Atomic Structure Part 2

10 Questions

Name: _____

Class: _____

Date: _____

Time:

Marks:

Comments:

Q1.

A simple spark counter can be used to detect charged particles. It is made by having two wires close together with a large voltage across them. When a charged particle passes through the gap between the wires a spark is seen.

(a) Give the names and symbols of **two** particles which will cause a spark.

(i) Name _____ Symbol _____

(2)

(ii) Name _____ Symbol _____

(2)

(b) A radioactive source was placed within 2 cm of the spark counter and lots of sparks were seen. A piece of paper was slid between the source and the counter. The sparking stopped.

(i) What type of radiation was being given off?

_____

(1)

(ii) The paper was removed and the source slowly moved away from the spark counter. Describe what will happen to the sparking.

_____

_____

_____

(2)

(c) A radioactive source gave a high reading using a Geiger-Müller tube and counter, but did not cause sparking when brought near to the spark counter. Why?

_____

_____

(1)

(Total 8 marks)

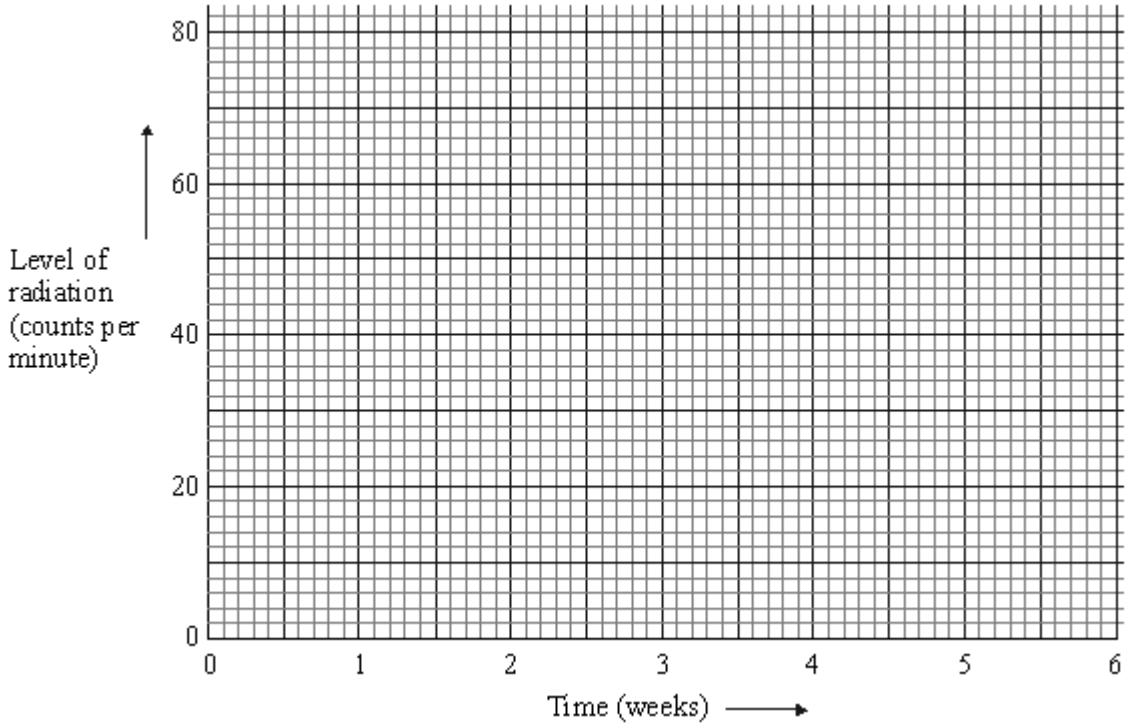
Q2.

Some students measure the level of radiation from a radioactive source during the same lesson each week over a period of six weeks.

Here are the results. (They have been corrected for background radiation.)

Time (weeks)	start	1	2	3	4	5	6
Level of radiation (average counts per minute)	66	44	34	29	16	12	8

(a) Using the graph paper below, display these results in the most appropriate way.



(5)

(b) What overall pattern is there in the students' results?

