Radioactive materials – 2021/20 GCSE 21st Physics Combined Science B

1. Nov 2021/Paper_J260/03/No.8

In 2011 an earthquake and tsunami damaged a nuclear power station in Japan. Radioactive isotopes were released and contaminated the area around the power station.

(a) Draw lines to connect each **description** with the correct **particle**.

Description	Particle
Isotopes of an element have the same number of	electrons
Isotopes of an element have a different number of	neutrons
	protons

[2]

(b) This table shows the half-lives of four of the isotopes released from the power station.

Isotope	Half-life
Tellurium-129	70 minutes
Caesium-137	30 years
Plutonium-239	24 000 years
Selenium-79	327 000 years

(i) If half-life was the only factor affecting how hazardous the isotope was, which isotope would be the most hazardous?

Put a (ring) around the correct answer.

Caesium-137 **Plutonium-239** **Selenium-79** **Tellurium-129**

[1]

(ii) Explain why your answer to **(b)(i)** is the most hazardous isotope.

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..... **[2]**

(c) Some of the radioactive isotopes from the power station were alpha emitters, some were beta emitters and some were gamma emitters.

(i) Explain why it is more hazardous to **breathe** in alpha emitters than to breathe in gamma emitters.

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..... **[2]**

(ii) Explain why it is more hazardous to be irradiated from **outside** the body by gamma emitters than by beta emitters.

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..... **[1]**

2. Nov 2020/Paper_J260/03/No.5

Kareem reads some information about isotopes. They are listed as symbols.

(a) **(i)** Carbon has 6 protons.

What is the symbol for the isotope carbon-14?

Put a (ring) around the correct answer.

$^{6}_{8}C$ $^{6}_{14}C$ $^{8}_{6}C$ $^{14}_{6}C$

[1]

(ii) The most common isotope of carbon is carbon-12.

Define the term isotope.

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..... **[1]**

(b) Uranium-238 is an isotope and decays into thorium-234 by emitting an alpha particle. This process is called alpha decay.

$$^{238}_{92}U \rightarrow {}^{234}_{90}Th + {}^{4}_{2}He$$

How does the nucleus change when uranium-238 decays?

Tick (✓) **one** box in each row.

	Decreases	Increases	Stays the same
Charge of nucleus			
Mass of nucleus			

[2]

(c)* Kareem is researching the effects of radiation.

In 1986, a nuclear reactor at the Chernobyl nuclear power plant exploded. A cloud of radioactive material spread over many countries. In the UK, radioactive rain fell on some hills, which caused the contamination of plants, which had the effect of contaminating the sheep who ate the plants. The sheep were then contaminated with caesium-137.

Currently in the UK, fish and shellfish may be irradiated with cobalt-60, to kill the bacteria that causes food poisoning. It also helps to make food last longer, and therefore reduce food waste.

	Cobalt-60	**Caesium-137**
Emits gamma radiation?	yes	yes
Half-life	5 years	30 years

Explain why **irradiated** fish are safe to eat, but **contaminated** sheep are not.

Use the information in the table to support your answer.

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..... **[6]**

3. Nov 2021/Paper_J260/07/No.3

Beth has a scan to investigate the blood supply to her heart. Before the scan a radioactive tracer is injected into her blood. The radioactive tracer is a gamma emitter with a half-life of 6 hours.

(a) A method is shown for how a scan of Beth's heart is produced after the injection of the radioactive tracer.

It is **not** in the correct order.

Method
1. Gamma radiation is emitted from the heart.
2. Gamma radiation is detected by a gamma camera.
3. The radioactive tracer decays.
4. A computer forms an image on a screen.
5. Radioactive tracer concentrates in the heart.

Write the numbers in the correct order. The first one has been done for you.

5				

[3]

(b) Another radioactive isotope used in nuclear medicine is a beta emitter with a half-life of 8 days.

(i) Explain **one** reason why this isotope is not suitable to produce a scan of Beth's heart.

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..... **[2]**

(ii) Suggest **one** medical use for this isotope.

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..... **[1]**

(c) Having an injection of a radioactive tracer into blood is an example of contamination with radioactive material.

(i) Compare the hazards of being contaminated by radioactive material with being irradiated by a radioactive material.

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..... **[3]**

(ii) Both beta and gamma radiation are ionising.

Explain how ionising radiation is hazardous to the human body.

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..... **[2]**

(iii) What fraction of the radioactive tracer remains radioactive 1 day after being injected into a person's blood?

Tracer half-life = 6 hours

Fraction = ... **[2]**

4. Nov 2020/Paper_J260/07/No.8

In **1986** there was an explosion at the Chernobyl nuclear reactor.

Caesium-137 is one of the largest sources of radioactivity left over from the explosion.

Caesium-137 has a half-life of 30 years.

(a) **(i)** Calculate the fraction of the radioactive emission from Caesium-137 that will still be present in **2076**.

Fraction = ... **[3]**

(ii) What year will the fraction have fallen to $\frac{1}{64}$ of the original radioactive emission?

Year = ... **[3]**

(b) The first international reports of the explosion were made when measuring instruments in Sweden detected high radiation levels in the air.

Since the explosion at Chernobyl, scientists in many countries have shared their research on radiation levels and its effects.

Give **two** reasons why these scientists should communicate their work to the public, politicians and other scientists.

1. .....

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2. .....

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[2]