AQA GCSE PHYSICS (HIGHER) · 8463

PHYSICS



EXAM QUESTION PACK

4.4.1 ATOMS AND ISOTOPES (PACK 2)

SCORE	PERCENTAGE
/106	%

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Q1.

(a) The table gives information about five radioactive isotopes.

Isotope	Type of radiation emitted	Half-life
Californium-241	alpha (α)	4 minutes
Cobalt-60	gamma (γ)	5 years
Hydrogen-3	beta (β)	12 years
Strontium-90	beta (β)	28 years
Technetium-99	gamma (γ)	6 hours

(i) What is an alpha (α) particle?

_____

_____

(1)

(ii) What is meant by the term half-life?

_____

_____

(1)

(iii) Which **one** of the isotopes could be used as a tracer in medicine? Explain the reason for your choice.

_____

_____

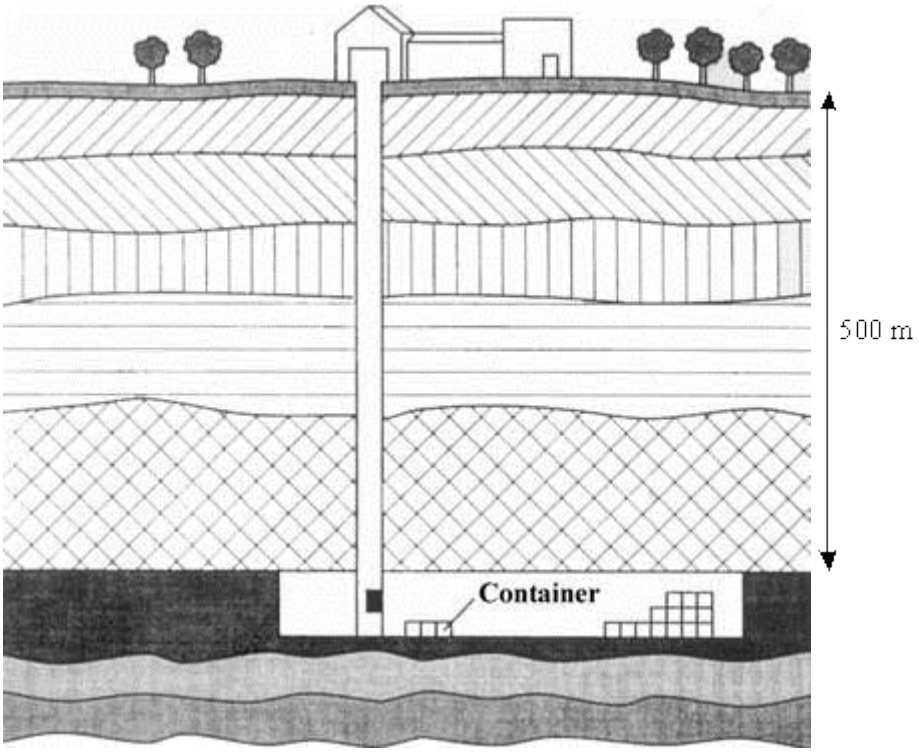
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(3)

(b) The increased use of radioactive isotopes is leading to an increase in the amount of radioactive waste. One method for storing the waste is to seal it in containers which are then placed deep underground.

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Some people may be worried about having such a storage site close to the area in which they live. Explain why.

_____

_____

_____

_____

_____

_____

_____

(3)

(Total 8 marks)

Q2.

Radon is a radioactive gas. Radon makes a major contribution to background radiation levels. Radon atoms decay by the emission of *alpha particles*.

(a) (i) What is an *alpha particle*?

