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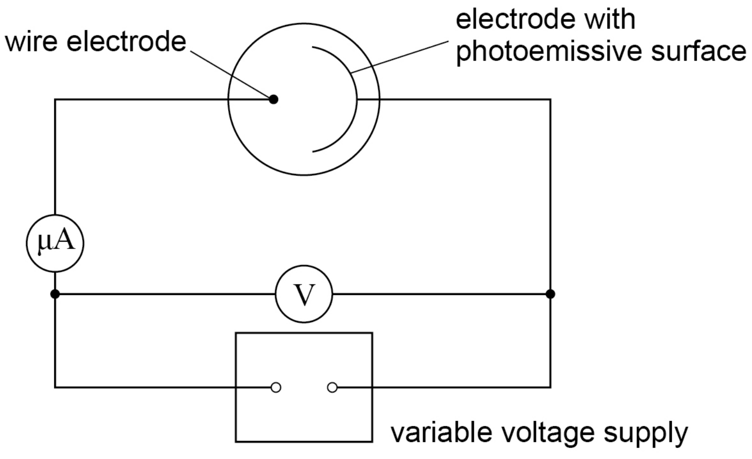
0 2 **Figure 1** shows an arrangement used to investigate the photoelectric effect.

Figure 1



A current is measured on the microammeter only when electromagnetic radiation with a frequency greater than a certain value is incident on the photoemissive surface.

0 2 . 1 Explain why the frequency of the electromagnetic radiation must be greater than a certain value.

[2 marks]

Current is caused by electrons in the photoemissive material gaining enough energy to overcome the work function of the metal and hence leave the surface of the metal.

For this to happen the energy of the incoming photos must be greater than this work function.

Since energy of a photo is E=hf then this means that the hihger the frequency the greater the photon energy.

Since photon E> work function there must be a a minimum, or threshold, frequency

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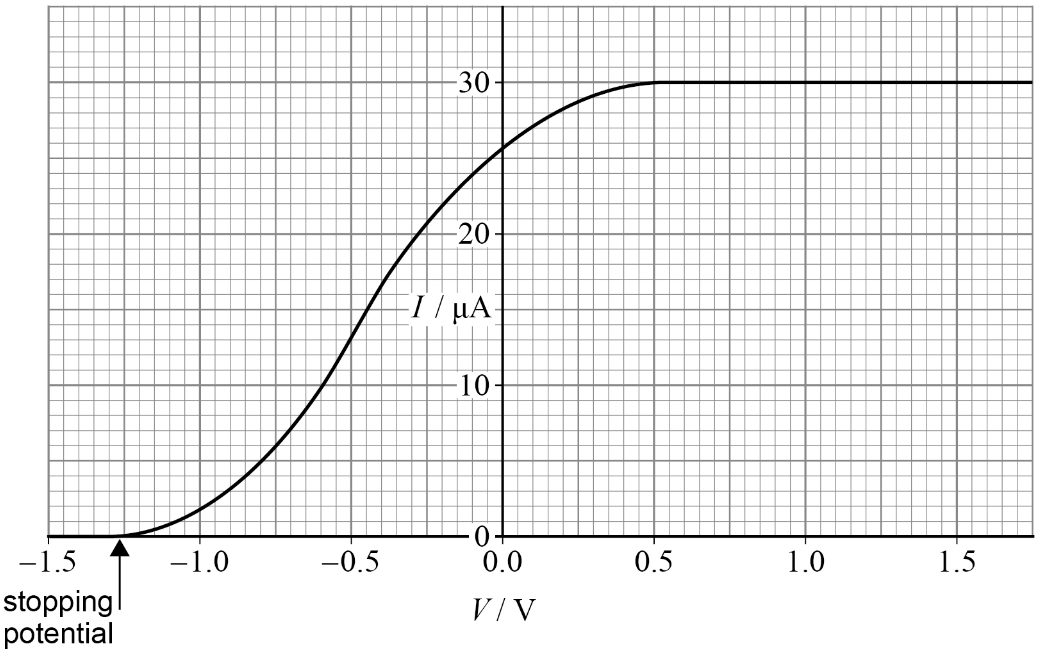
The apparatus in **Figure 1** is used with a monochromatic light source of constant intensity. Measurements are made to investigate how the current I in the microammeter varies with positive and negative values of the potential difference V of the variable voltage supply.

Figure 2 shows how the results of the investigation can be used to find the stopping potential.

Figure 2



0 2 . 2 Determine the number of photoelectrons per second leaving the photoemissive surface when the current is a maximum.

[2 marks]

I = 30µA = 30 × 10⁻⁶ C/s $q_e = 1.6 \times 10^{-19}$ C

∴ no of electrons is $\frac{30 \times 10^{-6}}{1.6 \times 10^{-19}}$ /s

number of photoelectrons per second = 1.9×10^{14}

Question 2 continues on the next page

Turn over ▶

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0 2 . 3 Explain why I reaches a constant value for positive values of V.

[2 marks]

Photoelectrons are emitted form the surface in a range of directions and speeds. Some will therefore miss the left hand electrode. However, as the pd is increased then the attractive force between these electrons and the lhs electrode increases and some electrons that would miss the electrode now hit it, and so the current increases. Eventfully all the emitted electrons hit the opposite electrode and so we have a maximum current

0 2 . 4 Explain why I decreases as the value of V becomes more negative.

[3 marks]

As the pd becomes more negative so there is an increasing repulsive force between the electrons and the electrode and some e- wont arrive at said electrode. Eventually the repulsive force increases to a point where there is no current as no photoelectrons arrive at the cathode.

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0 2 . 5 The investigation is repeated with a different photoemissive surface that has a smaller value of the work function. The source of electromagnetic radiation is unchanged.

Discuss the effect that this change in surface has on the value of the stopping potential.

[3 marks]

hf=Ekmax+Φ
So if Φ decreases then for a given hf (which we have as the e/m is unchanged) the Ekmax will increase and so will the stopping potential

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Turn over for the next question

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0 8 A photon has energy of 1×10^{18} eV.
An object of mass 0.03 kg has kinetic energy equal to the energy of the photon.

What is the speed of the object?

[1 mark]

A 1 m s^{-1} ○

B 3 m s^{-1} ○

C 10 m s^{-1} ○

D 30 m s^{-1} ○

0 9 A deuterium nucleus and a tritium nucleus fuse together to produce a helium nucleus and particle **X**.

$$^{2}_{1}\text{H} + ^{3}_{1}\text{H} \rightarrow ^{4}_{2}\text{He} + \mathbf{X}$$

What is **X**?

[1 mark]

A an electron ○

B a neutron ○

C a positron ○

D a proton ○

1 0 The radioactive nuclide $^{232}_{90}\text{Th}$ decays by one α emission followed by two β^{-} emissions.

Which nuclide is formed as a result of these decays?

[1 mark]

A $^{238}_{92}\text{U}$ ○

B $^{230}_{90}\text{Th}$ ○

C $^{228}_{90}\text{Th}$ ○

D $^{228}_{88}\text{Rn}$ ○