external load?

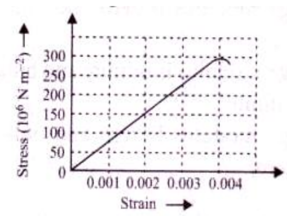


STRESS –STAIN CURVE

19. Substances which can be stretched to cause large strains are called
a) isomers b) plastomers
c) elastomers d) polymers

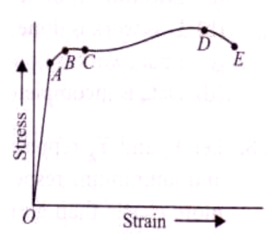
20.The breaking stress for a wire of unit cross-section is called
a) yield points
b) elastic fatigue
c) tensile strength
d) Young's modulus

21. Figure show the strain-stress cruce for a given material. The Young's modulus of the material is



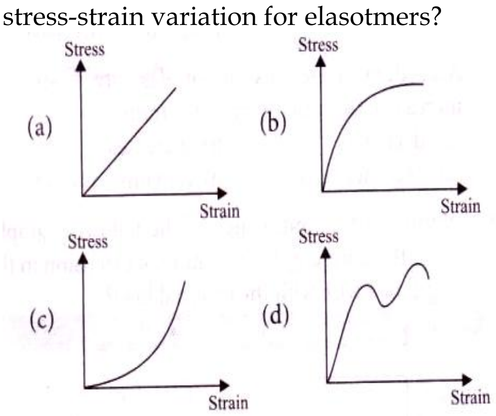
a) $5\times10^{9}\,Nm^{-2}$
b) $5\times10^{10}\,Nm^{-2}$
c) $7.5\times10^{9}\,Nm^{-2}$
d) $7.5\times10^{10}\,Nm^{-2}$

22. The stress-strain graph for a metal wire is as shown in the figure. In the graph, the region in which Hooke's law is obey, the ultimate strength and facture points are represented by



a) OA,C,D b) OB,D,E
c) OA,D,E d) OB,C,D

23. Which of the following graphs represent stress-strain variation for elasotmers?



ELASTIC MODULI

24. The ratio of ensile stress to the longitudinal strain is defined as
    a) bulk modulus
    b) Young's modulus
    c) shear modulus
    d) compressibility
25. Which of the following statements is incorrect?
    a) Young's modulus and shear modulus are relevant only for solids
    b) Bulk modulus is relevant for solids , liquids and gases
    c) Metals has larger values of Young's modulus that elastomers
    d) Alloys have larger values of Young's modulus than metals.
26. For a perfectly rigid body
    a) Young's modulus is infinite and bulk modulus is zero
    b) Young's modulus is zero and bulk modulus is infinite.
    c) Young's modulus is infinite and bulk modulus is also infinite
    d) Young's modulus is zero and bulk modulus is also zero
27. Identical spring of steel and copper $\left(Y_{steel} > Y_{copper}\right)$ are equally stretched .
    a) Less work is done on copped spring.
    b) Less work is done on steel spring.
    c) Equal work is done on both the springs.
    d) Data is incomplete
28. Let Y_S and Y_A represent Young's modulus for steel and aluminium respectively. It is said that steel is more elastic than aluminium. There fore it follows that.
    a) $Y_S = Y_A$ b) $Y_S < Y_A$
    c) $Y_S < Y_A$ d) $\frac{Y_S}{Y_A} = 0$
29. Which of the following substances has highest value of Young's modulus?
    a) Aliminiium b) Iron
    c) Copper d) Steel
30. If the work done in stretching a wire by 1 mm is 2J, 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) 16J b) 8J
    c) 4J d) $\frac{1}{4}J$
31. The following four wires of length L and radius r are made of the same material. Which of these will have larges extension, when the same tension is applied?
    a) L=100cm, r=0.2 mm
    b) L= 200cm, r=0.4 mm
    c) L= 300cm, r=0.6mm
    d) L=400 cm, r=0.8 mm
32. Four identical hollow cylindrical columns, support a big structure of mass M. The inner and outer radii of a column are R_1 and R_2 respectively. Assuming the load distribution to be uniform, the compressional strain of each column is
    (where Y is Young's modulus of the column)
    a) $\frac{Mg}{\pi\left(R_2^2 - R_1^2\right)Y}$ b) $\frac{Mg}{4\pi\left(R_2^2 - R_1^2\right)Y}$
    c) $\frac{Mg}{\pi\left(R_1^2 - R_2^2\right)Y}$
    d) $\frac{Mg}{4\pi\left(R_1^2 - R_2^2\right)Y}$
33. The elastic energy stored per unit volume in a stretched wire is
    a) $\frac{1}{2}\frac{stress}{Y}$ b) $\frac{1}{2}\frac{\left(stress\right)^2}{Y}$
    c) $\frac{1}{2}\frac{\left(stress\right)^2}{Y^2}$ d) $\frac{1}{2}\frac{stress}{Y^2}$
34. Two wires of the same material and length but diameter in the ratio 1:2 are stretched by the same load. The ratio of elastic potential energy per unit volume for the two wires is
    a) 1:1 b) 2:1
    c) 4:1 d) 16:1
35. Young's modulus of wire depends on
    a) diameter of the wire
    b) mass hanging form the wire
    c) length of the wire
    d) material of the wire
36. A light rod of length 2m is suspended from the ceiling horizontally by means of two vertical wires of equal length tied to its ends. One of the wires is made of steel and is of cross-section 0.1 cm^2 and the other of brass of cross se-section $0.2cm^2$. along the rod at what distance a weight may be hung to produce equal stresses in both the wires?
    ($Y_{steel} = 2\times10^{11}Nm^{-2}, Y_{brass} = 1\times10^{11}Nm^{-2}$)
    a) $\frac{4}{3}m$ from steel wire (b)
    b) $\frac{4}{3}m$ from brass wire
    c) 1 m from steel wire
    d) $\frac{1}{4}m$ from brass wire
37. In the question number 36, at which distance a weight may be hung along the road, in order to produce equal strains in both the wires?
    a) $\frac{4}{3}$ m from steel wire
    b) $\frac{4}{3}$ m from brass wire
    c) 1 m from steel wire
    d) $\frac{1}{4}$ m from brass wire

