



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.

$$E = \phi + KE_{\max}$$

$$\phi = \text{work function} = \frac{hc}{\lambda_{\max}} = \frac{6.63 \times 10^{-34} \times 3 \times 10^8}{2.9 \times 10^{-7}} = 6.86 \times 10^{-19} \text{ J}$$

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

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.

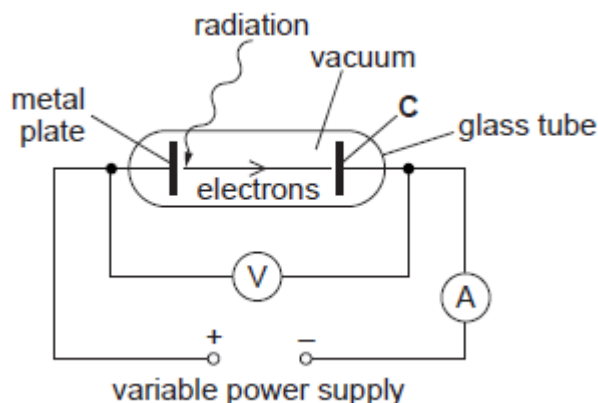


Fig. 19.1

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 0V to 3.0V.

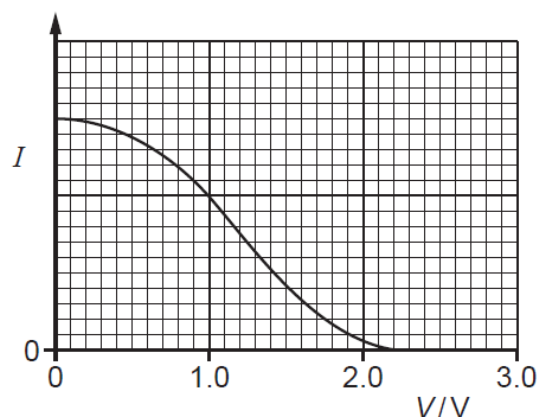


Fig. 19.2

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 V s **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 $KE_{max} = eV_{max} = 2.2 \text{ eV}$

Total Marks for Question Set 6: 10

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