PEARSON EDEXCEL GCSE PHYSICS (HIGHER) · 1PH0

PHYSICS



EXAM QUESTION PACK

TOPIC 6: RADIOACTIVITY (PACK 1)

SCORE	PERCENTAGE
/83	%

STEMUP

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Q1.

(a) Positrons are antiparticles of electrons.
The photograph shows a PET scanner that uses positrons to locate the site of a brain tumour.



Positrons are emitted by the radioactive isotope fluorine-18.
The fluorine-18 is attached to glucose.
The glucose is injected into the patient's blood stream and collects at the site of the tumour.

(i) Fluorine-18 has a half-life of 1.8 hours.
State one advantage and one disadvantage of using a substance with such a short half-life.

1. Advantage

(1)

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2. Disadvantage

(1)

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(ii) When a positron meets an electron they annihilate each other.
Explain how this enables the site of the tumour to be located.

(4)

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*(b) Positrons (β+ particles) are emitted from the nuclei of some atoms.
Electrons (β− particles) are emitted from the nuclei of other atoms.

The table gives some information about quarks.

quark	charge (compared to the charge on a proton)
u	+2/3
d	−1/3

Describe, in terms of quarks, how β+ particles are emitted from the nuclei of some atoms and β− particles are emitted from the nuclei of others.

(6)

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(Total for Question = 12 marks)

Q2.

Some rocks contained uranium when they were formed.

Radioactive decay in these rocks produces radon gas.

Explain why people living near these rocks have an increased health risk from background radiation.

(3)

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Q3.

Some rocks contained uranium when they were formed.

Radioactive decay in these rocks produces radon gas.

Explain why people living near these rocks have an increased health risk from background radiation.

(3)

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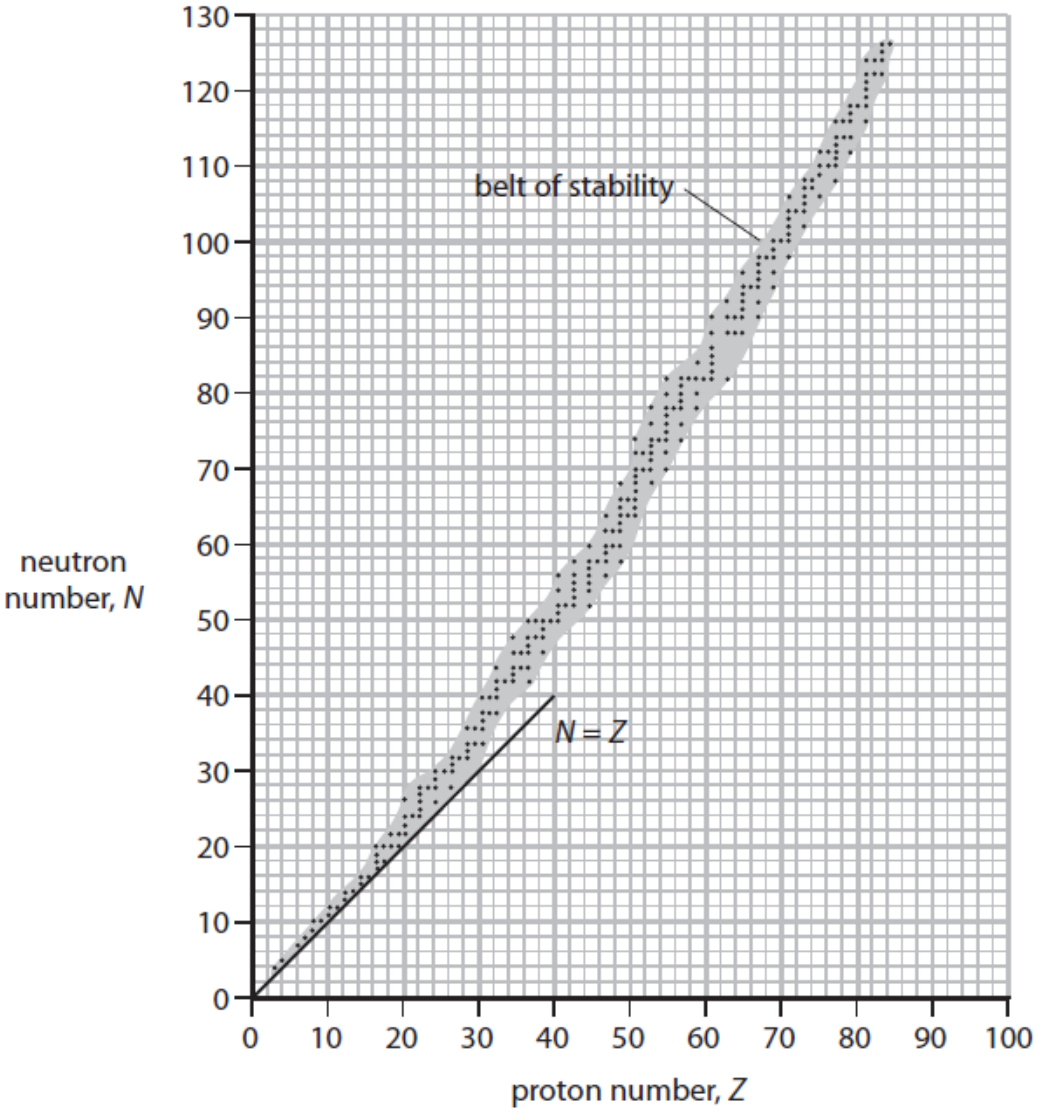
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Q4.

