Nuclear Review Spring 2016

1. Complete the following table:

	Isotopic Notation	# of Protons	# of Neutrons	Mass Number	Element Name
a.	$^{2}_{1}H$	1	1	2	Hydrogen - 2
b.	$^{37}_{17}Cl$	17	20	17	Chlorine - 17
c.	$^{107}_{60}Ag$	47	60	107	Silver-107

2. Complete the following table:

	Charge	Penetrating Ability
Alpha ($^{4}_{2}He$)	2+	low
Beta ($^{0}_{-1}e$)	-1	medium
Gamma (γ)	0	high

3. Complete the following:

a. Alpha emission: $^{235}_{92}U \rightarrow$ $^{4}_{2}He + ^{231}_{90}Th$

b. Beta emission: $^{210}_{83}Bi \rightarrow$ $^{0}_{-1}\beta + ^{210}_{84}Po$

c. Alpha emission $^{213}_{88}Ra \rightarrow$ $^{4}_{2}He + ^{209}_{86}Rn$

Gamma could accompany all of these.

4. Define half-life

Amount of time it takes for ½ of the amount of substance to decay into a new substance.

5. The half-life of chromium-51 is 28 days. If you have 2.00 grams of chromium, how many grams would remain after 56 days?

$A = \frac{A_0}{2^n}$ $\quad n = \frac{t}{T_{1/2}}$

$2.00\ g \xrightarrow[28]{} 1.00\ g \xrightarrow[56]{} \boxed{0.50\ g}$ $\qquad \frac{2.00}{2^{\frac{56}{28}}} = \boxed{0.50\ g}$

6. The half-life of Carbon-14 is 5730 yrs. What fraction of the original sample will still be Carbon-14 after 17190 yrs have passed?

Assume 100%

$n = \frac{17190}{5730} = 3$ $\qquad A_0 = \frac{100}{2^3} = 12.5\ \%$

$100 \longrightarrow 50 \longrightarrow 25 \longrightarrow \boxed{12.5\ \%}$

7. In the year 1992, a doctor's office purchased 2 grams of Cesium-137 that registered 400 radiation counts per second (cps). Given the half-life of Cesium is close to 30 yrs, how much radiation would be expected to remain by the year ~~2015~~ 2016?

$t = 2016 - 1992 = 24\ yrs.$

$n = \frac{24}{30} = 0.8$

$A_0 = \frac{2}{2^{0.8}} = \boxed{1.45\ g}$

or

$\frac{400}{2^{0.8}} = \boxed{230.\ cps}$

8. What is nuclear fission?

The divison of a heavy nuclide into 2 lighter nuclides, neutrons, & energy

9. What is nuclear fusion? Where does it occur naturally in our universe?

Fusion is the combination of 2 lighter nuclei into 1 heavy nuclide & tremendous energy. SUN

10. What type of reaction is used in nuclear power plants?

Fission (Fusion is not feasible currently due to the extreme heat needed to sustain the reaction)

12. What type of particle is A β, beta, B gamma, C α, alpha

13. Write a nuclear equation for the alpha decay of each of the below radioactive isotopes:

a. Radium-226 $^{226}_{88}Ra \rightarrow {}^{4}_{2}He + {}^{222}_{86}Rn$

b. Thorium-230 $^{230}_{90}Th \rightarrow {}^{4}_{2}He + {}^{226}_{88}Ra$

14. Write a nuclear equation for the beta decay of each of the below radioactive isotopes:

a. Radon-231 $^{231}_{86}Rn \rightarrow {}^{0}_{-1}\beta + {}^{231}_{87}Fr$

b. Krypton-81 $^{81}_{36}Kr \rightarrow {}^{0}_{-1}\beta + {}^{81}_{37}Rb$

15. Radium-226 undergoes three consecutive episodes of alpha decay followed by two episode of beta decay, followed by an episode of alpha decay. What isotope is present after this nuclear activity?

$^{226}_{88}Ra \rightarrow 3\,{}^{4}_{2}He + {}^{214}_{82}Pb \rightarrow 2\,{}^{0}_{-1}\beta + {}^{212}_{84}Po \rightarrow {}^{4}_{2}He + \boxed{{}^{208}_{82}Pb}$

16. Sodium-25 was to be used in an experiment, but it took 3.0 minutes to get the sodium from the reactor to the laboratory. If 5.0 mg of sodium-25 was removed from the reactor, how many mg of sodium-25 were placed in the reaction vessel 3.0 minutes later if the half-life of sodium-25 is 60 seconds?

$t = 3\ min = 180\ sec$

$T_{1/2} = 60\ sec$

$n = \frac{180}{60} = 3$

$50\ mg \rightarrow 25 \rightarrow 12.5 \rightarrow \boxed{6.25\ mg}$

$A = \frac{5.0}{2^3} = \boxed{0.625\ mg}$

17. A 2.5 gram sample of an isotope of strontium-90 was formed in a 1960 explosion of an atomic bomb at Johnson Island in the Pacific Test Site. The half-life of strontium-90 is 28 years. In what year will only 0.625 grams of this strontium-90 remain?

$2.5\ g \rightarrow 1.25 \rightarrow 0.625$

$n = 2 = \frac{t}{28}$

$t = 56\ yrs$

$1960 + 56 = \boxed{2016}$

$n = \frac{\ln\left(\frac{A_0}{A}\right)}{0.693} = \frac{\ln\left(\frac{2.5}{0.625}\right)}{0.693}$

$n = 2.00\ cycles$

$28(2) = 56\ yrs$

18. A 208 g sample of sodium-24 decays to 13.0 g of sodium-24 within 60.0 h. What is the half-life of this radioactive isotope?

$208 \rightarrow 104 \rightarrow 52 \rightarrow 26 \rightarrow 13\ g$

$n = 4 = \frac{60.0}{T_{1/2}}$

$T_{1/2} = 15.0\ hrs$

$\frac{t}{T_{1/2}} = \frac{\ln\left(\frac{A_0}{A}\right)}{0.693}$

$T_{1/2} = \frac{0.693\,t}{\ln\left(\frac{A_0}{A}\right)} = \frac{0.693(60.0)}{\ln\left(\frac{208}{13}\right)} = 15.0\ h$

19. The half-life of protactinium-234 is 6.75 hours. What percentage of a given sample will remain after 27 hours?

$100 \rightarrow 50 \rightarrow 25 \rightarrow 12.5 \rightarrow 6.25\ \%$

$n = \frac{27}{6.75} = 4$

$A = \frac{100}{2^4} = 6.25\ \%$

20. The half-life of radon-222 is 3.823 days. What was the original mass if 0.050 g. remains after 7.646 days

$0.20\ g \leftarrow 0.100 \leftarrow 0.050$

$n = \frac{7.646}{3.823} = 2$

$A_0 = A(2^n)$

$= 0.050(2^2)$

$A_0 = 0.20\ g$