_____

(1)

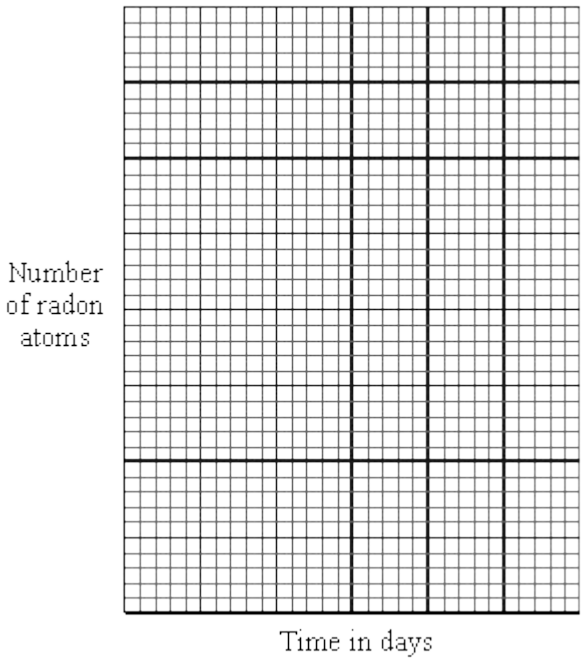
(ii) From which part of the radon atom does the alpha particle come?

_____

(1)

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(b) (i) A sample of air contains 40 000 radon atoms. The half-life of radon is four days. Draw a graph to show how the number of radon atoms present in a sample of air will change over a period of 12 days.



(3)

(ii) After 20 days, how many of the radon atoms from the original sample of air will have decayed? Show clearly how you work out your answer.

_____

_____

_____

Number of radon atoms decayed = _____

(3)

(c) Fairly constant concentrations of radon gas have been found in some deep mine shafts.

(i) Suggest why the concentration of radon gas remains fairly constant although the radon gas decays.

_____

_____

(1)

(ii) Explain why the long term exposure to large concentrations of radon gas could be a danger to health.

_____

_____

_____

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_____

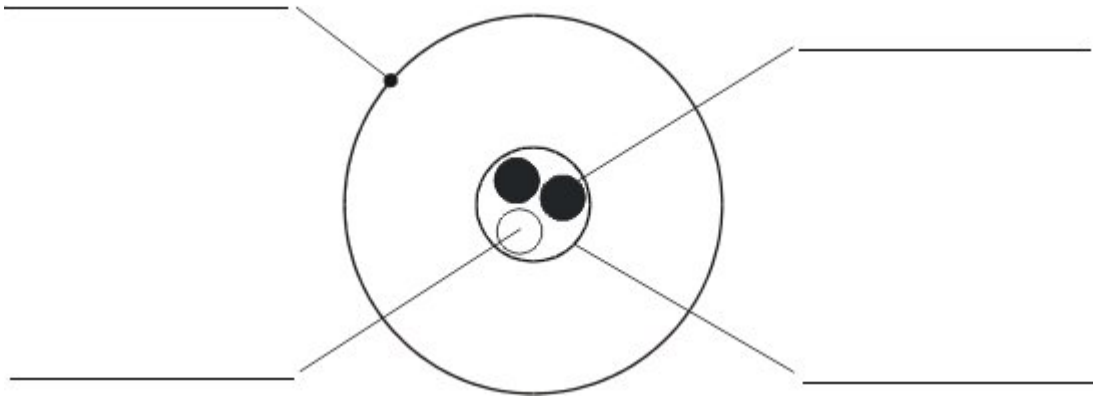
(2)

(Total 11 marks)

Q3.

(a) Tritium ($^{3}_{1}H$) is an isotope of hydrogen. Tritium has a proton number of 1 and a mass number of 3.

(i) The diagram below shows a simple model of a tritium atom. Complete the diagram by adding the names of the particles indicated by the labels.



(4)

(ii) Explain how the nucleus of an ordinary hydrogen atom is different from the nucleus of a tritium atom. Ordinary hydrogen atoms ($^{1}_{1}H$) have a mass number of 1.

_____

_____

_____

(2)

(iii) Tritium is a radioactive substance which emits beta (β) radiation.
Why do the atoms of some substances give out radiation?

