Unit 1
Particles,
Quantum
Phenomena
and Electricity

**3.3
Collisions
of
electrons
with
atoms**

AS15

3.3 Collisions of Electrons with Atoms

Ionization

Ions are atoms which carry a net charge because they have lost or gained one or more electrons. Positive ions, for example, are created by removing one or more electrons from a neutral atom. The process is known as **ionization**.
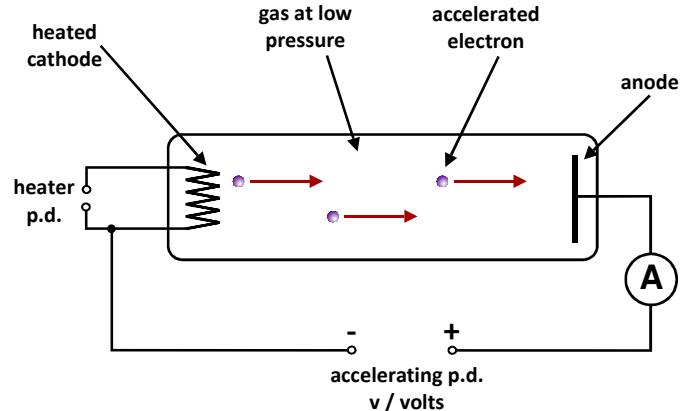

Ionization Energy

A gas-filled tube such as that shown opposite can be used to measure the energy needed to ionize an atom of the gas.

Electrons boiled out of the cathode by **thermionic emission** are accelerated through the gas to the anode. (The gas is at a low pressure otherwise the electrons would suffer too many collisions and would not reach the anode).

The ammeter reading will rise to a maximum value when all the electrons emitted from the cathode are reaching the anode. This is known at the saturation current.

If the accelerating p.d. is increased further, however, it will reach a value at which the anode current suddenly increases again. The increasing p.d. has been accelerating the electrons to higher and higher kinetic energies until, at a critical value, they have enough energy to knock an electron out of a gas atom when they collide. In other words, they **ionize** the atoms. These released electrons rush towards the anode and cause the increased current recorded by the ammeter.

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The graph opposite shows how the anode current varies with accelerating p.d.
The flat region is the saturation current. The steep rise occurs when ionization of the gas atoms begins. The ionization energy of the gas atom can be found from the equation

$$ionization\ energy = e \times V\ joules$$

Where e is the charge on an electron and V is the accelerating p.d. when ionization occurs.

anode current (vertical axis)

accelerating p.d. (horizontal axis)

ionization potential

The electronvolt (eV)
This is another unit in which we measure energy. It is much smaller than a joule and is usually used when discussing the energies of subatomic particles.
An electronvolt is the kinetic energy gained by one electron when it is accelerated through a p.d. of one volt.

$$1\ eV\ \equiv 1.6 \times 10^{-19}\ J$$