Oxford Cambridge and RSA

A level Physics B

H557/02 Scientific literacy in physics

Question Set 9

1 This question is about beta radiation from the decay of potassium-40 ($^{40}_{19}K$) in bananas.

(a) An average banana contains about 5×10^{-4} kg of potassium. About 0.012% of this potassium is the beta-emitting isotope, potassium-40.

Show that a single banana will have an activity in the range 10 – 20 Bq.

The mass of one mole of potassium-40 is 0.040 kg.

Potassium-40 decays with half-life 1.3×10^{9} years (4.1×10^{16} s).

[4]

(b) The average energy of the beta particles emitted by potassium-40 is 8.3×10^{-14} J.

Show that the equivalent dose received over 20 years by a 70 kg person who eats two bananas every week is about 10 mSv. Assume that all the ingested potassium-40 remained in the body during that time. The quality factor of beta radiation is 1.

[5]

(c) The risk of contracting cancer is about 5% per sievert. Calculate an estimate of the number of cancers produced in a population of 60 million over a period of twenty years from this equivalent dose.

[1]

(d) The amount of potassium-40 in the body is maintained at a steady level of about 2.0×10^{-5} kg for a 70 kg adult. The excess is excreted.

Suggest and explain one reason why the Government should **not** recommend that people should limit the number of bananas they eat on the basis of radiation risk.

[2]

Total Marks for Question Set 9: 12