Part #1: Radioactivity

1. Fill in the table below as a review. You will need your periodic table for this!

<table>
<thead>
<tr>
<th>Isotope</th>
<th>Total Protons (Atomic #)</th>
<th>Total Neutrons (Mass # - Atomic #)</th>
<th>Mass Number</th>
<th>Total Electrons Outside Nucleus</th>
<th>Format for Nuclear Equation</th>
</tr>
</thead>
<tbody>
<tr>
<td>K-40</td>
<td>19</td>
<td>21</td>
<td>40</td>
<td>19</td>
<td>$^{40}_{19}K$</td>
</tr>
<tr>
<td>Li-6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$^{6}_{3}Li$</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. Complete the following table.

<table>
<thead>
<tr>
<th>Name</th>
<th>Charge</th>
<th>Mass</th>
<th>Symbol</th>
<th>Penetrating Ability</th>
<th>Shield against Using?</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALPHA</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BETA</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GAMMA</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>POSITRON</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>e⁻ CAPTURE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3. Determine whether each of the following nuclides are stable. How did you determine this? Hint: Calculate the neutron-proton ratios for each.
   - Carbon-12
   - Oxygen-14
   - Radon-222

4. Write balanced nuclear equations for the following radioactive decays. Use the periodic table in your reference packet.
   - uranium-235 emits an alpha
   - actinium-227 emits a beta
   - Ra-223 emits an alpha
   - Rn-219 emits an alpha

   $^{43}_{19}K \rightarrow ^{43}_{28}Ca + _____$

   $^{235}_{92}U \rightarrow ^{229}_{90}Th + _____$

   $^{11}_{6}C + _____ \rightarrow ^{11}_{5}B$

   $^{13}_{7}N \rightarrow ^{9}_{6}O + _____$
5. Write a hypothetical decay series for uranium-238 that involves alpha and/or beta decay reactions. Flip a coin to determine which type of decay occurs. Heads is alpha decay and tails is beta decay. Repeat this process 15 times. At the end of your decay series calculate the neutron to proton ratio for your final isotope and predict if it is stable or unstable.

a) 

b) 

c) 

d) 

e) 

f) 

g) 

h) 

i) 

j) 

k) 

l) 

m) 

n) 

o) 

Part #2: Half-life

1. What is a radioactive nuclide? 

2. What is radioactive decay? 

3. What is half-life? 

4. If we start with 400 atoms of a radioactive substance, how many would remain after one half-life? after two half-lives? after three half-lives? after four half-lives?
5. If we start with 48 atoms of a radioactive substance, how many would remain after one half-life? _______
   after two half-lives? _______ after three half-lives? _________ after four half-lives? ______

6. If we start with 16 grams of a radioactive substance, how much will remain after three half-lives? ______

7. If we start with 120 atoms of a radioactive substance, how many will remain after three half-lives? ______

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Use the following graph to answer questions 8-11...

8. How long is a half-life for C-14? ______________

9. If only 25% of the carbon-14 remains, how old is the material containing the carbon-14? ______

10. If a sample originally had 120 atoms of C-14, how many atoms will remain after 16,110 years? ________

11. If a sample known to be about 10,740 years old has 400 carbon-14 atoms, how many atoms were in the sample when the organism died? __________

Use the following chart to answer questions 12-16.

<table>
<thead>
<tr>
<th>Radioactive Substance</th>
<th>Approximate half-life</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radon-222</td>
<td>4 days</td>
</tr>
<tr>
<td>Iodine-131</td>
<td>8 days</td>
</tr>
<tr>
<td>Radium-226</td>
<td>1600 years</td>
</tr>
<tr>
<td>Carbon-14</td>
<td>5730 years</td>
</tr>
<tr>
<td>Plutonium-239</td>
<td>24,120 years</td>
</tr>
<tr>
<td>Uranium-238</td>
<td>4,470,000,000 years</td>
</tr>
</tbody>
</table>

