All questions are for both separate science and combined science students

1 Alpha and beta particles may be emitted by unstable nuclei.

(a) (i) When an unstable nucleus emits an alpha particle, its atomic (proton) number

(1)

☒ **A** increases by 1

☒ **B** stays the same

☒ **C** decreases by 2

☒ **D** decreases by 4

(ii) When an unstable nucleus emits an alpha particle, its mass (nucleon) number

(1)

☒ **A** increases by 1

☒ **B** stays the same

☒ **C** decreases by 2

☒ **D** decreases by 4

(b) Compared to a beta particle, an alpha particle

(1)

☒ **A** causes less ionisation

☒ **B** has less charge

☒ **C** has less mass

☒ **D** has less penetrating power

(c) Describe how a teacher should measure the activity of a radioactive source using a Geiger-Muller detector.

(4)

(Total for Question 1 = 7 marks)

2 These questions are about radioactivity.

(a) Which of these is measured in becquerel (Bq)?

(1)

- ☒ **A** activity
- ☒ **B** frequency
- ☒ **C** half-life
- ☒ **D** radiation

(b) Which of these has a mass (nucleon) number of 4?

(1)

- ☒ **A** alpha particle
- ☒ **B** beta particle
- ☒ **C** gamma ray
- ☒ **D** x-ray

(c) Which of these is the same as an electron?

(1)

- ☒ **A** alpha particle
- ☒ **B** beta particle
- ☒ **C** gamma ray
- ☒ **D** x-ray

(d) Which of these is the most ionising?

(1)

- ☒ **A** alpha particle
- ☒ **B** beta particle
- ☒ **C** gamma ray
- ☒ **D** x-ray

(Total for Question 2 = 4 marks)

3 The table shows the nature of alpha and beta particles.

Particle	Nature
alpha	helium nucleus
beta	tron

Explain why alpha particles and beta particles have different penetrating powers.

(5)

(Total for Question 3 = 5 marks)

4 A teacher investigates the half-life of a radioactive isotope that decays quickly.

(a) The teacher measures the background activity.

Explain how this value should be used in the investigation.

(1)

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(b) Explain what is meant by the term **half-life**.

(2)

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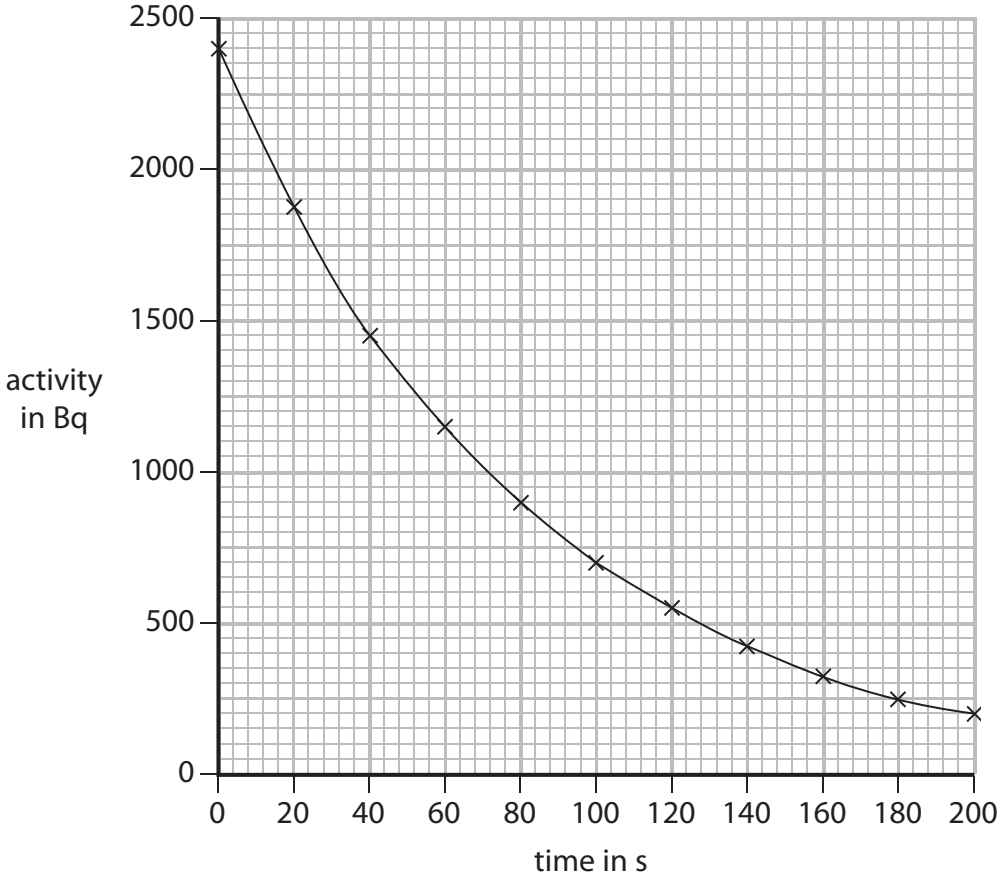
(c) The graph shows how the activity of a sample of the radioactive isotope changes with time.



