Mechanical Properties of Solids Test (NEET Pattern) 01:00 Hr

Important Instructions

This test contains **45 questions**. Each question carries **4 marks**. For each **correct** response the candidate will get **4 marks**. For each **incorrect** response, **one mark will be deducted** from the total scores. The maximum marks are **180**.

1. The diameter of a brass rod is 4 mm and Young's modulus of brass is 9×10^{10} N/m^2. The force required to stretch by 0.1% of its length is :

(1) 360π N

(2) 36 N

(3) 144×10^3 N

(4) 36×10^5 N

2. Two wires of equal length and cross-section area suspended as shown in figure. Their Young's modulus are Y_1 and Y_2 respectively. The equivalent Young's modulus will be:

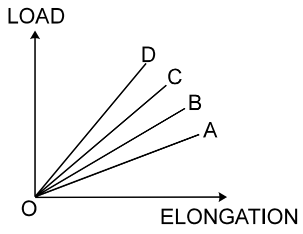
(1) $Y_1 + Y_2$

(2) $\frac{Y_1+Y_2}{2}$

(3) $\frac{Y_1 Y_2}{Y_1+Y_2}$

(4) $\sqrt{Y_1 Y_2}$

3. The load versus elongation graph for four wires of the same materials and same length is shown in the figure. The thinnest wire is represented by the line:



(1) OA

(2) OB

(3) OC

(4) OD

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

(1) 2×10^6 N

(2) 2×10^3 N

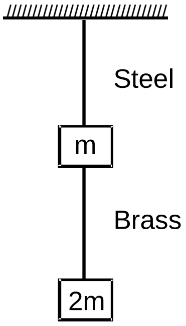
(3) 2×10^{-6} N

(4) 2×10^{-7} N

5. A force F is needed to break a copper wire having radius R. Then the force needed to break a copper wire of radius 2R will be:
(1) F/2
(2) 2F
(3) 4F
(4) F/4

6. A brass rod of length 2 m and cross-sectional area 2.0 cm^2 is attached end to end to a steel rod of length L and cross-sectional area 1.0 cm^2. The compound rod is subjected to equal and opposite pulls of magnitude 5×10^4 N at its ends. If the elongations of the two rods are equal, then length of the steel rod (L) is
($Y_{Brass} = 1.0 \times 10^{11}$ N/m^2 and $Y_{Steel} = 2.0 \times 10^{11}$ N/m^2)
(1) 1.5 m
(2) 1.8 m
(3) 1 m
(4) 2 m

7. If the ratio of lengths, radii and Young's moduli of steel and brass wires in the figure are a, b, c respectively. Then the corresponding ratio of increase in their lengths would be :



(1) $\frac{2ac}{b^2}$
(2) $\frac{3a}{2b^2c}$
(3) $\frac{3c}{2ab^2}$
(4) $\frac{2a^2c}{b}$

8. The breaking stress of a wire depends upon
(1) Length of the wire
(2) Radius of the wire
(3) Material of the wire
(4) Shape of the cross section

9. A steel wire of 1 m long and 1 mm^2 cross section area is hang from rigid support. When weight of 1 kg is hung from it then change in length will be (given $Y = 2 \times 10^{11}$ N/m^2)
(1) 0.5 mm
(2) 0.25 mm
(3) 0.05 mm
(4) 5 mm

10. 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 a applying forces at two ends, the ratio of the elongation in the thin wire to that in the thick wire is:

(1) 0.25

(2) 0.50

(3) 2.00

(4) 4.00

11. A 5m aluminium wire ($Y = 7 \times 10^{10}$ N/m^2) of diameter 3 mm supports a 40 kg mass. In order to have the same elongation in a copper wire ($Y = 12 \times 10^{10}$ N/m^2) of the same length under the same weight, the diameter should be in mm

(1) 1.75

(2) 2.0

(3) 2.3

(4) 5.0

12. A catapult's string made of rubber having cross section area 25 mm^2 and length 10 cm. To throw a 5 gm pebble it is stretched up to 5 cm and released. Velocity of projected pebble is (Young coefficient of elasticity of rubber is 5×10^8 N/m^2):

