

# Atoms and Nuclear Radiation

## Question Paper 1

Level	GCSE (9-1)
Subject	Combined Science: Trilogy - Physics
Exam Board	AQA
Topic	6.4 Atomic Structure
Sub-Topic	Atoms and Nuclear Radiation
Difficulty Level	Bronze Level
Booklet	Question Paper 1

**Time Allowed:** 59 minutes

**Score:** /58

**Percentage:** /100

**Grade Boundaries:**

**Q1.** The nuclei of some isotopes are radioactive.

- (a) Which of the following statements could apply to a radioactive nucleus?

Tick **one** box.

The nucleus will emit an atom.

☐

The nucleus will emit light.

☐

The nucleus will emit a neutron.

☐

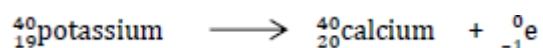
The nucleus will emit sound.

☐

(1)

- (b) Potassium-40 is a radioactive isotope present in food, such as bananas.

The following equation shows how potassium-40 will decay into calcium-40



Give one similarity and one difference between nuclei of potassium-40 and calcium-40

Similarity .....

Difference .....

(2)

- (c) The activity of a sample of potassium-40 is measured 3 times.

The measurements are given below.

**4906 Bq**

**4956 Bq**

**4889 Bq**

Which of the following statements explains why the readings are different?

Tick **one** box.

Radioactive decay is constant.

☐

Radioactive decay is hazardous.

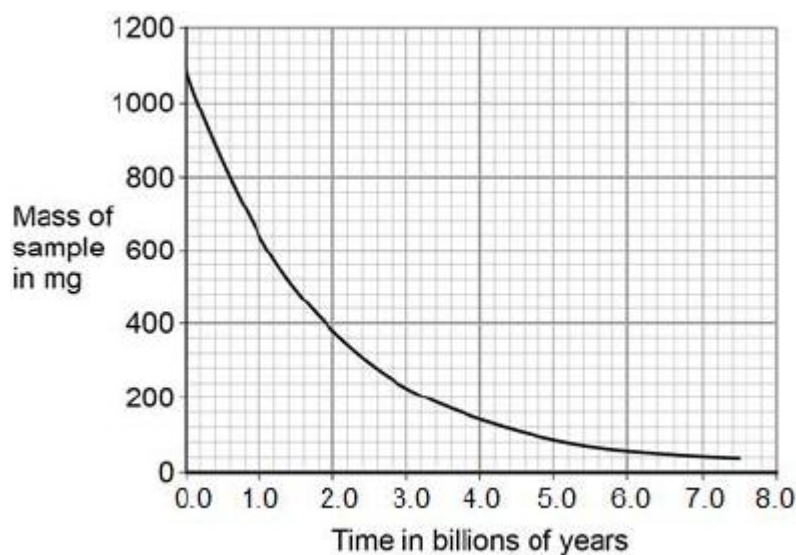
☐

Radioactive decay is random.

☐

(1)

- (d) The figure below shows how the activity of a sample of potassium-40 changes over time.



Use the figure above to determine the half-life of potassium-40.

.....  
 .....

Half-life = ..... billion years

(2)

- (e) When food is eaten, some of the radiation the food emits is detectable outside the body.

Which type of radiation would not be detectable outside the body?

Tick **one** box.

alpha

beta

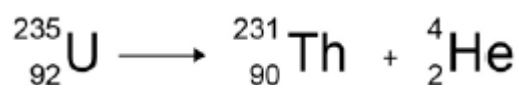
gamma

(1)  
(Total 7 marks)

**Q2.** This question is about radioactive decay.

- (a) **Figure 1** shows a nuclear equation for the decay of an atom of uranium.