(a) The diagram shows the stability curve for nuclear isotopes.



Complete the sentence by putting a cross (☒) in the box next to your answer.

An isotope above the curve will undergo β^- decay because it has

(1)

☒ **A** too few protons

☒ **B** too many protons

☒ **C** too few neutrons

☒ **D** too many neutrons

(b) Which statement is correct for β^+ and β^- particles?

Put a cross (☒) in the box next to your answer.

(1)

☒ **A** a β^+ is positively charged and a β^- is negatively charged

☒ **B** the mass of a β^+ is 1800 times the mass of a β^-

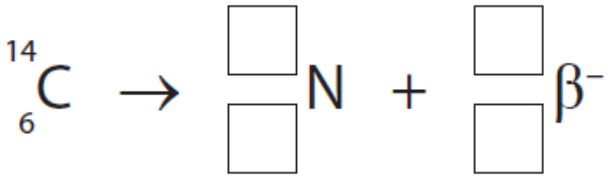
☒ **C** the charge on a β^+ is twice the charge on a β^-

☒ **D** a β^+ is a proton and a β^- is an electron

(c) Carbon-14 decays by emitting a β^- particle to form an isotope of nitrogen.

Complete the nuclear equation for this decay by filling in the boxes.

(2)



(d) Protons and neutrons both contain quarks.

Describe the arrangement of quarks in a proton.

(2)

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(e) Explain what happens to a nucleus during β^+ decay.

(2)