(1) 20 m/s

(2) 100 m/s

(3) 250 m/s

(4) 200 m/s

13. Four wires of the same material are stretched by the same load. The dimension of the wires are as given below. The one which has the maximum elongation is of

(1) diameter 1 mm and length 1 m

(2) diameter 2 mm and length 2 m

(3) diameter 0.5 mm and length 0.5 m

(4) diameter 3 mm and length 3 m

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

(1) Increases

(2) Decreases

(3) Becomes zero

(4) Remains constant

15. A square brass plate of side 1.0 m and thickness 0.005 m is subjected to a force F on its smaller opposite edges, causing a displacement of 0.02 cm. If the shear modulus of brass is 0.4×10^{11} N/m^2, the value of the force F is:

(1) 4×10^3 N

(2) 400 N

(3) 4×10^4 N

(4) 1000 N

16. A 50 kg motor rests on four cylindrical rubber blocks. Each block has a height of 4 cm and a cross-sectional area of 16 cm^2. The shear modulus of rubber is 2×10^6 N/m^2. A sideways force of 500 N is applied to the motor. The distance that the motor moves sideways is

(1) 0.156 cm

(2) 1.56 cm

(3) 0.312 cm

(4) 0.204 cm

17. If Poisson ratio is 0.4 and after increasing the length of a wire by 0.05% then decrease in its diameter will be :-

(1) 0.02%

(2) 0.1%

(3) 0.01%

(4) 0.4%

18. A metal block is experiencing an atmospheric pressure of 1×10^5 N/m^2, when the same block is placed in a vacuum chamber, the fractional change in its volume is (the bulk modulus of metal is 1.25×10^{11} N/m^2)

(1) 4×10^{-7}

(2) 2×10^{-7}

(3) 8×10^{-7}

(4) 1×10^{-7}

19. The compressibility of water is 46.4×10^{-6}/atm. This means that

(1) the bulk modulus of water is 46.4×10^6 atm

(2) volume of water decreases by 46.4 one-millionths of the original volume for each atmosphere increase in pressure

(3) when water is subjected to an additional pressure of one atmosphere, its volume decreases by 46.4%

(4) When water is subjected to an additional pressure of one atmosphere, its volume is reduced to 10^{-6} of its original volume.

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

(1) 10^8

(2) 2×10^8

(3) 10^9

(4) 2×10^9

21. 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°. Then angle of shear is:

(1) 12°

(2) 0.12°

(3) 1.2°

(4) 0.012°

22. The mean density of sea water is ρ, and bulk modulus is B. The change in density of sea water in going from the surface of water to a depth h is :

(1) $\frac{\rho gh}{B}$

(2) Bρgh

(3) $\frac{\rho^2 gh}{B}$

(4) $\frac{B\rho^2}{gh}$

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

(1) 1/4

(2) 4

(3) 8

(4) 16

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

(1) 6250 J

(2) 0.177 J

(3) 0.075 J

(4) 0.150 J

25. When a load of 5 kg is hung on a wire then extension of 3 meter takes place, then work done will be :-

(1) 75 J
(2) 60 J
(3) 50 J
(4) 100 J

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

(1) 0.2 J
(2) 10 J
(3) 20 J
(4) 0.1 J

27. Two wires of the same material and length but diameter in the ratio 1 : 2 are stretched by the same force. The ratio of potential energy per unit volume for the two wires when stretched will be :-

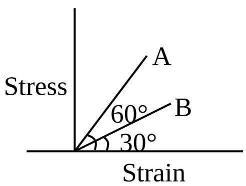
(1) 1 : 1
(2) 2 : 1
(3) 4 : 1
(4) 16 : 1

28. Two steel wires having same length are suspended from a ceiling under the same load. If the ratio of their energy stored per unit volume is 1 : 4, the ratio of their diameters is :

(1) 1 : 2
(2) $1 : \sqrt{2}$
(3) 2 : 1
(4) $\sqrt{2} : 1$

29. The stress versus strain graphs for wires of two materials A and B as shown is the figure. If Y_A and Y_B are the young's modulus of the materials, then-

(1) $Y_B = 2Y_A$
(2) $Y_A = Y_B$
(3) $Y_B = 3Y_A$
(4) $Y_A = 3Y_B$



30. Given the following values for an elastic material: Young's modulus = 7×10^{10} Nm^{-2} and Bulk modulus = 11×10^{10} Nm^{-2} . The Poisson's ratio of the material is -

