DPP - Daily Practice Problems

Name :   **Date :**

Start Time :   **End Time :**

PHYSICS 20

SYLLABUS : Mechanical Properties of solids

Max. Marks : 120   **Time : 60 min.**

GENERAL INSTRUCTIONS

- The Daily Practice Problem Sheet contains 30 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 solution booklet.
- 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. Refer syllabus sheet in the starting of the book for the syllabus of all the DPP sheets.
- 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.

DIRECTIONS (Q.1-Q.21) : There are 21 multiple choice questions. Each question has 4 choices (a), (b), (c) and (d), out of which **ONLY ONE** choice is correct.

Q.1 Length of a wire is doubled, when 20×10^8 N/m^2 stress is applied on it. Its Young's modulus of elasticity in N/m^2 will be

(a) 20×10^8 (b) 20×10^9

(c) 20×10^{10} (d) 10×10^8

Q.2 A steel wire of uniform cross-sectional area 2mm^2 is heated upto 50°C and clamped rigidly at two ends. If the temperature of wire falls to 30° then change in tension in the wire will be, if coefficient of linear expansion of steel is 1.1×10^{-5} /°C and young's modulus of elasticity of steel is 2×10^{11} N/m^2.

(a) 44 N   (b) 88 N

(c) 132 N   (d) 22 N

Q.3 The work done in increasing the length of a one metre long wire of cross-sectional area 1mm^2 through 1mm will be

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

(a) 250 J   (b) 10 J

(c) 5 J   (d) 0.1 J

Q.4 A spring is stretched by 3cm when a load of 5.4×10^6 dyne is suspended from it. Work done will be-

(a) 8.1×10^6 J   (b) 8×10^6 J

(c) 8.0×10^6 erg   (d) 8.1×10^6 erg

RESPONSE GRID	1. ⓐⓑⓒⓓ	2. ⓐⓑⓒⓓ	3. ⓐⓑⓒⓓ	4. ⓐⓑⓒⓓ

Space for Rough Work

Q.5 A wire of length 1m and area of cross section 4×10^{-8} m^2 increases in length by 0.2 cm when a force of 16 N is applied. Value of Y for the material of the wire will be

(a) 2×10^6 N/m^2 (b) 2×10^{11} kg/m^2

(c) 2×10^{11} N/mm^2 (d) 2×10^{11} N/m^2

Q.6 The volume of a solid rubber ball when it is carried from the surface to the bottom of a 200 m deep lake decreases by 0.1%. The value for bulk modulus of elasticity for rubber will be

(a) 2×10^9 Pa (b) 2×10^6 Pa

(c) 2×10^4 Pa (d) 2×10^{-4} Pa

Q.7 A steel wire is 4.0 m long and 2 mm in diameter. Young's modulus of steel is 1.96×10^{11} N/m^2. If a mass of 20 kg is suspended from it the elongation produced will be -

(a) 2.54 mm (b) 1.27 mm

(c) 0.64 mm (d) 0.27 mm

Q.8 A brass rod is to support a load of 400 N. If its elastic limit is 4.0×10^8 N/m^2 its minimum diameter must be -

(a) 1.13 mm (b) 2.26 mm

(c) 3.71 mm (d) 4.52 mm

Q.9 A 4.0 m long copper wire of cross sectional area 1.2 cm^2 is stretched by a force of 4.8×10^3 N stress will be -

(a) 4.0×10^7 N/mm^2 (b) 4.0×10^7 KN/m^2

(c) 4.0×10^7 N/m^2 (d) None of these

Q.10 A copper rod 2m long is stretched by 1mm. Strain will be -

(a) 10^{-4}, volumetric (b) 5×10^{-4}, volumetric

(c) 5×10^{-4}, longitudinal (d) 5×10^{-3}, volumetric

Q.11 A wire of cross sectional area 3mm^2 is just stretched between two fixed points at a temperature of 20°C. Determine the tension when the temperature falls to 20°C. Coefficient of linear expansion $\alpha = 10^{-5}$ /°C and $Y = 2 \times 10^{11}$ N/m^2.