**Figure 1**



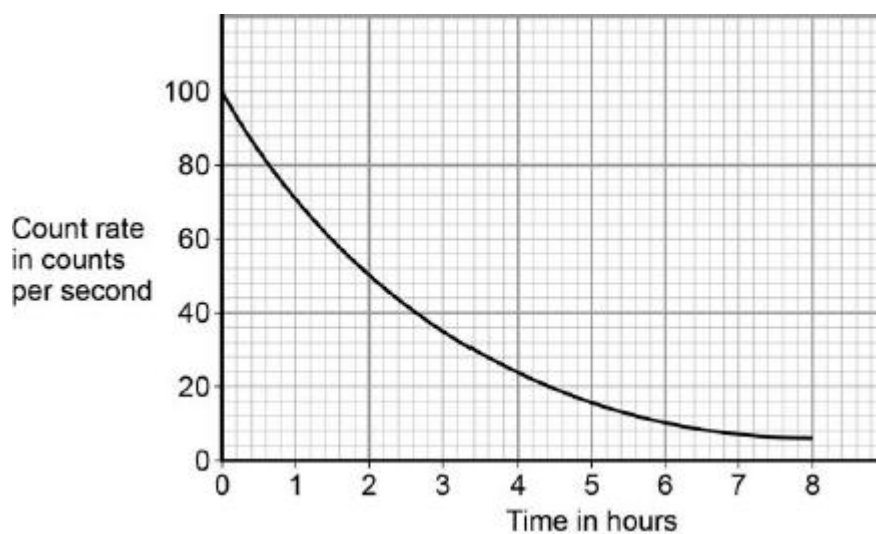
Use information from **Figure 1** to complete the table below.

	<b>U</b>	<b>Th</b>
Mass number	235	
Number of protons		90
Number of neutrons	143	

(3)

- (b) **Figure 2** shows how the count rate from a radioactive isotope changes with time.

**Figure 2**



What is the half-life of the radioactive isotope?

Explain why you chose that value.

Half-life = ..... hours

Explanation .....

.....

(2)

(c) When a radioactive isotope decays it can produce beta particles.

What is a beta particle?

Tick **one** box.

A high-speed electron

☐

A neutron and an electron

☐

A neutron and a proton

☐

A helium nucleus

☐

(1)

- (d) Beta particles can cause cancer.

Complete the sentences.

Use words from the box.

benign	controlled	differentiated	malignant	slow	uncontrolled
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Tumours form when cell division is .....

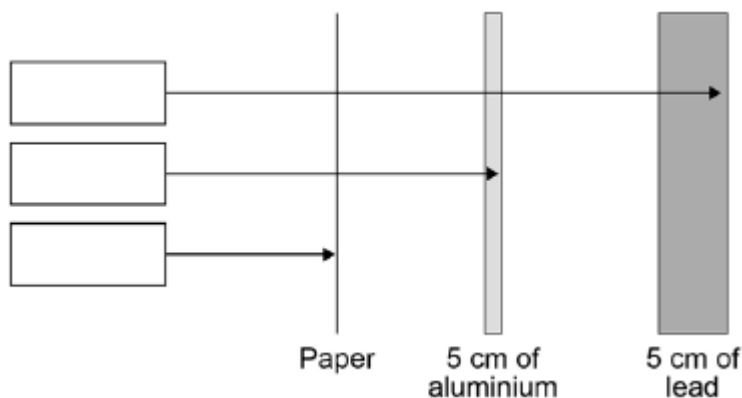
Tumours that do not invade other tissues are called .....

(2)  
(Total 8 marks)

**Q3.** Alpha, beta and gamma are types of nuclear radiation.

A teacher sets up a demonstration of the penetration properties of alpha, beta and gamma radiation.

The figure below shows the demonstration.



- (a) Complete the figure above by writing the name of the radiation in each box.

(2)

- (b) Give **two** safety precautions the teacher should take in the demonstration.

1 .....

.....

2 .....

.....

(2)

- (c) The table below shows how the count rate of a radioactive source changes with time.

<b>Time in seconds</b>	0	40	80	120	160
<b>Count rate in counts / second</b>	600	463	300	221	150

Describe the relationship shown in the table above.

.....  
 .....  
 .....  
 .....

(2)

- (d) Use the table above to predict the count rate after 200 seconds.

.....  
 .....  
 .....

Count rate = ..... counts / second

(2)

- (e) The half-life of the radioactive source is very short.

