	INDIAN SCHOOL AL WADI AL KABIR	
Class: XI	DEPARTMENT OF SCIENCE -2023-24 SUBJECT: PHYSICS	DATE : 05/11/2023
WORKSHEET NO:8 WITH ANSWERS	TOPIC: **MECHANICAL PROPERTIES OF SOLID**	A4 FILE FORMAT (PORTFOLIO)
CLASS & SEC:	NAME OF THE STUDENT:	ROLL NO.

OBJECTIVE TYPE QUESTIONS

1. The Young's modulus of a wire of length L and radius r is Y N/m^2. If the length and radius are reduced to L/2 and r/2, then its Young's modulus will be
   (a) Y (b) 2Y (c) 4Y (d) Y/2

2. A beam of metal of Young's modulus 'Y' 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) $1/Y^2$

3. When a certain weight is suspended from a long uniform wire, its length increases by 1 cm. If the same weight is suspended from another wire of the same material and length but having a diameter half of the first one then the increase in length will be
   (a)0.5cm (b)2cm (c)4cm (d)8cm

4. Hook's law defines
   (a) stress (b) strain (c) modulus of elasticity (d) elastic limit

5. The length of an iron wire is L and area of cross section is A. The increase in length is ℓ on applying the force F on its two ends. Which of the statement is correct?
   a) increase in length is proportional to area A
   b) increase in length is inversely proportional to its length L
   c) increase in length is inversely proportional to its area A
   d) increase in length is proportional to Young's modulus

6. The increase in length is $'\ell'$ of a wire of length 'L' by the longitudinal stress. Then the stress is proportional to
   (a) L/ ℓ (b) ℓ/L (c) $\ell x L$ (d) L^2

ASSERTION AND REASONING

DIRECTION: In the following questions, a statement of assertion (A) is followed by a statement of reason (R). Mark the correct choice as:
(a) Both assertion (A) and reason (R) are true and reason (R) is the correct explanation of assertion (A).
(b) Both assertion (A) and reason (R) are true but reason (R) is not the correct explanation of assertion (A).
(c) Assertion (A) is true but reason (R) is false.
(d) Both Assertion and Reason are false.

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

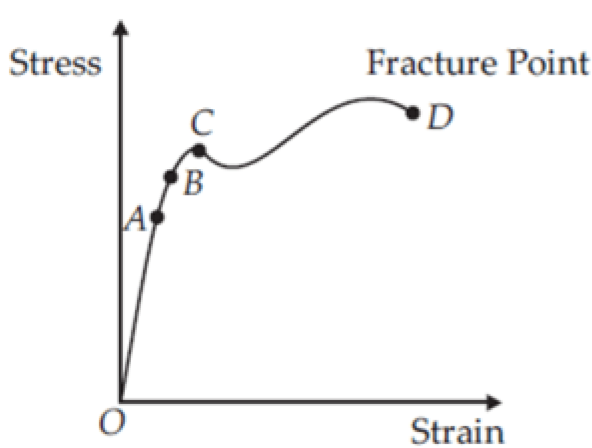
8. **Assertion :** Stress is the internal force per unit area of a body.
   Reason : Rubber is less elastic than steel.

9. **Assertion :** Spring balances show correct readings even after they had been used for a long time interval.
   Reason : On using for long time, spring balances do not losses its elastic strength.

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

CASE STUDY QUESTIONS

11. The graph shown below shows qualitatively the relation between the stress and the strain as the deformation gradually increases. Within Hooke's limit for a certain region stress and strain relation is linear. Beyond that up to a certain value of strain the body is still elastic and if deforming forces are removed the body recovers its original shape.



i. If deforming forces are removed up to which point the curve will be retraced?
(a) upto *OA* only
(b) upto *OB*

(c) upto *C*
(d) Never retraced its path
ii. In the above question, during loading and unloading the force exerted by the material are conservative up to
(a) *OA* only
(b) *OB* only
(c) *OC* only
(d) *OD* only
iii. During unloading beyond *B*, say *C*, the length at zero stress in now equal to
(a) less than original length
(b) greater than original length
(c) original length
(d) can't be predicted
iv. 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
v. Substances which can be stretched to cause large strains are called
(a) isomers
(b) plastomers
(c) elastomers
(d) polymers

12. The proportional region within the elastic limit of the stress-strain curve is of great importance for structural and manufacturing engineering designs. The ratio of stress and strain, called modulus of elasticity, is found to be a characteristic of the material. Experimental observation show that for a given material, the magnitude of the strain produced is same whether the stress is tensile or compressive. The ratio of tensile (or compressive) stress (σ) to the longitudinal strain (ϵ) is defined as Young's modulus and is denoted by the symbol Y.