_____

_____

_____

(3)

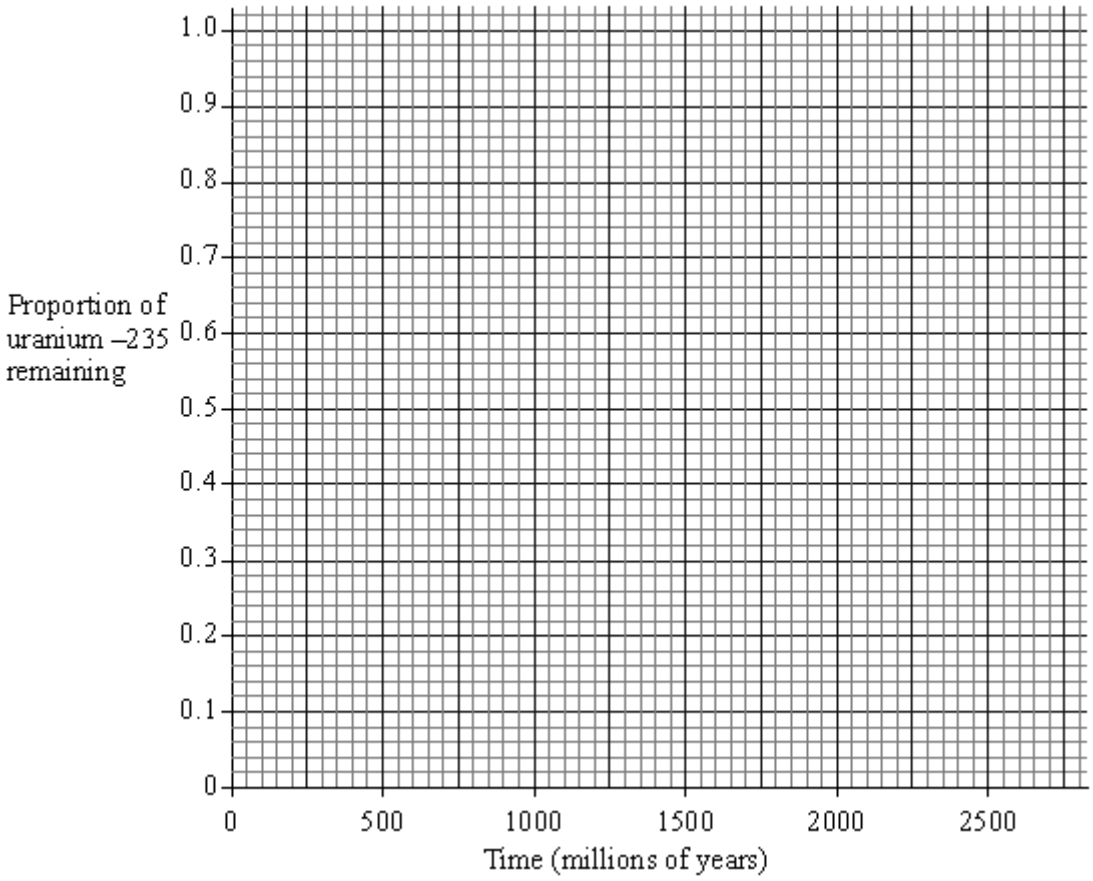
(Total 8 marks)

Q3.

Some rocks contain the radioactive isotope uranium-235 (^{235}U).

^{235}U has a half-life of 700 million years and, as it decays, lead-207 (^{207}Pb) is eventually formed.

(a) Draw a decay curve for ^{235}U on the graph below.



(4)

(b) Samples of an igneous rock gave an average ratio of 70 atoms of ^{235}U to 30 atoms of ^{207}Pb.

Use the decay curve you have drawn to estimate the age of the igneous rock.

Answer _____ million years.

(1)

(c) A sandstone rock which lies above the igneous rock contains traces of uranium-235 and of lead-207.

Why might it be unsatisfactory to use this uranium for dating the sandstone?

_____

_____

_____

_____

(2)

(Total 7 marks)

Q4.

(a) When an atom of thorium-232 decays, an alpha (α) particle is emitted from the nucleus.
An atom of radium is left behind.

An alpha particle consists of two protons and two neutrons.

We can represent this radioactive decay in a special kind of equation:

$$^{232}_{90}\text{Th} \longrightarrow {}^{4}_{2}\text{a} + {}^{228}_{88}\text{Ra}$$

228 ◄- - - number of nucleons (protons + neutrons)

88 ◄- - - number of protons

Thorium-228 is also radioactive.

