Important Questions for Class 11 Physics Chapter 8: Chapter 8 of Class 11 Physics, Mechanical Properties of Solids, explores the behavior of solids under external forces. Key topics include stress and strain, Hooke's Law, elastic moduli (Young's modulus, bulk modulus, and shear modulus), and Poisson's ratio. It also covers concepts like elasticity, plasticity, and the stress-strain curve, highlighting the proportional limit, yield point, and ultimate tensile strength.

Applications of elasticity in engineering and construction are discussed. Important questions focus on deriving stress-strain relationships, calculating elastic constants, solving problems involving load and deformation, and understanding the significance of elastic behavior in real-life scenarios. These questions strengthen problem-solving and analytical skills.

Important Questions for Class 11 Physics Chapter 8 Overview

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Important Questions for Class 11 Physics Chapter 8 Mechanical Properties of Solids

1. The stretching of a coil spring is determined by its shear modulus. Why?

Ans: Stretching of coil spring is determined by shear modulus as when a coil spring is stretched, neither its length nor its volume or its shape changes.

2. The spherical ball contracts in volume by 0.1% when subjected to a uniform normal pressure of 100 atmosphere. Calculate the bulk modulus of material of the ball.

Ans: Volumetric strain is given by:

$$Volumetric\ strain = \frac{\Delta V}{V} = 0.1$$

Normal Stress is 100 atmosphere

$$100 \times 10^5 = 10^7 N/m^2$$

Hence, the Bulk Modulus of the material of the ball will be:

$$K = \frac{\text{Normal Stress}}{\text{Volumetric Strain}} = \frac{10^7}{10^{-3}} = 10^{10} N/m^2$$

3. State Hooke's law.

Ans: According to Hooke's law the extension produced in the wire is directly proportional to the load applied within the elastic limit.

$$\Rightarrow Stress \propto Strain$$

Hence, $Stress = E \times Strain$

Where,

$E = Modulus\ of\ elasticity.$

4. What are ductile and brittle materials?

Ans.

Ductile materials are those that exhibit a wide plastic range that extends beyond the elastic limit. Materials that are ductile include iron, copper, and so forth.

Ductile materials are those that exhibit very little plastic range beyond the elastic limit. Glass, cast iron, and other materials are examples of brittle materials.

5. A steel cable with a radius of 1.5 cm supports a chairlift at a ski area. If the maximum stress is not to exceed N, what is the maximum load the cable can support?

Ans: In the above question it is given that:

Radius of the steel cable is $r = 1.5\,cm = 0.015\,m$.

Maximum allowable stress is $10^8 N/m^2$.

Now maximum stress will be:

$$\text{Maximum stress} = \frac{\text{Maximum force}}{\text{Area of cross section}}$$

Hence,

$$\text{maximum force} = \text{Maximum stress} \times \text{Area of cros-ssection}$$

So,

$$\text{maximum force} = 10^8 \times \pi(0.015)^2 = 7.065 \times 10^4 N$$

Therefore, the maximum load the cable can support is $7.065 \times 10^4 N$.

6. Compute the fractional change in volume of a glass slab, when subjected to a hydraulic pressure of 10 atm.

Ans: In the above question it is given that:

Hydraulic pressure exerted on the glass slab is $p = 10\,atm$.

Bulk modulus of glass is $B = 37 \times 10^9 N/m^2$.

Now,

Bulk modulus is given by:

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

Where,

$\frac{\Delta V}{V}$ is the fractional change in volume.

$$\frac{\Delta V}{V} = \frac{p}{B} = \frac{10 \times 1.013 \times 10^5}{37 \times 10^9} = 2.73 \times 10^{-5}$$

Therefore, the fractional change in volume of a glass slab is 2.73×10^{-5}.

2 Marks Questions

1. Write the characteristics of displacement.

Ans: Following are the characteristics of displacement:

(1) Displacement is a vector quantity having both magnitude and direction.