$Y = \sigma / \epsilon$

Since strain is a dimensionless quantity, the unit of Young's modulus is the same as that of stress i.e., $N\text{-}m^{-2}$ or Pascal (Pa). As steel has more modulus of elasticity than copper brass and aluminium hence steel is preferred in heavy-duty machines and in structural designs. Wood, bone, concrete and glass have rather small Young's moduli. Answer the following.

i. If stress strain changes then young's modulus is
a) Also changes
b) Remains constant
c) Either changes or remains constant depends on amount of stress and strain
d) None of these

ii. SI unit of young's modulus is
a) $N\text{-}m^{-2}$
b) Pascal (Pa).
c) $N\text{-}m^{-2}$ or Pascal (Pa).
d) None of these

iii. Which of the following is more elastic?
a) Aluminium

b) Steel
c) Wood
d) Glass

iv. Defines young's modulus. Give its SI unit and dimensions

v. Why steel is more preferred in heavy industries than copper and brass?

SHORT ANSWER QUESTIONS

13. State Hook's law.
14. Why the bridges are declared unsafe after long use?
15. Girders are in the form of letter I.Why?
16. A cable is cut to half of its original length, what will be the maximum load that it can support?
17. Differentiate Brittle and ductile based on stress- strain curve

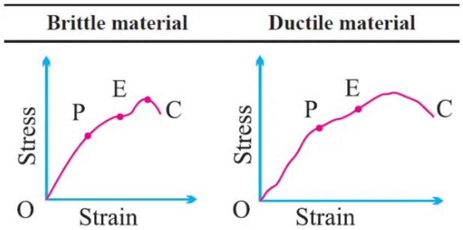
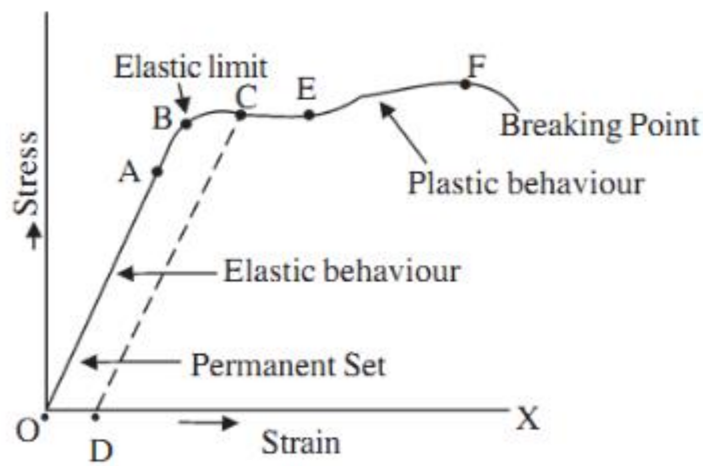
LONG ANSWER QUESTIONS

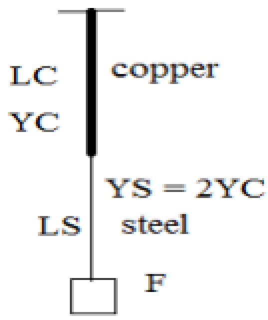
18. Derive the expression for [i] Young's modulus [ii]bulk modulus [iii]rigidity modulus
19. Explain how we can find the maximum height of a mountain using the knowledge of modulus of elasticity
20. A rubber cube of side 10cm has one side fixed, while a tangential force equal to 5000 dyne is applied to the opposite face. Find the shearing strain produced and the distance through which the strained side moves[rigidity modulus G = 2 x 10^7 dynes/cm^2]
21. The length of a wire increases 8mm when a weight of 5kg is hung. If the conditions are the same, but the radius of the wire is doubled, what will be the increase in its length?
22. When a wire is stretched by a certain force ,its elongation is 'x'. If the second wire of the same material has four times the length and double the radius of the first wire and is stretched by the same force as before, find its elongation?
23. An aluminium wire 1 m in length and radius 1 mm is loaded with a mass of 40 kg hanging vertically. Young's modulus of Al is 7.0 × 1010 N/m2. Calculate (a) tensile stress (b) change in length (c) tensile strain and (d) the force constant of such a wire.
24. A piece of copper wire has twice the radius of a piece of steel wire. One end of the copper wire is joined to one end of the steel wire so that both can be subjected to the same longitudinal force. Find the percentage increase in the steel wire, when the length of the copper wire has increased by 1% ['Y' for steel is twice that of copper]
25. Two pieces of wires A and B of the same material have their lengths in the ratio 1:2 and diameters are in the ratio 2:1.If they are stretched by same force ,what will be the ratio of their elongation ?