Atoms of this isotope also decay by emitting an alpha particle and producing an isotope of radium.

Complete the equation for this decay.

$$^{228}_{90}\text{Th} \longrightarrow$$

(4)

(b) An atom of radium-228 decays by emitting a beta (β) particle from the nucleus.

A beta particle is in fact an electron (symbol $^{0}_{-1}e$).

The effect of this is to change a neutron into a proton.

An atom of actinium remains.

This type of decay can also be represented by an equation:

$$^{228}_{88}\text{Ra} \longrightarrow {}^{0}_{-1}\text{e} + {}^{228}_{89}\text{Ac}$$

228 ◄- - - number of nucleons (protons + neutrons)

89 ◄- - - number of protons

This isotope of actinium is radioactive.

An atom of actinium-228 also decays by emitting a beta particle.

An isotope of thorium is left behind.

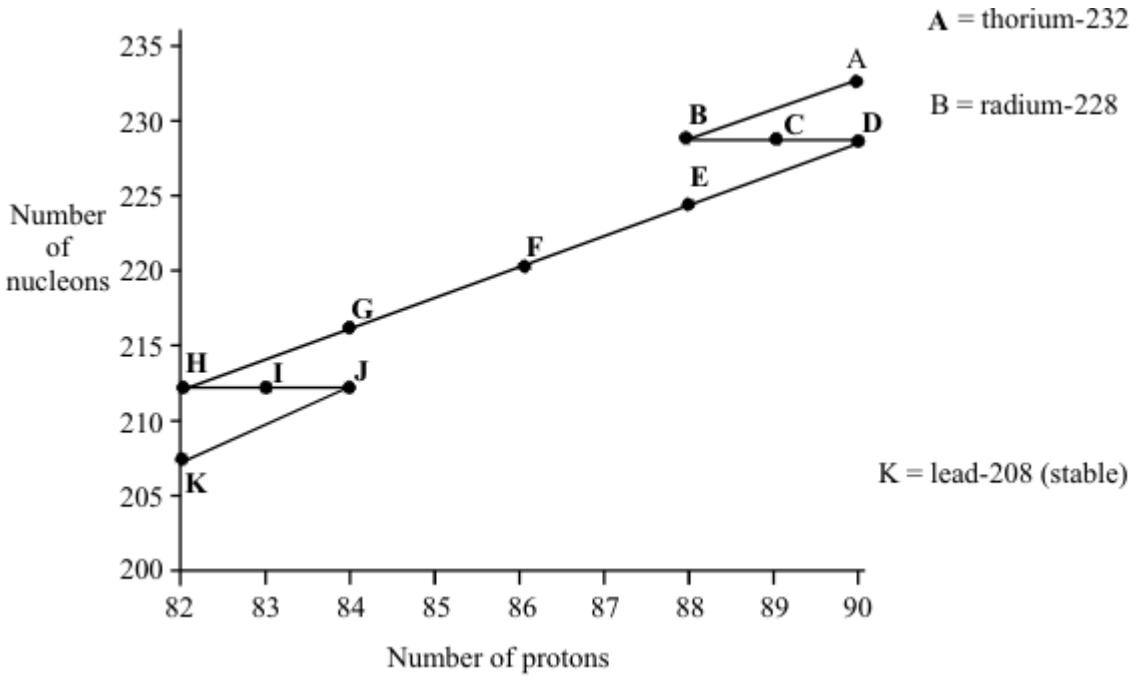
Complete the equation for this decay.

$$^{228}_{89}\text{Ac} \longrightarrow$$

(4)

(c) Thorium-232 eventually decays to the stable isotope lead-208.

All the steps in this process can be shown on a diagram.



(i) Complete the sentences:

During the decay from (A) to (B) a _____ particle is emitted.

During the decay from (B) to (C) a _____ particle is emitted.

During the decay from (E) to (F) a _____ particle is emitted.

During the decay from (I) to (J) a _____ particle is emitted.

(2)

(ii) The table shows how long it takes for half of the atoms of each isotope to decay.

ISOTOPE	TIME FOR HALF TO DECAY
A	billions of years
B	7 years
C	6 years
D	2 years
E	4 days
F	1 minute
G	0.4 seconds
H	10 hours
I	1 hour
J	0.3 microseconds

A rock sample contains:

- many atoms of thorium-232
- even more atoms of lead-208
- hardly any atoms of any of the other isotopes shown on the diagram

Explain this as fully as you can.

