PHYSICS

Mechanical Properties of Solids

Speed TEST 8 Chapter-wise

No. of Questions	Maximum Marks	Time
45	180	1 Hour

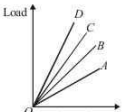
GENERAL INSTRUCTIONS

- This test contains 45 MCQ's. For each question only one option is correct. Darken the correct circle/ bubble in the Response Grid provided on each page.
- You have to evaluate your Response Grids yourself with the help of solutions provided at the end of this book.
- Each correct answer will get you 4 marks and 1 mark shall be deduced for each incorrect answer. No mark will be given/ deducted if no bubble is filled. Keep a timer in front of you and stop immediately at the end of 60 min.
- The sheet follows a particular syllabus. Do not attempt the sheet before you have completed your preparation for that syllabus.
- After completing the sheet check your answers with the solution booklet and complete the Result Grid. Finally spend time to analyse your performance and revise the areas which emerge out as weak in your evaluation.

1. 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

2. The load versus elongation graphs for four wires of same length and made of the same material are shown in the figure. The thinnest wire is represented by the line



(a) *OA*

(b) *OC*

(c) *OD*

(d) *OB*

3. A spring of force constant 800 N/m has an extension of 5 cm. The work done in extending it from 5 cm to 15 cm is

(a) 16 J (b) 8 J (c) 32 J (d) 24 J

4. A metal wire of length L_1 and area of cross-section A is attached to a rigid support. Another metal wire of length L_2 and of the same cross-sectional area is attached to the free end of the first wire. A body of mass M is then suspended from the free end of the second wire. If Y_1 and Y_2 are the Young's moduli of the wires respectively, the effective force constant of the system of two wires is

(a) $\frac{(Y_1Y_2)A}{2(Y_1L_2+Y_2L_1)}$ (b) $\frac{(Y_1Y_2)A}{(L_1L_2)^{1/2}}$

(c) $\frac{(Y_1Y_2)A}{Y_1L_2+Y_2L_1}$ (d) $\frac{(Y_1Y_2)^{1/2}A}{(L_2L_1)^{1/2}}$

5. 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 ?

(a) 1.0×10^{-2} (b) 1.2×10^{-2}

(c) 1.4×10^{-2} (d) 0.8×10^{-2}

6. 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 :

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

7. Choose the wrong statement.

(a) The bulk modulus for solids is much larger than for liquids.

(b) Gases are least compressible.

(c) The incompressibility of the solids is due to the tight coupling between neighbouring atoms.

(d) The reciprocal of the bulk modulus is called compressibility.

RESPONSE GRID	1. (a)(b)(c)(d)	2. (a)(b)(c)(d)	3. (a)(b)(c)(d)	4. (a)(b)(c)(d)	5. (a)(b)(c)(d)
	6. (a)(b)(c)(d)	7. (a)(b)(c)(d)			

Space for Rough Work

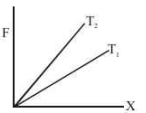
8. A copper wire of length 1.0 m and a steel wire of length 0.5 m having equal cross-sectional areas are joined end to end. The composite wire is stretched by a certain load which stretches the copper wire by 1 mm. If the Young's modulii of copper and steel are respectively 1.0×10^{11} Nm^{-2} and 2.0×10^{11} Nm^{-2}, the total extension of the composite wire is :

(a) 1.75 mm (b) 2.0 mm (c) 1.50 mm (d) 1.25 mm

9. A cube at temperature 0°C is compressed equally from all sides by an external pressure P. By what amount should its temperature be raised to bring it back to the size it had before the external pressure was applied. The bulk modulus of the material of the cube is B and the coefficient of linear expansion is a.