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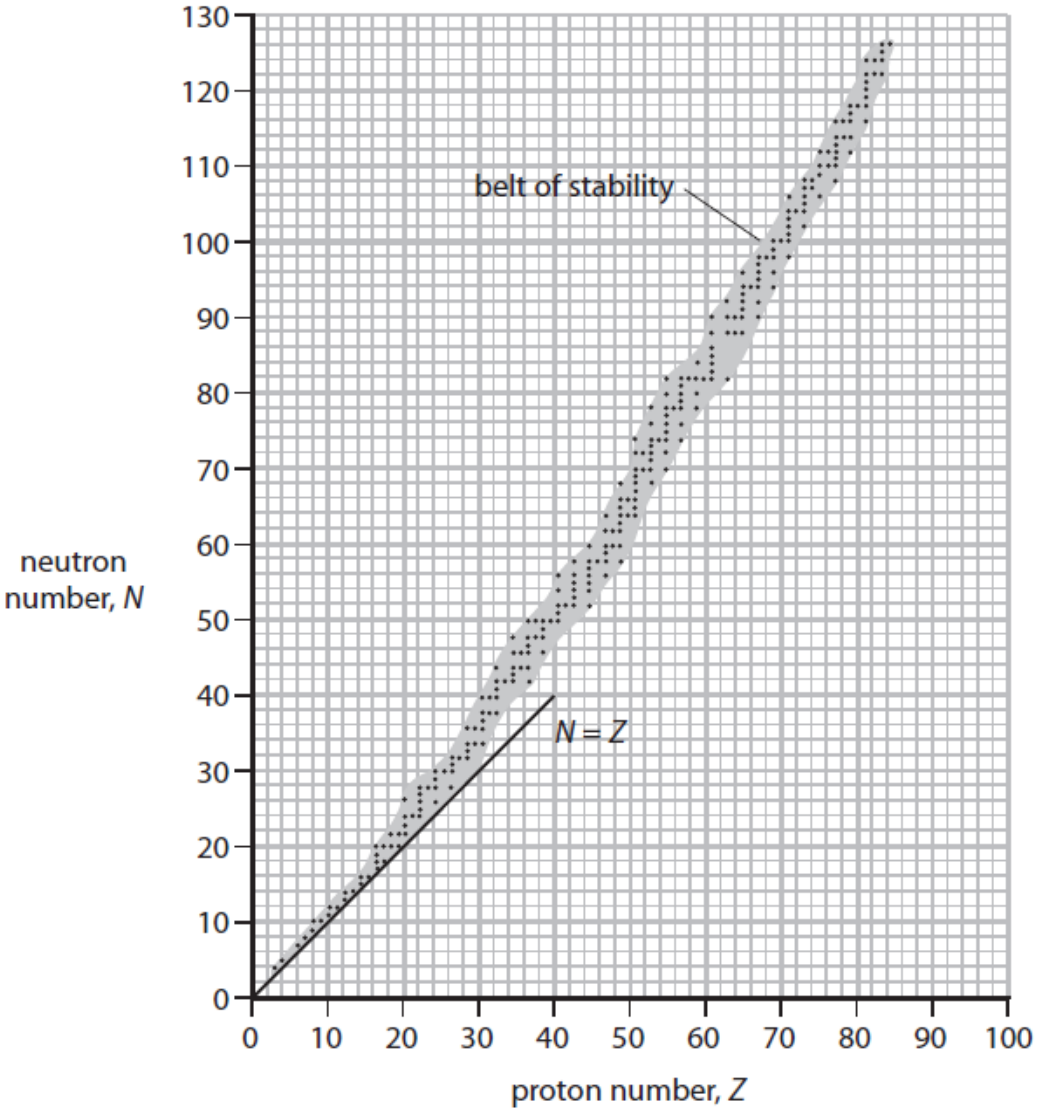
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Q5.

(a) The diagram shows the stability curve for nuclear isotopes.



Complete the sentence by putting a cross (☒) in the box next to your answer.

An isotope above the curve will undergo β^- decay because it has

(1)

☒ **A** too few protons

☒ **B** too many protons

☒ **C** too few neutrons

☒ **D** too many neutrons

(b) Which statement is correct for β^+ and β^- particles?

Put a cross (☒) in the box next to your answer.

(1)

☒ **A** a β^+ is positively charged and a β^- is negatively charged

☒ **B** the mass of a β^+ is 1800 times the mass of a β^-

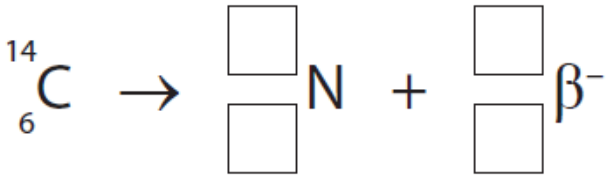
☒ **C** the charge on a β^+ is twice the charge on a β^-

☒ **D** a β^+ is a proton and a β^- is an electron

(c) Carbon-14 decays by emitting a β^- particle to form an isotope of nitrogen.

Complete the nuclear equation for this decay by filling in the boxes.

(2)



(d) Protons and neutrons both contain quarks.

Describe the arrangement of quarks in a proton.

(2)

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(e) Explain what happens to a nucleus during β^+ decay.

