



Roll No :  
Date : 2025-12-11

School : ACHIEVERS  
FOUNDATION  
Assessment : Mechanical  
properties of solid  
Subject : Physics  
Class : XI

Time : 00:00  
Marks: 50

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1 Why do molecules possess potential energy ? 1

**Ans :**

The interaction among the molecules binding them together leads to the potential energy.

2 Which type of substances are called elastomers ? Give one example. 1

**Ans :**

Those materials for which stress-strain variation is not a straight line within elastic limit e.g. Rubber.

3 Read the following two statements below carefully and state, with reasons, if it is true or false. 1

(a) The Young's modulus of rubber is greater than that of steel.

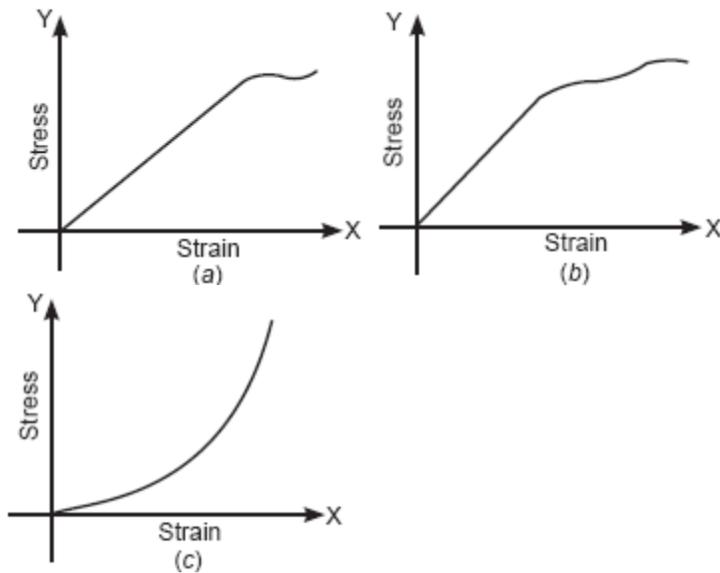
(b) The stretching of a coil is determined by its shear modulus.

**Ans :**

(a) It is false. The modulus of elasticity of steel is greater than that of steel. It is because, for producing same strain in steel and rubber, more stress is required in case of steel.

(b) It is true. The reason is that when a coil is stretched, there is neither a change in the length of the coil (length of the wire forming the coil spring) nor a change in its volume. Since, the change takes place in the shape of the coil spring, its stretching is determined by its shear modulus.

4 Following are the graphs of elastic materials. Which one corresponds to that of brittle material ? 1



**Ans :**(a)

5 Why does a spring balance show wrong measure after long use ? 1

**Ans :**The spring will lose its elastic character after to long use.

6 What are the factors that may affect elasticity of a material ? 1

**Ans :**

It is a material constant. So all the physical quantities that might alter the nature like density can alter it.

7 Name the two main groups of solids. 1

**Ans :**Crystalline and amorphous.

8 A wire is stretched by a certain amount under a load. If the load and radius both are increased to four times, find the stretch caused in the wire. 1

**Ans :**  $\Delta l \propto \frac{F}{A}$

$$\frac{\Delta l'}{\Delta l} = \frac{4F}{F} \times \frac{A}{16A} = \frac{1}{4}$$

9 Crystalline solids are called true solids. Why ? 1

**Ans :**

Because they have a well defined, regularly repeated three dimensional arrangement of ions/atoms/molecules.

10 Amorphous solids are not true solids. What are they called then ? 1

**Ans :**

Amorphous solids are called glassy solids and they are super cooled liquid of high viscosity.

11 Does the nature of forces differ in solids and liquids ? If yes, what is the difference there ? 1

**Ans :**

Yes, in case of liquids, there is a force of attraction between the atoms and molecules whereas in case of solids, there is a strong force of repulsion between them.

12 Which is more elastic : water or air ? Why ? 1

**Ans :**

Water is more elastic than air because bulk modulus of elasticity is reciprocal of compressibility and air is more compressible than water.

13 Why are springs made of steel and not of copper ? 1

**Ans :**

Under a given deforming force, the steel spring is stretched lesser than copper spring. Moreover, the steel spring recovers its original state quicker than copper after the removal of deforming force.

14 What do you mean by anisotropy ? Name the solid that shows anisotropy. 1

**Ans :**

It refers to the condition under which the physical properties (namely thermal, electrical, mechanical and optical) are different in different directions. (Calcite or any crystalline solid).

