**CLASS – 11**

**ASSIGNMENT- MECHANICAL PROPERTIES OF SOLIDS**

**(1 mark questions)**

1. Out of the following the most plastic material is
   (a) iron (b) wood (c) rubber (d) plasticine

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

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

4. Fluids can develop
   (a) longitudinal strains only (b) longitudinal and shearing strain
   (c) longitudinal, shearing and volumetric strain (d) volumetric strain only

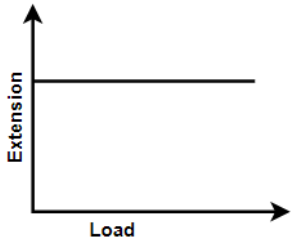
5. A steel cable with a radius 2cm supports a chairlift at a ski area. If the maximum stress is not to exceed $10^8$ N/m$^2$, the maximum load the cable can support is
   (a) $4\pi\times10^5$ N (b) $4\pi\times10^4$ N (c) $2\pi\times10^5$ N (d) $2\pi\times10^4$ N

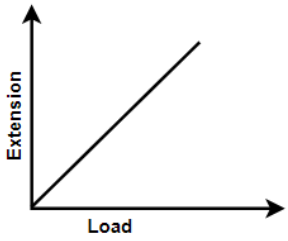
6. Stress is a _____ quantity.
   (a) scalar (b) vector (c) tensor (d) dimensionless

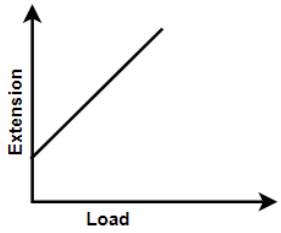
7. Stress and pressure are both force per unit area. Then in what respect does stress differ from pressure?
   _____
   _____

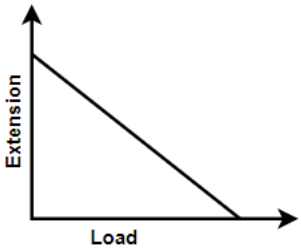
8. The ratio stress/strain remains constant for small deformation. What will be the effect on this ratio when the deformation made is very large?
   _____
   _____

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

(a) 


(b) 


(c) 


(d) 


10. According to Hooke's law of elasticity, the ratio of stress to strain
(a) decreases (b) increases (c) becomes zero (d) remains constant

11. The reciprocal of force constant is known as
(a) conductance (b) compliance (c) admittance (d) reactance

12. Write Hooke's law.
_____
_____

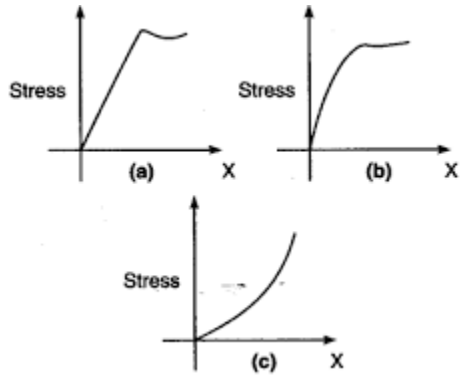
13. Is Hooke's law is applicable to all materials?
_____
_____

14. Solids which break above the elastic limit are
(a) brittle (b) ductile (c) malleable (d) elastic

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

16. 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.

17. Following are the graphs of elastic materials. Which one corresponds to that of brittle material?




_____

_____

18. What is elastic fatigue?

_____

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19. What do you mean by 'permanent set' in a body?

_____

_____

20. 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.