(1) 0.12
(2) 0.24
(3) 0.31
(4) 0.39

31. A copper wire of length 0.9 m and cross-sectional area 1.0 mm^2 is stretched by a load of 1kg. Young's modulus for copper is 1.2×10^{11} N/m^2 and g = $10 m/s^2$. The extension in wire in mm is -

(1) 0.013

(2) 0.075

(3) 0.11

(4) 0.13

32. In steel, the young's modulus and the strain at the breaking point are 2×10^{11} Nm^{-2} and 0.15 respectively. The stress at the break point for steel is –

(1) 1.33×10^{11} Nm^{-2}

(2) 1.33×10^{12} Nm^{-2}

(3) 7.5×10^{-3} Nm^{-2}

(4) 3×10^{10} Nm^{-2}

33. A metal rod of Young's modulus 2×10^{10} Nm^{-2} undergoes an elastic strain of 0.06%. The energy per unit volume stored in Jm^{-3} is:

(1) 3600

(2) 7200

(3) 10800

(4) 14400

34. If the compressibility of water is ρ per unit atmospheric pressure, then the decrease in volume (ΔV) due to atmospheric pressure P will be -

(1) $\rho P/V$

(2) ρPV

(3) ρ/PV

(4) $\rho V/P$

35. When 1 kg wt. is suspended from a wire, the increment produced is 2 mm, What will be the increment in lengths when 4 kg wt. is suspended from it:-

(1) 14 mm

(2) 8 mm

(3) 0.5 mm

(4) 10 mm

36. A cable that can support a load W is cut into two equal parts. The maximum load that can be supported by either part is–

(1) W/4

(2) W/2

(3) W

(4) 2W

37. Two wires of the same radius and material and having lengths in the ratio 8.9 : 7.6 are stretched by the same force. The strains produced in the two cases will be in the ratio :-

(1) 1 : 1

(2) 1 : 7.6

(3) 8.9 : 1

(4) 1: 3.2

38. A wire suspended vertically from one of its ends is stretched by attaching a weight of 400 N to the lower end. The weight stretches the wire by 3 cm. Then the elastic energy stored in the wire -

(1) 0.6 J

(2) 0.2 J

(3) 6 J

(4) 2 J

39. What is the Young's modulus of elasticity for a perfectly rigid body?

(1) Infinity

(2) Zero

(3) 1

(4) –1

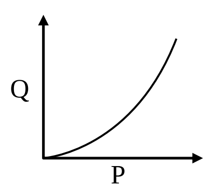
40. The graph shows the behaviour of a length of wire in the region for which the substance obeys Hook's law P and Q represent–

(1) P = applied force, Q = extension

(2) P = extension, Q = applied force

(3) P = extension, Q = stored elastic energy

(4) P = stored elastic energy, Q = extension



41. A substance breaks down under a stress of 10^5Pa. If the density of the substance is 2×10^3 kg/m^3, find the minimum length of the wire made of this substance which will break under its own weight ($g = 10$ m/s^2): -

(1) 10 m

(2) 2.5 m

(3) 4 m

(4) 5 m

42. A lift is tied with thick iron wire and its mass is 314 kg. What should be the minimum diameter of wire if the maximum acceleration of lift is 1.2 m/s^2 and the maximum safe stress of the wire is 1×10^7 N/m^2 ?

(1) 2 cm

(2) 1 cm

(3) 1.5 cm

(4) None of these

43. A sample of a liquid has an initial volume of 1.5 L. The volume is reduced by 0.2 mL, when the pressure increases by 140 kPa. What is the bulk modulus of the liquid?

