Physics--Chapter 9: Fluid Mechanics
Practice Problems

Practice 9A Buoyant Force

1. A piece of metal weighs 50.0 N in air, 36.0 N in water, and 41.0 N in oil. Find the densities of the following:
   a. the metal

   b. the oil

2. An empty rubber balloon has a mass of 0.0120 kg. The balloon is filled with helium at 0°C, 1 atm pressure, and a density of 0.181 kg/m^3. The filled balloon has a radius of 0.500 m.
   a. What is the buoyant force acting on the balloon?
   b. What is the net force acting on the balloon?

3. A 2.3 kg rectangular air mattress is 2.0 m long, 0.50 m wide, and 0.10 m thick. What mass can it support in water before sinking?

4. A ferry boat is 4.0 m wide and 6.0 m long. When a truck pulls onto it, the boat sinks 4.00 cm in the water. What is the weight of the truck?

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Practice 9B Pressure

1. In a car lift, compressed air exerts a force on a piston with a radius of 5.00 cm. This pressure is transmitted to a second piston with a radius of 15.0 cm.
   a. What force must the compressed air exert to lift a 1.33×10^4 N car?
   b. What air pressure produces this force? Neglect the weight of the pistons.

2. A 1.5 m wide by 2.5 m long water bed weighs 1025 N. Find the pressure that the water bed exerts on the floor. Assume that the entire lower surface of the bed makes contact with the floor.

3. A person rides up a lift to a mountaintop, but the person's ears fail to "pop"—that is, the pressure of the inner ear does not equalize with the outside atmosphere. The radius of each eardrum is 0.40 cm. The pressure of the atmosphere drops from 1.010×10^5 Pa at the bottom of the lift to 0.998×10^5 Pa at the top.
   a. What is the pressure on the inner ear at the top of the mountain?
   b. What is the net force on each eardrum?

Practice 9C Pressure as a Function of Depth

1. The Mariana Trench in the Pacific Ocean is about 11.0 km deep. If atmospheric pressure at sea level is 1.01×10^5 Pa, how much pressure would a submarine need to be able to withstand to reach this depth?

2. Two fish swim in a freshwater lake, one at a depth of 14.0 m and the other at a depth of 98.0 m. Assuming that the atmospheric pressure at the lake's surface is 1.01×10^5 Pa, what is the difference in pressure on the two fish?

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3. A beaker filled with mercury to a height of 0.20 m is placed inside a vacuum chamber in a laboratory. What is the pressure at the bottom of the beaker?

4. A container is filled with water to a depth of 20.0 cm. On top of the water floats a 30.0 cm thick layer of oil with a density of 0.70×10^3 kg/m^3.
   a. What is the pressure at the surface of the water?
   b. What is the absolute pressure at the bottom of the container?

Practice 9D Bernoulli's Equation

1. A large storage tank, open to the atmosphere at the top and filled with water, develops a small hole in its side at a point 16 m below the water level. If the rate of flow of water from the leak is 2.5×10^{-3} m^3/min, determine the following:
   a. the speed at which the water leaves the hole
   b. the diameter of the hole

2. A liquid with a density of 1.65×10^3 kg/m^3 flows through two horizontal sections of tubing joined end to end. In the first section, the cross-sectional are is 10.0 cm^2, the flow speed is 275 cm/s, and the pressure is 1.20×10^5 Pa. In the second section, the cross-sectional area is 2.50 cm^2. Calculate the following:
   a. the flow speed in the smaller section
   b. the pressure in the smaller section

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3. When a person inhales, air moves down the windpipe at 15 cm/s. The average flow speed of the air doubles when passing through a constriction in the bronchus. Assuming incompressible flow, determine the pressure drop in the constriction.

Practice 9E Gas Laws

1. Gas is confined in a tank at a pressure of 1.0×10^8 Pa and a temperature of 15.0°C. If half the gas is withdrawn and the temperature is raised to 65.0°C, what is the new pressure in the tank in Pa?

2. A gas bubble with a volume of 0.10 cm^3 is formed at the bottom of a 10.0 cm deep container of mercury. If the temperature is 27°C at the bottom of the container and 37°C at the top, what is the volume of the bubble just beneath the surface of the mercury? Assume that the surface is at atmospheric pressure.

3. A cylinder with a movable piston contains gas at a temperature of 27°C, with a volume of 1.5 m^3 and a pressure of 0.20×10^5 Pa. What will be the final temperature of the gas if it is compressed to 0.70 m^3 and its pressure is increased to 0.80×10^5 Pa?