(a) 120 KN (b) 20 N (c) 120 N (d) 102 N

Q.12 The compressibility of water is 5×10^{-10} m^2/N. If it is subjected to a pressure of 15 MPa, the fractional decrease in volume will be -

(a) 3.3×10^{-5} (b) 5.6×10^{-4}

(c) 7.5×10^{-3} (d) 1.5×10^{-2}

Q.13 The Young's modulus of steel is 2×10^{11} N/m^2 and its coefficient of linear expansion is 1.1×10^{-5} per deg. The pressure to be applied to the ends of a steel cylinder to keep its length constant on raising its temperature by 100ºC, will be -

(a) 5.5×10^4 N/m^2 (b) 1.8×10^6 N/m^2

(c) 2.2×10^8 N/m^2 (d) 2.0×10^{11} N/m^2

Q.14 For a given material, the Young's modulus is 2.4 times that of rigidity modulus. It's poisson's ratio is

(a) 1.2 (b) 1.02

(c) 0.2 (d) 2

Q.15 A wire of length 1m is stretched by a force of 10N. The area of cross-section of the wire is 2×10^{-6} m^2 and Y is 2×10^{11}N/m^2. Increase in length of the wire will be -

(a) 2.5×10^{-5} cm (b) 2.5×10^{-5} mm

(c) 2.5×10^{-5} m (d) None of these

Q.16 A stress of 1kg/mm^2 is applied on a wire. If the modulus of elasticity of the wire is 10^{10} dyne/cm^2, then the percentage increase in the length of the wire will be

(a) 0.007 (b) 0.0098 (c) 98 (d) 9.8

Q.17 A uniform steel wire of density 7800kg/m^3 is 2.5 m long and weighs 15.6×10^{-3} kg. It extends by 1.25 mm when loaded by 8kg. Calculate the value of young's modulus of elasticity for steel.

(a) 1.96×10^{11} N/m^2 (b) 19.6×10^{11} N/m^2

(c) 196×10^{11} N/m^2 (d) None of these

RESPONSE GRID					
	5. ⓐⓑⓒⓓ	6. ⓐⓑⓒⓓ	7. ⓐⓑⓒⓓ	8. ⓐⓑⓒⓓ	9. ⓐⓑⓒⓓ
	10. ⓐⓑⓒⓓ	11. ⓐⓑⓒⓓ	12. ⓐⓑⓒⓓ	13. ⓐⓑⓒⓓ	14. ⓐⓑⓒⓓ
	15. ⓐⓑⓒⓓ	16. ⓐⓑⓒⓓ	17. ⓐⓑⓒⓓ		

Space for Rough Work

Q.18 A metallic wire is suspended by suspending weight to it. If S is longitudinal strain and Y its young's modulus of elasticity then potential energy per unit volume will be

(a) $\frac{1}{2}Y^2S^2$ (b) $\frac{1}{2}Y^2S$

(c) $\frac{1}{2}YS^2$ (d) $2YS^2$

Q.19 The lengths and radii of two wires of same material are respectively L, 2L, and 2R, R. Equal weights are applied on then. If the elongations produced in them are l_1 and l_2 respectively then their ratio will be

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

(c) 8 : 1 (d) 1 : 8

Q.20 The ratio of radii of two wires of same material is 2 : 1. If these wires are stretched by equal forces, then the ratio of stresses produced in them will be

(a) 1 : 2 (b) 2 : 1

(c) 1 : 4 (d) 4 : 1

Q.21 A rod of length l and area of cross-section A is heated from 0°C to 100°C. The rod is so placed that it is not allowed to increase in length, then the force developed is proportional to

(a) l (b) l^{-1} (c) A (d) A^{-1}

DIRECTIONS (Q.22-Q.24) : In the following questions, more than one of the answers given are correct. Select the correct answers and mark it according to the following codes:

Codes :

(a) 1, 2 and 3 are correct **(b)** 1 and 2 are correct

(c) 2 and 4 are correct **(d)** 1 and 3 are correct

Q.22 Mark the correct statements

(1) Sliding of molecular layer is much easier than compression or expansion

(2) Reciprocal of bulk modulus of elasticity is called compressibility

(3) Hollow shaft is much stronger than a solid rod of same length and same mass

(4) It is difficult to twist a long rod as compared to small rod

Q.23 Which statements are false for a metal?

