Homework 16

We started discussing gases.
Gases “work hard” for us in our everyday life – for example, hot gas expanding in the cylinder of the engine makes the car move. To design a machine which uses gas to produce work we have to know in detail the behavior of gas at different conditions. As we learned, gas consists of huge number of microscopic particles called molecules or atoms (depending on the kind of the gas). It is not possible to track down or describe the motion of each molecule in a gas volume. Fortunately, we do not have to do that. We just have to know three important parameters and the way how they depend on each other. The parameters are:

- Pressure
- Volume
- Temperature

Strictly speaking, we just have to know any two of them – then we can calculate the third.
Let us discuss pressure first.
From our everyday experience we know well that the result of application of force depends not only on the force magnitude and direction but also on the area to which the force is applied. For example it is very hard to push, say, a match into a wooden panel, but we can easily do that with a pushpin. This is because in the last case the pressure produced by the pushpin is much higher. What is pressure?
In real world a force cannot be applied to an infinitely small point – the force is always applied to a certain finite area. Even the needle tip has an effective area (very small, though). To find pressure we have to divide normal force by the area to which the force is applied. So we can say that the pressure is a normal force applied to unit area.

$$\text{Pressure} = \text{Force}/\text{Area}$$

$$P=F/S$$

Pressure is measured in N/m^2. This unit is called Pascal (Pa) after a famous French mathematician, physicist and philosopher Blaise Pascal.

Blaise Pascal (1623-1662) (www.wikipedia.org)

Gas always applies pressure to the walls of the cylinder or any other vessel. The pressure can be low as in a balloon or high as in a barrel of a gun during the shot. Our atmosphere also produces pressure. It is ~ 100kPa (101,300Pa to be exact) at sea level.

1. Calculate total force applied by the atmosphere to a square surface 30cm x 30cm.
2. A 45kg skier has his ski on. The length of each ski is 1.5m; the width is 10 cm. Find pressure that the skier is applying to the snow.
3. What pressure you produce when you are pushing a pushpin into a wall with a force of 50N? Take the area of the pushpin tip as $0.01mm^2$.
4. A fish tank 60cm long, 40cm wide and 30cm high is full of water. Calculate pressure produced by the fish tank to the surface of the table.
5. Do the water molecules change when the water evaporates? How does the character of their motion change after evaporation?
6. What happens to gas molecules when we increase the temperature of the gas?
7. Why does a suction cap sticks to a smooth surface?
8. What happens to the air pressure inside the balloon if we squeeze the balloon? Why?
9. What happens to gas pressure if we will increase temperature of the gas? Why?
10. Why a regular light bulb is evacuated?