

ELASTICITY

1. A body of mass $m = 10 \text{ kg}$ is attached to one end of a wire of length 0.3 m . The maximum angular speed (in rad s^{-1}) with which it can be rotated about its other end in space station is (Breaking stress of wire $= 4.8 \times 10^7 \text{ Nm}^{-2}$ and area of cross-section of the wire $= 10^{-2} \text{ cm}^2$) is:
2. Two steel wires having same length are suspended from a ceiling under the same load. If the ratio of their energy stored per unit volume is $1 : 4$, the ratio of their diameters is:
 - (1) $1 : \sqrt{2}$
 - (2) $1 : 2$
 - (3) $2 : 1$
 - (4) $\sqrt{2} : 1$
3. In a Young's double slit experiment 15 fringes are observed on a small portion of the screen when light of wavelength 500 nm is used. Ten fringes are observed on the same section of the screen when another light source of wavelength λ is used. Then the value of λ is (in nm) _____.

4. A cube of metal is subjected to a hydrostatic pressure of 4 GPa . The percentage change in the length of the side of the cube is close to :
(Given bulk modulus of metal, $B = 8 \times 10^{10} \text{ Pa}$)
 - (1) 0.6
 - (2) 1.67
 - (3) 5
 - (4) 20
5. An object of mass m is suspended at the end of a massless wire of length L and area of cross-section, A . Young modulus of the material of the wire is Y . If the mass is pulled down slightly its frequency of oscillation along the vertical direction is:
 - (1) $f = \frac{1}{2\pi} \sqrt{\frac{YA}{mL}}$
 - (2) $f = \frac{1}{2\pi} \sqrt{\frac{YL}{mA}}$
 - (3) $f = \frac{1}{2\pi} \sqrt{\frac{mA}{YL}}$
 - (4) $f = \frac{1}{2\pi} \sqrt{\frac{mL}{YA}}$

SOLUTION

1. NTA Ans. (4.00)

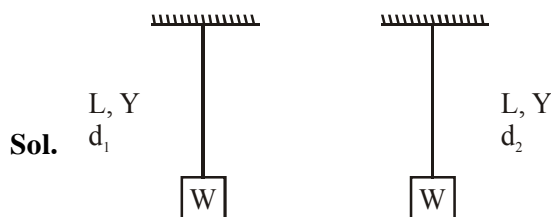
Sol. $T = m\omega^2 \ell$

$$\text{Breaking stress} = \frac{T}{A} = \frac{m\omega^2 \ell}{A}$$

$$\Rightarrow \omega^2 = \frac{4.8 \times 10^7 \times (10^{-2} \times 10^{-4})}{10 \times 0.3} = 16$$

$$\Rightarrow \omega = 4$$

2. NTA Ans. (4)



$$\frac{\text{Energy stored}}{\text{Volume}} = \frac{1}{2} \frac{(\text{Stress})^2}{Y}$$

$$\frac{u_1}{u_2} = \frac{1}{4} \Rightarrow 4u_1 = u_2$$

$$4 \frac{1}{2Y} \left[\frac{W \cdot 4}{\pi d_1^2} \right]^2 = \frac{1}{2Y} \left[\frac{W \cdot 4}{\pi d_2^2} \right]^2$$

$$4 = \left(\frac{d_1}{d_2} \right)^4$$

$$\Rightarrow \frac{d_1}{d_2} = \sqrt{2} : 1$$

∴ Correct answer (4)

3. NTA Ans. (750.00)

Sol. The length of the screen used portion for 15 fringes, and also for ten fringes

$$15 \times 500 \times \frac{D}{\lambda} = 10 \times \frac{\lambda D}{\lambda}$$

$$15 \times 50 = \lambda$$

$$\lambda = 750 \text{ nm}$$

∴ Correct answer 750

4. Official Ans. by NTA (2)

Sol. $B = \frac{\Delta P}{\frac{\Delta V}{V}}$

$$\left| \frac{\Delta V}{V} \right| = \frac{\Delta P}{B}$$

$$= \frac{4 \times 10^9}{8 \times 10^{10}} = \frac{1}{20}$$

$$\frac{\Delta \ell}{\ell} = \frac{1}{3} \times \frac{\Delta V}{V} = \frac{1}{60}$$

$$\begin{aligned} \text{Percentage change} &= \frac{\Delta \ell}{\ell} \times 100\% \\ &= \frac{100}{60} \% = 1.67\% \end{aligned}$$

5. Official Ans. by NTA (1)

Sol. An elastic wire can be treated as a spring with

$$k = \frac{YA}{\ell}$$

$$T = 2\pi \sqrt{\frac{m}{k}}$$

$$f = \frac{1}{2\pi} \sqrt{\frac{k}{m}} = \frac{1}{2\pi} \sqrt{\frac{YA}{m\ell}}$$

Ans. (1)