Advanced Chemistry Name _____

Hour _____

Advanced Chemistry
*Approximate* Timeline

**Students are expected to keep up with class work when absent.**

| | **CHAPTER 18 – THE NUCLEUS: A CHEMIST'S VIEW** | |
|---|---|---|
| **Day** | **Plans for the day** | **Assignment(s) for the day** |
| **1** | • 18.1 – Nuclear Stability and Radioactive Decay<br>○ Belt of Stability<br>○ Types of Radioactive Decay<br>○ Nuclear Reactions<br>• Assignment(s):<br>○ Homework:<br>○ Read sections: | • Assignment 18.0<br>• Assignment 18.1<br>• Read section(s) 18.2 |
| **2** | • 18.2 – The Kinetics of Radioactive Decay<br>○ Half-Life | • Read section(s) 18.3 – 18.4 |
| **3** | • 18.3 – Nuclear Transformations<br>• 18.4 – Detection & Uses of Radioactivity<br>○ Dating by Radioactivity<br>○ Medical Applications of Radioactivity | • Assignment 18.2<br>• Read section(s) 18.5 |
| **4** | • 18.5 – Thermodynamic Stability of the Nucleus | • Read section(s) 18.6 – 18.7 |
| **5** | • 18.6 – Nuclear Fission & Nuclear Fusion<br>• 18.7 – Effects of Radiation | • Assignment 18.3 |
| **6** | • Grade & discuss assignment<br>• Review for Chapter 18 Test | • |
| **7** | • Chapter 18 Test | • |

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Study Guides
Chapter 18 Quizzes

**Quiz 18.1 – Nuclear Stability and Radioactive Decay**

1. Define the following terms.
    a. nucleons
    b. isotopes
    c. nuclide
2. What is...
    a. a beta particle?
    b. an alpha particle?
    c. a gamma ray?
3. Given a pair of isotopes, predict which one is more stable.
4. Write balanced nuclear reactions showing:
    a. alpha emission
    b. beta emission
    c. positron emission
    d. k-electron capture

**Quiz 18.2 – 18.3**

*18.2 – The Kinetics of Radioactive Decay*

5. Define the term "half-life".
6. Use half-life to calculate the value of the rate constant.
7. Calculate the amount of radioactive isotope remaining after a given amount of time has passed.
8. Calculate the half-life a radioactive isotope.

*18.3 – Nuclear Transformations*

9. Define the term "nuclear transformation".

**18.6 – Nuclear Fission and Nuclear Fusion**

10. Define the term "fission".
11. Define the term "fusion".

Study Guide
Chapter 18 Test
Advanced Chemistry

At the completion of chapter 18 you should…

1. Know the definitions of the following terms.
    a. Isotope
    b. Nuclide
    c. Radioactive Decay
    d. Alpha Particle Production
    e. Beta Particle Production
    f. Gamma Ray
    g. Positron Production
    h. Electron Capture
    i. Rate of Decay
    j. Half-Life
    k. Mass Defect
    l. Binding Energy
    m. Fusion
    n. Fission
2. Know the three types of "natural" radioactivity and write balanced nuclear equations for each.
3. Know the two types of "induced" radioactivity and write balanced nuclear equations for each.
4. Know how to calculate ½-life.
5. Know how to calculate the age of rocks and organic materials.
6. Be able to calculate the mass defect of any isotope.
7. Be able to calculate binding energy.
8. Know the difference between fusion and fission.

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## Assignment 18.0 – Vocabulary

Define each of the following terms.

1. Isotope

2. Nuclide

3. Radioactive Decay

4. Alpha Particle Production

5. Beta Particle Production

6. Gamma Ray

7. Positron Production

8. Electron Capture

9. Rate of Decay

10. Half-Life

11. Mass Defect

12. Binding Energy

13. Fusion

14. Fission

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## Assignment 18.1 – Radioactive Decay and Nuclear Equations

1) Write balanced equations for each of the processes described below.

   A) Phophorus-32, which accumulates in the liver, decays by beta-particle production.

   B) Uranium-235, which is used in atomic bombs, decays initially by alpha-particle production.

2) In each of the following nuclear reactions, supply the missing particle.