(2)

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Q6.

A G-M tube is connected to a counter.
A teacher places the G-M tube near to a radioactive source.
A student starts the counter and clock at the same time and writes down the readings shown on the counter every 15 s.

The student plots the readings with a line of best fit, as shown in Figure 10.

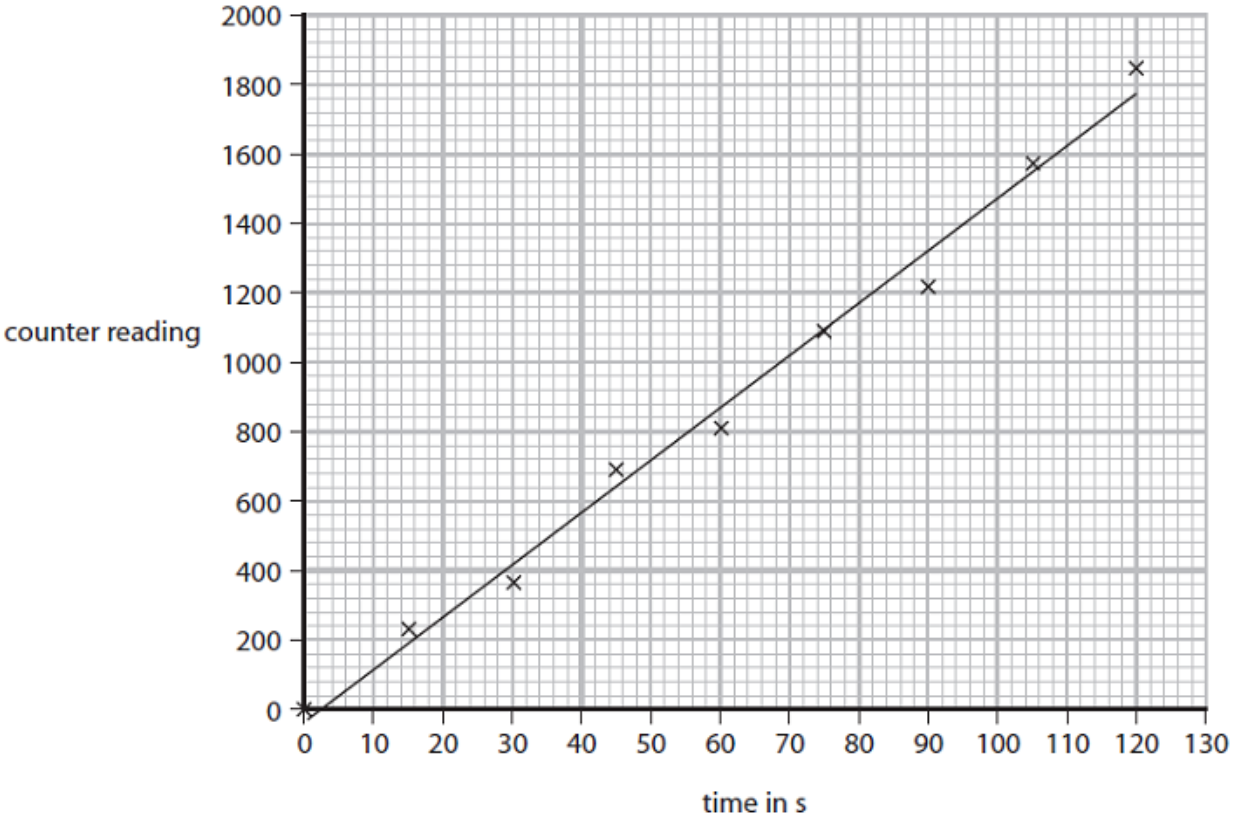


Figure 10

(i) Calculate the average count rate, in counts / s, from the graph.

Show your working on the graph.

(2)

average count rate = ... counts / s

(ii) The student says that the experiment must have been done carelessly because the data seemed quite scattered
away from the best fit line.

The teacher claims such results should be expected in radioactivity experiments.

Justify the teacher's claim.

(2)

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(Total for question = 4 marks)

Q7.

