

Nuclear Decay - Questions by Topic

Q1.

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 .

A student used a Geiger-Müller tube and counter to measure the count near to a radioactive source for one minute. He used this value to calculate the count rate due to the source in Bq.

Which of the following would decrease the percentage uncertainty in the student's value for the activity?

- A** Add the background count to the measured count.
- B** Increase the counting time to 10 minutes.
- C** Increase the distance of the Geiger-Müller tube from the source.
- D** Subtract the background count from the calculated count rate.

(Total for question = 1 mark)

Q2.

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 (). If you change your mind about an answer, put a line through the box and then mark your new answer with a cross (.

The activity of a radioactive source depends on the number of unstable nuclei in the source and the half-life of the source.

Which row in the table corresponds to a source with the greatest activity?

	Number of unstable nuclei in source	Half-life of source
<input type="checkbox"/> A	small	small
<input type="checkbox"/> B	small	large
<input checked="" type="checkbox"/> C	large	small
<input type="checkbox"/> D	large	large

(Total for question = 1 mark)

Q3.

A student used a detector and counter to determine the count rate near to a radioactive source. She also measured the background count for 10 minutes.

Which of the following must she do to obtain an accurate value for the count rate?

(1)

- A** Add the background count to her count rate.
- B** Add the background count rate to her count rate.
- C** Subtract the background count from her count rate.
- D** Subtract the background count rate from her count rate.

(Total for question = 1 mark)

Q4.

Cobalt-60 is an artificially produced radioisotope that can be used to treat cancer. It emits beta particles of energy 0.3 MeV and gamma rays of energy 1.3 MeV.

(a) Complete the nuclear equation for the beta decay of cobalt-60.

(2)



(b) State, with a reason, the penetrating powers of each of the two types of radiation emitted by the cobalt-60.

(2)

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(c) State one risk to a patient associated with the use of radioisotopes to treat cancer.

(1)

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(Total for question = 5 marks)

Q5.

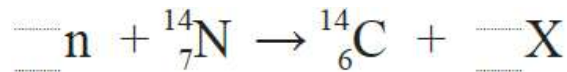
Carbon-12 is the stable isotope of carbon; most carbon exists in this form.

Carbon-14 is formed in the upper atmosphere. Carbon-14 is radioactive and decays randomly by emitting β^- particles.

(a) Carbon-14 is formed when a nitrogen nucleus absorbs a neutron.

(i) Complete the nuclear equation representing the formation of carbon-14 and identify the particle X.

(3)



X is

(ii) State what is meant by decays randomly.

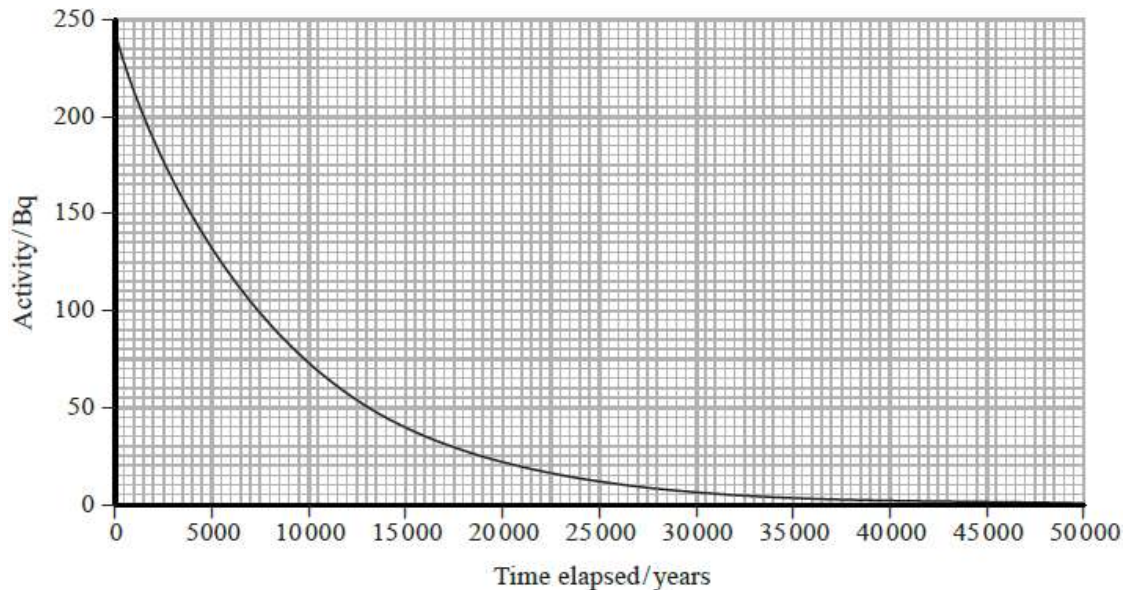
(1)