(2) Displacement of a given body can be positive, negative or zero.

4. What causes variation in velocity of a particle?

Ans: Variation in velocity of a particle happens when:

(1) magnitude of velocity changes

(2) direction of motion changes.

3. Sameer went on his bike from Delhi to Gurgaon at a speed of 60km/hr and came back at a speed of 40km/hr. What is his average speed for the entire journey?

Ans: In the above question it is given that:

Speed of the bike when Sameer travelled from Delhi to Gurgaon is $v_1 = 60km/hr$.

Come back speed is $v_2 = 40km/hr$.

Therefore, average speed will be:

$$Average\ speed = \frac{2v_1v_2}{v_1 + v_2} = \frac{2\,(60)\,(40)}{60 + 40} = 48km/hr$$

6. Displacement of a particle is given by the expression $x = 3t^2 + 7t9$, where x is in meters and t is in seconds. What is acceleration?

Ans: Expression of Displacement a particle is given by $x = 3t^2 + 7t9$

Therefore,

$v = \frac{dx}{dt} = 6t + 7$

And

$a = \frac{dv}{dt} = 6m/s^2$, which is the required acceleration.

7. A particle is thrown upwards. It attains a height (h) after 5 seconds and again after 9s comes back. What is the speed of the particle at a height h?

Ans: According to Newton's laws of motion:

$s = ut + \frac{1}{2}at^2$

The net displacement at $4s$ is zero as the particle comes to the same point at $9s$ where it was at $5s$.

Hence,

$0 = (u \times 4) - \frac{1}{2}(g)\,(4)^2$

$(u) \times 4 = \frac{1}{2}(g)\,(4)^2$

Hence,

$u = 2 \times 9.8 = 19.6m/s$

Hence, the speed of the particle at a height h is $19.6m/s$.

8. A balloon is ascending at the rate of 4.9m/s. A pocket is dropped from the balloon when situated at a height of 245m. How long does it take the packet to reach the ground? What is its final velocity?

Ans: In the above question it is given that:
Initial velocity, $u = 4.9m/s$
Height, $h = 245m$.
As the pocket is in freefall, $a = g = 9.8m/s^2$.
Therefore, using Newton's Laws of motion:
$s = ut + \frac{1}{2}at^2$
$245 = -4.9t + \frac{1}{2}(9.8)\,t^2$
$4.9t^2 - 4.9t - 245 = 0$
$\Rightarrow t = 7.6 \text{ or } -5.6$
Hence, $t = 7.6s$
Now, $v = u + at$
$v = -4.9 + 9.8\,(7.6) = 69.6m/s$
Hence, it takes $7.6s$ for the packet to reach the ground and the final velocity is $69.6m/s$.

9. The displacement x of a particle moving in one dimension under the action of constant force is related to the time by the equation $t = \sqrt{x} - 3$ where x is in meters and t is in seconds. Find the velocity of the particle at (1) t = 3s (2) t = 6s.
Ans: The given equation for displacement of particle is
$t = \sqrt{x} - 3$
$\Rightarrow x = (t+3)^2$
Now, velocity is calculated as:
$v = \frac{dx}{dt} = 2\,(t+3)$
Therefore,

i. v at $t = 3s$ will be:
$v = 2\,(3+3) = 12m/s$
And

ii. v at $t = 6s$ will be:
$v = 2\,(6+3) = 18m/s$

10. A hollow shaft is found to be stronger than a solid shaft made of the same material. Why?

Ans. The torque required to produce a given twist in a hollow cylinder is greater than that required to produce in a solid cylinder of same length and material through the same angle. Hence, a hollow shaft is found to be stronger than a solid shaft made of equal material.

