Chapter 5 HW Answers

Review Questions:

6. If you swim twice as deep, twice as much pressure is exerted on your ears.

In general: $P = Dgh$

Twice as deep: $(2P) = dg(2h)$

7. The water pressure 1 meter down is the same whether you are in a small pond or a huge lake. Pressure increases with depth. The volume of the body of water does not matter.

9. Pressure is exerted in all directions in a fluid; however, the greatest pressure is at the greatest depth. Pressure and buoyancy force are directly related ($F_B = PA$). Therefore, the greatest buoyancy force is from the greatest depth.

17. A 100-ton ship must displace **100 tons** of water. The buoyant force is equal to the weight of the water displaced, so the buoyant force is **100 tons**.

25. The pressure in every part of the fluid is increased.

27. The buoyant force is 1 N because the balloon is maintaining its altitude. If the buoyant force decreases, the balloon will fall towards the ground, if the buoyant force increases, the balloon will rise.

Exercises:

7. This is a difficult question to answer. The elephant has a relatively large weight force, but it is distributed over a relatively large area as compared to the spike heel. The woman has a relatively small weight force, but it is distributed over a small area. $P = F/A$

Let’s make some calculations and check…

Elephant: An average weight for an adult elephant is 8750 lbs. The area of one elephant foot is approximately 310 in^2

$$P = \frac{F}{A} = \frac{8750 \text{ lbs}}{4(310 \text{ in}^2)} = 7.1 \text{ lbs/in}^2$$

Woman: The average weight of a woman is 162.9 lbs. A spike heel is at most ¼ inch x ¼ inch (0.0625 in^2).

$$P = \frac{F}{A} = \frac{162.9 \text{ lbs}}{(0.0625 \text{ in}^2)} = 2{,}606.4 \text{ lbs/in}^2$$

If the woman steps on your foot with all of her weight on 1 spike heel, the pressure will be 367 times greater than if an elephant steps on you with one of its feet.

10. Yes. The buoyant force is equal to the weight of displaced fluid, so even if the pressure was constant at every depth, there would still be a buoyant force from displacing the fluid. However, the direction of the buoyant force would no longer be up; it would be equal in all directions.

17. The buoyant force on the ship does **not** change. However, the ship must displace more fresh water as compared to the salt water in order to have an equal amount of buoyant force because the fresh water has a lower density.

31. True. The elephant displaces more air than the balloon, so the buoyant force on the elephant is greater than the buoyant force on the balloon.

33. The buoyant force on the hydrogen balloon is the same because the balloon is the same size, and thus displaces the same amount of air. However, the hydrogen balloon has less weight, so it will float at a higher altitude.

Problem:

4. area of boat = 5 m x 2 m = 10 m^2
mass on boat = 400 kg

The change in the height of the water line is found from using both of the equations for pressure.

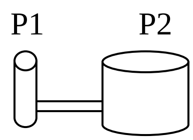
$$\frac{F}{A} = Dgh \quad \rightarrow \quad h = \frac{F}{ADg} = \frac{(400\text{ kg})(9.81\text{ m/s}^2)}{(10\text{ m}^2)(1000\text{ kg/m}^3)(9.81\text{ m/s}^2)} = \mathbf{0.04\text{ m} = 4\text{ cm}}$$

6. mass = 1 kg

Need the volume this mass of gold will displace. We can find volume using the density equation. (Look up density of gold → see page 116 of your text)

$$D = \frac{m}{V} \quad \rightarrow \quad V = \frac{m}{D} = \frac{1\text{ kg}}{19{,}300\text{ kg/m}^3} = 0.0000518\text{ m}^3 = \mathbf{51.8\text{ cm}^3}$$

9. The pressures must be equal.



P1 = P2

$$\frac{F1}{A1} = \frac{F2}{A2}$$

We can compare diameters because the diameter leads to area.

$$\frac{F1}{2\text{ cm}} = \frac{F2}{6\text{ cm}} \quad \rightarrow \quad \frac{F2}{F1} = \frac{6\text{ cm}}{2\text{ cm}} = \frac{\mathbf{3}}{\mathbf{1}}$$

The larger diameter piston will exert 3 times more force than is applied to the small piston.

Additional:

A. Salt water has a higher density so less of it must be displaced to equal your body weight.

B. a) The weight can be found, after first finding the mass from the density equation.

$$D = \frac{m}{V} \quad \rightarrow \quad m = DV = (550\ \text{kg/m}^3)(4\ \text{m x } 4\ \text{m x } 0.3\ \text{m}) = 2,640\ \text{kg}$$

$$W = mg = (2{,}640\ \text{kg})(9.81\ \text{m/s}^2) = \mathbf{25{,}898.4\ N}$$

B b) F_B = **25,898.4 N**

B c) Set the two equations for pressure equal to each other.

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

$$h = \frac{F}{ADg} = \frac{25{,}898.4\ \text{N}}{(4\ \text{m x } 4\ \text{m})(1000\ \text{kg/m}^3)(9.81\ \text{m/s}^2)} = \mathbf{0.165\ m = 16.5\ cm}$$

<u>**Bonus Question**</u>**:** One way to figure this out is to start with a ratio, to compare.

F_1 = weight of raft
F_2 = weight to sink raft, to have water reach top of height (0.3 m)
H_1 = height of water line on raft
H_2 = height of water line when raft sinks

We want F_2.

$$\frac{F_2}{H_2} = \frac{F_1}{H_1} \qquad F_2 = \frac{F_1}{H_1} \times H_2 = \frac{(25{,}898\ \text{N})(0.3\ \text{m})}{0.165\ \text{m}} = 47{,}087\ \text{N}$$

Now we need to subtract the raft's weight to determine how much weight can be added.

47,087 N – 25,898 N = **21,189 N**