(a) P/Bα (b) P/3 Bα (c) 3$\pi\alpha$/B (d) 3B/P

10. The diagram below shows the change in the length X of a thin uniform wire caused by the application of stress F at two different temperatures T_1 and T_2. The variation shown suggests that



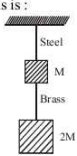
(a) $T_1 > T_2$

(b) $T_1 < T_2$

(c) $T_2 > T_1$

(d) $T_1 \geq T_2$

11. If the ratio of lengths, radii and Young's moduli of steel and brass wires in the figure are *a*, *b* and *c* respectively, then the corresponding ratio of increase in their lengths is :



(a) $\frac{3c}{2ab^2}$

(b) $\frac{2a^2c}{b}$

(c) $\frac{3a}{2b^2c}$

(d) $\frac{2ac}{b^2}$

12. The Young's modulus of brass and steel are respectively 10^{10} N/m^2, and 2×10^{10} N/m^2. A brass wire and a steel wire of the same length are extended by 1 mm under the same force, the radii of brass and steel wires are R_B and R_S respectively. Then

(a) $R_S = \sqrt{2}\, R_B$ (b) $R_S = R_B/\sqrt{2}$

(c) $R_S = 4R_B$ (d) $R_S = R_B/4$

13. Steel ruptures when a shear of 3.5×10^8 N m^{-2} is applied. The force needed to punch a 1 cm diameter hole in a steel sheet 0.3 cm thick is nearly:

(a) 1.4×10^4 N (b) 2.7×10^4 N

(c) 3.3×10^4 N (d) 1.1×10^4 N

14. A ball falling in a lake of depth 400 m has a decrease of 0.2% in its volume at the bottom. The bulk modulus of the material of the ball is (in N m^{-2})

(a) 9.8×10^9 (b) 9.8×10^{10}

(c) 1.96×10^{10} (d) 1.96×10^9

15. A circular tube of mean radius 8 cm and thickness 0.04 cm is melted up and recast into a solid rod of the same length. The ratio of the torsional rigidities of the circular tube and the solid rod is

(a) $\frac{(8.02)^4 - (7.98)^4}{(0.8)^4}$ (b) $\frac{(8.02)^2 - (7.98)^2}{(0.8)^2}$

(c) $\frac{(0.8)^2}{(8.02)^4 - (7.98)^4}$ (d) $\frac{(0.8)^2}{(8.02)^3 - (7.98)^2}$

16. Two wires are made of the same material and have the same volume. However wire 1 has cross-sectional area *A* and wire 2 has cross-sectional area 3*A*. If the length of wire 1 increases by Δx on applying force *F*, how much force is needed to stretch wire 2 by the same amount?

(a) 4*F* (b) 6*F* (c) 9*F* (d) *F*

17. In materials like aluminium and copper, the correct order of magnitude of various elastic modului is:

(a) Young's modulus < shear modulus < bulk modulus.

(b) Bulk modulus < shear modulus < Young's modulus

(c) Shear modulus < Young's modulus < bulk modulus.

(d) Bulk modulus < Young's modulus < shear modulus.

18. What per cent of length of wire increases by applying a stress of 1 kg weight/mm^2 on it?
(Y = 1×10^{11} N/m^2 and 1 kg weight = 9.8 newton)

(a) 0.0067% (b) 0.0098%

(c) 0.0088% (d) 0.0078%

19. An elastic string of unstretched length *L* and force constant *k* is stretched by a small length *x*. It is further stretched by another small length *y*. The work done in the second stretching is :

(a) $\frac{1}{2}ky^2$ (b) $\frac{1}{2}k(x^2 + y^2)$

(c) $\frac{1}{2}k(x+y)^2$ (d) $\frac{1}{2}ky(2x+y)$

20. Two, spring *P* and *Q* of force constants k_p and $k_Q\left(k_Q = \frac{k_p}{2}\right)$ are stretched by applying forces of equal magnitude. If the energy stored in *Q* is E, then the energy stored in *P* is

(a) E (b) 2E (c) E/2 (d) E/4

RESPONSE GRID					
	8. (a)(b)(c)(d)	**9.** (a)(b)(c)(d)	**10.** (a)(b)(c)(d)	**11.** (a)(b)(c)(d)	**12.** (a)(b)(c)(d)
	13. (a)(b)(c)(d)	**14.** (a)(b)(c)(d)	**15.** (a)(b)(c)(d)	**16.** (a)(b)(c)(d)	**17.** (a)(b)(c)(d)
	18. (a)(b)(c)(d)	**19.** (a)(b)(c)(d)	**20.** (a)(b)(c)(d)		

Space for Rough Work

21. The pressure that has to be applied to the ends of a steel wire of length 10 cm to keep its length constant when its temperature is raised by 100°C is:

(For steel Young's modulus is $2\times10^{11}\ Nm^{-2}$ and coefficient of thermal expansion is $1.1\times10^{-5}\ K^{-1}$)

