

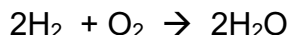
Name \_\_\_\_\_

### Nuclear Chemistry

- Use the symbols for and distinguish between alpha ( ${}^4_2\text{He}$ ), and beta ( ${}_{-1}^0\text{e}$ ) nuclear particles, and gamma ( $\gamma$ ) radiation include relative mass..
- Use shorthand notation of particles involved in nuclear equations to balance and solve for unknowns. Example: The neutron is represented by ( ${}_0^1\text{n}$ ).
- Discuss the penetrating ability of alpha, beta, and gamma radiation.
- Conceptually describe nuclear decay, including:
  - Decay as a random event, independent of other energy influences
  - Using symbols to represent simple balanced decay equations
  - Half-life (including simple calculations).
- Contrast fission and fusion.
- Cite illustrations of the uses of nuclear energy, including, but not limited to: electricity, carbon-14 dating, and radioisotopes for medicine (tracers, ionizing radiation, gamma sterilization, etc).

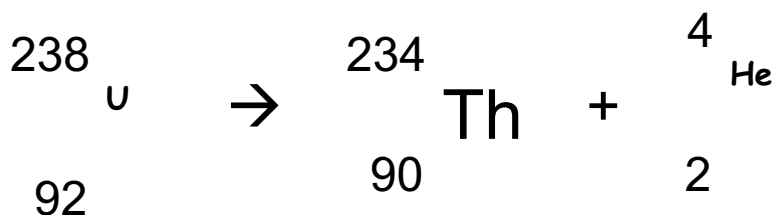
### **Nuclear Reactions & Ordinary Chemical Reactions**

Regular chemical reactions involve only the out electrons of atoms. In a chemical reaction, elements do not change from one to another.



Nuclear reactions involve the atomic nucleus.

When an atomic nucleus changes, it is very probable that the products will be different elements than the reactants.

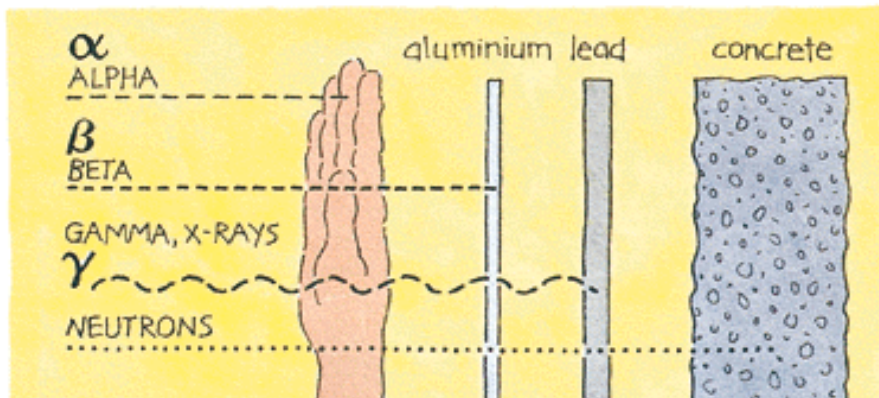


Many nuclei are radioactive.

This means they are unstable and will decay by emitting a particle, transforming the nucleus into another nucleus, or into a lower energy state.

A chain of decays takes place until a stable nucleus is reached.

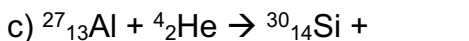
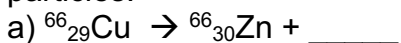
### Nuclear Symbols



While all particles produced by the decay of an atomic nucleus have the energy to penetrate substances, some particles have much more energy than others.

## Balancing Nuclear Equations Practice

1. Complete and balance these nuclear equations by supplying the missing particles:



2. Strontium-90 Has half-life of 28 years. If a 1.00-mg sample was stored for 112 years. What mass of Sr-90 would remain?