3 Marks Questions

1. Define from the velocity time graph, $v = u + at$

Ans: Consider the graph given below

Slope of graph is $\tan\theta = \frac{u-v}{t}$
And $\tan\theta = a$
Hence, $at = u - v$
$v = u + at$

2. A particle is moving along a straight line and its position is given by the relation $x = \left(t^3 - 6t^2 - 15t + 40\right) m$
Find

a. The time at which velocity is zero.
b. Position and displacement of the particle at that point.
c. Acceleration

Ans: Given expression of position is $x = \left(t^3 - 6t^2 - 15t + 40\right) m$.
$v = \frac{dx}{dt} = \left(3t^2 - 12t - 15\right) m/s$ and
$a = \frac{dv}{dt} = (6t - 12)\, m/s^2$

a. Calculating time at which velocity is zero,
$\left(3t^2 - 12t - 15\right) = 0$
$t^2 - 4t - 5 = 0$
$(t - 5)(t + 1) = 0$
$\therefore t = 5, -1$
Hence, $t = 5s$

b. Position at $t = 5s$ is given by

$x = (5)^3 - 6(5)^2 - 15(5) + 40 = -60$

Position at $t = 0s$ is given by

$x = (0)^3 - 6(0)^2 - 15(0) + 40 = 40$

Hence displacement$= x_5 - x_0 = -60 - 40 = -100m$

c. Acceleration at $t = 5s$ is given by:

$a = 6(5) - 12 = 18m/s^2$

3. A police jeep on a petrol duty on national highway was moving with a speed of 54km/hr. in the same direction. It finds a thief rushing up in a car at a rate of 126km/hr in the same direction. Police sub – inspector fired at the car of the thief with his service revolver with a muzzle speed of 100m/s With what speed will the bullet hit the thief's car?

Ans: In the above question it is given that:

$V_{PJ} = 54km/hr = 15m/s$

$V_{TC} = 126km/hr = 35m/s$

$v_b = 100m/s$

Hence,

Velocity of car w.r.t. police, $V_{CP} = 35 - 15 = 20m/s$

Velocity of bullet w.r.t. car, $V_{BC} = 100 - 20 = 80m/s$

Hence, the bullet will hit the car with velocity $80m/s$.

4. Establish the relation $S_{nth} = u + \frac{a}{2}(2n-1)$ where the letters have their usual meanings.

Ans: We have, $S_{nth} = u + \frac{a}{2}(2n-1)$.

We know that $S_{nth} = S_n - S_{n-1}$

And

$S_n = un + \frac{1}{2}an^2$

$S_{n-1} = u(n-1) + \frac{1}{2}a(n-1)^2$

$$S_{nth} = un + \frac{1}{2}an^2 - u(n-1) - \frac{1}{2}a(n-1)^2$$

Hence,

$$S_{nth} = u - \frac{1}{2}a + na$$

Therefore,

$$S_{nth} = u + \frac{a}{2}(2n-1)$$

Hence proved.

5. A stone is dropped from the top of a cliff and is found to travel 44.1m diving the last second before it reaches the ground. What is the height of the cliff? g = 9.8m/s2

Ans: Consider the height of the cliff to be h m.

$u = 0m/s$,

$a = g = 9.8m/s^2$.

If n is the total time taken by the stone while falling,

$$S_{nth} = u + \frac{a}{2}(2n-1)$$

$$44.1 = 0 + \frac{9.8}{2}(2n-1)$$

$n = \frac{10}{2} = 5s$

6. Establish from the velocity time graph, a uniform accelerated motion.

Ans: Consider the graph given in the question.

The displacement of the particle is given by the area under the v-t graph.

$S = area\ OABC$

$S = area\ of\ rectangle\ AODC + area\ of\ ADB$

Hence,

$S = (OA \times OC) + \left(\frac{1}{2}AD \times BD\right)$

$S = ut + \frac{1}{2}(AD) \times \left(\frac{AD \times DB}{AD}\right)$

$S = ut + \frac{1}{2}(AD)^2 \times \left(\frac{DB}{AD}\right)$

$S = ut + \frac{1}{2}(t)^2 \times \left(\frac{DB}{AD}\right)$

$S = ut + \frac{1}{2}(t)^2 \times (a)$

$\left[\text{As } a = \tan\theta = \frac{BD}{AD}\right]$

Therefore,

$S = ut + \frac{1}{2}at^2$

7. (a) Define the term relative velocity.

