OAK HARBOR PUBLIC SCHOOLS

CONCEPTUAL CHEMISTRY COURSE

OAK HARBOR PUBLIC SCHOOLS
Open Educational Resources

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Attribution

The team developing these materials combine 100 years of teaching experience. They were powered by many pounds of chocolate, not a few cups of coffee, and the desire to create an engaging NGSS aligned course for all chemistry students. In the creation process experiments were tested, classrooms were disrupted, and messes were made. This group included teachers with many years of experience and those just entering the field. Team members included several with expertise in science standards and test development at both state and national levels. This course was developed in align to Next Generation Science Standards as adopted by the State of Washington. The team received a one day training from Ambitious Science Teaching on modeling which is incorporated throughout. Team members were also granted a workshop for POGIL (Process Oriented Guided Inquiry Learning). The team developed a working template using the 5E model (Engage, Explore, Explain, Extend/Elaborate, Evaluate) for developing lesson plans and utilized the cK-12 Foundation's open education textbook system.

This chemistry resource was written with the financial support of Washington State Office of Superintendent of Public Instruction's Open Education Resource Grant and Oak Harbor Public Schools. Without the support of these organizations the creation of these materials would not have been possible.

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UNIT 1:
STRUCTURE AND PROPERTIES OF MATTER

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Unit 1: Structure and Properties of Matter

Standard:

HS-PS1-1: Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms.

Model:

Question: Why do elements that look similar react differently in water?

Materials:

- Water
- Beakers
- Protective Shield
- Magnesium
- Calcium
- Sodium
- Aluminum

Procedure:
Allow students to make initial observations of the physical properties of each substance.
Place a small sample of each element into a beaker of water for students to observe the reaction.

Learning Objective:

I can communicate my existing ideas about atomic structure.

Engage:

Kesler Stations: Periodic Table and Reactivity

Learning Objectives:

I can determine an atom's chemical properties based on valence electrons.
I can describe how elements are classified on the periodic table.

Explore:

1. PhET Simulator: Build an Atom!
2. Living by Chemistry Create a Table Card Sort and Breaking the Code Questions

Learning Objectives:

I can describe how the organization of the periodic table is based on reactivity and atomic mass.
I can predict the characteristics of a missing element on the periodic table based on its position on the periodic table.

Explain:

1. cK-12 Atomic Number

   Learning Objectives:

   I can identify the the components of the nucleus.
   I can identify the number of protons, electrons and neutrons in an element.
   I can describe an element's location based on its atomic number.

2. cK-12 Valence Electrons

   Learning Objectives:

   I can determine the number of valence electrons an element has based on its location.
   I can describe how valence electrons determine reactivity.

3. Build an Atom Notes

   Learning Objective:

   I can identify components and properties of subatomic particles.

4. Breaking the Code Notes

   Learning Objective:

   I can describe properties and trends used to organize the periodic table.

Extend/Elaborate:

Revisit Model

Redraw a model of a sodium atom.

Include the following:

- number of protons
- total number of electrons
- valence electrons
- nucleus
- energy shells

Include an explanation about why sodium is so reactive using the words period and group.

Learning Objective:

I can revise a model to add detail about atomic structure.

Evaluate:

1. Task

Select one of the following elements to complete your task on:

2. Test

Elements Reacting with Water

Name _____ Date _____ Period ___

Name of Element	**BEFORE:** Draw what you think **will happen** when the element is put into water.	**AFTER:** Draw what **happened** after the element was put in water.

Name of Element	Draw a **MODEL**: Draw what you think **the atoms** of the element and water looked like when the sample was put into water.

PhET Simulator: Build an Atom!

Name: _____

Date: _____ Period: _____

1) Go to the following: http://phet.colorado.edu/en/simulation/build-an-atom and click **Play**, then select **Atom**.

2) Use the tools to build any three, different types of atoms and fill in the information about them below:

Element Name: _____	**Element Name:** _____	**Element Name:** _____
# of protons: _____ # of neutrons: _____ # of electrons: _____ Sketch: Atomic #: _____ Mass #: _____ Symbol on Periodic Table: _____	# of protons: _____ # of neutrons: _____ # of electrons: _____ Sketch: Atomic #: _____ Mass #: _____ Symbol on Periodic Table: _____	# of protons: _____ # of neutrons: _____ # of electrons: _____ Sketch: Atomic #: _____ Mass #: _____ Symbol on Periodic Table: _____

3) Which subatomic particle determines the ***identity*** of the atom? What **evidence** does the simulator give you for this?

_____

_____

_____

4) Create a Hydrogen (H) atom (1 proton, 1 neutron, 1 electron). Follow the directions, observe what happens and complete the table below. **(You need to RESET back to your original Hydrogen (H) atom (1 proton, 1 neutron, 1 electron) after you make each change!)**

	Add a Neutron (to original atom)	**Add an Electron** (to original atom)	**Add a Proton** (to original atom)
Observe and record ALL changes to the original Hydrogen (H) atom when each subatomic particle is added!	**How does it change the:** Overall charge: _____ Mass: _____ Atomic Number: _____ Type of Atom: _____	**How does it change the:** Overall charge: _____ Mass: _____ Atomic Number: _____ Type of Atom: _____	**How does it change the:** Overall charge: _____ Mass: _____ Atomic Number: _____ Type of Atom: _____

5) Based on what you've observed, **<u>which two particles appear to determine the mass of the overall atom</u>?** Which particle ***doesn't*** seem to have a measurable impact on the mass? Explain why you think this is!

_____

_____

_____

6) Based on what you've observed, ***summarize the relationship*** between how protons, neutrons and electrons affect the overall charge of an atom.

_____

_____

_____

7) If you've been paying attention, you should have noticed that the term **<u>Ion</u>** appears from time to time. Experiment with the simulator and list the two ways you can create a positive ion and a negative ion:

   a) Two ways to create a ***positive*** ion:

      _____

   b) Two ways to create a ***negative*** ion:

      _____

   c) What do you think the term ion means?