38. A wire of length L and radius r is clamped at one end. One stretching the other end of the wire with a force F, the increase in its length is l. If a another wire of same material but of length 2L and radius 2r is stretched with a force 2F, the increase in its length will be

a) $\frac{l}{4}$ b) $\frac{l}{2}$

c) l d) 2l

39. The radii and Young's moduli 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 present, the percentage increase in length of the wire B is

a) 1.0 b) 1.5

c) 2.0 d) 3.0

40. A steel cable with a radius 2cm supports a chairlift at a skin area. If the maximum stress is not to exceed 10^8 Nm^{-2}, the maximum load the cable can support is

a) $4\pi\times10^5 N$ b) $4\pi\times10^4 N$

c) $2\pi\times10^5 N$ d) $2\pi\times10^4 N$

41. A steel rod of length 1 m and radius 10mm is stretched by a force 100kN along its length. The stress produced in the rod is $\left(Y_{steel}=2\times10^{11}Nm^{-2}\right)$

a) $3.18\times10^6 Nm^{-2}$

b) $3.18\times10^7 Nm^{-2}$

c) $3.18\times10^8 Nm^{-2}$

d) $3.18\times10^9 Nm^{-2}$

42. In the question number 41, the percentage strain produced in the rod is

a) 0.4% b) 0.8%

c) 0.16% d) 0.24%

43. A steel wire can support a maximum load of W before reaching its elastic limit. How much load can another wire, made out of identical steel but with a radius one half the radius of the first wire , support before reaching its elastic limit?

a) W b) $\frac{W}{2}$

c) $\frac{W}{4}$ d) 4W

44. A uniform rod of mass m, length L, area of cross section A is rotated about an axis passing through one of its ends and perpendicular to its length with constant angular velocity ω in a horizontal plane. If Y is the Young's modulus of the material of road, the increase in to length due to rotation of rod is

a) $\frac{m\omega^2L^2}{AY}$ b) $\frac{m\omega^2L^2}{2AY}$

c) $\frac{m\omega^2L^2}{3AY}$ d) $\frac{2m\omega^2L^2}{AY}$

45. A wire stretches by a certain amount under a load. If the load and radius both are increased to four times. The stretch caused in the wire is

a) l b) $\frac{l}{2}$

c) $\frac{l}{3}$ d) $\frac{l}{4}$

46. A wire of length L has a linear mass density μ and area of cross –section A and the Young's modulus Y is suspended vertically from a rigid support. The extension produced in the wire due to its own weight is

a) $\frac{\mu gL^2}{YA}$ b) $\frac{\mu gL^2}{2YA}$

c) $\frac{2\mu gL^2}{YA}$ d) $\frac{2\mu gL^2}{3YA}$

47. In the question number 46, if the mass M is hung at the free end of the wire, then the extension produced in the wire is

a) $\frac{mgL^2+MgL}{2YA}$ b) $\frac{2\mu gL^2+MgL}{2YA}$

c) $\frac{\mu gL^2+2MgL}{2YA}$ d) $\frac{\mu gL^2+MgL}{YA}$

48. A 15 kg mass fastened to the end of a steel wire of unscratched length 1.0 m is whirled in a vertical circle with an angular velocity of 2 rev s^{-1} at the bottom of the circle. The cross-section of the wire is 0.05cm^2. The elongation of the wire when the mass is at the lowest point of its path is

