Ch. 22 Nuclear Chemistry Review

Simply reading this review is not as good of a review as using your time and knowledge to complete this review. You should use these answers to check your own once you have completed your review.

1. Write the isotope notation (2 ways to do this) for Uranium with both the mass # (use 239) and atomic number from the periodic table. Which number is on top, which one is on bottom?
   $^{293}_{92}U$ **or Uranium-293; the top number is the mass of the isotope and the bottom number is the atomic number.**
2. Write the isotope notation (2 ways to do this) for lead with both the mass # (use 213) and atomic number from the periodic table. $^{213}_{82}PB$ **or Lead-213; the top number is the mass of the isotope and the bottom number is the atomic number.**
3. Explain the meaning of the numbers in the following isotope notation: $^{244}_{94}Pu$ **the "Pu" means that it is an isotope of plutonium, the top number (244) is the mass of the isotope (P + N) and the bottom number is the atomic number.**
4. When you write out an isotope in the form "Xenon-143," what does the 143 mean? **The number after the isotope name represents the mass of the isotope which is the sum of the protons and neutrons.**
5. What do the variables in $E=mc^2$ mean? **E = energy, m = mass, and c = speed of light. This equation represents that you can convert mass to energy.**
6. What is the symbol for an alpha, a beta and a gamma particle? **Alpha** $^{4}_{2}He$ **, Beta** $^{1}_{-1}\beta$**, and gamma** γ
7. What are beta particles? **A beta particle is an electron emitted from the nucleus during beta decay, which converts a neutron to a proton.**
8. What is a gamma ray? **A high energy type of decay emitted from the nucleus as atoms return to their ground state. The identity of the atom does not change. Gamma is the strongest and most dangerous decay.**
9. What is an Alpha particle? **Alpha decay is when a helium nuclei ($^{4}_{2}He$) is emitted from the nucleus to make it more stable.**
10. Which of the above types of radiation is the most dangerous, AKA penetrates the most through materials? **Gamma decay is most penetrating, Alpha particles penetrate the least, and beta particles penetrate more than alpha, but less than gamma.**
11. Which radioactive particle is most massive? **Alpha decay ($^{4}_{2}He$) has a mass of 4 amu.**
12. Why do nuclear reactions occur? **Because unstable isotopes seek stability but changing the neutron to proton ratio so they fall within the band of stability.**
13. What is the difference between fission and fusion? **Both fission and fusion create large amounts of energy. Fission is when a large unstable isotope (for example uranium) is struck by a neutron. The unstable isotope breaks into daughter nuclides. This reaction generates more free neutrons, which strike more unstable uranium nuclides causing the reaction to proceed at a faster rate. Fusion is when two small hydrogen nuclides fuse together to form a helium nuclide.**
14. Define radioactive decay. **Radioactive decay is the spontaneous disintegration of a nucleus into a slightly lighter nucleus accompanied by the emission of particles, electromagnetic radiation, or both.**
15. Define half-life. **Half-life is the time required for a radioactive nuclide to decay.**
16. What is something you can use half-life for? (hint think Carbon 14) **Medical uses and carbon dating.**

17. What makes radioactive materials unstable? **Their neutron to proton ratio is outside the band of stability, meaning it exceeds a 1.5 neutron to 1 proton ratio.**
18. What element is mostly likely to be used in fusion reactions to meet energy needs in a nuclear power plant? **Uranium**
19. Where does the heat in a nuclear reaction come from? **The power plant uses the nuclear energy released from the fission reaction to heat water and generate steam to turn a turbine.**
20. For this test, you can hand-write anything you think is helpful on a 3x5 notecard, which you can use on the test. **Will you take the time to make a notecard? Historically, students who take the time to make a notecard do better on the test, not because they used their notecard, but because they took the time to make one, and therefore reviewed their material an extra few times.**
21. What isotope is commonly used for fission reactions? **Uranium-235**
22. Why is carbon-14 commonly used for radioactive dating? **Because it has a precisely known half-life (5,715 years) and Carbon was in many living things so ancient artifacts made from once living things contain carbon.**
23. A nuclear reactor in a nuclear power plant generates heat. What is that heat used for? **To turn a steam turbine and generate electricity.**
24. Be able to identify fission and fusion reactions. **Fission is a large atom (like uranium) breaking apart into smaller atoms, and fusion is hydrogen isotopes combining to make a helium nuclide.**

Problems:

1. Write out and balance the alpha decay of Berrylium-9. $^{9}_{4}Be + {}^{4}_{2}He \rightarrow {}^{12}_{6}C + {}^{1}_{0}n$
2. Write out and balance the beta decay of **Iridium-192**. $^{192}_{77}Ir \rightarrow {}^{0}_{-1}\beta + {}^{192}_{78}Pt$
3. The half-life of carbon is 5,715 years. How many milligrams of carbon-14 remain after 11,430 years if you start with 1000 mg? (Find out how many half-lives – then cut 1000mg in half that many times!)

   How many half-lives? $\frac{11{,}340\ years}{5{,}715\ years} = 1.984\ halflives$

   so

   $$1000g * \left({}^{1}/_{2}\right)^{1.984} = 252.8\ g\ remaining$$
4. The half-life of cobalt-60 is 10.47 min. How many milligrams of cobalt-60 remain after 41.88 min. if you start with 80 mg?

   How many half-lives? $\frac{41.88\ min}{10.47\ min} = 4.0\ halflives$

   so

   $$80mg * \left({}^{1}/_{2}\right)^{4} = 5\ mg\ remaining$$

5. Balance the following: $^{218}_{84}Po \rightarrow {}^{4}_{2}He + {}^{214}_{82}Pb$ What type of decay? **Alpha decay.**
6. Balance the following: $^{37}_{18}Ar + {}^{0}_{-1}e \rightarrow {}^{37}_{17}Cl$ What type of decay? **Beta decay** $^{0}_{-1}e$ **is the same as** $^{0}_{-1}\beta$
7. Balance the following: $^{226}_{88}Rn \rightarrow {}^{222}_{86}Ra + {}^{4}_{2}He$ What type of decay? **Alpha decay.**