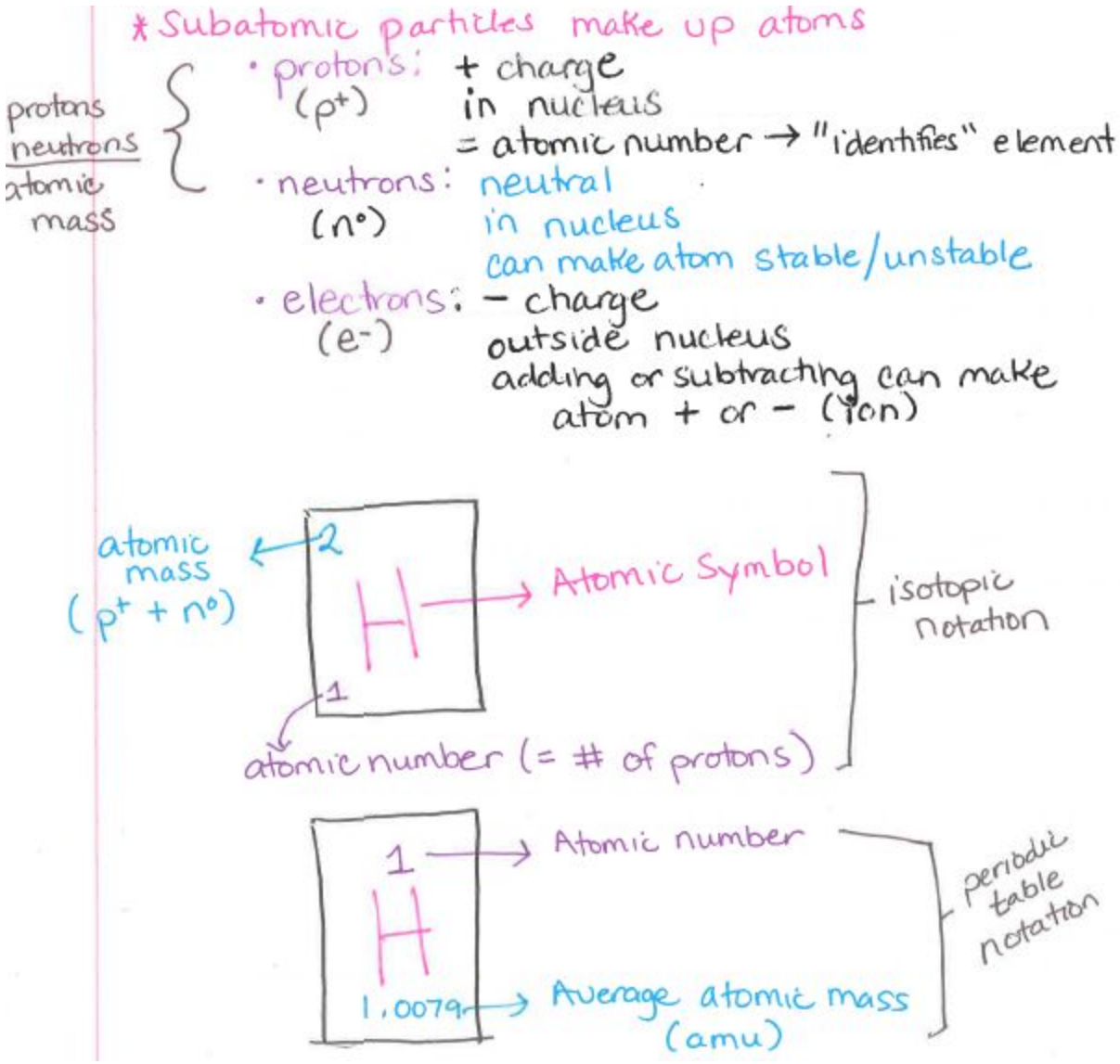
      _____

8) Click **Symbol** at the very bottom of the simulator window. Pick three, ***new*** atoms to create. Display a sketch of the atom as well as how it would appear on the Periodic Table:

Element Name: _____	**Element Name:** _____	**Element Name:** _____
Sketch of atom:	Sketch of atom:	Sketch of atom:
How it would appear on periodic table:	How it would appear on periodic table:	How it would appear on periodic table:

9) Click **Game** at the bottom of the simulator window. Play the four games- can you get all ***five stars*** each time?! ☺

Build an Atom Notes



Breaking the Code Notes

I. Elements on periodic table are organized according to their properties.
   A. Physical properties: props that can be measured w/o causing a change in the substance
      * examples: color, conductivity, malleability
   B. Chemical properties: a characteristic that a substance in a chemical reaction produces a new substance
      * example: reacts w/ water or acid

II. Elements that share chemical + physical properties are classified as
   A. Metals
   B. Non-metals
   C. Metalloids aka 'semi-metals'

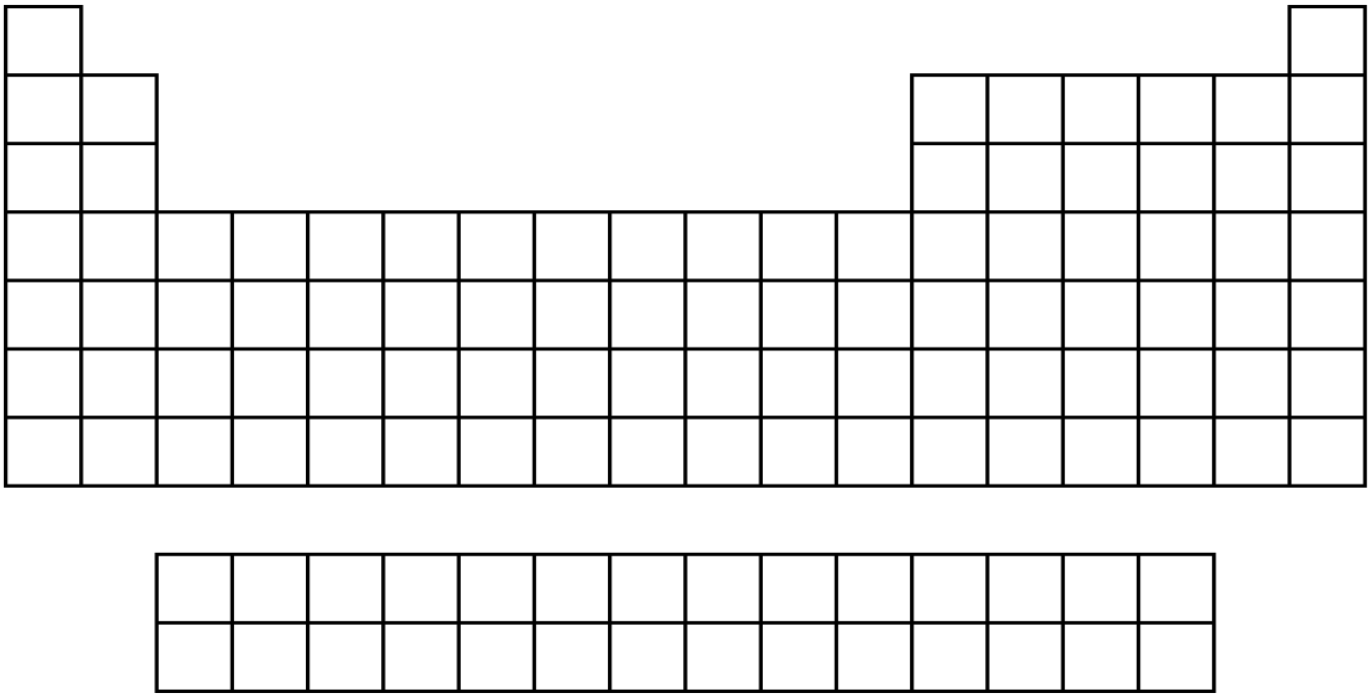
III The columns + rows show patterns and trends in characteristics
   A. Columns = families or groups
   B. Rows = Periods