A G-M tube is connected to a counter.
A teacher places the G-M tube near to a radioactive source.
A student starts the counter and clock at the same time and writes down the readings shown on the counter every 15 s.

The student plots the readings with a line of best fit, as shown in Figure 8.

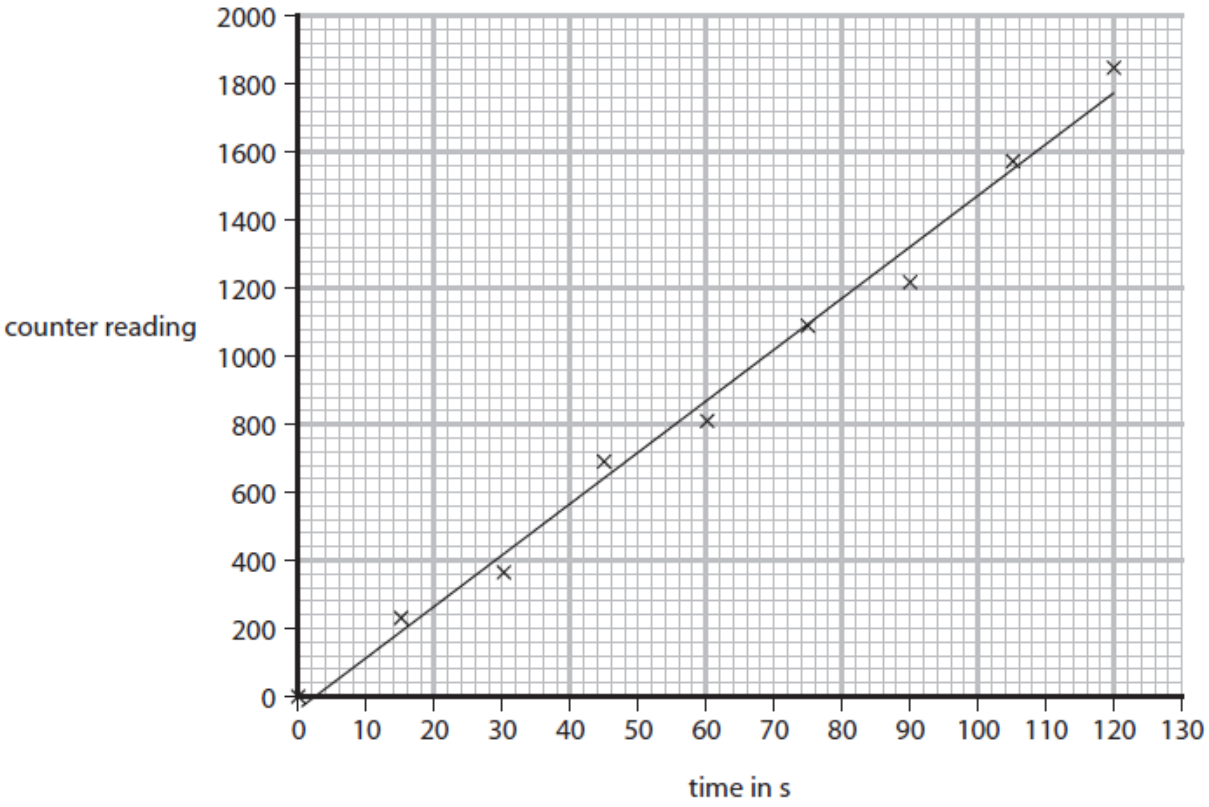


Figure 8

(i) Calculate the average count rate, in counts / s, from the graph.

Show your working on the graph.

(2)

average count rate = ... count / s

(ii) The student says that the experiment must have been done carelessly because the data seemed quite scattered away from the best fit line.

The teacher claims such results should be expected in radioactivity experiments.

Justify the teacher's claim.

(2)

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(Total for question = 4 marks)

Q8.

This question is about radioactivity.

Radium-223 is a radioactive substance.

Radium-223 is an alpha emitter.

The half-life of radium-223 is 11 days.

A radioactive source contains 1.7×10^{23} nuclei of radium-223.

