Test: Nuclear Models and Radioactivity

1.

(a) The nucleus has thousands of times more mass than the electrons.

(b) The atom is tens of thousands of times larger than the nucleus.

2.

(a) 92

(b) 131

(c) $N = A - Z$

(d) They have the same number of protons (charge properties).

3.

(a) beta minus

(b) helium nucleus

(c) positron and neutrino

(d) high-energy nucleus (excess energy to release)

4.

(a) Alpha particles have twice as much charge as beta and thousands of times more mass. Therefore alpha particles have a much higher ionising power.

(b) Since alpha particles have a high ionising power, they ionise often as they travel through matter. Since the alpha particles lose energy (slow down) each time they ionise, they will not travel very far.

(c) -either-

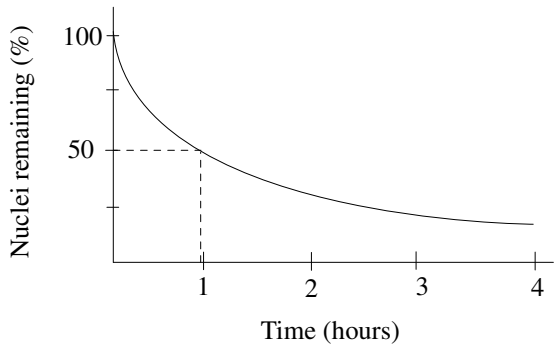
Limiting exposure time, since this will reduce the total number of ionisations that can occur.

-or-

Increasing distance from the source, since the radiation spreads out (and is absorbed by the air) as it travels so less will reach the doctor.

5.

(a)



(b) $\frac{171}{57} = 3$ half-lives

$5.8\times10^{24}\times\frac{1}{2}\times\frac{1}{2}\times\frac{1}{2}$

$= 7.3\times10^{23}$ nuclei

(c) The activity of a radioactive substance is the number of radioactive nuclei that decay per unit time.

(d) Advantage: will not stay active in the body for very long

Disadvantage: cannot be used after being stored or transported long distances

6.

(a) To balance the mass number (235 = 138 + 95 + 2)

(b) $m_i = 3.9030 \times 10^{-25}$ kg

$m_f = 2.2900 \times 10^{-25} + 1.5765 \times 10^{-25} + 2 \times 1.6749 \times 10^{-27}$

$= 3.9000 \times 10^{-25}$ kg

$\Delta m = m_f - m_i$

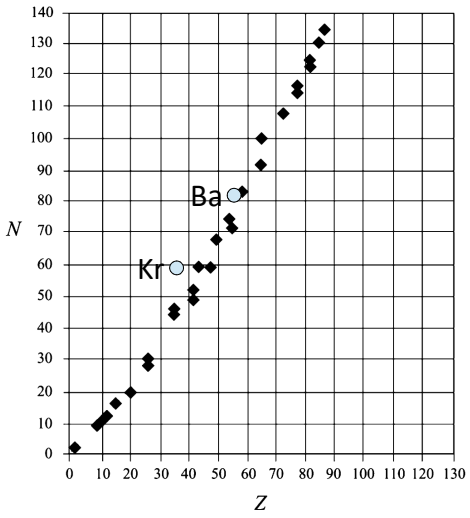
$= 3.89998185 \times 10^{-25} - 3.9029959 \times 10^{-25}$

$= 3.002 \times 10^{-28}$ kg

$E_b = \Delta m c^2 = 3.002 \times 10^{-28} \times \left(3.00 \times 10^8\right)^2$

$= 2.70 \times 10^{-11}$ J

(c)



(d) Nuclei that undergo fission are large therefore have many neutrons. The products of nuclear fission are smaller so they don't need as many neutrons. Having excess neutrons means the unstable nuclei will convert neutrons into protons and emit electrons (beta minus) to balance the charge.

(e) A fission power reactor relies on chain reactions caused when neutrons emitted by one uranium-235 fission induce further fissions. If the uranium fuel is not enriched then the not enough neutrons will be absorbed by uranium-235 nuclei to continue the reaction.

(f) The neutrons emitted by uranium-235 fission are travelling too fast to be absorbed by another uranium-235 in order to induce another fission. The moderator slows down the neutrons quickly (by collisions) without absorbing them, so the chain reaction can continue.

(g) High temperatures are required for fusion to occur (not required for fission).