

The Morley Academy

4. Atomic Structure Mastery Booklet

(Physics Paper 1)

Name : _____

Teacher : _____

Date Given : _____

These booklets are a consolidation of your learning. They should be used in the following way – You should attempt the questions WITHOUT looking at the answers. Then mark your questions with **green pen** and add any missing marks you missed. You should then present the completed document to your teacher to show WITHIN TWO weeks of receiving the booklet.

THIS WILL IMPROVE YOUR GRADES...!!

Q1.

Sources of background radiation are either natural or man-made.

- (a) Which **two** of the sources listed in the table are natural sources of background radiation?

Tick **two** boxes.

Cosmic rays

☐

Medical X-rays

☐

Nuclear power stations

☐

Nuclear weapons testing

☐

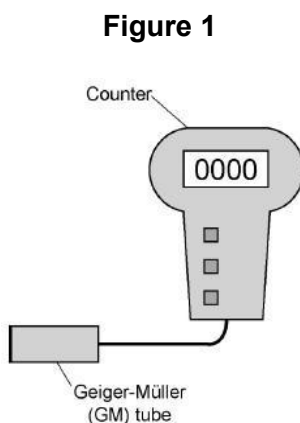
Radon gas

☐

(2)

A teacher used a Geiger-Müller (GM) tube and counter to measure the background radiation in his laboratory.

Figure 1 shows the GM tube and counter.



- (b) The table gives three readings taken by the teacher at three different times on the same day.

Counts in 1 minute
16
21
18

What is the most likely reason for the readings being different?

Tick **one** box.

Radioactive decay is a random process.

☐

The air pressure in the laboratory increased.

☐

The background radiation increased during the day.

☐

The temperature in the laboratory decreased.

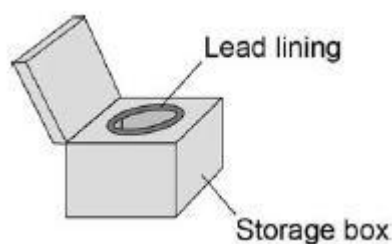
☐

(1)

- (c) The teacher takes a radioactive source from a storage box.

Figure 2 shows the box.

Figure 2



Why does storing the radioactive source in the box reduce the risk of radiation exposure to the teacher?

Tick **one** box.

The lead lining absorbs the emitted radiation.

☐

The lead lining reflects the emitted radiation.

☐

The lead lining transmits the emitted radiation.

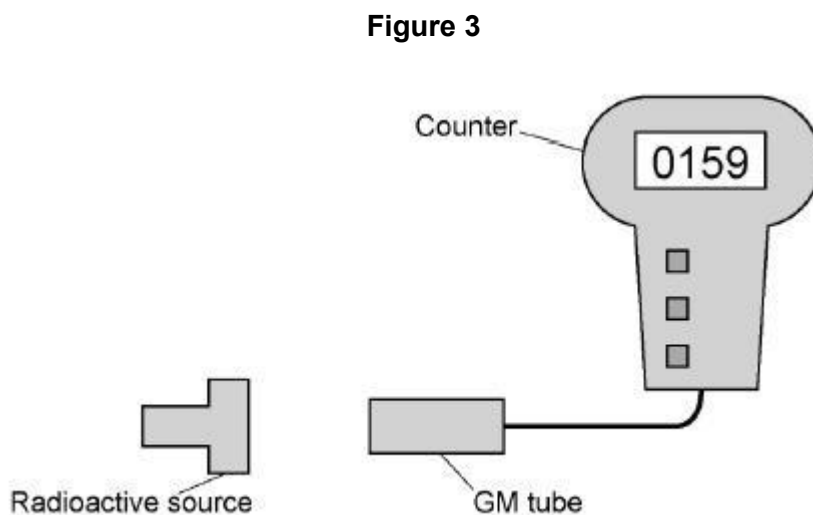
☐

(1)

- (d) **Figure 3** shows how the teacher used the GM tube and counter to measure the radiation emitted from the radioactive source.

The counter was reset to zero.

The count after one minute was 159.



How should the teacher calculate the counts from the radioactive source?

Tick **one** box.

Add the background count to 159

☐

Divide the background count by 159

☐

Multiply the background count by 159

☐

Subtract the background count from 159

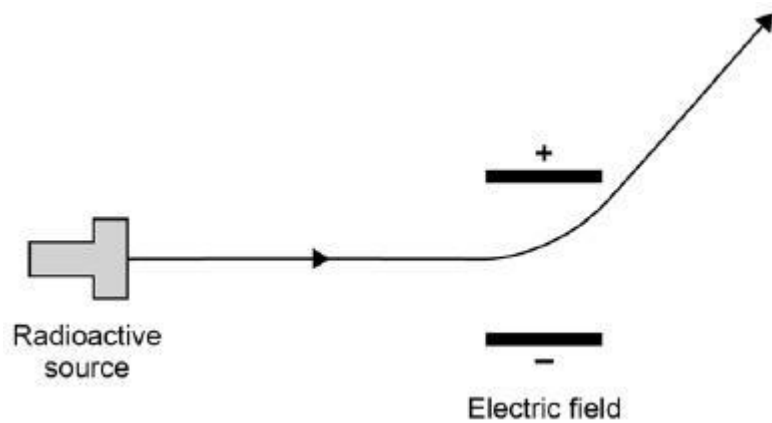
☐

(1)

- (e) The teacher passed the radiation through an electric field.

Figure 4 shows the path that the radiation took through the electric field.

Figure 4



What type of radiation was being emitted by the radioactive source?

Tick **one** box.

Alpha ☐ Beta ☐ Gamma ☐ Neutron ☐

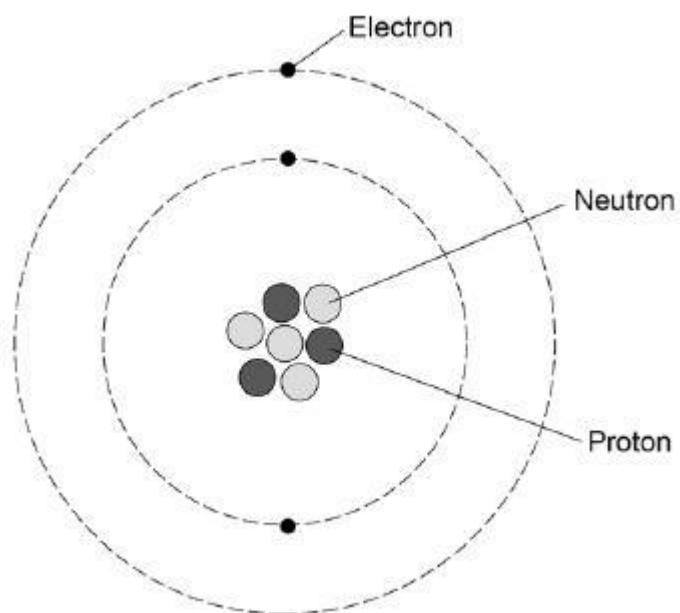
Explain the reason for your answer.