Task: Structure and Properties of Matter

Part 1: Location on the Periodic Table

1. What is the name of your element?

2. Fill in the symbol for your element in the correct location.



Part 2: Location versus Properties of Atoms

- Identify the number of each part of an atom of your element
- Explain how the location of your element provides information about:

1. Protons

2. Total electrons

3. Electrons in the outermost energy level

Part 3: Trends on the Periodic Table

1. On the blank periodic table, fill in the symbol of another element in the **same period** as your element
   a. Compare the **atomic structure** of your element to the other element

   b. Compare the **reactivity** of your element to the other element

2. On the blank periodic table, fill in the symbol of another element in the **same group** as your element
   a. Compare the **atomic structure** of your element to the other element

   b. Compare the **reactivity** of your element to the other element

Task Rubric: Structure and Properties of Matter

Learning Evidence	1 point
Correct location of element on the Periodic Table	
Correct number of protons, electrons and number of electrons in outermost shell	
Correct explanation of how location indicates number of protons	
Correct explanation of how location indicates total number of electrons	
Correct explanation of how location indicates number of outer level electrons	
Compare the structure of your element to an element in the same period	
Compare the reactivity of your element to an element in the same period	
Compare the structure of your element to an element in the same group	
Compare the reactivity of your element to an element in the same group	
Total	/9

Test: Structure and Properties of Matter **Name:** **Period:**

1. How many protons does carbon (C) have?
    a. 4
    b. 12
    c. 14
    d. 6
2. What is similar between arsenic (As) and selenium (Se)? **Select all that apply.**
    - number of outermost electrons
    - number of protons
    - number of total electrons
    - reactivity
    - nothing
3. Which element has 85 protons?
    a. krypton (Kr)
    b. radium (Ra)
    c. astatine (At)
    d. rubidium (Rb)
4. Which element has 7 outermost electrons?
    a. bromine (Br)
    b. neon (Ne)
    c. nitrogen (N)
    d. potassium (K)

5. What is similar between oxygen (O) and sulfur (S)? **Select all that apply.**
    - number of outermost electrons
    - number of protons
    - number of total electrons
    - reactivity
    - nothing
6. How many total electrons does silicon (Si) have?
    a. 28
    b. 4
    c. 3
    d. 14
7. How many outermost electrons does barium (Ba) have?
    a. 6
    b. 137
    c. 56
    d. 2
8. Which of the following elements is most reactive?
    a. sodium (Na)
    b. aluminum (Al)
    c. magnesium (Mg)
    d. silicon (Si)

UNIT 2:
NUCLEAR PROCESSES

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Unit 2: Nuclear Processes

Standard:

HS-PS1-8: Develop models to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay. (fission, fusion, radioactive decay)

Model:

Materials:

- Geiger counter
- Radioactive samples as available
- White plate
- Orange Fiestaware plate (U)
- Trinitite sample (Pu)
- Smoke detector (Am)

Procedure:

Ask students to predict which item is most radioactive.
Hold each item in close proximity to the Geiger counter.
Students should draw a model of the uranium atom showing neutrons, protons and electrons.
Students should draw a model of the atom after it has changed.
Demonstrate what is happening in the model to make it radioactive.

Learning Objective:

I can communicate my existing ideas about decay processes in the nucleus of an atom in terms of changing neutrons and protons.

Engage:

1. POGIL Isotopes
2. POGIL: Isotope Notes

Learning Objectives:

I can determine the number of protons and neutrons in an atom based on the isotope symbol.
I can describe the similarities and differences in isotopes of an element.

Explore:

1. Living By Chemistry "Nuclear Quest Game"
2. Nuclear Quest Notes

Learning Objectives:

I can explain the different processes involved in nuclear changes and the conditions required for those processes.

I can explain the connection between nuclear changes and changes in atomic identity.

Explain:

1. cK-12 Isotopes

   Learning Objectives:

   I can write elements in isotopic notation.
   I can identify the number of neutrons in different isotopes.

2. cK-12 Nuclear Decay Processes

   Learning Objective:

   I can differentiate between 3 different types of decay.

3. ck-12 Nuclear Fission Processes

   Learning Objective:

   I can explain the process of fission.

4. ck-12 Nuclear Fusion

   Learning Objective:

   I can explain the process of fusion.

5. Types of Nuclear Decay Notes

Extend/Elaborate:

1. **Revisit Model**

   Redraw model of radioactive decay

   Include the following:

   - Radioactive nucleus of uranium
   - Arrow indicating change
   - Alpha particle
   - Thorium-234 nucleus

   Learning Objective:

   I can revise a model to add detail about decay processes in the nucleus of an atom.

