PHYS 1200 Physics of Everyday Experience

Review questions and exercises for Lecture 12 (F-1)

1. What are the main differences between solids, liquids, and gases?
2. What is the mass of a cube of iron with sides that are 1 cm in length?
3. What is the cause of the pressure exerted by a gas on its container?
4. Why does the earth's moon have no atmosphere?
5. What force is exerted on a 100 m^2 area of the earth by the atmosphere?
6. In a class demonstrations a metal can was crushed when the air was pumped out of it. What force caused the can to be crushed?
7. How does the pressure on a submerged vessel change with depth?
8. What is the pressure at a depth of 100 m?
9. What force suspends the column of mercury in a barometer?
10. What principle is illustrated by Pascal's vases?

Answers:

1. The main differences are the separation of the atoms and the strength of the forces between the atoms. The atoms are closest in solids and farthest apart in gases. The forces are strongest in solids and weakest in gases.

2. The mass density of iron is 2300 kg/m^3. Since density is mass per unit volume, the mass of an object is the density x the volume. m = density x Vol. The volume must be expressed in cubic meters. Since a cm is 0.01 m = 10^{-2} , 1 cm^3 = 1 $(10^{-2}$ m$)^3$ = 1 x 10^{-6} m^3, so the mass is

   m = 2300 kg/m^3 x 1 x 10^{-6} m^3 = 2.3 x 10^3 x 1 x 10^{-6} = 2.3 x 10^{-3} kg = 2.3 g.

3. Air pressure is due to the average force exerted by the atoms as they collide with the walls of the container. An individual atom exerts a very small force, but there is a very large number of atoms, so the effect is significant.

4. The relatively weak gravity of the moon is not sufficient to hold on to any atmospheric particles.

5. P = F/A → F = P A = 1 x 10^5 Pa x 100 m^2 = 1 x 10^7 Pa.

6. Before the can was evacuated, there were air molecules hitting both the inside and outside of the can, so the net effect was zero force. When the air molecules on the inside were pumped out, the unbalanced effect of the air molecules hitting the outside of the can crushed it.

7. Pressure increases with depth.

8. P(h) = P(0) + ρgh, where P(0) is the atmospheric pressure at the surface = 1 x 10^5 Pa.

   → P(100 m) = 1 x 10^5 Pa + (1000 kg/m^3)(10 m/s^2)(100 m) = 1 x 10^5 + 1 x 10^6. To add these numbers, realize that 1 x 10^5 = 0.1 x 10^6, so that P(100 m) = 1.1 x 10^6 Pa

9. Atmospheric pressure

10. Pascal's vases illustrates the principle that the pressure in a fluid depends only on its depth and not on the shape of the container. Therefore, the fluid level is the same in each of the tubes.