_____

_____

_____

_____

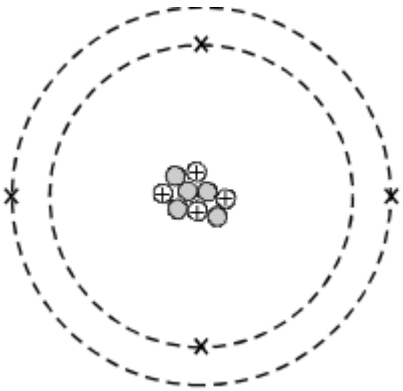
_____

(3)

(Total 13 marks)

Q5.

The diagram shows an atom.



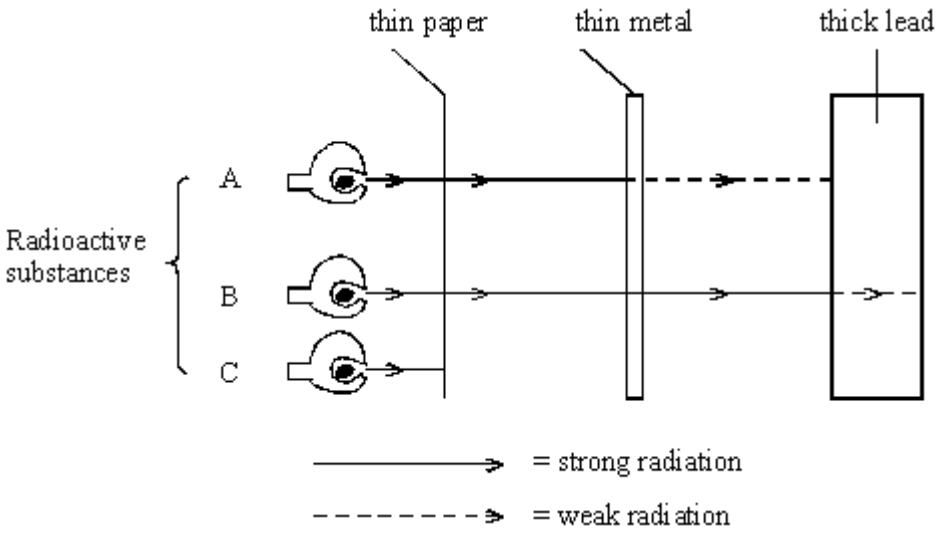
How many protons are there in the nucleus of the atom? _____

What is the mass number of the atom? _____

(Total 2 marks)

Q6.

The diagram shows what happens to the radiation from three radioactive substances when different materials are put in the way.



Choose types of radiation from this list to complete the table below.

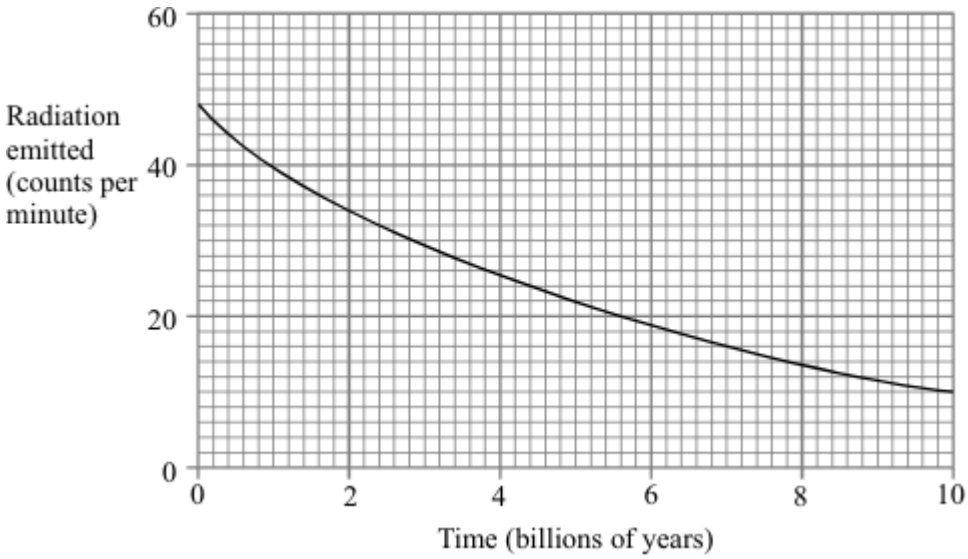
α (**alpha**) β (**beta**) γ (**gamma**) UV **(ultraviolet)**

RADIOACTIVE SUBSTANCE	TYPE OF RADIATION IT EMITS
A	
B	
C	

(Total 3 marks)

Q7.

