Nuclear Chemistry

Radioactivity

1. Marie Curie discovered that atoms are made up of smaller particles. She discovered the spontaneous disintegration of some elements into smaller pieces.

* Radioactivity (radioactive decay – decay of nucleus)

Nuclear Reactions vs. Chemical Reactions

2. Nuclear reactions involve the nucleus (# of protons + # of neutrons) The nucleus opens, and protons and neutrons are rearranged.

3. The opening of the nucleus releases a tremendous amount of energy that holds the nucleus together – called binding energy

4. 'Normal" chemical reactions involve electrons not protons and neutrons.

Types of Nuclear Radiation

Radiation	Symbol in Equation	Penetrating Ability
A) Alpha (α) – positively charged Helium Isotope	$^{4}_{2}\alpha$	can't pass through a piece of paper
B) Beta (β) - an electron	$^{0}_{-1}\beta$	faster & more penetrating than alpha particles can't pass thru aluminum foil
C) Gamma Ray (γ) – pure energy, EM waves w/ highest frequency & shortest wavelength	$^{0}_{0}\gamma$	stopped by thick dense materials such as concrete or lead

Other Symbols

a) Neutron – Symbol – $^{1}_{0}n$ (# ← mass; charge & atomic #)

b) Positron – Symbol – $^{0}_{+1}e$

c) Proton – Symbol – $^{1}_{+1}H$

Balancing Nuclear Reactions

5. Atomic numbers and mass numbers must balance. Use a particle or an isotope to fill in the missing protons and neutrons.

6. **Alpha Emission**

Ex: $^{226}_{88}Ra \rightarrow {}^{4}_{2}\alpha + {}^{222}_{86}Rn$

$\rightarrow$

Mass Number: (protons + neutrons)	=
Atomic Number: (protons)	=

7. **Beta Emission**

Ex: $^{239}_{92}U \rightarrow {}^{0}_{-1}B + {}^{239}_{93}Np$

$\rightarrow$

Mass Number: (protons + neutrons)	=
Atomic Number: (protons)	=

Learning Check #1

8. What radioactive isotope is produced in the following bombardment of Boron?

$^{10}_{5}B + {}^{4}_{2}He \rightarrow {}^{13}_{7}N + {}^{1}_{0}n$

Learning Check #2

9. Write the nuclear equation for the Beta emitter Co-60.

$^{60}_{27}Co \rightarrow {}^{0}_{-1}B + {}^{60}_{28}Ni$

Gamma Ray Emission

10. New elements or new isotopes of known elements are produced by bombarding an atom with a subatomic particle such as a proton or neutron—or even a much heavier particle.

11. Reactions using neutrons are called gamma reactions because gamma rays are usually given off.

12. Radioisotopes used in medicine are usually made by gamma reactions.

13. Example of a gamma reaction:

$$^{31}_{15}P + {}^{1}_{0}n \rightarrow {}^{32}_{15}P + {}^{0}_{0}\gamma$$