Mechanical Properties of Solids Important Questions With Answers

NEET Physics 2023

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1. 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___

   a) $\frac{mgL}{A(L_1-L)}$ b) $\frac{mgL_1}{AL}$ c) $\frac{Mg(L_1-L)}{AL}$ d) $\frac{MgL}{AL_1}$

   Solution : -

   $Y = \frac{FL}{A\Delta L} = \frac{mgL}{A(L_1-L)}$

2. A copper rod of 88 cm and an aluminium rod of unknown length have their increase in length independent of increase in temperature. The length of aluminium rod is: $\left(\mathrm{a_{Cu}} = 1.7 \times 10^{-5}\ \mathrm{K^{-1}}\right.$ and $\left.\mathrm{a_{Al}^{-2.2}} \times 10^{-5}\ \mathrm{K^{-1}}\right)$____

   a) $113.9\ \mathrm{cm}$ b) $88\ \mathrm{cm}$ **c)** $68\ \mathrm{cm}$ d) $6.8\ \mathrm{cm}$

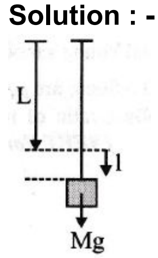
   Solution : -

   $\mathrm{a_{Cu}L_{Cu}} = \mathrm{a_{Al}L_{Al}}$
   $1.7 \times 10^{-5} \times 88\ \mathrm{cm} = 2.2 \times 10^{-5} \times \mathrm{L_{Al}}$
   $\mathrm{L_{Al}} = \frac{1.7 \times 88}{2.2} = 68\ \mathrm{cm}$

3. When a block of mass M is suspended by a long wire of length L, the length of the wire becomes L + l. The elastic potential energy stored in the extended wire is____

   a) mgI **b)** $\frac{1}{2}\mathrm{mgl}$ c) $\frac{1}{2}\mathrm{mgL}$ d) mgl

   Solution : -

   $\mathrm{U} = \frac{1}{2}$ (work done by gravity)
   $\mathrm{U} = \frac{1}{2}\mathrm{Mgl}$

4. The approximate depth of an ocean is 2700 m. The compressibility of water is $45.4 \times 10^{-11}\ \mathrm{Pa^{-1}}$ and density of water is $10^3\ \mathrm{kg/m^3}$. What fractional compression of water will be obtained at the bottom of the ocean?

   a) 1.0×10^{-2} **b)** 1.2×10^{-2} c) 1.4×10^{-2} d) 0.8×10^{-2}

   Solution : -

   Compressibility of water $K = 45.4 \times 10^{-11}\ \mathrm{Pa^{-1}}$ density of water $P = 10^3\ \mathrm{kg/m^3}$ depth of ocean, $h = 2700\ \mathrm{m}$
   We have to find $\frac{\Delta V}{V} = ?$
   As we know, compressibility,
   $K = \frac{1}{B} = \frac{(\Delta V/V)}{P} (P = P_{gh})$ Thus, $(\Delta V/V) = KPgh$
   $= 45.4 \times 10^{-11} \times 10^3 \times 10 \times 2700 = 1.2258 \times 10^{-2}$

5. Copper of fixed volume ' V ' is drawn into wire of length ' T '. When this wire is subjected to a constant force ' P ', the extension produced in the wire is $\mathrm{D}l'$. Which of the following graphs is a straight line?

a) $\mathrm{D}l$ versus 1/l **b) $\mathrm{D}l$ versus l^2** c) $\mathrm{D}l$ versus 1/l^2 d) $\mathrm{D}l$ versus l

Solution : -

As we have $Y=\frac{\frac{F}{A}}{\frac{\Delta l}{l}} \Rightarrow \Delta l=\frac{Fl}{AY}$

But V=A l so $A=\frac{V}{l}$

So, $\Delta l=\frac{Fl^2}{VY} \propto l^2$

Thus graph Δl versus l^2 will give a straight line.

6. The following four wires are made of the same material. Which of these will have the largest extension when the same tension is applied?

a) $Length=100 \mathrm{~cm}, diameter=1 \mathrm{~mm}$ b) $Length=200 \mathrm{~cm}, diameter=2 \mathrm{~mm}$

c) $Length=300 \mathrm{~cm}, diameter=3 \mathrm{~mm}$ **d)** $Length=50 \mathrm{~cm}, diameter=0.5 \mathrm{~mm}$

Solution : -

$F=\frac{YA}{L} \times l$

Therefore, extension, $l \alpha \frac{L}{A} \alpha \frac{L}{D^2}$

[$\because$ F and Y are constant]

$l_1 \alpha \frac{100}{1^2} \Rightarrow l_1 \alpha 100 ; l_2 \alpha \frac{200}{2^2} \Rightarrow l_2 \alpha 50$

$l_3 \alpha \frac{300}{3^2} \Rightarrow l_3 \alpha \frac{100}{3} ; l_4 \alpha \frac{50}{\frac{1}{4}} \Rightarrow l_4 \alpha 200$

The ratio of $\frac{L}{D^2}$ is maximum for case (d).