(1) $Y < \eta$ (2) $Y = \eta$

(3) $Y < 1/\eta$ (4) $Y > \eta$

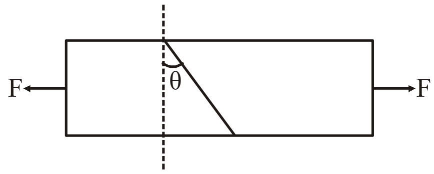
Q.24 Which of the following relations are false

(1) $3Y = K(1-\sigma)$ (2) $\sigma = (6K+\eta)Y$

(3) $K = \frac{9\eta Y}{Y+\eta}$ (4) $\sigma = \frac{0.5Y-\eta}{\eta}$

DIRECTIONS (Q.25-Q.27) : Read the passage given below and answer the questions that follows :

A bar of cross section A is subjected to equal and opposite tensile forces F at its ends. Consider a plane through the bar making an angle θ with a plane at right angles to the bar as shown in figure.



Q.25 The tensile stress at this plane in terms of F, A and θ is

(a) $\frac{F\cos^2\theta}{A}$ (b) $\frac{F}{A\cos^2\theta}$

(c) $\frac{F\sin^2\theta}{A}$ (d) $\frac{F}{A\sin^2\theta}$

Q.26 In the above problem, for what value of θ is the tensile stress maximum ?

(a) Zero (b) 90° (c) 45° (d) 30°

RESPONSE GRID					
	18. ⓐⓑⓒⓓ	19. ⓐⓑⓒⓓ	20. ⓐⓑⓒⓓ	21. ⓐⓑⓒⓓ	22. ⓐⓑⓒⓓ
	23. ⓐⓑⓒⓓ	24. ⓐⓑⓒⓓ	25. ⓐⓑⓒⓓ	26. ⓐⓑⓒⓓ	

Space for Rough Work

Q.27 The shearing stress at the plane, in terms of F, A and θ is

(a) $\frac{F\cos 2\theta}{2A}$ (b) $\frac{F\sin 2\theta}{2A}$

(c) $\frac{F\sin\theta}{A}$ (d) $\frac{F\cos\theta}{A}$

DIRECTIONS (Qs. 28-Q.30) : Each of these questions contains two statements: Statement-1 (Assertion) and Statement-2 (Reason). Each of these questions has four alternative choices, only one of which is the correct answer. You have to select the correct choice.

(a) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.

(b) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1.

(c) Statement -1 is False, Statement-2 is True.

(d) Statement -1 is True, Statement-2 is False.

Q.28 **Statement -1 :** Steel is more elastic than rubber.

Statement -2 : Under given deforming force, steel is deformed less than rubber.

Q.29 **Statement -1 :** Bulk modulus of elasticity (K) represents incompressibility of the material.

Statement -2 : Bulk modulus of elasticity is proportional to change in pressure.

Q.30 **Statement -1 :** The bridges declared unsafe after a long use.

Statement -2 : Elastic strength of bridges losses with time.

RESPONSE GRID	27. ⓐⓑⓒⓓ	28. ⓐⓑⓒⓓ	29. ⓐⓑⓒⓓ	30. ⓐⓑⓒⓓ

DAILY PRACTICE PROBLEM SHEET 20 - PHYSICS			
Total Questions	30	Total Marks	120
Attempted		Correct	
Incorrect		Net Score	
Cut-off Score	32	Qualifying Score	52
Success Gap = Net Score – Qualifying Score			
Net Score = (Correct × 4) – (Incorrect × 1)			