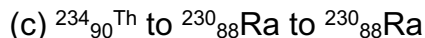
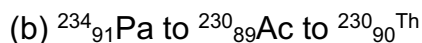
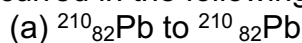
3. Write nuclear equation for the alpha decay of



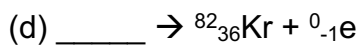
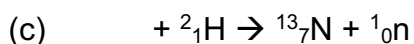
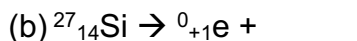
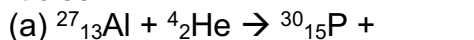
4. Write nuclear equations for the beta decay of



5. Determine the type of emission or emissions (alpha, beta, or gamma) that occurred in the following transitions:



6. Complete and balance these nuclear equations by supplying the missing particles:



7. Strontium-90 has half-life of 28 years. If a sample was tested in 1980 and found to be emitting 240 counts/ min, in what year would the same sample be found to be emitting 30counts/min? How much of the original Sr-90 would be left?

### Radioactivity

Match the three types of emission with the following ideas. Each may be used once, more than once, or not at all.

a) alpha                      b) beta                      c) gamma

\_\_\_ 1. Two protons and two neutrons

\_\_\_ 2. High speed electron

\_\_\_ 3.

\_\_\_ 4.  ${}^4_2\text{He}$

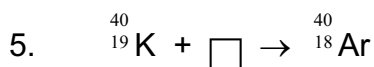
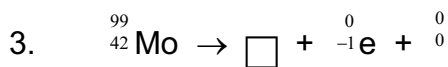
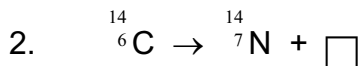
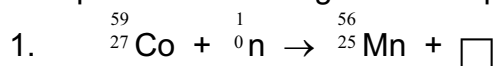
\_\_\_ 5. Higher energy than x-rays

\_\_\_ 6.

\_\_\_ 7. Helium nucleus

\_\_\_ 8.  ${}^0_{-1}\text{e}$

Complete the following nuclear equations:

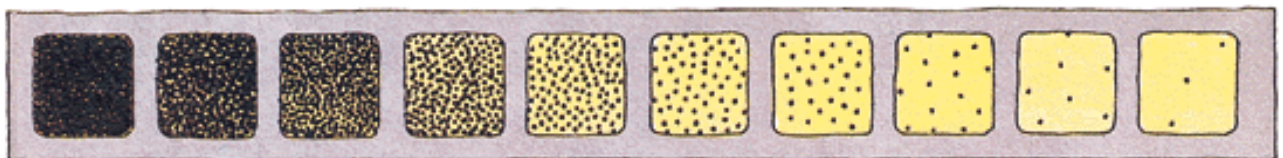


## Half-Life

The length of time it takes for one-half of the atoms of a radioactive nuclide to disintegrate.

Half-Life Table		
Nuclide	Half-life	Decay Type
${}^6_2\text{He}$	0.802 seconds	Beta-minus
${}^{227}_{92}\text{U}$	1.3 minutes	Alpha and Gamma
${}^3_1\text{H}$	12.3 years	Beta-minus
${}^{14}_6\text{C}$	5730 years	Beta-minus
${}^{235}_{92}\text{U}$	$7.1 \times 10^8$ years	Alpha and Gamma

*Decay rate of radioactivity: After ten half lives, the level of radiation is reduced to one thousandth*



Time:      One half life   two      three      four      five      six      seven      eight      nine
















Many radioactive particles decay into other radioactive particles, however, the final product of radioactive decay will always be a stable substance.

Uranium-238 goes through a long sequence of decays before it finally becomes stable.

The 14 individual decays that lead from U-238 to Pb-206 are shown here.

How many alpha particles are released?

