PHYS 1200 Physics of Everyday Experience

Review questions and exercises for Lecture 13 (F-2)

1. A crate weighing 6400 N has dimensions 1 m by 2 m by 4 m. On what side should this crate be placed on a surface so that it exerts the least pressure on that surface?
2. What is the mass of one liter (1000 cm^3) of ethanol (mass density = 0.789 g/cm^3)?
3. What is Pascal's principle?
4. What is the principle underlying the use of a hydraulic jack?
5. When you drink pop using a straw, what principle are you employing?
6. Why are dams thicker at their base than at their top?
7. Explain the origin of the buoyant force on an object.
8. An object weighing 60 N having a volume of 5.9 liters is placed in water. What will happen?
9. Why do oil tanker that are filled with crude oil float lower in the ocean than ones that are empty?

Solutions (You should try to solve the problems before reading the solutions.)

1. The pressure P = F/A, where in this case F is the weight of the crate, W. Thus to minimize the pressure, the crate should be placed on the side with the largest area, which in this case is the 2 m x 4 m side. Then A = 8 m^2 and P = 6400 N / 8 m^2 = 800 Pa.

2. mass = density x volume = 0.789 g/cm^3 x 1000 cm^3 = 789 g or 0.789 kg.

3. Pascal's principle states that a change in pressure in an enclosed fluid at rest is transmitted *undiminished* to all points in the fluid.

4. Pascal's principle is the physics on which the hydraulic jack operates.

5. When you suck on the top of the straw you lower the air pressure at that point. Then the atmospheric pressure on the surface of the pop pushes it up the straw and into your mouth.

6. The pressure of the water is higher at the base of the dam, so the dam must be thicker there to support the water pressure.

7. The pressure in a liquid increases with depth. So any object that is submerged will experience a higher pressure on the bottom side than on the top side. The difference in the pressures on the bottom and top is the origin of the buoyant force.

8. Displaced water weights 10 N/liter. The buoyant force is equal to the weight of the displaced water (Archimedes' principle). So the weight of displaced water in this case is 5.9 liters x 10 N/liter = 59 N. This is the maximum buoyant force that occurs if the object is completely submerged. Since the buoyant force is less than the weight of the object, the object will sink to the bottom.

9. A full oil tanker weighs more than an empty one and thus requires a larger buoyant force to remain afloat. The buoyant force is larger when the tanker displaces more water, so when full it sits lower on the surface.