Mandatory Assignment #4
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Lesson Plan – Investigating Chain Reactions related to energy

Background Info:

Course: Chemistry, Grade 10-12 mixed

Inquiry level: Students are working in a Storyline Curriculum where there are Working with the Unit Question of "How could a small amount of nuclear material power an entire city but also destroy it? Should we use it?" and in the activity for this lesson the Driving lesson question is: How can we capture and use this energy for something other than a bomb?

I would categorize this lesson as Interactive to inquiry Lab, different tasks fall into the different levels.

In the iHUB Nuclear storyline, this lesson (7) uses the PhET for Nuclear Fission with the intent of the following:

Learning Outcomes/ Task:

- Use a model of the U-235 fission reaction to construct an explanation of how nuclear power plants safely harness this reaction to produce energy from mass.

- Explore some simulations that might help us see this process in action. Using the simulations, we investigate how the amount of "control rods", which absorb free neutrons, and the amount of free neutrons to catalyze the fission reaction impacts the amount of energy released in a nuclear power plant.

Teacher background to guide students towards: We find that there needs to be a balance of control rods and free neutrons to promote a sustained but controlled reaction. Too many control rods or too few free neutrons and the reaction cannot sustain. Too many free neutrons or not enough control rods and the reaction gets out of control and quickly uses all the fuel to produce a "bomb". Finding the balance between the number of free neutrons and control rods is key to safely harnessing the energy produced by the fission of U-235.

**Standards:** **Use a model of** the U-235 fission reaction to **construct an explanation** of how nuclear power plants safely harness this reaction to produce energy from mass.

HS-PS3-2 from NGSS :Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motion of particles (objects) and energy associated with the relative positions of particles (objects).

DCI: **PS3.A: Definitions of Energy**

- Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system. That there is a single quantity called energy is due to the fact that a system's total energy is conserved, even as, within the system, energy is continually transferred from one object to another and between its various possible forms. (HS-PS3-1),(HS-PS3-2)

- At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy. (HS-PS3-2) (HS-PS3-3)
- These relationships are better understood at the microscopic scale, at which all of the different manifestations of energy can be modeled as a combination of energy associated with the motion of particles and energy associated with the configuration (relative position of the particles). In some cases the relative position energy can be thought of as stored in fields (which mediate interactions between particles). This last concept includes radiation, a phenomenon in which energy stored in fields moves across space. (HS-PS3-2)

**LESSON PLAN:**

Student activity: https://docs.google.com/document/d/1COsDkwRLtbzfFjj-FF2lzkzqJz9KdibZO52GyQXRccU/edit?usp=sharing

"Lesson plan" from the iHUB Lesson Materials:

LEARNING PLAN: CONNECTED INVESTIGATIONS (for a more detailed description, click on the number to the left)

1 (10 min) Ask students to remember what we figured out last class. How do nuclear reactions compare to the chemical reactions we examined in the Fuels Unit?

2 (15 min) Facilitate an Initial Ideas discussion about how the amount of energy released during a nuclear reaction can be controlled.

3 (20 min) Using a PhET simulation, students investigate how nuclear reactors control the energy released during the fission reaction.

4 (15 min) Students jigsaw the dynamic relationships between control rods, free neutrons, rate of energy production, and safety by creating models of meltdown, safe energy production, and limited energy production.

5 (10 min) Facilitate a Consensus Building discussion and add ideas to the Incremental Model Tracker.

6 (5 min) Use the DQB or analyze a graph to motivate the question: If nuclear power is so great, why don't we use it more?

My added comments to the lesson plan:

I will guide the beginning of the lesson, then ask them to complete the assignment for Fermi in the table groups. This student handout has a reading from Fermi about work in 1939 and the energy released during the work his group was doing on fission of Uranium.

Our students all have 1 to 1 devices so they will complete the PhET independently but then be allowed to discuss with their team (table groups). The Main investigation in this lesson is the PhET for Nuclear Fission. This may be accompanied by a separate "lab" write up that is intended to be a guided lab activity for the students to gather information and data to understand the process of fission more and be able to start to discuss the energy as it relates to the movement of neutrons and the transfer of energy to thermal energy which can be used to do work for the system when in a nuclear reactor.

**<u>Additional resources</u>** for students to investigate as needed will be the two videos below. Some students will be more comfortable with the fission concepts from previous lessons and may not need these resources.

Student Video for additional information about neutron speed and motion as it relates to chain reactions https://www.youtube.com/watch?v=zyE-PVQh3Wc

Student support video for E=mc2 https://www.youtube.com/watch?v=FU6y1XIADdg crash course video (Start to 5:19 basics and equation, 5:19 to 5:45 for chain reactions, 5:45 to 7:35 for fission and meltdown. Info on Fusion from 7:37 to end)

NASA Connection. – not sure…

**<u>Formative and Summative Assessments</u>**: As students work through the student handout, engage in discussions, draw graphs related to the data they collect, I monitor for misconceptions, ask prompting questions to make sure they are moving in the right direction, and suggest discussion amongst their table groups to make sure there is correct consensus on major discussion points of the lesson.