

9 (a) Explain what is meant by

(i) the *radioactive decay* of a nucleus, and

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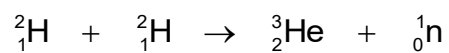
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(ii) *nuclear fusion*.

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(b) The nuclear fusion of two nuclei of deuterium is represented by the nuclear equation.



Mass of a deuterium nucleus =  $3.345 \times 10^{-27}$  kg

Mass of a helium nucleus =  $5.008 \times 10^{-27}$  kg

Mass of a neutron =  $1.675 \times 10^{-27}$  kg

(i) Calculate the energy released during the fusion reaction.

energy released = ..... J [2]

- (ii) Calculate the energy released per kilogram of deuterium nucleus during the fusion reaction.

energy released per kg = ..... J kg<sup>-1</sup> [3]

- (c) Artificial pacemakers that are used to stimulate the heart may be designed to run on nuclear energy. Early types of such nuclear batteries contain 0.16 g of Plutonium-238 and produces 0.75 mW of power when new.

- (i) Given that the half-life of Plutonium-238 is 88 years, calculate its decay constant.

decay constant = .....  $\text{s}^{-1}$  [2]

(ii) Hence determine the initial activity of 0.16 g of the Plutonium-238 source.

initial activity = .....  $\text{s}^{-1}$  [2]

(iii) One of the decay chain of Plutonium-238 involves a series of alpha decays which leads to Uranium-234, followed by Thorium-230 and then to Radium-226. The half-life of Uranium-234 is 246,000 years.

1. Determine the change in mass per Plutonium-238 decay into Uranium-234.

change in mass = ..... kg [2]

2. State one assumption made in (iii)1.

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.....[1]

(iv) Suggest why it is important to investigate the decay chain of Plutonium-238 in the design of such a nuclear battery.

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.....[1]

(d) Radioactivity as a source of radiation can have both good and bad effects. Some of the sources contributing to background radiation can be rocks and soil or medical treatment.

(i) Name another source of background radiation which makes a major contribution.

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[1]

- (ii) Suggest why, when monitoring low radiation levels in the body for medical purposes, it is important to reduce background count rate to a minimum.

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[2]

**END OF PAPER**