Answers to Exercise 2.3
Balancing Nuclear Reaction Equations

1.

(a) $^{238}_{92}U + ^{1}_{0}n \rightarrow ^{239}_{92}U$

(b) $^{239}_{92}U \rightarrow ^{239}_{93}Np + ^{0}_{-1}\beta$

(c) $^{239}_{93}Np \rightarrow ^{239}_{94}Pu + ^{0}_{-1}\beta$

(d) $^{239}_{94}Pu + ^{1}_{0}n \rightarrow ^{240}_{94}Pu$

(e) $^{240}_{94}Pu \rightarrow ^{236}_{92}U + ^{4}_{2}\alpha$

2.

(a) $^{138}_{54}Xe$

Set up and balance a nuclear reaction equation to find the mass number and atomic number of the second nuclide: $^{240}_{94}Pu \rightarrow ^{100}_{40}Zr + 2^{1}_{0}n + ^{138}_{54}Xe$

*Remember that the two neutrons *each* contribute 1 to the total mass number on the products side of the equation: 100 + 2 + 138 = 240 (and 0 to the total atomic number on the products side of the equation: 40 + 54 = 94)*

(b) It is unusual for fission to be spontaneous. Most fission reactions require induction by striking the nuclide with a neutron.

This temporarily makes a new isotope in a high-energy form. The extra neutron adds to the nucleus, but it does not tend to strike the nucleus and "stick" in exactly the right way to give the lowest energy possible arrangement of protons and neutrons. This high-energy form of the new nucleus releases some of the excess energy by breaking into smaller pieces (fission).

3.

(a) $^{110}_{52}Te \rightarrow ^{106}_{50}Sn + ^{4}_{2}\alpha$

(b) $^{23}_{12}Mg \rightarrow ^{23}_{11}Na + ^{0}_{+1}\beta$

(c) $^{59}_{28}Ni + ^{0}_{-1}e \rightarrow ^{59}_{27}Co$

or $^{59}_{28}Ni + ^{0}_{-1}\beta \rightarrow ^{59}_{27}Co$

(d) $2^{12}_{6}C \rightarrow ^{20}_{10}Ne + ^{4}_{2}He$

or $2^{12}_{6}C \rightarrow ^{20}_{10}Ne + ^{4}_{2}\alpha$

or $^{12}_{6}C + ^{12}_{6}C \rightarrow ^{20}_{10}Ne + ^{4}_{2}He$

or $^{12}_{6}C + ^{12}_{6}C \rightarrow ^{20}_{10}Ne + ^{4}_{2}\alpha$