St. Mary's Anglican Girls' School

90

Year 12

Atomic Physics

Test

2008

Constants
See Constants Sheet

Name _____

Marks _____/ **44**

Instructions
- Please state all answers accurate to **three significant figures**.
- Please show **all** working to obtain **all** marks.

1. Light is said to exhibit dual properties in that it has both wave like and particle like behaviour.

a) Describe two examples of the wave like behaviour of light.

(2 mark)

_____

_____

b) Describe one example of the particle like behaviour of light.

(1 mark)

_____

2. For each of the following, name a major region(s) of the electromagnetic spectrum associated with the below situations …

a) Will cause fluorescence.

(1 mark)

_____

b) Emitted by hot objects.

(1 mark)

_____

c) Can pass through lead.

(1 mark)

_____

d) Is used for satellite communication.

(1 mark)

_____

e) Can be diffracted by a hill.

(1 mark)

_____

f) Can be used to kill bacteria.

(1 mark)

_____

3. Explain the following using hydrogen gas as the example substance being "excited",

a) Describe what is meant by an energy level.

(2 marks)

b) Explain how the hydrogen line emission spectrum is produced.

(3 marks)

c) Explain how an atom of hydrogen can be ionised.

(2 marks)

4. An electron is moving east at 5.00×10^3 m/s inside your television after you turn it on. The electron passes through a magnetic flux density of 8.00×10^{-5} T acting out of the page.

a) Draw a diagram of this situation and mark on the diagram the direction of the force.

(2 marks)

b) What is the magnitude of the force acting on the electron?

(2 marks)

c) What is the acceleration of the electron?

(1 mark)

d) What is the radius of curvature of the electron?

(2 marks)

5. An electron collides with an atom in the ground state and causes it to become excited. The atom then releases a single photon of wavelength 0.200 μm.

a) What is the "colour" of the wavelength produced? Support your answer with calculations and logic.

(2 marks)

b) If the excited electron falls from an energy level of -6.70×10^{-19} J to the ground state to create the 0.200 μm photon, what is the energy of the ground state level in electron volts?

?

(3 marks)

c) What minimum frequency of light is required to ionise this atom.

(2 marks)

6. What type of spectrum is produced by the following situations? Explain

a) Electrons are passed in a stream through an elemental gas.

(1 mark)

_____

b) A solid is heated strongly up until it glows.

(1 mark)

_____

c) White light which has passed through a solution of copper sulphate is analysed.

(1 mark)

_____

d) Light from the sun passes through the earth's atmosphere before being analysed.

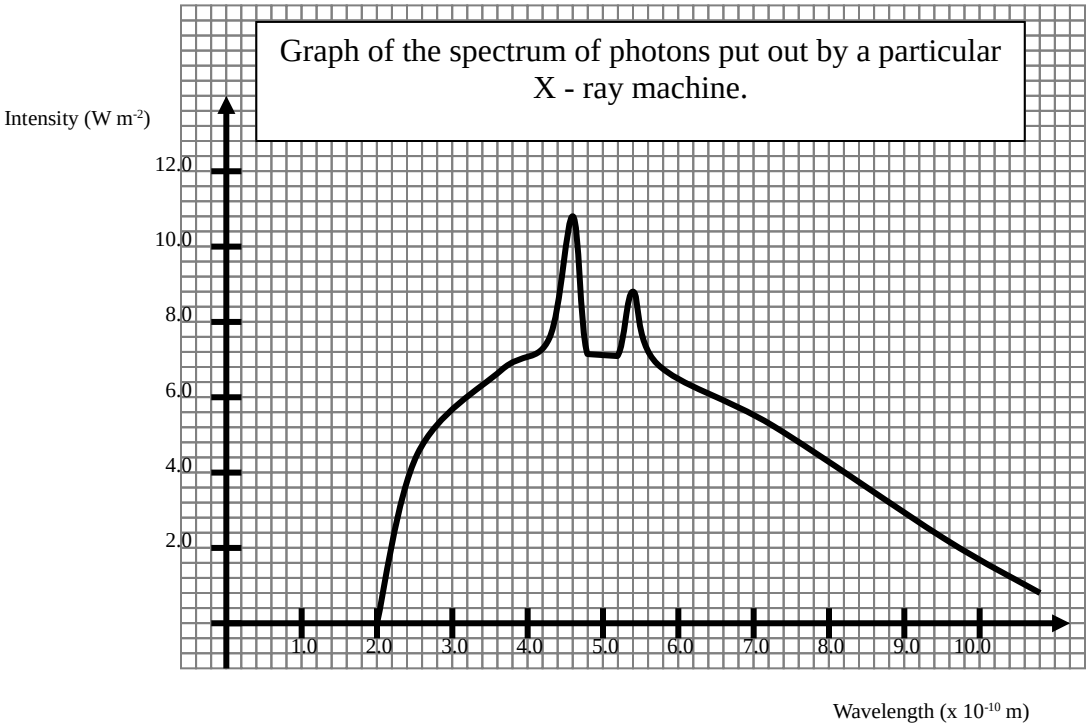
(1 mark)

