OCR
Oxford Cambridge and RSA

A Level Physics A

H556/02 Exploring physics

Question Set 6

1(a) Electromagnetic radiation is incident on a negatively charged zinc plate. Electrons are emitted from the surface of the plate when a weak intensity ultraviolet source is used. Electrons are not emitted at all when an intense visible light from a lamp is used.

Explain these observations. **[4]**

- Photons from the EM radiation have one-to-one interactions with the excess electrons on the zinc plate.
- Unless the energy of a photon (which is a function of the frequency - $E = hf$) is greater than the work function of the zinc, then an electron will not be emitted.
- This is why visible photons emits no electrons - their frequency and hence their energy is too low, lower than the work function. UV, with higher f, has an $E >$ work function.
- The energy of photons is independent of intensity

(b) The **maximum** wavelength of the electromagnetic radiation incident on the surface of a metal which causes electrons to be emitted is 2.9×10^{-7} m.

Calculate the maximum kinetic energy of electrons emitted from the surface of the metal when each incident photon has energy of 5.1 eV.

- $E = \phi + KE_{MAX}$

$$\phi = \text{work function} = \frac{hc}{\lambda_{MAX}} = \frac{6.63 \times 10^{-34} \times 3 \times 10^{8}}{2.4 \times 10^{-7}} = 6.86 \times 10^{-19} \text{ J}$$

$$KE_{MAX} = E - \phi = (5.1 \times 1.6 \times 10^{-19}) - 6.86 \times 10^{-19} = 1.30 \times 10^{-19} \text{ J}$$

maximum kinetic energy = 1.3×10^{-19} J **[3]**

(c) Electromagnetic radiation of constant wavelength is incident on a metal plate. Photoelectrons are emitted from the metal plate. Fig. 19.1 shows an arrangement used to determine the maximum kinetic energy of electrons emitted from a metal plate.

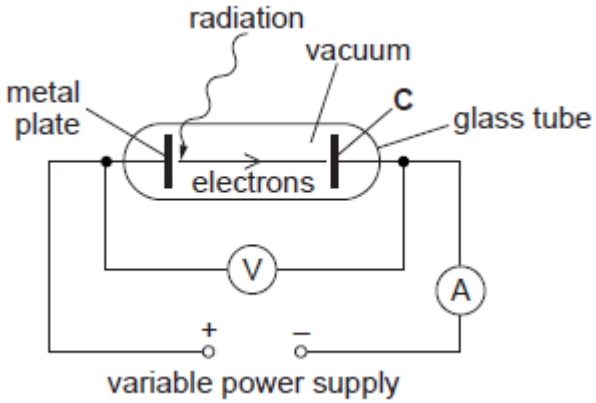

Fig. 19.1

The metal plate and the electrode **C** are both in a vacuum. The electrode **C** is connected to the negative terminal of the variable power supply.
Fig. 19.2 shows the variation of current I in the circuit as the potential difference V between the metal plate and **C** is increased from 0 V to 3.0 V.

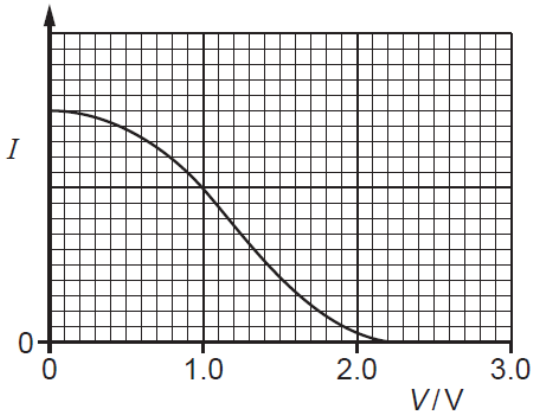

Fig. 19.2

Explain why the current decreases as V increases and describe how you can determine the maximum kinetic energy of the emitted electrons. **[3]**

- As V increases, C gains a negative charge and hence repels electrons
- Because the emitted electrons have a range of speeds, at low Vs C repels the slowest electrons and I drops
- Eventually by 2.2V, the charge on C is enough to repel all electrons and I drops to 0.
- KE_{max} has been transferred to work against charge, so $KE_{max} = eV_{max} = 2.2$ eV

Total Marks for Question Set 6: 10