Nuclear chemistry help sheet

1. **Atomic Number and Mass Number**
   a. Atomic Notation – commonly used to specify the number of protons and neutrons in the atom

   Mass number
   Atomic number $^{235}_{92}\mathrm{U}$ Atomic symbol

   b. Atomic Number – the number of protons
   c. Mass Number – the number of protons + neutrons
   d. Number of neutrons = mass number – atomic number
   e. Isotopes – atoms of an element that have different number of neutrons.
      $^{1}_{1}\mathrm{H}$, $^{2}_{1}\mathrm{H}$, and $^{3}_{1}\mathrm{H}$ $^{31}_{15}\mathrm{P}$ and $^{28}_{15}\mathrm{P}$
2. **Common forms of radioactive decay**

Decay Type	Particle	Particle Mass	Particle Charge	Change in mass number	Change in Atomic number
Alpha	$^{4}_{2}\mathrm{He}$ or $^{4}_{2}\alpha$	4	2+	Decreases by 4	Decreases by 2
Beta	$^{0}_{-1}\beta$ or $^{0}_{-1}e^{-}$	0	1-	No change	Increases by 1
Positron	$^{0}_{+1}e$ or $^{0}_{+1}\beta$	0	1+	No change	Decreases by 1
Electron Capture	$^{0}_{-1}\beta$ or $^{0}_{-1}e^{-}$	0	1-	No change	Decreases by 1
Gamma	$^{0}_{0}\gamma$	0	0	No Change	No Change

3. **Balancing nuclear equation**
   a. Sum of reactants mass = sum of products mass
   b. Sum of reactants atomic numbers = sum of product atomic numbers
   c. Elements may change
   d. Example:

   $$^{18}_{9}\mathrm{F} \rightarrow {}^{18}_{8}\mathrm{O} + {}^{0}_{1}\mathrm{e}$$

4. **Half-lives and isotopic dating**
   a. Radioactive decay follows first order kinetics (see kinetics handout).
   b. Half-life is characteristic of each isotope
   c. Relative abundance is used estimate the age of objects
      i. Age of rock – U-235 – half-life of 4.5 billion years
      ii. Organic materials in archeological sites – C-14 – half-life of 5730 years - Dates between 500 and 50, 000 years old
      iii. Age of wines – H(T)-3 – half-life of 12.26 years – dates up to 100 years
5. **Fusion, Fission, Transmutation**
   a. Fusion – smaller atoms come together to form larger atoms
   b. Fission – larger atoms break apart to form small atoms
   c. Transmutation (artificial) – elements are converted from one to another