_____

7. An atom has lost two electrons to form an ion. The ion is travelling at 10.0 % of the speed of light before entering a uniform magnetic field at right angles. The ion travels in a half circle of diameter 42.2 cm in the magnetic field. If the speed of the particle is now halved, the magnetic field strength doubled and an extra electron is removed from the ion, what is the new radius of curvature?

(4 marks)

8.



a) What is the accelerating voltage that has produced the following X - ray graph?

(2 marks)

b) What has caused the peaks in the graph?

(2 marks)

9. A geologist is testing a rock to see if it contains any phosphorescent chemicals. Describe how the geologist should test the rock and the results that would confirm or refute the presence of phosphorescent chemicals.

(2 marks)

End of Test

St. Mary's Anglican Girls' School

Year 12

Atomic Physics

Test

Answers

2008

Constants
See Constants Sheet

Name _____

Marks _____/ **44**

Instructions
- Please state all answers accurate to **three significant figures**.
- Please show **all** working to obtain **all** marks.

1. Light is said to exhibit dual properties in that it has both wave like and particle like behaviour.

a) Describe two examples of the wave like behaviour of light.

(2 mark)

Reflection, Refraction, Diffraction, etc

NOT PHOTOELECTRIC EFFECT

b) Describe one example of the particle like behaviour of light.

(1 mark)

Photoelectric effect, Reflection.

2. For each of the following, name a major region(s) of the electromagnetic spectrum associated with the below situations …

a) Will cause fluorescence.

(1 mark)

Ultraviolet

b) Emitted by hot objects.

(1 mark)

Infra red

c) Can pass through lead.

(1 mark)

Gamma

d) Is used for satellite communication.

(1 mark)

Radio waves or microwaves

e) Can be diffracted by a hill.

(1 mark)

Radio waves or microwaves

f) Can be used to kill bacteria.

(1 mark)

Ultra violet or X-rays

3. Explain the following using hydrogen gas as the example substance being "excited",

a) Describe what is meant by an energy level.

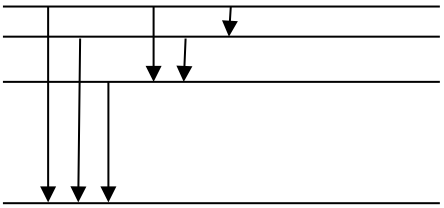
(2 marks)

Electrons orbit at various distances from the nucleus of an atom. Electrons orbiting closer to an atom have less potential energy that electrons probing further out. An energy level is the potential energy that an electron possesses when it is in a particular orbit around an atom.

b) Explain how the hydrogen line emission spectrum is produced.

(3 marks)

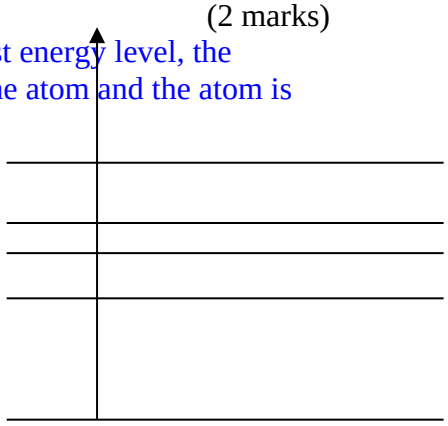
When excited electrons within the energy level system fall downwards though various levels until there are as close to the nucleus as there is a space available, this results in photons of light being given off. Each photon of light has a characteristic colour or frequency depending n the difference between the energy levels. These photons of light are passed thought a glass prism to disperse them due to the differences in refractive index. This results in different lines of light forming on a dark screen. We call this a line emission spectrum.



c) Explain how an atom of hydrogen can be ionised.

