ALL SAINTS' COLLEGE

Year 12 Physics – ATAR
Wave particle duality and quantum physics test
July 2016

Time allowed: 50 minutes
Total marks available: 50
Show calculation answers to 3 significant figures

Student Name:________________________

1. Consider Young's double slit experiment; when a coherent green light source is projected through 2 small slits that are several hundred nanometres apart; an image is produced on a screen.

a) Explain why the image on the screen is regions of light and dark bands.

(2)

b) This indicates that light is behaving as a: *(circle a response)* particle wave

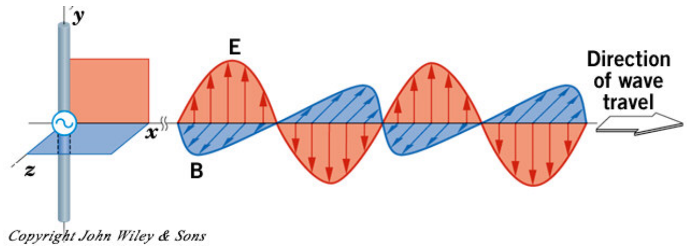
(1)

2. Describe 2 ways that an atom in its ground state can become "excited".

(2)

3. A light wave is often depicted as 2 waves propagating perpendicular to each other. Explain the meaning of the 2 waves in this diagram.

(2)



4. Consider the photoelectric effect. Blue light of wavelength 445 nm shines on a metal whose work function is 1.80 eV.

a) Calculate the maximum kinetic energy of the ejected electrons.

(3)

b) Red light of wavelength 770 nm is shone onto the same metal. Will the photoelectric effect occur in this instance? Explain briefly.

(4)

5. A green light emitting diode (LED) emits monochromatic light with a wavelength of 532 nm. The LED has a power rating of 40.0 mW.

a) Calculate the photon energy of the LED.

(2)

b) Calculate how many photons are emitted when the LED illuminates for 180 milliseconds.

(3)

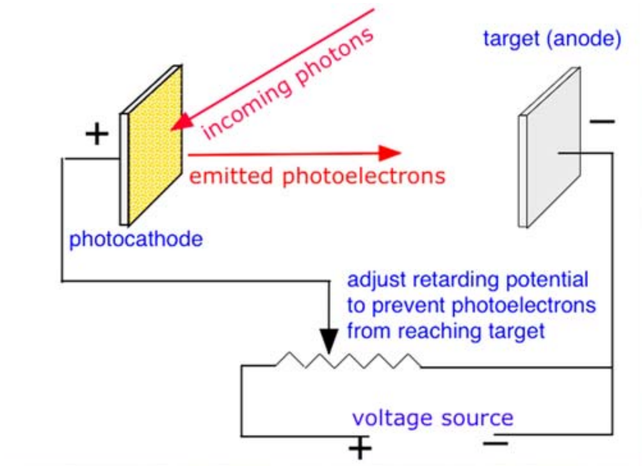
c) If the LED had the same power rating but was blue instead of green how many photons would it emit in comparison? Circle a response

(1)

Greater number Same number Lesser number Impossible to know

Continued on next page

6. Some students conduct an experiment with the photoelectric effect equipment shown in the diagram. Yellow light of wavelength 555 nm is shone onto the photocathode and current flows. They adjust the voltage source to find the stopping voltage that prevents photoelectrons reaching the anode. This occurs at -0.61 V.



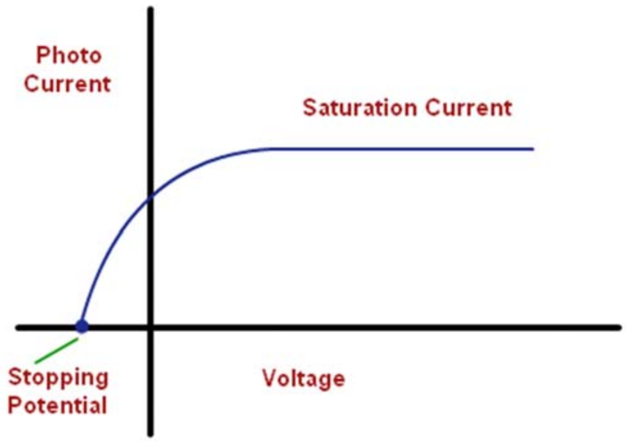
a) Calculate the speed of the fastest moving electrons when they are emitted from the cathode.