Space for Rough Work

DAILY PRACTICE PROBLEMS

PHYSICS SOLUTIONS 20

1. **(a).** $Y = \frac{MgL}{\pi r^2 \Delta \ell}$
but $Mg/\pi r^2 = 20 \times 10^8$ & $\Delta \ell = L$ then
$Y = 20 \times 10^8\ N/m^2$

2. **(b).** $F = Y\alpha \Delta t A$
$A = 2 \times 10^{-6}\ m^2, Y = 2 \times 11\ N/m^2$
$\alpha = 1.1 \times 10^{-5}, t = 50 - 30 = 20°C$
$F = 2 \times 10^{11} \times 1.1 \times 10^{-5} \times 20 \times 2 \times 10^{-6} = 88N.$

3. **(d).** Work done on the wire

$W = \frac{1}{2} F \times \ell = \frac{1}{2} \times$ stress x volume x strain

$W = \frac{1}{2} \times Y \times strain^2 \times volume$

$W = \frac{1}{2} \times Y \times \frac{\Delta \ell^2}{L^2} \times AL = \frac{YA\Delta L^2}{2L}$

$W = \frac{2 \times 10^{11} \times 10^{-6} \times 10^{-6}}{2 \times 1} = 0.1\ J$

4. **(d).** $W = \frac{1}{2} \times$ load $\times$ elongation

$W = \frac{1}{2} \times 5.4 \times 10^6 \times 3$
$W = 8.1 \times 10^6$ ergs

5. **(d).** By Hook's law

$Y = \frac{F/A}{\ell/L} = \frac{FL}{A\ell}$

$Y = \frac{16 \times 1}{(4 \times 10^{-8})\ (0.2 \times 10^{-2})} = 2 \times 10^{11}\ N/m^2$

6. **(a).** $B = -\frac{\Delta PV}{\Delta V}$
Given, $\Delta P = hdg = 200 \times 10^3 \times 10$
$\Delta P = 2 \times 10^5\ N/m^2$

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

$\therefore B = \frac{2 \times 10^6}{10^{-3}} = 2 \times 10^9\ N/m^2$

7. **(b).** $Y = \frac{stress}{strain} = \frac{F/A}{\ell/L} = \frac{FL}{A\ell}$

$\therefore \ell = \frac{FL}{AY} = \frac{20 \times 9.8 \times 4}{\pi \times (10^{-3})^2 \times 1.96 \times 10^{11}}$
$= 1.27 \times 10^{-3}\ m = 1.27\ mm$

8. **(a).** Limiting stress $= 4.0 \times 10^8\ N/m^2$

$\frac{F}{A} = \frac{400}{A} = 4.0 \times 10^8$
or $A = 10^{-6}\ m^2$

$\therefore D = \left(\frac{4A}{\pi}\right)^{1/2} = \left(\frac{4 \times 10^{-6}}{\pi}\right)^{1/2}$

$= 1.13 \times 10^{-3}\ m = 1.13\ mm$

9. **(c).** Stress $= \frac{F}{A} = \frac{4.8 \times 10^3\ N}{1.2 \times 10^{-4}\ m^2} = 4.0 \times 10^7\ N/m^2$

10. **(c).** Strain $= \frac{\Delta \ell}{\ell} = \frac{1 \times 10^{-3}}{2} = 5 \times 10^{-4}$, longitudinal

11. **(c).** $F = YA\alpha\Delta t$
$= 2 \times 10^{11} \times 3 \times 10^{-6} \times 10^{-5} \times 20$
$F = 120\ N.$

12. **(c).** Compressibility

$\chi = \frac{1}{K} = -\frac{\Delta V}{V \Delta p} = 5 \times 10^{-10}$

$\therefore$ Fractional decrease in volume

$= -\frac{\Delta V}{V} = \chi \Delta p = 5 \times 10^{-10} \times 15 \times 10^6$

$= 7.5 \times 10^{-3}$

13. **(c).** Increase in length on heating $\Delta \ell = \alpha L \Delta T$
To annul this increase if pressure applied is p then

