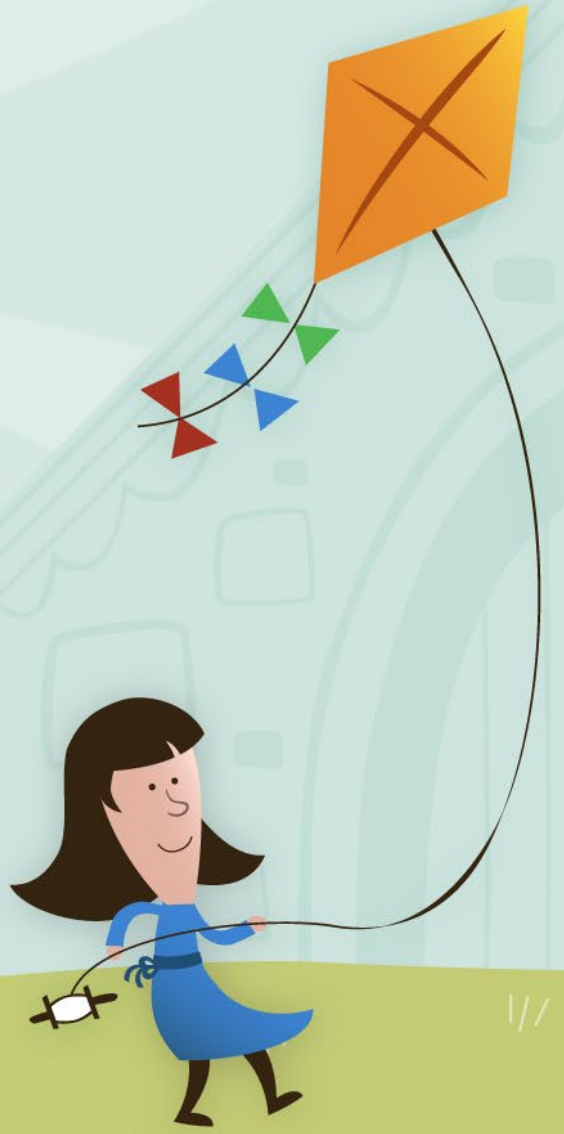
JEE Main 2021

Chapter wise Solution

Properties of Matter

PHYSICS



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MCQ

Q.1. In order to determine the Young's Modulus of a wire of radius 0.2 cm (measured using a scale of least count = 0.001cm) and length 1m (measured using a scale of least count = 1mm), a weight of mass 1kg (measured using a scale of least count = 1 g) was hanged to get the elongation of 0.5cm (measured using a scale of least count 0.001cm). What will be the fractional error in the value of Young's Modulus determined by this experiment?

[16 Mar 2021 Shift -2]

(1) 0.14%
(2) 0.9%
(3) 9%
(4) 1.4%

MCQ

Q.2. If Y, K and η are the values of Young's modulus, bulk modulus and modulus of rigidity of any material respectively. Choose the correct relation for these parameters.

[16 Mar 2021 Shift -2]

(1) $K = \frac{Y\eta}{9\eta - 3Y} N/m^2$

(2) $\eta = \frac{3YK}{9K + Y} N/m^2$

(3) $Y = \frac{9\,K\eta}{3\,K - \eta} N/m^2$

(4) $Y = \frac{9K\eta}{2\eta + 3K} N/m^2$

MCQ

Q.3. The normal density of a material is ρ and its bulk modulus of elasticity is K. The magnitude of increase in density of material, when a pressure P is applied uniformly on all sides, will be:

[26 Feb 2021 Shift -1]

(1) $\frac{\rho K}{P}$

(2) $\frac{K}{\rho P}$

(3) $\frac{PK}{\rho}$

(4) $\frac{\rho P}{K}$

MCQ

Q.4. The length of metallic wire is l_1 when tension in it is T_1. It is l_2 when the tension is T_2. The original length of the wire will be:

[26 Feb 2021 Shift -2]

(1) $\frac{l_1+l_2}{2}$

(2) $\frac{T_1 l_1 - T_2 l_2}{T_2 - T_1}$

(3) $\frac{T_2 l_1 + T_1 l_2}{T_1 + T_2}$

(4) $\frac{T_2 l_1 - T_1 l_2}{T_2 - T_1}$

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Integer

Q.13. Two separate wires A and B are stretched by 2 mm and 4 mm respectively, when they are subjected to a force of 2N. Assume that both the wires are made up of same material and the radius of wire B is 4 times that of the radius of wire A. The length of the wires A and B are in the ratio of a : b. Then a/b can be expressed as 1/x where x is ____

[18 2021 Shift -1]

Integer

Q.13. A uniform metallic wire is elongated by 0.04m when subjected to a linear force F. The elongation, if its length and diameter is doubled and subjected to the same force will be ___ cm.