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(b) Carbon is taken in by living organisms throughout their lives. Whilst an organism is alive, the ratio of carbon-14 to carbon-12 in the organism stays the same.

From the time that the organism dies, the ratio of carbon-14 to carbon-12 decreases. Hence certain ancient objects can be dated using the decay of carbon-14.

An activity-time graph for carbon-14 is shown.



Use the graph to show that the half-life of carbon-14 is about 6000 years.

(2)

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(c) A scientist is trying to determine the age of an ancient wooden object. A sample prepared from this object gives a corrected count rate of 10.9 Bq. The corrected count rate of a sample obtained from living wood is 29.6 Bq. The two samples have the same mass.

(i) State why the count rates have to be corrected.

(1)

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(ii) State one procedure that would increase the accuracy obtained for the count rates of these samples.

(1)

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(iii) Calculate the age of the ancient object.

Assume the half-life of carbon-14 is 6000 years.

(3)

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Age of ancient object =

(d) A news report claims that a dinosaur skull has been found, and suggests that the skull is 68 million years old.

Explain why carbon-14 dating could not have been used to determine the age of this skull.

(2)

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*(e) A website includes the following statement about heavy nuclei:

Particles in the nucleus are held together by a force scientists call nuclear binding energy. It is possible to overcome the binding energy in some large atoms, such as uranium atoms, causing the atoms to undergo fission.

Comment on this statement.

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(Total for question = 17 marks)

Q6.

In the early part of the 20th century the Nobel Prize winner George de Hevesy made the first use of a radioactive tracer. He studied the transportation of a small sample of the isotope lead-212 in a broad bean plant.

(a) Complete the nuclear equation for the decay of Pb-212.

(2)



(b) The half life of ${}^{212}\text{Pb}$ is 3.83×10^4 s.

(i) State what is meant by the term half life.

(1)

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(ii) Show that the decay constant of ^{212}Pb is about $2 \times 10^{-5} \text{ s}^{-1}$ and hence calculate the fraction of the original sample that will remain after a time of 1 day (86 400 s).

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Fraction remaining =

(iii) The energy released in this decay is $9.12 \times 10^{-14} \text{ J}$.

Calculate the decrease in mass in kg that occurs in the decay of one Pb-212 atom.

(2)

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Decrease in mass = kg

(c) The isotope of bismuth produced by the decay of Pb-212 is itself radioactive. It produces both alpha and beta particles with an overall half life which is much shorter than that of the lead.

Discuss how the decay of the bismuth isotope could affect the measurements made on the activity of the broad bean plant.

(2)

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Q7.

Technetium-99m is an unstable isotope which decays by emitting γ radiation. The decay process is random. The half life of this isotope is 2.16×10^4 s.

(a) (i) State what is meant by 'random'.

(1)

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(ii) State what is meant by 'half life'.

(1)

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(b) A sample containing 7.30×10^{19} atoms of technetium-99m is prepared for use in a medical application.

(i) Show that the activity of the sample when it is prepared is about 2.3×10^{15} Bq.

(3)

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(ii) Calculate the activity of the sample 1 day after the sample was prepared.

1 day = 86 400 s

(2)

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Activity of sample after 1 day =

(Total for question = 7 marks)

Q8.

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

The initial count rate recorded by a detector placed close to a radioactive sample is 4800 Bq. After 12 hours the count rate has fallen to 300 Bq.

Which of the following is the half-life of the sample?

