8 (a) Radioactive decay is a random and spontaneous process. The stationary radioactive isotope Plutonium-238 $\left({}^{238}_{94}\text{Pu}\right)$ decays by emitting an alpha particle.

The daughter nucleus is an isotope of Uranium. The mass of ${}^{238}_{94}\text{Pu}$ is 238.0496 u and the mass of an α-particle is 4.0026 u.

(i) Explain what is meant by a spontaneous process.

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……..…….....[2]

(ii) Write down an equation representing the decay, indicating clearly the atomic number and mass number of each nucleus.

……..…….....[2]

(iii) Given that the total kinetic energy of the products is 5.649 MeV, calculate,

1. in terms of atomic mass units, the mass of the uranium nucleus formed in the reaction,

mass of uranium nucleus = ……u [3]

2. the ratio of the kinetic energy of the α-particle to that of the uranium nucleus formed,

ratio = …… [3]

3. the kinetic energy of the α-particle, in MeV.

kinetic energy of α-particle = ……MeV [2]

(b) Fig. 8.1 shows a simple experiment set up by a student to estimate the activity of a radioactive source. The source emits α, β and γ-radiation particles and is placed 10 cm from a detector that is connected to a counter.

The detector is capable of detecting all types of radioactive emissions.

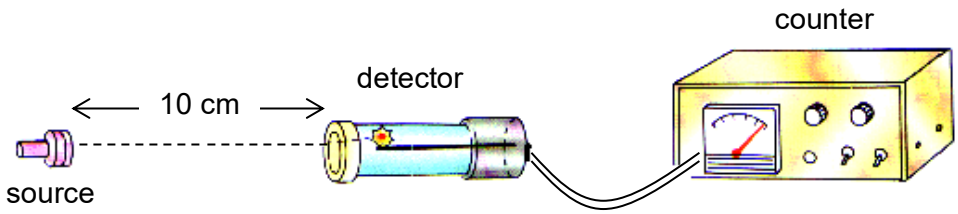

Fig. 8.1

(i) Distinguish between α and γ-radiation in terms of their relative ionizing strength and penetrating abilities.

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……[2]

(ii) Explain whether emission of α-particles will be detected in the above set-up.

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……[1]

(iii) Without the source, the counter gives a count-rate of 600 min^{-1}. When the source is placed 10 cm in front of the detector, the following count rates are observed at two different times, *t.*

t / hour	Count-rate / min^{-1}
0	7009
6.0	1401

Calculate the half life of the source.

half-life = …….. hours [3]

(iv) State two effects of ionizing radiation on living tissues and cells.

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