Name of the Student:_____
Max. Marks : 18 Marks **Time : 18 Minutes**

Q1.

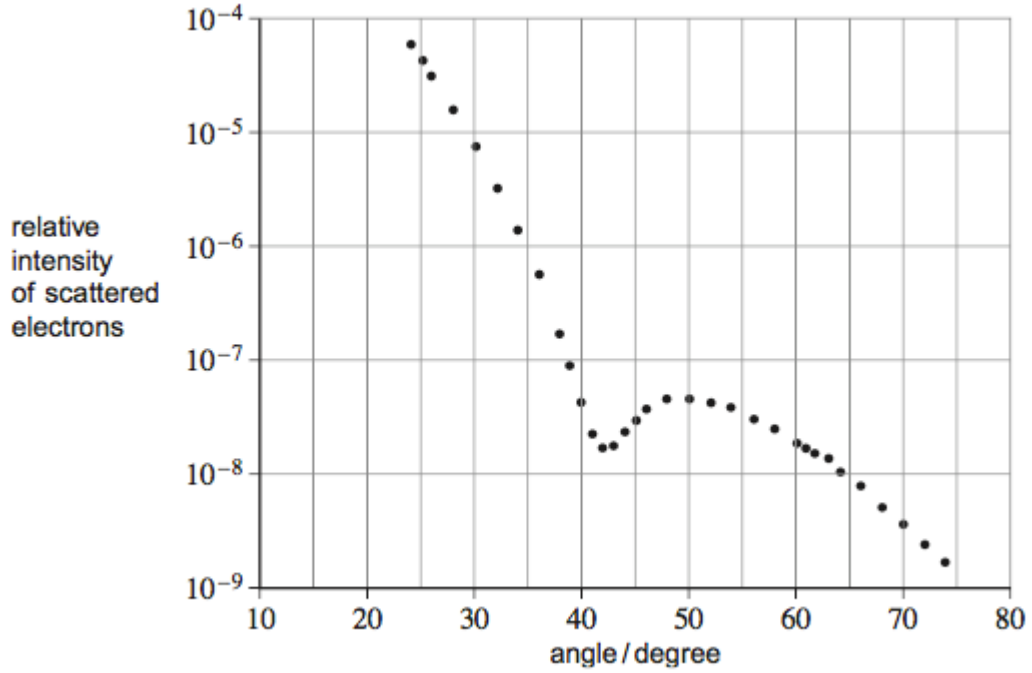
(a) The radius of a nucleus may be determined by electron diffraction. In an electron diffraction experiment a beam of electrons is fired at oxygen-16 nuclei. Each electron has an energy of 5.94×10^{-11} J.

The approximation, momentum = $\frac{\text{energy}}{\text{speed of light}}$ can be used for electrons at this energy.

(i) Show that the de Broglie wavelength λ of each electron in the beam is about 3.3×10^{-15} m.

(2)

(ii) The graph shows how the relative intensity of the scattered electrons varies with angle due to diffraction by the oxygen-16 nuclei. The angle is measured from the original direction of the beam.



The angle θ of the first minimum in the electron-diffraction pattern is given by

$$\sin\theta = \frac{0.61\lambda}{\text{nuclear radius}}$$

Calculate the radius of an oxygen-16 nucleus using information from the graph.

radius = _____ m

(1)

(b) Rutherford used the scattering of α particles to provide evidence for the structure of the atom.

(i) Sketch a labelled diagram showing the experimental arrangement of the apparatus used by Rutherford.

(2)

(ii) State and explain the results of the scattering experiment.
Your answer should include the following:

- the main observations
- the significance of each observation
- how the observtions placed an upper limit on the nuclear radius.

The quality of your written communication will be assessed in your answer.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(6)

(Total 11 marks)

Q2.

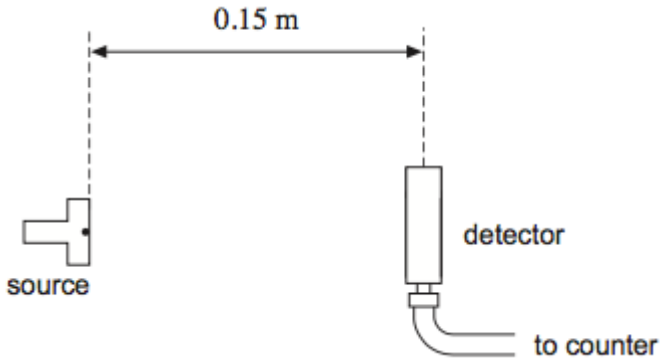
(a) The exposure of the general public to background radiation has changed substantially over the past 100 years.
State **one** source of radiation that has contributed to this change.

_____

_____

(1)

(b) A student measures background radiation using a detector and determines that background radiation has a mean count-rate of 40 counts per minute. She then places a γ ray source 0.15 m from the detector as shown below.



With this separation the average count per minute was 2050.

The student then moves the detector further from the γ ray source and records the count-rate again.

(i) Calculate the average count-rate she would expect to record when the source is placed 0.90 m from the detector.

count-rate = _____ min^{-1}

(3)

(ii) The average count per minute of 2050 was determined from a measurement over a period of 5 minutes. Explain why the student might choose to record for longer than 5 minutes when the separation is 0.90 m.

_____

_____

_____

_____

(1)

(iii) When the detector was moved to 0.90 m the count-rate was lower than that calculated in part **(b)(i)**. It is suggested that the source may also emit β particles.

Explain how this can be checked.

(2)
(Total 7 marks)