12. If we start with 8000 atoms of radium-226, how much would remain after 3,200 years? ______

13. If we start with 20 atoms of plutonium-239, how many would remain after 48,240 years? ______

14. If we start with 60 atoms of uranium-238, how many remain after 4,470,000,000 years? ______

15. If we start with 24 atoms of iodine-131, how many remain after 32 days? ______

16. Which nuclide is the most stable? Which nuclide is the least stable?

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Part #3: Detection of Radioactivity

1. How does radiation produce ions in matter?

2. Summarize the detection methods used to detect radiation presented in the presentations and in your textbook.

3. What units are used to measure radiation? Define the ones presented in your notes and in your textbook.
Part #4: Nuclear Power and Nuclear History

1. What two fissionable isotopes are used in a fission reactor?

2. Describe how a nuclear fission reaction creates energy in a power plant. In other words, how does a nuclear power plant generate electricity?

3. Describe the function of the fuel rods, control rods, moderator, and coolant in a fission reactor. List examples of substances used for each of these jobs.

4. Briefly describe the nuclear power plants in North Carolina.

5. Briefly describe the Chernobyl accident.

6. Briefly describe any of the historical events pertaining to nuclear chemistry that were presented in the presentations or from your textbook.

7. What is the difference between fission and fusion?

8. Why isn't fusion currently used to produce energy?

Part #5: Biological Effects of Radiation

1. What type of radiation…
   easily penetrate human tissue? ____________________________
   stopped by skin? ____________________________
   penetrates 1-2 cm beneath the skin? ____________________________

2. What is a free radical and what can it do to a biological system? ____________________________
   __________________________________________________________________________________

3. Clearly describe ARS (acute radiation sickness). ____________________________
   __________________________________________________________________________________
   __________________________________________________________________________________
   __________________________________________________________________________________

4. Two units used to measure radiation doses are the rad which stands for ____________________________
and the rem which stands for _________________________________.

6. You are exposed to radiation on a regular basis. List several sources.

7. Why is it useful to monitor how many X-rays you receive annually?

8. How does nuclear radiation damage biological tissue? Why is it so harmful? Explain any health effects that may result.

9. List several uses of nuclear. Briefly describe and explain any from your presentation notes and the textbook.

**Part #6: Nuclear Review Multiple Choice Questions**

1. Atoms that have unstable nuclei and will change into a different atom are said to be:
   A. Fluorescent  B. Isotopes  C. Radioactive  D. Colorful

2. Alpha particles have ____ charge.  A. Positive  B. Negative  C. No

3. The identity of an element is determined by its number of…
   A. Electrons  B. Neutrons  C. Protons + neutrons  D. Protons

4. Atoms of the same element with different masses are called:
   A. Isotopes  B. Radioactive  C. Semiconductors  D. Transuranium

5. Which radiation has the poorest penetration?  A. Alpha particles  B. Beta particles  C. Gamma rays

6. A beta particle is a/an:
   A. Electron  B. Helium nucleus  C. Proton  D. Hydrogen nucleus

7. Which radiation can be stopped by a piece of metal foil?
   A. Alpha particle  B. Beta particle  C. Gamma rays  D. X-rays

8. The product of a decay reaction has a mass that has decreased by 4. What type of decay occurred?
   A. Gamma decay  B. Fission  C. Alpha decay  D. Beta decay

9. The product of a nuclear decay did not change mass or atomic number. What type of decay occurred?
   A. Fusion  B. Alpha decay  C. Gamma decay  D. Beta decay

10. The changing of one element into another by a nuclear reaction is called:
    A. Transmutation  B. Transuranium  C. Decomposition  D. Combustion

11. The half life of a radioisotope is 3 days. If you started with 600 mg of material, how much would be left in 15 days?  A. 18.75mg  B. 75 mg  C. 37.5 mg  D. Cannot determine

12. You start with 800 grams of a radioisotope. In 36 hours, there are 100 grams left. What is the half-life of this radioisotope?  A. 3 hours  B. 12 hours  C. 22 hours  D. 10 hours

13. To balance a nuclear reaction, the mass number on both sides of the equation must be equal but the atomic number can be different.  A. True  B. False