**Electricity & Energy**

**Gas Laws & Kinetic Theory**

**Summary**

The pressure, temperature and volume of gases are related to each other by the **gas laws**.

**Pressure, Force & Area**

$$pressure=\frac{force}{area}$$

$$P=\frac{F}{A}$$

$$F=PA$$

$$A=\frac{F}{P}$$

N

Pa

m2

*P*

*F*

*A*

**Pressure** is a measure of the force per unit area exerted on a surface.

Pressure is measured in pascals (Pa) or newtons per square metre (N m-2).

1 Pa = 1 N m-2.

Pressure can be reduced by spreading the force out over a large area (e.g. snowshoes and tractor tyres).

Pressure can be increased by exerting a force on a small area (e.g. the blade of a knife or the point of a nail).

The pressure of a gas is due to the force exerted by the particles of the gas when they collide with the walls of the container.

The **temperature** of a gas is a measure of the average kinetic energy of the particles in a gas.

The lowest possible temperature, the temperature at which all particle motion stops, is known as **absolute zero**.

On the **Celsius** temperature scale absolute zero is -273 °C.

On the **kelvin** temperature scale absolute zero is 0 K.

NOTE: To convert temperatures from Celsius to kelvin, add 273.

To convert temperatures from kelvin to Celsius, subtract 273.

A change in temperature of 1 °C is the same as a change of 1 K.

Gases expand to fill the container they are in, so the **volume** of a gas is the same as the volume of the container the gas is in.

**Pressure and Volume (Boyle’s Law)**

The pressure of a fixed mass of gas is inversely proportional to the volume of the gas, provided the temperature of the gas remains constant.

$$P∝\frac{1}{V}$$

$P\_{1}V\_{1}=P\_{2}V\_{2}$

0

**Pressure and Temperature (Gay-Lussac’s Law)**

The pressure of a fixed mass of gas is directly proportional its kelvin temperature, provided the volume of the gas remains constant.

$$P∝T$$

$$\frac{P\_{1}}{T}\_{1}= \frac{P\_{2}}{T\_{2}}$$

0

**Volume and Temperature (Charles’ Law)**

The volume of a fixed mass of gas is directly proportional its kelvin temperature, provided the pressure of the gas remains constant.

$$V∝T$$

$$\frac{V\_{1}}{T}\_{1}= \frac{V\_{2}}{T\_{2}}$$

0

The three gas laws can be combined into a **general gas equation**:

$$\frac{P\_{1}V\_{1}}{T}\_{1}= \frac{P\_{2}V\_{2}}{T\_{2}}$$

The relationships between pressure, temperature and volume can be explained by **kinetic theory**. In kinetic theory it is assumed that all the particles in a gas are in constant random motion and do not lose energy when they collide with each other or the walls of the container.

**Pressure and Temperature**

**(Gay-Lussac’s Law)**

* increase the temperature of the gas
* kinetic energy, and speed, of gas particles increases
* particles collide with walls of container more often and with a greater individual force
* total force on container walls increases
* area of walls is the same
* pressure increases

**Volume and Temperature**

**(Charles’ Law)**

* increase the temperature of the gas
* kinetic energy, and speed, of gas particles increases
* particles collide with walls of container more often and with a greater individual force
* total force on container walls increases
* for pressure to remain constant the area of the walls must increase
* volume increases

**Pressure and Volume**

**(Boyle’s Law)**

* decrease the volume of the gas
* particles collide with walls of container more often, but with the same individual force
* total force on container walls increases
* area of walls decreases
* pressure increases