Give **one** reason why the source would be much less hazardous after 800 seconds.

.....  
 .....

(1)

(Total 9 marks)

**Q4.** Atoms contain three types of particle.

- (a) Draw a ring around the correct answer to complete the sentence.

The particles in the nucleus of the atom are

electrons and neutrons.
electrons and protons.
neutrons and protons.

(1)

- (b) Complete the table to show the relative charges of the atomic particles.

Particle	Relative charge
Electron	-1
Neutron	
Proton	

(2)

- (c) (i) A neutral atom has no overall charge.

Explain this in terms of its particles.

.....

.....

.....

.....

(2)

- (ii) Complete the sentence.

An atom that loses an electron is called an .....  
and has an overall ..... charge.

(2)



- (d) *In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.*

Some substances are radioactive. They may emit alpha or beta particles.

Describe the characteristics of alpha particles and beta particles in terms of their:

- structure
- penetration through air and other materials
- deflection in an electric field.

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(6)  
(Total 13 marks)

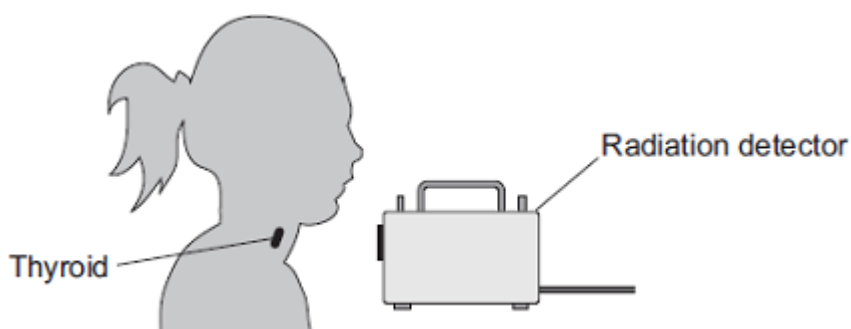
- Q5.(a)** The names of three types of radiation are given in **List A**. Some properties of these three types of radiation are given in **List B**.

Draw **one** line from each type of radiation in **List A** to its correct property in **List B**.

<b>List A</b> Type of radiation	<b>List B</b> Property of radiation
alpha	will pass through paper but is stopped by thin metal
beta	has the shortest range in air
gamma	will not harm human cells
	is very weakly ionising

(3)

- (b) The radioactive isotope iodine-123 can be used by a doctor to examine the thyroid gland of a patient. The iodine, taken as a tablet, is absorbed by the thyroid gland. The gamma radiation emitted as the iodine atoms decay is detected outside the body.



The doctor uses an isotope emitting gamma radiation to examine the thyroid gland rather than an isotope emitting alpha or beta radiation.

Which **one** of the following gives a reason why gamma radiation is used?

Tick (✓) **one** box.

Gamma radiation will pass through the body.

☐

Gamma radiation is not deflected by a magnet.

☐

Gamma radiation has a long range in air.

☐

(1)

(c) Iodine-123 has a half-life of 13 hours.

Use a word from the box to complete the sentence.

all	half	most
-----	------	------

After 13 hours ..... of the iodine-123 atoms the thyroid absorbed have decayed.

(1)

(d) Iodine-123 and iodine-131 are two of the isotopes of iodine.

Draw a ring around the correct answer to complete the sentence.

The nucleus of an iodine-123 atom has the same number of

electrons		as the
neutrons		
protons		

nucleus of an iodine-131 atom.

(1)  
(Total 6 marks)

**Q6.** Certain types of atom emit alpha, beta or gamma radiation. The radiation is emitted from the centre of the atom.

- (a) What name is given to the centre of an atom?

.....

(1)

- (b) The sign below is used to warn people that a radiation source is being used in a laboratory.



Why is it important to warn people that a radiation source is being used?

.....

.....

(1)

- (c) Before using a radiation source, a teacher asked her class whether there was any way that she could reduce the amount of radiation that the source emitted. Three students each gave an answer to the teacher.

Keep the source in a freezer. It will emit less radiation.