Calculate the number of radium-223 nuclei remaining in the source after a time of 33 days.

(2)

number of radium-223 nuclei remaining = ...

(Total for question = 2 marks)

Q9.

The intensity of gamma radiation can be measured using a Geiger-Müller tube and counter.

The count rate recorded by the counter tube depends on how far away the Geiger-Müller tube is from the gamma radiation source.

The equation relating count rate to distance from the source is

$$\text{count rate} = \frac{k}{d^2}$$

where d is the distance from the source and k is a constant.

A Geiger-Müller tube is placed 0.70 m from a source of gamma radiation.

The counter displays a count rate of 85 000 count per minute.

Calculate the count rate recorded when the Geiger-Müller tube is placed 1.3 m away from the same gamma radiation source.

(3)

count rate = ... counts per minute

(Total for question = 3 marks)

Q10.

Some questions must be answered with a cross in a box (☒). If you change your mind about an answer, put a line through the box (☒) and then mark your new answer with a cross (☒).

Radioactive tracers can be used when scanning a person's kidneys.

A radioactive isotope is injected into a person's blood stream.

The isotope emits radiation.

As the blood flows through the kidneys, this radiation is detected outside the body by a scanner.

(i) What type of radiation travels from the kidney to the scanner?

(1)

☒ **A** alpha

☒ **B** beta plus

☒ **C** beta minus

☒ **D** gamma

(ii) During the scan, a technician needs to take readings for about 30 minutes.

The half-life of the isotope used is about 6 hours.

1. State why an isotope with a half-life of about 6 minutes is **not** suitable.

(1)

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2. State why an isotope with a half-life of about 6 days is **not** suitable.

(1)

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(iii) State **two** ways of reducing the radiation risks to the technician.

(2)

1 .....

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2 .....

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(Total for question = 5 marks)

Q11.

Radio waves and gamma radiation are at opposite ends of the electromagnetic spectrum.

Compare how these two electromagnetic radiations are produced.

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(Total for question = 6 marks)

Q12.

Radio waves and gamma radiation are at opposite ends of the electromagnetic spectrum.

Compare how these two electromagnetic radiations are produced.

(6)

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(Total for question = 6 marks)

Q13.

* Nuclear fission and nuclear fusion are two non-renewable sources of energy.

Compare nuclear fission and nuclear fusion as possible sources of energy for generating electricity using a nuclear reactor.

Your comparison should refer to

- the differences between nuclear fission and nuclear fusion
- the relative advantages and difficulties involved in using these sources.

(6)

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(Total for question = 6 marks)

Q14.

Fluorine-19 is a stable isotope of the element fluorine.

The element fluorine also has several radioactive isotopes.

Describe **one** similarity and **one** difference between the numbers of particles in one nucleus of fluorine-19 and one nucleus of a radioactive isotope of fluorine.

(2)

similarity .....

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difference .....

.....

(Total for question = 2 marks)

Q15.

* Gamma radiation is produced by radioactive decay.

Alpha radiation and beta radiation are also produced by radioactive decay.

Compare the processes of alpha decay and beta decay.

Your answer should include what each radiation is and what effect each decay has on the original nucleus.

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(Total for question = 6 marks)

Q16.

* Gamma radiation is produced by radioactive decay.

Alpha radiation and beta radiation are also produced by radioactive decay.

Compare the processes of alpha decay and beta decay.

Your answer should include what each radiation is and what effect each decay has on the original nucleus.

(6)

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(Total for question = 6 marks)

Q17.

Carbon-13 and carbon-14 are isotopes of carbon.

Nuclei of carbon-13 and carbon-14 can be represented by these symbols

$$^{13}_{6}C \quad \text{and} \quad ^{14}_{6}C$$

Complete the table for an atom of carbon–13 and an atom of carbon–14.

(2)

	number of neutrons in the nucleus	number of electrons in orbit around the nucleus
carbon-13		
carbon-14		

(Total for question = 2 marks)

Q18.

Carbon-13 and carbon-14 are isotopes of carbon.

