ELASTICITY

1. A body of mass m = 10 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 = 4.8×10^7 Nm^{-2} and area of cross-section of the wire = 10^{-2} 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 = 8×10^{10} 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. $T = m\omega^2\ell$

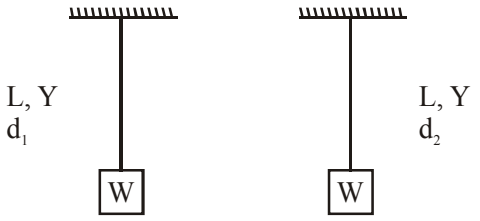
$$\text{Breaking stress} = \frac{T}{A} = \frac{m\omega^2\ell}{A}$$

$$\Rightarrow \omega^2 = \frac{4.8\times10^7\times(10^{-2}\times10^{-4})}{10\times0.3} = 16$$

$$\Rightarrow \omega = 4$$

2. NTA Ans. (4)

Sol.



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

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

$$4\frac{1}{2Y}\left[\frac{W\cdot4}{\pi d_1^2}\right]^2 = \frac{1}{2Y}\left[\frac{W\cdot4}{\pi d_2^2}\right]^2$$

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

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

$\therefore$ Correct answer (4)

3. NTA Ans. (750.00)

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

$$15\times500\times\frac{D}{\lambda} = 10\times\frac{\lambda D}{\lambda}$$

$15 \times 50 = \lambda$

$\lambda = 750$ nm

$\therefore$ Correct answer 750

4. Official Ans. by NTA (2)

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

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

$$= \frac{4\times10^9}{8\times10^{10}} = \frac{1}{20}$$

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

$$\text{Percentage change} = \frac{\Delta\ell}{\ell}\times100\%$$

$$= \frac{100}{60}\% = 1.67\%$$

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)