(1) 1.05×10^9 Pa

(2) 1.1×10^9 Pa

(3) 1.2×10^9 Pa

(4) 1.4×10^9 Pa

44. A stretched rubber has:-

(1) Increased kinetic energy

(2) Increased potential energy

(3) Decreased kinetic energy

(4) Decreased potential energy

45. A long elastic wire is stretched by 2 cm and its potential energy is U. If the wire is stretched by 10 cm, the P.E., will be-

(1) 5U

(2) 25U

(3) U/5

(4) U/20

Answer Key

Question	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Answer	1	2	1	1	3	4	2	3	3	3	3	3	3	4	3
Question	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Answer	1	1	3	2	4	2	3	4	3	1	4	4	4	4	4
Question	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
Answer	2	4	1	2	2	3	1	3	1	3	4	1	1	2	2

SOLUTIONS

1. d = 4mm

$Y = 9 \times 10^{10}\ N/m^2$

$\frac{F}{A} = Y\frac{\Delta\ell}{\ell}$

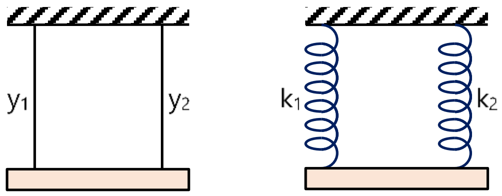
$F = AY\frac{\Delta\ell}{\ell}$

$= \pi(2 \times 10^{-3})^2 \times 9 \times 10^{10} \times \frac{0.1}{100}$

$= \pi \times 4 \times 10^{-6} \times 9 \times 10^{7}$

$= 360\ \pi$ N.

2.



$k_{eq} = k_1 + k_2$

$\frac{Y(2A)}{\ell} = \frac{Y_1A}{\ell} + \frac{Y_2A}{\ell}$

$Y = \frac{Y_1+Y_2}{2}$

3. $\frac{F/A}{\Delta\ell/\ell} = Y$

$\frac{F}{\Delta\ell} = \frac{YA}{\ell} = \text{slope} \Rightarrow$ Y & ℓ are same for all them

slope α A

4. Area = 1 cm^2

$\Delta\ell = 1.1\,\ell - \ell$

$\Rightarrow\ Y = 2 \times 10^{11}\ N/m^2$

$\frac{F}{A} = Y\frac{\Delta\ell}{\ell}$

$F = AY\left(\frac{0.1\ell}{\ell}\right)$

$= 1 \times 10^{-4} \times 2 \times 10^{11} \times 0.1$

$= 2 \times 10^{6}$N

5. $\frac{F}{A} = Y\frac{\Delta\ell}{\ell}$

$Y\frac{\Delta\ell}{\ell}$ are constant

$F = AY\frac{\Delta\ell}{\ell} \quad \Rightarrow F \propto A \Rightarrow \quad F' = 4F$

6. $\ell_B = 2\text{m}, \ell_S = L$

$A_B = 2\ \text{cm}^2, \ A_S = 1\ \text{cm}^2$

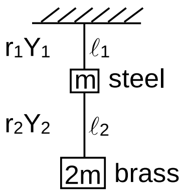
$\Delta\ell_B = \Delta\ell_S$

$\frac{F}{A_B}\frac{L_B}{Y_B} = \frac{F}{A_S}\frac{L_S}{Y_S}$

$L_S = \frac{A_S Y_S}{A_B Y_B} L_B = \frac{1}{2} \times \frac{2\times10^{11}}{1\times10^{11}} \times 2 = 2\text{m}$

7. $\frac{\ell_1}{\ell_2} = a \quad \frac{r_1}{r_2} = b$

$\frac{Y_1}{Y_2} = c$



$\Delta\ell_1 = \frac{(3mg)\ell_1}{A_1 Y_1}$

$\Delta\ell_2 = \frac{(2mg)\ell_2}{A_2 Y_2}$

$\frac{\Delta\ell_1}{\Delta\ell_2} = \frac{3\ell_1}{2\ell_2 A_1 Y_1} \times A_2 Y_2 \quad = \frac{3}{2}\frac{a}{b^2 c} = \frac{3a}{2b^2 c}$

8. Breaking stress is characteristic property of wire. Independent to shape and size.

9. $\Delta L = \frac{FL}{YA} \quad \Rightarrow \quad \Delta L = \frac{mgL}{YA} = \frac{(10)(1)}{2\times10^{11}\times(1\times10^{-6})} = 0.05\text{mm}$

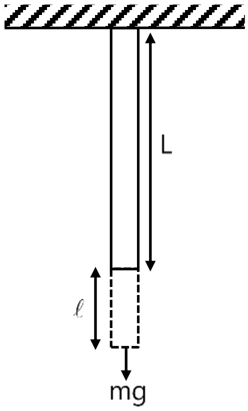
10. $Y = \frac{\left(\frac{F}{A}\right)}{\frac{\Delta L_1}{L}} \qquad$ ...(i)

$Y = \frac{\left(\frac{F}{4A}\right)}{\frac{\Delta L_2}{2L}} \qquad$ ...(ii)

$\frac{\Delta L_1}{\Delta L_2} = 2$

11. When strain is small, the ratio of the longitudinal stress to the corresponding longitudinal strain is called Young's modulus (Y) of the material of the body.

