Answers to Exercise 2.5
Radiation and Radioactivity

1.

(a) alpha radiation

(b) beta radiation

While some nuclear reactions also release positrons, they annihilate upon encountering electrons.

(c) gamma radiation, neutrons, neutrinos

(d) gamma radiation

Neutrinos have <u>very</u> small mass.

(e) alpha radiation

(f) gamma radiation, neutrons, neutrinos

Penetrating power decreases with the mass and charge of the radiation.

(g) neutrons

2. The absorbed dose of radiation is the amount of energy absorbed per kg of exposed tissue.

The equivalent dose of radiation is the amount of energy of gamma radiation that it would take to do the same amount of biological damage (per kg of exposed tissue).

A conversion factor (relative biological effectiveness = RBE) is used to account for the fact that different types of radiation interact differently with biological tissues:

$$equivalent\ dose = RBE \times absorbed\ dose$$

Absorbed dose is measured in grays (Gy). Equivalent dose is measured in sieverts (Sv). Both are equivalent to J/kg.

3.

(a) gamma radiation

(b) $absorbed\ dose = 0.001\frac{Gy}{min} \times 3\ h \times \frac{60\ min}{1\ h} = 0.2\ Gy$ *1 sig. fig.*

(c) $equivalent\ dose = RBE \times absorbed\ dose = 20\frac{Sv}{Gy} \times 0.2\ Gy = 4\ Sv$ *1 sig. fig.*

(d) $absorbed\ dose = \frac{energy\ absorbed}{mass\ tissue}$ ****1 Gy = 1 J/kg****

$energy\ absorbed = absorbed\ dose \times mass\ tissue$

$energy\ absorbed = 0.2\ \frac{J}{kg} \times 27pg \times \frac{1kg}{1000g} \times \frac{1g}{10^{12}pg} = 5 \times 10^{-15}J$ *1 sig. fig.*