Student Learning Map

Unit Topic:

Key Learning(s):
Nuclear Chemistry

Unit Essential Question:
What is radioactivity?

Instructional Tools
mm Lab
Penny Lab
Film: Perry Nuclear Power Plant

Concept:	Concept:	Concept:	Concept:
Particles in Atoms	Radioactivity	1/2 Life	Nuclear fission + fusion

Lesson EQ:	Lesson EQ:	Lesson EQ:	Lesson EQ:
1. What particles are in atoms? 2. Where are these particles located? 3. What is the charge of these particles? 4. How are the # of particles symbolized?	1. What is ~~a A~~ a radioactive atom? 2. What are the types of radiation 3. How are nuclear eqns written?	1. What is 1/2 life? 2. How is 1/2 life calculated? 3. How does 1/2 life relate to human health?	1. How are fission and fusion different? 2. How does a nuclear power plant work?

Vocabulary:	Vocabulary:	Vocabulary:	Vocabulary:
atomic number isotopic notation mass number proton, neutron electron nucleus	ionizing radiation nonionizing radiation alpha beta gamma		fission fusion reactor core

9.1 Particles in Atoms

I. Particles in atoms

1.

2.

3.

II. Particles in Nucleus

1.

2.

III. Terms

1. atomic number

2. mass number

3. isotope

4. isotopic notation

IV. Counting Atomic Particles

Symbol	Electrons	Protons	Neutrons
87 Rb 37			
238 U 92			
235 U 92			
131 I 53			
239 Np 93			
226 Ra 88			
222 Rn 86			
210 Bi 83			

V. What is missing???

1. 40
K
?

2. 198
?
85

3. 197
Au
?

4. 4
?
2

5. 24
?
12

6. ?
Rn
86

7. 27
Al
?

8. 218
?
84

9.2 Radioactivity

Radioactive elements spontaneously emit radiation because of an unstable nucleus.

Unstable nuclei are can be large nuclei such as the actinides or certain isotopes where the number of protons and neutrons leads to instability.

Types of Radiation

	Alpha	Beta	Gamma
Also called	Helium nuclei ${}^{4}_{2}\text{He}$	Electron ${}^{0}_{-1}e^-$	High energy electromagnetic radiation
symbol	α	β	γ
Charge	+2	-1	0
Common source	Radium-226	Carbon-14	Cobalt-60
Penetrating power	Low	Moderate	High
Shielding	Paper, cloths	Metal foil	Lead, concrete

Nonionizing radiation

Ionizing radiation

Examples of Nuclear Equations

Uranium-238 alpha decay

$$ {}^{238}_{92}\text{U} \longrightarrow {}^{4}_{2}\text{He} + {}^{234}_{90}\text{Th} $$

Beta decay of a carbon-14

$$ {}^{14}_{6}\text{C} \rightarrow {}^{0}_{-1}\beta + {}^{14}_{7}\text{N} $$

Problems

1. Bismuth-214 decays to produce an isotope and an alpha particle

2. copper-66 decays to produce the isotope Zn-66

3. radon-217 decays to polonium-213

4. nitrogen-14 is bombarded with alpha particles to produce an isotope of fluorine

5. rubidium-87 decays into strontium-87

6. bismuth decays into thallium-193

7. carbon-14 decays into a beta particle plus an unknown isotope

8. an unknown isotope of thorium decays into protactinium-234 plus a beta particle

Lab Partners: Period:

M & M™ Decay

PURPOSE:
The purpose of this activity is to demonstrate the pattern of radioactive decay during several half-lives of "radioactive" M&M™s.

The half-life of a radioisotope is unique to a particular isotope. Half-lives can range from 3.0×10^{-7} seconds (polonium-212) to 4.5×10^{9} years (uranium-238). Other examples include I-131 – 8.1 days, Rn-222 – 3.83 days, Sr-90 – 28 years and Ra-226 – 1600 years.

PRELAB QUESTIONS:

1. Define half-life.

2. What percent of the original sample will remain after 1 half-life? After 3 half-lives?

PROCEDURE

1. Obtain a cup of radioactive M&M™s.
2. Count the number of pennies in the sample you received. This number will be the original number of radioactive atoms.
3. Put all of the M&M™s back into the cup. Shake it and pour the sample out onto a clean work surface. Separate the stable M&M™s (M up) from the unstable, or radioactive, M&M™s. Count the unstable M&M™s. Record in data table.
4. Put the unstable ones back in your cup and repeat step 3 (shake, separate, count) until all M&M™s are stable.
5. Graph data as requested.