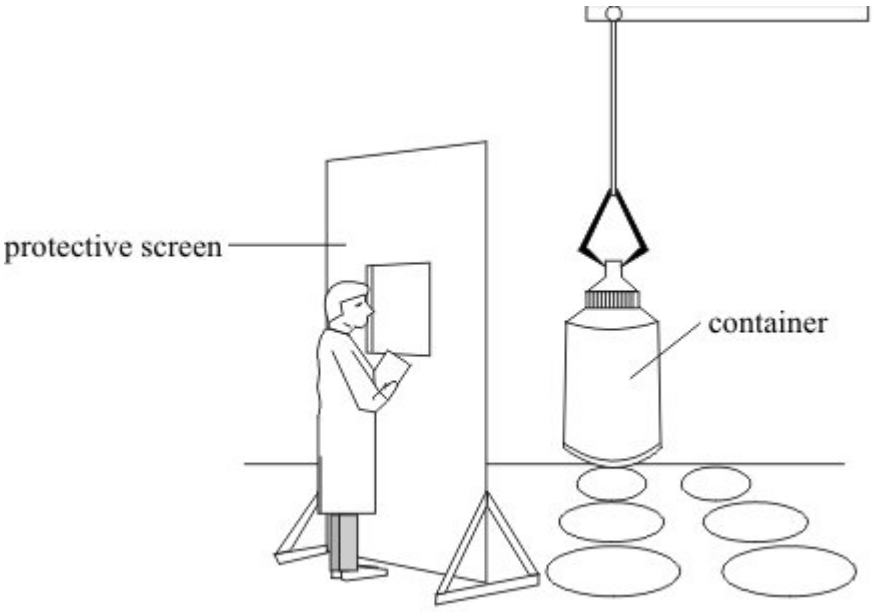
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(2)

(b) Tritium is one of the elements found in the waste material of the nuclear power industry. The diagram below shows a worker behind a protective screen. The container holds a mixture of different waste materials which emit alpha (α), beta (β) and gamma (γ) radiation.

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Suggest a suitable material for the protective screen. The material should prevent radiation from the container reaching the worker. Explain your answer.

_____

_____

_____

(2)

(Total 10 marks)

Q4.

(a) Complete the table about atomic particles.

ATOMIC PARTICLE	RELATIVE MASS	RELATIVE CHARGE
proton		+1
neutron	1	0
electron	negligible	

(2)

(b) Use the Data Sheet to help you to answer some parts of this question.

Read the following passage about potassium.

Potassium is a metallic element in Group 1 of the Periodic Table.
It has a proton (atomic) number of 19.

Its most common isotope is potassium-39, ($^{40}_{19}K$).

Another isotope, potassium-40, ($^{40}_{19}K$), is a radioisotope.

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(i) State the number of protons, neutrons and electrons in potassium-39.

Number of protons _____

Number of neutrons _____

Number of electrons _____

(2)

(ii) Explain why potassium-40 has a different mass number from potassium-39.

_____

(1)

(iii) What is meant by a *radioisotope*?

_____

_____

(1)

(iv) Atoms of potassium-40 change into atoms of a different element. This element has a proton (atomic) number of 20 and a mass number of 40.

Name, or give the symbol of, this new element.

_____

(1)

(v) Explain in terms of atomic structure, why potassium-39 and potassium-40 have the same chemical reactions.

_____

(1)

(c) (i) Name a suitable detector that could be used to show that potassium-40 gives out radiation.

_____

(1)

(ii) Name a disease which can be caused by too much exposure to a radioactive substance such as potassium-40.

_____

(1)

(Total 10 marks)

Q5.

(a) Atoms are made up of three types of particle called protons, neutrons and electrons. 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 has already been done for you.

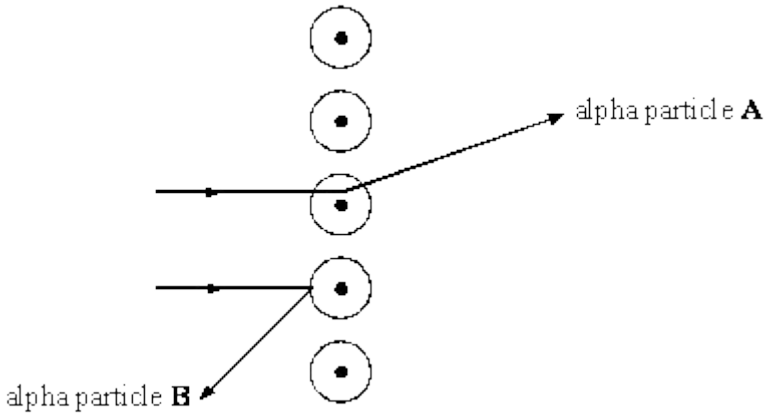
PARTICLE	RELATIVE MASS	RELATIVE CHARGE

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proton	1	+1
neutron		
electron		

(2)

(b) The diagram below shows the paths of two alpha particles **A** and **B**, into and out of a thin piece of metal foil.



