4.2 Atoms & Nuclear Radiation

Question Paper

Course	AQA GCSE Physics
Section	4. Atomic Structure
Topic	4.2 Atoms & Nuclear Radiation
Difficulty	Medium

Time allowed: 60

Score: /42

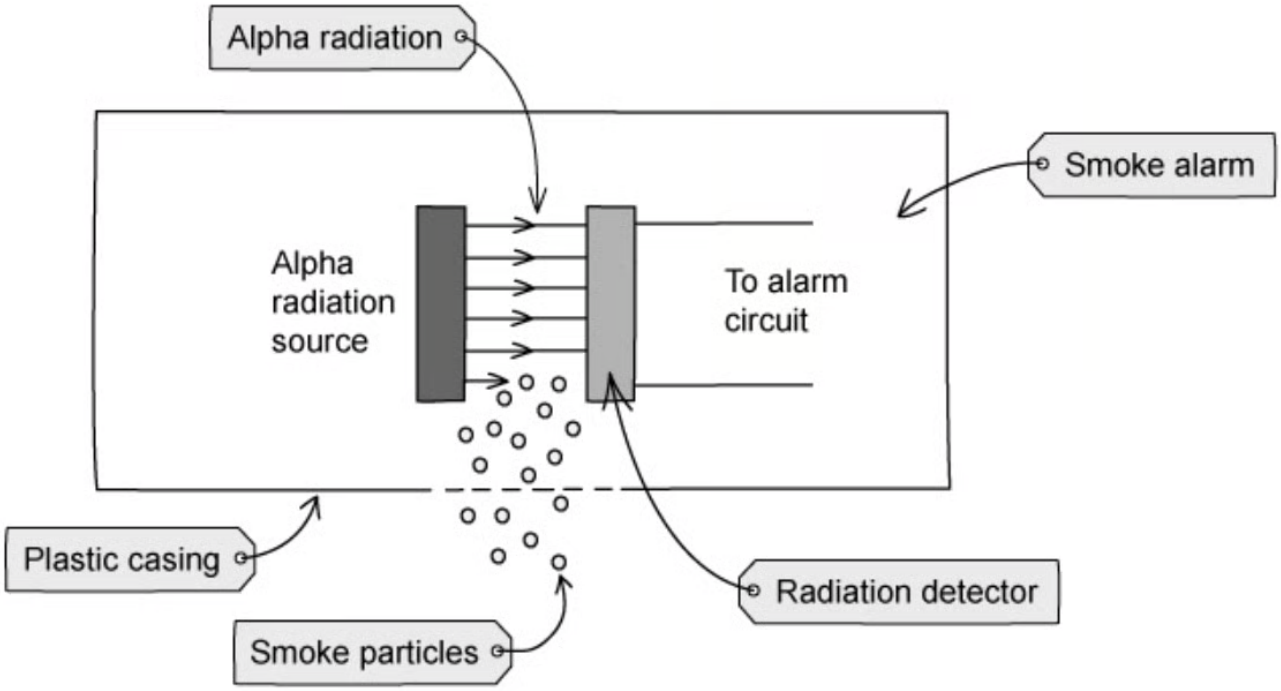
Percentage: /100

Question 1a

(a) Household smoke alarms use alpha radiation sources to detect smoke.

Figure 1 shows how a smoke alarm works.

Figure 1



The smoke alarm does not sound while alpha radiation is detected by the detector.

Explain why the alarm sounds when smoke particles enter the casing.

[1 mark]

[1 mark]

Question 1b

(b) Why is using an alpha emitter in a smoke alarm safe to use in a house?

[1 mark]

[1 mark]

Question 1c

(c) Explain why the smoke alarm would not work if the alpha source were replaced by a beta or gamma source.