DATA TABLE

Number of Radioactive Atoms Remaining	Number of Half-Lives
	0

EXTENSION 1

Penny Half-Life

Problem
Do pennies follow a typical half-life radioactive decay pattern?

Materials
50 pennies
shoe box with lid
graph paper

Let's Investigate
In this extension you will investigate a model for radioactive decay. The radioactive sample will be the head's side of a penny. As it decays, it turns into tails. Begin by placing 50 pennies in the bottom of the cardboard box. Because this should represent the situation before radioactive decay begins, all pennies should have the head's side facing up. You will be closing the lid and shaking the sample for 30 seconds. The number of heads remaining will represent the amount of the original sample that has not yet decayed. Before you begin shaking, use your knowledge of half-life to complete the column in the data table for "predicted number of heads remaining."

Once the prediction column has been completed, begin collecting data. With all pennies in the heads-up position, close the box and shake it for 30 sec. After that time, count the number of coins in the heads-up position. Record this value in the data table. Remove all the tails-up pennies from the box. Repeat this procedure for five half-lives. Remember to record your data and to remove the tails-up pennies after each half-life.

Number of Half-Lives	Predicted Number of Heads Remaining	Actual Number of Heads Remaining
0		
1		
2		
3		
4		
5		

Summing Up
1. How does the predicted number of heads compare to the actual number of heads after one half-life? After two half-lives? After four half-lives?
2. Prepare a graph of the half-lives versus the predicted and actual number of heads. Place both sets of data on the same graph. Remember to label all parts of your graph and to include a key.
3. Would you consider this penny simulation to be a good model for demonstrating radioactive decay? In what ways is it accurate and in what ways is it inaccurate?

