Practice Question Set For A-Level
Subject : Physics
Paper-2 Topic : 11_Nuclear Radiation

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Name of the Student:_____
Max. Marks : 18 Marks **Time : 18 Minutes**

Q1.

All living organisms contain ^{12}C and radioactive ^{14}C. The concentration of ^{14}C in the organism is maintained whilst the organism is alive, but starts to fall once death has occured.

(a) The count rate obtained from wood from an old Viking ship is 14.7 min^{-1} per gram of wood, after being corrected for background radiation. The corrected count rate from similar living wood is 16.5 min^{-1} per gram of wood

Calculate the age of the ship in years.

^{14}C. has a half life of 5700 years.

(4)

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Age of ship = ...years

(b) The concentration of ^{14}C in living organisms might have been greater in the past.

Explain how this would affect the age that you have calculated.

(2)

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(Total for question = 6 marks)

Q2.

An old type of camping lamp used a 'gas mantle'. The gas mantle is heated by the gas flame on the lamp and emits a bright white light. Gas mantles used to contain thorium-230.

Thorium-230 decays by alpha emission to form an isotope of radium. A student keeps a radioactive gas mantle

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in a sealed polythene bag. The student suggests that over a period of a year a significant volume of helium gas will be collected, since an alpha particle is a helium nucleus.

Give reasons why the sealed plastic bag is suitable for collecting the gas.

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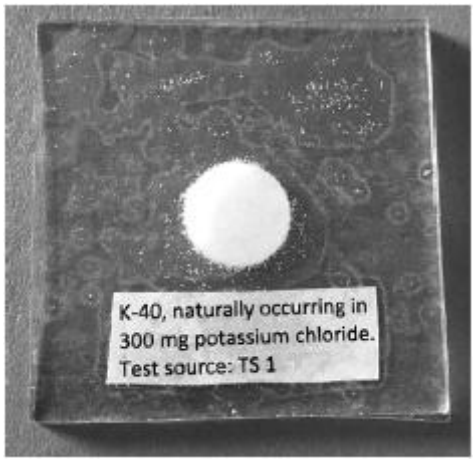
(Total for question = 2 marks)

Q3.

A school science department keeps a sample of potassium chloride to use as a test source for Geiger-Müller tubes.



Potassium contains 0.012% of the unstable isotope potassium-40.

Potassium-40 undergoes β^- decay, producing a stable isotope of calcium.

Complete the nuclear equation for this decay.

(2)

$$^{40}_{19}\mathrm{K} \rightarrow \underline{\quad}\mathrm{Ca} + \underline{\quad}\beta$$

(Total for question = 2 marks)

Q4.

In 2011, a tsunami was caused by a massive earthquake centred some distance off the coast of Japan. The tsunami caused a cooling system failure at the Fukushima Nuclear Power Plant. This resulted in a nuclear meltdown and radioactive materials were released into the surroundings.

A reservoir beside one of the reactor buildings contained a large volume of water. In 2013, this water was found to have an extremely high concentration of caesium-137.

Caesium-137 is a radioactive isotope of caesium.

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(i) Complete the nuclear equation for the decay of caesium-137.

$$^{137}_{55}\mathrm{Cs} \rightarrow \text{____}\mathrm{Ba} + \text{____}\beta^{-} + {}^{0}_{0}\bar{\nu}_{e}$$

(2)

(ii) An activity of 2.35 × 1012 Bq per m^3 of water in the reservoir was measured. It is suggested that a safe level for the activity of all water in the reservoir would be 100 Bq.

Calculate the time in years for the caesium-137 to decay to a safe level.

volume of water in reservoir = 5000 m^3

half-life of caesium-137 = 30 years

(4)

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Time = ... years

(Total for question = 6 marks)

Q5.

At the Culham Centre for Fusion Energy (CCFE) experiments are carried out to investigate nuclear fusion and the properties of plasmas. A plasma consists of ionised gas, containing positive ions and electrons.

In a fusion experiment at CCFE, ions of two isotopes of hydrogen fuse to produce helium ions and fast-moving neutrons.

Fusion occurs naturally in the core of stars.

Explain why very high densities of matter and very high temperatures are needed to bring about and maintain nuclear fusion in stars.

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(Total for question = 2 marks)

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