Radiation Inquiry Lab Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Date performed: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

To be used for: Physical Science, Conceptual Physics, Physics 1, and Chemistry

Georgia Performance Standards:

**(Physical Science)**

**SPS3. Students will distinguish the characteristics and components of radioactivity.**

a. Differentiate among alpha and beta particles and gamma radiation.

b. Differentiate between fission and fusion.

**(Physics)**

**SP2. Students will evaluate the significance of energy in understanding the structure of matter and the universe.**

1. Relate the energy produced through fission and fusion by stars as a driving force in the universe.

**SP3. Students will evaluate the forms and transformations of energy.**

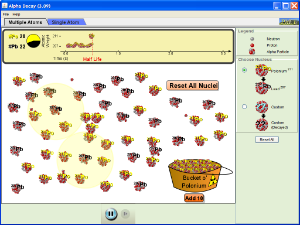
a. Analyze, evaluate, and apply the principle of conservation of energy and measure the components of work-energy theorem by describing total energy in a closed system.

b. Explain the relationship between matter and energy.

**Alpha Decay**

1. Go to <file:///C:/Program%20Files/PhET/simulations/sims5b83.html?sim=Alpha_Decay>

This is the Phet Alpha Decay lab. And press “run now.”

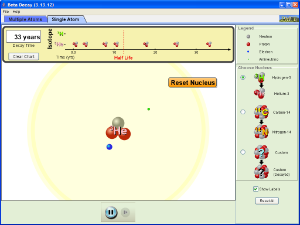
1. [](file:///C:\Program%20Files\PhET\sims\nuclear-physics\alpha-decay_en.jnlp)Click the tab to the right that says, “Single Atom.”At the top you will see a timer and a atomic weight chart.
2. Below the time chart is the simulation area.
3. On the right you will see a legend for the particles in the simulation area.
4. Below the simulation area is a graphic - the red line on the graph is the total energy of the system, the blue line on the graph is potential energy and the black line is the norm.

(you may have to reset the simulation several times to complete your observations, make sure to reset your chart each time.)

**Observations to record in your Lab notebook for Alpha Decay.**

1. What atom are you beginning with? Include the mass, symbol and atomic number in the format. \_\_\_\_\_\_\_\_\_\_\_\_
2. After the alpha decay what atom are you left with? In the  format
3. What was the particle that was emitted composed of?
4. Write the emitted alpha particle in  format.
5. Based on the periodic table, would any element have the same format as the alpha particle? If so, what element would it be?
6. Looking at the graphic at the bottom, in relation to the lines, where does the original particle begin?
7. Where is the original particle just before it emits the alpha particle?
8. Where is the resulting particle after the emission of the alpha particle?
9. Did the emission of the alpha particle always occur at the same, or nearly the same time, in you different runs?
10. On the energy graph at the bottom, does the alpha particle follow a certain path? If so describe the path?

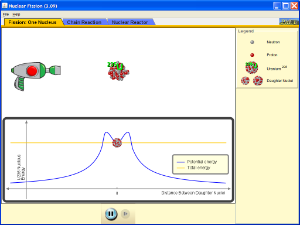
**Beta Decay**

1. **[](file:///C:\Program%20Files\PhET\sims\nuclear-physics\beta-decay_en.jnlp)**Go to <file:///C:/Program%20Files/PhET/simulations/sims5a17.html?sim=Beta_Decay>. The Beta Decay simulation.
2. You will see a similar chart at the top with time and Isotopes at the top.
3. To the right you will have the legend for the particles and a selection of starting atoms.
4. Begin by making sure that you select the Hydrogen-3 isotope.
5. Once again you may have to run the simulation several times to make all observations, make sure you are watching the simulations carefully.

**Observations to record in your Lab notebook for Beta Decay.**

1. Write the Hydrogen-3 isotope in the  format.
2. Describe the particle(s) emitted in Beta decay.
3. Write the resulting isotope in the  format.
4. Perform at least 5 runs of the simulation. Does the Beta decay occur at the same, or nearly the same, time?
5. Select the Carbon-14 isotope and repeat steps 1-4.

**Nuclear Fission**

[](file:///C:\Program%20Files\PhET\sims\nuclear-physics\nuclear-fission_en.jnlp)Go to <file:///C:/Program%20Files/PhET/simulations/simse233.html?sim=Nuclear_Fission> , the nuclear fission simulation.