(Take , g = $10ms^{-2}, Y_{steel}=2\times10^{11}Nm^{-2}$)

a) 0.52mm b) 1.52 mm

c) 2.52 mm d) 3.52 mm

49. A wire of length L and area of cross-section A, is stretched by a load. The elongation produced in the wire is *l*. If Y is the 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) $\frac{YA}{l}$

50. A metal wire of length L_1 and area of cross-section A is attached to a rigid support. Another metal wire of length L_2 and of the same cross-sectional area is attached to the free end of the first wire. A body of mass M is then suspended from the free end of the second wire. If Y_1 and Y_2 are the Young's moduli of the wires respectively, the effective force constant of the system of two wires is

a) $\frac{[(Y_1Y_2)A]}{[2(Y_1L_2+Y_2L_1)]}$ b) $\frac{[(Y_1Y_2)A]}{(L_1L_2)^{1/2}}$

c) $\frac{[(Y_1Y_2)A]}{(Y_1L_2+Y_2L_1)}$ d) $\frac{[(Y_1Y_2)^{1/2}A]}{(L_1L_2)^{1/2}}$

51. The area of a cross-section of steel wire is 0.1cm^2 and Young's modulus of steel is $2\times10^{11}\text{Nm}^{-2}$. The force required to stretch by 0.1% of its length is

a) 1000 N b) 2000 N
c) 4000 N d) 5000 N

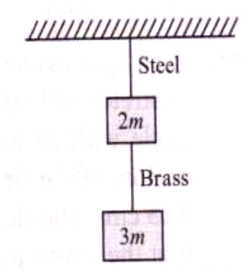
52. A stone of mass m tied to one end of a wire of length L. The diameter of the wire is D and it is suspended vertically. The stone is now rotated in a horizontal plane and makes an angle θ with the vertical. If Young's modulus of the wire is Y, then the increase in the length of the wire is

a) $\frac{4\text{mgL}}{\pi\text{D}^2\text{Y}}$ b) $\frac{4\text{mgL}}{\pi\text{D}^2\text{Y}\sin\theta}$
c) $\frac{4\text{mgL}}{\pi\text{D}^2\text{Y}\cos\theta}$ d) $\frac{4\text{mgL}}{\pi\text{D}^2\text{Y}\tan\theta}$

53. When the load on a wire is increased from 3 kg wt to 5 kg wt the elongation increases from 0.61 mm to 1.02 mm. The required work done during the extension of the wire is

a) $16\times10^{-3}\text{J}$ b) $8\times10^{-2}\text{J}$
c) $20\times10^{-2}\text{J}$ d) $11\times10^{-3}\text{J}$

54. If the ratio of diameters, lengths and Young's moduli of steel and brass wires shown in the figure are p, q and r respectively. Then the corresponding ratio of increase in their lengths would be



a) $\frac{3\text{q}}{5\text{p}^2\text{r}}$ b) $\frac{5\text{q}}{3\text{p}^2\text{r}}$
c) $\frac{3\text{q}}{5\text{pr}}$ d) $\frac{5\text{q}}{3\text{pr}}$

55. A copper wire of length 2.4 m and a steel wire of length 1.6 m, both of diameter 3 mm, are connected end to end. When stretched by a load, the net elongation is found to be 0.7 mm. The load applied is

$(\text{Y}_{\text{copper}} = 1.2\times10^{11}\text{Nm}^{-2},\ \text{Y}_{\text{steel}} = 2\times10^{11}\text{N m}^{-2})$

a) $1.2\times10^2\text{N}$ b) $1.8\times10^2\text{N}$
c) $2.4\times10^2\text{N}$ d) $3.2\times10^2\text{N}$

56. In the question number 55, the ratio of elongation of steel to the copper wires is

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

57. A steel wire of length 4.5 m and cross-sectional area $3\times10^{-5}\text{m}^2$ stretches by the same amount as a copper wire of length 3.5 m and cross-sectional area of $4\times10^{-5}\text{m}^2$ under a given load. The ratio of the Young's modulus of steel to that of copper is

a) 1.3 b) 1.5
c) 1.7 d) 1.9

58. The Young's modulus of a wire of Length L and radius r is Y. If the length is reduced to $\frac{\text{L}}{2}$ and radius is $\frac{\text{r}}{2}$, then the Young's modulus will be

a) $\frac{\text{Y}}{2}$ b) Y
c) 2Y d) 4Y

59. A copper and a steel wire of the same diameter are connected end to end. A deforming force F is applied to this composite wire which causes a total elongation of this composite wire which causes a total elongation of 1 cm. The two wires will have

a) the same stress and strain
b) the same stress but different strain
c) the same strain but different stress
d) different strains and stress