(3)

b) Calculate the work function of the metal stating your answer in eV.

(3)

The students plot a curve of photocurrent versus voltage for the yellow light and obtain the curve below.



c) Explain why the curve flattens on the section labelled “saturation current”.

(2)

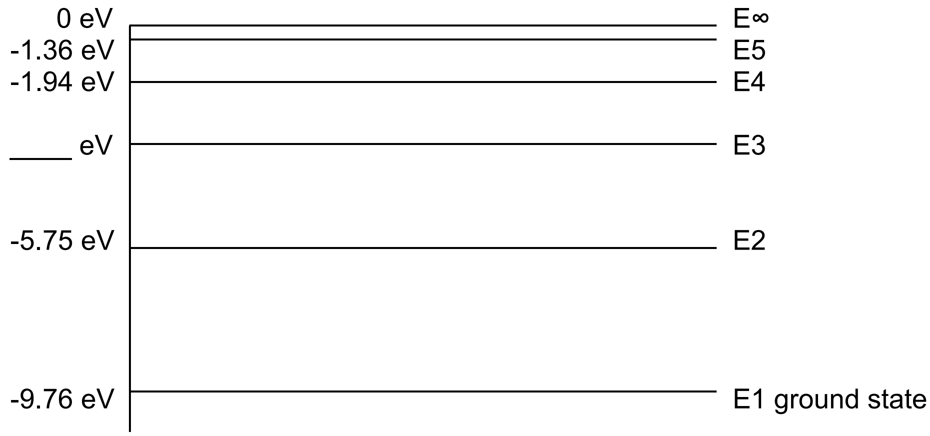
d) On the graph above, sketch the approximate shape of the curve if the yellow light is halved in intensity and label it “half intensity”.

(1)

e) On the graph above, sketch the approximate shape of the curve obtained if indigo light at a higher intensity is used instead of yellow light. Label this curve “indigo”.

(1)

7. The diagram below details some of the energy levels for the Waugium atom.



a) The ground state atom absorbs a 185 nm photon which causes an excitation to E3. Determine the energy of E3 in electron volts to 3 significant figures.

(4)

b) State the minimum photon energy in eV that could ionise the atom in its ground state.

(1)

c) Which energy level transition is responsible for the longest wavelength (nm) possible in the emission spectrum of Waugium as the ionised electron returns to its ground state?

(1)

d) Which area of the electromagnetic spectrum does a 185 nm photon belongs to? *(Remember that the SCSA F&C sheet is a rough guide only).*

(1)

e) An atomic electron is at E5. How many lines in the emission spectrum would be possible for the energy levels considered above if it returns to the ground state?

(1)

Number of lines =

f) A **single** Waugium atom in the ground state is bombarded by **one** electron of kinetic energy of 4.50 eV. Detail in the table below the possible photon energies observable on de-excitation and the possible bombarding electron energy after passing through the Waugium atom.

(2)

Possible photon energies on de-excitation (eV)	Bombarding electron energy after colliding with atomic electron (eV)

g) Can the ground state atom absorb a 7.88 eV photon? Explain briefly.

(1)

h) Can the ground state atom absorb a 14.8 eV photon? Explain briefly.

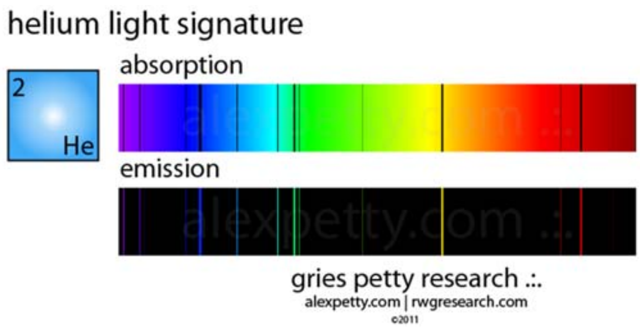
(1)

Continued on next page

8. A proton is travelling at 85% of the speed of light. Calculate the de Broglie wavelength of the proton. (momentum = mass x velocity)

(3)

9. The diagram shows an absorption spectrum for helium when viewed through a spectroscope. Black lines are shown on an otherwise continuous background. Explain how this absorption spectrum is formed.



(3)

10. Calculate the momentum of a 622 nm orange photon.

(2)

End of test