15 When the pressure on a sphere is increased by 80 atmospheres, then its volume decreases by 0.01%. Find the bulk modulus of elasticity of the material of sphere. 1

**Ans :** Here  $P = 80 \text{ atmospheres}$   
 $= 80 \times 1.013 \times 10^5 \text{ Nm}^{-2}$

$\therefore \frac{\Delta V}{V} = 0.01 / 100$

$$B = \frac{PV}{\Delta V} = \frac{80 \times 1.013 \times 10^5}{(0.01)/100}$$
$$= 8.1 \times 10^{10} \text{ Nm}^{-2}$$

16 What is the value of bulk modulus for an incompressible liquid ? 1

**Ans** :Infinity.

17 What is the value of modulus of rigidity for a liquid ? 1

**Ans** :Zero.

18 The length of a wire is reduced by half. What will be the effect on the increase in its length under a given load ? 1

**Ans** :

Increase in length will be reduced to half since  $\Delta l \propto l_i$ , where  $l_i$  is initial length.

19 A wire is replaced by another wire of same length and material but of twice diameter . 1

(i) What will be the effect on the increase in its length under a given load ?

(ii) What will be the effect on the maximum load which it can bear ?

**Ans** :

(i) Increase in length will be reduced to one fourth as  $\Delta l \propto \frac{1}{r^2}$ .

(ii) Maximum bearable load becomes four times as breaking force  $\propto$  area  
(=  $\pi r^2$ )

20 The breaking force for a wire is  $F$ . What will be the breaking forces for : 1

(i) two parallel wires of this size and

(ii) for a single wire of double thickness ?

**Ans** :(i)  $2F$  (ii)  $4F$ .

21 A metal bar of length  $L$ , area of crosssection  $A$ , Young's modulus  $Y$  and coefficient of linear expansion  $\alpha$  is clamped between two stout pillars. 1

What is the force exerted by the bar when it is heated through  $t$  °C ?

**Ans** : $YA \alpha t$ .

22 The Young's modulus of a wire of length  $L$  and radius  $r$  is  $Y$ . If the length is reduced to  $L/2$  and radius  $r/2$ . What will be its Young's modulus ? 1

**Ans** : $Y$ , since it is a material constant.

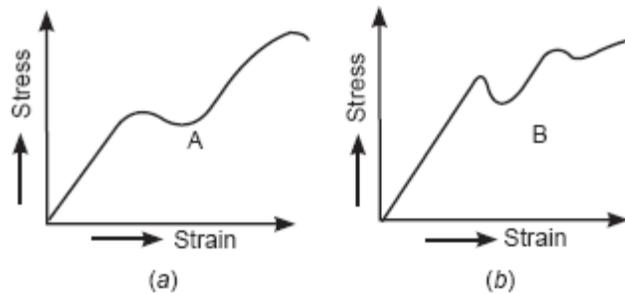
23 What does Hooke's law essentially define ? 1

**Ans** :Elastic limit.

24 The stress versus strain graphs for two materials A and B are shown below :

1

(The graphs are to the same scale.)



- (i) Which material has greater Young's modulus ?
- (ii) Which material is more ductile ?
- (iii) Which is more brittle ?

**Ans :**

- (i) A, because for producing the same strain, more stress is required in case of the material A.
- (ii) A, because it has a greater plastic range.
- (iii) B, because it has a lesser plastic range.

25 Bridges are declared unsafe after long use. Why ?

1

**Ans :**

A bridge undergoes alternating stress and strain for a large number of times during its use. When bridge is used for long time, it loses its elastic strength. Therefore, the amount of strain in the bridge for a given stress will become large and ultimately, the bridge will collapse. So, they are declared unsafe after long use.

26A long spring is stretched by 2 cm and its potential energy is  $V$ . If the spring is stretched by 10 cm, its potential energy will be:

1

- (a)  $V/5$
- (b)  $V/25$
- (c)  $5V$
- (d)  $25V$

**Ans :** (d)

P.E. of a stretched spring,  $V = \frac{1}{2}kx^2$  where  $k$  is the spring constant

$$\therefore V = \frac{1}{2}k \times 2^2 \text{ or } k = \frac{V}{2}$$

$$\begin{aligned} \text{and Now, P.E., } V' &= \frac{1}{2}k \times 10^2 \\ &= \frac{1}{2} \left( \frac{V}{2} \right) \times 100 = 25 \text{ V} \end{aligned}$$