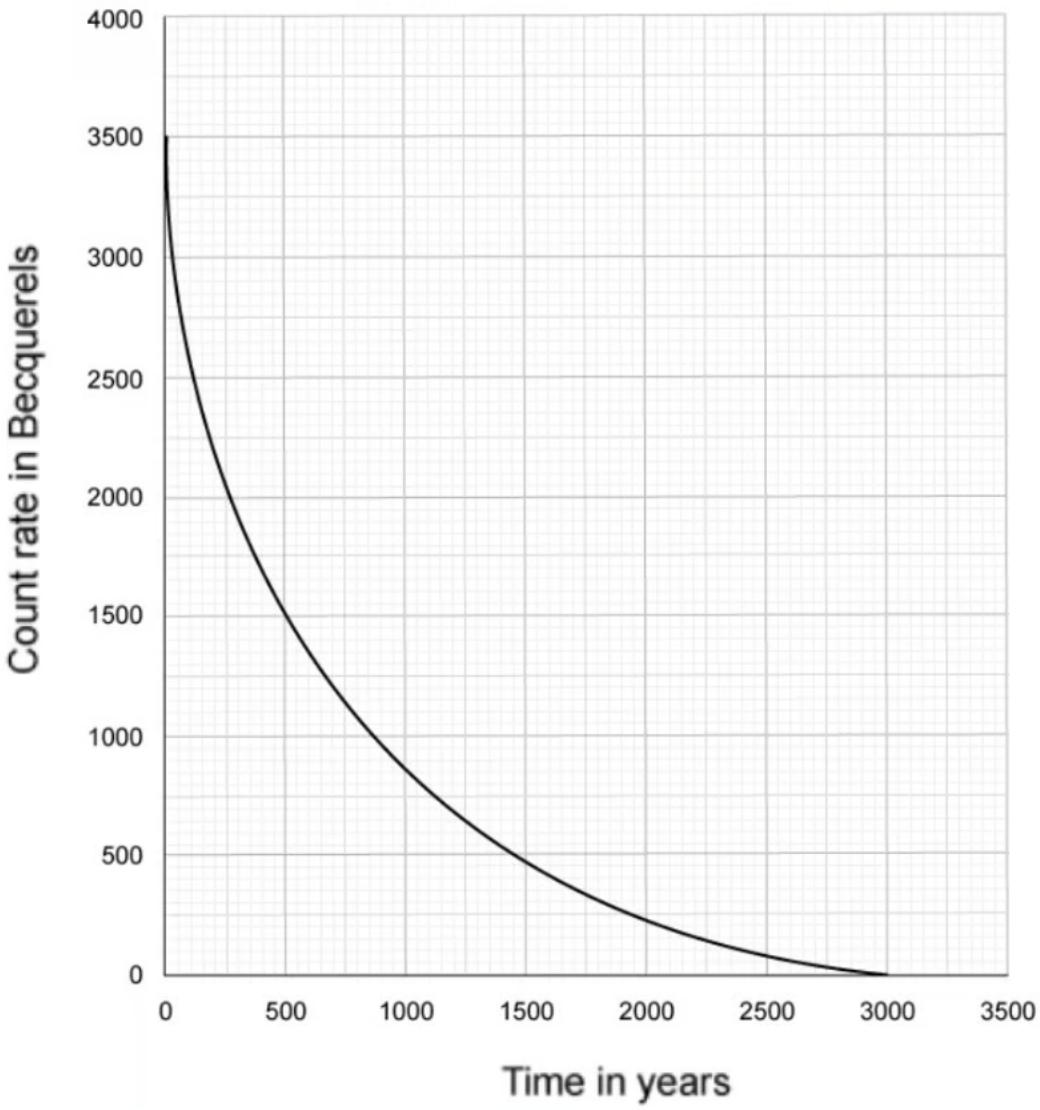
[2 marks]

[2 marks]

Question 1d

(d) **Figure 2** shows how the count rate from the alpha source in the smoke alarm varies with time.

Figure 2



Calculate the half life of the alpha source in the smoke alarm.

[2 marks]

[2 marks]

Question 1e

(e) Explain why it is an advantage for the alpha emitter in the smoke alarm to have a long half life.

[2 marks]

[2 marks]

Question 2a

(a) Of the three types of radiation, alpha (α), beta (β) and gamma (γ), which **two** will pass through a sheet of paper?

[1 mark]

[1 mark]

Question 2b

(b) Which **two** types of radiation will be deflected by a magnetic field?

[1 mark]

[1 mark]

Question 2c

(c) Which type of radiation has the shortest range in air?

[1 mark]

[1 mark]

Question 2d

(d) A student suggests that the halflife of a radioactive source could be decreased by heating it in a Bunsen burner. The student thinks that this would speed up the radioactive decays, and make it decay more quickly.

Suggest why the student is wrong.

[1 mark]

[1 mark]

Question 2e

(e) Protactinium-234 is a radioactive isotope that is often used in school science experiments. It emits beta radiation.

How is an atom of protactinium-234 different to the isotope protactinium-236?

