Q1.(a) Scattering experiments are used to investigate the nuclei of gold atoms.
In one experiment, alpha particles, all of the same energy (monoenergetic), are incident on a foil made from a single isotope of gold.

(i) State the main interaction when an alpha particle is scattered by a gold nucleus.

.....

.....

(1)

(ii) The gold foil is replaced with another foil of the same size made from a mixture of isotopes of gold. Nothing else in the experiment is changed.

Explain whether or not the scattering distribution of the monoenergetic alpha particles remains the same.

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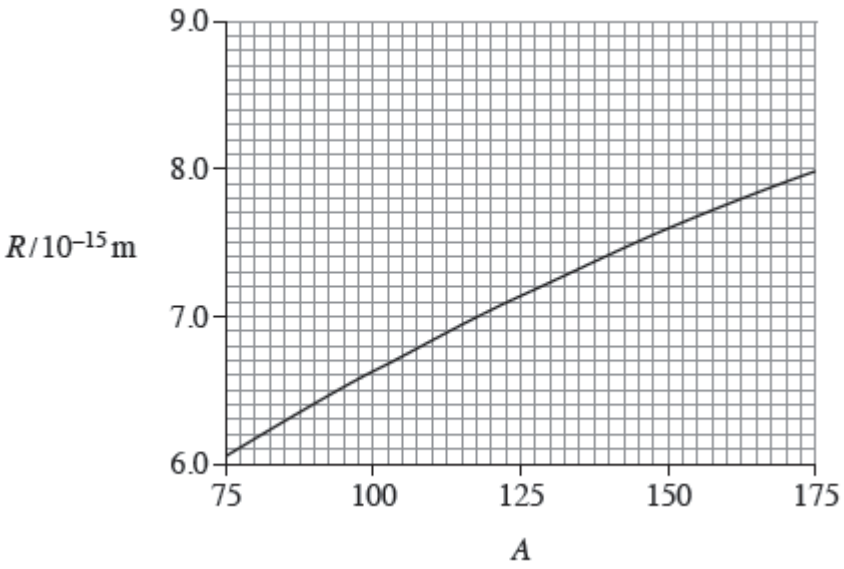
(1)

(b) Data from alpha−particle scattering experiments using elements other than gold allow scientists to relate the radius R, of a nucleus, to its nucleon number, A.
The graph shows the relationship obtained from the data in a graphical form, which obeys the relationship $R = r_0 A^{\frac{1}{3}}$



(i) Use information from the graph to show that r_0 is about 1.4×10^{-15} m.

(1)

(ii) Show that the radius of a $^{51}_{23}\mathrm{V}$ nucleus is about 5×10^{-15} m.

(2)

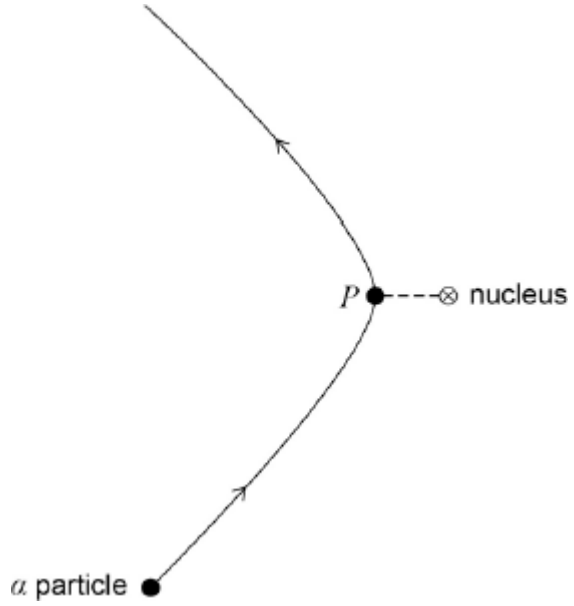
(c) Calculate the density of a $^{51}_{23}\mathrm{V}$ nucleus.

State an appropriate unit for your answer.

density ..... unit .....

(3)
(Total 8 marks)

Q2. The diagram shows the path of an α particle deflected by the nucleus of an atom. Point P on the path is the point of closest approach of the α particle to the nucleus.



Which of the following statements about the α particle on this path is correct?

A Its acceleration is zero at P. ⬭

B Its kinetic energy is greatest at P. ⬭

C Its potential energy is least at P. ⬭

D Its speed is least at P. ⬭

(Total 1 mark)

Q3. In an experiment to investigate the structure of the atom, α particles are directed normally at a thin metal foil which causes them to be scattered.

(a) (i) In which direction will the number of α particles per second be a maximum?

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(ii) State what this result suggests about the structure of the atoms in the metal.

.....

.....

(2)

(b) A small number of α particles are scattered through 180°.

Explain what this suggests about the structure of the atoms in the metal.