$Y = \frac{\text{stress}}{\text{strain}} = \frac{F/A}{\Delta\ell/L} = \frac{F.L}{\pi r^2 \Delta\ell}$



Given, $Y_1 = 7 \times 10^{10}\ N/m^2$

$Y_2 = 12 \times 10^{10}\ N/m^2$

$D_1 = 3mm$

$\therefore\ \frac{Y_2}{Y_1} = \left(\frac{D_1}{D_2}\right)^2$

$\frac{12\times10^{10}}{7\times10^{10}} = \left(\frac{3}{D_2}\right)^2$

$\Rightarrow \frac{3}{D_2} = \sqrt{\frac{12}{7}}$

$D_2 = 3\sqrt{\frac{7}{12}} \approx 2.3\ mm$

12. Potential energy stored in rubber is converted into kinetic energy.

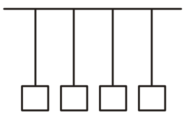
$\frac{1}{2}mv^2 = \frac{1}{2}\frac{YA(\Delta L)^2}{L}$

$V = \sqrt{\frac{YA(\Delta L)^2}{mL}}$

$= \sqrt{\frac{5\times10^8\times25\times10^{-6}\times(5\times10^{-2})^2}{5\times10^{-3}\times10\times10^{-2}}}$

$= 250\ m/s$

13. $\frac{\Delta\ell}{\ell} = \frac{F}{AY}$



$\Delta\ell \propto \frac{\ell}{A}$

14. $Y = \frac{\text{Stress}}{\text{Strain}} = \text{Constant}$

It depends only on nature of material

15. $F = \eta A\frac{x}{h} = 0.4 \times 10^{11} \times 1 \times .005 \times \frac{.02\times10^{-2}}{1} = 4\times10^4\ N$

16. $\frac{F}{A} = \eta\frac{x}{h}$

$\frac{500}{4\times16\times10^{-4}} = 2 \times 10^6 \frac{x}{4\times10^{-2}} \Rightarrow x = \frac{5\times10^{-2}}{32} m = 0.156\ cm$

17. Poison's ratio = $\frac{\text{Lateralstrain}}{\text{Longitudinalstrain}}$

$\therefore$ Lateral strain $= 0.4 \times \frac{0.05}{100}$

$= 0.02\%$

18. $\frac{\Delta V}{V} = \frac{p}{B} = \frac{1\times10^5}{1.25\times10^{11}} = 8 \times 10^{-7}$

19. $46.4 \times 10^{-6}/\text{atm} = \frac{1}{B}$

$B = \frac{1}{46.4\text{x}10^{-6}}$; $B = \frac{P}{\Delta v/v} \Rightarrow \frac{\Delta v}{v} = \frac{\Delta p}{B} = 46.4 \text{ x } 10^{-6}$.

20. depth = 200 m

$\frac{\Delta V}{V} = \frac{0.1}{100} = 10^{-3}$

density $= 1 \times 10^3 \text{ kg}/m^3$

$g = 10 \text{ m}/s^2$

$B = \frac{\Delta p}{\Delta v/v} = \frac{hg\rho}{\Delta v/v} \Rightarrow B = 200 \times 10 \times 10^3 \times 1000 = 2 \times 10^9$

21. Angle of shear $\phi = \frac{r\theta}{L} = \frac{4\times10^{-1}}{100} \times 30° = 0.12°$

22. $\frac{\Delta V}{V} = \frac{h\rho g}{B} \Rightarrow \quad \frac{\Delta\rho}{\rho} = \frac{h\rho g}{B}$