2. Living By Chemistry "Old Gold" fusion and fission worksheet

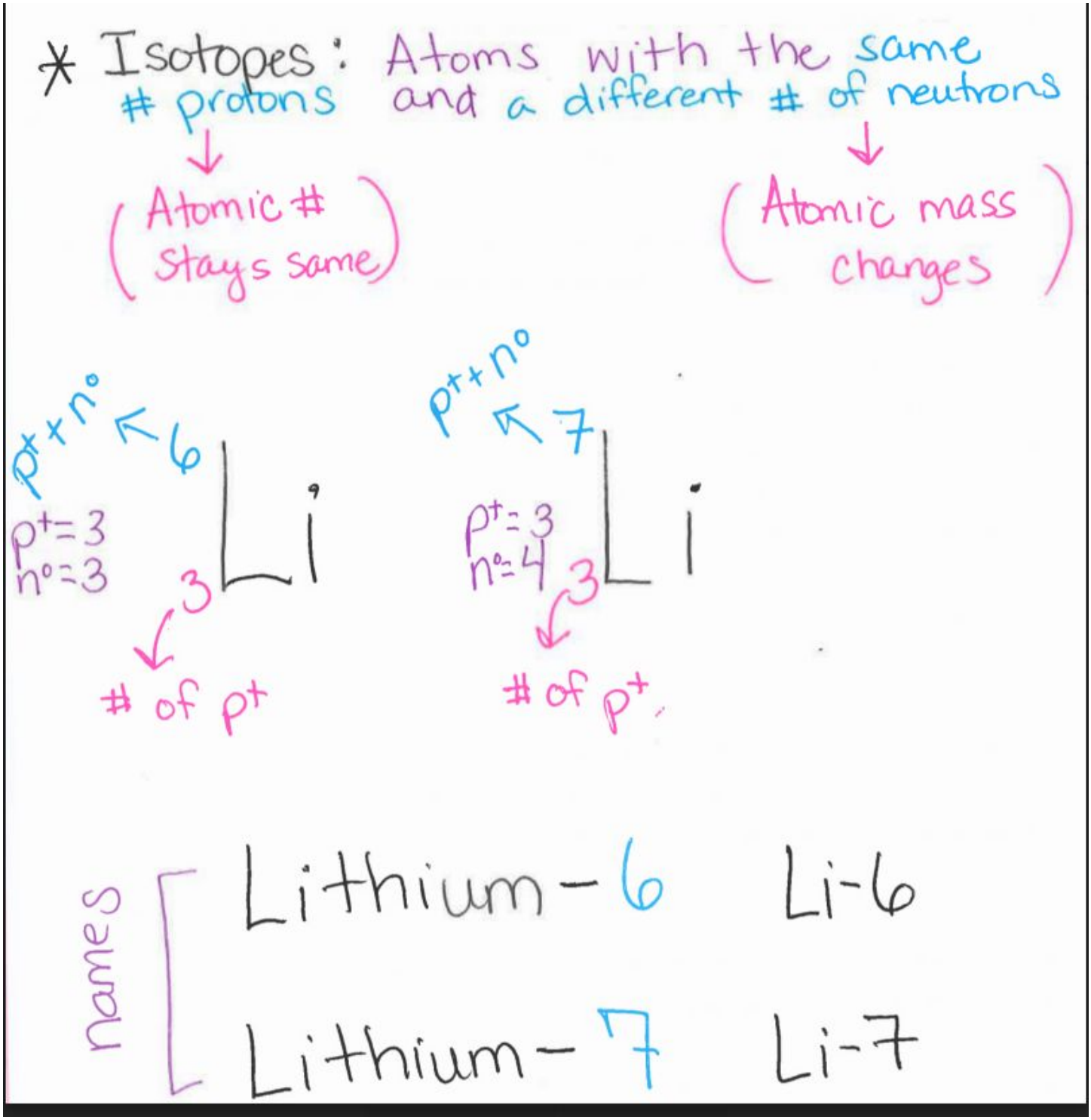
Learning Objectives:

I can explain how different elements are formed through nuclear reactions.
I can write a mup question balanced nuclear chemical equation.
I can describe the mechanism behind a nuclear chain reaction.

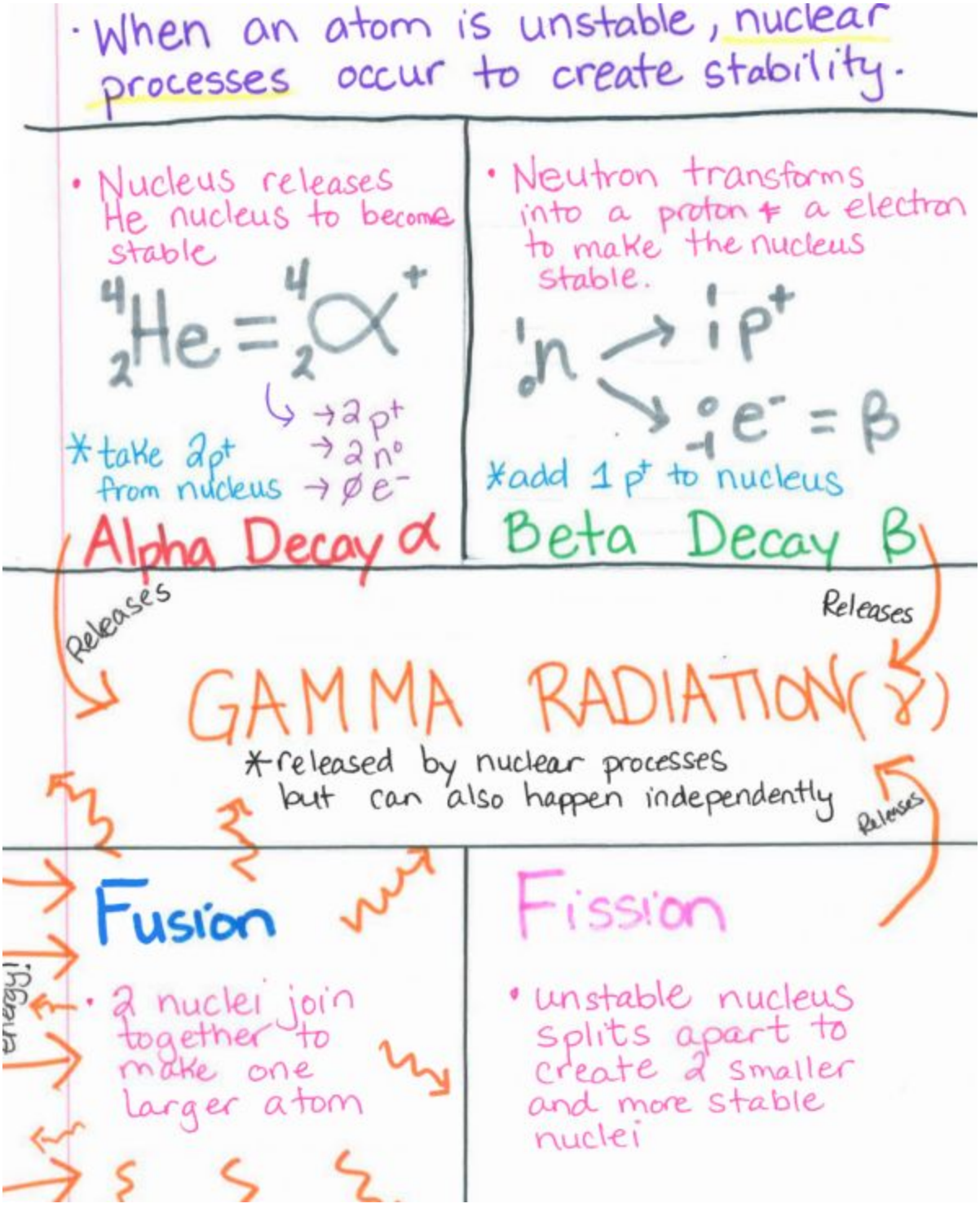
Evaluate:

