

- 8 (a) Radioactive decay is a random and a spontaneous process.

Explain what is meant by

- (i) *radioactive decay*,

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

- (ii) *a random process*,

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

- (iii) *a spontaneous process*.

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

- (b) In a Voyager spacecraft, electrical power is provided using plutonium-238 ( $^{238}_{94}\text{Pu}$ ).

Plutonium-238 nuclei emit  $\alpha$ -particles of energy 5.48 MeV. The half-life of plutonium-238 is 86.4 years.

Some of the energy of the emitted  $\alpha$ -particles is converted into thermal energy and then into electrical energy.

Calculate

- (i) the probability per second of the decay of a plutonium-238 nucleus,

probability = .....  $\text{s}^{-1}$  [3]



- (ii) the mass of plutonium-238 required for the energy per unit time of the emitted  $\alpha$ -particles to be 2400 W. Explain your working.

mass = ..... kg [6]

- (c) Initially, of the 2400 J of energy produced per second by the decay of the plutonium-238, 160 J of electrical energy is generated per second.

- (i) Calculate the efficiency of the conversion process.

efficiency = ..... % [1]

- (ii) Use data in (b) to determine the electrical power that is generated after 3.2 years.

power = ..... W [2]





(d) Some data for three radioactive isotopes are given in Fig. 8.1.

isotope	half-life	principal radiation
plutonium-238	86.4 years	$\alpha$ -particles
polonium-210	138 days	$\alpha$ -particles
strontium-90	27.7 years	$\beta$ -particles

**Fig. 8.1**

Suggest and explain, for a space flight lasting several years, one advantage of plutonium-238 as compared with

(i) polonium-210,

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..... [2]

(ii) strontium-90.

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..... [2]

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