CLASS – 11

WORKSHEET- MECHANICAL PROPERTIES OF SOLIDS

A. Elastic Behaviour 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

(2 marks questions)

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

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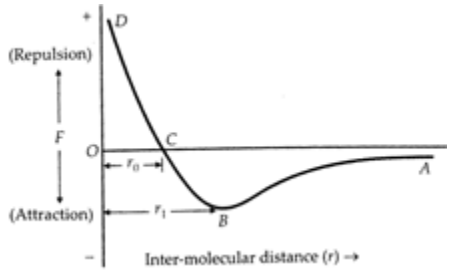
(3 marks questions)

5. 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.



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B. Stress and Strain

(1 mark questions)

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

2. 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

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

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

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

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(3 marks question)

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

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

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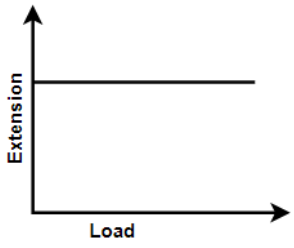
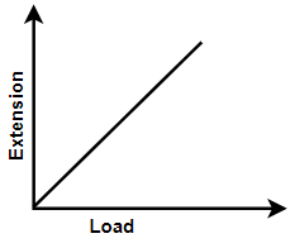
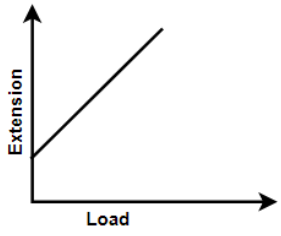
C. Hooke's law

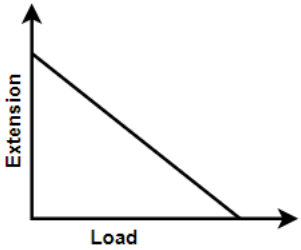
(1 marks questions)

1. 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) 

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

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

4. Write Hooke's law.
   _____
   _____

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

D. Stress Strain Curve

(1 mark questions)

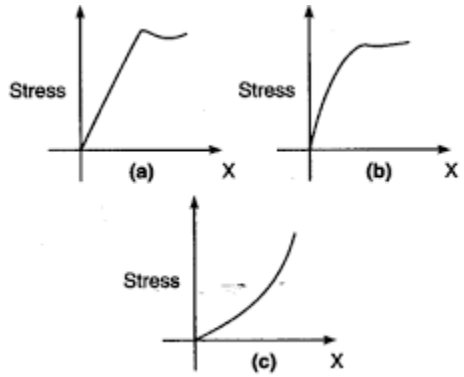
1. Solids which break above the elastic limit are
   (a) brittle (b) ductile (c) malleable (d) elastic

2. 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

3. 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.

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



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5. What is elastic fatigue?
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6. What do you mean by 'permanent set' in a body?
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(3 marks questions)

7. On the basis of stress-strain curves, distinguish between ductile and brittle materials.
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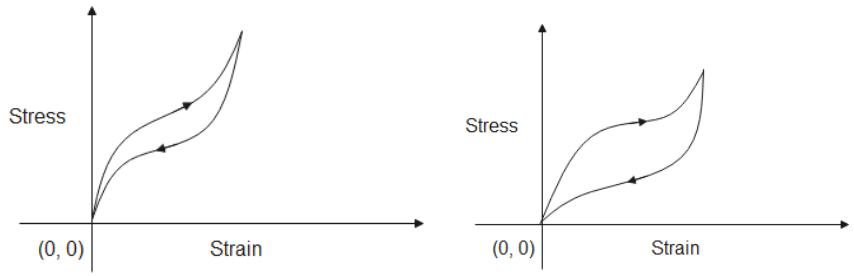
(5 marks questions)

8. 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?

9. (a) Describe elastic hysteresis. Mention its two applications.

(b) What is elastic after effect?

E. Elastic Moduli

(1 mark questions)

1. 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.

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

3. 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

4. Which is more elastic rubber of copper?
   _____
   _____

5. Define compressibility of a material.
   _____
   _____

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

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

8. What is the value of bulk modulus for an incompressible liquid?
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9. 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?
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   _____

10. Why steel is more elastic than rubber?

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11. 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) $1/Y^2$

12. Why are bridges declared unsafe after a long use?

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13. Why are electric poles given hollow structure?