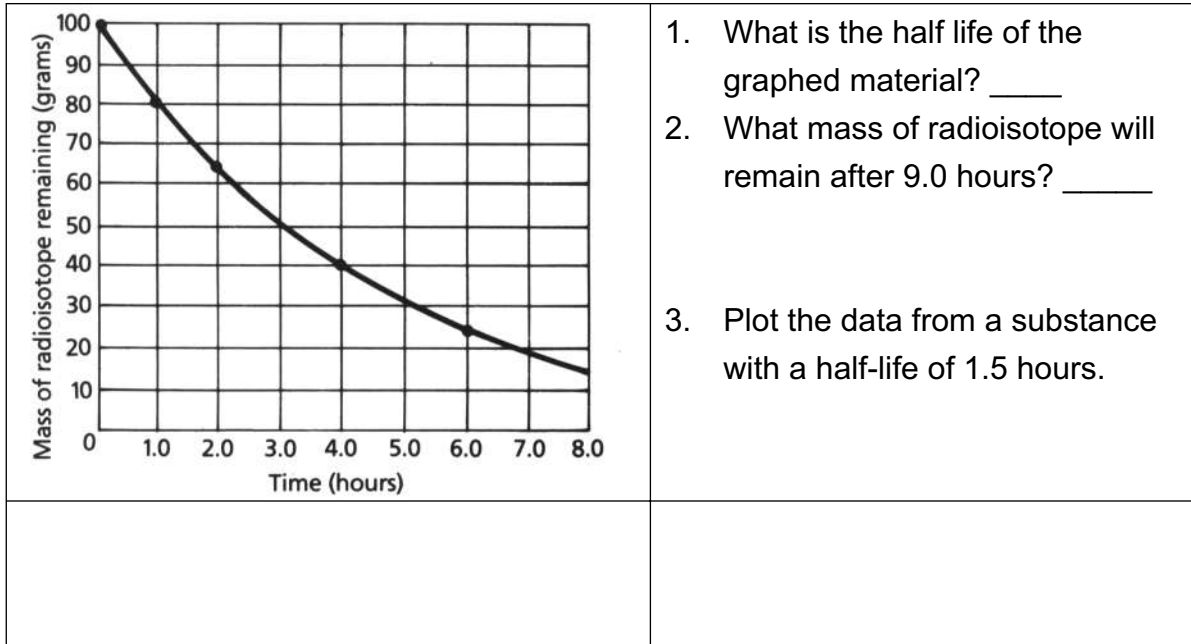
How many beta particles?  
are released?

URANIUM 238 (U238) RADIOACTIVE DECAY		
type of radiation	nuclide	half-life
	 uranium-238	4.47 billion years
$\alpha$	 thorium-234	24.1 days
$\beta$	 protactinium-234m	1.17 minutes
$\beta$	 uranium-234	245000 years
$\alpha$	 thorium-230	8000 years
$\alpha$	 radium-226	1600 years
$\alpha$	 radon-222	3.823 days
$\alpha$	 polonium-218	3.05 minutes
$\alpha$	 lead-214	26.8 minutes
$\beta$	 bismuth-214	19.7 minutes
$\beta$	 polonium-214	0.000164 seconds
$\alpha$	 lead-210	22.3 years
$\beta$	 bismuth-210	5.01 days
$\beta$	 polonium-210	138.4 days
$\alpha$	 lead-206	stable

### HALF-LIFE PROBLEMS

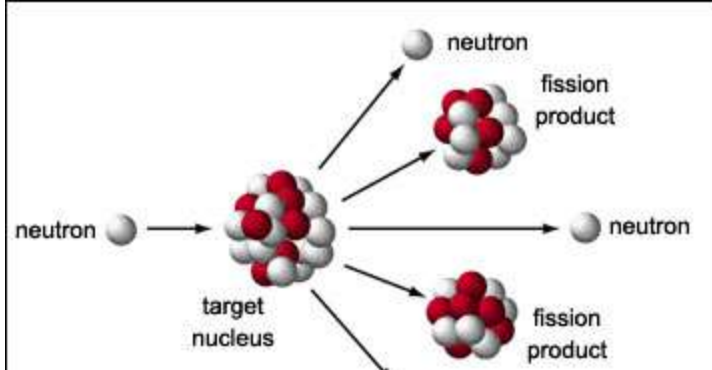
1. An isotope of cesium (cesium-137) has a half-life of 30 years. If 1.0 mg of cesium-137 disintegrates over a period of 90 years, how many mg of cesium-137 would remain?

2. A 2.5 gram sample of an isotope of strontium-90 was formed in a 1960 explosion of an atomic bomb at Johnson Island in the Pacific Test Site. The half-life of strontium-90 is 28 years. In what year will only 0.625 grams of this strontium-90 remain?
3. Actinium-226 has a half-life of 29 hours. If 100 mg of actinium-226 disintegrates over a period of 58 hours, how many mg of actinium-226 will remain?

