Minilab [25 pts]
Nuclear Processes
α, β Decay; Nuclear Fission

Name _____
Lab Partner _____
Period _____ ***Date*** _____

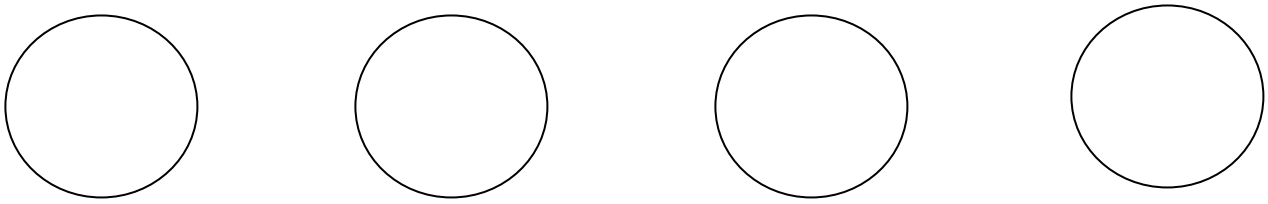
Goal: To better understand natural/artificial transmutation and nuclear fission.

Part A: Alpha Decay
Start by opening the PhET model "Alpha Decay" and start by clicking on the "Single Atom" tab.

1. [1 pt] Observe the decay of Po-211. Write a nuclear equation for the decay of Polonium-211.

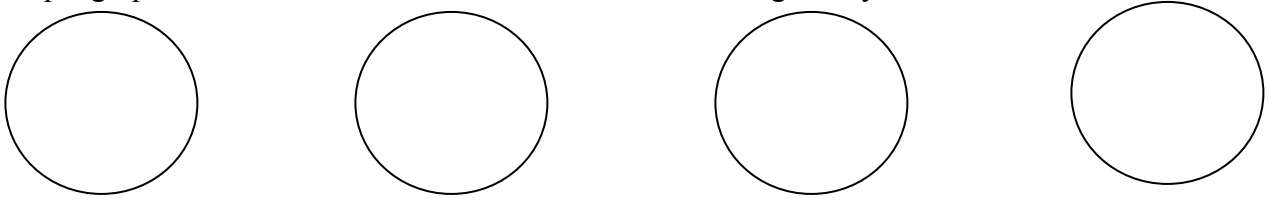
2. [1 pt] What happens to the energy of the nucleus when an atom of Polonium-211 decays?

3. [2 pts] The half-life of Po-211 is approximately 500 ms (0.5 s). **Without using the PhET model**, sketch a pie graph indicating the number of **undecayed Po-211 atoms** for a reaction starting with 100 total atoms.



t= 0.5s t=1.0s t=1.5s t=2s

Click on the "Multiple Atoms" and press the pause button. Simulate the decay of 100 Po-211 atoms by adding 100 atoms from the "Bucket o' Polonium." Click "play" and then pause every 0.5 s. Sketch what the pie graph looks like at the times shown. Reset and start again if you need to.



t= 0.5s t=1.0s t=1.5s t=2s

4. [2 pts] Compare your prediction to the results that you observed. Do the results match (or come close to) your predictions? How can you explain any discrepancies?

5. [2 pts] Is it reasonable to assume that if you start with 10 atoms of Polonium, that 0.5s later only 5 will remain undecayed? What would you expect if you start with 500 atoms? Explain.

Part B: Beta Decay
Open the "Beta Decay" PhET model. Make sure that you click on the "Single Atom" tab.

6. [1 pt] Observe the beta decay in the PhET model. Write a nuclear equation for the process.

7. [2 pts] When an atom undergoes beta decay, what subatomic particle does the beta particle come from? What other subatomic particle is produced in this process?

Part C: Nuclear Fission
Open the "Nuclear Fission" PhET model. Make sure that you click on the "Fission: One Nucleus" tab.

8. [4 pts] Briefly describe the process by which Uranium-235 can be made unstable and undergo fission. What happens to the energy of the U-235 when the neutron strikes it? Write a nuclear equation for the process that produces 3 neutrons, Krypton-92, and another nucleus that you must determine.

9. [3 pts] Using the "Chain Reaction" tab within the model, add various amounts of U-235 and U-238. What happens to the chain reaction as more U-238 is added? What happens to U-238 when it is struck with a neutron? To U-238?

10. [1 pt] Add a containment vessel and determine the criteria and settings needed to create an atomic bomb.

11. [1 pt] Explain why *weapons-grade* Uranium would not likely contain very much Uranium-238.

12. [2 pts] Use the "Nuclear Reactor" tab to determine the purpose of control rods within a nuclear fission reactor.

13. [3 pts] Watch the following YouTube videos: Nuclear Fission Chain Reaction (https://youtu.be/0v8i4v1mieU), Mousetrap Fission (https://youtu.be/vjqIJW_Qr3c). Are they good analogies of nuclear fission? If we were to use mousetraps and ping-pong balls to illustrate fission, what would each represent? Is there anything missing from this model?