(3)

(Total 8 marks)

Q2.

The diagram shows a lithium atom.



- (a) What is the mass number of this lithium atom?

Tick **one** box.

3 ☐

4 ☐

7 ☐

10 ☐

(1)

- (b) What is the atomic number of a lithium atom?

Tick **one** box.

3 ☐

4 ☐

7 ☐

10 ☐

Give a reason for your answer.

(2)

- (c) Complete the sentence.

Choose the answer from the box.

circles	levels	rings
----------------	---------------	--------------

The electrons in an atom orbit in different energy _____.

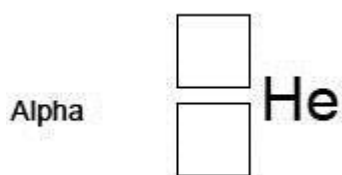
(1)

- (d) Some atomic nuclei are unstable and decay by emitting an alpha particle or a beta particle.

Complete the symbols for an alpha particle and a beta particle.

Use answers from the box.

-1	0	1	2	4
-----------	----------	----------	----------	----------



(3)

- (e) Doctors may use nuclear radiation to diagnose certain types of illness.

The table below gives data about three radiation sources used.

Each source emits beta radiation.

Radiation source	Half-life in minutes
Carbon-11	20
Nitrogen-13	10
Oxygen-15	2

Explain why oxygen-15 is likely to pose the least risk to a patient.

(2)

(Total 9 marks)

Q3.

Nuclear fission and nuclear fusion are two processes that release energy.

(a) The following nuclear equation represents the fission of uranium-235 (U-235).



Chemical symbols:

- Ba = barium
- Kr = krypton
- ${}_0^1\text{n}$ = neutron

Describe the process of nuclear fission.

Use the information in the equation.

(4)

(b) Explain what happens in the process of nuclear fusion.

- (c) Fission reactors are used in nuclear power stations.

Engineers are developing fusion reactors for use in power stations.

Fusion uses isotopes of hydrogen called deuterium and tritium.

- Deuterium is naturally occurring and can be easily extracted from seawater.
- Tritium can be produced from lithium. Lithium is also found in seawater.

The table shows the energy released from 1 kg of fusion fuel and from 1 kg of fission fuel.

Type of fuel	Energy released from 1 kg of fuel in joules
Fusion	3.4×10^{14}
Fission	8.8×10^{13}

Suggest **two** advantages of the fuel used in a fusion reactor compared with the fuel used in a fission reactor.

1. _____

2. _____

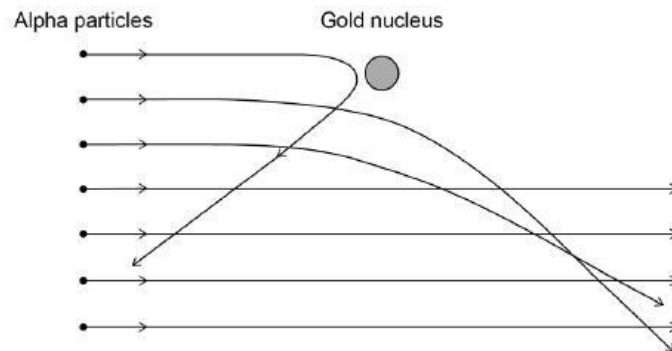
(2)

(Total 9 marks)

Q4.

In the early 20th century, scientists developed an alpha particle scattering experiment using gold foil.

The diagram shows the paths of some of the alpha particles in the alpha particle scattering experiment.



- (a) Explain how the paths of the alpha particles were used to develop the nuclear model of the atom.

(4)

- (b) Niels Bohr adapted the nuclear model by suggesting electrons orbited the nucleus at specific distances.

Explain how the distance at which an electron orbits the nucleus may be changed.

(3)
(Total 7 marks)

Q5.

Many countries use nuclear power stations to generate electricity.
Nuclear power stations use the process of nuclear fission to release energy.

- (a) (i) What is nuclear fission?

(1)

- (ii) Plutonium-239 is one substance used as a fuel in a nuclear reactor. For nuclear fission to happen, the nucleus must absorb a particle.

What type of particle must be absorbed?

(1)

- (b) Nuclear **fusion** also releases energy.
Nuclear fusion happens at very high temperatures. A high temperature is needed to overcome the repulsion force between the nuclei.

- (i) Why is there a repulsion force between the nuclei of atoms?

(1)

- (ii) Where does nuclear fusion happen naturally?

(1)

- (c) In 1991, scientists produced the first controlled release of energy from an experimental nuclear **fusion** reactor. This was achieved by fusing the hydrogen isotopes, deuterium and tritium.

Deuterium is naturally occurring and can easily be extracted from seawater. Tritium can be produced from lithium. Lithium is also found in seawater.

The table gives the energy released from 1 kg of fusion fuel and from 1 kg of fission fuel.

Type of fuel	Energy released from 1 kg of fuel in joules
--------------	--

Fusion fuel	3.4×10^{14}
Fission fuel	8.8×10^{13}

- (i) Suggest **two** advantages of the fuel used in a fusion reactor compared with plutonium and the other substances used as fuel in a fission reactor.

1. _____

2. _____

(2)

- (ii) Some scientists think that by the year 2050 a nuclear fusion power station capable of generating electricity on a large scale will have been developed.

Suggest **one** important consequence of developing nuclear fusion power stations to generate electricity.

(1)

- (d) Tritium is radioactive.

After 36 years, only 10 g of tritium remains from an original sample of 80 g.

Calculate the half-life of tritium.

Show clearly how you work out your answer.