Nuclei of carbon-13 and carbon-14 can be represented by these symbols

$$^{13}_{6}C \quad \text{and} \quad ^{14}_{6}C$$

Complete the table for an atom of carbon-13 and an atom of carbon-14.

(2)

	number of neutrons in the nucleus	number of electrons in orbit around the nucleus
carbon-13		
carbon-14		

(Total for question = 2 marks)

Q19.

State what is meant by the term 'half-life'.

(1)

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(Total for question = 1 mark)

Q20.

Students are given the apparatus shown in Figure 12 and a protractor.

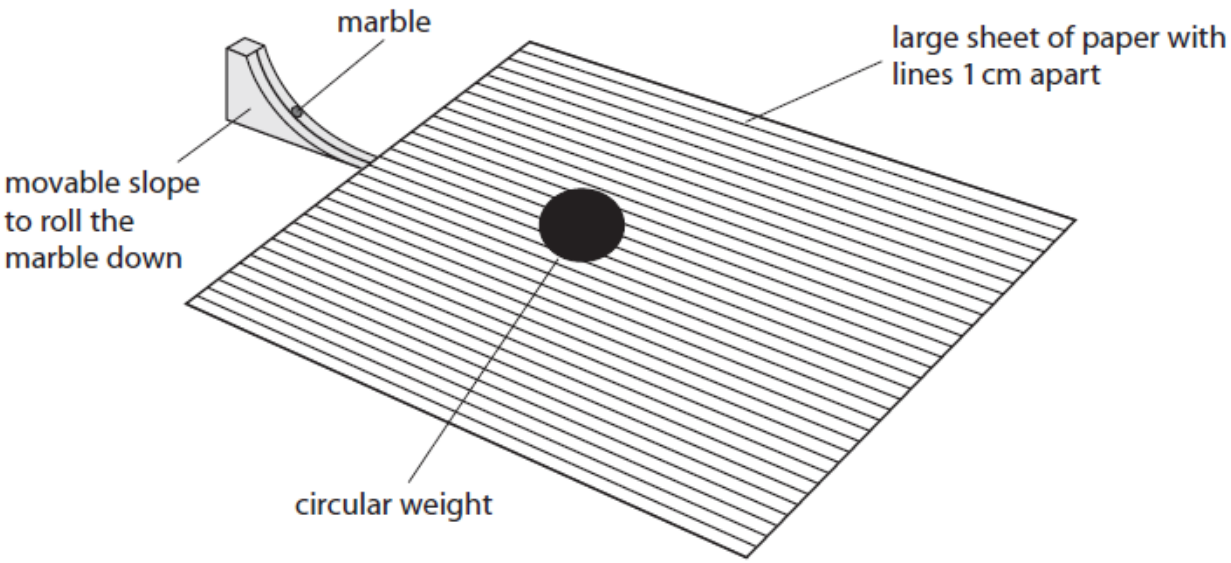


Figure 12

(i) Describe how the students could use the apparatus to model the scattering of alpha particles.

(2)

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(ii) Give **one** limitation of this model.

(1)

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(Total for question = 3 marks)

Q21.

Describe how the energy released in the chain reaction in a nuclear reactor is used to drive a turbine in a nuclear power station.

(3)

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(Total for question = 3 marks)

Q22.

Students are given the apparatus shown in Figure 8 and a protractor.