(2 marks)

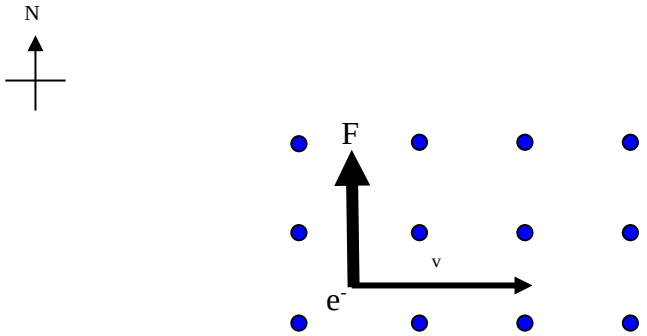
When an atom of hydrogen receives more energy than the lowest energy level, the electron in the ground state has enough energy to escape from the atom and the atom is said to be ionised.



4. An electron is moving east at 5.00 x 10^3 m/s inside your television after you turn it on. The electron passes through a magnetic flux density of 8.00 x 10^{-5} T acting out of the page.

a) Draw a diagram of this situation and mark on the diagram the direction of the force.

(2 marks)



b) What is the magnitude of the force acting on the electron?

(2 marks)

F = q v B

F = 1.6 x 10^{-19} x 5 x 10^3 x 8 x 10^{-5}

F = 6.40 x 10^{-20} N

c) What is the acceleration of the electron?

(1 mark)

F = ma

6.40 x 10^{-20} = 9.11 x 10^{-31} x a

a = 7.03 x 10^{10} m/s^2 towards centre of circle

d) What is the radius of curvature of the electron?

(2 marks)

r = mv / qB

r = 9.11 x 10^{-31} x 5 x 10^3 / 1.6 x 10^{-19} x 8 x 10^{-5}

r = 3.56 x 10^{-4} m

5. An electron collides with an atom in the ground state and causes it to become excited. The atom then releases a single photon of wavelength 0.200 μm.

a) What is the "colour" of the wavelength produced? Support your answer with calculations and logic.

(2 marks)

$c = \lambda f$

$f = 3 \times 10^{8} / 0.2 \times 10^{-6}$

$f = 1.5 \times 10^{15}$ Hz

f > 7 x 10^14 Hz and so is not visible and is in the Ultra Violet range.

b) If the excited electron falls from an energy level of -6.70×10^{-19} J to the ground state to create the 0.200 μm photon, what is the energy of the ground state level in electron volts?

(3 marks)

Energy of ground state = -6.70×10^{-19} + energy of photon

Energy of ground state = $-6.70 \times 10^{-19} + -(6.63 \times 10^{-34} \times 3 \times 10^{8} / 0.2 \times 10^{-6})$

Energy of ground state = -1.6645×10^{-18} J

Energy (eV) = -10.4 eV

c) What minimum frequency of light is required to ionise this atom.

(2 marks)

Energy = h f

f = Energy / h

f = $1.664 \times 10^{-18} / 6.63 \times 10^{-34}$

f = 2.51 x 10 15 Hz

6. What type of spectrum is produced by the following situations? Explain

a) Electrons are passed in a stream through an elemental gas.

(1 mark)

Line Emission Spectra.

b) A solid is heated strongly up until it glows.

(1 mark)

Continuous emission spectra

c) White light which has passed through a solution of copper sulphate is analysed.

(1 mark)

Band Absorption Spectra

d) Light from the sun passes through the earth's atmosphere before being analysed.