7. The compressibility of water is 4×10^{-5} per unit atmospheric pressure. The decrease in volume of $100 \mathrm{~cm}^3$ of water under a pressure of 100 atmosphere will be___

a) $0.4 \mathrm{~cm}^3$ b) $1 \times 10^{-5} \mathrm{~cm}^3$ c) $0.025 \mathrm{~cm}^3$ d) $0.004 \mathrm{~cm}^3$

Solution : -

$K=\frac{1}{B}=\frac{\Delta V/V}{P}$. Here, P=100 atm,

$K=4 \times 10^{-5}$ and V =100 cm^3.

Therefore, DV =0.4 cm^3

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

a) $YS/2$ b) $\mathrm{S}^2\mathrm{Y}/2$ **c)** $\mathrm{S}^2/2\mathrm{Y}$ d) $\mathrm{S}/2\mathrm{Y}$

Solution : -

Energy stored per unit volume

$=\frac{1}{2} \times$ stress $\times$ strain

$=\frac{1}{2} \times$ stress $\times$ (stress / Young's modulus)

$=\frac{1}{2} \times$ (stress $)^2/($ Young's modulus)

$=\frac{S^2}{2Y}$

9. Two wires A and B are of the same material. Their lengths are in the ratio 1: 2 and the diameter are in the ratio 2: 1. If they are pulled by the same force, then increase in length will be in the ratio____

a) 2: 1 b) 1: 4 **c) 1: 8** d) 8: 1

Solution : -

We have, Young's modulus of elasticity

$Y=\frac{F}{\pi r^2} \times \frac{L}{l}$

As Y, F remain same for both the wires, we have,

$$\frac{1}{n^2}\frac{L_1}{l_1} = \frac{1}{r_2^2}\frac{L_2}{l_2}$$

$$\Rightarrow \frac{l_1}{l_2} = \frac{r_2^2 \times L_1}{n^2 \times L_2} = \frac{(D_2/2)^2 \times L_1}{(D_1/2)^2 \times L_2}$$

$$\Rightarrow \frac{l_1}{l_2} = \frac{D_2^2 \times L_1}{D_1^2 \times L_2} = \frac{D_2^2}{(2D_2)^2} \times \frac{L_2}{2L_2} = \frac{1}{8}$$

So, $l_1 : l_2 = 1 : 8$

10. You have four wires A, B, C, D of same material having same area of cross - section such that length of A > B > C > D, the breaking force of
    a) A > B > C > D b) A < B < C < D **c) A = B = C = D** d) A/B - C/D
11. The reciprocal of Bulk modulus (1/K) is called
    a) Young's modulus b) modulus of rigidity c) Hooke's law **d) compressibility**
12. Ductile substances are those in which
    a) there is no elastic limit b) there is no breaking point c) Hooke's law is not applicable
    d) there is a large gap between elastic limit and breaking point
13. Brittle substanceare those in which there is
    a) no elastic b) no breaking point **c) small gap between elastic limit and breaking point**
    d) large gap between elastic limit and breaking point
14. The energy stored in a stained wire is given by
    a) 1/2 stress x strain **b) 1/2 load x elongation** c) 1/2 stress / strain d) 1/2 load / eloongation
15. The value of Bulk modulus for a perfectly right body is
    a) infinity b) zero c) one d) ±1
16. If both the length and radius of the wire are doubled. how does the rnodulus of elasticity change?
    a) becomes one fourth b) halved c) doubled **d) remains unchanged**
17. The Young's modulus of a Wire is numerically equal to the stress Which Will
    a) Not change the length of the wire **b) Double the length of the wire** c) Increase the length by 50%
    d) Change the radius of the wire to half
18. A rope of nylon of radius 1.5cm has a breaking strength of 1.6 x 10^5N.The breaking strength of a similar rope of radius 7.5mm shall be
    a) 1.6 x 10^5N b) 0.8 x 10^5N **c) 0.4 x 10^5N** d) 0.2 x 10^5N
19. You have a wire whose area of cross section is 5mm^2 and get stretched by 0.2mm by a certain load.If another wire of the same material has 3/2 times its area of cross section, the extension for the same load will be
    a) 0.2mm b) 0.24mm **c) 0.133mm** d) 0.03mm
20. Four wires of the same material are Stretched by the same load. The dimensions are given below. Which of them will elongate the most
    a) length 100 cm, diameter 1 mm b) length 200 cm, diameter 2 mm c) length 300 cm, diameter 3 mm
    d) length 400 cm, diameter 0.5 mm
21. With the increase in temperature, the Young's modulus of a material
    a) increases **b) decrease** c) remains same d) fluctuates
22. The upper face of a (side 4cm) is displaced 2 mm parallel to itself when 100 N forces are applied at the and lower faces. The lower face is fixed. The strain produced in the cube is
    a) 5 b) 0.5 **c) 0.05** d) 0.005
23. One end of uniform wire of length L and of weight W is attached rigidly to a point in the roof and a weight WI is suspended from its lower end. If s is the area Of cross-section of the wire. the stress in the wire at a height (3L/4) from its lower end is
    a) W_1/s b) [W_1/s+W/4]s **c) [W_1+3W/4]s** d) W_1+W/s