$\Delta\rho = \frac{\rho^2 gh}{B}$

23. $U = \frac{1}{2}kx^2 = \frac{1}{2}\frac{AY}{\ell}(\Delta\ell)^2$

$\Rightarrow \frac{U_2}{U_1} = \frac{A_2}{A_1}\frac{\ell_1}{\ell_2} = \frac{\pi r_2^2 \ell_1}{\pi r_1^2 \ell_2} = \frac{(2)^2}{1/2} = 8$

$\therefore \quad U_2 = 8U_1 = 16 \text{ J}$

24. $U = \frac{1}{2}Y\,(\text{strain})^2 \text{ Volume} = \frac{1}{2} \times 2 \times 10^{11} \times \left(\frac{10^{-3}}{4}\right)^2 \times (3 \times 10^{-6}) \times (4)$

$U = 0.075 \text{ J}$

25. Work done $= \Delta U = \frac{1}{2} \times$ Force $\times$ Extension

$= \frac{1}{2} \times 5 \times 10 \times 3 = 75\text{J}$

26. Elastic energy stored in the wire is

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

$= \frac{1}{2}\frac{F}{A} \times \frac{\Delta L}{L} \times AL$

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

$= \frac{1}{2} \times 200 \times 1 \times 10^{-3} = 0.1 \text{ J}$

27. $\frac{r_1}{r_2} = \frac{1}{2}$

PE (per unit volume) $= \frac{1}{2Y}\left(\frac{F}{A}\right)^2$

$PE \propto 1/A^2$

$\frac{PE_1}{PE_2} = \frac{{A_2}^2}{{A_1}^2} = \frac{r_2^4}{r_1^4} = 16 : 1$

28. $\frac{du}{dv} = \frac{1}{2}$ stress $\times \frac{\text{stress}}{Y}$

$= \frac{1}{2}\frac{F^2}{A^2Y}$

$\frac{du}{dv} \propto \frac{1}{d^4}$

$\frac{\left(\frac{du}{dv}\right)_1}{\left(\frac{du}{dv}\right)_2} = \frac{d_2^4}{d_1^4} = \frac{1}{4}$

$\frac{d_1}{d_2} = (4)^{1/4}$

$\frac{d_1}{d_2} = \sqrt{2} : 1$

29. $\frac{Y_A}{Y_B} = \frac{\tan 60°}{\tan 30°} = \frac{\sqrt{3}}{\frac{1}{\sqrt{3}}} = 3$

so $Y_A = 3Y_B$.

30. $K = \frac{Y}{3(1-2\sigma)}$ or $11 \times 10^{10} = \frac{7\times10^{10}}{3(1-2\sigma)}$

or $\frac{7}{33} = 1 - 2\sigma$

or $2\sigma = 1 - \frac{7}{33}$, $\sigma = \frac{26}{33\times2} = 0.39$

31. $Y = \frac{FL}{A\Delta L}$

$\therefore \ \Delta L = \frac{FL}{YA} = \frac{1\times10\times0.9}{1.2\times10^{11}\times10^{-6}} = .075 \times 10^{-3}\text{m} = .075\text{ mm}$

32. Stress = Y ×strain = $2 \times 10^{11} \times 0.15\text{ Nm}^{-2}$

$= 3 \times 10^{10}\text{ Nm}^{-2}$

33. Energy/Volume $= \frac{1}{2} \times$ stress × strain

$= \frac{1}{2} Y \times \text{strain} \times \text{strain} = \frac{1}{2} Y (\text{strain})^2$

$= \frac{1}{2} \times 2 \times 10^{10} \times 0.06 \times 10^{-2} \times 0.06 \times 10^{-2}$

$= 3600\text{ Jm}^{-3}$.

34. $K = \frac{P}{\frac{\Delta V}{V}}$ or $\frac{1}{K} = \frac{\Delta V/V}{P}$

or $\rho = \frac{\Delta V}{PV}$ or $\Delta V = \rho PV$.

35. $Y_1 = Y_2$

$\left|\frac{F_1(\ell)}{A\Delta\ell_1} = \frac{F_2(\ell)}{A(\Delta\ell_2)}\right|$, $\Delta\ell_2 = \frac{F_2}{F_1}\Delta\ell_1 = \frac{40}{10} \times 2\text{mm} = 8\text{mm}$

36. Breaking stress = $\frac{F}{\mathbf{A}}$

Does not depends on length

37. $Y = \frac{\text{stress}}{\text{strain}}$; Strain = $\frac{\text{stress}}{Y} = \frac{F/\pi r^2}{Y}$.