Ans: The relative velocity of any object A with respect to object B is termed as the time rate of change of position of A with respect to B.

(b) Write the expression for relative velocity of one moving with respect to another body when objects are moving in the same direction and are moving in opposite directions?

Ans: Consider two objects to be moving in the same direction,

Then,

$\vec{V}_{AB} = \vec{V}_A - \vec{V}_B$

Where,

$\vec{V}_A$ is the velocity of A.

$\vec{V}_B$ is the velocity of B.

$\vec{V}_{AB}$ is the velocity of A with respect to B.

Now consider two objects to be moving in the opposite direction,

Then,

$\vec{V}_{AB} = \vec{V}_A - \left(-\vec{V}_B\right) = \vec{V_A} + \vec{V_B}$

Where, $-\vec{V_B}$ indicates that B moves in the direction opposite to A.

(c) A Jet airplane traveling at the speed of 500km/hr ejects its products of combustion at the speed of 1500km/h relative to the Jet plane. What is the speed of the latter with respect to an observer on the ground?

Ans: We have,

Velocity of the Jet plane, $V_J = 500km/hr$

Velocity of gases w.r.t. Jet plane $V_{gJ} = -1500km/hr$ (direction is opposite)$\vec{V}_{gJ} = \vec{V}_g - \left(-\vec{V}_J\right) = \vec{V_g} + \vec{V_J}$

Now, we know that hot gases also come out in opposite direction of the Jet plane,

Velocity of the gas, $V_g = -1500 + 500 = -1000km/hr$.

8. Define (i) $v = u + at$ (ii) $v^2 \ u^2 = 2as$ by calculus method

Ans:

(i) Acceleration is given by:

$a = \frac{dv}{dt}$

$\Rightarrow dv = adt$

Integrating on both sides,

$\int dv = \int adt$

Hence, $v = at + k$ ..... (1)

Where, k is the constant.

When, $t = 0$ and $\theta = u$

We get $k = u$

Hence, $v = u + at$.

(ii) We have, $a = \frac{dv}{dt}$

Multiplying and dividing by dx,

$a = \frac{dv}{dt} \times \frac{dx}{dx}$

$a = \frac{dv}{dt} \times \theta$

$adx = vdv$

As $\frac{dx}{dt} = v$

On integrating,

$a \int_{x_0}^{x} dx = \int_{v}^{\theta} vdv$

Hence, $a(x - x_0) = \frac{u^2}{2} - \frac{v^2}{2}$

As $(x - x_0 = s)$

$as = \frac{u^2 - v^2}{2}$

9. Explain:

1) Elastic Body 2) Plastic Body 3) Elasticity.

Ans:

1. Elastic Body: An elastic body is defined as the body which completely regains its original configuration immediately after the removal of deforming force on it. For example, Quartz and phosphor Bronze.

2. Plastic Body: A plastic body is defined as the body which does not regain its original configuration at all on the removal of deforming force, however the deforming force may be. For example, Paraffin wax.
3. Elasticity: Elasticity is defined as the property of the body to regain its original configuration, when the deforming forces are removed.

Benefits of Using Important Questions for Class 11 Physics Chapter 8

Using important questions for Class 11 Physics Chapter 8, Mechanical Properties of Solids, offers several benefits:

Focused Preparation: The questions target essential topics like stress, strain, and elastic moduli, streamlining your study efforts.

Exam-Oriented Practice: These questions align with exam patterns, helping you anticipate frequently asked concepts.

Concept Clarity: Solving these questions enhances your understanding of fundamental principles and applications.

Time Management: Practice improves speed and accuracy for tackling exam questions effectively.

Confidence Boost: Regular practice builds confidence and reduces exam-related anxiety.