Feedback for the homework task: The Rutherford experiment on the structure of the atom

General point:

You should not say amount of electrons/protons/neutrons/atoms – you can count electrons/protons/neutrons/atoms so you say number of electrons/protons/neutrons/atoms etc. Amount is used for commodities that cannot be numbered.

E.G.

I spent a considerable **number of** years touring Africa… not 'amount of years'…
I spent a considerable **amount of** time on my homework… not 'number of time'… (you can number years, hours, minutes and seconds but not time…)

If you can measure it as a number then use 'number of' – if you can't it is 'amount of'

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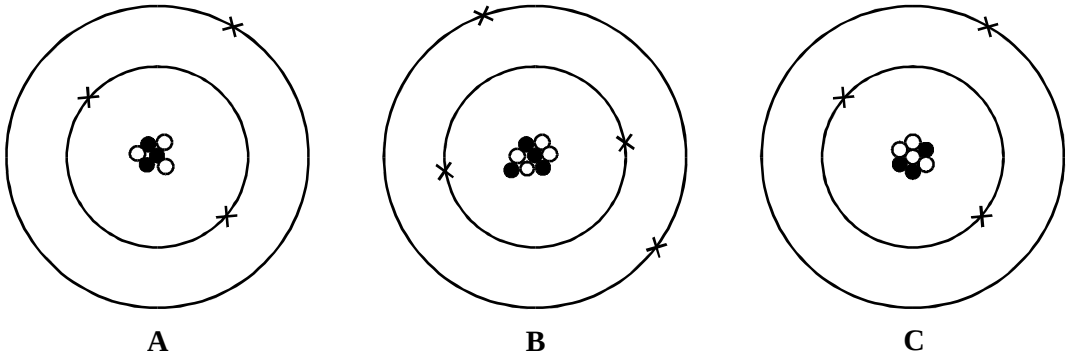
1. The diagrams below represent three atoms, **A**, **B** and **C**.



(a) Two of these atoms are from the **same** element.
Which of **A**, **B** and **C** is an atom of a different element? Give **one** reason for your answer.

- If you look at the diagrams you can see that the number of **X** for the electrons (you know they are electrons 'cause they are orbiting the nucleus) is the same as the number of ● - that means that those must be the protons and O must be the neutrons
- Elements all have their own individual value for the number of protons – so A and C are the same element and B is the different element.
- These are all neutral atoms but if they gained or lost electrons it would NOT change what element they were. Your answer should therefore not refer to electrons. The number of electrons simply affects the net charge of the atom/ion (if it is neutral you call it an atom – if charged an ion)

The answer is therefore B – the reason being it has a different number of protons to A or C

(2)

(b) Two of these atoms are isotopes of the same element.
Which **two** are isotopes of the same element? Explain your answer.

- We have already established that A and C are both the same element. BUT they are different A has three neutrons – C has four.

The answer is therefore A and C – the reason being they have a different number of neutrons but the same number of protons.

(3)

(c) Which of the particles O, ● and **X**, shown in the diagrams:
(i) has a positive charge; ● - protons are positive (ii) has no charge; O (iii) has the smallest mass? X – electrons are negligible in mass

(3)

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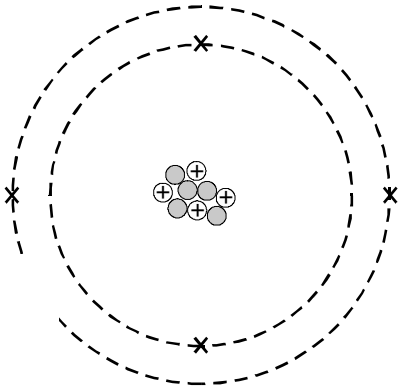
(d) Using the same symbols as those in the atom diagrams, draw an alpha particle.

An alpha particle has 2 protons and 2 neutrons (NO electrons)

(1)
(Total 9 marks)

2. The diagram shows an atom.

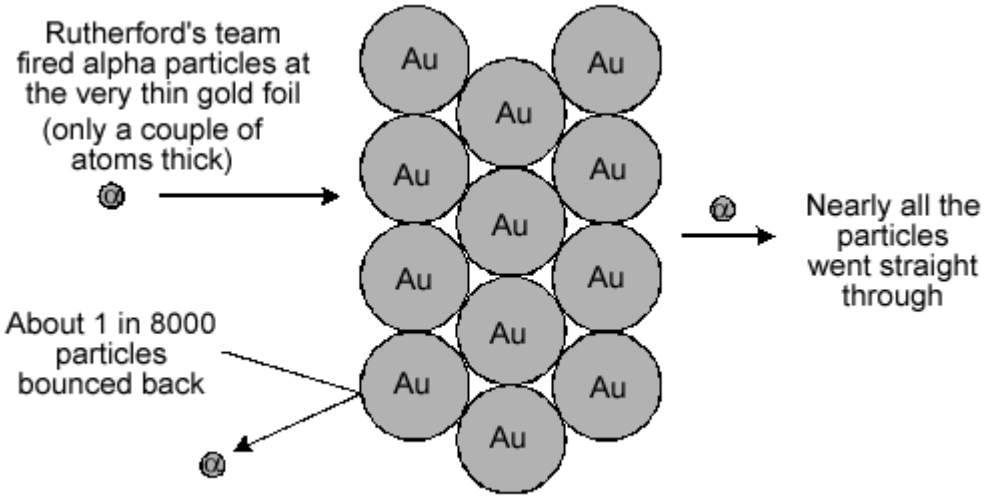


How many protons are there in the nucleus of the atom? 4 (just the positive ones)

