

## TURNING POINTS The Discovery of the electron

### 1-1 Thermionic emission of electrons

1. At a suitable p.d. the electrons can be pulled out of some of the gas atoms in the tube so that they become ionised. The positive ions produced that are close to the cathode are then attracted to the it. Their collision with the cathode causes electrons to be emitted from the cathode. The electrons are then accelerated towards the anode and collide with gas atoms ionising them. The gas thus conducts electricity.

When the positive ions and electrons recombine photons are emitted so the gas glows near the cathode. Atoms excited by collision with the electrons moving towards the anode (the cathode rays) de-excite and emit photons so the gas glows.

Photons emitted are in the visible and UV range.

2. (a) The glowing gas is distorted because it results from the passage of charged particles. A moving charged particle in a magnetic field experiences a force and thus changes direction (direction given by Fleming's LH rule).  
  
(b) The negative particles produced are always electrons irrespective of which gas is in the tube.

3. (a) (i) In Figure 2, the cell connected to the filament is used to heat it up so that the free electrons in the metal will have enough kinetic energy to escape the metal surface and thus be emitted.

(ii) The high voltage unit is to produce a p.d. to accelerate the electrons away from the cathode towards the anode.

(b) The tube needs to be evacuated so that the electrons do not collide with gas atoms and lose energy.

4.  $u = 0 \text{ ms}^{-1}$ ,  $v = ?$ , p.d. = 4000 V,  $e = 1.60 \times 10^{-19} \text{ C}$ ,  $m_e = 9.11 \times 10^{-31} \text{ kg}$

$$\text{work done} = eV = 1.60 \times 10^{-19} \times 4000 \text{ J} (= 6.4 \times 10^{-16} \text{ J})$$

$$\text{kinetic energy} = \frac{1}{2} mv^2 = \frac{1}{2} \times 9.11 \times 10^{-31} \times v^2$$

work done = kinetic energy gained

$$eV = \frac{1}{2} mv^2 \text{ hence } v^2 = \frac{2eV}{m_e} = \frac{2 \times 1.60 \times 10^{-19} \times 4000}{9.11 \times 10^{-31}}$$

$$v^2 = 1.405 \dots \times 10^{15} \text{ m}^2\text{s}^{-2}$$

$$v = 3.748 \dots \times 10^7 \text{ ms}^{-1}$$

$$= 3.75 \times 10^7 \text{ ms}^{-1}$$