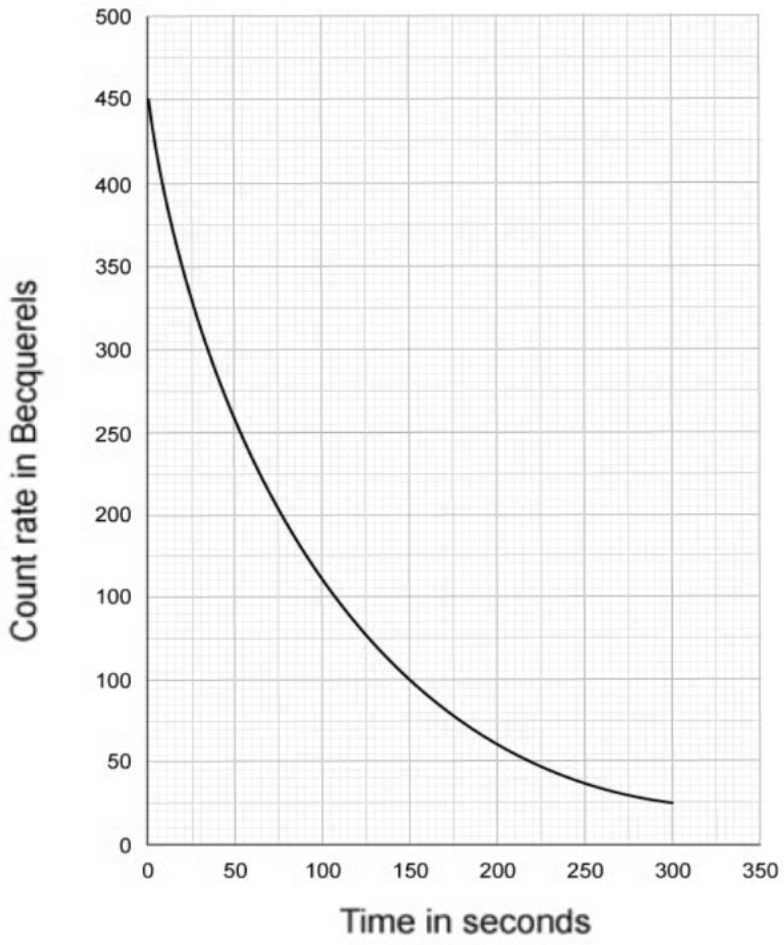
[1 mark]

[1 mark]

Question 2f

(f) **Figure 3** shows how the count rate of a sample of protactinium-234 changes with time.

Figure 3



Use the graph to calculate the halflife of protactinium-234

Show clearly how you used the graph to obtain your answer.

[2 marks]

[2 marks]

Question 3a

Table 1 shows how the activity of a sample of plutonium-238 varies with time.

Table 1

Time in years	0	50	100	150	200	250
Activity in Bq	980	660	450	305	205	140

(a) Plot a graph of activity (y-axis) against time (x-axis).

[4 marks]

[4 marks]

Question 3b

(c) Use your graph to determine the halflife of plutonium-238.

Show your working.

[2 marks]

[2 marks]

Question 3c

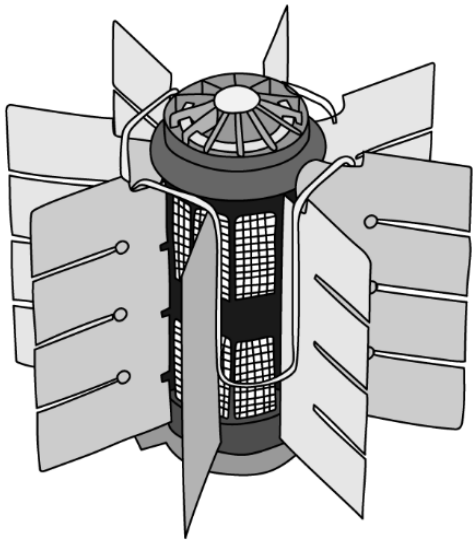
(d) Plutonium-238 can be used as a power source for a **radioisotope thermoelectric generator (RTG)**.

The thermal energy produced by the plutonium-238 is converted to electrical energy to power spacecraft.

The Cassini space probe was powered with such a device.

Figure 4 shows what an RTG looks like. The radioactive sources are inside the metal container.

Figure 4



Plutonium-238 is an alpha emitter.