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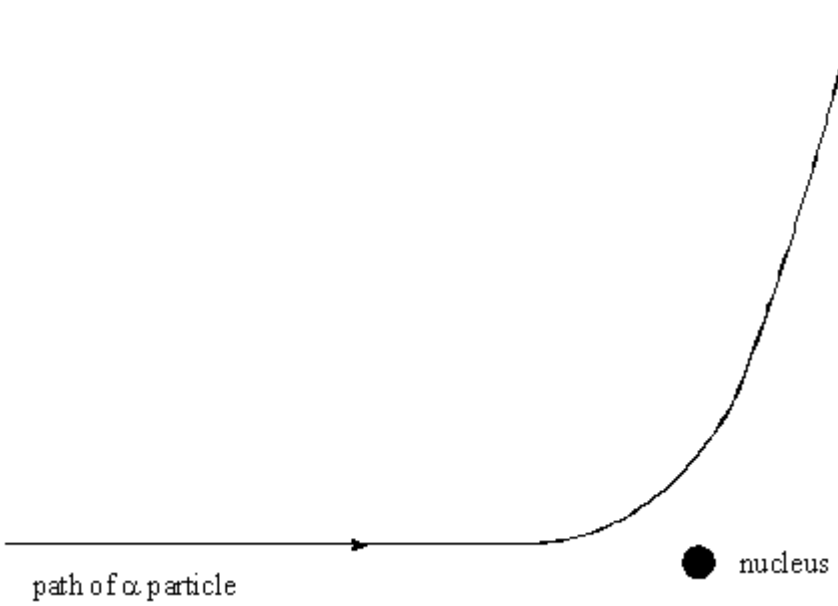
(2)

(c) The figure shows the path of an α particle passing near a nucleus.



(i) Name the force that is responsible for the deflection of the α particle.

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(ii) Draw an arrow on the diagram in the direction of the force on the α particle in the position where the force is a maximum.

(iii) The nucleus is replaced with one which has a larger mass number and a smaller proton number.

Draw on the diagram the path of an α particle that starts with the same velocity and position as that of the α particle drawn.

(4)
(Total 8 marks)

Q4.(a) (i) Why is it necessary to remove the air from the chamber in a Rutherford scattering experiment?

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(ii) Give **two** conclusions that can be deduced about the nucleus from the results of such an experiment.

conclusion 1 .....

.....

conclusion 2 .....

.....

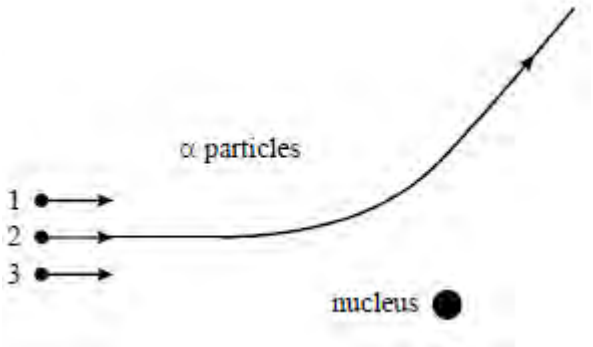
(iii) What force or interaction is responsible for Rutherford scattering?

.....

(4)

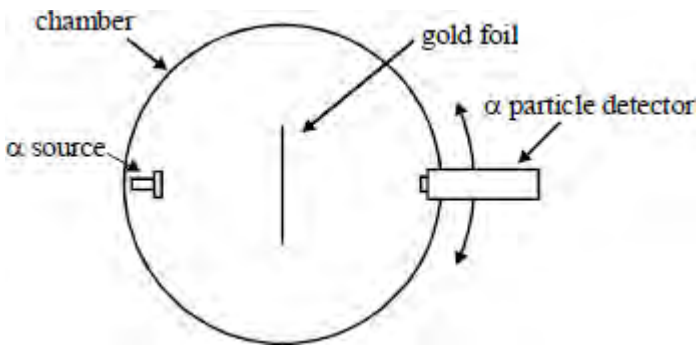
(b) The figure shows three α particles, all with the same kinetic energy, directed at a nucleus. The path followed by α particle 2 is given.

Draw lines on the figure to show the paths followed by α particles 1 and 3.



(2)
(Total 6 marks)

Q5. The diagram below shows the apparatus used to investigate Rutherford scattering, in which α particles are fired at a gold foil.



(a) Why is it essential for there to be a vacuum in the chamber?

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.....

(2)

(b) What observations made with this apparatus support each of the following conclusions?
No explanation is required.

(i) The nuclear radius of gold is much smaller than its atomic radius.

.....

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(ii) Most of the mass of an atom of gold is contained in its nucleus.