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14. Mention two applications of elasticity.

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(2 marks questions)

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

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16. 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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17. A square lead slab of side 50cm and thickness 5.0cm is subjected to a shearing force (on its narrow face) of magnitude 9.0×10^4N. The lower edge is riverted to the floor. How much is the upper edge displaced if the shear modulus of the lead is 5.6×10^9 N/m?

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

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

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

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(3 marks questions)

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

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23. (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.

24. 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 = 2.0×10^{11} Nm^{-2} and g = 10 ms^{-2}).

25. 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?

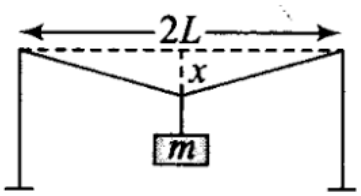
26. A structural steel rod has a radius of 10mm and a length 1m. A 100kN force F stretches it along the length. Calculate (a) the stress (b) elongation, and (c) strain on the rod. Given that the Young's modulus of the structural steel is 2.0×10^{11} Nm^{-2}.

27. 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}.

28. A steel wire has length 2m, radius 1mm and Y = 2 $\times 10^{11}$ 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?

29. 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?

30. 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.



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

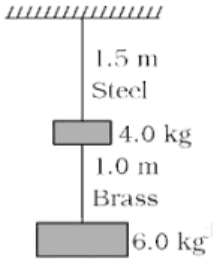
32. A steel wire of length 4.7m and cross section area 3.0×10^{-5} m^2 stretches by the same amount as a copper wire of length 3.5m and cross sectional area of 4.0×10^{-5} m^2 under a given load. What is the ratio of the Young's modulus of steel to that of copper?

33. (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?

34. (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 1.03×10^{3} kg m^{-3}? Compressibility of water is 45.8×10^{-11} Pa^{-1}.

(5 marks questions)

35. 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.



36. (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?

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ASSERTION REASON TYPE QUESTIONS

(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**

(e) If assertion is false but reason is true

1. Assertion: Then stretching of a coil is determined by its shear modulus.
   Reason: Shear modulus change only shape of a body keeping its dimensions unchanged.

Ans. (a) Both assertion and reason are true and reason is the correct explanation of assertion.
Because the stretching of coil simply changes its shape without any change in the length of the wire used in coil. Due to which shear modulus of elasticity is involved.

2. Assertion: Steel is more elastic than rubber.
   Reason: Under given deforming force, steel is deformed less than rubber.

Ans. (a) Both assertion and reason are true and reason is the correct explanation of assertion.
Elasticity is a measure of tendency of the body to regain its original configuration. As steel is deformed less than rubber therefore steel is more elastic than rubber.

3. Assertion: Strain is a unitless quantity.
   Reason: Strain is equivalent to force.

Ans. (c) Assertion is true but reason is false
Strain is the ratio of change in dimensions of the body to the original dimensions. Because this is a ratio, therefore, it is a dimensionless quantity.

4. Assertion: It is easier to spray water in which some soap is dissolved.
   Reason: Soap is easier to spread.

Ans. (c) Assertion is true but reason is false
On adding soap, surface tension of water decreases, the spraying of water becomes easy.

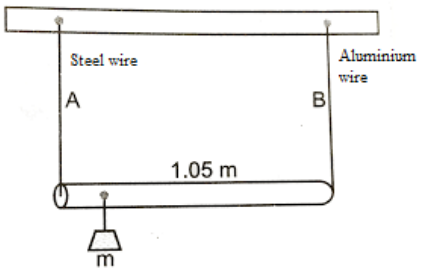
5. Assertion: It is better to wash the clothes in cold soap solution.
   Reason: The surface tension of cold solution is more than the surface tension of hot solution.

Ans. (d) Both assertion and reason are false

The soap solution has less surface tension as compared to ordinary water and its surface tension decreases further on heating. The hot soap solution can, therefore spread over large surface area and also it has more wetting power. It is on account of this property that hot soap solution can penetrate and clean the clothes better than the ordinary water.

CHALLENGING PROBLEMS

1. 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?



2. 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.