(a) 2.2×10^{8} Pa (b) 2.2×10^{9} Pa

(c) 2.2×10^{7} Pa (d) 2.2×10^{6} Pa

22. A steel ring of radius r and cross sectional area A is fitted onto a wooden disc of radius R (R > r). If the Young's modulus of steel is Y, then the force with which the steel ring is expanded is

(a) A Y (R/r) (b) A Y (R − r)/r

(c) (Y/A)[(R − r)/r] (d) Y r/A R

23. Two wires A and B of same material and of equal length with the radii in the ratio 1 : 2 are subjected to identical loads. If the length of A increases by 8 mm, then the increase in length of B is

(a) 2 mm (b) 4 mm (c) 8 mm (d) 16 mm

24. A material has poisson's ratio 0.50. 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

25. The upper end of a wire of diameter 12mm and length 1m is clamped and its other end is twisted through an angle of 30°. The angle of shear is

(a) 18° (b) 0.18° (c) 36° (d) 0.36°

26. The pressure on an object of bulk modulus B undergoing hydraulic compression due to a stress exerted by surrounding fluid having volume strain $\left(\frac{\Delta V}{V}\right)^2$ is

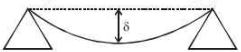
(a) $B^2\left(\frac{\Delta V}{V}\right)$ (b) $B\left(\frac{\Delta V}{V}\right)^2$

(c) $\frac{1}{B}\left(\frac{\Delta V}{V}\right)$ (d) $B\left(\frac{\Delta V}{V}\right)$

27. A structural steel rod has a radius of 10 mm and length of 1.0 m. A 100 kN force stretches it along its length. Young's modulus of structural steel is $2\times10^{11}\ Nm^{-2}$. The percentage strain is about

(a) 0.16% (b) 0.32% (c) 0.08% (d) 0.24%

28. A beam of metal supported at the two edges is loaded at the centre. The depression at the centre is proportional to



(a) Y^2 (b) Y (c) 1/Y (d) $1/Y^2$

29. When a 4 kg mass is hung vertically on a light spring that obeys Hooke's law, the spring stretches by 2 cms. The work required to be done by an external agent in stretching this spring by 5 cms will be ($g = 9.8\ m/sec^2$)

(a) 4.900 joule (b) 2.450 joule

(c) 0.495 joule (d) 0.245 joule

30. The length of a metal is ℓ_1 when the tension in it is T_1 and is ℓ_2 when the tension is T_2. The original length of the wire is

(a) $\frac{\ell_1+\ell_2}{2}$ (b) $\frac{\ell_1T_2+\ell_2T_1}{T_1+T_2}$

(c) $\frac{\ell_1T_2-\ell_2T_1}{T_2-T_1}$ (d) $\sqrt{T_1T_2\ell_1\ell_2}$

31. For the same cross-sectional area and for a given load, the ratio of depressions for the beam of a square cross-section and circular cross-section is

(a) 3 : π (b) π : 3 (c) 1 : π (d) π : 1

32. The bulk moduli of ethanol, mercury and water are given as 0.9, 25 and 2.2 respectively in units of $10^9\ Nm^{-2}$. For a given value of pressure, the fractional compression in volume is $\frac{\Delta V}{V}$. Which of the following statements about $\frac{\Delta V}{V}$ for these three liquids is correct ?

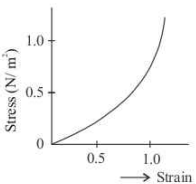
(a) Ethanol > Water > Mercury

(b) Water > Ethanol > Mercury

(c) Mercury > Ethanol > Water

(d) Ethanol > Mercury > Water

33. The graph given is a stress-strain curve for



(a) elastic objects (b) plastics

(c) elastomers (d) None of these

34. A metal rod of Young's modulus $2\times10^{10}\ N\ m^{-2}$ undergoes an elastic strain of 0.06%. The energy per unit volume stored in $J\ m^{-3}$ is

