

Homework 2

Nuclear Engineering 162

Due 13 February 2008

II.1 Turner 3.14 (Page 80)

The ${}_{88}^{226}\text{Ra}$ nucleus emits a 4.60-MeV alpha particle 5.5% of the time when it decays to ${}_{86}^{222}\text{Rn}$.

- (a) Calculate the Q value for this decay.
- (b) What is the recoil energy of the ${}^{222}\text{Rn}$ atom?

II.2 Turner 3.17 (Page 80)

- (a) Calculate the energy released in the beta decay of ${}_{15}^{32}\text{P}$.
- (b) If a beta particle has 650 keV, how much energy does the antineutrino have?

II.3 Turner 3.26 (Page 81)

- (a) Calculate the Q values for the decay of ${}_{28}^{57}\text{Ni}$ by positron emission and by electron capture.
- (b) Draw the decay scheme.

II.4 Turner 3.28 (Page 81)

Calculate the recoil energy of the technetium atom as a result of photon emission in the isomeric transition ${}_{43}^{99m}\text{Tc} \longrightarrow {}_{43}^{99}\text{Tc} + \gamma$.

II.5 Turner 4.5 (Page 103)

The isotope ${}^{132}\text{I}$ decays by β^- emission into stable ${}^{132}\text{Xe}$ with a half-life of 2.3 h.

- (a) How long will it take for $\frac{7}{8}$ of the original ${}^{132}\text{I}$ atoms to decay?
- (b) How long will it take for a sample of ${}^{132}\text{I}$ to lose 95% of its activity?

II.6 Turner 4.11 (Page 103)

How many atoms are there in a 1.16-MBq source of

- (a) ${}^{24}\text{Na}$?
- (b) ${}^{238}\text{U}$?

II.7 Turner 4.16 (Page 104)

A sample contains 1.0 GBq of ${}^{90}\text{Sr}$ and 0.62 GBq of ${}^{90}\text{Y}$.

- (a) What will be the total activity of the sample 10 days later?
- (b) What will be the total activity of the sample 29.12 years later?

II.8 Turner 4.21 (Page 105)

${}^{136}\text{Cs}$ (half-life = 13.7 d) decays β^- into ${}^{136m}\text{Ba}$ (half-life = 0.4 s), which decays γ into stable ${}^{136}\text{Ba}$:



- (a) Calculate the decay constant of ^{136}Cs .
- (b) Calculate the specific activity of ^{136}Cs .
- (c) Starting with a pure 10^{10} Bq sample of ^{136}Cs at time $t=0$, how many atoms of ^{136m}Ba decay between time $t_1=13.7\text{d}$ (exactly) and time $t_2=13.7\text{ d} + 5\text{ s}$ (exactly)?

II.9 Turner 4.24 (Page 105)

A 40-mg sample of pure ^{226}Ra is encapsulated.

- (a) How long will it take for the activity of ^{222}Rn to build up to 10 mCi?
- (b) What will be the activity of ^{222}Rn after 2 years?
- (c) What will be the activity of ^{222}Rn after 1000 years?
- (d) What is the ratio of the specific activity of ^{222}Rn to that of ^{226}Ra ?

II.10 Turner 4.28 (Page 105)

The average mass of potassium in the human body is about 140 g. From the abundance and half-life given in Appendix D, estimate the average activity of ^{40}K in the body.

II.11 Activity of Banana

Bananas naturally contain several different radioactive isotopes. List each isotope and average concentration. Compared to the average annual exposure how much does banana consumption represent? Please site the Internet or other resources you used in answering this question.