THERMIONIC EMISSION

In 1873, Guthrie observed that a charged, red-hot conductor would quickly:

1. lose negative charge
2. retain positive charge

↳ This was a much more effective way of freeing e^- (to create cathode rays) (compared to discharge tube)

Thermionic Emission

what is Thermionic Emission?

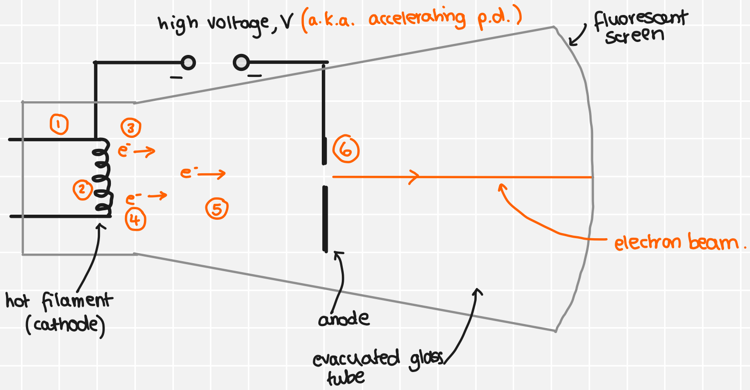

diagram of cathode ray tube (containing an electron gun.)

↳ used in oscilloscopes, TV sets, computer monitors and electron microscopes in 20th Century.

1. in a metal, 1-2 electrons per atom are usually delocalised
2. The work function (ϕ) of a metal is the minimum E to liberate an e^- from metal surface. This E can be supplied by heating (e^- gain thermal E).
3. If thermal energy gained $> \phi$, e^- are emitted ∴ Thermionic emission.

NB: thermionic $\phi \neq$ photoelectric ϕ

4. Hot cathode generates e^- by thermionic emission.
   - if directly heated, made of tungsten + zirconium dioxide (to ↓ ϕ)
   - if indirectly heated, made of nickel coated in oxides (required lower temp.)
5. E field between cathode + anode accelerates e^- towards anode.

   ↳ Energy gained by e^-:

   $$E = QV \quad \text{(accelerating p.d.)}$$
   $$= eV \quad \text{(charge on electron)}$$

   ↳ is converted into KE of e^-:

   $$KE = \frac{1}{2}mv^2$$

   $$\therefore \boxed{eV = \frac{1}{2}mv^2}$$

6. Narrow beam created by 'gap' in anode.

Controlling the cathode ray tube

1. Increase I in filament
   - hotter filament
   - more e^- emitted per second
   - denser e^- beam
2. Increasing accelerating p.d.
   - larger F experience by e^- due to E field
   - more work done on e^-
   - higher gain in KE
   - e^- faster in beam.

Consequences of $\boxed{eV = \frac{1}{2}mv^2}$

1. v of electrons is entirely dependent on the accelerating p.d.
2. definition of electronvolt:

   'the energy gained by an electron that is accelerated through a p.d. of 1V'

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