$p = Y\frac{\Delta \ell}{L} = Y\alpha\Delta T$

$= 2 \times 10^{11} \times 1.1 \times 10^{-5} \times 100 = 2.2 \times 10^8\ N/m^2$

14. **(c).** $y = 2\eta(1 + \sigma)$
$y = 2.4 \times \eta$
$2.4\eta = 2\eta(1 + \sigma)$
$(1 + \sigma) = 1.2$
$\sigma = 0.2$

15. **(c).** Stress $= F/A = 10/(2 \times 10^{-6}) = 5 \times 10^6\ N/m^2$

Strain $= \frac{Stress}{Y} = \frac{5 \times 10^6}{2 \times 10^{11}} = 2.5 \times 10^{-5}$

$\ell = L \times strain = 1 \times 2.5 \times 10^{-5}$
$\ell = 2.5 \times 10^{-5}\ m$

16. **(b).** $\frac{\Delta \ell}{L} = \frac{Mg}{AY} = \frac{1000 \times 980 \times 100}{10^{12} \times 0.01}$

$\Delta \ell = 0.0098$ cm.

17. **(a).** Volume = Mass/density
Area of cross-section = volume/length

$= \frac{\text{mass}}{\text{density} \times \text{length}} = \frac{15.6 \times 10^{-3}}{7800 \times 2.5} = 8 \times 10^{-7} \text{ m}^2$

$Y = \frac{F\ell}{A\Delta L} = \frac{8 \times 9.8 \times 2.5}{(8 \times 10^{-7}) \times 1.25 \times 10^{-3}}$

$Y = 1.96 \times 10^{11} \text{ N/m}^2$

18. **(c).** Potential energy per unit volume = u

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

But $Y = \frac{\text{stress}}{\text{strain}}$

$\therefore$ stress = Y x strain = Y x S

$\therefore$ Potential energy per unit volume = u

$= \frac{1}{2} \times (YS)S = \frac{1}{2} YS^2$

19. **(d).** $\frac{\ell_1}{\ell_2} = \frac{L_1 r_2^2}{L_2 r_1^2}$

$L_1 = L, L_2 = 2L, r_1 = 2R., r_2 = R$

$\therefore \frac{\ell_1}{\ell_2} = \frac{L}{2L} \cdot \frac{R^2}{4R^2} = \frac{1}{8}$

20. **(c).** stress $= \frac{\text{Force}}{\text{Area}} = \frac{F}{\pi r^2}$

$\therefore$ stress $S \propto \frac{1}{r^2}$

$\therefore \left(\frac{S_1}{S_2}\right) = \left(\frac{r_2}{r_1}\right)^2$

Given $\frac{r_1}{r_2} = \frac{2}{1} \quad \therefore \quad \frac{S_1}{S_2} = \frac{1}{4}$

21. **(c)** $F = YA\alpha\Delta\theta \therefore F \propto A$

22. **(a)** For twisting, angle of shear $\phi \propto \frac{1}{L}$

i.e. if L is more then ϕ will be small.

23. **(a)** $Y = 2\eta(1+\sigma)$

24. **(a)** $Y = 2\eta(1+\sigma) \Rightarrow \sigma = \frac{0.5Y - \eta}{\eta}$

25. **(a)** Tensile stress $= \frac{F\cos\theta}{a/\cos\theta} = \frac{F\cos^2\theta}{a}$

26. **(a)** Tensile stress is maximum when $\cos^2\theta$ is maximum, i.e., $\theta = 0°$

27. **(b)** Shearing stress $= \frac{F\sin\theta}{a/\cos\theta} = \frac{F\sin\theta\cos\theta}{a}$

$= \frac{F\sin 2\theta}{2a}$

28. **(a)** Elasticity is a measure of tendency of the body to regain its original configuration. As steel is deformed less than rubber therefore steel is more elastic than rubber.

29. **(a)** Bulk modulus of elasticity measures how good the body is to regain its original volume on being compressed. Therefore, it represents incompressibility of the material.

$K = \frac{-PV}{\Delta V}$ where P is increase in pressure, ΔV is change in volume.

30. **(a)** 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.