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 \( M = 235 \) \( _{92}U \) 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. \( _1^1H, _1^2H, \) and \( _1^3H \) \( _31P \) and \( _32P \)

2. Common forms of radioactive decay

<table>
<thead>
<tr>
<th>Decay Type</th>
<th>Particle</th>
<th>Particle Mass</th>
<th>Particle Charge</th>
<th>Change in mass number</th>
<th>Change in Atomic number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alpha</td>
<td>( ^4_2He ) or ( ^4_2\alpha )</td>
<td>4</td>
<td>2+</td>
<td>Decreases by 4</td>
<td>Decreases by 2</td>
</tr>
<tr>
<td>Beta</td>
<td>( 0_{-1}\beta ) or ( 0_{-1}e^- )</td>
<td>0</td>
<td>1-</td>
<td>No change</td>
<td>Increases by 1</td>
</tr>
<tr>
<td>Positron</td>
<td>( 0_+e ) or ( 0_+\beta )</td>
<td>0</td>
<td>1+</td>
<td>No change</td>
<td>Decreases by 1</td>
</tr>
<tr>
<td>Electron Capture</td>
<td>( 0_{-1}\beta ) or ( 0_{-1}e^- )</td>
<td>0</td>
<td>1-</td>
<td>No change</td>
<td>Decreases by 1</td>
</tr>
<tr>
<td>Gamma</td>
<td>( 0_0\gamma )</td>
<td>0</td>
<td>0</td>
<td>No Change</td>
<td>No Change</td>
</tr>
</tbody>
</table>

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:

      \( ^{18}_9F \rightarrow ^{18}_8O + ^0_{-1}e \)

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