27 Two rods of different materials having coefficient of thermal

1

expansion  $\alpha_1, \alpha_2$  and Young's modulus  $Y_1, Y_2$  respectively are fixed between two rigid massive walls. The rods are heated such that they undergo the same increase in temperature. There is no bending of the rods. If  $\alpha_1 : \alpha_2 = 2 : 3$ , the thermal stresses developed in the two rods are equal provided  $Y_1 : Y_2$  is equal to

- (a) 2 : 3
- (b) 1 : 1
- (c) 3 : 2
- (d) 4 : 9

**Ans :** (c)

Expansion in rod due to rise in temperature = compression in rod

$$\therefore \frac{\alpha_1}{\alpha_2} = \frac{Y_1}{Y_2} \text{ or } \frac{Y_1}{Y_2} = \frac{\alpha_2}{\alpha_1} = \frac{3}{2}$$

28 The upper end of a wire of radius 4 mm and length 100 cm is clamped and its other end is twisted through an angle of  $30^\circ$ . The angle of shear is

1

- (a)  $12^\circ$
- (b)  $1.2^\circ$
- (c)  $0.12^\circ$
- (d)  $0.012^\circ$

Ans : (c)

Angle of twist at free end

$$= 30^\circ = \frac{30}{180} \times \pi \text{ rad} = \frac{\pi}{6} \text{ rad}$$

Displacement of the free surface,

$$\Delta L = \frac{2\pi r}{2\pi} \times \frac{\pi}{6} = \frac{\pi r}{6} = \frac{\pi \times 0.4}{6} \text{ cm}$$

Angle of shear or shearing strain =  $\frac{\Delta L}{L}$

$$= \frac{\pi \times 0.4/6}{100} \text{ rad}$$

$$= \frac{\pi \times 0.4}{6 \times 100} \times \frac{180}{\pi} \text{ degree} = 0.12^\circ$$

29 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

1

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

Ans : Here,  $\Delta l = x$ ,  $Y = \frac{F/A}{\Delta l/L}$  or  $\frac{YA\Delta l}{L}$

The work is done from 0 to  $x$  (change in length), so the

(c) average distance =  $\frac{0 + \Delta l}{2} = \frac{\Delta l}{2}$

Work done = Force  $\times$  Distance

$$= \frac{YA\Delta l}{L} \times \frac{\Delta l}{2} = \frac{YA(\Delta l)^2}{2L} = \frac{YAx^2}{2L}$$

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

1

- (a)  $K(l_1 - l_2)$   
(b)  $K(l_1 + l_2)/2$   
(c)  $K(l_1^2 + l_2^2)$   
(d)  $K(l_2^2 - l_1^2)/2$

Ans : (d)

The energy stored in the spring for extension  $l_1 = \frac{1}{2}Kl_1^2$ .

The energy stored in the spring for extension  $l_2 = \frac{1}{2}Kl_2^2$ .

Therefore work done in increasing its extension for

$$l_1 \text{ to } l_2 = \frac{1}{2}Kl_2^2 - \frac{1}{2}Kl_1^2$$

31 A rod elongates by  $l$  when a body of mass  $M$  is suspended from it. The work done is:

1

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

**Ans :** (b)

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

32 Rigidity modulus of steel is  $h$  and its Young's modulus is  $Y$ . A piece of steel of cross-sectional area  $a$  is stretched into a wire of length  $L$  and area  $a/10$ . Then

1

- (a)  $Y$  increases and  $\eta$  decreases  
(b)  $Y$  and  $\eta$  remain the same  
(c)  $Y$  decreases and  $\eta$  increases  
(d) Both  $Y$  and  $\eta$  increases

**Ans :**

(b)

Modulus of rigidity and Young's Modulus of elasticity are constants for a given material.

33 When an elastic material with Young's modulus  $Y$  is subjected to stretching stress  $S$ , the elastic energy stored per unit volume of the material is

1

- (a)  $YS/2$   
(b)  $YS^2/2$   
(c)  $S^2/2Y$   
(d)  $S/2Y$

**Ans :**(c)

Elastic energy per unit volume,

$$\begin{aligned} u &= \frac{1}{2} \times \text{Stress} \times \text{Strain} \\ &= \frac{1}{2} \times \text{Stress} \times \frac{\text{Stress}}{\text{Young modulus}} \\ &= \frac{1}{2} S \times \frac{S}{Y} = \frac{S^2}{2Y} \end{aligned}$$

34 One end of a uniform wire of length  $L$  and of weight  $W$  is attached rigidly to a point in the roof and weight  $W_1$  is suspended from the lower end. If

1

S is the area of cross-section of the wire, the stress in the wire at a height  $3/4$  from its lower end is;

