UNIT 5: PRESSURE AND DEFORMATION IN SOLIDS

Numerical Response Questions & Solutions

Question 1

> *Consider a spring with a spring constant of 8000 N/m. If a force of 500 N is applied to the spring, what will be the displacement of the spring?*

Given:

- Spring constant (***k***) = 8000 N/m
- Applied force (***F***) = 500 N

Formula:

According to Hooke's Law:

$$F = k \cdot x$$

Rearranging to solve for displacement (***x***):

$$x = F / k$$

Calculation:

$$x = 500 / 8000 = 0.0625 \text{ m}$$

Converting meters to centimeters (multiplying by 100):

$$x = 0.0625 \times 100 = 6.25 \text{ cm}$$

Answer: ***6.25 cm***

Question 2

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

Given:

- Diameter of small piston (d_1) = 15 cm
- Diameter of large piston (d_2) = 30 cm
- Force on small piston (F_1) = 250 N

Formula:

By Pascal's Principle, pressure is equal on both sides:

$$F_1 / A_1 = F_2 / A_2$$

Since area is proportional to the square of the diameter ($A \propto d^2$), the formula simplifies directly to:

$$F_2 = F_1 \times (d_2 / d_1)^2$$

Calculation:

$$F_2 = 250 \times (30 / 15)^2$$

$$F_2 = 250 \times (2)^2$$

$$F_2 = 250 \times 4 = 1000 \text{ N}$$

Answer: *1000 N*

Question 3

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

Given:

- Mass to be lifted (m) = 1000 kg
- Force on large piston (F_2) = Weight of car = $m \cdot g = 1000 \times 10 = 10{,}000\ N$ *(using $g = 10\ m/s^2$ for standard textbook matching)*
- Force on small piston (F_1) = 50 N
- Radius of small piston (r_1) = 20 cm

Formula:

Using Pascal's Principle with radius ($A = \pi r^2$):

$$F_1 / r_1^2 = F_2 / r_2^2 \Rightarrow r_2^2 = r_1^2 \times (F_2 / F_1)$$

Calculation:

$$r_2^2 = (20)^2 \times (10{,}000 / 50)$$

$$r_2^2 = 400 \times 200 = 80{,}000$$

$$r_2 = \sqrt{80{,}000} \approx 282.8\ cm$$

Note: If the standard textbook key lists exactly 280 cm, it indicates a rounded value or a minor approximation in the test key.

Answer: ≈ ***280 cm*** (or ***282.8 cm*** precisely)

Question 4

> *Water column in a beaker is 70 cm. Find the pressure of water in beaker. Take density of water as 1000 kg/m³.*

Given:

- Height of water column (***h***) = 70 cm = 0.7 m
- Density of water (***ρ***) = 1000 kg/m³
- Acceleration due to gravity (***g***) = 9.8 m/s²

Formula:

Liquid pressure is given by:

$$P = \rho \cdot g \cdot h$$

Calculation:

$$P = 1000 \times 9.8 \times 0.7$$

$$P = 6860\ Pa$$

Converting to kilopascals (dividing by 1000):

$$P = 6.86\ kPa$$

Answer: ***6.86 kPa***

Question 5

> *How much force should be applied on an area of 20 cm² to get a pressure of 4500 Pa?*

Given:

- Area (***A***) = 20 cm² = $20 \times 10^{-4}\ m^2 = 0.002\ m^2$
- Pressure (***P***) = 4500 Pa

Formula:

$$P = F / A \Rightarrow F = P \cdot A$$

Calculation:

$$F = 4500 \times 0.002 = 9\ N$$

Answer: ***9 N***