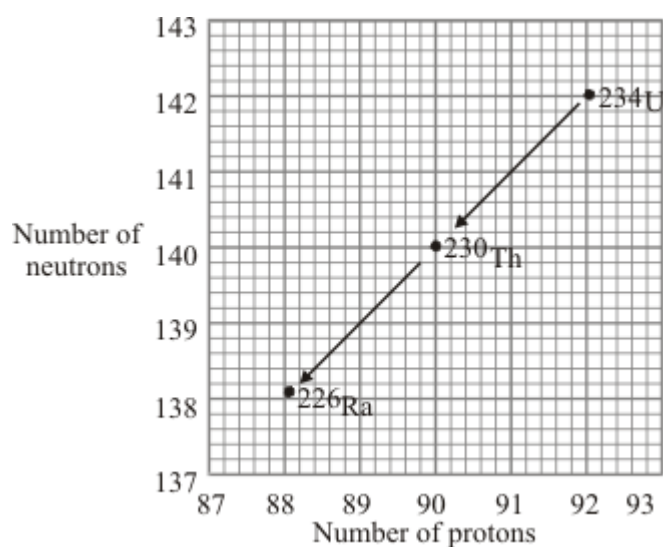
Half-life = _____ years

(2)

(Total 9 marks)

Q6.

- (a) Uranium-234 (^{234}U) is a radioactive element. The graph shows the number of protons and neutrons in the nuclei of the elements formed when uranium-234 decays.



- (i) How does the graph show that uranium-234 (^{234}U) and thorium-230 (^{230}Th) emit alpha particles?

(1)

- (ii) What makes uranium and thorium different elements?

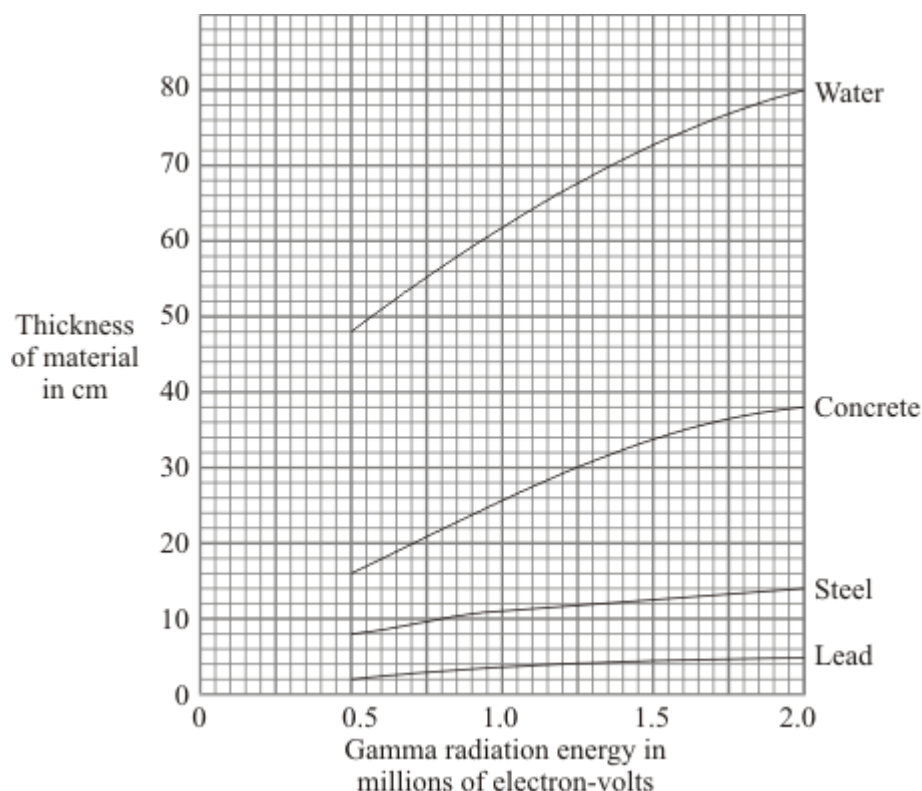
(1)

- (iii) Radioactive decay may also produce gamma radiation.

Why does the emission of gamma radiation **not** cause a new element to be formed?

(1)

- (b) The graph shows how the thickness of different materials needed to absorb 90% of the gamma radiation emitted by a source depends on the energy of the radiation. The energy of the gamma radiation is given in units called electron-volts.



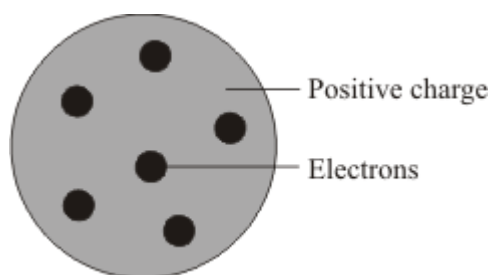
- (i) Which of the materials shown is least effective at absorbing gamma radiation? Use the information in the graph to give a reason for your answer.

(1)

- (ii) For gamma radiation of energy 1.5 million electron-volts, how many times more effective is steel than water at absorbing the radiation? Show clearly how you obtain your answer.

(2)

- (c) Scientists in the early twentieth century thought that atoms were made up of electrons scattered inside a ball of positive charge. This was called the 'plum-pudding' model of the atom.



Plum pudding model

Rutherford and Marsden did an experiment, in which a beam of alpha particles was aimed at a thin sheet of gold.

Explain how the results of this experiment led to a new model of the atom.

You may include one or more diagrams in your answer.

Q7.

In 2011 an earthquake caused severe damage to a nuclear power station in Japan.

The damage led to the release of large amounts of radioactive iodine-131 ($^{131}_{53}\text{I}$) into the atmosphere.

- (a) The table gives some information about an atom of iodine-131 ($^{131}_{53}\text{I}$).

Complete the table.

mass number	131
number of protons	53
number of neutrons	

(1)

- (b) Complete the sentence.

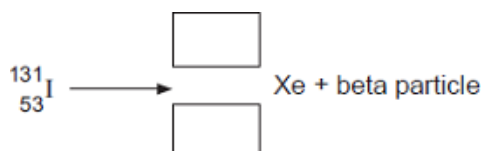
The number of protons in an atom is called the proton number or the _____ number.

(1)

- (c) An atom of iodine-131 decays into an atom of xenon (Xe) by emitting a beta particle.

- (i) The decay of iodine-131 can be represented by the equation below.

Complete the equation by writing the correct number in each of the **two** boxes.