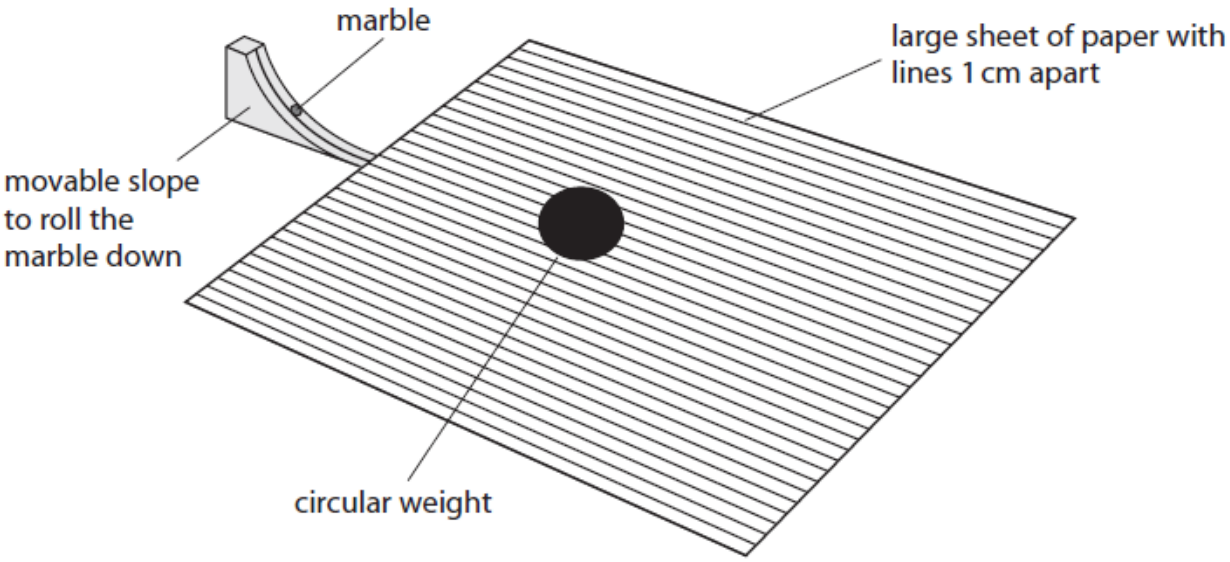


Figure 8

(i) Describe how the students could use the apparatus to model the scattering of alpha particles.

(2)

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(ii) Give **one** limitation of this model.

(1)

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(Total for question = 3 marks)

Q23.

Describe how the thermal energy from nuclear fission can be used to turn the electrical generator in a power station.

(2)

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(Total for question = 2 marks)

Q24.

Stars may originate as a nebula.

(i) Describe the process that then occurs to produce the conditions necessary for nuclear fusion in a new star.

(3)

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(ii) The energy, E, released in nuclear fusion is equivalent to loss in mass, m, according to the equation.

$$E = mc^2$$

where c is the velocity of light.

$c = 3.00 \times 10^8$ m/s

In 1 second, the energy radiated by the Sun is 3.86×10^{26} J.

Calculate the loss in mass of the Sun in 1 second.

(2)

loss in mass = ... kg

(Total for question = 5 marks)

Q25.

Radium-223 is a radioactive substance.

Radium-223 is an alpha emitter.

The half-life of radium-223 is 11 days.

A radioactive source contains 1.7×10^{23} nuclei of radium-223.

Calculate the number of radium-223 nuclei remaining in the source after a time of 33 days.

(2)

number of radium-223 nuclei remaining = ...

(Total for question = 2 marks)

Q26.

Sometimes food can become contaminated with radioactive substances.

Describe the harmful effects of eating food contaminated with radioactive substances.

(2)

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(Total for question = 2 marks)

Q27.

Sometimes food can become contaminated with radioactive substances.

Describe the harmful effects of eating food contaminated with radioactive substances.

(2)

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(Total for question = 2 marks)

Q28.

Answer the question with a cross in the box you think is correct ☒ . If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒ .

This question is about radioactivity.

Alpha (α), beta (β) and gamma (γ) are three types of radioactive emissions.

Which statement describes **all** of these radioactive emissions?

(1)

☐ **A** ionising and emitted by stable nuclei

☐ **B** ionising and emitted by unstable nuclei

☐ **C** neutral and emitted by stable nuclei

☐ **D** neutral and emitted by unstable nuclei

(Total for question = 1 mark)

Q29.

Nuclear fusion provides the energy source for stars including the Sun.

Describe what happens during nuclear fusion.

(3)

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(Total for question = 3 marks)

Q30.

Carbon–14 is radioactive and has a half-life of 5 700 years.

The number of radioactive carbon–14 atoms in a very old piece of wood is found to have decreased from 1 000 000 to 125 000.

Determine the age of the piece of wood.

(2)

age of wood = ... years

(Total for question = 2 marks)