Strain does not depend on the length

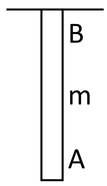
38. Energy stored $= \frac{1}{2}F(\Delta\ell) = \frac{1}{2}(400)(3) \times 10^{-2} = 6$ J

39. Since strain is zero therefore Y is infinite.

40. $U = \frac{1}{2}\left(\frac{YA}{\ell}\right)(\Delta\ell)^2 = \frac{1}{2}kx^2$

Graph between extension and stored elastic energy will be parabolic

41. Stress at B is maximum, so the wire will break first at B if stress here becomes 10^5 Pa:



$\frac{mg}{A} = 10^5$ Pa

$\Rightarrow \frac{AL\rho g}{A} = 10^5 \Rightarrow L = \frac{10^5}{\rho g} = 5$ m

42. The tension, T in the rope of the lift when it goes upward is given by

T = m (g + a) = 314 × 11 N

Let r be the radius of the wire, then maximum stress will be $T/\pi r^2$

Hence, $T/\pi r^2 = 1.1 \times 10^7$

43. $B = -\frac{\Delta P}{\Delta V/V} = -\frac{V\Delta P}{\Delta V}$

$= -\frac{1.5\times140\times10^3}{-0.2\times10^{-3}} = 1.05 \times 10^9$ Pa

44. $U = \frac{1}{2}\frac{YA}{L} \times (\Delta L)^2$

$\Delta L \uparrow$

$U \uparrow$, U = Potential energy

45. $U = \frac{1}{2}\frac{YA}{L} \times (\Delta L)^2$

$\therefore \frac{U_2}{U_1} \propto \left(\frac{\Delta l_2}{\Delta l_1}\right)^2 = \left(\frac{10}{2}\right)^2$

$\frac{U_2}{U_1} = 25$

$\frac{U_2}{U} = 25$

$\Rightarrow U_2 = 25U$

Mechanical Properties of Solids NEET PYQs

1. The following four wires are made of the same material. Which of these will have the largest extension when the same tension is applied?
(1) length = 300cm, diameter = 3mm
(2) length = 50 cm, diameter = 0.5 mm
(3) length = 100 cm, diameter = 1mm
(4) length = 200 cm, diameter = 2mm

NEET UG 2013 (+4 /−1)

2. Copper of fixed volume 'V; is drawn into wire of length 'l'. When this wire is subjected to a constant force 'F', the extension produced in the wire is 'Δl'. Which of the following graphs is a straight line ?
(1) Δl versus $\frac{1}{l}$
(2) Δl versus l^2
(3) Δl versus $\frac{1}{l^2}$
(4) Δl versus l

AIPMT 2014 (+4 /−1)

3. The approximate depth of an ocean is 2700 m. The compressibility of water is 45.4×10^{-11} Pa^{-1} and density of water is 10^3 kg/m^3. What fractional compression of water will be obtained at the bottom of the ocean ?
(1) 1.0×10^{-2}
(2) 1.2×10^{-2}
(3) 1.4×10^{-2}
(4) 0.8×10^{-2}

AIPMT 2015 (+4 /−1)

4. The Young's modulus of steel is twice that of brass. Two wires of same length and of same area of cross section, one of steel and another of brass are suspended from the same roof. If we want the lower ends of the wires to be at the same level, then the weights added to the steel and brass wires must be in the ratio of :
(1) 1 : 1
(2) 1 : 2
(3) 2 : 1
(4) 4 : 1

Re-AIPMT 2015 (+4 /−1)

5. The bulk modulus of a spherical object is 'B'. If it is subjected to uniform pressure 'p', the fractional decrease in radius is :-

(1) $\frac{B}{3p}$

(2) $\frac{3p}{B}$

(3) $\frac{p}{3B}$

(4) $\frac{p}{B}$

NEET(UG) 2017 (+4 /−1)

6. Two wires are made of the same material and have the same volume. The first wire has cross-sectional area A and the second wire has cross-sectional area 3A. If the length of the first wire is increased by Δl on applying a force F, how much force is needed to stretch the second wire by the same amount?