(a) 3600 (b) 7200 (c) 10800 (d) 14400

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

(a) 1 : 2 (b) 4 : 1 (c) 2 : 1 (d) 16 : 1

RESPONSE GRID					
	21. (a)(b)(c)(d)	**22.** (a)(b)(c)(d)	**23.** (a)(b)(c)(d)	**24.** (a)(b)(c)(d)	**25.** (a)(b)(c)(d)
	26. (a)(b)(c)(d)	**27.** (a)(b)(c)(d)	**28.** (a)(b)(c)(d)	**29.** (a)(b)(c)(d)	**30.** (a)(b)(c)(d)
	31. (a)(b)(c)(d)	**32.** (a)(b)(c)(d)	**33.** (a)(b)(c)(d)	**34.** (a)(b)(c)(d)	**35.** (a)(b)(c)(d)

Space for Rough Work

36. The length of an elastic string is a metre when the longitudinal tension is 4 N and b metre when the longitudinal tension is 5 N. The length of the string in metre when the longitudinal tension is 9 N is

(a) $a-b$ (b) $5b-4a$ (c) $2b-\frac{1}{4}a$ (d) $4a-3b$

37. A force of 10^3 newton, stretches the length of a hanging wire by 1 millimetre. The force required to stretch a wire of same material and length but having four times the diameter by 1 millimetre is

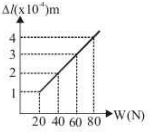
(a) 4×10^3 N (b) 16×10^3 N

(c) $\frac{1}{4}\times10^3$ N (d) $\frac{1}{16}\times10^3$ N

38. A steel wire of length l and cross sectional area A is stretched by 1 cm under a given load. When the same load is applied to another steel wire of double its length and half of its cross section area, the amount of stretching (extension) is

(a) 0.5 cm (b) 2 cm (c) 4 cm (d) 1.5 cm

39. The adjacent graph shows the extension (Δl) of a wire of length 1 m suspended from the top of a roof at one end with a load W connected to the other end. If the cross-sectional area of the wire is 10^{-6} m^2, calculate the Young's modulus of the material of the wire :



(a) 2×10^{11} N/m^2 (b) 2×10^{-11} N/m^2

(c) 3×10^{-12} N/m^2 (d) 2×10^{-13} N/m^2

40. 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 = 10m/s^2, then the volume elasticity in N/m^2 will be

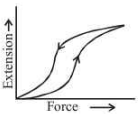
(a) 10^8 (b) 2×10^8 (c) 10^9 (d) 2×10^9

41. A ball is falling in a lake of depth 200 m creates a decrease 0.1 % in its volume at the bottom. The bulk modulus of the material of the ball will be

(a) 19.6×10^{-8} N/m^2 (b) 19.6×10^{10} N/m^2

(c) 19.6×10^{-10} N/m^2 (d) 19.6×10^{8} N/m^2

42. The diagram shows a force-extension graph for a rubber band. Consider the following statements :



I. It will be easier to compress this rubber than expand it

II. Rubber does not return to its original length after it is stretched

III. The rubber band will get heated if it is stretched and released

Which of these can be deduced from the graph:

(a) III only (b) II and III (c) I and III (d) I only

43. The Poisson's ratio of a material is 0.5. If a force is applied to a wire of this material, there is a decrease in the cross-sectional area by 4%. The percentage increase in the length is:

(a) 1% (b) 2% (c) 2.5% (d) 4%

44. 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?

(a) Δl versus $\frac{1}{l}$ (b) Δl versus l^2

(c) Δl versus $\frac{1}{l^2}$ (d) Δl versus l

45. When a 4 kg mass is hung vertically on a light spring that obeys Hooke's law, the spring stretches by 2 cms. The work required to be done by an external agent in stretching this spring by 5 cm will be (g = 9.8 m/sec^2)

(a) 4.900 joule (b) 2.450 joule

(c) 0.495 joule (d) 0.245 joule

RESPONSE GRID					
	36. (a)(b)(c)(d)	37. (a)(b)(c)(d)	38. (a)(b)(c)(d)	39. (a)(b)(c)(d)	40. (a)(b)(c)(d)
	41. (a)(b)(c)(d)	42. (a)(b)(c)(d)	43. (a)(b)(c)(d)	44. (a)(b)(c)(d)	45. (a)(b)(c)(d)

PHYSICS CHAPTERWISE SPEED TEST-8			
Total Questions	45	Total Marks	180
Attempted		Correct	
Incorrect		Net Score	
Cut-off Score	50	Qualifying Score	70
Success Gap = Net Score – Qualifying Score			
Net Score = (Correct × 4) – (Incorrect × 1)			

Space for Rough Work