1. Task
2. Test

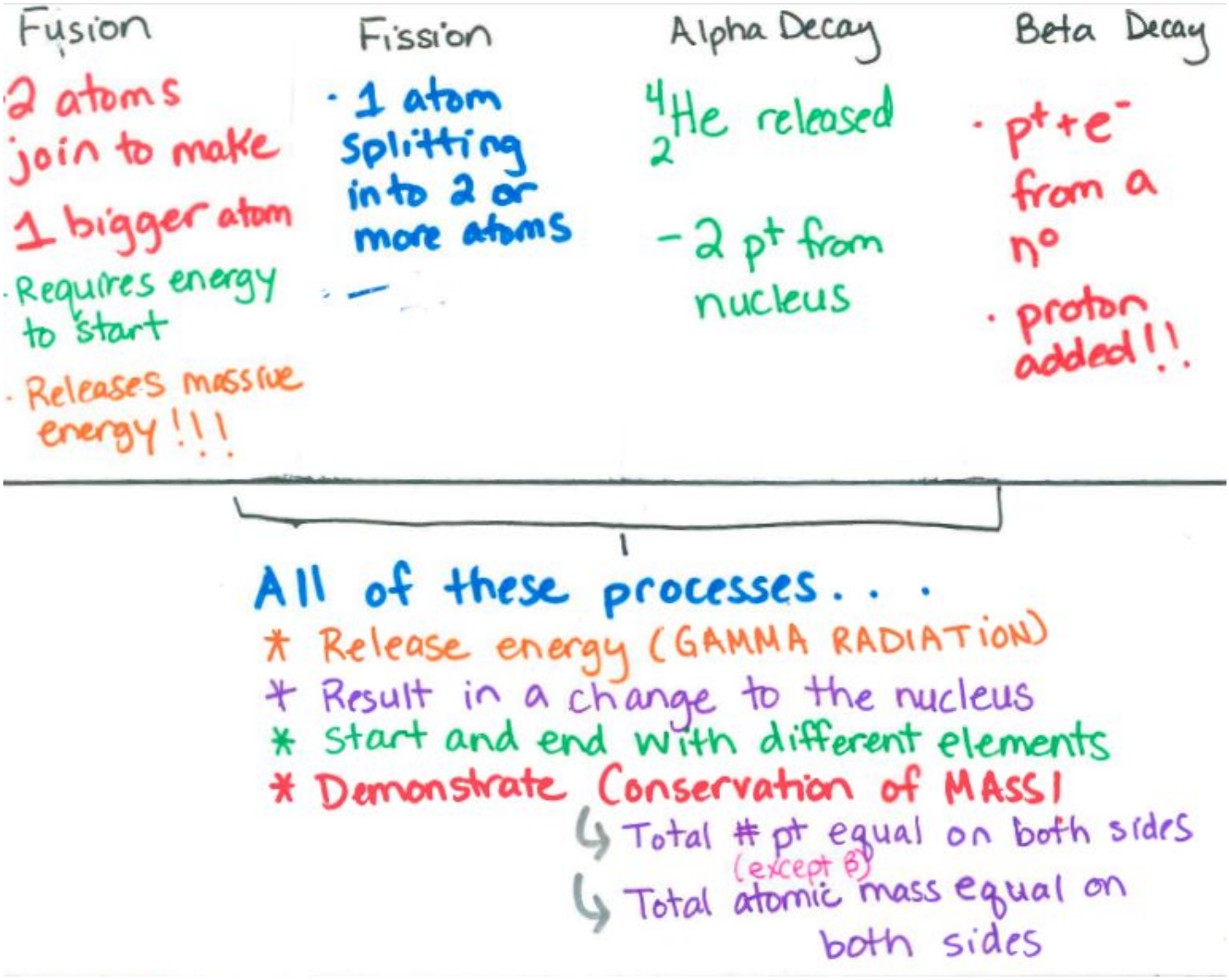
POGIL: Isotope Notes



Nuclear Quest Notes



Types of Nuclear Decay Notes



Task: Nuclear Processes

Part 1: Modeling Fusion

For your chosen element:

1. Create a new model that shows a nuclear fusion reaction that can produce your element.
2. Describe how your model demonstrates what happens to the total number of neutrons plus protons & the energy of the system during the fusion reaction.

Part 2: Modeling Fission

For your chosen element:

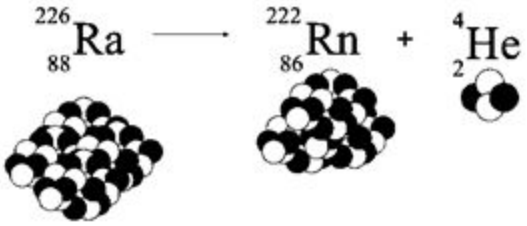
1. Create a new model that shows a nuclear fission reaction that could happen to your element.
2. Describe how your model demonstrates what happens to the total number of neutrons plus protons & the energy of the system during the fission reaction

Task Rubric: Nuclear Processes

Learning Evidence	1 point
Model shows the correct number of neutrons in the nucleus before nuclear decay happens.	
Model shows how nuclear decay happens including changes in numbers of protons and neutrons & flow of energy including gamma radiation.	
Model correctly identifies the type of decay shown in (alpha or beta).	
Model accurately shows a fusion process that could produce the element.	
Accurate description of what happens to the total number of neutrons plus protons & the energy of the system during the fusion reaction.	
Model accurately shows a nuclear fission reaction that could happen to your element.	
Accurate description of what happens to the total number of neutrons plus protons & the energy of the system during the fission reaction.	
Total	/7