(1) 9F

(2) 6F

(3) 4F

(4) F

NEET(UG) 2018 (+4 /−1)

7. When a block of mass M is suspended by a long wire of length L, the length of the wire become (L+l). The elastic potential energy stored in the extended wire is :-

(1) Mgl

(2) MgL

(3) $\frac{1}{2}$Mgl

(4) $\frac{1}{2}$MgL

NEET(UG) 2019 (+4 /−1)

8. The stress-strain curves are drawn for two different materials X and Y. It is observed that the ultimate strength point and the fracture point are close to each other for material X but are far apart for material Y. We can say that materials X and Y are likely to be (respectively)

(1) ductile and brittle

(2) brittle and ductile

(3) brittle and plastic

(4) plastic and ductile

NEET(UG) 2019 (Odisha) (+4 /−1)

9. A wire of length L, area of cross section A is hanging from a fixed support. The length of the wire changes to L_1 when mass M is suspended from its free end. The expression for Young's modulus is :

(1) $\frac{MgL}{A(L_1-L)}$

(2) $\frac{MgL_1}{AL}$

(3) $\frac{Mg(L_1-L)}{AL}$

(4) $\frac{MgL}{AL_1}$

NEET(UG) 2020 (+4 /−1)

Answer Key

Question	1	2	3	4	5	6	7	8	9
Answer	**2**	**2**	**2**	**3**	**3**	**1**	**3**	**2**	**1**

SOLUTIONS

1. $Y = \frac{F/A}{\Delta\ell/\ell} \Rightarrow \Delta\ell = \frac{F\ell}{YA} = \frac{F\ell}{Y\pi r^2} \Rightarrow \Delta\ell \propto \frac{\ell}{r^2}$

for ℓ = 50 cm & diameter = 0.5 mm,

ℓ is maximum

2. $Y = \frac{\frac{F}{A}}{\frac{\Delta\ell}{\ell}} \Rightarrow \Delta\ell = \frac{F\ell}{AY}$

But $V = A\ell$ so $A = \frac{V}{\ell}$ (V = volume)

Therefore $\Delta\ell = \frac{F\ell^2}{VY} \propto \ell^2, \Delta\ell \propto \ell^2$

3. As we know

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

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

Now $P = \rho gh$ & compressibility 'C' $= \frac{1}{B}$

so $\frac{\Delta V}{V} = \rho gh(C)$

$= 10^3 \times 9.8 \times 2700 \times 45.4 \times 10^{-11}$

$= 1.201 \times 10^{-2}$

4. $Y = \frac{F\ell}{A\Delta\ell} \Rightarrow \Delta\ell = \frac{F\ell}{AY}$

$(\Delta\ell)_{\text{stell}} = (\Delta\ell)_{\text{Brass}}$

$\Rightarrow \frac{W_S\ell}{AY_S} = \frac{W_B\ell}{AY_B}$

$\Rightarrow \frac{W_S}{W_B} = \frac{Y_S}{Y_B} = \frac{2}{1}$

5. $B = \frac{\Delta P}{-\frac{\Delta V}{V}}, \frac{\Delta V}{V} = \frac{3\Delta R}{R}$

$B = \frac{\Delta P}{\frac{-3\Delta R}{R}} \Rightarrow -\frac{\Delta R}{R} = \frac{P}{3B}$ ($\Delta P = P$)

6. $Y = \frac{F\ell}{A\Delta\ell}$ $\because V = A\ell$ so $\ell = \frac{V}{A}$

So $F = \frac{YA\Delta\ell}{\ell} = \frac{YA^2\Delta\ell}{V}$, $F \propto A^2$

$\frac{F_1}{F_2} = \left(\frac{A_1}{A_2}\right)^2 \Rightarrow \frac{F}{F_2} = \left(\frac{A}{3A}\right)^2 = \frac{1}{9} \Rightarrow F_2 = 9F$

7. $U = \frac{1}{2}(\text{force})(\text{elongation})$

$= \frac{1}{2}(Mg)\ell = \frac{1}{2}Mg\ell$

9. $Y = \frac{FL}{A\Delta L} = \frac{MgL}{A(L_1 - L)}$