Photons - Questions by Topic

Q1.

*In 1921, Albert Einstein was awarded the Nobel Prize for Physics "for his discovery of the law of the photoelectric effect".

To explain this effect, Einstein proposed that electromagnetic radiation should be modelled as a particle rather than as a wave.

Explain why, when considering the photoelectric effect, treating electromagnetic radiation as a particle is a more successful model than treating electromagnetic radiation as a wave.

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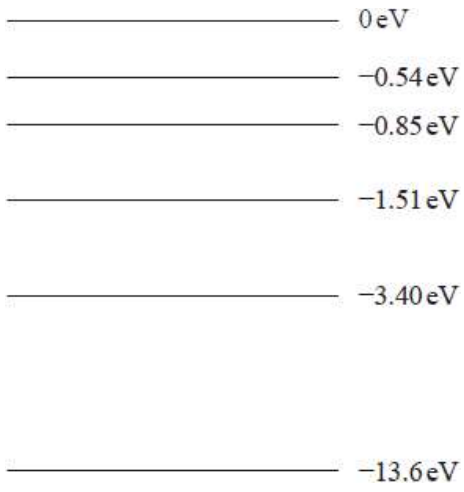
(Total for question = 6 marks)

Q2.

The diagram shows some of the energy levels for an atom of hydrogen.



Determine the transition between energy levels that would result in the release of a photon with a frequency of 7.48×10^{13} Hz.

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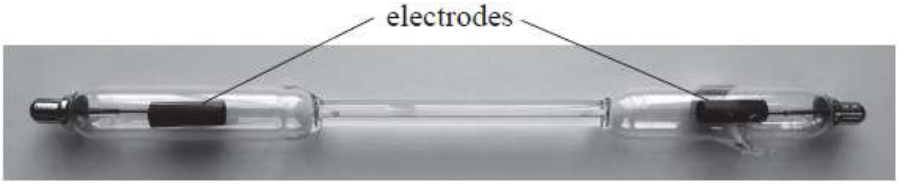
Transition from ..... eV to ..... eV

(Total for question = 3 marks)

Q3.

In 1857, Heinrich Geissler invented the first gas discharge tube. A sodium gas discharge tube is shown.



When a high potential difference is applied between the electrodes, electrons move through the sodium gas in the tube. The electrons collide with the sodium atoms. The tube then gives out visible light with a wavelength of 589 nm.

(a) Describe the process by which visible light is emitted from the sodium atoms.

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(b) Calculate the energy, in eV, of a photon of visible light with a wavelength of 589 nm.

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Photon energy = ... eV

(c) Light from the tube was directed through a diffraction grating, labelled as having

300 lines per mm. The diffraction pattern produced was displayed on a flat screen. The student measured the distance *s* between the central maximum and the first-order maximum on the screen. He also measured the distance *D* from the diffraction grating to the screen.

Determine whether the labelling of the diffraction grating as having 300 lines per mm was correct.

s = 0.234 m
D = 1.30 m
λ = 589 nm

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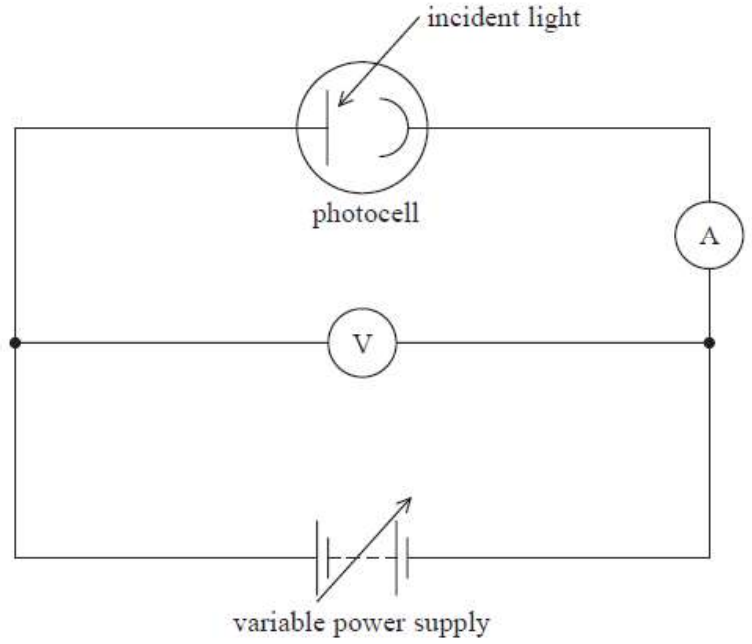
(Total for question = 9 marks)

Q4.

Photocells make use of the photoelectric effect. The following circuit can be used to determine the work function of a metal used in a photocell.



(a) State what is meant by the work function of a metal.

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(b) This photocell works with ultraviolet light but does not work with visible light.

Explain why.

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(c) An experiment was carried out using this circuit. The potential difference applied to the photocell opposes the movement of the electrons through the photocell, reducing the current.

(i) The variable power supply was initially set at 0 V and the reading on the ammeter was 2.4 μA.

The intensity of the ultraviolet light was then increased without changing the frequency.

Explain what happened to the reading on the ammeter.

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(ii) The variable power supply was adjusted until the reading on the ammeter became 0 μA. The reading on the voltmeter was 3.59 V.

Calculate the work function, in joules, of the metal used in the photocell.

frequency of ultraviolet used = 2.00×10^{15} Hz

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Work function = ... J

(Total for question = 10 marks)

Q5.

When the photoelectric effect occurs, light incident on the surface of a metal releases electrons.

Which of the following is an experimental observation of the photoelectric effect?

☒ **A** Electrons are only released after light has been incident for a long time.

☒ **B** Increasing the frequency of the light increases the maximum kinetic energy of the released electrons.

☒ **C** Increasing the intensity of the light increases the maximum kinetic energy of the released electrons.

☒ **D** Only light with a wavelength above a threshold value releases electrons.

(Total for question = 1 mark)