(2)

- (ii) A sample of rainwater contaminated with iodine-131 gives a count rate of 1200 counts per second.

Calculate how many days it will take for the count rate from the sample of rainwater to fall to 75 counts per second.

Half-life of iodine-131 = 8 days

Show clearly how you work out your answer.

_____ days

(2)

- (iii) If people drink water contaminated with iodine-131, the iodine-131 builds up in the thyroid gland. This continues until the thyroid is saturated with iodine-131 and cannot absorb any more. The radiation emitted from the iodine-131 could cause cancer of the thyroid.

In Japan, people likely to be drinking water contaminated with iodine-131 were advised to take tablets containing a non-radioactive isotope of iodine.

Suggest why this advice was given.

(2)

(Total 8 marks)

Q8.

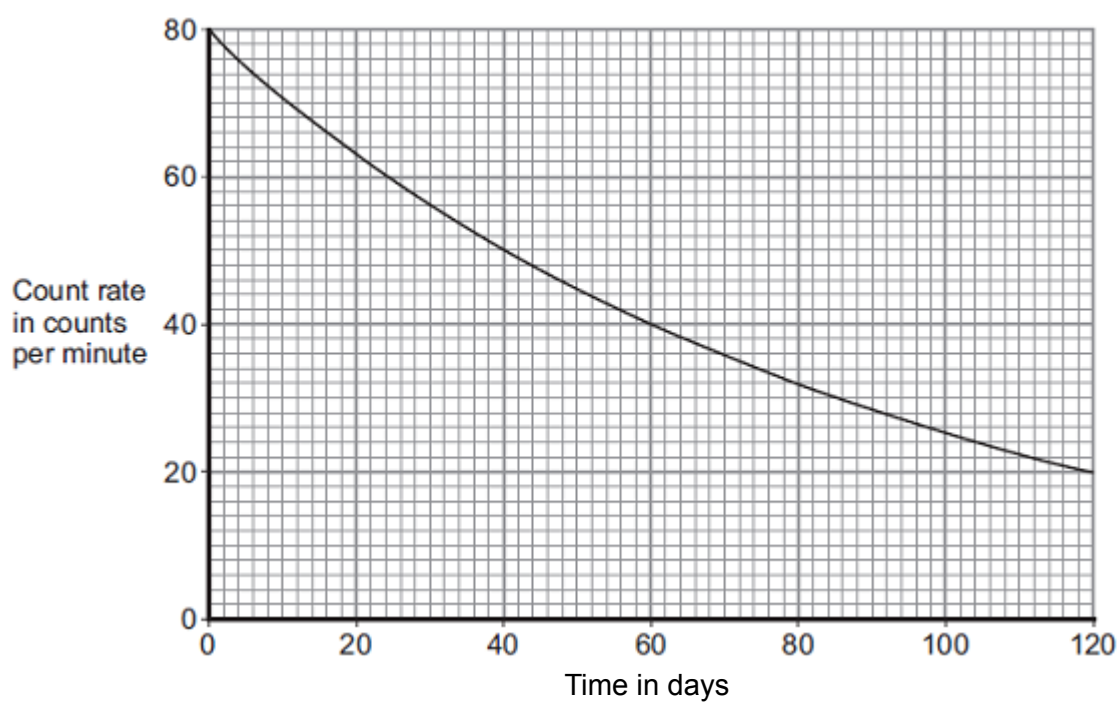
Different radioactive isotopes have different values of half-life.

- (a) What is meant by the 'half-life' of a radioactive isotope?

(1)

- (b) **Figure 1** shows how the count rate from a sample of a radioactive isotope varies with time.

Figure 1



Use information from **Figure 1** to calculate the half-life of the radioactive isotope.

Show clearly on **Figure 1** how you obtain your answer.

Half-life = _____ days

(2)

- (c) The table below shows data for some radioactive isotopes that are used in schools.

Radioactive isotope	Type of radiation emitted	Half-life in years
Americium-241	Alpha and gamma	460
Cobalt-60	Gamma	5
Radium-226	Alpha, beta and gamma	1600
Strontium-90	Beta	28
Thorium-232	Alpha and beta	1.4×10^{10}

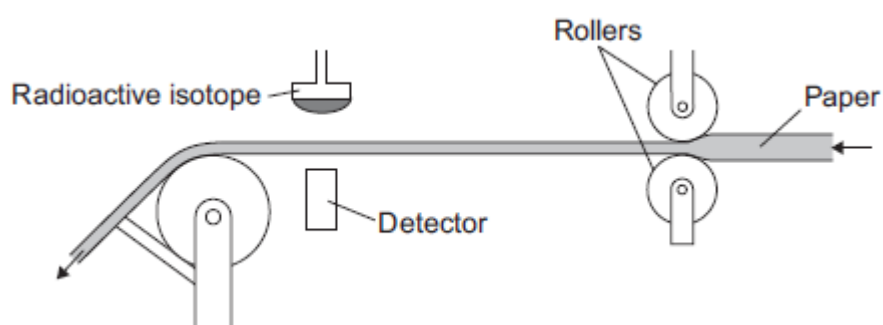
- (i) State which radioactive isotope in the table above emits only radiation that is **not** deflected by a magnetic field.

Give a reason for your choice.

(2)

- (ii) **Figure 2** shows a radioactive isotope being used to monitor the thickness of paper during production.

Figure 2



State which radioactive isotope in the table should be used to monitor the thickness of the paper.

Explain your choice.

(3)

All the radioactive isotopes in the table have practical uses.

State which source in the table would need replacing most often.

Explain your choice.

(3)

- (iii) When the radioactive isotopes are not in use, they are stored in lead-lined wooden boxes.

The boxes reduce the level of radiation that reaches the surroundings.

Figure 3 shows two of these boxes.

Figure 3



© David McKean

State **one** source from the table which emits radiation that could penetrate the box.

Explain your answer.

(3)

(Total 14 marks)

Q9.

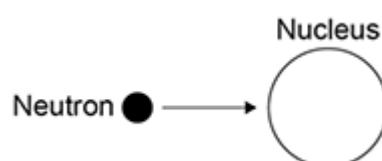
Electricity is generated in a nuclear power station.

Fission is the process by which energy is released in the nuclear reactor.

(a) **Figure 1** shows the first part of the nuclear fission reaction.