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.

_____

_____

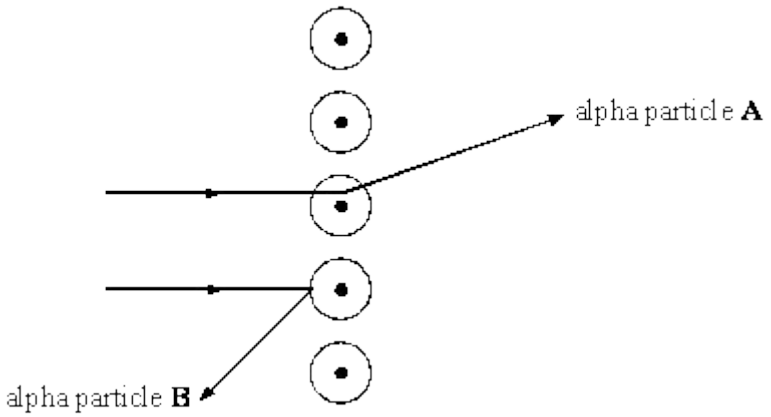
_____

(3)

(Total 5 marks)

Q6.

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



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(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.

_____

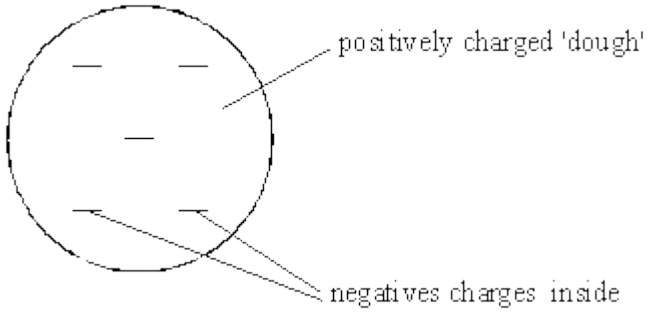
_____

_____

_____

(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.

_____

_____

_____

_____

_____

(2)

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

_____

_____

_____

_____

_____

_____

(3)

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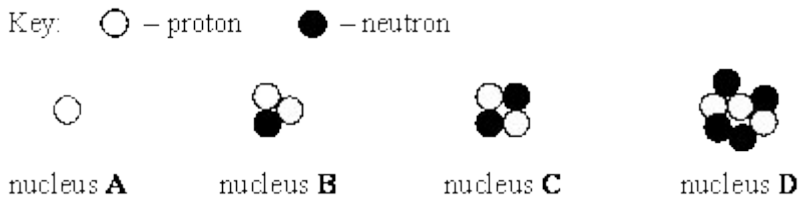
(c) We now believe that atoms are made up of three types of particles called protons, neutrons and electrons.

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		
electron		

(2)

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



(i) State the mass number of C.

_____

(ii) Which two are isotopes of the same element?

_____ and _____

Explain your answer.

_____

_____

_____

_____

(4)

(Total 14 marks)

Q7.

Use the Data Sheet to help you answer this question.
This question is about elements and atoms.

(a) About how many different elements are found on Earth?
Draw a **ring** around the correct number.