21. The ratio of shearing stress to the shearing strain is define as
(a) Young's modulus (b) bulk modulus (c) shear modulus (d) compressibility

22. 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

23. Which is more elastic rubber of copper?

_____

_____

24. Define compressibility of a material.

_____
_____

25. What does the slope of stress versus strain graph give?
_____
_____

26. Write dimensionless formula of Young's modulus.
_____
_____

27. What is the value of bulk modulus for an incompressible liquid?
_____
_____

28. For solids with elastic modulus of rigidity, the shearing force is proportional to shear strain. On what factor does it depend in case of fluids?
_____
_____

29. Why steel is more elastic than rubber?
_____
_____

30. 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) $1/Y^2$

31. Why are bridges declared unsafe after a long use?
_____
_____

32. Why are electric poles given hollow structure?
_____
_____

33. Mention two applications of elasticity.
_____
_____

**(2 marks Questions)**

34. What is perfectly elastic body? Give an example in which is close to perfectly elastic.

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35. Define modulus of elasticity. Name its three components.

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_____

36. When the tension in a metal wire is $T_1$, its length is $l_1$. When the tension is $T_2$, its length is $l_2$. Find the natural length of wire.

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_____
_____

37. A square lead slab of side 50cm and thickness 5.0cm is subjected to a shearing force (on its narrow face) of magnitude $9.0\times10^4$N. The lower edge is riverted to the floor. How much is the upper edge displaced if the shear modulus of the lead is $5.6\times10^9$ N/m?

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_____
_____
_____

38. A wire of length l, area of cross section A and Young's modulus Y is stretched by an amount x. What is the work done in stretching the wire?

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_____
_____

39. Determine the volume contraction of a solid copper cube, 10cm on an edge, when subjected to a hydraulic pressure of $7.0\times10^6$ Pa. (Bulk modulus of Cu = $140510^9$ Pa).

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_____

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40. Given the following values for an elastic material: Young's modulus = $7\times10^{10}$N $m^{-2}$ and bulk modulus = $11\times10^{10}$ N $m^{-2}$. Calculate the Poisson's ratio of the material.

_____
_____
_____
_____

41. How is the knowledge of elasticity be used to estimate the maximum height of a mountain on earth?

_____
_____
_____
_____

42. Read each of the statements below carefully and state, with reasons, if it is true or false?
(a) The modulus of elasticity of rubber is greater than that of steel.
(b) The stretching of a coil is determined by its shear modulus.

_____
_____
_____
_____

43. A piece of copper having a rectangular cross-section of 15.2 mm × 19.1 mm is pulled in tension with 44,500 N force producing only elastic deformation. Calculate the resulting strain. [Ans. 0.001277]

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_____
_____
_____

44. A steel cable with a radius 1.5cm supports a chairlift at a ski area. If the maximum stress is not to exceed $10^8$ $Nm^{-2}$, what is the maximum load the cable can support?
[Ans. $7.07\times10^4$ N]

_____
_____
_____
_____

45. A rigid bar of mass 15 kg is supported symmetrically by three wires each 2.0 m long. These at each end are of copper and the middle one is of iron. Determine the ratios of their diameters if each is to have the same tension. [Ans. 1.3]

46. Compute the bulk modulus of bulk modulus of water from the following data: Initial volume = 100.0 litre, pressure increase = 100.0 atm, final volume = 100.5 litre (1 atm = $1.013\times10^5$ Pa) [Ans. $2.023\times10^9$ Pa]

47. What is the density of ocean water at a depth where the pressure is 80.0 atm, given that its density of surface is $1.03\times10^3$ $kgm^{-3}$? Compressibility of water = $45.8\times10^{-11}$ $Pa^{-1}$. Given an atm = $1.013\times10^5$ Pa. [Ans. $1.034\times10^3$ $kgm^{-3}$]

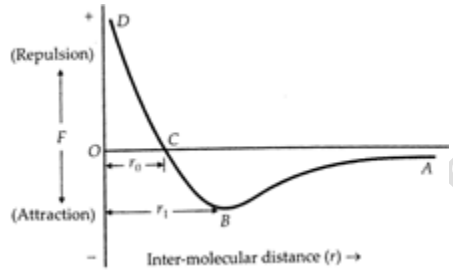
48. Compute the fractional change in volume of a glass slab, when subjected to a hydraulic pressure of 10 atm. [Ans. $2.74\times10^{-5}$]

49. Determine the volume contraction of a solid copper cube, 10 cm on an edge, when subjected to hydraulic pressure of $7.0\times10^6$ Pa. [Ans. 0.05 $cm^3$]

50. How much should the pressure on a litre of water be changed to compress it by 0.10%? [Ans. $2.2\times10^6$ $Nm^{-2}$]

**(3 marks Questions)**

51. In the diagram a graph between the intermolecular force F acting between the molecules of a solid and the distance r between them is shown. Explain the graph.