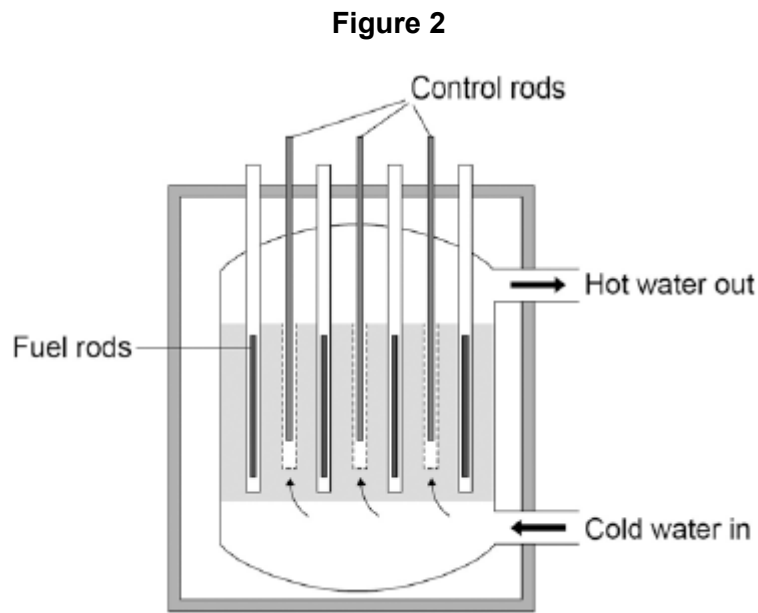
Complete **Figure 1** to show how the fission process starts a chain reaction.

Figure 1



(3)

- (b) **Figure 2** shows the inside of a nuclear reactor in a nuclear power station.



In a nuclear reactor a chain reaction occurs, which causes neutrons to be released.

The control rods absorb neutrons.

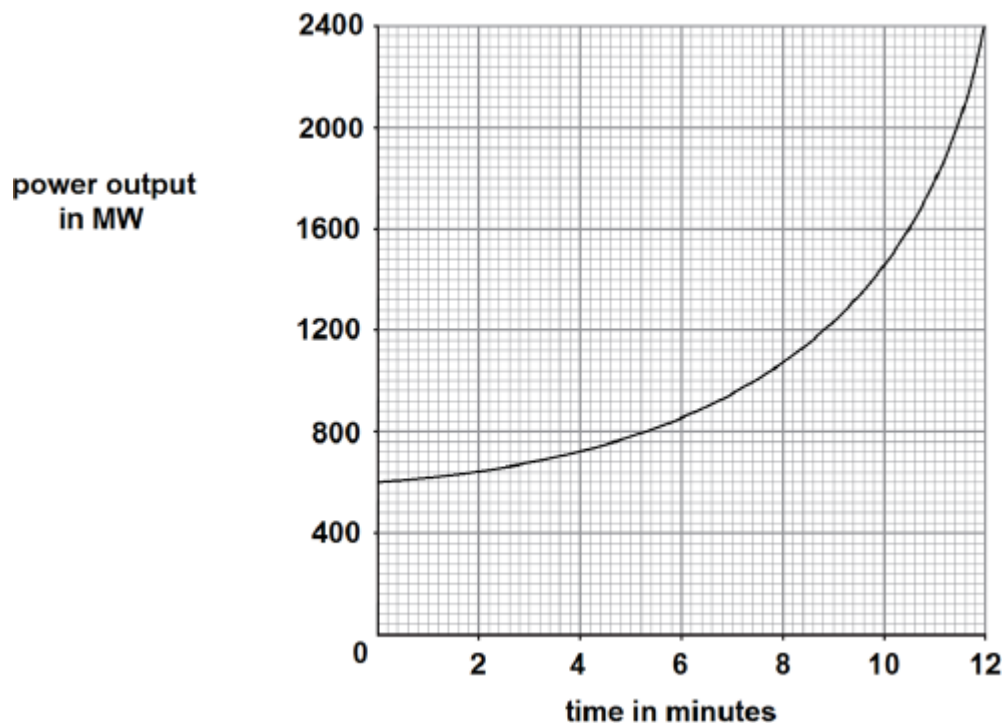
The control rods can be moved up and down.

Explain how the energy released by the chain reaction is affected by moving the control rods.

(2)

- (c) **Figure 3** shows how the power output of the nuclear reactor would change if the control rods were removed.

Figure 3



Calculate the rate of increase of power output at 10 minutes.

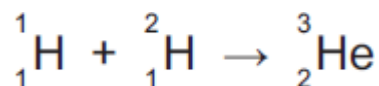
Rate of increase of power output = _____ MW / minute

(2)

(Total 7 marks)

Q10.

The equation below shows the process by which two atomic nuclei join to form a different nucleus.



- (a) Where does the process shown by the equation above happen naturally?

Tick (✓) **one** box.

Inside the Earth

☐

Inside a nuclear power station

Inside the Sun

(1)

- (b) Use the correct answer from the box to complete the sentence.

fission	force	fusion
----------------	--------------	---------------

The process of joining two atomic nuclei to form a different nucleus is called nuclear _____.

(1)

- (c) What is released during this process?

Draw a ring around the correct answer.

charge **energy** **force**

(1)

(Total 3 marks)

Q11.

Atoms are different sizes.

One of the heaviest naturally occurring stable elements is lead.

Two of its isotopes are lead-206 ($^{206}_{82}\text{Pb}$) and lead-208 ($^{208}_{82}\text{Pb}$).

- (a) (i) What is meant by 'isotopes'?

(2)

- (ii) How many protons are in the nucleus of a $^{206}_{82}\text{Pb}$ atom?

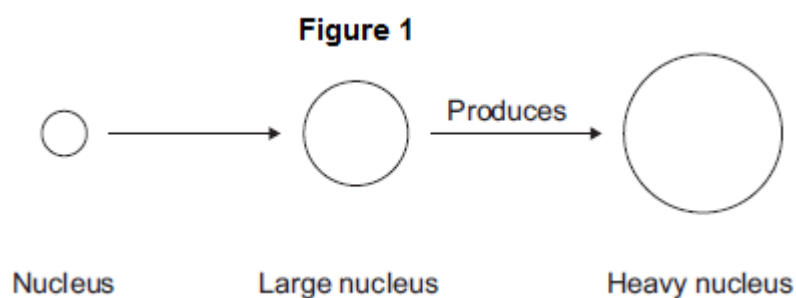
(1)

- (iii) How many neutrons are in the nucleus of a $^{206}_{82}\text{Pb}$ atom?