The graph shows how the amount of radiation emitted by a sample of the radionuclide uranium 238 (U^{238}) changes as time passes.



(a) What is the half-life of uranium 238 (U^{238})?
(You should show how you obtained your answer. You may do this on the graph if you wish.)

_____

_____

Answer _____

(3)

(b) What fraction (or percentage) of the uranium 238 (U^{238}) atoms will have decayed after 9 billion years?

_____

(1)

(c) Uranium 238 (U^{238}) decays through a long series of intermediate radionuclides to stable atoms of the isotope lead 206 (Pb).

A sample of igneous rock contains 3 atoms of uranium 238 (U^{238}) for every atom of lead 206 (Pb^{206}).

(i) The intermediate radionuclides are not important when estimating the age of the rock. Explain why.

_____

_____

(1)

(ii) Estimate the age of the rock.
(You should explain how you obtained your answer.)

_____

_____

_____

Answer _____ billion years

(3)

(Total 8 marks)

Q8.

When atoms of uranium 238 (U^{234}) decay they produce another radionuclide called thorium 234 (Th^{234})

Thorium 234 (Th^{234}) decays by emitting beta radiation.

(i) What does beta radiation consist of?

_____

(1)

(ii) Thorium 234 (Th^{238}) decays to form protactinium 234 (Pa^{234}).

What differences are there between the nucleus of a protactinium 234 (Pa^{234}) atom and the nucleus of a thorium 234 (Th^{234}) atom?

_____

_____

(2)

(Total 3 marks)

Q9.

Lithium batteries are used in laptops.

The batteries contain a lithium compound.
The formula of the compound is $LiCoO_2$

(a) Complete the table to show the number of atoms of each element in the formula, $LiCoO_2$

Lithium has been completed for you

Element	**Number of atoms in the formula $LiCoO_2$**
Lithium, Li	1
Cobalt, Co	
Oxygen, O	

(2)

(b) Some laptops have caught fire.

Scientists think sparks caused the fires.
The sparks caused small particles of lithium in the batteries to react with oxygen.

(i) Suggest where the oxygen reacting with the lithium came from.

_____

_____

(1)

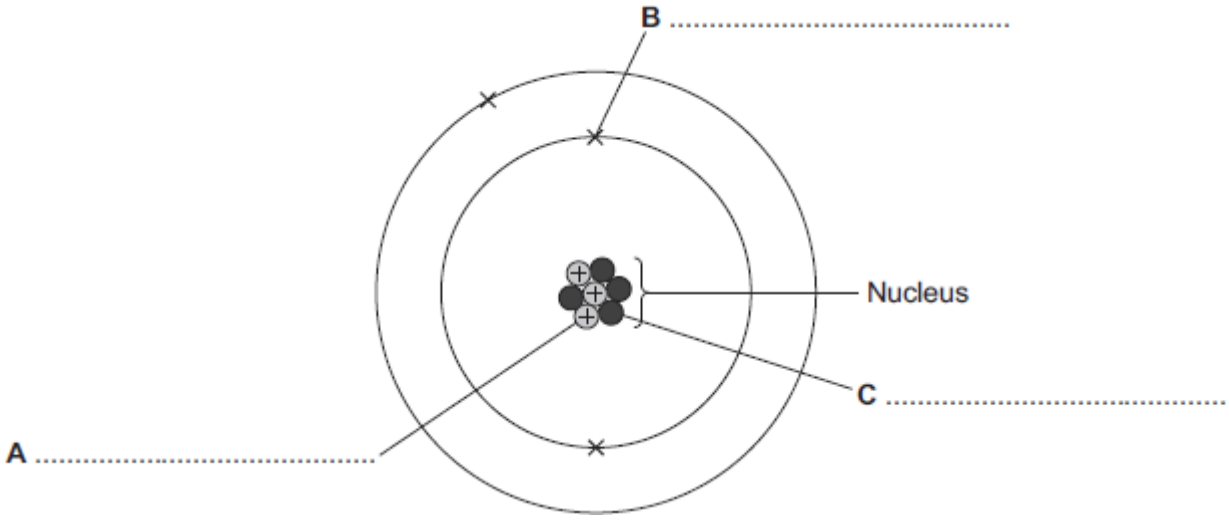
(ii) Name the product of the reaction between lithium and oxygen.