52. Define the term strain. Why it has no units and dimensions? What are different types of strain?

53. Define the term stress. Give its units and dimensions. Describe the different types of stress.

54. On the basis of stress-strain curves, distinguish between ductile and brittle materials.

55. Define Poisson's ratio. Write an expression for it. What is the significance of negative sign in this expression?

56. (a) What is elastic potential energy?
(b) Derive an expression for the elastic potential energy stored in a stretched wire under stress.
(c) Prove that elastic energy density is equal to ½ × stress × strain.

57. A wire of area of cross section 3.0 $mm^2$, and natural length 50cm, is fixed at one end and a mass of 2.1kg is hung from the other end. Determine the elastic potential energy stored

in the wire in the steady state. (Given: Young's modulus of the material of the wire = $2.0\times10^{11}$ $Nm^{-2}$ and g = 10 $ms^{-2}$).

58. A box shaped piece of gelatin dessert has a top area of $15cm^2$ and a height of 3cm. When a shearing force of 0.50N is applied to the upper surface, the upper surface displaces 4mm relative to the bottom surface. What are the shearing stress, shearing strain and the shear modulus for the gelatin?

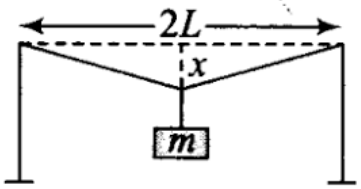
59. A structural steel rod has a radius of 10mm and a length 1m. A 100kN force F stretches it along the length. Calculate (a) the stress (b) elongation, and (c) strain on the rod. Given that the Young's modulus of the structural steel is $2.0\times10^{11}$ $Nm^{-2}$.

60. If the normal density of sea water is 1.00 g $cm^{-3}$, what will be its density at a depth of 3km? Given compressibility of water = 0.0005 per atmosphere, 1 atmosphere pressure = $10^6$ dyne $cm^{-2}$, g = 980 cm $s^{-2}$.

61. A steel wire has length 2m, radius 1mm and Y = 2 ×$10^{11}$ N/$m^2$. A 1kg sphere is attached to one end of the wire and whirled in a vertical circle with an angular velocity of 2 revolutions per second. What is the elongation of the wire when the sphere is at the lowest point of the vertical circle?

62. A cable is replaced by another cable of the same length and material but of half the diameter.
(a) How does this affect its elongation under a given load?
(b) How many times will be the maximum load it can now support without exceeding the elastic limit?

63. A steel wire of length 2l and cross section area A is stretched within elastic limit as shown in figure. Calculate the strain in the wire.



64. Define shear modulus. With the help of a diagram, explain how shear modulus can be calculated.

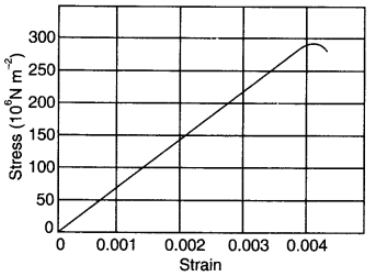
65. A steel wire of length 4.7m and cross section area $3.0\times10^{-5}$ $m^2$ stretches by the same amount as a copper wire of length 3.5m and cross sectional area of $4.0\times10^{-5}$ $m^2$ under a given load. What is the ratio of the Young's modulus of steel to that of copper?

