

- 1 (a) A student uses a computer for an average of 5 hours every day. The battery supplies a current of 3.5 A to the computer.

Calculate how many electrons flow through the computer's battery in 5 hours.

(4)

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Number of electrons

- (b) The computer's screen emits visible light photons with an average frequency of 5.5×10^{14} Hz. The power of the light emitted is 10 W.

Calculate the number of photons emitted per second from the computer screen.

(3)

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Number of photons

(Total for Question 7 marks)

2 Ultraviolet radiation incident on a zinc plate releases electrons from the zinc's surface. The energy of each incident photon is 5.4 eV. Zinc has a work function of 4.3 eV.

(a) (i) State the name given to this effect.

(1)

(ii) State the speed of the photons.

(1)

(iii) What is meant by the work function of a metal?

(1)

(b) An electron is emitted from the surface of the zinc.

(i) Calculate the maximum kinetic energy of the electron in joules.

(3)

Maximum kinetic energy

(ii) Calculate the maximum speed of the electron.

(2)

Maximum speed

(c) The intensity of the ultraviolet radiation is doubled.

State what happens to the maximum speed of an electron emitted from the zinc.

(1)

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(Total for Question 9 marks)

*3 In 1921, Albert Einstein won the Nobel Prize for his work on the photoelectric effect.

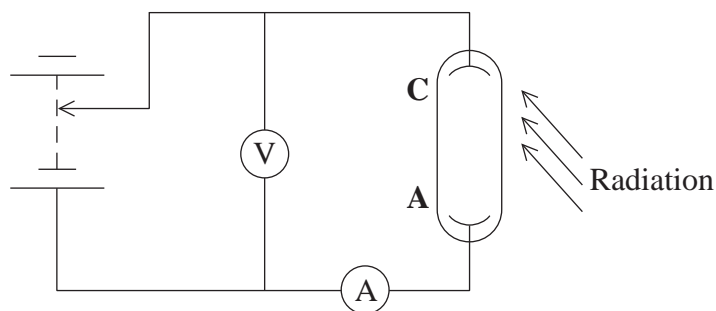
The results of experiments on the photoelectric effect show that:

- photoelectrons are not released when the incident radiation is below a certain threshold frequency;
- the kinetic energy of the photoelectrons released depends on the frequency of the incident light and not its intensity.

Explain how these results support a particle theory, but not a wave theory of light.

(Total for Question = 6 marks)

4 The diagram shows the apparatus for an experiment on the photoelectric effect.



- (a) A light is shone onto the cathode **C** and a potential difference is applied between the cathode and the anode **A** of the photocell. A sensitive ammeter is used to detect any current that flows.

The light is replaced by one of the same intensity, but a different photon energy. The results are shown in the table below.

	Photon energy/eV	Intensity of light/W m⁻²	Work function/eV	Ammeter reading/A
First light	1.8	1.0	2.3	0.0
Second light	3.8	1.0	2.3	5.0×10^{-12}

Explain why the first ammeter reading is zero.

(2)

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- (b) The experiment is repeated using the same two photon energies but the intensities of the sources are increased. Add the new ammeter readings to the table below.

(2)

	Photon energy/eV	Intensity of light/W m⁻²	Work function/eV	Ammeter reading/A
First light	1.8	4.0	2.3	
Second light	3.8	4.0	2.3	

(c) (i) The cathode metal is lithium.

Express the work function of lithium in joules.

Work function of lithium = 2.3 eV

(2)

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Work function = J

(ii) Ultraviolet radiation with photon energy of 4.8×10^{-18} J is shone onto the lithium cathode.

Calculate the maximum speed of the photoelectrons that are emitted.

(4)

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Maximum speed =

(Total for Question = 10 marks)

- 5 In the late 1880s it was discovered that a negatively-charged zinc plate loses its charge when exposed to ultraviolet radiation.

Explain why this happens, but only with ultraviolet radiation and not white light. You are expected to complete a calculation to support your answer.

work function of zinc = 6.9×10^{-19} J

(6)

(Total for Question = 6 marks)

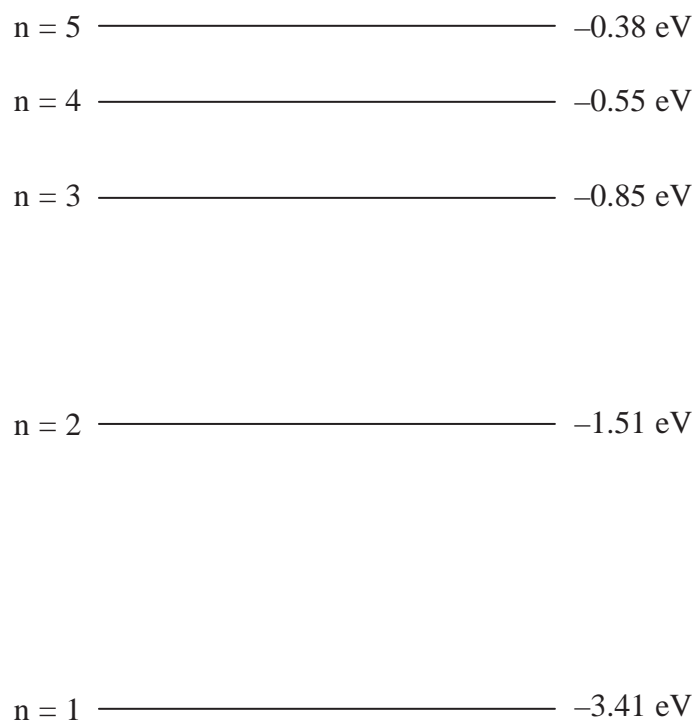
6 Helium was first discovered because of dark lines observed in the continuous spectrum of light from the Sun. The lines were caused by a few specific frequencies of light in the spectrum being present at very much lower intensity than the rest.

Scientists deduced that this was due to an unknown element in the Sun's atmosphere.

(a) Explain how helium in the Sun's atmosphere caused this set of dark lines.

(5)

(b) The diagram shows some of the energy levels for an atom of another element.



(i) Determine which energy levels are associated with photons of frequency 4.6×10^{14} Hz.

(4)

(ii) Suggest why the energy levels all have a negative value.

(2)

(c) Lines such as those described in (a) can be used to determine the motion of stars relative to the Earth.

Suggest how these lines may be used to determine the motion of stars.

(3)

(Total for Question = 14 marks)