

HW 5-8: REVIEW – Honors
Nuclear Chemistry

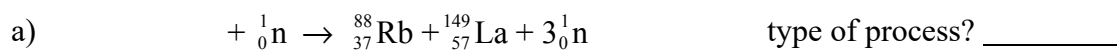
Name _____
Period _____ Date _____

Topics:

- No questions on alpha, beta and gamma radiation properties or reactions, except anything given on this review
- Radioactive decay half-life problems; nuclear decay series.
- Fission, fusion-- equations, definitions and examples of each. Forces at work during the processes. Why are both fission and fusion favorable?
- Nuclear power plants-- fuel, control rods, moderator, meltdowns, basics of nuclear reactor accidents
- $E=mc^2$ calculations. Interpretation of Mass Defect graph. Understand that energy-mass is always conserved, but mass is converted to energy in nuclear reactions
- General sources, effects, measurement, and uses of radiation.
- C-14 Dating article: Concept of formation, carbon cycled, decay in steady state; why C-14 ratio decreases after death of organism; Limits; Don't memorize exact reactions, but know concepts.
- Star Born Article: how were elements besides hydrogen formed? Balance of gravity and expanding radiation.
- Other Articles/Videos (Alchemist's Dream, Fusion Energy)

Sample Problems:

1) Complete these nuclear equations and indicate if they are fission or fusion.



- 2) The earliest artificial transmutation reaction-- performed by Rutherford in 1911 in his discovery that the proton was a hydrogen atom, involved bombarding nitrogen-14 with an alpha particle, producing a proton (hydrogen-1). Write out the reaction and determine the other product.
- 3) An isotope of one particular actinoid undergoes fission when struck with a neutron and produces the daughter nuclei strontium-93 and cerium-148 plus 3 neutrons. Write out the equation and determine the identity of the parent nucleus.
- 4) Strontium-90 decays through beta decay. If it has a half-life of 29 years, how long does it take until 75% has decayed? (*How much remains radioactive?*)
- 5) After 12.5 hours, 96 μg of a particular isotope has decayed to 3.0 μg . What is its half-life?

- 6) Why is the equation $E = mc^2$ significant in a nuclear reaction, but not in a chemical reaction?
- 7) Describe the basic processes in fusion and fission (no forces). How is energy released during these processes? How does Mass Defect relate to the stability of a nucleus?
- 8) a) How much energy (in pJ) is released when this alpha decay takes place? ${}^{226}_{88}\text{Ra} \longrightarrow {}^{222}_{86}\text{Rn} + {}^4_2\text{He}$
 mass of ${}^{226}\text{Ra} = 226.025360$ amu; mass of ${}^{222}\text{Rn} = 222.017530$ amu; mass of ${}^4\text{He} = 4.00260361$ amu
(See reference charts for formulas and more constants.)
- b) Convert this to MJ/mol
- 9) The mass of one atom of ${}^{17}_8\text{O}$ is 16.9991315 amu.
- a) Determine the mass defect for the formation of one atom of ${}^{17}_8\text{O}$, in amu (write out the “reaction” to form ${}^{17}_8\text{O}$ from its individual particles).
- b) Determine the energy released by the formation of one mol of ${}^{17}_8\text{O}$, in J/mol
- c) Determine the energy released (mass defect) by formation of ${}^{17}_8\text{O}$, in MeV/nucleon (1 MeV = 9.6483×10^{10} J/mol)

- 10) Referring to the Mass Defect chart in your notes, explain why fusion of element up through Fe releases energy (i.e. products are more stable), but fusing elements above Fe requires energy.
- 11) Why does the fission of U-235 produce a nuclear chain reaction?
- 12) Explain why atomic bombs explode and nuclear power plants produce a steady amount of heat. (*Include & explain the concepts of enrichment and critical mass*).
- 13) What is the purpose of control rods in a nuclear power plant?
- 14) What is the purpose of a moderator in a nuclear power plant?
- 15) Why is it safer to use water as a moderator instead of graphite?
- 16) Why is fusion not currently used in nuclear power plants?
- 17) Why do stars contract after the supply of hydrogen starts to run low?
- 18) Why is it more difficult to fuse two helium nuclei together than to fuse two hydrogen nuclei together?
Discuss the forces involved.

19) What happens within the contracting star to enable and initiate fusion of helium? Describe the forces between the nuclei.

20) Under what conditions will a supernova occur? What happens when a supernova does occur?

21) Why do C-14 levels stay constant when an organism is alive, but C-14 levels decrease when the organism dies? (*You don't need to know the specific reactions involved, just know the basic concepts.*)

22) Why is nuclear radiation called "ionizing" radiation? What other radiation is also ionizing?

23) Why is ionizing radiation dangerous to living organisms? What are the two kinds of damage that can result?

24) List and explain the three methods discussed for detection of nuclear radiation.

25) _____ T or F? The majority of radiation that a typical human receives is man-made.

26) _____ T or F? Eating bananas should be avoided because they contain potassium-40.

27) _____ T or F? Radiation can be beneficial and harmful. Give examples. _____