ANSWERS

No	ANSWER	marks
1.	(a) Y	1
2.	(c) 1/Y	1
3.	(c)4cm	1

4.	(c) modulus of elasticity	1
5.	(c)increase in length is inversely proportional to its area A	1
6.	(b) ℓ/L	1
7.	(c) Assertion (A) is true but reason (R) is false.	1
8.	(b) Both assertion (A) and reason (R) are true but reason (R) is not the correct explanation of assertion (A).	1
9.	(d) Both Assertion and Reason are false.	1
10.	(a) Both assertion (A) and reason (R) are true and reason (R) is the correct explanation of assertion (A).	1
11.	i. (b) ii. (b) : Point B is the elastic limit iii. (b) : Beyond B even if deforming forces are removed still some deformation is left. iv. (c) : The breaking stress for a wire of unit cross-section is called tensile strength. v. (c) : Substances which can be stretched to cause large strains are called elastomers.	5
12	i) b ii) c iii) b iv) The ratio of tensile (or compressive) stress (σ) to the longitudinal strain (ϵ) is defined as Young's modulus and is denoted by the symbol Y. Y= **σ / ϵ** the unit of Young's modulus is the same as that of stress i.e., **N-m^{-2}** or Pascal (Pa) and its dimensional formula is **[ML^{-1} T^{-2}]** v) Steel is more preferred in heavy industries than copper and brass because steel has more modulus of elasticity that is higher young's modulus than copper and brass. In short steel is more elastic than copper and brass.	5
13.	For small deformations the stress and strain are proportional to each other Stress α strain Stress= k× strain	1
14.	A bridge during its use undergoes alternating strains for a large number of times each day, depending upon the movement of vehicles on it when a bridge is used for long time, it losses its elastic strength. Due to which the amount of strain in the bridge for a given stress will become large and ultimately, the bridge may collapse. This may not happen, if the bridges are declared unsafe after long use.	1
15.	To minimize buckling and to reduce the cost of construction of beams	2
16.	stress =load/area .	2

	The breaking stress is independent of the length of the cable. Hence, the maximum load supported by the cable after cutting remains the same, that is, same as original.	
17.	 For Brittle material, the plastic region between E and C is very small and it will break soon after the elastic limit is crossed.(eg:glass) The ductile materials have good plastic range and such materials can be easily changed into different shapes and can be drawn into thin wires.(eg:copper)	2
18	Refer notes	5
19		3
20.	Ans. X = ɵ x 10 = $2.5x10^{-5}$ cm Young's modulus 'Y' = linear stress/ linear strain= FL/Al	2
21	Y = FL/Al R = 2r, Y = same Ans. [2 x 10-3 m]	2
22	Y = FL/Al F = same L = 4L, R = 2r, Ans: ℓ1 = ℓ	2

23	(a) Stress $= \frac{F}{A} = \frac{mg}{\pi r^2} = \frac{40 \times 10}{\pi \times \left(1 \times 10^{-3}\right)^2} = 1.27 \times 10^8 N/m^2$ (b) $\Delta L = \frac{FL}{AY} = \frac{40 \times 10 \times 1}{\pi \times \left(1 \times 10^{-3}\right)^2 \times 7 \times 10^{10}} = 1.8 \times 10^{-3} m$ (c) Strain $= \frac{\Delta L}{L} = \frac{1.8 \times 10^{-3}}{1} = 1.8 \times 10^{-3}$ (d) $F = Kx = K\Delta L$ K = Force constant $K = \frac{F}{\Delta L} = \frac{40 \times 10}{1.8 \times 10^{-3}} = 2.2 \times 10^5 N/m$	5
24	$\frac{\Delta \ell_c}{\ell_c}$  $Y = \frac{F/A}{\Delta l / l}$ $\frac{\Delta l}{l} = \frac{F}{YA}$ $\frac{\Delta l_c}{l_c} = \frac{F}{Y_c A_c} = \frac{F}{Y_c \pi (r_c)^2}$ ------(1) $\frac{\Delta l_s}{l_s} = \frac{F}{Y_s A_s} = \frac{F}{Y_s \pi (r_s)^2}$ ------(2) Dividing (1) by (2) $\frac{\Delta l_c / l_c}{\Delta l_s / l_s} = \frac{Y_s (r_s)^2}{Y_c (r_c)^2} = \frac{Y_s}{Y_c} \times \left(\frac{r_s}{r_c}\right)^2 = (2) \times (\frac{1}{2})^2$ $\Rightarrow \frac{\Delta l_c / l_c}{\Delta l_s / l_s} = \frac{1}{2}$ $\frac{\Delta \ell_s}{\ell_s} = 2 \frac{\Delta \ell_c}{\ell_c} = 2x1\% = 2\%$	3
25.	$Y = \frac{FL1}{\pi r1^2 \ell 1}$ ---[a] And $Y = \frac{FL2}{\pi r2^2 \ell 2}$ ---[b] [1:8]	2

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