1. You will begin on the “one nucleus screen.”
2. You will see a “gun” that will fire a particle at the nucleus.
3. To fire the gun, click on the red circle.
4. To the right of the simulation area you will see the legend of the symbols for the simulation.
5. In the chart at the bottom you have the blue line that represents the potential energy of the nucleus.
6. The gold line represents the total energy of the nucleus/system.

Observations to record in your lab notebook for “One Nucleus Fission”

1. Write the nucleus in the  format.
2. Fire the particle gun at the nucleus and describes what happens to the nucleus in the simulation area. Watch carefully because you want to describe the process from the time that the particle strikes the nucleus until the nucleus changes.
3. When the nucleus changes describe everything that comes out.
4. Now, pay attention to the chart at the bottom of the simulation.
5. Describe the chart (or sketch it, before the particle is fired) make sure to give the location of the total energy line.
6. After firing the particle, describe what you see happening to the energy on the chart from the time that the particle strikes the nucleus until the nucleus separates.
7. What was the particle that was fired at the nucleus to begin the reaction?

**Go to the “Chain reaction” Tab**.

Perform and record your observations in your lab notebook for “Chain Reaction”

For Chain reactions in the controls section on the right, just below the legend, check the box for “containment vessel.” Drag on one of the handles to expand the containment vessel until the outer limit just touches the boundary of the simulation screen.

**Chain Reaction Part 1:**

Create a chart or table in your lab notebook that has 2 columns, one for nuclei and one for % U-235 fissioned. You will be going from 25 nuclei to 75 nuclei in increments of 5.

As a starting point, go into the controls section and set the number of both the U-235 nuclei and the U-238 nuclei to “1.” Fire the particle at each nucleus and record what happens.

In the controls section, click in the box for U-235 nuclei and set the number to 25, make sure that the U-238 nuclei is at zero. Fire the particle into the containment vessel at a nuclei and describe what happens. You can aim the particle gun at a particular nuclei by dragging on the muzzle. Fire the particle at least 5 times and record the highest “U-235 nuclei fissioned percentage. Do this in increments of 5. You may record any qualitative data that you think is necessary as you go.

**Chain Reaction Part 2:**

You will be repeating Part 1 with the exception that you will set the U-238 nuclei to 5, (you will keep this as a constant). Perform the simulation as you did in “Chain Reaction Part 1.”

Question: Did you achieve the same results with the same number of U-235 nuclei?

**Time Permitting:**

Play with the “Nuclear Reactor.” You can drag the handle on the “control rod adjuster” to move the control rods.

Lab Report Discussions: (Make sure to draw a box around you lab discussions for each part.)

**Alpha Decay Discussion:** Write your own – theory, law, principle, or hypothesis – about an alpha particle. **(Make sure that you identify your response as one of the 4 choices)**. Ex. Explain why it happens, describe what will always happen, tell what you expect to normally happen. Is the alpha particle always the same? What happens to the original atom? Physics 1: Calculate the binding energy of the beginning atom, resulting atom, and the alpha particle. Is the binding energy of the beginning atom the same as the sum of the binding energy of the resulting atom and particle?

Remember, you may conduct research before you write your discussion and include that in your discussion as long as you cite the reference.

Closing Thoughts: Do you think that radioactive decay is the same as fission? Explain you answer.

**Dazzle me with your brilliance in your explanation and your use of the appropriate terms.**

Chain reaction Discussion: Write your own – theory, law, principle, or hypothesis – about chain reactions. **(Make sure that you identify your response as one of the 4 choices)** Ex. Explain why it happens, describe what will always happen, tell what you expect to normally happen. Is a chain reaction always the same?

**Nuclear Fission Discussion**: Write your own – theory, law, principle, or hypothesis – about nuclear fission. **(Make sure that you identify your response as one of the 4 choices)** Ex. Explain why it happens, describe what will always happen, tell what you expect to normally happen. Is the result of fission predictable? What happens to the original atom? Are all atoms subject to fission?

**Radioactive Decay, Compare and contrast Discussion:** Explain how alpha decay and beta decay are similar. Identify the differences between the particles and emissions. Which particle do you assume would move at a greater speed or have more energy?

**Beta Decay Discussion:** Write your own – theory, law, principle, or hypothesis – about an beta particle. **(Make sure that you identify your response as one of the 4 choices)** Ex. Explain why it happens, describe what will always happen, tell what you expect to normally happen. Is the beta particle always the same? What happens to the original atom?

W