60. Which of the following apparatus is used to determine the Young's modulus of the material of a given wire?

a) Searle b) sonometer
c) Metre bridge d) Resonance tube

61. With rise in temperature, the Young's modulus of elasticity

a) increases b) decreases
c) remains unchanged d) None of these

62. The length of a rubber cord is $l_1\text{m}$ when the tension is 4 N and $l_2\text{m}$ when the tension is 6 N. The length when the tension is 9 N, is

a) $(2.5l_2 - 1.5l_1)\text{m}$ b) $(6l_2 - 1.5l_1)\text{m}$
c) $(3l_1 - 2l_2)\text{m}$ d) $(3.5l_2 - 2.5l_1)\text{m}$

63. The ratio of shearing stress to the shearing strain is defined as

a) Young's modulus b) bulk modulus
c) shear modulus d) compressibility

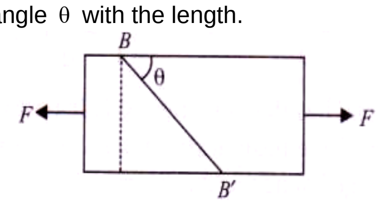
64. The shear modulus is also known as

a) bulk modulus b) Young's modulus
c) modulus of rigidity d) Possion's ratio

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

a) shearing stress there is change in volume
b) hydraulic stress there is no change in shape.
c) shearing stress there is no change in shape.
d) hydraulic stress there is no change in volume.

66. A bar of cross-sectional area A is subjected two equal and opposite tensile forces at its ends as shown in figure. Consider a plane BB' making an angle θ with the length.



The ratio of tensile stress to the shearing stress on the plane BB' is

a) $\tan\theta$ b) $\sec\theta$
c) $\cot\theta$ d) $\cos\theta$

67. In the question number 66, for what value of θ, shearing stress is maximum?
a) 0^o b) 30^o
c) 45^o d) 90^o

68. Two parallel and opposite forces each 5000 N are applied tangentially to the upper and lower faces of a cubical metal block of side 25 cm. The angle of shear is
(The shear modulus of the metal is 80 GPa).
a) 10^{-4}rad b) 10^{-5}rad
c) 10^{-6}rad d) 10^{-7}rad

69. The edge of an aluminium cube is 10 cm long. One face of the cube is firmly fixed to a vertical wall. A mass of 100 kg is then attached to the opposite face of the cube. The vertical deflection of this face is (Shear modulus of aluminium $= 25\text{ GPa},\ g = 10\text{m s}^{-2}$)
a) $4\times10^{-5}\text{m}$ b) $4\times10^{-6}\text{m}$
c) $4\times10^{-7}\text{m}$ d) $4\times10^{-8}\text{m}$

70. For most materials the Young's modulus is n times the modulus of rigidity, where n is
a) 2 b) 3
c) 4 d) 5

71. A square lead slab of side 50 cm and thickness 10 cm is subjected to a shearing force (on its narrow face) of $9\times10^4\text{N}$. The lower edge is riveted to the floor. How much will the upper edge be displaced? (Shear modulus of lead= $5.6\times10^9\text{Nm}^{-2}$)
a) 0.16 mm b) 1.6 mm
c) 0.16 cm d) 1.6 cm

72. The metal cube of side 10 cm is subjected to a shearing stress of 10^4N m^{-2}. The modulus of rigidity if the top of the cube is displaced by 0.05 cm with respect to its bottom is
a) $2\times10^6\text{N m}^{-2}$ b) 10^5N m^{-2}
c) $1\times10^7\text{N m}^{-2}$ d) $4\times10^5\text{N m}^{-2}$

73. For an ideal liquid
a) bulk modulus is infinite and shear modulus is zero
b) bulk modulus is zero and shear modulus is infinite.
c) bulk modulus is infinite and shear modulus is also infinite.
d) bulk modulus is zero and shear modulus is also zero.

74. Which of the following statements is incorrect?
a) The bulk modulus for solids is much larger than for liquids.
b) Gases are least compressible
c) For a system in equilibrium, the value of bulk modulus is always positive.
d) The SI unit of bulk modulus is same that of pressure.

75. A sphere contracts in volume by 0.01%, when taken to the bottom of sea 1 km deep. The bulk modulus of the material of the sphere is (Given density of sea water may be taken as $1.0\times10^3\text{kgm}^{-3}$).
a) $4.9\times10^{10}\text{Nm}^{-2}$ b) $9.8\times10^{10}\text{Nm}^{-2}$
c) $4.9\times10^9\text{Nm}^{-2}$ d) $9.8\times10^9\text{N m}^{-2}$

76. The bulk modulus of water if its volume changes from 100 litre to 99.5 litre under a pressure of 100 atm is
(Take $1\text{ atm} = 10^5\text{ N m}^{-2}$)
a) $2\times10^7\text{Nm}^{-2}$ b) $2\times10^8\text{Nm}^{-2}$
c) $2\times10^9\text{Nm}^{-2}$ d) $2\times10^{10}\text{Nm}^{-2}$

