Nuclear Worksheet

Chem 1400

1. Complete each of the following nuclear transformations.

(a) $^{235}_{92}\mathrm{U} + {}^{1}_{0}\mathrm{n} \rightarrow \_\_\_\_ + {}^{90}_{37}\mathrm{Rb} + 2\,{}^{1}_{0}\mathrm{n}$

(b) $^{232}_{90}\mathrm{Th} \rightarrow \_\_\_\_\_ + {}^{4}_{2}\alpha$

(c) $^{6}_{3}\mathrm{Li} + \_\_\_\_\_ \rightarrow 6\ {}^{3}_{1}\mathrm{H} + {}^{4}_{2}\alpha$

(d) $^{56}_{26}\mathrm{Fe} + {}^{2}_{1}\mathrm{H} \rightarrow \_\_\_\_\_ + {}^{4}_{2}\alpha$

2. Write a balanced nuclear reaction to represent each of the following decay processes.

(a) Sr-90 decay by beta emission

(b) ^{251}Cf decay by alpha emission

(c) tritium (^{3}H) decay by beta emission

(d) fluorine-18 decay by positron emission

3. Carbon-11 ($t_{½}$ = 20 min) is manufactured in hospital basements for incorporation into drug molecules for medical diagnostic work. Radiation emitted by decaying carbon-11 is detected in such tests and used to locate the labeled drug molecule in a patient's body.

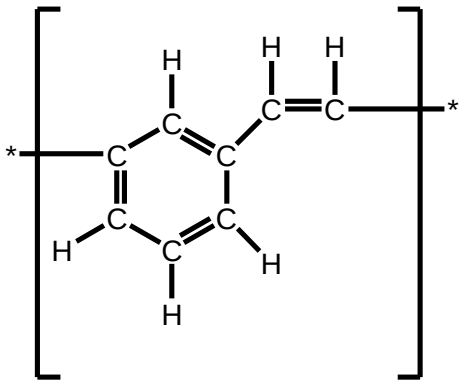
(a) Boron-11 is a non-radioactive isotope. Identify two reasons why boron-11 would not work for this test.

1.

2.

(b) Suppose a medical test requires a minimum of 10 nanograms (1 ng = 10^{-9} g) of ^{11}C to be injected into the patient. As much as 35 min elapses, from the moment of ^{11}C manufacture in the basement, through the drug synthesis in a hospital laboratory, to the point of injection into the patient. Will 40 ng of ^{11}C made in the hospital basement be sufficient to have the minimum amount necessary by the time the labeled drug reaches the patient? Explain, supporting your answer with numerical reasoning.

4. Hydrogen has three principle isotopes: ^{1}H, ^{2}H, ^{3}H. The first two are non-radioactive. Watch manufacturers are using the beta-emitter tritium (hydrogen-3, $t_{½}$ = 12 y) to illuminate the dials of watches. The tritium is incorporated into the polystyrene plastic used to coat the watch parts. Another beta emitter is ^{15}C($t_{½}$ = 2.4 s). Comment on the utility of using tritium and not ^{15}C for this application.



polystyrene plastic

5. One cited advantage of fusion nuclear reactors is the fact that the process will stop abruptly when the system is cooled or pressure is released. Simple safe guards like this won't work for typical fission reactors.

(a) Write an example of a simple nuclear fusion reaction. Consult your text or in-class notes.

(b) Contrast your reaction in (a) with a typical fission reaction.

(c) How are fission reactions stopped or controlled?

6. Complete the Annual Radiation Dose survey found on page 334 of the text.