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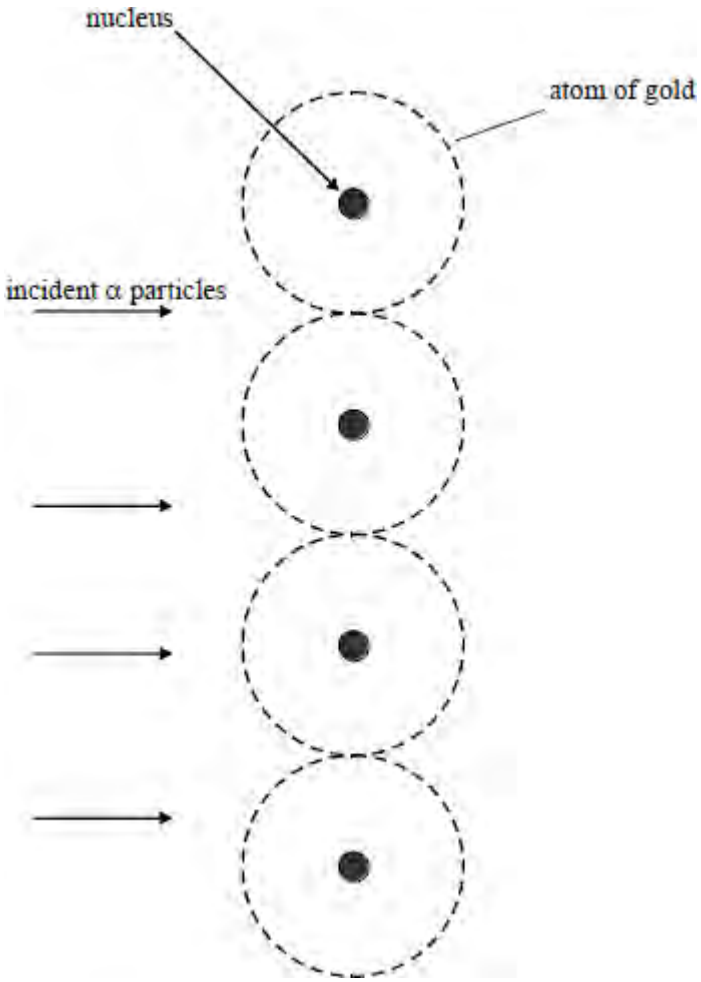
(3)

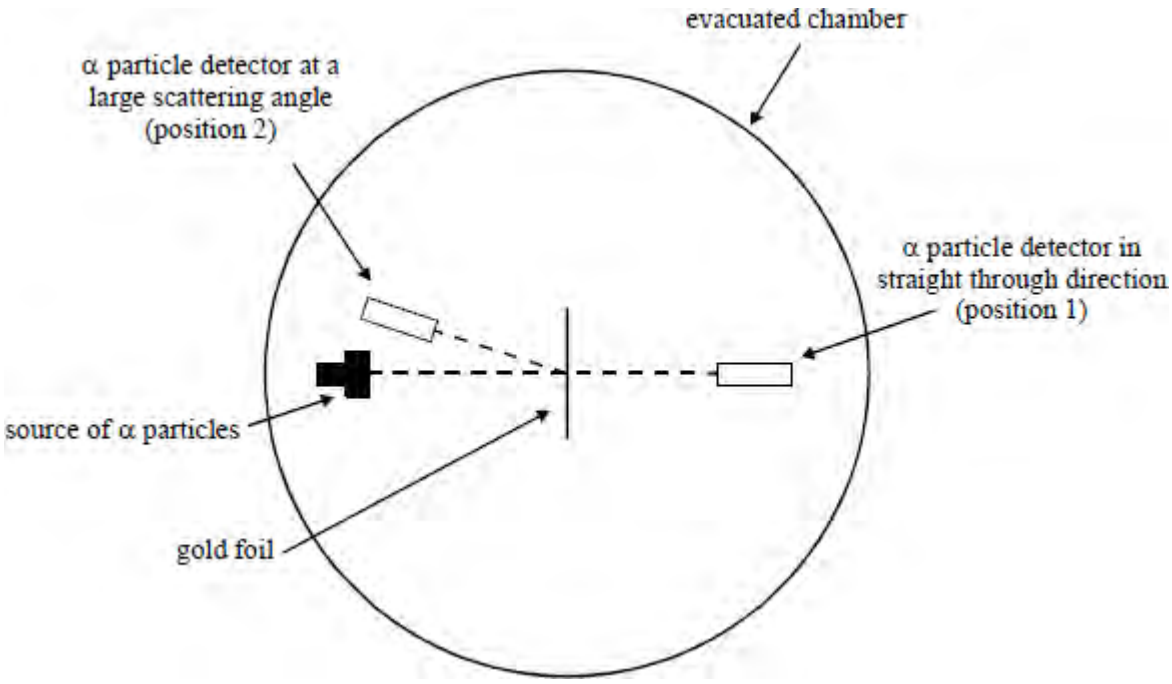
(c) The drawing below shows α particles incident on a layer of atoms in a gold foil.

On this figure draw the complete path followed by **each** of the α particles shown.



(3)
(Total 8 marks)

Q6. The figure below represents an experiment on Rutherford scattering in which α particles are directed at a gold foil. The detector is shown in two positions in the evacuated chamber.



(a) Why is it necessary to remove the air from the apparatus?

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(b) Explain why the gold foil should be very thin.

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(c) Explain why the count rate from the α particle detector in position 1 is much greater than that in position 2.
What can be deduced from this observation about the structure of the atom and the properties of the nucleus of gold?

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(Total 6 marks)