Test: Nuclear Processes **Name:** **Period:**

1. The diagram below shows radon changing into radium and helium. What is the total mass of the products?



(A) 4

(B) 218

(C) 222

(D) 226

2. What type of radioactive decay does not emit either protons or electrons?

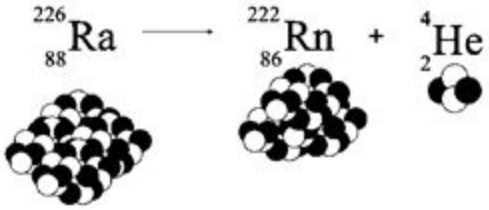
(A) alpha

(B) beta

(C) gamma

(D) delta

3. The diagram shows radioactive decay of radon. What happens to energy in this reaction?



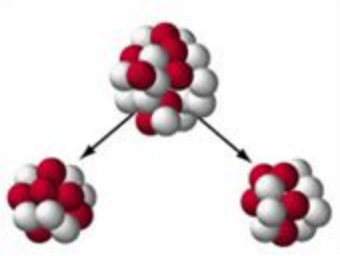
(A) Large amounts of energy are released by this nuclear reaction.

(B) Nuclear energy is transformed into chemical energy.

(C) No energy is absorbed or released by this reaction.

(D) Energy is absorbed by this reaction.

4. What process does this image represent?



(A) Radioactive decay because neutrons are separating from an atom.

(B) Fusion because an atom separates to make two atoms.

(C) Fusion because two atoms combine to become a larger atom.

(D) Fission because an atom separates to make two smaller particles.

5. An atom of which element is modeled in the diagram below?

The model uses + for protons and 0 for neutrons.

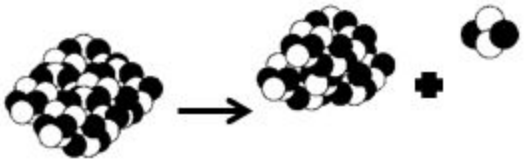
(A) lithium

(B) nitrogen

(C) carbon

(D) boron

6. The type of radioactive decay shown in the diagram emits a helium atom. What type of radioactive decay is this?



(A) gamma

(B) beta

(C) alpha

(D) epsilon

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UNIT 3:
LIFE CYCLE OF STARS

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Unit 3: Life Cycle of Stars

Standards:

HS-ESS1-1: Develop a model based on evidence to illustrate the life span of the sun and the role of nuclear fusion in the sun's core to release energy that eventually reaches Earth in the form of radiation.
HS-ESS1-3: Communicate scientific ideas about the way stars, over their life cycle, produce elements.

Model:

Question: How does the sun work?

Model the life cycle of a Human:
Model the life cycle of a Star:
After watching the video of the sun, describe which part of your model demonstrates where the sun is in the cycle.

Learning Objective:

I can communicate my existing ideas about life cycles of stars.

Engage:

1. POGIL: Life Cycles of Stars
2. Life Cycles of Stars Notes

Learning Objectives:

I can draw and label a diagram that shows five stages of the life cycle for three types of stars.
I can compare the life spans of five types of stars.
I can describe how the core temperature of a star changes over its life cycle

Explore:

1. POGIL: How the matter of the universe is created in stars
2. How the matter of the universe is created in stars Notes

Learning Objectives:

I can describe the basic process of fusion that occurs in a star to create new types of atoms.
I can describe the relationship between the stage of a star's life cycle and the types of elements produced at that stage, based on evidence from analyzing a star life cycle diagram and basic data table.
I can describe how the mass of a star affects the masses of elements produced over the entire lifespan of low-to-average mass stars, large mass stars, and very large mass stars.

Explain:

1. cK-12 Star Life Cycles
2. cK-12 Star Power
3. The Elements: Forged in Stars Video
4. Kesler Stations: Life Cycle of a Star

Learning Objectives:

I can describe the life cycle of stars, including stages & different forms of star death.
I can explain how the process of nuclear fusion creates heavy elements inside of stars.

Extend/Elaborate:

Revisit Model

Add the following to your model:

- Fusion of hydrogen
- Main sequence
- Nebula
- Red giant
- Average mass star
- Fusion of elements up to #26 (Fe)
- White dwarf
- Planetary nebula

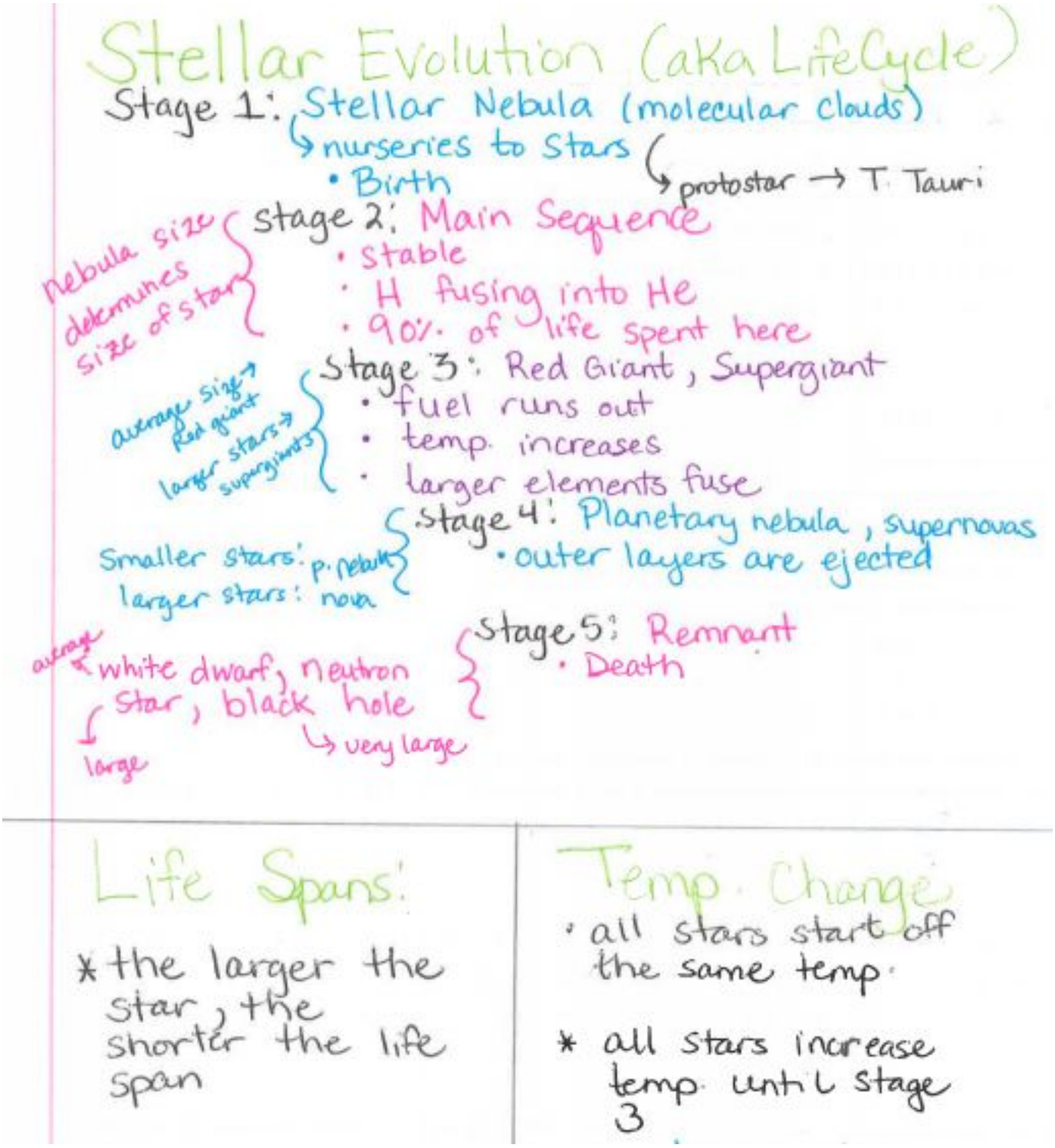
Learning Objective:

I can revise a model to add detail about the life cycle of stars.

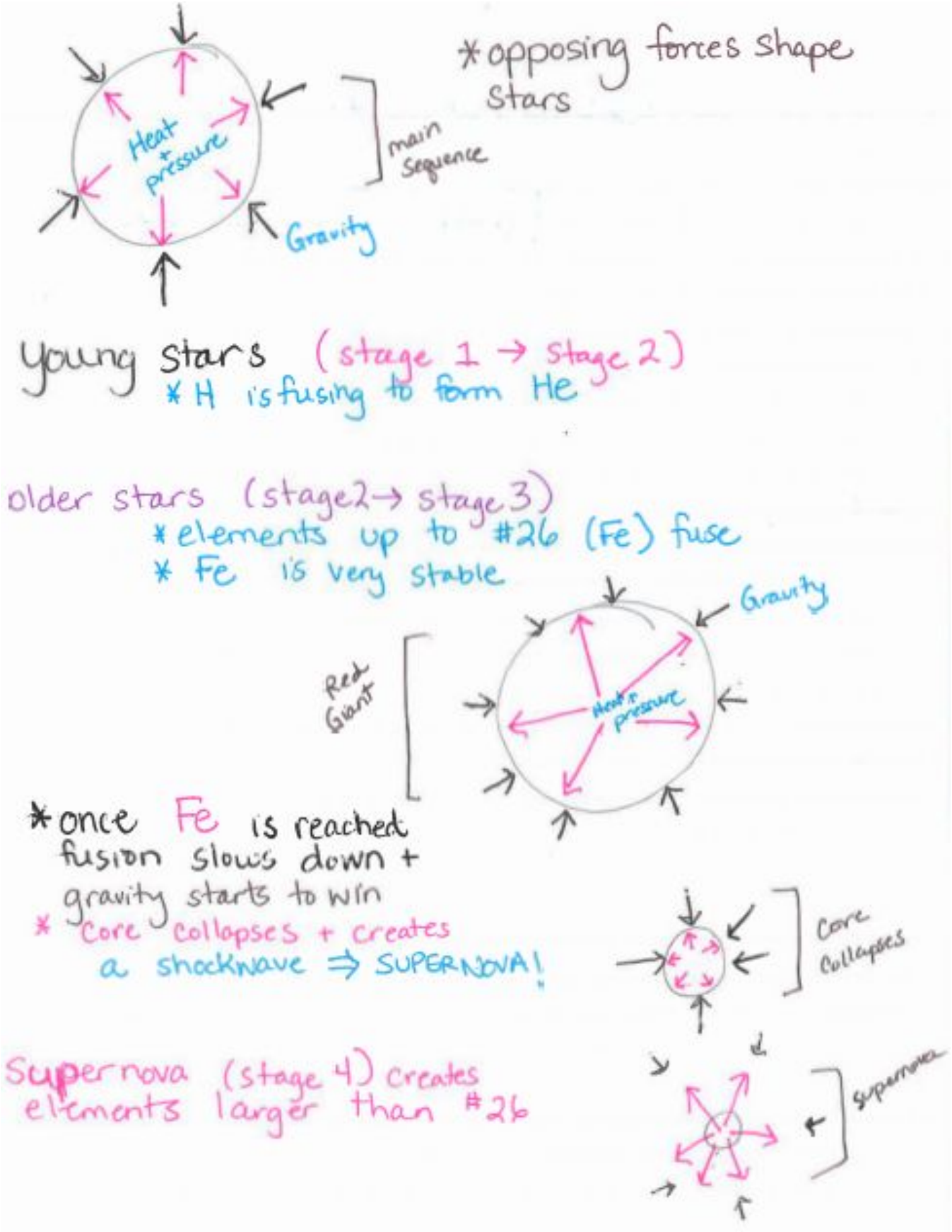
Evaluate:

1. Task
2. Test

Life Cycles of Stars Notes



How the matter of the universe is created in stars Notes



Task: Life Cycle of Stars

Part 1: Modeling fusion in the Sun

Create a model of the sun to illustrate the following:

1. Life span of the sun.
2. What determines the life span of the sun.
3. The role of nuclear fusion in the sun's core to release energy
4. How energy is transferred from the sun to Earth in the form of radiation.

Part 2: Explaining origin of elements

1. Write a paragraph that explains the relationship between the life cycle of the stars, the production of elements, and the conservation of the number of protons plus neutrons in stars.
2. Write a paragraph that describes which elements are formed by which processes (Big Bang, fusion in star cores, death of stars).

Part 3: Explaining origin of your element

1. Using the format of your choice, describe the process that formed your chosen element.
    - If formed in the core of a star, identify the star's mass and stage of development.
    - If formed during the death of a star, identify the type & size of the star and the process of its death.

