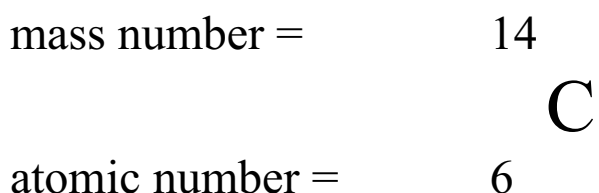


## Unit 12 Nuclear Chemistry

**Nuclear Chemistry**- study of the structure of atomic nuclei and nuclear change.

**Nuclear Reactions**- isotopes of one element are changed into isotopes of another element.

Chemical Symbols



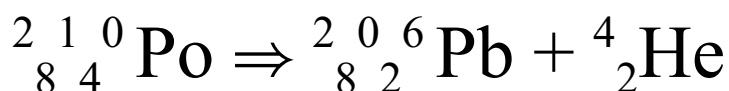
**Radioactive decay**- when unstable nuclei lose energy by emitting radiation to attain more stable atomic configurations. Three types:

**Alpha ( $\alpha$ ) decay**- radioactive decay of an atomic nucleus that is accompanied by the emission of an alpha particle ( ${}^4_2\text{He}$ ).

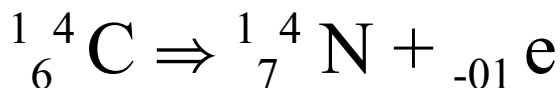
**Beta ( $\beta$ ) decay**- radioactive decay in which an electron ( ${}^0_{-1}\text{e}$ ) is emitted.

**Gamma ( $\gamma$ ) decay**- high energy photons that are emitted by radioactive nuclei.

Alpha particle has 2 protons and 2 neutrons, just like the  ${}^4_2\text{He}$  nucleus. An  $\alpha$ -particle will decrease the atomic number by 2, decrease mass by 4, and carries a +2 charge.



Beta particle is a fast moving electron, denoted by the symbol  $\text{e}^-$  or  ${}^0_{-1}\text{e}$ . A  $\beta$ -particle has insignificant mass, carries a -1 charge, and increases the atomic number by 1.



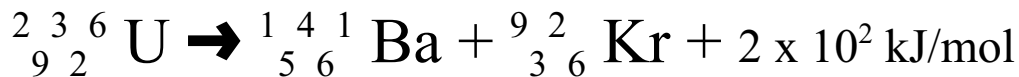
Gamma rays have no mass, do not carry a charge, and usually accompany  $\alpha$ - and  $\beta$ -particles.

Penetration of radiation

Least                      Most  
Alpha → Beta → Gamma

paper → wood → concrete

**Nuclear Fission**- splitting of a nucleus. A very heavy nucleus is split into 2 approximately equal fragments. Chain reaction releases several neutrons which split more nuclei.



**Nuclear Fusion** - combining of nuclei. Two lighter nuclei combine to form a single heavier nucleus. Does not occur under standard conditions (+ repels +).

Advantages - inexpensive, no radioactive waste.

Disadvantages- requires huge amount of energy to start, difficult to control.



<http://cnx.org/content/m42659/latest/?collection=col11406/latest>

**Half Life**- time required for half of a radioisotope's nuclei to decay into its products.

For example, suppose you have 10.0 grams of strontium-90, which has a half life of 29 years. How much will be remaining after x number of years?

$$\text{mass}_{\text{final}} = \text{mass}_{\text{initial}} \times (0.5)^n \quad n = \text{number of half-lives}$$

Example problems

If gallium-68 has a half-life of 68.3 minutes, how much of a 160.0 mg sample is left:

after 1 half life?

$$\text{Answer} = 80.0 \text{ mg}; m_f = 160.0 \text{ mg} \times (0.5)^1 = 80.0 \text{ mg}$$

After 2 half lives?

$$\text{Answer} = 40.0 \text{ mg}; m_f = 160.0 \text{ mg} \times (0.5)^2 = 40.0 \text{ mg}$$

After 3 half lives?

$$\text{Answer} = 20.0 \text{ mg}; m_f = 160.0 \text{ mg} \times (0.5)^3 = 20.0 \text{ mg}$$

# Assignment

## Problem 1

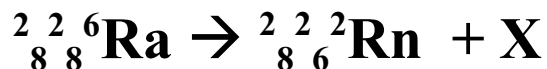
Iodine-131 is a radioactive isotope with a half-life of 8 days. How many grams of a 64 g sample of iodine-131 will remain at the end of 8 days?

## Problem 2

How many grams of a 64 g sample of iodine-131 will remain at the end of 32 days?

## Problem 3

Complete the equation below by filling in the missing part:

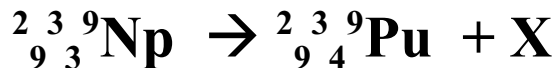


what is X?

two neutrons?    two protons?    beta particle,  ${}^0_{-1}\text{e}$ ?    alpha particle,  ${}^4_2\text{He}$ ?

## Problem 4

Complete the equation below by filling in the missing part:



What is the particle X?

a positron?    a neutron?    alpha particle,  ${}^4_2\text{He}$ ?    beta particle,  ${}^0_{-1}\text{e}$ ?

## Alternate Assignment

### Problem 1

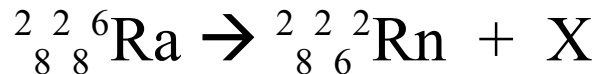
Iodine-131 is a radioactive isotope with a half-life of 8 days. How many grams of a 64 g sample of iodine-131 will remain at the end of 8 days?

### Problem 2

How many grams of a 64 g sample of iodine-131 will remain at the end of 24 days?

### Problem 3

In the equation



what is X?

two neutrons?

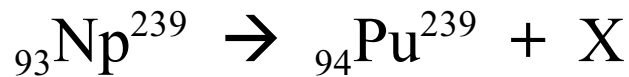
two protons?

beta particle,  ${}^0_{-1}\text{e}$ ?

alpha particle,  ${}^4_2\text{He}$ ?

### Problem 4

In the nuclear change



What is X?

a proton?

a neutron?

alpha particle,  ${}^4_2\text{He}$ ?

beta particle,  ${}^0_{-1}\text{e}$ ?