- (a)  $W_1/S$
- (b)  $(W_1 + W/4)S$
- (c)  $(W_1 + 3W/4)/S$
- (d)  $(W_1 + W)/S$

**Ans :**(c)

Total force acting at a point  $3L/4$  from its lowest end  
= Weight suspended + Weight of the wire of length  $3L/4$   
=  $(W_1 + 3W/4)$ . Hence stress

$$= \frac{\text{Force}}{\text{Area}} = \frac{(W_1 + 3W/4)}{S}$$

35 Bulk modulus of water is  $2 \times 10^9 \text{ N/m}^2$ . The pressure required to increase the density of water by 0.1% in  $\text{N/m}^2$  is

1

- (a)  $2 \times 10^9$
- (b)  $2 \times 10^8$
- (c)  $2 \times 10^6$
- (d)  $2 \times 10^4$

**Ans :** (c)

$$\Delta p = K \frac{\Delta \rho}{\rho} = 2 \times 10^9 \times \left( \frac{0.1}{100} \right) = 2 \times 10^6 \text{ N/m}^2$$

36 A wire fixed at the upper end stretches by length  $l$  by applying a force  $F$ .

1

The work done in stretching is

- (a)  $F/2l$
- (b)  $Fl$
- (c)  $2Fl$
- (d)  $Fl/2$

**Ans :**(d)

Work done = Average force  $\times$  Extension

$$= \left( \frac{0 + F}{2} \right) \times l = \frac{1}{2} Fl$$

37 Wire 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,

1

when each is stretched by the same tension, the ratio of energy stored in A to that in B is:

- (a) 2 : 3
- (b) 12 : 1
- (c) 3 : 2
- (d) 6 : 1

**Ans :**(b)

Given  $D_A = 2 D$ ;  $l_A = 3l$ ,  $D_B = D$ ,  $l_B = l$

$F_A = F = F_B$ ,  $Y_A = Y_B = Y$

**Energy stored (E) =  $\frac{1}{2} \times \frac{(\text{Stress})^2}{Y} \times \text{Volume}$**

$$\therefore E_A = \frac{1}{2} \frac{F/\pi(2D)^2}{Y} \times \frac{\pi(2D)^2}{4} \times 3l$$

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

$$\frac{E_A}{E_B} = \frac{12}{1}$$

38 The maximum load a wire can withstand without breaking, when its length is reduced to half of its original length, will

1

- (a) be double.
- (b) be half.
- (c) be four times.
- (d) remain same.

**Ans :**(d)

Breaking stress (F/A) does not depend on length.

39 The temperature of a wire is doubled. The Young's modulus of elasticity

1

- (a) will also double.
- (b) will become four times.
- (c) will remain same.
- (d) will decrease.

**Ans :** (d)

As  $Y = \frac{FL}{A\Delta L}$ , when temperature is doubled,  $\Delta L$  increases, and accordingly  $Y$  decreases.

40A 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

1

- (a)  $\frac{Y_{\text{Copper}}}{Y_{\text{Iron}}}$                       (b)  $\sqrt{\frac{Y_{\text{Iron}}}{Y_{\text{Copper}}}}$
- (c)  $\sqrt{\frac{Y_{\text{Iron}}^2}{Y_{\text{Copper}}^2}}$                       (d)  $\frac{Y_{\text{Iron}}}{Y_{\text{Copper}}}$

Ans : (b)

As 
$$Y = \frac{FL}{A\Delta L}$$

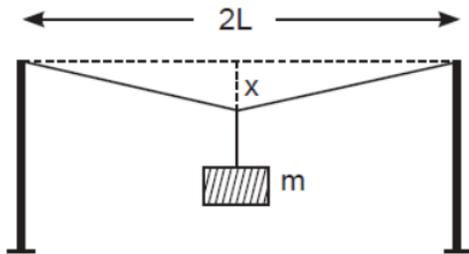
$$= \frac{FL}{(\pi D^2/4)\Delta L} = \frac{4FL}{\pi D^2 \Delta L}$$

For same tension ( $F$ ),  $Y \propto \frac{1}{D^2}$  or  $D \propto \frac{1}{\sqrt{Y}}$

or 
$$\frac{D_{\text{Copper}}}{D_{\text{Iron}}} = \sqrt{\frac{Y_{\text{Iron}}}{Y_{\text{Copper}}}}$$

41A mild steel wire of length  $2L$  and cross-sectional area  $A$  is stretched, well within elastic limit, horizontally between two pillars figure. A mass  $m$  is suspended from the mid point of the wire. Strain in the wire is