77. The average depth of Indian ocean is about 3000ms. The fractional compression, $\frac{\Delta V}{V}$ of water at the bottom of the ocean is
(Given: Bulk modulus of the water
$= 2.2\times10^9\text{N m}^{-2}$ and $g = 10\text{ ms}^{-2}$)
a) 0.82% b) 0.91%
c) 1.36% d) 1.24%

78. The density of water at the surface of the ocean is ρ and atmospheric pressure is P_0. If the bulk modulus of water is K, what is the density of ocean water at a depth where the pressure is nP_0?
a) $\frac{\rho K}{K - nP_0}$ b) $\frac{\rho K}{K + nP_0}$
c) $\frac{\rho K}{K - (n-1)P_0}$ d) $\frac{\rho K}{K + (n+1)P_0}$

79. If stress-strain relation for volumetric change is in the form $\frac{\Delta V}{V_0} = KP$ where P is applied uniform pressure, then K stands for
a) shear modulus b) compressibility
c) Young's modulus d) bulk modulus

80. Among solids, liquids and gases, which posses the greatest bulk modulus?
a) Solids
b) Liquids
c) Gases
d) Both solids and liquids

81. A glass slab is subjected to a pressure of 10 atm. The fractional change in its volume is
(Bulk modulus of glass $= 37\times10^9\text{N m}^{-2}$,
$1\text{ atm} = 1\times10^5\ \ \text{m}^{-2}$)
a) 2.7×10^{-2} b) 2.7×10^{-3}
c) 2.7×10^{-4} d) 2.7×10^{-5}

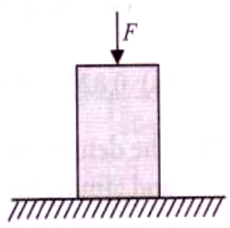
82. To what depth must a rubber ball be taken in deep sea so that its volume is decreased by 0.1%.(Take, density of sea water $= 10^3\text{ kg m}^{-3}$, bulk modulus of rubber $= 9\times10^8\text{N m}^{-2}, g = 10\text{ m s}^{-2}$)
a) 9 m b) 18 m
c) 90 m d) 180 m

83. The compressibility of water is $6\times10^{-10}\text{N}^{-1}\text{m}^2$. If one litre is subjected to a pressure of $4\times10^7\text{Nm}^{-2}$, the decrease in its volume is
a) 10 cc b) 24 cc
c) 15 cc d) 12 cc

84. How much pressure should be applied on a litre of water if it is to be compressed by 0.1%?
(Bulk modulus of water =2100 MPa)
a) 2100 kPa b) 210 kPa
c) 2100 MPa d) 210 MPa

85. The volume change of a solid copper cube 10 cm on an edge, when subjected to a pressure of 7 MPa is
(Bulk modulus of copper=140 GPa)
a) $5\times10^{-2}\text{cm}^3$ b) $10\times10^{-2}\text{cm}^3$
c) $15\times10^{-2}\text{cm}^3$ d) $20\times10^{-2}\text{cm}^3$

86. A metal cylinder of length L is subjected to a uniform compressive force F as shown in the figure. The material of the cylinder has Young's modulus Y and Poisson's ratio σ. The change in volume of the cylinder is



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

87. For a given material, the Young's modulus is 2.4 times that of the modulus of rigidity. Its Poisson's ratio is
a) 2.4 b) 1.2
c) 0.4 d) 0.2

88. A material has Poisson's ratio 0.5. 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 c) zero

89. The relation between Y, η and B is
a) $\frac{1}{Y}=\frac{1}{3\eta}+\frac{1}{9B}$ b) $\frac{9}{Y}=\frac{1}{\eta}+\frac{3}{B}$
c) $\frac{1}{\eta}=\frac{1}{B}+\frac{1}{Y}$ d) $\frac{9}{Y}=\frac{3}{\eta}+\frac{1}{B}$

90. A material has Poisson's ratio 0.2 . If a uniform rod of its suffers longitudinal strain 4.0×10^{-3}, calculate the percentage change in its volume.
a) 0.15% b) 0.02%
c) 0.24% d) 0.48%

91. One end of a nylon rope of length 4.5 m and diameter 6 mm is fixed to a free limb. A monkey weighing 100 N jumps to catch the free end and stays there. Find the elongation of the rope (Given Young's modulus of nylon $=4.8\times10^{11}\text{Nm}^{-2}$ and Poisson's ratio of nylon =0.2)

a) $0.332\,\mu\text{m}$ b) $0.151\,\mu\text{m}$
c) $0.625\,\mu\text{m}$ d) $0.425\,\mu\text{m}$