_____

(1)

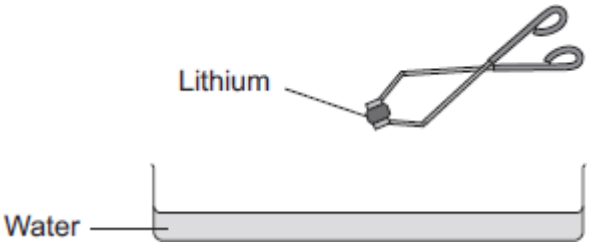
(c) The diagram below shows the structure of a lithium atom.

Name the particles labelled **A**, **B** and **C** on the diagram.



(3)

(d) Lithium hydroxide and hydrogen are produced when lithium reacts with water.



(i) Describe what you would **see** when lithium is added to water.

_____

_____

_____

_____

(2)

(ii) Complete the word equation for the reaction between lithium and water.

lithium + water ⟶ _____ + _____

(1)

(Total 10 marks)

Q10.

A gold medal was made for a competition.

By Fighting Irish 1977 (Flickr: 2012 Olympics Gold Medal) [CC-BY-2.0], via Wikimedia Commons

(a) The mass number of gold is 197.

Describe the structure of a gold atom.

Use the Chemistry Data Sheet to help you answer this question.

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(b) Bronze medals are made from an alloy of copper.

By Edgars Košovojs (Own work) [CC-BY-SA-3.0 or GFDL], via Wikimedia Commons

Copper can be extracted by phytomining.

(i) Why is phytomining being used to extract copper?

_____

_____

(1)

(ii) Give the main steps involved in the phytomining process.

_____

_____

_____

_____

_____

_____

(3)

(Total 8 marks)

Mark schemes

Q1.

(a) (i) and (ii) in any order

1

(i) alpha

accept Greek symbol (α)

1

He^{2+} **or** $^{4}_{2}He$

1

(ii) beta

accept Greek symbol (β) ***or*** *electron*

1

e^{-} or $^{0}_{-1}e$

mass and automatic numbers are not required

accept e

1

(b) (i) alpha

accept symbol

1

(ii) decreases

then stops (entirely) **or** after a few cm

accept stops because α can only travel a few cm in air

1

(c) it's gamma

accept its not ionising ***or*** *it is not charged* ***or*** *it's not α or β because a spark counter only measures α or β*

1

[8]

Q2.

(a) at least **6** points correctly plotted

gains 1 mark

(to better than half a square) **but all** points correctly plotted

gains 2 marks

2

any **line** graph related to plotted points;
point (3,29) discounted;
best fit smooth curve

each for 1 mark

3

(b) radiation decreases with time

gains 1 mark

but decreases quickly at first then more slowly
gains 2 marks

but *idea that* it (about) halves every 2 weeks **or** half-life is (about) 2 weeks
gains 3 marks

3

[8]

Q3.

(a) one relevant point correctly plotted
gains 1 mark

but two relevant points correctly plotted
gains 2 marks

but three relevant points correctly plotted
gains 3 marks

curved line drawn accurately through the points
for 1 further mark

4

(b) age of igneous rock = 400 ± 100 million years

1

(c) sandstone is a sedimentary rock
for 1 mark

there is likely to be some lead-207 present
or from the rocks from which the sandstone was formed
for 1 mark

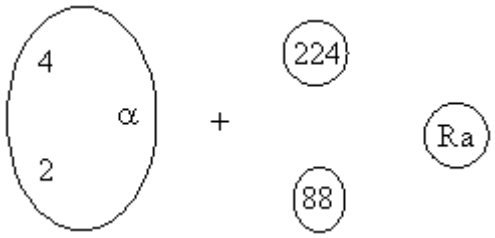
(*allow* ^{207}Pb may not have come from this ^{235}U)

2

[7]

Q4.