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40 50 60 70 80 90

(1)

(b) The following are parts of an atom:

electron neutron nucleus proton

Choose from the list the one which:

(i) has no electrical charge; _____

(ii) contains two of the other particles; _____

(iii) has very little (negligible) mass. _____

(3)

(c) Scientists have been able to make new elements in nuclear reactors. One of these new elements is fermium. An atom of fermium is represented by the symbol below.

$$^{257}_{100}\mathrm{Fm}$$

(i) How many protons does this atom contain? _____

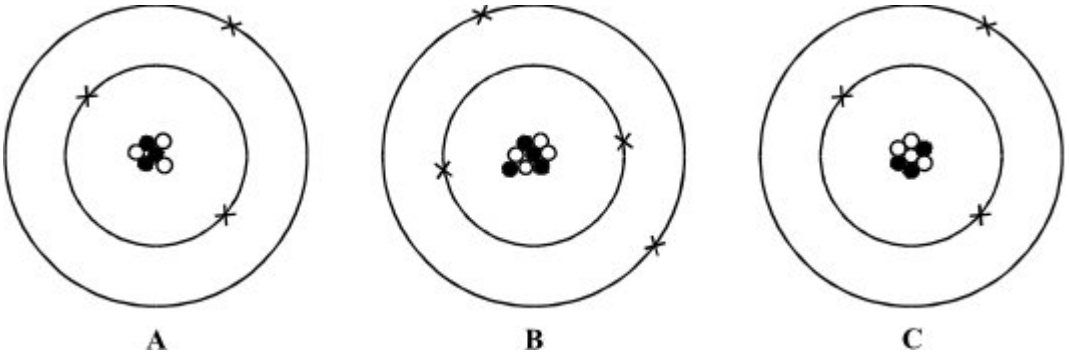
(ii) How many neutrons does this atom contain? _____

(2)

(Total 6 marks)

Q8.

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



(a) Two of the atoms are from the **same** element.

(i) Which of **A**, **B** and **C** is an atom of a different element? _____

(ii) Give **one** reason for your answer.

_____

_____

_____

(2)

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(b) Two of these atoms are isotopes of the same element.

(i) Which **two** are isotopes of the same element? _____ and _____

(ii) Explain your answer.

_____

_____

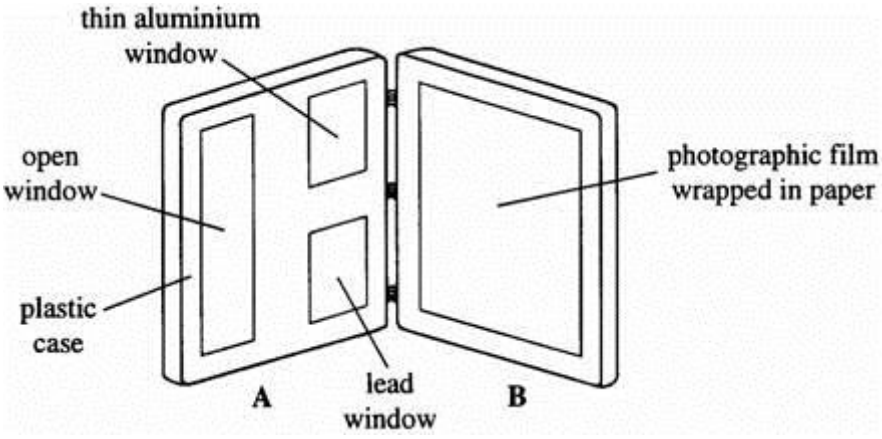
_____

(3)

(Total 5 marks)

Q9.

The diagram shows a film badge worn by people who work with radioactive materials. The badge has been opened. The badge is used to measure the amount of radiation to which the workers have been exposed.



(a) The detector is a piece of photographic film wrapped in paper inside part **B** of the badge.
Part **A** has "windows" as shown.

Complete the sentences below.

When the badge is closed

(i) _____ radiation and _____ radiation can pass through the open window and affect the film.

(1)

(ii) Most of the _____ radiation will pass through the lead window and affect the film.

(1)

(b) Other detectors of radiation use a gas which is ionised by the radiation.

(i) Explain what is meant by *ionised*.

_____

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_____

(1)

(ii) Write down **one** use of ionising radiation.

_____

(1)

(c) Uranium-238 has a very long half-life. It decays via a series of short-lived radioisotopes to produce the stable isotope lead-204.

Explain, in detail, what is meant by:

(i) *half-life*,

_____

_____

(1)

(ii) *radioisotopes*.

_____

_____

_____

_____

(2)

(d) The relative proportions of uranium-238 and lead-204 in a sample of igneous rock can be used to date the rock.
A rock sample contains three times as many lead atoms as uranium atoms.

