**1** A photon of wavelength 640 nm is incident on a metal surface. The work function of the metal is 3.70 eV.

**a** Calculate the energy of the photon in eV

**b** Explain what happens to the photon when it strikes the metal surface given a photoelectron is emitted.

**c** Explain any assumptions you have made in your explanation.

**2** Ultraviolet light of wavelength 250 nm is incident on a metal surface. If the photoelectron emitted has kinetic energy 0.63 eV, identify the type of metal used from the table below.

| Work function / eV | Type of metal |
|---|---|
| 3.70 | Mg |
| 4.30 | Al |
| 4.32 | Ag |

**3** The threshold frequency of a metal is $8.97 \times 10^{14}$ Hz. Light of wavelength 300 nm is incident on the metal surface.

**a** What does the threshold frequency explain about the way the metal behaves?

**b** Write down Einstein's photoelectric equation

**c** Explain how the threshold frequency can be used to calculate the work function for the metal. Calculate the work function in eV for this metal.

**d** Calculate the energy of the incident photon in eV.

**e** Find the maximum kinetic energy of the photoelectrons emitted from the surface of the metal in eV.

**f** A stopping potential is applied to the metal in order to just stop electrons leaving the surface. Find the value of the stopping potential $V_S$ required to achieve this.

(all calculations to 3 sf please)

**4** Photoelectrons are emitted from a metal surface when light of wavelength 400 nm is incident on the surface. If the maximum speed of the photoelectrons is $2.22 \times 10^5$ $ms^{-1}$,

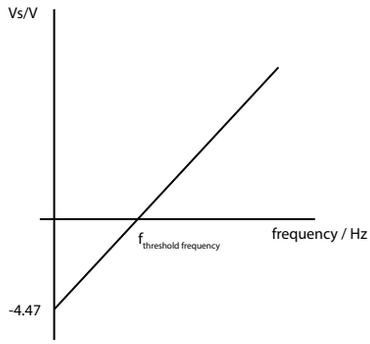
**a** find the maximum kinetic energy of the photoelectrons in J

**b** find the stopping potential required to just stop the photoelectrons being emitted from the surface.

**c** why don't all photoelectrons leave the metal surface with maximum possible kinetic energy?

(mass of electron is $9.11 \times 10^{-31}$ kg)

**5** The graph shows the results from a photocell with a zinc photocathode.




Given the wavelength of light that just starts to produce photoelectrons from the surface of zinc is 278 nm

**a** find the threshold frequency of light causing photoelectrons to emitted from zinc

**b** calculate the gradient of the graph

**c** Give an equation for the line based on Einstein's photoelectric equation

**d** Show how the gradient of the graph can be used to estimate a value for Planck's constant.

**e** Calculate Planck's constant from the gradient of the graph.

(fundamental unit of charge is $1.6 \times 10^{-19}$ C)

**6** A photocell produces a current of 0.6 μA when light of wavelength 590 nm is incident on the surface delivering 0.5 mW of light energy to the photocell.

**a** Calculate the charge following from the anode every second in C.

**b** Calculate the number of photoelectrons emitted from the surface of the metal every second.

**c** For the light incident on the anode, calculate the photon energy in J.

**d** Calculate the number of photons incident on the surface every second.

**e** Calculate the efficiency of the photocell in converting photons into photoelectrons

The intensity of the light source is doubled but the wavelength of the light remains the same.

**f** What happens to the number of photons incident on the surface per second?

**g** What happens to the number of photoelectrons incident on the surface per second?

**h** What happens to the maximum speed of the photoelectrons emitted from the surface compared to the first experiment?