- A** 2.4 hours
- B** 3.0 hours
- C** 4.0 hours
- D** 12 hours

(Total for question = 1 mark)

Q9.

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 ☒.

The half-life of protactinium is 70 s.

After which of the times below would the activity of a sample of protactinium have decreased to less than 2% of its initial value?

- A** 70 s
- B** 210 s
- C** 350 s
- D** 420 s

(Total for question = 1 mark)

Q10.

Radiation beam therapy can be used to kill cancerous cells in the body. One treatment for brain tumours directs many narrow beams of radiation from different directions onto the cancerous cells.

What would be the most suitable radiation to use?

- A** alpha radiation because it is very ionising
- B** alpha radiation because it is high energy
- C** gamma radiation because it is very penetrating
- D** gamma radiation because it has a very short wavelength

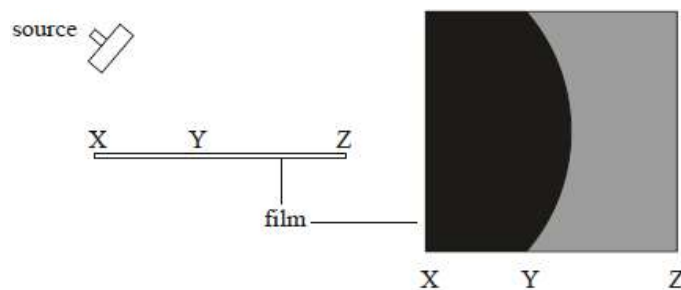
(Total for question = 1 mark)

Q11.

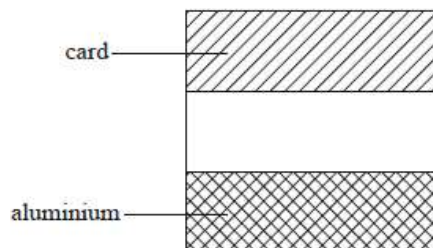
When exposed to ionising radiation photographic film darkens. The darkness of the film shows how much ionising radiation the film has been exposed to.

A source emitting α , β , and γ radiation was placed a small distance from some photographic film in a light-tight box.

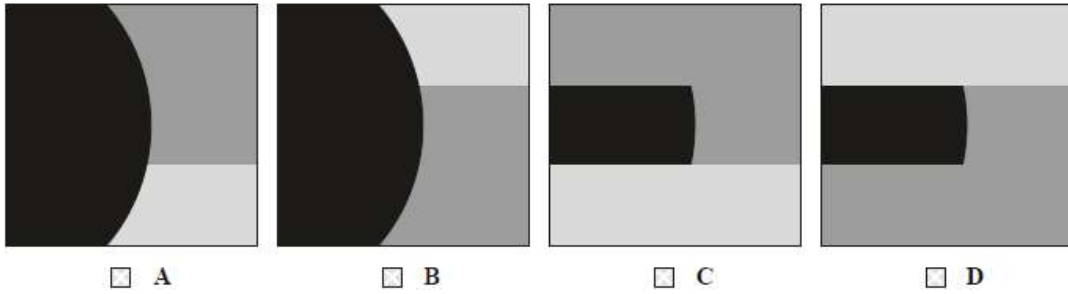
The film became darkened as shown. X, Y and Z are points on the film.



A second film is covered by strips of card and aluminium as shown.



Select the diagram that shows how the film would be darkened with these strips in place.



(Total for question = 1 mark)

Q12.

Low-activity, sealed radioactive sources are used in schools to demonstrate the properties of ionising radiations. Three sources have been mixed up.

The sources and the radiations that they emit are shown in the table.

Source	Radiation emitted
Americium	α
Radium	α, β, γ
Strontium	β, γ

(a) State what is meant by the activity of a radioactive source.

(1)

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(b) Describe an experiment using absorbers of different materials that could be carried out to identify the sources.

You must explain how the data collected could be used to distinguish between the three sources.

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(c) The school also has a γ source with a stated activity of 185 kBq. The current activity of the source is determined to be 25.7 kBq.

Calculate the time elapsed since the source was produced.

half-life of source = 5.26 years

(3)

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Time elapsed =

(Total for question = 10 marks)