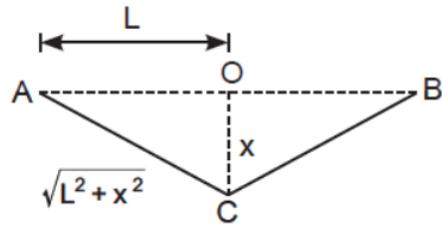
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- (a)  $\frac{x^2}{2L^2}$                       (b)  $\frac{x}{L}$
- (c)  $\frac{x^2}{L}$                       (d)  $\frac{x^2}{2L}$

**Ans :** (a)

Refer to Fig



Change in length,

$$\begin{aligned}\Delta L &= AC - AO \\ &= [L^2 + x^2]^{1/2} - L \\ &= L \left[ 1 + \frac{1}{2} \frac{x^2}{L^2} \right] - L = \frac{x^2}{2L}\end{aligned}$$

$$\text{Longitudinal strain} = \frac{\Delta L}{L} = \frac{x^2/2L}{L} = \frac{x^2}{2L^2}$$

42 Two wires A and B of the same material have radii in the ratio 2 : 1 and lengths in the ratio 4 : 1. The ratio of the normal forces required to produce the same change in the lengths of these two wires is

1

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

**Ans :**(a)

43 A steel ring of radius  $r$  and cross-section area  $A$  is shifted 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

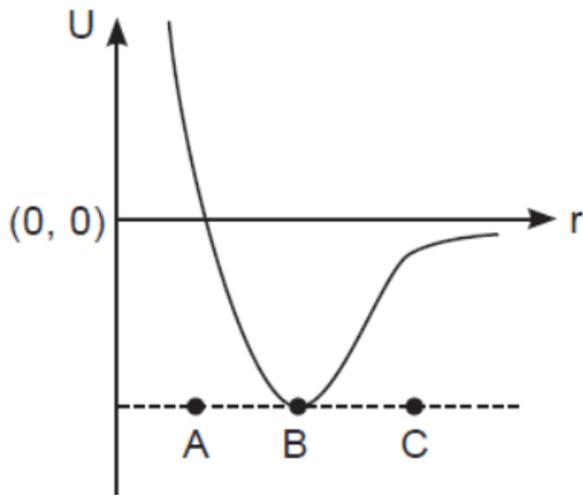
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- (a)  $AER/r$
- (b)  $AE(R - r)/r$
- (c)  $E(R - r)/Ar$
- (d)  $Er/AR$

**Ans :**(b)

44 The potential energy  $U$  between two molecules as a function of the distance  $r$  between them has been shown in the adjoining figure. The two molecules are

1

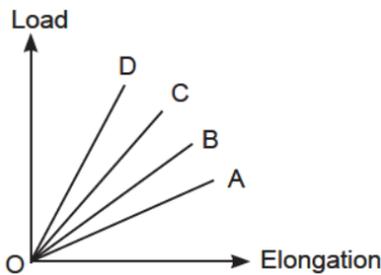


**Ans :**

- (a) attracted when  $r$  lies between A and B and repelled when  $r$  lies between B and C.
- (b) attracted when  $r$  lies between B and C and repelled when  $r$  lies between A and B.
- (c) attracted when they reach B.
- (d) repelled when they reach B.

45 The load versus elongation graph for four wires of the same material is shown in the fig. The thinnest wire is represented by the line.

1



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

**Ans :**(c)

46 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

1

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

**Ans :** (d)

$$U = \frac{1}{2} F \times \Delta l = \frac{1}{2} \times 200 \times 10^{-3} = 0.1 \text{ J.}$$

47 Modulus of rigidity of ideal liquids is

1

- (a) infinity.
- (b) zero.
- (c) unity.
- (d) some finite small non-zero constant value.

**Ans :**

(b) As  $\eta = \frac{\text{Shearing stress}}{\text{Shearing strain}}$

and since liquids cannot sustain shear stress,  $\eta = 0$  in their case.

48 A spring is stretched by applying a load to its free end.

1

The strain produced in the spring is

- (a) volumetric.
- (b) shear.
- (c) longitudinal and shear.
- (d) longitudinal.

**Ans :**(c)

The length and shape of the spring change.

49 Property of a body by virtue of which it regains its original dimension and shape on removal of external deforming force is known as \_\_\_\_\_.

1

**Ans :** elasticity

50 Maximum stress within which the body regain its original shape and configuration after the removal of deforming force is called \_\_\_\_\_.

1

**Ans :** elastic limit