9.4 Nuclear Reactions

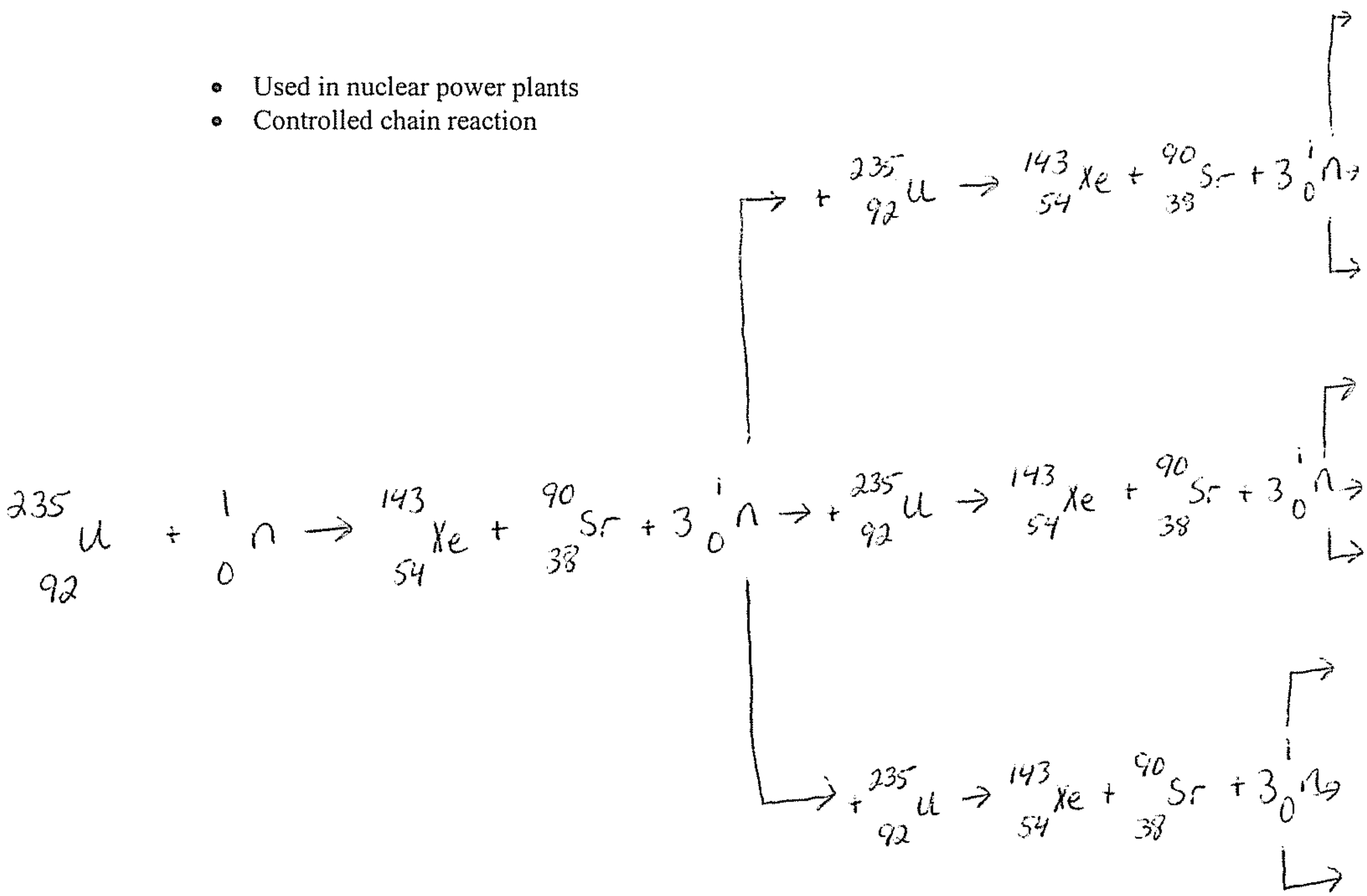
Nuclear Fission –

Ex. $4\ ^{1}_{1}H$ $\quad ^{4}_{2}He + 2\ ^{1}_{+1}e^-$

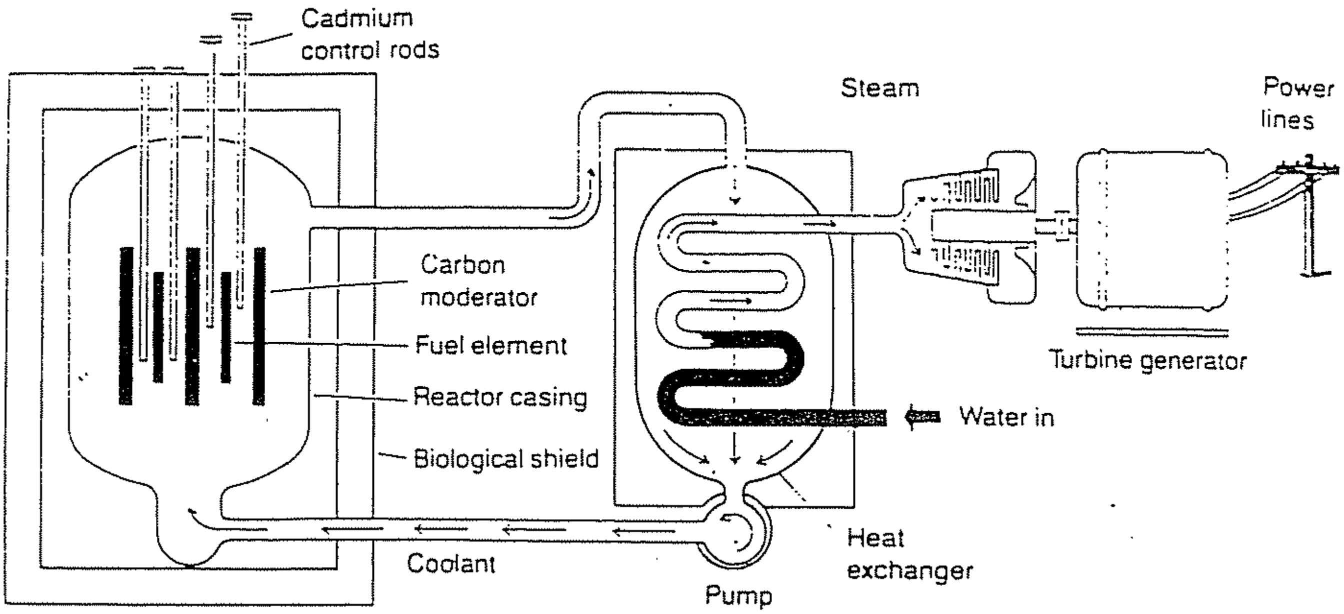
Fusion reactions have no waste, but the temperatures melt the containers. Only seen on the sun

Nuclear Fission –

- Used in nuclear power plants
- Controlled chain reaction



Parts of a Nuclear Power Plant



Problem: Storage of Nuclear Waste