66. (a) Define modulus of rigidity.
(b) A steel cable with a radius of 1.5cm supports a chairlift at a ski area. If the maximum stress is not to exceed $10^8$ $n/m^2$, what is the maximum load, the cable can support?

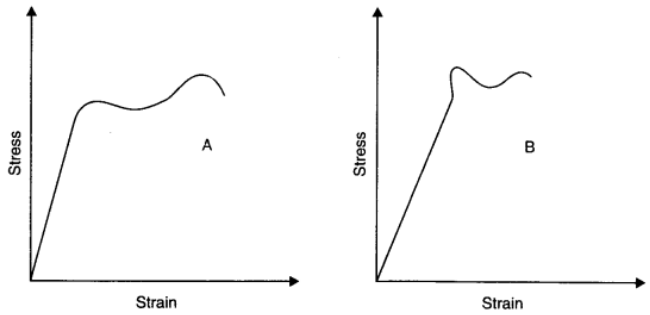
67. (a) Which is more elastic, rubber or steel. Give reason.
(b) What is the density of water at a depth where pressure is 80.0 atm, given that its density at the surface is $1.03\times10^3$ kg $m^{-3}$? Compressibility of water is $45.8\times10^{-11}$ $Pa^{-1}$.

68. A steel wire of length 4.7m and cross-section $3.0\times10^{-5}$ $m^2$ stretches by the same amount as a copper wire of length 3.5m and cross-section $4.0\times10^{-5}m^2$ under a given load. What is the ratio of the Young's modulus of steel to that of copper? [Ans. 1.79]

69. Figure shows the stress-strain curve for a given material. What are (a) Young's modulus (b) approximate yield strength for the material? [Ans. $7.5\times10^{10}$ $N/m^2$, $3\times10^8$ $N/m^2$]



70. The stress-strain graphs for materials A and B are shown in figure.




The graphs are drawn to the same scale

(a) Which of the material has greater Young's modulus?

(b) Which material is more ductile?

(c) Which is more brittle?

(d) Which of the two is stronger material?

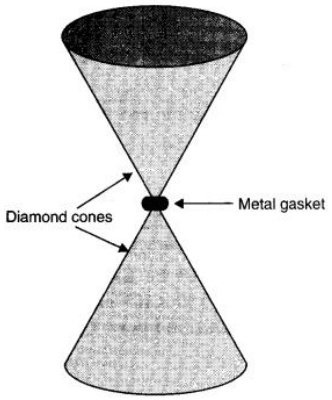
71. The edge of an aluminium cube is 10cm long. One face of the cube is firmly fixed to a vertical wall. A mass of 100kg is then attached to the opposite face of the cube. The shear modulus of aluminium is 25 G Pa. What is the vertical deflection of this face? (1Pa = 1 $n/m^2$) [Ans. $4\times10^{-7}$ m]

72. Four identical hollow cylindrical columns of mild steel support a big structure of mass 50,000 kg. The inner and outer radii of each column are 30cm and 40cm respectively. Assuming the load distribution to be uniform, calculate the compressional strain of each column. The Young's modulus of steel is $2.0\times10^{11}$Pa. [Ans. $2.8\times10^{-6}$]

73. A 14.5 kg mass, fastened to the end of the steel wire of unstretched length 1.0m, is whirled in a vertical circle with an angular velocity of 2 levels at the bottom of the circle. The cross-sectional area of the wire is 0.005 $cm^2$. Calculate the elongation of the wire when the mass is at the lowest point of its path. [Ans. $1.87\times10^{-3}$m]

74. Anvils made of single crystals of diamond, with shape as shown in figure are used to investigate behaviour of materials under very high pressures. Flat faces at the narrow end of the anvil have a diameter of 0.5mm, and the wire ends are subjected to a compressional force of 50,000 N. What is the pressure at the tip of the anvil?

[Ans. $2.55\times10^{11}$ $Nm^{-2}$]




76. A mild steel wire of length 1.0m and cross-sectional area $0.50\times10^{-2}$ $cm^2$ is stretched, well within its elastic limit, horizontally between two pillars. A mass of 100 g is suspended from the mid-point of wire. Calculate the depression at the mid-point.