(i) What fraction of the original uranium is left in the rock?

(Assume that there was no lead in the original rock.)

_____

_____

(1)

(ii) The half-life of uranium-238 is 4500 million years.

Calculate the age of the rock.

_____

_____

_____

Age _____ million years

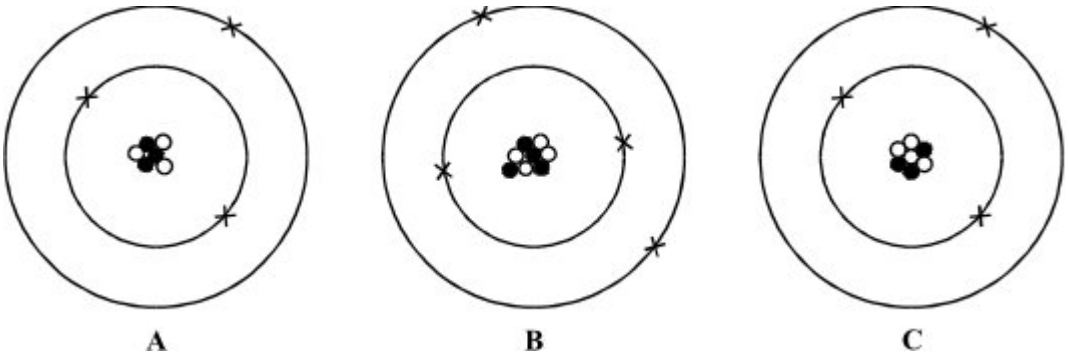
(2)

(Total 10 marks)

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Q10.

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



(a) Two of these atoms are from the **same** element.

(i) Which of **A**, **B** and **C** is an atom of a different element? _____

(ii) Give **one** reason for your answer.

_____
_____

_____
_____

_____
_____

(2)

(b) Two of these atoms are isotopes of the same element.

(i) Which **two** are isotopes of the same element? _____ and _____

(ii) Explain your answer.

_____
_____

_____
_____

_____
_____

(3)

(c) Which of the particles ○, ● and **X**, shown in the diagrams:

(i) has a positive charge; _____

(ii) has no charge; _____

(iii) has the smallest mass? _____

(3)

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

(1)

(Total 9 marks)

Q11.

In some areas of the U.K. people are worried because their houses are built on rocks that release radon.

Read the information about radon.

- It is a gas.
- It is formed by the breakdown of radium.
- It emits alpha radiation.
- Each radon atom has 86 protons.
- Each radon atom has 136 neutrons.

(i) How many electrons has each atom of radon? _____

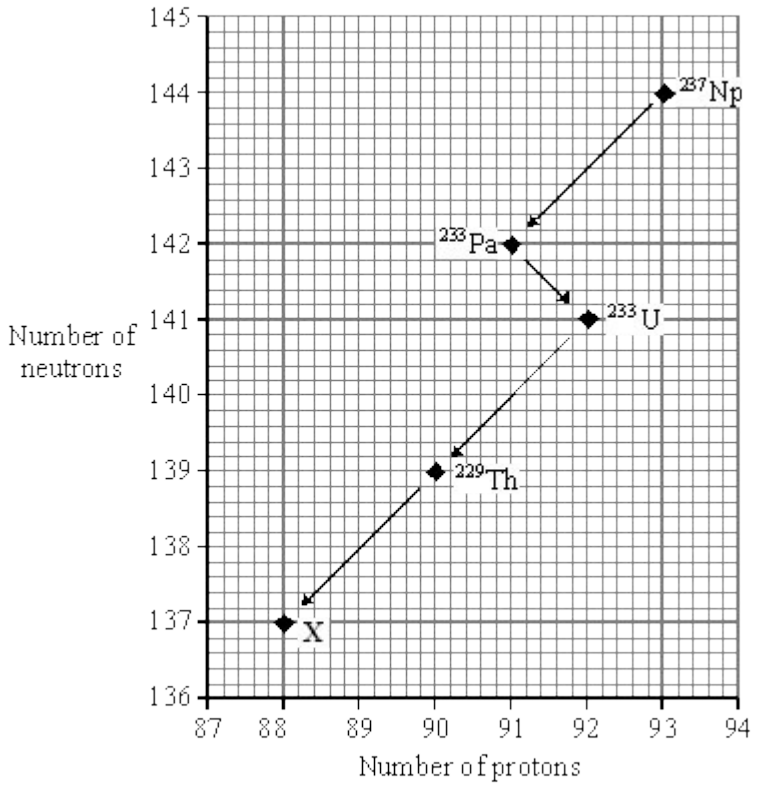
(ii) What is the mass (nucleon) number of radon? _____

(Total 2 marks)

Q12.

