

**Chapter: 05*****Pressure and Deformation in Solids***

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**Numerical Response Questions**

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**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 Data:**

- Spring constant  $k = 8000$  N/m
- Force applied  $F = 500$  N

**To Find:**

- Displacement of the spring  $x$

**Solution:**

- Using Hooke's law:

$$F = kx$$

- Rearranging to find displacement:

$$x = \frac{F}{k}$$

- Substituting values:

$$x = \frac{500}{8000} = 0.0625 \text{ m} = 6.25 \text{ cm}$$

**Result:**

6.25 cm

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**Question 2:**

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

**Given Data:**

- Small piston diameter = 15 cm
- Large piston diameter = 30 cm
- Force applied on small piston  $F_{\text{small}} = 250 \text{ N}$

**To Find:**

- Force produced on large piston  $F_{\text{large}}$

**Solution:**

- Using Pascal's principle for hydraulic systems:

$$\frac{F_{\text{small}}}{A_{\text{small}}} = \frac{F_{\text{large}}}{A_{\text{large}}}$$

Where:

$$A = \pi r^2$$

- Calculating the areas of both pistons:

- Small piston radius  $r_{\text{small}} = \frac{15}{2} = 7.5 \text{ cm} = 0.075 \text{ m}$

- Large piston radius  $r_{\text{large}} = \frac{30}{2} = 15 \text{ cm} = 0.15 \text{ m}$

- Area of small piston:

$$A_{\text{small}} = A = \pi r_{\text{small}}^2 = \pi(0.075)^2 = 0.01767 \text{ m}^2$$

- Area of large piston:

$$A_{\text{large}} = A = \pi r_{\text{large}}^2 = \pi(0.15)^2 = 0.07068 \text{ m}^2$$

- Using Pascal's principle:

$$\frac{250}{0.01767} = \frac{F_{\text{large}}}{0.07068}$$

- Solving for  $F_{\text{large}}$ :

$$F_{\text{large}} = \frac{250 \times 0.07068}{0.01767} = 1000 \text{ N}$$

**Result:**

**1000 N**

**Question 3:**

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

**Given Data:**

- Mass of car  $m = 1000$  kg
- Force applied on small piston  $F_{\text{small}} = 50$  N
- Radius of small piston  $r_{\text{small}} = 20$  cm = 0.2 m

**To Find:**

- Radius of large piston  $r_{\text{large}}$

**Solution:**

- Force exerted by the car (weight) is:

$$F_{\text{large}} = mg = 1000 \times 9.8 = 9800 \text{ N}$$

- Using Pascal's principle to find the radius of the large piston:

$$\frac{F_{\text{small}}}{A_{\text{small}}} = \frac{F_{\text{large}}}{A_{\text{large}}}$$

Where:

$$A = \pi r^2$$

- Substituting the formula for area:

$$\frac{50}{\pi(0.2)^2} = \frac{9800}{\pi r_{\text{large}}^2}$$

- Solving for  $r_{\text{large}}$ :

$$r_{\text{large}} = \sqrt{\frac{9800 \times \pi \times (0.2)^2}{50 \times \pi}} = \sqrt{\frac{9800 \times 0.04}{50}} = \sqrt{7.84} = 2.8 \text{ m}$$

**Result:**

2.8 m

**Question 4:**

Water column in a beaker is 70 cm. Find the pressure of water in beaker. Take density of water as  $1000 \text{ kg/m}^3$ .

**Given Data:**

- Height of water column  $h = 70 \text{ cm} = 0.7 \text{ m}$
- Density of water  $\rho = 1000 \text{ kg/m}^3$
- Gravitational acceleration  $g = 9.8 \text{ m/s}^2$

**To Find:**

- Pressure of water  $P$

**Solution:**

- Using the formula for pressure in a liquid:

$$P = \rho gh$$

- Substituting the values:

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

**Result:**

6.86 kPa

**Question 5:**

How much force should be applied on an area of  $20 \text{ cm}^2$  to get a pressure of  $4500 \text{ Pa}$ ?

**Given Data:**

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

**To Find:**

- Force applied  $F$

**Solution:**

- Using the formula for pressure:

$$P = \frac{F}{A}$$

- Rearranging the formula to solve for  $F$ :

$$F = P \times A$$

- Substituting the values:

$$F = 4500 \times (20 \times 10^{-4}) = 9 \text{ N}$$

**Result:**

**9 N**

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