92. In question number 91, what will be the change in the diameter of the rope?
a) $8.8\times10^{-9}\text{m}$ b) $7.4\times10^{-9}\text{m}$
c) $6.4\times10^{-8}\text{m}$ d) $5.6\times10^{-9}\text{m}$

APPLICATIONS OF ELASTIC BEHAVIOUR OF MATERIALS

93. Assuming that shear stress at the base of a mountain is equal to the force per unit area due to its weight. Calculate the maximum possible height of a mountain on the earth if breaking stress of a typical rock is $3\times10^{8}\text{Nm}^{-2}$ and its density is $3\times10^{3}\text{kg m}^{-3}$. (Take $g=10\,\text{ms}^{-2}$)
a) 4 km b) 8 km
c) 10 km d) 16 km

94. With what minimum acceleration can a fireman slide down a rope whose breaking strength is two third of his weight?
a) $\frac{g}{2}$ b) $\frac{2}{3}g$
c) $\frac{3}{2}g$ d) $\frac{g}{3}$

95. 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) $\frac{1}{Y}$ d) $\frac{1}{Y^2}$

96. Two strips of metal are riveted together at their ends by four rivets, each of diameter 6 mm. Assume that each rivet is to carry one quarter of the load. If the shearing stress on the rivet is not to exceed 6.9×10^{7} Pa, the maximum tensioned by the riveted strip is
a) $2\times10^{3}\text{N}$ b) $3.9\times10^{3}\text{N}$
c) $7.8\times10^{3}\text{N}$ d) $15.6\times10^{3}\text{N}$

97. A spring is made of steel and not of copper because
a) steel is more elastic than copper
b) steel is less elastic than copper
c) steel is more plastic than copper
d) steel is less plastic than copper

98. A bar of length l, breadth b and depth d is supported at its ends and is loaded at the centre by a load W. If Y is the Young's modulus of the material of the bar, then the depression δ at the centre is
a) $\frac{Wl^3}{4bd^3Y}$ b) $\frac{Wb^3}{4dl^3Y}$
c) $\frac{Wd^3}{4lb^3Y}$ d) $\frac{Wl^3}{bd^3Y}$

99. Two rods A and B of the same material and length have radii r_1 and r_2 respectively. When they are rigidly fixed at one end and twisted by the same torque applied at the other end, the ratio

$\left[\dfrac{\text{the angle of twist at the end of A}}{\text{the angle of twist at the end of B}}\right]$

a) $\dfrac{r_1^2}{r_2^2}$ b) $\dfrac{r_1^3}{r_2^3}$

c) $\dfrac{r_2^4}{r_1^4}$ d) $\dfrac{r_1^4}{r_2^4}$

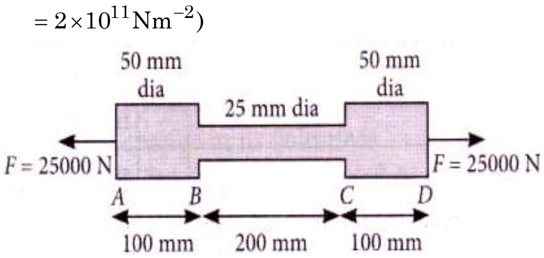
100. Match the Column I with Column II.

Column I		Column II	
(A)	The shape of rubber heel changes under stress	(p)	Young's modulus of elasticity is involved
(B)	In a suspended bridge, there is a strain in the ropes by the load of the bridge	(q)	Bulk modulus of elasticity is involved
(C)	In an automobile tyre, when air is compressed, the shape of tyre changes	(r)	Modulus of rigidity is involved
(D)	A solid body is subjected to a deforming force	(s)	All the moduli of elasticity are involved

a) A – q, B – r, C – s, D – p
b) A – p, B – q, C – r, D – s
c) A – r, B – q, C – p, D – s
d) A – r, B – p, C – q, D – s

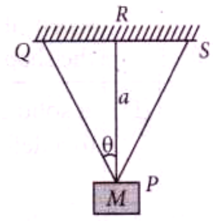
(HOTS) HIGHER ORDER THINKING SKILLS

1. A steel bar ABCD 40 cm long is made up of three parts AB, BC and CD, as shown in figure. The rod is subjected to a pull of 25 kN. The total extension of the rod is (Young's modulus for steel $= 2\times10^{11}\,\text{Nm}^{-2}$)



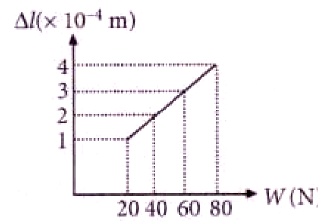
a) 0.0637 mm b) 0.0647 mm
c) 0.0657 mm d) 0.0667 mm

2. Three elastic wires, PQ, PR and PS support a body P of mass M, as shown in figure. The wires are of the same material and cross-sectional area, the middle one being vertical. The load carried by middle wire is



a) $Mg/1+2\cos^2\theta$
b) $Mg/1+2\cos^3\theta$
c) $Mg\cos^2\theta/1+2\cos^3\theta$
d) $Mg\cos\theta/1+2\cos^3\theta$

