Nuclear Reactions – Fission, Fusion and Radioactivity:

**Goal:** You will be responsible for sharing the information you learned with other students while learning something new from them!

**Fact Sheet:** You must create a fact sheet that includes key ideas about your topic. You will use this as you help others understand your concept.

**Include:**
- Title for your concept
- Names of students who worked on the fact sheet
- Main ideas to help explain your topic
- No complete sentences – Use key words, phrases, and lists to explain ideas
- Color
- Pictures and/or diagrams to explain concepts or illustrate ideas mentioned
- Neatness and legibility matter – make sure the fact sheet makes sense!

*Remember, other people have NOT read your article and so are completely reliant on your fact sheet and presentation to understand the concept.*

**Directions:** Answer these questions based on the information provided by the groups.

1. **What is a radioactive element?**

   Radioactive elements have unstable nuclei so that radiation is released as the nucleus breaks apart.

2. **Provide at least 2 characteristics for each type of radiation:**

<table>
<thead>
<tr>
<th>Alpha Particles:</th>
<th>Beta Particles:</th>
<th>Gamma Rays:</th>
</tr>
</thead>
<tbody>
<tr>
<td>These are the lowest energy particles (and largest – made of protons &amp; neutrons) &amp; can be stopped by very little; however if you inhale or ingest them, the radiation can still damage you.</td>
<td>These higher energy electrons can “burn” skin that’s not protected by layers of clothing or shielded by metal. Again, if it gets inside the body, it can be very damaging.</td>
<td>These are high energy waves that will go through your body and damage cells too. They can only be stopped by many inches of lead or many feet of concrete.</td>
</tr>
</tbody>
</table>

3. **How do humans come into contact with radiation?**

   Radiation is naturally occurring and our bodies have evolved to be able to handle low-levels of radiation all the time. People can have heightened exposure.

4. **Compare and contrast acute and chronic exposure to radiation. What does each of these mean?**

<table>
<thead>
<tr>
<th>Acute exposure:</th>
<th>Chronic exposure:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large amount of radiation in a short amount of time</td>
<td>Small amounts of radiation, but occurring frequently and spread out over time</td>
</tr>
</tbody>
</table>

5. **How can radiation affect humans?**

   Radiation can damage the normal functioning of cells – affecting DNA processes results in the potential for cancerous cell growth and possible illness/death.
6. Explain fission. Include a picture of the process and an explanation of what is produced.

Fission occurs when a nucleus is unstable and breaks apart. This creates new, lighter atoms along with energy, radiation and possibly additional neutrons (which could be used to break apart more nuclei).

PICTURE NEEDED!

7. What does U-235 mean?
U stands for uranium and the 235 represents the atomic mass of one isotope (type) of uranium.

- Compare and contrast U-235, U-238 and U-234. How are they similar and how are they different?
  All of these atoms are uranium (and have the same number of protons); however, each has a different atomic mass (different number of neutrons). This differing atomic mass results in differing stability for each of these atoms so they naturally decay at different rates.

8. Nuclear power plants use heat to turn liquid water into a gas which is used to power a generator to create electricity. Explain why U-235 is used in most nuclear power plants.
U-235 can be induced (forced) to start breaking apart and we can use control rods to control the speed of the reaction. Lots of heat is generated with the nuclear reaction. And, very little U-235 can be used to generate a lot of energy.

9. What is the difference between spontaneous fission and induced fission?

<table>
<thead>
<tr>
<th>Spontaneous Fission:</th>
<th>Induced Fission:</th>
</tr>
</thead>
<tbody>
<tr>
<td>The natural rate that radiactive nuclei break apart</td>
<td>Creating a situation where we force a nucleus to start breaking apart</td>
</tr>
</tbody>
</table>

10. What is fusion? Include a diagram of fusion in your answer.

Fusion is the merging of two light nuclei (usually hydrogen, but sometimes helium or carbon) into a larger nucleus. This process can only occur under very high temperature and pressure. It results in the release of lots of energy and radiation.

PICTURE NEEDED!

11. What is plasma?
Plasma is another state of matter and has high energy particles.

- Explain how plasma is involved in fusion.
  Plasma state is required for fusion to occur – that high temperature/pressure situation allows for nuclei to combine.

12. Explain the three things necessary for a fusion reaction.

High temperatures, high pressure and confinement are necessary for fusion to occur. This is possible in the sun (and stars) due to their high mass (and therefore gravity). We use a variety of methods (lasers and magnetic fields) to create these conditions on Earth.

13. Scientific research on fission and fusion began at similar times. Yet, we currently only have nuclear fission power plants. Explain why we don’t have both.
We’re able to induce fusion in U-235 and harness the incredible amount of energy released as heat for steam power generation. However, we have to input a lot of energy to even create the conditions necessary for fusion.