Name KEY Date _____ Class _____

SIMILAR 1, 6, 9
2, 4
5, 7
3, 10

24–1 Practice Problems

A_0 = BEGIN
A_E = END
T = TIME
$T_{1/2}$ = ½LIFE

1. The half-life of cesium-137 is 30.2 years. If the initial mass of a sample of cesium-137 is 1.00 kg, how much will remain after 151 years?

$A_E = A_0 \cdot (.5)^{t/t_{1/2}}$

$A_E = 1.00\text{kg} \cdot (.5)^{151/30.2}$

$= 0.0313\text{kg}$

2. Given that the half-life of carbon-14 is 5730 years, consider a sample of fossilized wood that, when alive, would have contained 24 g of carbon-14. It now contains 1.5 g of carbon-14. How old is the sample?

$t = \frac{\log \frac{A_E}{A_0}}{\log .5} \cdot t_{1/2}$

$t = \frac{\log \frac{1.5}{24}}{\log .5} \cdot 5730$

$t = 22920$ years

3. A 64-g sample of germanium-66 is left undisturbed for 12.5 hours. At the end of that period, only 2.0 g remain. What is the half-life of this material?

$t_{1/2} = \frac{\log .5}{\log \frac{A_E}{A_0}} \cdot t$

$t_{1/2} = \frac{\log .5}{\log \frac{2.0}{64}} \cdot 12.5 = 2.5\text{ hours}$

4. With a half-life of 28.8 years, how long will it take for 1 g of strontium-90 to decay to 125 mg?

$t = \frac{\log \frac{A_E}{A_0}}{\log .5} \cdot t_{1/2}$

$t = \frac{\log \frac{.125}{1.0}}{\log .5} \cdot 28.8$

$t = 86.4$ years

5. Cobalt-60 has a half-life of 5.3 years. If a pellet that has been in storage for 26.5 years contains 14.5 g of cobalt-60, how much of this radioisotope was present when the pellet was put into storage?

$A_0 = \frac{A_E}{.5^{t/t_{1/2}}}$

$A_0 = \frac{14.5\text{g}}{(.5)^{26.5/5.3}} = 464\text{g}$

6. A 1.000-kg block of phosphorus-32, which has a half-life of 14.3 days, is stored for 100.1 days. At the end of this period, how much phosphorus-32 remains?

$A_E = A_0 \cdot (.5)^{t/t_{1/2}}$

$A_E = 1.000\text{kg} \cdot (.5)^{100.1/14.3}$

$A_E = 7.81 \times 10^{-3}\text{ kg}$

7. A sample of air from a basement is collected to test for the presence of radon-222, which has a half-life of 3.8 days. However, delays prevent the sample from being tested until 7.6 days have passed. Measurements indicate the presence of 6.5 µg of radon-222. How much radon-222 was present in the sample when it was initially collected?

$A_0 = \frac{A_E}{.5^{t/t_{1/2}}}$

$A_0 = \frac{6.5\mu\text{g}}{.5^{7.6/3.8}} = 26\mu\text{g}$

~~8.~~ A 0.500 *M* solution of iodine-131, which has a half-life of 8.0 days, is prepared. After 40. days, how much iodine will remain in 1.0 L of solution? Express the result in moles.

DO NOT DO

9. The half-life of sodium-25 is 1.0 minute. Starting with 1 kg of this isotope, how much will remain after half an hour?

$A_E = A_0 \cdot (.5)^{t/t_{1/2}}$

$A_E = 1\text{ kg} \cdot (.5)^{30/1}$

$A_E = 9.31 \times 10^{-10}\text{ kg}$

10. What is the half-life of polonium-214 if, after 820. seconds, a 1.0-g sample decays to 31.25 mg?

$t_{1/2} = \frac{\log .5}{\log \frac{A_E}{A_0}} \cdot t$

$t_{1/2} = \frac{\log .5}{\log \frac{.03125}{1}} \cdot 820 = 164\text{s}$

Name _____ Date _____ Class _____

24–1 *Practice Problems (continued)*

11. Bombardment of aluminum-27 by alpha particles produces phosphorus-30 and one other particle. Write the nuclear equation for this reaction and identify the other particle.

Neutron

$^{27}_{13}Al + {}^{4}_{2}He \longrightarrow {}^{30}_{15}P + {}^{1}_{0}n$

12. Plutonium-239 can be produced by bombarding uranium-238 with alpha particles. How many neutrons will be produced as a by product of each reaction? Write the nuclear equation for this reaction.

3 Neutrons

$^{238}_{92}U + {}^{4}_{2}He \longrightarrow {}^{237}_{94}Pu + 3\,{}^{1}_{0}n$

13. When bombarded with neutrons, cobalt-59 is converted to cobalt-60. What is the nuclear equation for this reaction?

$^{59}_{27}Co + {}^{1}_{0}n \longrightarrow {}^{60}_{27}Co$

14. One method for producing plutonium-239 is by bombarding uranium-238 with deuterium (hydrogen-2), which produces neptunium-238 and 2 neutrons. The unstable neptunium then decays to form plutonium-238. Write the nuclear equations for this two-step reaction. What other particle is produced in the second reaction?

① $^{238}_{92}U + {}^{2}_{1}H \longrightarrow {}^{238}_{93}Np + 2\,{}^{1}_{0}n$

② $^{238}_{93}Np \longrightarrow {}^{238}_{94}Pu + {}^{0}_{-1}\beta$

15. Neutron bombardment of plutonium-239 yields americium-240 and another particle. Write the nuclear equation and identify the other particle produced.

$^{239}_{94}Pu + {}^{1}_{0}n \longrightarrow {}^{240}_{95}Am + {}^{0}_{-1}\beta$

16. Alpha-particle bombardment of plutonium-239 produces a neutron and another isotope. Write the nuclear equation for this reaction and identify the isotope.

$^{239}_{94}Pu + {}^{4}_{2}He \longrightarrow {}^{242}_{96}Cm + {}^{1}_{0}n$

Curium-242

17. One possible result of the impact of a neutron on a uranium-235 nucleus is the splitting of the uranium into tellurium-137, zirconium-97, and two other particles. Write the nuclear equation for this reaction and identify the two other particles.

$^{235}_{92}U + {}^{1}_{0}n \longrightarrow {}^{137}_{52}Te + {}^{97}_{40}Zr + 2\,{}^{1}_{0}n$

2 Neutrons

18. When bombarded with neutrons, lithium-6 produces an alpha particle and an isotope of hydrogen. Write the nuclear equation for this reaction. What isotope of hydrogen is produced?

$^{6}_{3}Li + {}^{1}_{0}n \longrightarrow {}^{4}_{2}He + {}^{3}_{1}H$

Tritium

19. With what particle would you bombard sulfur-32 to produce hydrogen-1 and phosphorus-32? Write the appropriate nuclear equation.

$^{32}_{16}S + {}^{1}_{0}n \longrightarrow {}^{1}_{1}H + {}^{32}_{15}P$

Neutron

20. With what particle would you bombard bismuth-209 to produce astatine-211 and 2 neutrons? Express this reaction in the form of a nuclear equation.

$^{209}_{83}Bi + {}^{4}_{2}He \longrightarrow {}^{211}_{85}At + 2\,{}^{1}_{0}n$

Alpha Particle