(a)

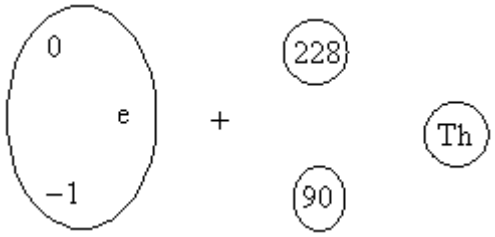


[Accept He^{2+} for α]

each ○ *for 1 mark*

4

(b)



[Accept β for e]

each ◯ *for 1 mark*

4

(c) (i) beta/ β alpha/ α
alpha/ α beta/ β
beta/ β but alpha/ α
alpha/ α beta/ β
[i.e. consistent for 1; consistent and correct for 2]

gains 2 marks

2

(ii) *ideas that*

- many thorium atoms because they take so long to decay*
- (many lead atoms because) the thorium has been decaying for so long/for billions of years

or (because) the rock is so/very/billions of years of years old

- many lead atoms because this is the stable end product [of the decay series]
- few atoms of other isotopes because they decay so quickly*

[*N.B. credit answers in terms of half-life]

any three for 1 mark each

3

[13]

Q5.

- 4
- 9

each for 1 mark

[2]

Q6.

A β / beta
B γ / gamma
C α / alpha

for 1 mark each

[3]

Q7.

(a) indication (in writing or on graph) of finding point where radiation is halved (e.g. to 24 [from an initial 48]) <u>and relating to the time difference between the two points</u>

gains 1 mark

but

4.2-4.8*
(*i.e. in this range, including extremes)
gains 2 marks

units billions of years
for 1 mark

3

(b) ¾ **or** 75%
[allow ecf from (a)]
for 1 mark

1

(c) (i) *idea that* the intermediate nuclides are relatively short-lived
for 1 mark

1

(ii) *idea that* ¼ has decayed **or** ¾ remains
gains 1 mark

but
read graph for radiation level of 36 (stated or shown on graph itself)
gains 2 marks

but
1.6-1.8* (billion years)
(* i.e. in this range, including extremes)
gains 3 marks

3

[8]

Q8.

(i) (fast moving) electrons (from the nucleus)
(*allow* negatively charged particles)
for 1 mark

1

(ii) protactinium has one neutron fewer
protactinium has one proton more
(*credit* has different numbers of neutrons / protons *with one mark*)
for 1 mark each

2

[3]

Q9.

(a) (Cobalt) 1

1

(Oxygen) 2

1

(b) (i) the lithium compound / $LiCoO_2$
allow from air / atmosphere / water (vapour)
allow the battery
ignore cracks, fan, gaps, surroundings and computer

1

(ii) lithium oxide

if correctly named, ignore at attempts at formula

allow Li_2O the letters L and O must be uppercase, and the letter i lowercase and the number a subscript

ignore references to di, tri etc

*do **not** accept lithium hydroxide*

1

(c) A = proton

1

B = electron

1

C = neutron

1

(d) (i) any **two** from:

- lithium moves (about on surface)

or

lithium floats

- lithium gets smaller
  allow lithium dissolves
  ignore lithium melts

- bubbles (of gas)
  allow fizzing / smoke
  ignore flame, sparks, cloudy water, any colours

2

(ii) lithium hydroxide + hydrogen

in either order

allow LiOH for lithium hydroxide allow H_2 for hydrogen the letters L, O and H must be uppercase, and the letter i lowercase and the number a subscript

1

[10]

Q10.

(a) protons = 79

allow proton number is 79

ignore atomic number

1

electrons = 79

1

neutrons = 118

1

protons **and** neutrons in nucleus and electrons in shells / energy levels / orbits around nucleus

*allow for **1** mark, protons, neutrons and electrons if no other*

mark obtained

1

(b) (i) supply of copper(-rich) ores is limited

allow can extract copper from low grade ores

or

to limit the environmental impact (of traditional mining)

ignore environmentally friendly unqualified

or

more economical than other methods

ignore it is cheaper unless qualified

1

(ii) plants (grown on land containing copper)

1

(plants) absorb copper compounds / ions

allow minerals

ignore copper / metal

1

(plants) burned to produce ash / metal compounds

1

[8]