_____ (1)

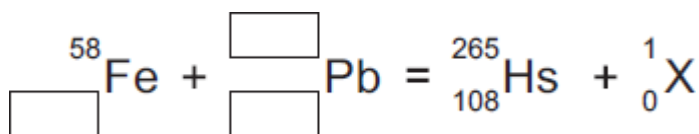
- (b) A nucleus can be accelerated in a particle accelerator and directed at a large nucleus. This produces a heavy nucleus that will decay after a short time.

This is shown in **Figure 1**.



- (i) In 1984, nuclei of iron (Fe) were directed at nuclei of lead (Pb). This produced nuclei of hassium (Hs).

Complete the equation for this reaction by writing numbers in the empty boxes.



(3)

- (ii) Use the correct answer from the box to complete the sentence.

an electron	a proton	a neutron
-------------	----------	-----------

The particle **X** in part (b)(i) is _____.

(1)

- (iii) After acceleration the iron nuclei travel at a steady speed of one-tenth of the speed of light.

The speed of light is 3.00×10^8 m/s.

Calculate the time taken for the iron nuclei to travel a distance of 12 000 m.

Time taken = _____ s

(2)

- (iv) Linear accelerators, in which particles are accelerated in a straight line, are **not** used for these experiments. Circular particle accelerators are used.

Suggest why.

(3)

- (c) Hassium-265 ($^{265}_{108}\text{Hs}$) decays by alpha emission with a half-life of 0.002 seconds.

- (i) What is meant by 'half-life'?

Tick (✓) **two** boxes.

	Tick (✓)
The average time for the number of nuclei to halve	
The time for count rate to be equal to background count	
The time for background count to halve	
The time for count rate to halve	

(2)

- (ii) Complete the equation for the decay of Hs-265 by writing numbers in the empty boxes.



(2)

- (d) The table below shows how the atomic radius of some atoms varies with atomic number.

Atomic	Atomic radius in
--------	------------------

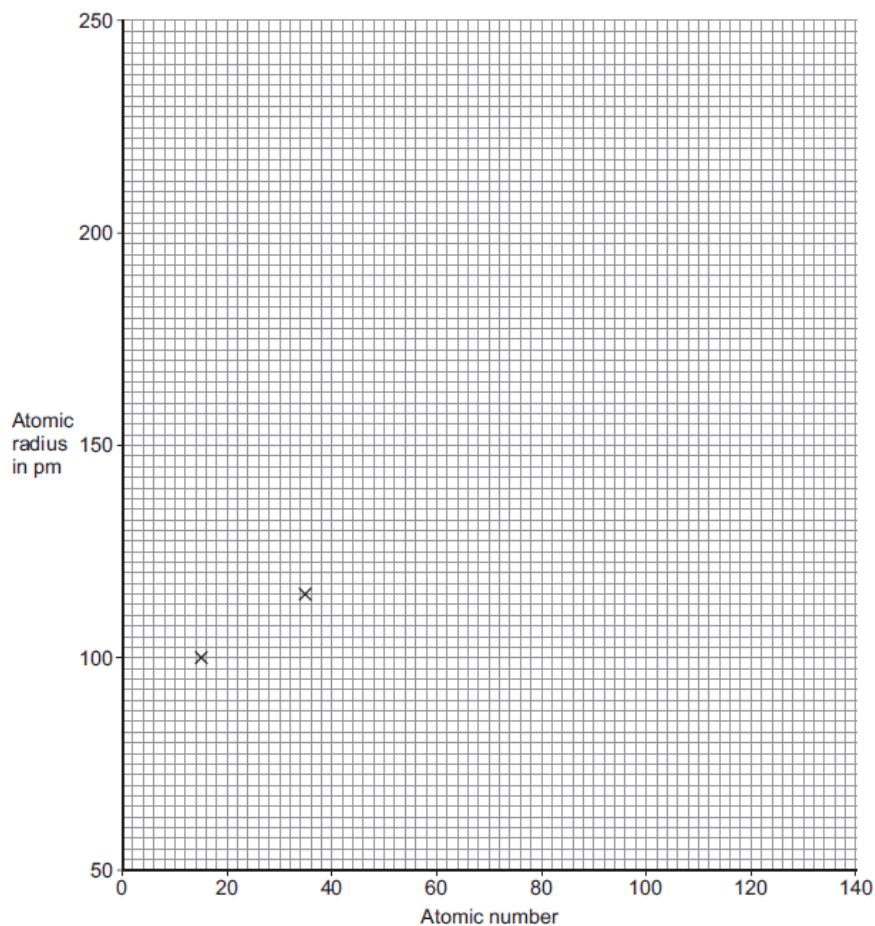
number	picometres (pm)
15	100
35	115
50	130
70	150
95	170

$$1 \text{ pm} = 10^{-12} \text{ m}$$

- (i) On **Figure 2**, use the data from the table above to plot a graph of atomic radius against atomic number and draw a line of best fit.

Two points have been plotted for you.

Figure 2



(2)

- (ii) Scientists believe that the element with atomic number 126 can be produced and that it will be stable.

Use your graph in **Figure 2** to predict the atomic radius of an atom with atomic number 126.

Atomic radius = _____ pm

(1)

(Total 20 marks)

Q12.

A student models the random nature of radioactive decay using 100 dice.

He rolls the dice and removes any that land with the number 6 facing upwards.

He rolls the remaining dice again.

The student repeats this process a number of times.

The table below shows his results.

Roll number	Number of dice remaining
0	100
1	84
2	70
3	59
4	46
5	40
6	32
7	27
8	23

- (a) Give **two** reasons why this is a good model for the random nature of radioactive decay.