[Ans. 1.07 cm]

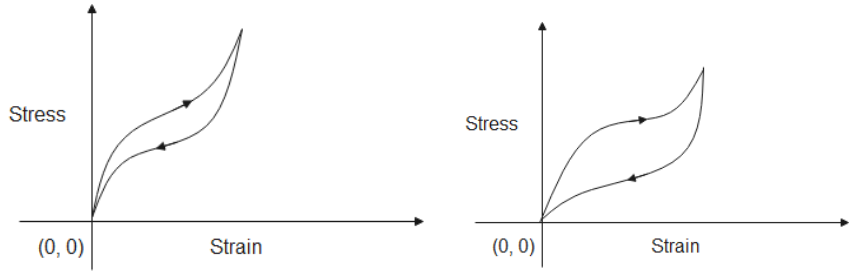
77. Two strips of metal are riverted together at their ends of four rivets, each of diameter 6.0 mm. What is the maximum tension that can be exerted by the riverted strip if the shearing stress on the rivet is not to exceed $2.3\times10^{9}$ Pa? Assume that each rivet is to carry one quarter of the load. [Ans. 260 kN]

78. The Marina trench is located in the Pacific Ocean and at one place it is nearly eleven km beneath the surface of water. The water pressure at the bottom of the trench is about $1.1\times10^{8}$ Pa. A steel ball of initial volume $0.32m^3$ is dropped into the ocean and falls to the bottom of the trench. What is the volume of the ball when it reaches to the bottom?

[Ans. $2.02\times10^{-4}m^3$]

**(5 marks Questions)**

79. Two different types of rubber are found to have stress strain curves as shown in the figure.



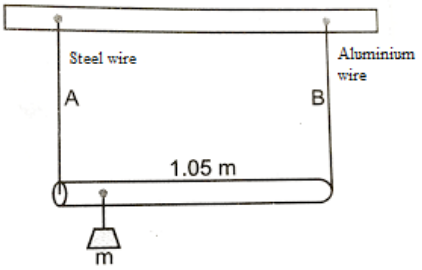

(a) In which significant ways do these curves shown in the figure differ from the stress strain curve of a metal wire?

(b) A heavy machine is to be installed in a factory. To absorb variations fo the machine, a block of rubber is placed between the machinery and the floor. Which of these two rubber A and B would you prefer to use for this purpose? Why?

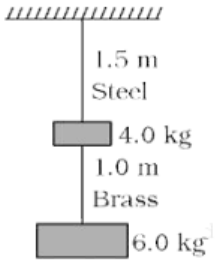
(c) Which of the two rubber materials would you choose for a car tyre?

80. (a) Describe elastic hysteresis. Mention its two applications.
(b) What is elastic after effect?

81. A rod of length 1.05m having negligible mass is supported at its ends by two wires of steel (wire A) and aluminium (wire B) of equal lengths as shown in figure. The cross section areas of wires A and B are 1.0 $mm^2$ and 2.0 $mm^2$ respectively. At what point along the rod should a mass m be suspended in order to produce (a) equal stresses and (b) equal strains in both steel and aluminium wires?



82. Two wires of diameter 0.25cm, one made of steel and the other of brass are loaded as shown in figure. The unloaded length of steel wire is 1.5m and that of brass wire is 1.0m. Compute the elongations of the steel and the brass wire.



83. A wire of cross sectional area A is stretched horizontally between two clamps located at a distance 2l metres from each other. A weight W kg is suspended from the midpoint of the wire. If the vertical distance through which the midpoint of the wire moves down be $x < l$, then find (i) the strain produced in the wire (ii) the stress on the wire, (iii) If Y is the Young's modulus of the wire, then find the value of x.

84. (a) Explain why should the beams used in the construction of bridges have large depth and small breadth.
(b) Why are girders given I shape?