**A**

Put it in acid. It will destroy the radiation.



**B**

You can't do anything to change the amount of radiation emitted.



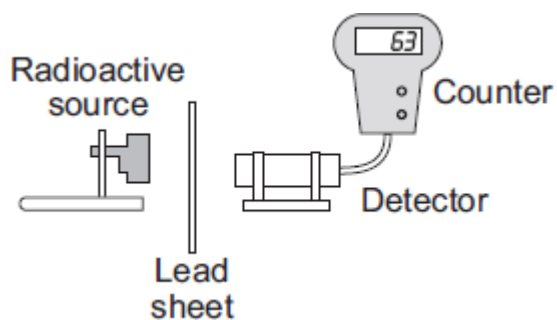
**C**

Which **one** of the students, **A**, **B** or **C**, is correct?

Write your answer in the box.

(1)

- (d) The diagram shows the apparatus used by the teacher to demonstrate how one type of radiation is able to pass through lead.



One lead sheet, 2 mm thick, was placed between the source and the detector and a count rate was taken. Extra lead sheets were added. For each extra lead sheet, a new count rate was taken and recorded in the table.

Number of lead sheets	Count rate in counts per minute
1	226
2	220
3	210
4	190
5	185

Which type of radiation was the source emitting: alpha, beta or gamma?

.....

Give the reason for your answer.

.....

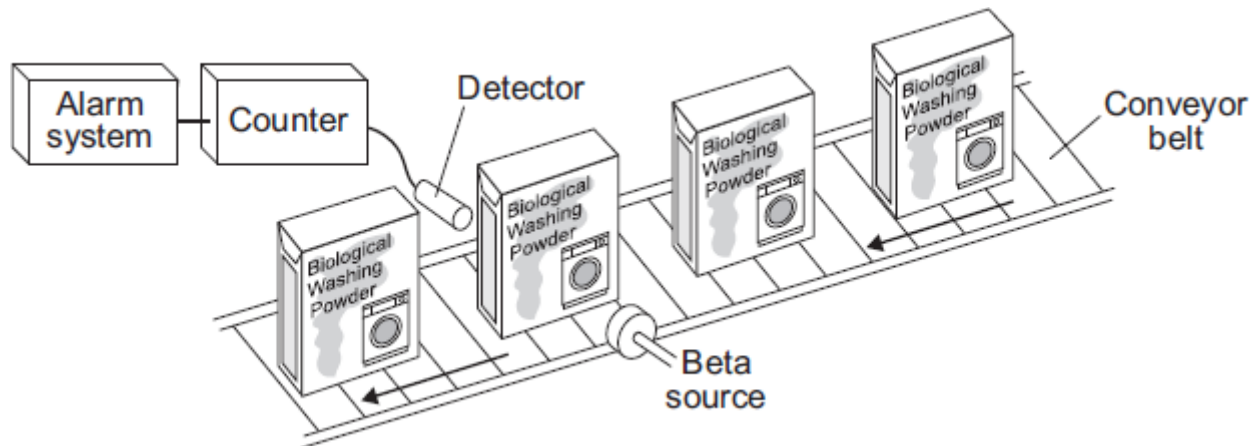
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(2)

- (e) The diagram shows how a company detects any boxes left empty by an automatic filler.

When an empty box passes between the beta source and the detector, a buzzer sounds. A worker then removes the box from the conveyor belt.

