WLHS / Chemistry / Monson

Name_____
Date_____Per_____

COMPUTER ACTIVITY: Nuclear Chemistry Simulations

Complete the following nuclear chemistry simulations individually or in groups of two. Follow the instructions given below for each simulation. Make careful observations as you work through the simulations and answer the questions in each section.

Simulations can be found at goo.gl/LXxc6V or: **https://phet.colorado.edu/en/simulations/category/chemistry**

Build an Atom

1) Click on *Build an Atom* and press the play button.
2) When the program opens, click the Symbol in the middle of the screen to maximize element, symbol, mass number, and net charge.
3) Show the stability of the atom by clicking the box "Stable/Unstable"
4) Build the following *neutral* isotopes of hydrogen by adding the appropriate number of protons, neutrons, and electrons:

$$_{1}^{1}H,\ _{1}^{2}H,\ _{1}^{3}H$$

• How are these isotopes similar?_____

• How are these isotopes different?_____

• Which isotope of hydrogen is the most stable? Why?_____

_____

5) Build the following *neutral* isotopes of carbon by adding the appropriate number of protons, neutrons, and electrons: $_{6}^{12}C,\ _{6}^{13}C,\ _{6}^{14}C$

• Carbon-14 is unstable. Identify the type of decay that would yield a stable nucleus (alpha or beta)*.*

• Write the isotopic symbol for the new element formed.

6) Click the ***Game*** **tab near the lower right of the screen.** Play each game and record your time and score below:

Game	Time	Score (/10)
		
		
		
		

Nuclear Fission

1) Go back to **goo.gl/LXxc6V** or: **https://phet.colorado.edu/en/simulations/category/chemistry**
2) Click on ***Nuclear Fission*** **and choose download.**
3) Click the ***Fission: One Nucleus*** **tab.**
4) Experiment with shooting the neutron gun and watch what happens.

• What happens when the U-235 nucleus is "hit" with a neutron? There are a number of things that happen here, describe all of them in as much detail as you can. **You may "reset the nucleus" as many times as you like and repeat until you are confident you have accurately described what happens.** ***Use the pause button when needed.***

5) Click on the ***Chain Reaction*** **tab.**

6) Experiment with changing the settings and shooting the neutron gun and watch what happens. Then answer the questions below.

• Click the 'Reset All' button and then set the initial number of U-235 nuclei to 100 and U-238 to 0. What happens when you fire the neutron gun?

• Explain what makes this a "chain reaction".

• Click 'Reset' and then set the initial number of U-238 nuclei to 100 and U-235 to 0. Explain what happens when you fire the gun. Does this cause a chain reaction? Try multiple times to start a chain reaction with the U-238. Explain why this happens.

• What is U-239? In what ways is it different from U-238?

7) Set the initial numbers of U-235 nuclei and U-238 nuclei to the numbers in the table below. Record your results.

U-235	**100**	**70**	**50**	**30**	**0**
U-238	**0**	**30**	**50**	**70**	**100**
% of ^{235}U fissioned after 1 firing					
# firings required to fission all ^{235}U					N/A

• What happens to the reaction as the proportion of U-238 nuclei increases? Explain why this happens.

• If you were trying to design the most efficient nuclear fission reactor possible, what ratio of U-235 to U-238 would you want? Explain why. *Remember, a nuclear reactor should not have **uncontrolled** chain reactions, but also must undergo consistent fission events.*

FINAL STEP: Click on the *Nuclear Reactor* tab.

1) Experiment with changing the settings and firing the neutrons and watch what happens. Then answer the questions below. Watch very closely to the fission reactions as they happen. **Specifically watch what happens to the "loose" (freed) neutrons after the reaction.**

• What happens if the neutrons hit another nucleus?

• What happens if the neutrons hit a control rod?

• Compare the chain reaction that occurs when the control rods are inserted further into the reactor versus when they are pulled all/mostly out of the reactor.

• If the purpose of a nuclear reactor in a power plant is to produce energy, **why are there control rods?**