7 (a) (i) Explain the term background radiation and state **two** separate sources of background radiation.

....

....

....

.... [3]

(ii) The background count rate was recorded 5 times. The results are shown in Table 7.1.

Table 7.1

background count rate $/\text{min}^{-1}$
20
15
22
19
14

Explain what can be deduced about radioactive decay from these results.

....

.... [1]

(b) Discuss the effect of different amounts of ionising radiation on living cells.

....

....

....

.... [4]

(c) The isotope americium-241 is used in smoke detectors in homes and offices.

(i) Explain what is meant by the term isotope.

....

.... [1]

(ii) An americium-241 (Am) nucleus has 146 neutrons in its nucleus and decays into a nucleus of neptunium (Np) by emitting an alpha-particle.

Write a balanced nuclear equation for this decay.

[2]

(iii) Explain why using americium-241 in smoke detectors is unlikely to cause harm to the occupants of the building.

....

....

.... [2]

(iv) Suggest why an alpha-emitter is used for detecting smoke in a smoke detector.

....

.... [1]

(d) Americium-241 has a half-life of 432 years.

Estimate the time taken for the activity of an americium-241 source to decrease to 10% of its initial activity.

time = ... years [2]

(e) **(i)** The alpha-particles emerge from the nucleus with kinetic energy of 5.49 MeV.

Calculate the overall loss in mass due to the alpha-decay of an americium-241 nucleus.

mass = ... kg [2]

(ii) A sample of americium-241 used in a smoke detector initially decays at the rate of 1.15×10^{12} decays per year.

Calculate the initial rate of loss of mass due to these decays.

rate of loss of mass = ... kg year^{-1} [2]

[Total: 20]