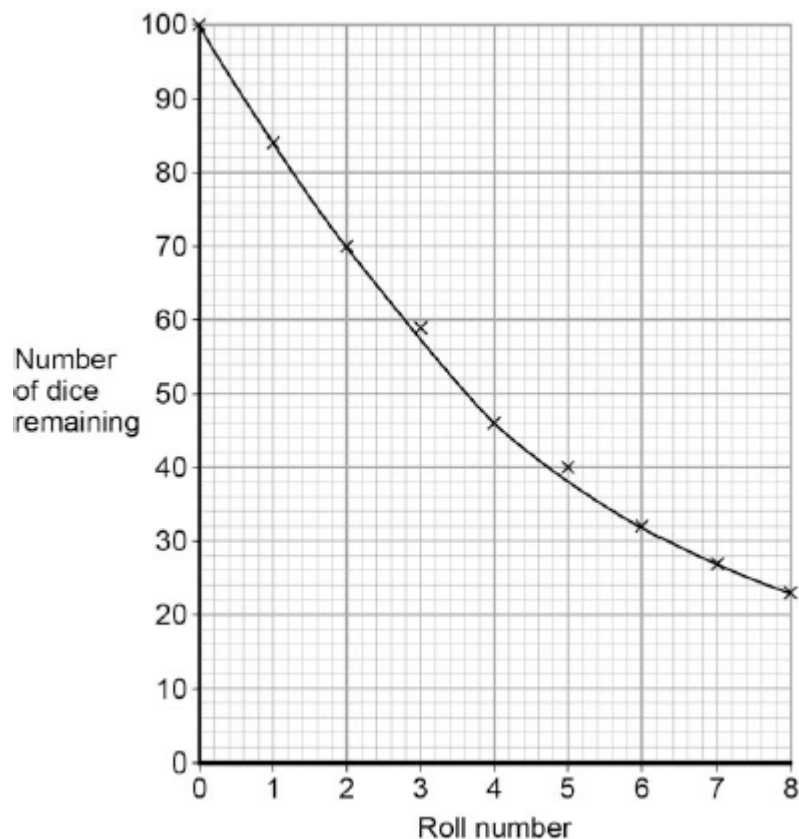
1. _____

2. _____

(2)

- (b) The student's results are shown in **Figure 1**.

Figure 1



Use **Figure 1** to determine the half-life for these dice using this model.

Show on **Figure 1** how you work out your answer.

Half-life = _____ rolls

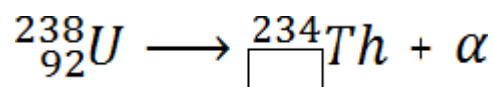
(2)

- (c) A teacher uses a protactinium (Pa) generator to produce a sample of radioactive material that has a half-life of 70 seconds.

In the first stage in the protactinium generator, uranium (U) decays into thorium (Th) and alpha (α) radiation is emitted.

The decay can be represented by the equation shown in **Figure 2**.

Figure 2



Determine the atomic number of thorium (Th) 234.

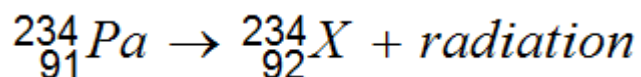
Atomic number = _____

(1)

- (d) When protactinium decays, a new element is formed and radiation is emitted.

The decay can be represented by the equation shown in **Figure 3**.

Figure 3



When protactinium decays, a new element, **X**, is formed.

Use information from **Figure 2** and **Figure 3** to determine the name of element **X**.

(1)

- (e) Determine the type of radiation emitted as protactinium decays into a new element.

Give a reason for your answer.

(2)

- (f) The teacher wears polythene gloves as a safety precaution when handling radioactive materials.

The polythene gloves do **not** stop the teacher's hands from being irradiated.

Explain why the teacher wears polythene gloves.

(2)

(Total 10 marks)

Mark schemes

Q1.

- | | | | |
|-----|---|---|------------|
| (a) | cosmic rays | 1 | |
| | radon gas | 1 | |
| (b) | radioactive decay is a random process | 1 | |
| (c) | the lead lining absorbs the emitted radiation | 1 | |
| (d) | subtract the background count from 159 | 1 | |
| (e) | beta | 1 | |
| | beta is negatively charged | 1 | |
| | (so is) attracted to positive plate | | |
| | or | | |
| | (so is) repelled by negative plate | 1 | |
| | | | [8] |

Q2.

- | | | | |
|-----|--|---|--|
| (a) | 7 | 1 | |
| (b) | 3 | 1 | |
| | number of <u>protons</u> | | |
| | <i>reason only scores if 3 chosen</i> | 1 | |
| (c) | levels | 1 | |
| (d) | ${}^4_2\text{He}$ | 1 | |
| | <i>correct order only</i> | 1 | |
| | ${}^0_{-1}\text{e}$ | 1 | |
| (e) | shorter half-life (than the other sources) | 1 | |

exposure time to radiation is shorter

1

[9]

Q3.

(a) a uranium nucleus

1

absorbs a neutron

1

(uranium-236 nucleus) splits into two smaller nuclei

or

Kr and Ba nuclei

or

krypton and barium nuclei

1

and releases 3 neutrons and energy

1

(b) light nuclei

1

join to form a heavier nucleus

allow hydrogen nuclei for light nuclei

allow helium nucleus for heavier nucleus

1

(some of the) mass of the nuclei is converted to energy

allow particles for nuclei

1

(c) any **two** from:

- easy to obtain / extract
- available in (very) large amounts
- releases more energy (per kg)

*do **not** accept figures **only***

naturally occurring is insufficient

seawater is renewable is insufficient

less cost is insufficient

allow produces little / no radioactive waste

2

[9]

Q4.

(a) most alpha particles pass straight through the atom

1

which shows that the atom is mostly empty space

1

very few alpha particles are deflected through a large angle

which shows the atom contains a nucleus where the mass / charge of the atom is concentrated

1

1

- (b) electron may absorb electromagnetic radiation
full credit may be scored for a description of an electron emitting electromagnetic radiation

1

(and) move further from the nucleus

1

to a higher energy level

1

[7]

Q5.

- (a) (i) splitting of a(n atomic) nucleus
do not accept splitting an atom

1

- (ii) Neutron

1

- (b) (i) nuclei have the same charge
or
nuclei are positive
accept protons have the same charge

1

- (ii) (main sequence) star
accept Sun or any correctly named star
accept red (super) giant

1

- (c) (i) any **two** from:
- easy to obtain / extract
 - available in (very) large amounts
 - releases more energy (per kg)
- do not accept figures only*
- produces little / no radioactive waste.
naturally occurring is insufficient
seawater is renewable is insufficient
less cost is insufficient

2

- (ii) any **one** from:
- makes another source of energy available
 - increases supply of electricity
 - able to meet global demand
 - less environmental damage
 - reduces amount of other fuels used.
accept any sensible suggestion

accept a specific example
accept a specific example

1

(d) 12

allow 1 mark for obtaining 3 half-lives

2

[9]

Q6.