Neptunium-237 (^{237}Np) is a radioactive element. The graph shows the numbers of neutrons and protons in the nuclei of the elements formed when ^{237}Np decays.

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(a) Use the periodic table on the Data Sheet to identify element **X**.

_____
_____

(1)

(b) Why are ^{233}Pa and ^{233}U considered to be different elements?

_____
_____

_____
_____

(1)

(c) What type of radiation is released when ^{237}Np decays to form ^{233}Pa?

_____
_____

(1)

(d) What change takes place in the nucleus when ^{233}Pa changes into ^{233}U?

_____
_____

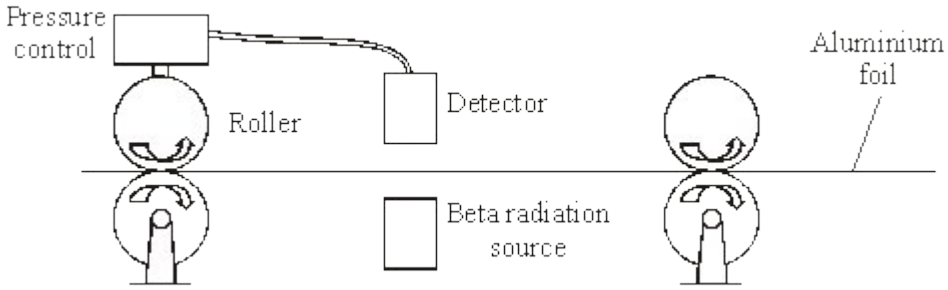
(1)

(Total 4 marks)

Q13.

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The diagram shows how the thickness of aluminium foil is controlled.
The thicker the aluminium foil, the more radiation it absorbs.



(a) The designers used a beta radiation source for this control system.

(i) Why would an alpha radiation source be unsuitable in this control system?

_____

_____

(1)

(ii) Why would a gamma radiation source be unsuitable in this control system?

_____

_____

(1)

(b) The substance used in the beta radiation source is radioactive.

(i) Why are some atoms radioactive?

_____

_____

(1)

(ii) Explain why radiation is dangerous to humans.

_____

_____

_____

_____

(2)

(Total 5 marks)

Q14.

(a) Complete the sentences about atoms.

In an atom, the number of electrons is equal to the number of _____ .

All atoms of an element have the same number of _____ .

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Isotopes of the same element have different numbers of _____ .

(3)

(b) Complete the sentence.

When an atom of a radioactive element emits alpha radiation, an atom of a different element is formed. A different element is formed because the radioactive element has lost _____ .

(1)

(Total 4 marks)

Q15.

$^{99}_{43}Tc$ (technetium) is produced by the radioactive decay of $^{99}_{42}Mb$ (molybdenum).

What change occurs in the nucleus of a molybdenum atom when this happens?

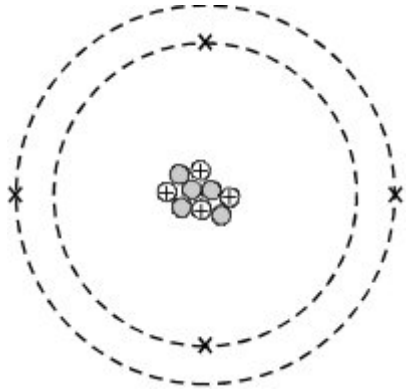
_____

_____

(Total 1 mark)

Q16.

The diagram shows an atom.



How many protons are there in the nucleus of the atom? _____

What is the mass number of the atom? _____

(Total 2 marks)

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