3. The adjacent graph shows the extension (Δl) of a wire of length 1 m 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. The Young's modulus of the material of the wire is



a) $2\times10^{11}\text{N/m}^2$ b) $2\times10^{-11}\text{N/m}^2$
c) $3\times10^{-12}\text{N/m}^2$ d) $2\times10^{-13}\text{N/m}^2$

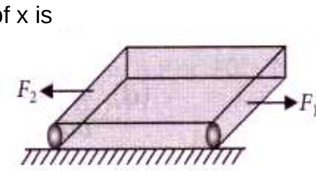
4. A solid sphere of radius R, made of a material of bulk modulus K, is surrounded by a liquid in a cylindrical container. A massless piston of area A floats on the surface of the liquid. When a mass M is placed on the piston to compress the liquid the fractional change in the radius of the sphere, $\delta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

a) $Mg/2AK$ b) $Mg/3AK$
c) Mg/AK d) $2Mg/3AK$

5. One end of a horizontal thick copper wire of length 2L and radius 2R is welded to an end of another horizontal thin copper wire of length L and radius R. When the arrangement is stretched by applying forces at two ends, the ratio of the elongation in the thin wire to that in the thick wire is

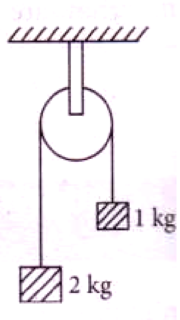
a) 0.25 b) 0.50
c) 2.00 d) 4.00

6. Two opposite forces $F_1 = 120\,\text{N}$ and $F_2 = 80\,\text{N}$ act on an elastic plank of modulus of elasticity $Y = 2\times10^{11}\text{N/m}^2$ and length $l = 1\,\text{m}$ placed over a smooth horizontal surface. The cross-sectional area of the plank is $S = 0.5\,\text{m}^2$. The change in length of the plank is $x\times10^{-9}\text{m}$. The value of x is



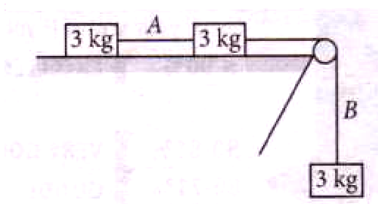
a) 1.0 b) 1.5
c) 1.4 d) 1.1

7. Two blocks of masses 1 kg and 2 kg are connected by a metal wire going over a smooth pulley as shown in figure. The breaking stress of the metal is $(40/3\pi)\times10^6\ \mathrm{N/m^2}$. If $g = 10\ \mathrm{m\,s^{-1}}$, then the minimum radius of the wire used if it is not to break is



a) 0.5 mm b) 1 mm
c) 1.5 mm d) 2 mm

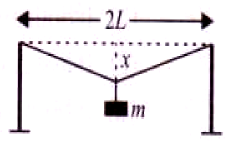
8. Three equal masses 3 kg are connected by massless string of cross sectional area $0.005\,\mathrm{cm^2}$ and Young's modulus $2\times10^{11}\mathrm{N/m^2}$. In the absence of friction, the longitudinal strain in the wire



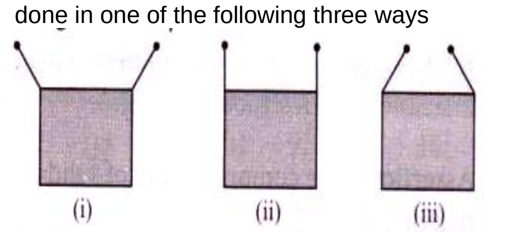
a) $\mathrm{A\ is\ }10^{-4}$ b) $\mathrm{B\ is\ }2\times10^{-4}$
c) Both (a) and (b) d) None of these

<u>(NCERT) EXEMPLAR PROBLEMS</u>

1. Modulus of rigidity of ideal liquids is
   a) infinity
   b) zero
   c) unity
   d) some finite small non-zero constant value.
2. The maximum load a wire can withstand without breaking, when its length is reduced to half of its original length, will
   a) be double
   b) be half
   c) be four times
   d) remain same.
3. The temperature of a wire is doubled. The Young's modulus of elasticity will
   a) also double
   b) become four times
   c) remain same
   d) decrease.
4. A spring is stretched by applying a load to its free end. The strain produced in the spring is
   a) volumetric
   b) shear
   c) longitudinal and shear
   d) longitudinal.
5. A rigid bar of mass M is supported symmetrically by three wires each of length L. Those at each end are of copper and the middle one is of iron. The ratio of their diameters, if each is to have the same tension, is equal to
   a) $\frac{Y_{copper}}{Y_{iron}}$ b) $\sqrt{\frac{Y_{iron}}{Y_{copper}}}$
   c) $\frac{Y_{iron}^2}{y_{copper}^2}$ d) $\frac{Y_{iron}}{Y_{copper}}$
6. A mild steel wire of length 2L and cross-sectional area A is stretched, well within elastic limit, horizontally between two pillars as shown in the figure. A mass m is suspended from the mid point of the wire. Strain in the wire is



   a) $\frac{x^2}{2L^2}$ b) $\frac{x}{L}$
   c) $\frac{x^2}{L}$ d) $\frac{x^2}{2L}$
7. A rectangular frame is to be suspended symmetrically by two strings of equal length on two supports as shown in the figure. It can be done in one of the following three ways



