PHOTOELECTRIC EFFECT

1. (a) The following equation describes the release of electrons from a metal surface illuminated by electromagnetic radiation.

$$hf = k.e._{\text{max}} + \phi$$

Explain briefly what you understand by each of the terms in the equation.

hf ....

....

$k.e._{\text{max}}$ ....

....

ϕ ....

....

(3)
(Total 3 marks)

2. A 60 W light bulb converts electrical energy to visible light with an efficiency of 8%. Calculate the visible light intensity 2 m away from the light bulb.

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....

....

Intensity = ...

(3)

The average energy of the photons emitted by the light bulb in the visible region is 2 eV. Calculate the number of these photons received per square metre per second at this distance from the light bulb.

....

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....

Number of photons = ...m^{-2} s^{-1}

(2)
(Total 5 marks)

3. (a) Describe briefly how you would demonstrate in a school laboratory that different elements can be identified by means of their optical spectra

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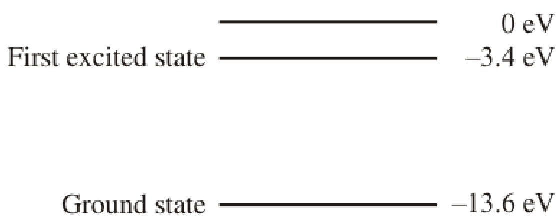
(3)

(b) The diagram below is a simplified energy level diagram for atomic hydrogen.



A free electron with kinetic energy 12 eV collides with an atom of hydrogen and causes is to be raised to its first excited state.

Calculate the kinetic energy of the free electron (in eV) after the collision.

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Kinetic energy = ...

Calculate the wavelength of the photon emitted when the atom returns to its ground state.

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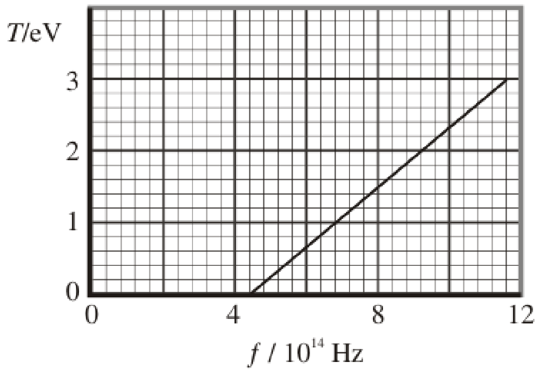
Wavelength = ...

(4)

(Total 7 marks)

4. The graph shows how the maximum kinetic energy T of photoelectrons emitted from the surface of sodium metal varies with the frequency f of the incident radiation.



Why are no photoelectrons emitted at frequencies below 4.4×10^{14} Hz?

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(1)

Calculate the work function Ø of sodium in eV.

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....

....

Work function = ...

(3)

Explain how the graph supports the photoelectric equation $hf = T + Ø$

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....

(2)

How could the graph be used to find a value for the Planck constant?

....

....

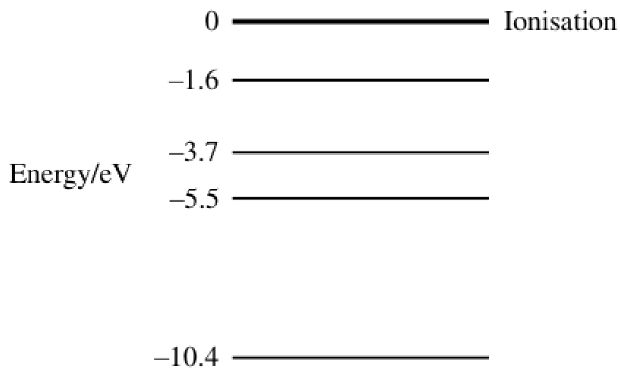
(1)

Add a line to the graph to show the maximum kinetic energy of the photoelectrons emitted from a metal which has a greater work function than sodium.

(2)

(Total 9 marks)

5. The diagram shows some of the outer energy levels of the mercury atom.



Calculate the ionisation energy in joules for an electron in the -10.4 eV level.

....

....

Ionisation energy = ...

(2)

An electron has been excited to the -1.6 eV energy level. Show on the diagram all the possible ways it can return to the -10.4 eV level.

(3)

Which change in energy levels will give rise to a yellowish line (λ = 600 nm) in the mercury spectrum?

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....

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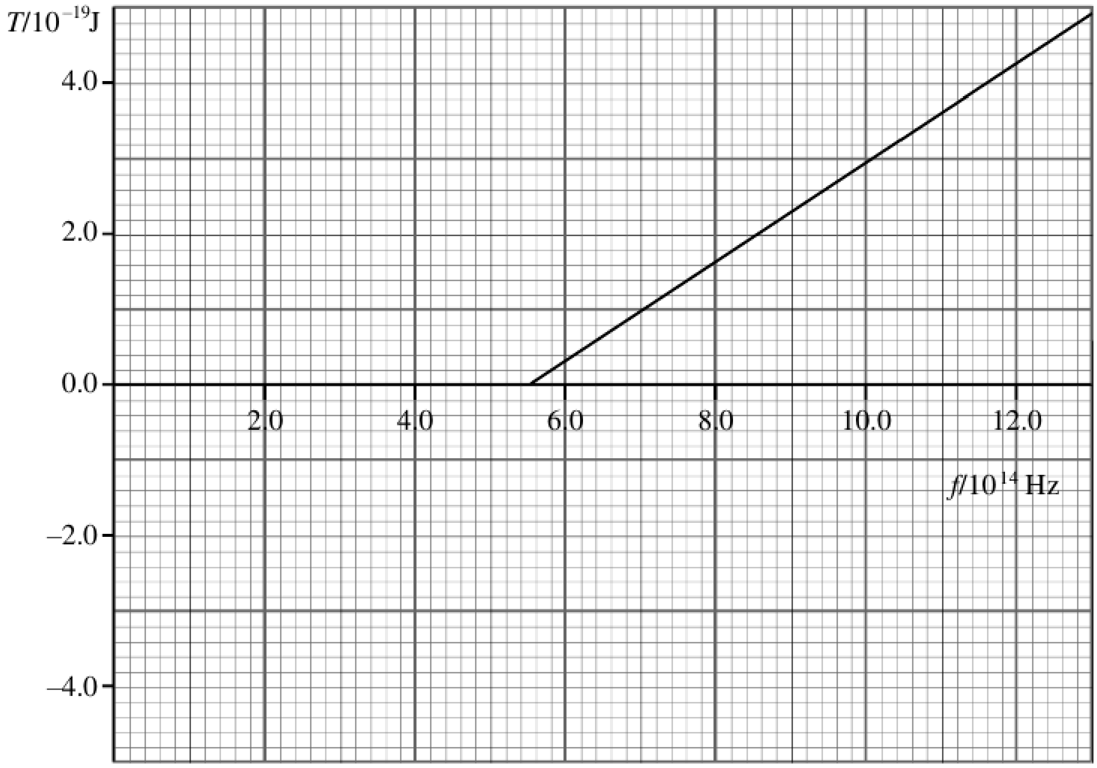
(4)

(Total 9 marks)

6. The graph shows how the maximum kinetic energy T of photoelectrons emitted from the surface of sodium metal varies with the frequency f of the incident electromagnetic radiation.



Use the graph to find a value for the Planck constant.

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....

Planck constant = ...

Use the graph to find the work function ϕ of sodium metal.

Work function = ...

(2)

Calculate the stopping potential when the frequency of the incident radiation is 9.0×10^{14} Hz.

....

Stopping potential = ...