(i) Use the graph to find the half-life of the isotope.

(2)

half-life = ... s

(ii) The teacher takes a new reading every 20 s.

Suggest why the teacher measures the activity so frequently.

(1)

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(Total for Question 4 = 6 marks)

5 An unstable isotope of strontium has a half-life of 28.8 years.

It is a beta emitter and can be represented by this symbol.

$$^{90}_{38}\mathrm{Sr}$$

(a) (i) What is the mass number of this isotope?

(1)

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(ii) Explain the meaning of the term **half-life**.

(2)

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(iii) A person can absorb strontium atoms, which stay in their bones.

Explain why strontium-90 in the bones is a serious health hazard.

(2)

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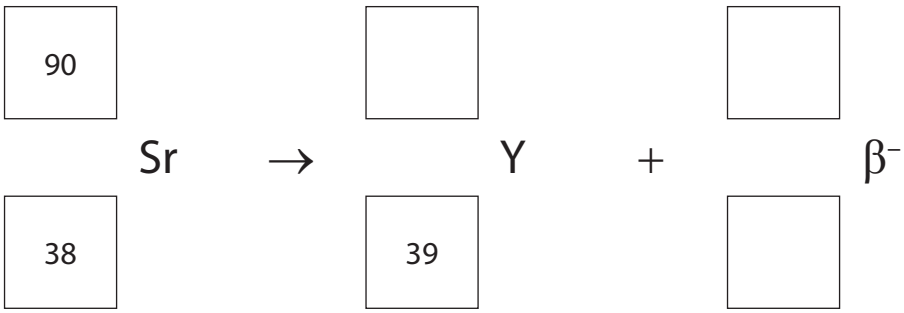
(b) When a strontium-90 nucleus emits a beta particle, it decays to form yttrium-90.

(i) Complete the equation for this decay.

(2)



(ii) Yttrium-90 is also an unstable isotope.

Explain why strontium-90 and yttrium-90 can both be described as isotopes, even though they have different numbers of protons.

(2)

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(Total for Question 5 = 9 marks)

6 Iodine-131 is a radioactive isotope that emits beta particles.

(a) The equation for this decay is

$$^{131}_{53}\mathrm{I} \rightarrow {}^{A}_{Z}\mathrm{Xe} + {}^{0}_{-1}\mathrm{e}$$

(i) The atomic (proton) number for iodine-131 is

(1)

☒ **A** 0

☒ **B** 53

☒ **C** 78

☒ **D** 131

(ii) The mass (nucleon) number for Xe is

(1)

☒ **A** –1

☒ **B** 0

☒ **C** 53

☒ **D** 131

(b) Iodine-131 is used to treat thyroid cancer.

This radioactive isotope is allowed to enter the tumour.

Explain why iodine-131 is suitable for this treatment.

(2)

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(Total for Question 6= 4 marks)

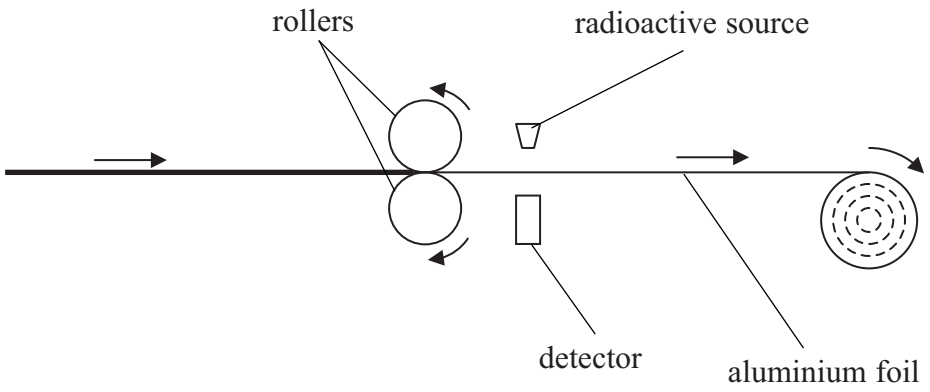
7 There are different types of ionising radiation.

(a) Complete the table to show the properties of each type. **(2)**

Type of ionising radiation	Charge	Emitted by
alpha particle		unstable nuclei
beta particle		unstable nuclei
gamma ray	0	

(b) The diagram shows a machine which makes aluminium foil.

The machine uses a radioactive source to measure the thickness of the foil.



The radioactive source emits beta particles.

The output from the detector indicates the thickness of the foil.

Explain why beta particles are used, rather than alpha particles or gamma rays.

(3)

(c) The radioactive source contains strontium-90.

A strontium-90 nucleus emits a beta (β) particle.

(i) Complete the equation to show how strontium-90 decays.

(1)

$$^{90}_{38}\text{Sr} \longrightarrow \text{.....} \text{Y} + {}^{0}_{1}\beta$$

(ii) Which of these describes what happens to the strontium-90 nucleus when it emits a beta (β) particle?

(1)

☒ **A** the number of protons stays the same

☒ **B** the number of protons increases

☒ **C** the number of neutrons stays the same

☒ **D** the number of neutrons increases

(Total for Question 7 7 marks)