# AQA A-Level Physics

## 12.1 The discovery of the electron

Flashcards

What is meant by thermionic emission?

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A filament is heated up using an electric current, this causes the delocalised electrons to gain energy. Eventually they gain enough energy for the electron to leave the metal surface as a beam of electrons

How are cathode rays made in a discharge tube?

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- Electrons are released by thermionic emission.
- The electrons are repelled by the cathode and accelerated towards an anode.

Why is light emitted from a discharge tube?

## Why is light emitted from a discharge tube?

The strong potential difference between the anode and cathode cause atoms in the discharge tube to ionise. When this occurs the ionises atoms (which are now positive ions) are attracted to the cathode. They accelerate towards and then collide into the cathode. When this happens electrons leave the cathode and go on to excite other atoms. When these atoms de excite they release photons of light.

What is the speed, v, of each electron leaving the anode in a cathode ray?

# What is the speed, v, of each electron leaving the anode?

The work done on each electron by the potential difference V between the anode and the cathode is eV (e - electron charge).

The kinetic energy of each electron, with speed v, passing through the hole is ½ mv^2

The work done on each electron increases KE at the cathode, then the speed, v, of each electron leaving the anode is given by ½ mv^2=eV
So v= sqrt(2eV/m)

How do you work out the specific charge of an electron?

How do you work out the specific charge of an electron?

*The charge of an electron / the mass of an electron*

Ie. $e/m_e$

State 3 methods used to work out the specific charge of an electron

State 3 methods used to work out the specific charge of an electron

- Using a magnetic field
- Using m = mv / Be
- Using e / m = v / Br

Why must electron tubes be evacuated when working out specific charge?

Why must electron tubes be evacuated when working out specific charge?

So the electrons do not collide with air particles and lose energy in the collisions.

If gas is pumped into a electron tube, why must the pressure be low?

# If gas is pumped into a electron tube, why must the pressure be low?

A low pressure means less molecules which is beneficial because too many gas molecules could disrupt the path of the electrons. This is because the more air particles, the more interaction between them and the electrons. Which could mean the electrons won't be able to travel the whole length of the tube.

Who was Thomson?

## Who was Thomson?

A physicist who conducted experiments to investigate cathode rays, and the particles that are produced. This included him carrying out experiments determining the specific charge of an electron.

Thomson found out that the specific charge of an electrons was how many times larger than the specific charge of an hydrogen ion? And why was the significant?

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1800 times

It was significant because before finding out the specific charge of an electron, Hydrogen ions had the largest known specific charge.

Why was Thomson's experiments important?

## Why was Thomson’s experiments important?

- Showed that electrons were negatively charged.
- Showed that the specific charge of a particle is a characteristic of that type of particle as all electron has the same specific charge.
- The specific charge was very high which showed that an electron had to have little mass.

What was the aim of Millikan's experiments?

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To determine the charge of the electrons.

In Millikan's experiment, what forces are acting on the droplet when it is stationary?

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Gravity and an electric force which is equal and opposite to the gravitational force.

i.e. $mg=QV/d$

In Millikan’s experiments, explain the journey of a falling droplet when there is no electric field?

In Millikan’s experiments, explain the journey of a falling droplet when there is no electric field?

The droplet will begin falling and accelerating as it does the drag acting on it will increase. Eventually the weight will equal drag force and the droplet  will fall at **terminal velocity.**

What is Stokes’ law?

What is Stokes' law?

$$F = 6\pi\eta rv$$

Which is used to work out the force on a droplet due to drag.

How is Stoke's law used to work out the radius of the droplet?

## How is Stoke's law used to work out the radius of the droplet?

- As the droplet is moving at terminal velocity the forces acting on it will balance.
- Therefore → $6\pi\eta rv = mg$
- We assume the droplet is a sphere which would suggest its volume is $4\pi r^3/3$
- Mass = density($\rho$) /volume so $6\pi\eta rv = \rho \times g /(4\pi r^3/3)$
- Which if you rearrange you get $\mathbf{r^2 = 9\eta v /2\rho g}$

How did Millikan use the value of the radius to determine the charge of an electron?

How did Millikan use the value of the radius to determine the charge of an electron?

He used the radius to determine the mass of the droplets. That way he could calculate the weight of a droplet. He then know the pd required for an object to remain stationary. Therefore the charge could be worked out using QV/d = mg

How did Millikan cause the droplet to move down from stationary in the presence of an electric field?

How did Millikan cause the droplet to move down from stationary in the presence of an electric field?

Milikan decreased the pd which would have reduced the electric field. Therefore unbalancing the forces and making the resultant force on the object act downwards.

Why was Millikan's experiments significant?

# Why was Millikan's experiments significant?

It helped him to conclude that charge of an electron, by assuming that the charge on each droplet would be a multiple of the charge of an electron. He found the common factor between the different charges found that there were no charges less than approx $1.6 \times 10^{-19}$ Millikan showed that the charge on all material is quantised.