FBISE 9th Class Physics New Book Notes Chapter 3

NUMERICAL RESPONSE QUESTIONS

Q1. Consider a spring with a spring constant of 8000Nm^{-1}. If a force of 500 N is applied to the spring, what will be the displacement of the spring?

Solution:
To find the displacement of the spring when a force is ,applied, we can use Hooke's Law, which states: $\mathbf{F = kx}$

Given data; Force applied $F = 500$ N; Spring constant $k = 8000\text{Nm}^{-1}$
Required: Displacement $x = ?$
We rearrange the formula to solve for displacement:
Hooke's Law, which states: $\mathbf{F = k}\boldsymbol{x} \Rightarrow x = \frac{\mathbf{F}}{\mathbf{k}}$

$$x = \frac{500\text{ N}}{8000\text{Nm}^{-1}} = 0.0625\text{ m or }6.25\text{ cm}$$

So, the displacement of the spring when a force of 500 N is applied is 0.0625 m, or 6.25 cm.

Q2. In a force multiplier, small piston has diameter of 15cm and large piston has diameter of 30 cm. If 250N force is applied on the small piston then how much force will produce on large piston? (Ans. 1000 N)

Solution:
Given data: Diameter of small piston $= \text{d}_1 = 15$ cm
Diameter of large piston $= \text{d}_2 = \mathbf{30}$cm
Radius of small piston $= \text{r}_1 = 7.5$ cm
Radius of large piston $= r_2 = 15$ cm
Applied force on small piston $= \mathbf{F} = \mathbf{250}$N

Required: Applied force on large piston $= \text{F}_2 = ?$

Using Pascal's law: $\boldsymbol{\frac{F_2}{F_1} = \frac{A_2}{A_1} = \frac{\pi r_2^2}{\pi r_1^2}}$

$$\Rightarrow \frac{P_2}{F_1} = \frac{r_2^2}{r_1^2} \Rightarrow F_2 = \frac{r_2^2}{r_1^2} \times F_1 \Rightarrow F_2 = \frac{(15)^2}{(7.5)^2} \times 250$$

$$\Rightarrow F_2 = \frac{225}{56.25} \times 250 \Rightarrow F_2 = 4 \times 250 \Rightarrow F_2 = 1000\text{ N}$$

Q3. A hydraulic car lift lifts a car of mass 1000 kg when we apply force of 50N on small piston. Radius of Its small piston is 20cm. Find the radius of Its large piston.

Solution:
Given data; Mass of car $= \text{m} = \mathbf{1000}$kg
Force on small piston $= \text{F}_1 = \mathbf{50}$N
Radius of small piston $= r_1 = \mathbf{20}\text{cm} = \mathbf{0.20}\text{m}$
Radius of large piston $= r_2 = ?$
First, we will find force on larger piston from the weight of car.

Force on large piston 'F_2' = weight of car 'w'
Therefore, $\mathbf{w} = \mathrm{mg} = 1000 \times 9.8 = \mathbf{9800}\,\mathrm{N}$
Using Pascal's law:

$$\Rightarrow \frac{F_2}{F_1} = \frac{A_2}{A_1} = \frac{\pi r_2^2}{\pi r_1^2} \Rightarrow \frac{F_2}{F_1} = \frac{r_2^2}{r_1^2} \Rightarrow r_2 = \sqrt{\frac{F_2}{F_1} \times r_1^2}$$

Putting values,

$$\Rightarrow r_2 = \sqrt{\frac{9800}{50} \times (0.20)^2} \Rightarrow r_2 = \sqrt{196 \times 0.04}$$

$$\Rightarrow r_2 = \sqrt{7.84} \Rightarrow r_2 = 2.8\ \mathrm{m}$$

Q4. Water column in a beaker is 70 cm. Find the pressure of water in beaker. Take density of water as $1000\ \mathrm{kg\ m^{-3}}$. (Ans. 6.86kPa)

Solution:

Given data: Height of water column $= \mathbf{h} = \mathbf{70}\mathrm{cm} = 0.7\ \mathrm{m}$ Density of water $= \rho = 1000\ \mathrm{kg\ m^{-3}}$
Acceleration $= \mathrm{g} = 9.8\ \mathrm{ms^{-2}}$
Required: Pressure of water in beaker: $= \mathrm{P} = ?$
The relation for pressure: $\mathbf{P} = \boldsymbol{\rho g h}$

$$\Rightarrow P = 1000 \times 9.8 \times 0.7 \Rightarrow P = 6860 \Rightarrow Pa = 6.86\mathrm{kPa}$$

Q5. How much force should be applied on an area of $20\ \mathrm{cm^2}$ to get a pressure of $4500\ \mathrm{Pa}$? (Ans. 9 N)

Solution:

Given datai Pressure $= \mathrm{P} = 4500\ \mathrm{Pa}$

$$\text{Pressure} = \mathrm{P} = 4500\ \mathrm{Pa}$$
$$\text{Area} = \mathrm{A} = \mathbf{20}\mathrm{cm^2} = 20 \times 10^{-4}\ \mathrm{m^2} = 0.002\ \mathrm{m^2}$$

Required: Force = ?

$$\Rightarrow \text{Pressure} = \frac{\text{Force}}{\text{Area}} \Rightarrow P = \frac{F}{A}$$
$$\Rightarrow F = P \times A$$
$$\Rightarrow \text{Force} = 4500\ \mathrm{Pa} \times 0.002\ \mathrm{m^2}$$
$$\Rightarrow \text{Force} = F = 9\ \mathrm{N}$$