What is the mass number of the atom? 9 (count all particles in the nucleus)

(Total 2 marks)

3.



When they first carried out this experiment scientists thought that all the parts in atoms were evenly spread out.

(a) What did the scientists expect to happen in this experiment?

All of the particles to go through - not bounce back – only be deflected a tiny bit if at all

(2)

(b) **Use five of the following words to complete this sentence (you may use them more than once).**

tiny large massive space shells positive negative charge mass

The experiment showed that atoms must be mostly empty …. but that there was a very ….. dense nucleus at the centre of the atom and that that contained all of the ……. ……. and most of the ……..

The experiment showed that atoms must be mostly empty **space** but that there was a very **tiny** dense nucleus at the centre of the atom and that that contained all of the **positive charge** and most of the **mass**

(5)
(Total 7 marks)

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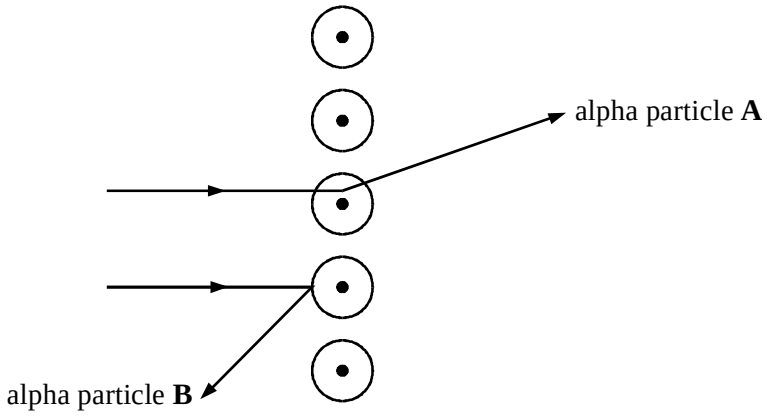
4. The diagram below shows the paths of two alpha particles A and B into and out of a thin piece of metal foil.



(a) The paths of the alpha particles depend on the forces on them in the metal.
Describe the model of the atom which is used to explain the paths of alpha particles aimed at thin sheets of metal foil.

You are asked to describe the model <u>not</u> to explain the paths!

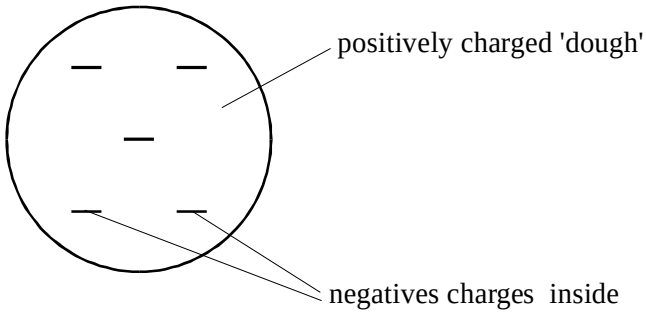
They wanted you to say:

- Nucleus
- positive charge / protons in nucleus
- electrons / negative charges orbit nucleus

each for 1 mark

(3)

(b) Scientists used to believe that atoms were made up of negative charges embedded in a positive 'dough'. This is called the 'plum pudding' model of the atom.
The diagram below shows a model of such an atom.



(i) Explain how the 'plum pudding' model of the atom can explain why alpha particle ***A*** is deflected through a very small angle.

- positive dough repels positive alpha particles **or** positive charges repel
- forces are small because the concentration of the positive charge is small

each for 1 mark

(2)

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(ii) Explain why the 'plum pudding' model of the atom can not explain the large deflection of alpha particle **B**.

- large force needed
- +ves in plum pudding spread out - *may appear in (i)*
- positive charge must be concentrated in nucleus to provide a big enough repulsive force for back-scattering

for 1 mark each

The electrons are so tiny and spread out that they would have a very tiny effect – but any effect they did have would be attractive not repulsive. The mark scheme said ignore references to electrons altogether!

(3)

(c) We now believe that atoms are made up of three types of particles called protons, neutrons and electrons.

Copy and complete the table below to show the relative mass and charge of a neutron and an electron. The relative mass and charge of a proton have already been done for you.

