NAME: **HONORS CHEMISTRY**

SECTION: Nuclear Chemistry Review Sheet

After studying chapter 19 (new textbook), you should be able to:

- Explain the processes of radioactivity and radioactive decay.
- Distinguish between nuclides, isotopes and radioisotopes.
- Describe the characteristics of alpha, beta, and gamma radiation and list their origins.
- Explain how radiation damages human tissue.
- Apply three ways of predicting nuclide stability.
- Define the terms nuclear stability, half-life, and transmutation.
- Write balanced nuclear equations that describe radioactive decay or nuclear transformations.
- Compare fission and fusion processes.
- Describe chain reactions and the role of the critical mass in nuclear fission processes.
- Calculate the amount of radioisotope remaining using the half-life method.
- Explain how radioisotopes can be used to date objects.
- Discuss the use of radiotracers in medicine.
- Calculate mass defect, binding energy, and binding energy per nucleon.

Problems for you to try:

1. State two properties that are conserved in nuclear change.

2. List the steps used in balancing a nuclear equation.

3. Do radiotracers generally have long or short half-lives? Why?

4. What does it mean to say that fissionable material possesses a critical mass? Can a chain reaction occur when a sample has less than the critical mass?

5. What is a chain reaction? How does a chain reaction involving uranium-235 sustain itself?

6. Compare alpha, beta and gamma radiation in terms of what is released and the change in the atomic number and mass number of the nucleus. How do they compare in penetrating power?

7. Compare and contrast electrons and positrons.

8. Complete each of the following nuclear equations.

   a) $^{14}_{7}N + {}^{4}_{2}He \rightarrow$ _____ + $^{1}_{1}H$

   b) $^{238}_{92}U \rightarrow$ _____ + $^{4}_{2}He$

   c) $^{231}_{90}Th \rightarrow$ _____ + $^{0}_{-1}e$

   d) $^{231}_{91}Pa \rightarrow$ _____ + $^{4}_{2}He$

   e) $^{7}_{3}Li + {}^{1}_{1}H \rightarrow$ _____ + $^{4}_{2}He$

   f) $^{32}_{16}S + {}^{1}_{0}n \rightarrow$ _____ + $^{1}_{1}H$

   g) $^{14}_{7}N +$ _____ $\rightarrow {}^{14}_{6}C + {}^{1}_{1}H$

   h) $^{129}_{55}Cs +$ _____ $\rightarrow {}^{129}_{54}Xe$

9. Write a balanced nuclear equation to show the change that results when $^{239}_{93}Np$ decays by emitting a beta particle.

10. Write a balanced nuclear equation to show the production of $^{100}_{45}Rh$ by electron capture. (i.e., an electron is a reactant in this equation.)

11. Explain what is meant by the half-life of a radioactive nuclide.

12. The half-life of $^{60}_{27}Co$ is 5.27 years.
    a. Find the number of half-lives in 31.62 years.

    b. How much of an original sample of $^{60}_{27}Co$will remain after 26.35 years?

13. The half-life of theoretical element Rg is 20. days. If you start with a sample of element Rg that has a mass of 80. grams, calculate the mass of element Rg remaining after a period of 60 days has elapsed.

14. After 42 days, a 2.0 g sample of a radioactive nuclide contains only 0.25 g of the nuclide. What is the half-life of the nuclide?

15. The actual mass of a $^{10}_{5}B$ nucleus is 10.0129385 amu. If the mass of $^{1}_{1}H$ = 1.0078252 amu and the mass of $^{1}_{0}n$ = 1.0086652 amu, calculate each of the following:
    a. Expected mass of an atom of boron-10

    b. Mass defect for a $^{10}_{5}B$ atom

    c. Total binding energy, in joules, for $^{10}_{5}B$

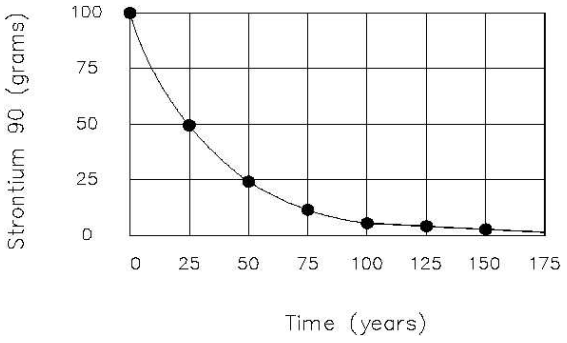
    d. Binding energy per nucleon in the boron-10 atom

16. The binding energy per nucleon for an atom of element X is 1.13 x 10^{-12} J. Is the nucleus of element more or less stable than the nucleus of $^{10}_{5}B$ from question 13? Explain.

17. The ancient alchemists dreamed of being able to turn lead into gold. By using lead-206 as the target atom of a powerful accelerator, we can attain that dream in principle. Find a one-step process that will convert $^{206}_{82}Pb$ into a nuclide of gold. You may use alpha particles, beta particles, positrons, or protons. Write the nuclear equation to turn lead into gold.

18. Use illustrations to compare fission and fusion.

19. Use the graph to determine the half-life of strontium-90.



20. Classify each of these statements as always true, AT; sometimes true, ST, or never true, NT.
    a. _____ Beta radiation is emitted when a radioisotope decays.
    b. _____ Gamma radiation has a negative charge.
    c. _____ Gamma radiation and X-radiation are high energy electromagnetic radiation.
    d. _____ A radioisotope has a half-life of 12 minutes. After 36 minutes, only one-third of the radioactive atoms initially present will remain.
    e. _____ In nuclear fusion, the nuclei of two large atoms fuse together.
    f. _____ When a beta particle is emitted, the atomic number increases by 1, and the mass number stays the same.
    g. _____ When a radioactive nucleus emits an alpha particle, its atomic number decreases by 4, and its mass number decreases by 2.
    h. _____ When a gamma ray is emitted, atomic mass and atomic number increase.
    i. _____ If you start with 100 g of a radioisotope, after 10 half-lives, there will be none of the radioisotope left.