[24 Feb 2021 Shift - 2]

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Properties of Matter – Solution

Q. 1

(4)

$$Y = \frac{\text{Stress}}{\text{Strain}} = \frac{FL}{Al} = \frac{mg.L}{\pi R^2 \cdot \ell}$$

$$\frac{\Delta Y}{Y} = \frac{\Delta m}{m} + \frac{\Delta L}{L} + 2 \cdot \frac{\Delta R}{R} + \frac{\Delta \ell}{\ell}$$

$$\frac{\Delta Y}{Y} \times 100 = 100 \left[\frac{1}{1000} + \frac{1}{1000} + 2\left(\frac{0.001}{0.2}\right) + \frac{0.001}{0.5}\right]$$

$$= \frac{1}{10} + \frac{1}{10} + 1 + \frac{1}{5} = \frac{14}{10} = 1.4\%$$

Q. 2 **(1)**

$$\Rightarrow y = 3k(1 - 2\sigma)$$

$$\Rightarrow \sigma = \frac{1}{2}\left(1 - \frac{y}{3k}\right) \quad \ldots(1)$$

$$\Rightarrow y = 2\eta(1 + \sigma)$$

$$\Rightarrow \sigma = \frac{y}{2\eta} - 1 \quad \ldots(2)$$

by comparing equation (1) and (2), we get

$$\Rightarrow \frac{y}{2\eta} - 1 = \frac{1}{2}\left(1 - \frac{y}{3k}\right)$$

$$\Rightarrow \frac{y}{\eta} - 2 = 1 - \frac{y}{3k}$$

$$\Rightarrow \frac{y}{\eta} = 1 + 2 - \frac{y}{3k} \Rightarrow \frac{y}{\eta} = 3 - \frac{y}{3k}$$

$$\Rightarrow \frac{y}{3k} = 3 - \frac{y}{\eta} \Rightarrow \frac{y}{3k} = \frac{3\eta - y}{\eta}$$

$$\Rightarrow k = \frac{\eta y}{9\eta - 3y}$$

Q. 3 **(4)**

$$\text{Bulk modulus } K = \frac{-\Delta P}{\frac{\Delta V}{V}} = \frac{-\Delta pV}{\Delta V}$$

We know, $\rho = \frac{M}{V}$

So, $\frac{-\Delta\rho}{\rho} = \frac{\Delta V}{V}$

$$K = \frac{-\Delta P}{\left(-\frac{\Delta\rho}{\rho}\right)} = \frac{\rho \Delta P}{\Delta\rho}$$

$$\Delta\rho = \frac{\rho \Delta P}{K}$$

$$\Delta\rho = \frac{\rho P}{K}$$

Q. 4 **(4)**

From young's modulus relation $\left(y = \frac{\frac{F}{A}}{\left(\frac{\Delta l}{l}\right)}\right)$

we can write for 1^{st} case

$$\frac{T_1}{A} = \frac{y(\ell_1 - \ell)}{\ell}$$

we can write for 2^{nd} case

$$\frac{T_2}{A} = \frac{y(\ell_2 - \ell)}{\ell}$$

$$\frac{T_1}{T_2} = \frac{\ell_1 - \ell}{\ell_2 - \ell}$$

$$T_1\ell_2 - T_1\ell = T_2\ell_1 - T_2\ell$$

$$\frac{T_2 l_1 - T_1 l_2}{T_2 - T_1} = \ell$$

Q. 5

(32)

$$\text{For A} \frac{E}{\pi r^2} = y \frac{2\text{ mm}}{a} \ldots(1)$$

$$\text{For B} \frac{E}{\pi \cdot 16 r^2} = y \frac{4\text{ mm}}{b} \ldots(2)$$

$$\therefore (1)/(2)$$

$$16 = \frac{2b}{4a}$$

$$\frac{a}{b} = \frac{1}{32}$$

$$\therefore \text{Answer} = 32$$

Properties of Matter – Solution

Q. 6

(2)

$$y = \frac{F/A}{\Delta\ell/\ell}$$

$$\Rightarrow \frac{F}{A} = y\frac{\Delta\ell}{\ell}$$

$$\Rightarrow \frac{F}{A} = y \times \frac{0.04}{\ell} \quad \ldots(1)$$

When length \& diameter is doubled.

$$\Rightarrow \frac{F}{4A} = y \times \frac{\Delta\ell}{2\ell} \quad \ldots(2)$$

$(1) \div (2)$

$$\frac{F/A}{F/4\,A} = \frac{y \times \frac{0.04}{\ell}}{y \times \frac{\Delta\ell}{2\ell}}$$

$$4 = \frac{0.04 \times 2}{\Delta\ell}$$

$$\Delta\ell = 0.02$$

$$\Delta\ell = 2 \times 10^{-2}$$

$$\therefore x = 2$$