   The tension in the strings will be
   a) the same in all cases
   b) least in (i)
   c) least in (ii)
   d) least in (iii)
8. Consider two cylindrical rods of identical dimensions, one of rubber and the other of steel. Both the rods are fixed rigidly at one end to the roof. A mass M is attached to each of the free ends at the centre of the rods.
   a) Both the rods will elongate but there shall be no perceptible change in shape.
   b) The steel rod will elongate and change shape but the rubber rod will only elongate.
   c) The steel rod will elongate without any perceptible change in shape, but the rubber rod will elongate and the shape of the bottom edge will change to an ellipse.
   d) The steel rod will elongate, without any perceptible change in shape, but the rubber rod will elongate with the shape of the bottom edge tapered to a tip at the centre.

<u>ASSERTION & REASON</u>

Directions: In the following questions, a statement of assertion is followed by a statement of reason. Mark the correct choice as:

(a) If both assertion and reason are true and reason is the correct explanation of assertion.

(b) If both assertion and reason are true but reason is not the correct explanation of assertion.

(c) If assertion is true but reason is false.

(d) If both assertion and reason are false.

1. **Assertion:** If we apply force to a lump of putty or mud, they have no gross tendency to regain their previous shape.
   Reason: This type of substances are called plastic substances.
2. **Assertion:** Steel and brass are more elastic than copper and aluminium.
   Reason: That's why they are preferred in heavy-duty machines and in structural designs.
3. **Assertion:** The compressibility of solids is less than that of gases and liquids.
   Reason: There is tight coupling between the neighbouring atoms in solids.
4. **Assertion:** In spring ball model, displace any ball from its equilibrium position the spring system tries to restore the ball back to its original position.
   Reason: The elastic behaviour of solids can be explained in terms of microscopic nature of the solid.
5. **Assertion:** Stress is the internal force per unit area of a body.
   Reason: Rubber is more elastic than steel.
6. **Assertion:** Spring balances show incorrect readings after using for a long time.
   Reason: On using for a long time, springs in the balances lose their elastic strength.
7. **Assertion:** A solid sphere placed in the fluid under high pressure is compressed uniformly on all sides.
   Reason: The volume of solid sphere will decrease with change of its geometrical shape.
8. **Assertion:** Hydrostatic pressure is not a vector quantity.
   Reason: Pressure is force divided by area, and force is a vector quantity.
9. **Assertion:** For small deformations, the stress and strain are proportional to each other.
   Reason: A class of solids called elastomers does not obey Hooke's law.
10. **Assertion:** The materials which have very small range of plastic extension are called brittle materials.
    Reason: If the stress is increased beyond the elastic limit, the material will break.
11. **Assertion:** The stress-strain behaviour varies from material to material.
    Reason: A rubber can be pulled to several times its original length and still returns to its original shape.
12. **Assertion:** To increase the length of a thin steel wire of $0.1\ \mathrm{cm}^2$ cross sectional area by 0.1%, a force of 2000 N is required , its $\mathrm{Y} = 200 \times 10^9 \mathrm{N\ m}^{-2}$.
    Reason: It is calculated by $\mathrm{Y} = \dfrac{\mathrm{F} \times \mathrm{L}}{\mathrm{A} \times \Delta \mathrm{L}}$
13. **Assertion**: Strain is a unitless quantity.
    Reason: Strain is equivalent to force.
14. **Assertion:** The maximum height of a mountain on earth can be estimated from the elastic behaviour of rocks.
    Reason: At the base of mountain, the pressure is less than elastic limit of earth's supporting material.
15. **Assertion:** A hollow shaft is found to be stronger than a solid shaft made of same size and material.
    Reason: The torque required to produce a given twist in hollow cylinder is greater than that required to twist a solid cylinder of same size and material.

ANSWER KEY

MCQs CORNER

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

HOTS

1. a)	2. b)	3. a)	4. b)	5. c)	6. a)
7. b)	8. c)				

NCERT EXEMPLAR PROBLEMS

1. b)	2. d)	3. d)	4. c)	5. b)	6. a)
7. c)	8. d)				

ASSERTION & REASON CORNER

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