(1 mark)

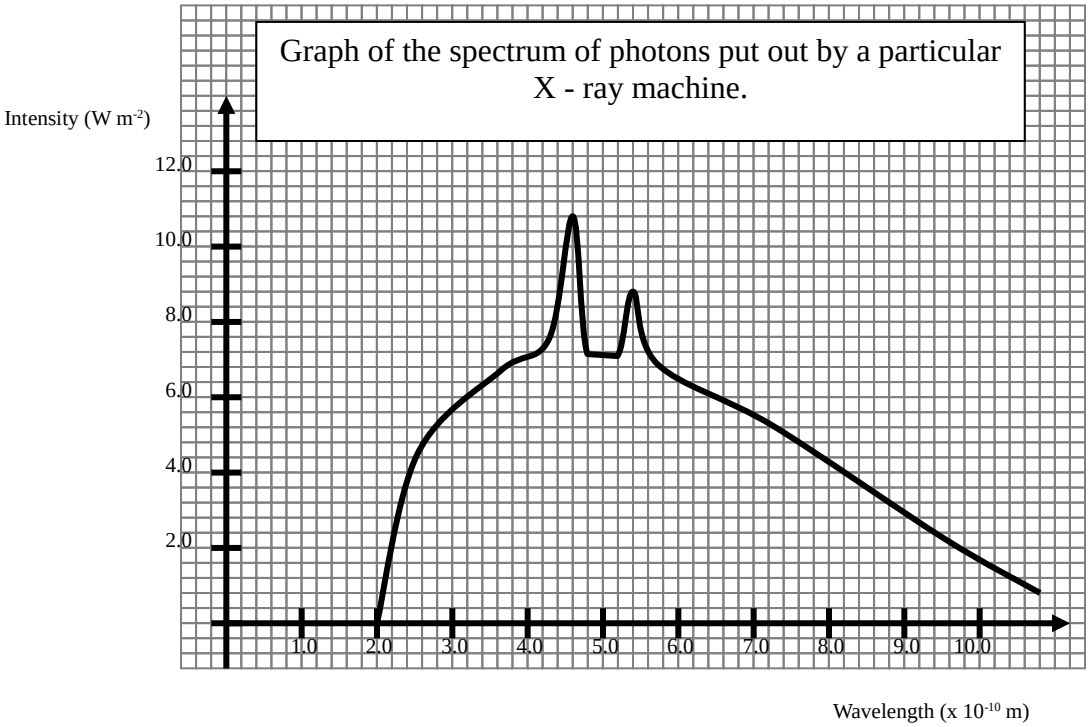
Line absorption spectra or line and band absorption spectra.

7. An atom has lost two electrons to form an ion. The ion is travelling at 10.0 % of the speed of light before entering a uniform magnetic field at right angles. The ion travels in a half circle of diameter 42.2 cm in the magnetic field. If the speed of the particle is now halved, the magnetic field strength doubled and an extra electron is removed from the ion, what is the new radius of curvature?

(4 marks)

Before	After
$v = 3 \times 10^{7}$ m/s $q = 2 \times 1.6 \times 10^{-19}$ C $r = 21.1$ cm $= 21.1 \times 10^{-2}$ m $r = m v / q B$ $21.1 \times 10^{-2} = (m v / q B)$	Modified $r = n^{o} \times 21.1 \times 10^{-2} = (m v / q B) \times (½ \times 2 / 2 \times 3)$ Modified $r = n^{o} \times 21.1 \times 10^{-2} = (m v / q B) \times (1 / 6)$ Modified $r = 1/6^{o} \times 21.1 \times 10^{-2}$ **New $r = 3.52 \times 10^{-2}$ m**

8.



a) What is the accelerating voltage that has produced the following X - ray graph?

(2 marks)

h c / λ = W = q V

V = h c / q λ

V = 6.63 x 10 $^{-34}$ x 3 x 10^{8} / 1.6 x 10 $^{-19}$ x 2 x 10 $^{-10}$

V = 6.22 x 10^{3} V

b) What has caused the peaks in the graph?

(2 marks)

Inner orbital electrons in the target are dislodged by the bombarding electrons leaving a vacancy. This vacancy is filled by an electron falling form an excited stated resulting in an X-ray being produced.

9. A geologist is testing a rock to see if it contains any phosphorescent chemicals. Describe how the geologist should test the rock and the results that would confirm or refute the presence of phosphorescent chemicals.

(2 marks)

Expose the rock or visible light (or higher) that is capable of exciting the electrons in the chemicals of the rock into higher energy states. Then place the rock into a room with no light and see if it is glowing. If it is it is due to phosphorescence. If it is not the rock is not phosphorescent.

End of Test