FLIPPED around PHYSICS

3.6.1 Boyle's law

Boyle's Law describes the relationship between *pressure (P)* and *volume (V)* for a fixed mass of gas at a constant temperature.

$$P \times V = constant$$

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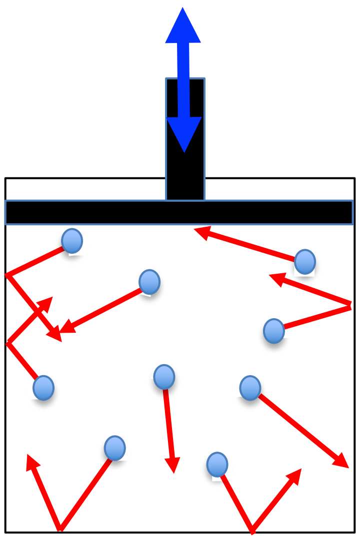
(1)✏If the volume (V) was decreased, what would happen to the pressure (P)? (Hint: The two multiplied together must always give the same value.)

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

Consider the situation, below. 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. In this case the pressure multiplied by the volume is a constant.



It is found that the pressure increases as the volume is decreased.

Pressure is affected by the impact force of collisions and the frequency of collisions with the walls.

The impact force of a collision is related to the speed that the particles are moving.

The mean speed of particles is related to the temperature. The higher the temperature, the greater the speed.

(3)✏Does the impact force change if the temperature remains constant? Explain. (Hint: Look at the information you are given, above.)

(4)✏Why does the frequency of collisions with the walls increase when the volume is decreased? (Hint: Think about how far particles have to travel between collisions.)

Worked example using Boyle's law equation

Question:
A 1.5m^3 *container of gas at atmospheric pressure (=*$1.01 \times 10^5 Pa$*) is compressed to a volume of 0.50m*^{3}*. What is the pressure in the compressed container?*

Answer:
Boyle's law tells us that the $pressure \times volume$ is a constant. This means that:

$$pressure \times volume\ (at\ start) = pressure \times volume\ (at\ end)$$
$$P_1 \times V_1 = P_2 \times V_2$$
$$1.01 \times 10^5 \times 1.5 = P_2 \times 0.5$$
$$P_2 = \frac{1.01 \times 10^5 \times 1.5}{0.5} = \underline{3.03 \times 10^5 Pa}$$

(5)✏A 0.01m^3 *container of gas at atmospheric pressure (=*$1.01 \times 10^5 Pa$*) is expanded to a volume of 0.05m*^{3}*. What is the pressure in the expanded container? (Hint: Follow the same method as shown in the example, above.)*

(6)✏A 100cm^3 *sealed syringe, containing a gas at atmospheric pressure (=*$1.01 \times 10^5 Pa$*), is compressed. The pressure in the compressed syringe is measured to be* $3.25 \times 10^5 Pa$*. What is the volume (in cm*^{3}*) of the compressed syringe? (Hint: Use* $P_1 \times V_1 = P_2 \times V_2$ *to find* V_2*.)*

(7)✏A bubble of gas from a diver's face mask rises to the surface. The volume of the bubble when it leaves the diver's mask is 1.5mm^3*. At the surface (where the pressure is* $1.01 \times 10^5 Pa$*), the bubble has a volume 2.5mm*^{3}*. What is the pressure on the diver's mask? (Hint: Use* $P_1 \times V_1 = P_2 \times V_2$ *to find* P_1*.)*