Explain why it is safe for scientists to handle RTG units without protective clothing.

[2 marks]

[2 marks]

Question 4a

(a) An atom of the isotope tungsten-183 emits an alpha particle and decays into an atom of hafnium.

An alpha particle is the same as a helium nucleus. State the symbol and notation used to represent an alpha particle in nuclear equations.

[1 mark]

[1 mark]

Question 4b

(b) How many protons and how many neutrons are there in an alpha particle?

[2 marks]

Number of protons = _____

Number of neutrons = _____

[2 marks]

Question 4c

(c) The equation below represents the decay of tungsten-183.

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

[2 marks]

$$^{184}_{74}W \longrightarrow \square\!\!\square Po + \text{alpha particle}$$

[2 marks]

Question 4d

(d) Atoms of the isotope iodine-128 decay by emitting a beta particle.

State the symbol and notation used to represent a beta particle in nuclear equations.

[1 mark]

[1 mark]

Question 4e

(e) Beta decay does **not** cause the mass number of an atom to change.

Explain why not.

[2 marks]

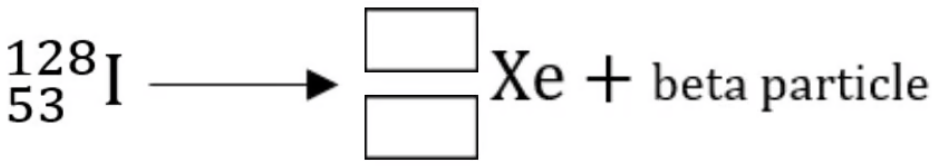
[2 marks]

Question 4f

(f) The equation representing the decay of iodine-128 to xenon is shown below.

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

[2 marks]



[2 marks]

Question 4g

(g) If Iodine-128 were to decay via alpha decay instead of via beta decay, it would produce a different element to xenon.

Explain why.

[2 marks]

[2 marks]

Question 4h

(h) There is a possibility that iodine-128 can emit a gamma ray.

State the change(s) to the nucleus that would occur if iodine-128 emitted a gamma ray.

[1 mark]

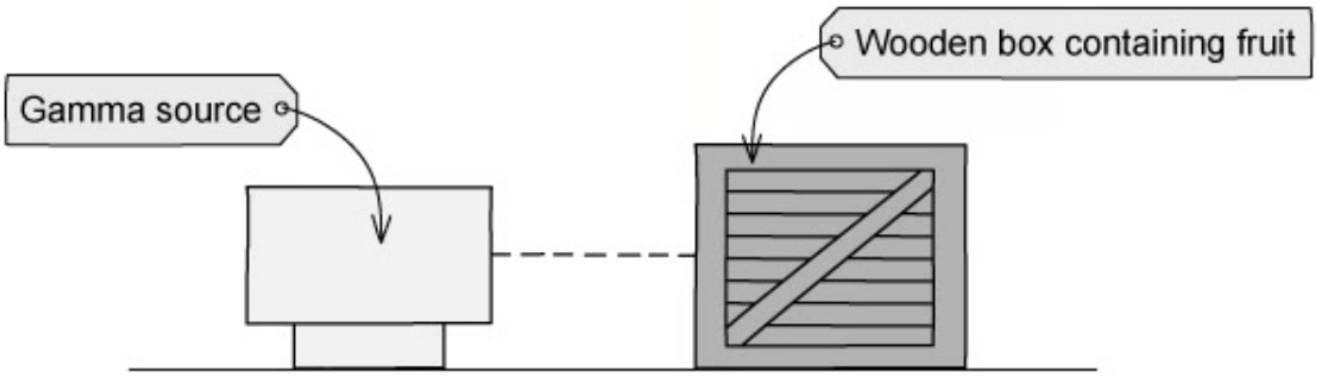
[1 mark]

Question 5a

(a) **Figure 5** shows how gamma radiation can be used to irradiate food stored in a wooden box.

The radiation kills bacteria on the food.

Figure 5



Explain why gamma radiation, rather than alpha radiation is used to kill bacteria on the food.

[2 marks]

[2 marks]

Question 5b

(b) The box has this label:

Explain why food which has been irradiated with gamma radiation is safe to eat.

[2 marks]

[2 marks]

Question 5c

(c) Explain why foods which had been contaminated with an alpha emitter would **not** be safe to eat.

[2 marks]

[2 marks]