- (a) (i) both lose 2 protons and (2) neutrons
accept changes by 2 protons and 2 neutrons

1

- (ii) different number of protons (in the nucleus)
accept different atomic number
*do **not** accept different number of protons and neutrons or*
different mass number
ignore electrons

1

- (iii) gamma involves no change in the number of protons (in the nucleus)
or gamma is a wave (not a particle)
*do **not** accept number of neutrons*
and / or protons
ignore electrons

1

- (b) (i) water because
*both material **and** reason required*

for all energy values the thickness
of water needed to absorb (90% of)
the radiation is more than the other materials

*accept thickness of water required is always more
than the other materials*

1

- (ii) 6
allow 1 mark for obtaining both correct values 72
***and** 12 from graph*
allow 1 mark for incorrect values 71 and / or
11 from graph evaluated correctly

2

- (c) any **three** from:
may be scored on annotated diagram provided
not negated elsewhere

- most (alpha) particles passed
undeflected / straight through the gold
- suggesting most of the atom is empty (space)

- a few (alpha) particles scattered / deflected through (very) large angles
accept repelled
*do **not** accept reflected / rebound / bounce back*
- suggesting a concentrated / small nucleus
- nucleus is positive because it repels the positive (alpha) particles
no reference to experiment, maximum 1 mark

3

[9]

Q7.

(a) 78

1

(b) atomic

1

(c) (i) 131

correct order only

1

54

1

(ii) 32 (days)

allow 1 mark for showing 4 half-lives provided no subsequent step

2

(iii) limits amount of iodine-131 / radioactive iodine that can be absorbed

accept increases level of non-radioactive iodine in thyroid

*do **not** accept cancels out iodine-131*

1

so reducing risk of cancer (of the thyroid)

accept stops risk of cancer (of the thyroid)

1

[8]

Q8.

(a) (average) time taken for the amount / number of nuclei / atoms (of the isotope in a sample) to halve

or

time taken for the count rate (from a sample containing the isotope) to fall to half

accept (radio)activity for count rate

1

(b) 60 ± 3 (days)

1

indication on graph how value was obtained

1

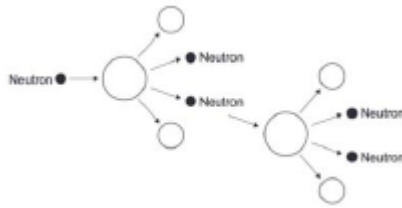
(c) (i)	cobalt(-60)	1
	<i>gamma not deflected by a magnetic field</i> or <i>gamma have no charge</i> <i>dependent on first marking point</i> <i>accept (only) emits gamma</i> <i>gamma has no mass is insufficient</i> <i>do not accept any reference to half-life</i>	1
(ii)	strontium(-90)	1
	any two from: • <i><u>only</u> has beta</i> • <i>alpha would be absorbed</i> • <i>gamma unaffected</i> • <i>beta penetration / absorption depends on thickness of paper</i> <i>if thorium(-232) or radium(-226) given, max 2 marks can be awarded</i>	2
(iii)	cobalt(-60)	1
	shortest half-life <i>accept half-life is 5 years</i> <i>dependent on first marking point</i>	1
	so activity / count rate will decrease quickest	1
(iv)	americium(-241) / cobalt(-60) / radium(-226)	1
	gamma emitter	1
	(only gamma) can penetrate lead (<i>of this box</i>) <i>do not allow lead fully absorbs gamma</i>	1
		[14]

Q9.

(a)	Nucleus splitting into two fragments and releasing two or three neutrons	1
	(at least one) fission neutron shown to be absorbed by additional large nucleus and causing fission	1
	two or three additional neutrons released from fission reaction	

1

This diagram would gain all 3 marks:



- (b) lowering the control rods increases the number of neutrons absorbed
accept converse description

1

(so) energy released decreases

1

allow changing the position of the control rods affects the number of neutrons absorbed for 1 mark

- (c) rate of increase between 240 and 276 (MW / min)

2

allow 1 mark for attempt to calculate gradient of line at 10 minutes

[7]

Q10.

- (a) inside the Sun

1

- (b) fusion

1

- (c) energy

1

[3]

Q11.

- (a) (i) (atoms with the) same number of protons
allow same atomic number
or same proton number

1

(atoms with) different number of neutrons
allow different mass number

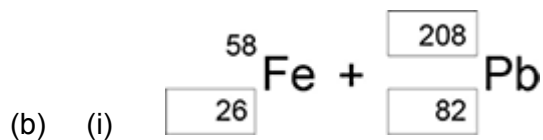
1

- (ii) 82

1

- (iii) 124

1



1 mark for each correct box

3

(ii) (a) neutron

1

(iii) 4.0×10^{-4} (s)

or

0.0004

$$3.00 \times 10^8 \times 0.1 = 12\,000 / t$$

gains 1 mark

2

(iv) particles need to travel a large distance

1

equipment would have to be very long

1

with circular paths long distances can be accommodated in a smaller space

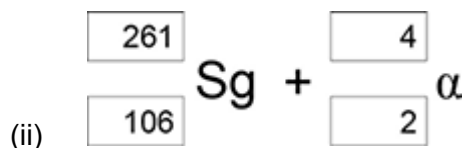
1

(c) (i) the average time for the number of nuclei to halve

1

the time for count rate to halve

1



1 mark if top boxes total = 265

***and** bottom boxes total = 108*

1 mark for 4 and 2 for alpha

2

(d) (i) 3 plotted points

$\pm \frac{1}{2}$ small square

1

best line through points

- (ii) 190–205 (pm)
or correct from student's line

1

1

[20]

Q12.

- (a) cannot predict which dice / atom will 'decay'
accept answers given in terms of 'roll a 6'

1

cannot predict when a dice / atom will 'decay'

1

- (b) 3.6 to 3.7 (rolls)
allow 1 mark for attempt to read graph when number of dice
= 50

2

- (c) 90

1

- (d) uranium

1

- (e) beta

1

proton number has gone up (as neutron decays to proton and e^-)

1

- (f) prevents contamination

or

prevents transfer of radioactive material to teacher's hands

1

which would cause damage / irradiation over a longer time period.

1

[10]