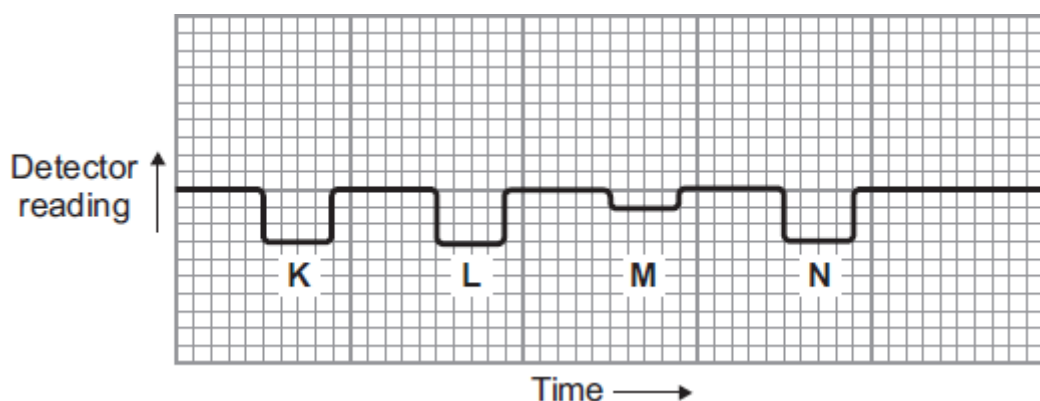


- (i) Why would this system **not** work if an alpha source were used instead of the beta source?

.....  
 .....

(1)

- (ii) The chart shows how the detector reading changes as boxes pass along the conveyor belt.



Which part of the chart, **K**, **L**, **M** or **N**, shows that an empty box is passing between the beta source and the detector?

.....

Give a reason for your answer.

.....

(2)  
(Total 8 marks)

- Q7.** (a) The names of the three types of nuclear radiation are given in **List A**.  
Some properties of these types of radiation are given in **List B**.

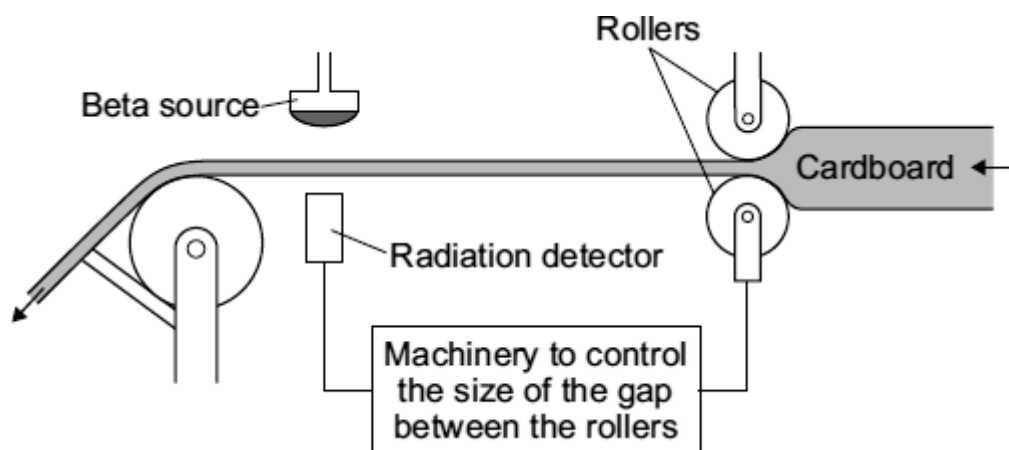
Draw a straight line to link each type of radiation in **List A** to its correct property in **List B**.

Draw only **three** lines.

<b>List A</b> Type of nuclear radiation	<b>List B</b> Property of radiation
Alpha	Has the same mass as an electron
Beta	Very strongly ionising
Gamma	Passes through 10 cm of aluminium
	Deflected by a magnetic field but not deflected by an electric field

(3)

- (b) The diagram shows a system used to control the thickness of cardboard as it is made.



The cardboard passes through a narrow gap between a beta radiation source and a radiation detector.

The table gives the detector readings over 1 hour.

Time	Detector reading
08:00	150
08:15	148
08:30	151
08:45	101
09:00	149

- (i) Between 08:00 and 08:30, the cardboard is produced at the usual, correct thickness.

Explain how you can tell from the detector readings that the cardboard produced at 08:45 is thicker than usual.

.....

.....

.....

.....

(2)

- (ii) Which would be the most suitable half-life for the beta source?

Draw a ring around your answer.



six days

six months

six years

(1)

- (iii) This control system would **not** work if the beta radiation source was replaced by an alpha radiation source.

Why not?

.....

.....

(1)

(Total 7 marks)