   A) $^{73}Ga \rightarrow {}^{73}Ge + $ _____

   B) $^{192}Pt \rightarrow {}^{188}Os + $ _____

   C) $^{205}Bi \rightarrow {}^{205}Pb + $ _____

   D) $^{241}Cm + $ _____ $\rightarrow {}^{241}Am$

3) Many elements have been synthesized by bombarding relatively heavy atoms with high-energy particles in particle accelerators. Complete the following nuclear reactions, which have been used to synthesis elements.

   A) _____ $+ {}^{4}_{2}He \rightarrow {}^{243}_{97}Bk + {}^{1}_{0}n$

   B) ${}^{238}_{92}U + {}^{12}_{6}C \rightarrow$ _____ $+ 6\ {}^{1}_{0}n$

   C) ${}^{249}_{98}Cf +$ _____ $\rightarrow {}^{260}_{105}Db + 4\ {}^{1}_{0}n$

   D) ${}^{249}_{98}Cf + {}^{10}_{5}B \rightarrow {}^{257}_{103}Lr +$ _____

4) One type of commercial smoke detector contains a minute amount of radioactive americium-241, which decays by alpha-particle production. The alpha-particles ionize molecules in the air, allowing it to conduct an electric current. When smoke particles enter the conductivity of the air is changed and the alarm buzzes.

A) The complete decay of $^{241}Am$ involves successively alpha, alpha, beta, alpha, alpha, beta, alpha, alpha, alpha, beta, alpha, and beta production. Write equations showing each step of the decay process.

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## Assignment 18.2 – Kinetics of Radioactive Decay

1) Radioactive copper-64 decays with a half-life of 12.8 days.

   A) What is the value of k in $s^{-1}$?

   B) A chemist obtains a fresh sample of copper-64 and measures its radioactivity. She then determines that to do an experiment, the radioactivity cannot fall below 25% of the initial measured value. How long does she have to do the experiment?

2) Iodine-131 is used in the diagnosis and treatment of thyroid disease and has a half-life of 8.1 days. If a patient with thyroid disease consumes a sample of NaI containing 10micrograms of iodine-131, how long will it take for the amount of iodine-131 to decrease to 1/100 of the original amount?

3) Assume a constant $^{14}C$ / $^{12}C$ ratio of 13.6 counts per minute per gram of living matter. A sample of a petrified tree was found to give 1.2 counts per minute per gram. How old is the petrified tree? ($t_{1/2}$ of $^{14}C$ = 5730 years)

4) The Br-82 nucleus has a half-life of $1.0 \times 10^3$ min. If you wanted 1.0 g of Br-82 and the delivery time was 3.0 days, what mass of NaBr should you order? Assume all of the Br in the NaBr was Br-82)

5) Phosphorus-32 is a commonly used radioactive nuclide in biological research. The half-life of P-32 is 14.3 days. What mass of P-32 is left from an original sample of 175 mg of $Na_3PO_4$ after 35 days? Assume that all of the P in $Na_3PO_4$ is P-32 and the atomic mass of P-32 is 32.0.

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## Assignment 18.3 – Energy Changes in Nuclear Reactions

1) The earth receives $1.8 \times 10^{14}$ kJ/s of solar energy.

   A) What mass of solar material is converted to energy over a 24 hour period to provide the daily amount of solar energy to the earth?

   B) What mass of coal would have to be burned to provide the same amount of energy? (Coal releases 32 kJ of energy per gram when burned.)

2) The mass of a neutron is 1.00866 g/mol, a proton's mass is 1.00728 g/mol, and the mass of Fe-56 is 55.9349 g/mol.

   A) Write an equation showing the formation of an iron-56 *nucleus* from protons and neutrons.

   B) Calculate the mass defect for one mole of this isotope.

   C) Calculate the binding energy for one mole of this isotope.

3) The easiest fusion reaction to initiate is: ${}^{2}_{1}H + {}^{3}_{1}H \rightarrow {}^{4}_{2}He + {}^{1}_{0}n$. Calculate the energy released per mole of ${}^{4}_{2}He$ produced. The atomic masses are ${}^{2}_{1}H$, 2.01410 amu; ${}^{3}_{1}H$, 3.01605 amu; ${}^{4}_{2}He$, 4.00260 amu. The masses of the electron and the neutron are 0.00054858 amu and 1.00866 amu respectively.