24. Dimensional formula of stress is same as that of
    a) impulse b) strain c) force **d) pressure**
25. Young's modulus of a material has the same unit as
    a) stress b) energy c) compressibility d) pressure
26. Elastic limit is equal to
    a) Young's modulus b) Modulus of rigidity **c) stress** d) strain
27. Which of the following is not a unit of Young's modulus?
    a) Nm^{-2} b) Mega Pascal (MPa) c) dyne cm^{-2} **d) Nm^{-1}**
28. A wire suspended vertically from one end, is stretched by attaching a weight 200 N to the lower end. The weight stretches the wire by 1 mm. The energy gained by the wire is
    a) 0.1 J b) 0.2 J c) 0.4 J d) 4 k
29. A spring of force constant k is cut into two equal parts. The force constant of each part is
    a) k/2 b) k **c) 2k** d) 4k
30. Young's modulus of a wire depends on
    a) its material b) its length c) its area of cross-section d) both (b) and (c)
31. The property of a body by virtue of which it tends to regain its original size and shape of a body when applied force is removed, is known as
    a) fluidity **b) elasticity** c) plasticity d) rigidity
32. Elasticity is shown by materials because inter-atomic or inter-molecular forces
    a) increases when a body is deformed b) decreases when a body is deformed
    c) remains same when a body is deformed **d) becomes non-zero when a body is deformed**
33. 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**
34. A wire is stretched to double its length. The strain is
    a) 2 **b) 1** c) Zero d) 0.5
35. Elasticity is due to
    a) decrease of PE with separation between atoms/molecules
    b) increase of PE with separation between atoms/molecules **c) asymmetric nature of PE curve**
    d) None of the above
36. A uniform bar of square cross-section is lying along a frictionless horizontal surface. A horizontal force is applied to pull it from one of its ends, then
    a) the bar is under same stress throughout its length
    b) the bar is not under any stress because force has been applied only at one end
    c) the bar simply moves without any stress in it
    d) the stress developed gradually reduces to zero at the end of the bar where no force is applied
37. 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
38. A wire of diameter 1 mm breaks under a tension of 1000 N. Another wire of same material as that of the first one, but of diameter 2 mm breaks under a tension of
    a) 500 N b) 1000 N c) 10000 N **d) 4000 N**
39. The length of a wire increases by 1% by a load of 2 kg-wt. The linear strain produced in the wire will be
    a) 0.02 b) 0.001 **c) 0.01** d) 0.002
40. A uniform cube is subjected to volume compression. If each side is decreased by 1%, then bulk strain is
    a) 0.01 b) 0.06 c) 0.02 **d) 0.03**

41. 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 liquids and gases.
   c) Metals have larger values of Young's modulus than elastomers
   d) Alloys have larger values of Young's modulus than metals.
42. When a pressure of 100 atmosphere is applied on a spherical ball of rubber, then its volume reduces to 0.01 %. The bulk modulus of the material of the rubber in dyne cm^{-2} is
   a) 10×10^{12} b) 100×10^{12} **c) 1×10^{12}** d) 20×10^{12}
43. Modulus of rigidity of ideal liquids is
   a) infmity **b) Zero** c) unity d) some finite small non-zero constant value
44. 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 **d) Zero**
45. A wire of length 2 m is made from 10 cm^3 of copper. A force F is applied so that its length increases by 2 mm. Another wire of length 8 m is made from the same volume of copper. If the force F is applied to it, its length will increase by
   a) 0.8 cm b) 1.6 cm c) 2.4 cm **d) 3.2 cm**
46. In steel, the Young's modulus and the strain at the breaking point are $2 \times 10^{11} Nm^2$ and 0.15, respectively. The stress at the breaking point for steel is therefore
   a) $1.33 \times 10^{11}\ Nm^{-2}$ b) $1.33 \times 10^{12}\ Nm^{-2}$ c) $7.5 \times 10^{-13}\ Nm^{-2}$ **d) $3 \times 10^{10}\ Nm^{-2}$**
47. Elasticity of a material can be altered by
   a) annealing b) hammering c) adding impurities **d) All of the above**
48. 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**
49. In solids, inter-atomic forces are
   a) totally repulsive b) totally attractive **c) combination of (a) and (b)** d) None of these
50. The nature of molecular forces resembles with the nature of the
   a) gravitational force b) nuclear force **c) electromagnetic force** d) weak force