PARTICLE	RELATIVE MASS	RELATIVE CHARGE
proton	1	+1
neutron	1	0
electron	0.00055	-1

The mass of an electron is NOT zero – it is negligible – the exam boards and old text books and some sites will have it as zero but if you put zero you get no mark!
To get a mark you had to have the whole line correct – no half marks are awarded at GCSE

(2)

(d) The diagrams below show the nuclei of four different atoms **A**, **B**, **C** and **D**.

Key: ○ – proton ● – neutron

nucleus **A** nucleus **B** nucleus **C** nucleus **D**

(i) State the mass number of *C*. 4

(ii) Which two are isotopes of the same element? B and C (1) Explain your answer. because they have the same number of protons (1) but different numbers of neutrons (1)

(4)

(Total 14 marks)

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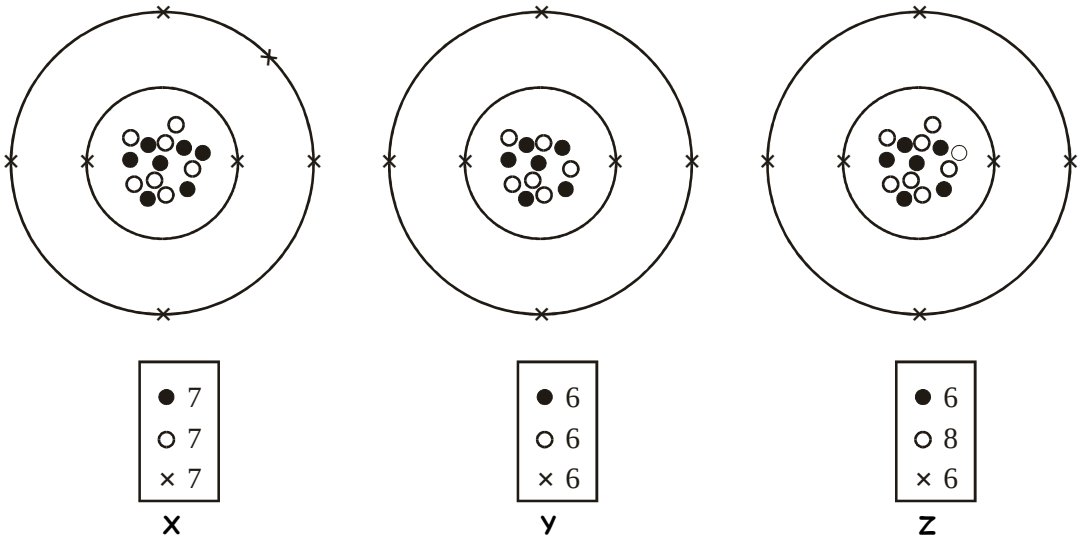
5. (a) The diagrams represent three atoms **X**, **Y** and **Z**.

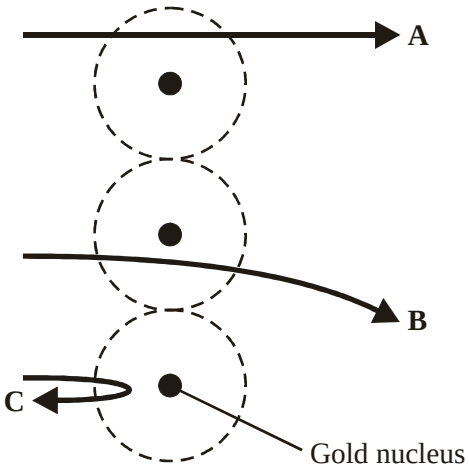


Which **two** of the atoms are from the same element? Give a reason for your answer.

Again you need to work out what the symbols mean:

- If you look at the diagrams you can see that the number of **X** for the electrons (you know they are electrons 'cause they are orbiting the nucleus) is the same as the number of ● - that means that those must be the protons and ○ must be the neutrons
- That means that **Y and Z** are isotopes of the same element – **they have the same number of protons (or atomic number)**

(2)



(b) In the early part of the 20th century some scientists investigated the paths taken by positively charged alpha particles into and out of a very thin piece of gold foil. The diagram shows the paths of three alpha particles.

Explain the different paths **A**, **B** and **C** of the alpha particles.
To gain full marks in this question you should write your ideas in good English. Put them into a sensible order and use the correct scientific words.

Here you do have to explain the paths of the alpha particles…

A – alpha particle passes straight through the empty space of the atom
or it is a long way from the nucleus

B – alpha particle deflected / repelled / repulsed by the (positive) nucleus

C – alpha particle heading straight for the nucleus is deflected / repelled / repulsed backwards

*do **not** accept hits the nucleus*
*do **not** accept answers referring to refraction*
*do **not** accept answers in terms of reflected backwards unless qualified in terms of repulsion*

(The underlined words are required for the mark for each path description)

(3)
(Total 5 marks)