Ch. 1


11. The end product is a stable isotope.

19. An increase in the neutron/proton ratio causes instability.

10. 222 Rn 13 C 3 Li 22 C1 37 K 43 C1 4 He

1. 3 H

20. 3 H

21. No form of radioactivity increases the mass number. The mass number either decreases or stays the same. β decay will increase the atomic number.

22. The nucleus of an atom is held together by binding energy. The binding energy results from the decrease in mass when the individual particles combine to form the nucleus.
23. \[ {^{238}}\text{U} + {^0}\text{n} \rightarrow {^{239}}\text{U} \rightarrow {^{240}}\text{Pu} + {^2}\text{He} \]

\[ 118 - 46 = 72 \text{ neutrons} \]
\[ 72 = 1.5 \times \text{Np} \text{ ratio} \]

This is greater than the ratio for stable Pb, so it is most likely a Po derivative (see sec. 4.8).

24a) Fe 56

\[ 26 \text{ protons} \times 1.007 \text{ amu/}p = 26.182 \]
\[ 30 \text{ neutrons} \times 1.009 \text{ amu} / n = 30.27 \]
\[ 26 \times e^- \times 0.005 \text{ amu} / e = -0.13 \]

Expected mass: 56.45 amu
Actual mass: 55.93 amu

Mass defect: \(-0.5201 \text{ amu}\)

25.

a) \[ {^{210}}\text{Po} \rightarrow \frac{4}{2} \alpha + \left( {^{206}}\text{Pb} \right) \]

b) \[ {^{234}}\text{P} \rightarrow 1\beta + \left( {^{234}}\text{U} \right) \]

c) \[ {^{131}}\text{I} \rightarrow {^{131}}\text{Xe} + 1\beta \]

Book had wrong symbol.

d) \[ {^{230}}\text{Th} \rightarrow {^{226}}\text{Ra} + \frac{4}{2} \alpha \]

e) \[ {^{243}}\text{Cm} \rightarrow {^{239}}\text{Pu} + \alpha \]

f) \[ {^{235}}\text{U} \rightarrow \left( {^{235}}\text{U} + \frac{4}{2} \beta \right) \]

\[ {^{236}}\text{U} \rightarrow {^{236}}\text{U} + \frac{4}{2} \beta \]
Ch. 5

1. Electrical power, diagnosis & therapy, radioisotope dating, fission reactor, atomic pile, uranium 235, breeder reactor, plutonium 239, fusion reactor.

2. Radioisotope dating, radioactive elements, half lives.

3. The heat from the pile is used to convert water to steam. The steam drives a turbine, which in turn generates electricity. After the steam leaves the turbine, it is cooled in a condenser tower and the process is repeated to keep the system of being heated.

4. Electricity can be generated by wind, water or sun light.

5. If all the rods were removed, the reactor would overheat and melt down. However, it would not undergo a nuclear explosion.

6. If all the rods were inserted, the reactor would shut down, producing no heat.

7. Nuclear explosion cannot occur because a commercial reactor does not have a critical mass. It can undergo a meltdown where the entire pile is destroyed by heat and a chemical explosion can take place.
19. \[ {^{239}\text{U}} \rightarrow {^{239}\text{Ne}} + \gamma + \nu \rightarrow {^{239}\text{Pa}} \] 

20. It accumulates in the Earth, if e.g., with \( \beta < \gamma \) and \( \gamma \) has an 8-day half-life.

25. Least penetrating \( \alpha < \beta < \gamma \) most penetrating

Must ions \( \alpha > \beta \) at least 885

26. SEE NEXT PAGE

28. 0.1g/\text{kg} \times 100 = 0.1\% 

This is equivalent to \( 10^{-4} \) or 

\( 1 \text{ at } 57,300 \text{ yrs} \) or 

\( 1 \text{ at } 10 \text{ yrs} \) and 

\( 1 \text{ at } 1 \text{ sec} \) or

Anything greater than \( 10 \text{ yrs} \) life, the balance will red 0

30. 0.1% means at least 6 half-lives so the atom is greater than 57,300 yrs old (\( T_2 = 57,300 \text{ yrs} \))

31. The presence of \( ^{246}\text{Pa} \) would give a greater total # of atoms, so the \( ^{238}\text{U} \) remaining would be lower, giving an older age of the Earth (\( \frac{^{238}\text{U}}{^{238}\text{U} + ^{235}\text{U}} \))
Assume the shroud was made in 1200, so it is about 803 years old.

\[ \frac{893}{5730} \text{ years} = 0.15 \text{ as the number of half-lives. About 80% remains} \]

(2) It should have a short half-life and be a d. emitter.

(2) Calculate the \% of Te-99m that remains

\[ \frac{19}{100} = 19\% \]

To decrease to just under 1\% requires 10 half-lives (Table 5.4).

(2) The t 1/2 for Te-99m is 6 hours, so it will take \( 10 \times 6 = 60 \) hours for the process to occur.

(3) It formed in 20 AD, the cloth is 1974 years old.

\[ \frac{1974}{5730} = 0.34 \text{ half-life} \]

After \( \frac{3}{4} \) of a half-life \( \approx 80\% \) remains

For 1320 AD, the cloth is 704 years old.

\[ \frac{704}{5730} = 0.13 \text{ half-life} \]

Only about 78% has decayed \( \approx 93\% \) remains