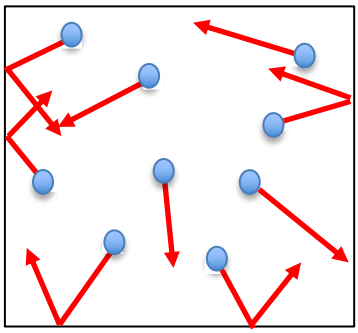
6.6.1 The gas laws

videos

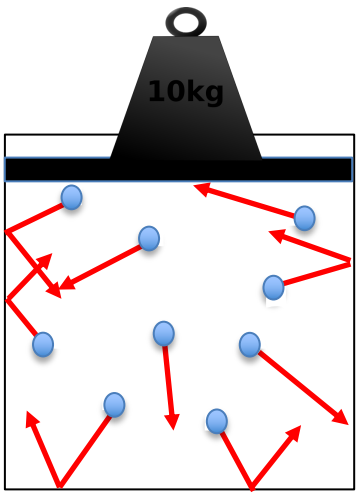
The gas laws describe how the temperature (T), volume (V) and pressure (P) are related for a gas. It is useful to think about the movement of the constituent gas molecules when attempting to understand the behaviour of the gas as a whole.

Consider a container filled with a gas:



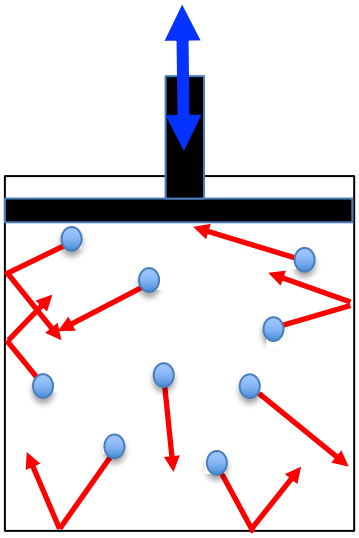
The gas molecules are spaced out and moving quickly. They bounce against the sides of the container, pushing out on the container wall. This creates a pressure on the walls. Remember, that $pressure = \frac{force}{area}$.
Temperature is a measure of the mean speed of the molecules.

(1) What would happen to the pressure if the temperature of the gas increased, but the volume of the container remained fixed? Explain in terms of the speed of the molecules and the impacts on the container walls.



Consider the situation, left. Here the volume of the container can change as the piston rises and falls. The pressure in the container supports the weight placed on the piston. This means that the pressure is kept constant (i.e. the pressure needed to support the weight ($= pressure \times area$)).

(2) What would happen to the volume of the container if the temperature of the gas increased? Explain in terms of the speed of the molecules and the impacts on the container walls.



Consider the situation, left. Here the volume of the container can be changed by moving a piston up and down. If this is done slowly, the temperature remains unchanged.

(3) What would happen to the pressure in the container if the volume decreased? Explain in terms of the frequency of molecules bouncing off the container walls.

The 3 situations, above, are described by three gas laws:

Boyle's Law

Boyle's Law describes the relationship between pressure and volume for a gas at a fixed temperature.

$$PV = constant$$

(4) How would you describe the mathematical relationship between P and V?

(5) A 1.5litre container of gas at atmospheric pressure ($1.01 \times 10^5 Pa$) *is compressed to a volume of 0.5litres. What is the pressure in the compressed container?*

Charles' Law

Charles' Law describes the relationship between temperature and volume for a gas at a fixed pressure.

$$\frac{V}{T} = constant$$

(Note: You must use temperature in kelvin in any calculation.)

(6) How would you describe the mathematical relationship between T and V?

(7) A 10litre container of gas at 300K is heated to 500K. The container is allowed to expand, so that the pressure is a constant. What is the new volume of the gas?

The Pressure Law (or Gay-Lussac's Law)

The Pressure Law describes the relationship between temperature and pressure for a fixed volume of gas.

$$\frac{P}{T} = constant$$

(Note: You must use temperature in kelvin in any calculation.)

(8) How would you describe the mathematical relationship between T and P?

(9) A container of gas at 300K and atmospheric pressure ($1.01 \times 10^5 Pa$) *is heated to 1000K. The volume of the container can't change. What is the pressure in the heated container?*