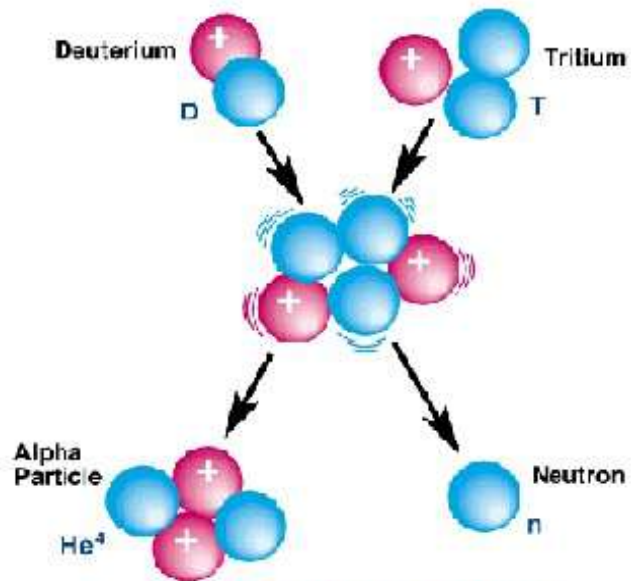


- Fission: heavy nuclei are split into lighter nuclei. Fission reactions are relatively easy to control but produce radioactive wastes.
- Fusion: light nuclei are combined to form heavier nuclei. Fusion reactions are difficult to initiate and control but produce little radioactive wastes.

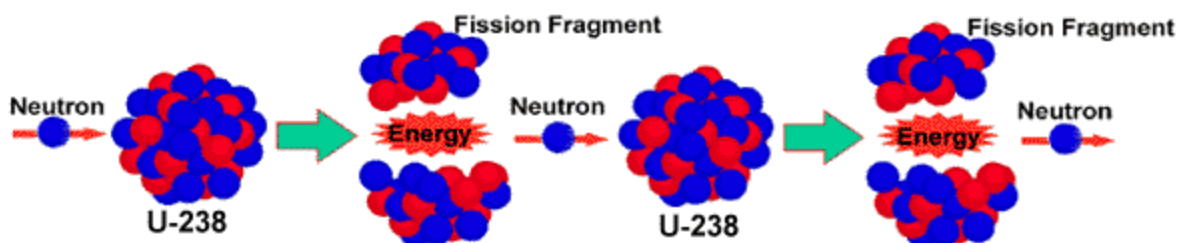




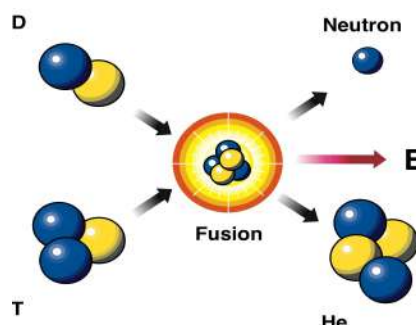
### Deuterium-Tritium Fusion Reaction



**ENERGY MULTIPLICATION**  
About 450:1



1. Determine the isotope used to disorders, from

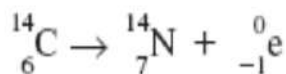


half-life of Iron-59, an  
diagnose blood  
the following data?

Elapsed Time (days)	Mass remaining
0	2.00 g
22.25	1.41g
44.50	1.00g
89.00	0.500g

- a. 22.25 days
- b. 44.50 days**
- c. 89.00 days
- d. 156.0 days

2. When carbon-14 decays, it emits a beta particle to produce nitrogen-14, as shown below.



3. When copper-67 undergoes beta decay, which of the following isotopes is produced?

- A. copper-66
- B. copper-68
- C. nickel-67
- D. zinc-67**

4. Which radioactive emission requires the most shielding?

- a. positrons
- b. gamma rays**

- c. beta particles
- d. alpha particles

5. The given reaction:  $^{27}_{13}\text{Al} + ^4_2\text{He} \rightarrow ^{31}_{15}\text{P}$  best represents

- a. beta decay.
- b. artificial transmutation.
- c. fission.
- d. fusion.