Task Rubric: Life Cycle of Stars

Learning Evidence	1 point
Model identifies the sun's fuel.	
Model shows the products of the fusion processes in the sun.	
Model indicates the approximate life span of the sun and the reason for that life span	
Model shows how energy released by the sun reaches earth	
Explains the relationships between the life cycle of the stars, the production of elements, and the conservation of the number of protons plus neutrons in stars.	
Describes which elements are formed from high-energy collisions of protons and neutrons during the Big Bang/ early universe before any stars existed.	
Describes which elements are formed by fusion in star cores.	
Describes which elements are formed by star death.	
Describes the process which formed the chosen element. • If formed in a star, identify the star's mass and stage of development. • If formed during the death of a star, identify the type & size of the star and the process of its death.	

Test: Life Cycle of Stars **Name:** **Period:**

1. What is the approximate life span of the sun?

   (A) 100 million years

   (B) 10 billion years

   (C) 5 million years

   (D) 100,000 years

2. What happens during nuclear fusion?

   (A) Chemical bonds are broken, forming new compounds and releasing energy.

   (B) Atoms disintegrate completely, forming individual atomic particles and releasing energy.

   (C) Atoms combine, forming heavier elements and releasing energy.

   (D) Large atoms split, forming lighter elements and releasing energy.

3. The energy released from fusion reactions in the core of a star should cause the star to explode. What prevents a star from exploding?

   (A) Gravitational force

   (B) Electromagnetic force

   (C) Weak nuclear force

   (D) Strong nuclear force

4. Which process forms elements heavier than iron?

   (A) Death of a star

   (B) Fusion in star cores

   (C) Cosmic ray interaction

   (D) The Big Bang

5. What happens during nuclear fusion?

(A) The total number of atoms remains the same.

(B) The total number of neutrons and protons remains the same.

(C) The total number of neutrons and protons increases.

(D) The total number of neutrons and protons decreases

6. Which element below is formed by fusion in star cores?

(A) Hydrogen

(B) Gold

(C) Helium

(D) Uranium

7. What do all stars begin as?

(A) Nebula

(B) White Dwarf

(C) Red Giant

(D) Supernova

8. How is the energy that warms the surface of Earth and powers life on Earth transferred from the sun?

(A) Heat energy from combustion reactions in the sun is conducted through space to Earth.

(B) Atoms of hydrogen and helium from the core of the sun are transported to Earth by solar winds.

(C) Electromagnetic radiation released from fusion reactions carries energy from the sun to Earth.

(D) Kinetic energy of atoms is carried from the core of the sun to Earth's atmosphere by convection.

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UNIT 4:
BONDING AND BOND ENERGY

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Unit 4: Bonding and Bond Energy

Standards:

HS-PS1-2: Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.

HS-PS1-4: Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy.

Model:

Question: How does a chainsaw/engine work?

Materials:
Gas powered chainsaw

Procedure:
Take students outside to watch the starting of a chainsaw.

Learning Objective:

I can describe how a steam engine works.

Engage:

Kesler Stations: Chemical Bonds

Learning Objectives:

I can describe how elements form bonds.
I can investigate how valence electrons relate to chemical bonds.
I can differentiate between ionic and covalent bonding.

Explore:

Bond Energy

Learning Objectives:

I can determine which fuel causes the steam powered boat to travel the greatest distance.
I can illustrate that the release or absorption of energy from a chemical reaction system depends on the changes in total bond energy.
I can describe the relationship between chemical bonds and energy.

Explain:

1. ck-12 Molecular Formula

2. ck-12 Electron Dot Diagrams
3. ck-12 Octet Rule

Learning Objective:

I can explain the outcome of a simple chemical reaction based on the outermost electron states of atoms.

4. ck-12 Ionic Bond
5. ck-12 Covalent Bond

Learning Objective:

I can identify the numbers and types of bonds in products and reactant.

6. ck-12 Combustion Reaction

Learning Objective:

I can discuss how patterns of attraction allow the prediction of the type of reaction that occurs.

7. ck-12 Bond Energy
8. Bond Energy Notes
9. ck-12 Potential Energy Diagrams
10. ck-12 Endothermic Reactions
11. ck-12 Exothermic Reactions

Learning Objectives:

I can explain that the release or absorption of energy from a chemical reaction system depends on the changes in total bond energy.
I can identify/ speculate what type of bond (single, double, triple) is present in the fuel burned based on the info in the bond energy table.

Extend/Elaborate:

Revisit Model

Make adjustments and add detail.

Include the following:

- endothermic
- exothermic
- bonding
- activation energy

Learning Objective:

I can revise a model based on evidence to illustrate or predict relationships between components of a system.

Evaluate:

1. Task
2. Test

Chainsaw Model

Explain how you think a chainsaw/engine works.

Draw a model of the chainsaw *system*.
A *system* is a group of related parts that make up a whole and can carry out functions its individual parts cannot.
Your model should include:

- The main parts of the chainsaw system (include only big, general parts, not detailed mechanical parts)
- The inputs and outputs of **matter** (What kind of matter goes into the system & what kinds come out?)
- The inputs and outputs of **energy** (What form of energy goes into the system & what forms come out?)
- An explanation of where and how any transformations of matter or energy are happening

Research "Greenhouse Gases":
What is a greenhouse gas?

List three examples of greenhouse gasses.

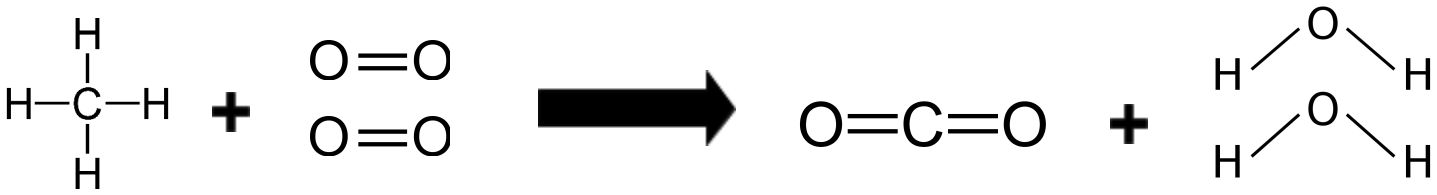
Describe one example of how a greenhouse gas is produced by human activity

Bond Energy

What fuel makes the boat go farthest?

Model 1: Energy of bonds in a reaction system

In Model 1 natural gas (methane) is burned by combining methane (CH_4) with oxygen (O_2) and lighting the flame. This results in the production of carbon dioxide (CO_2) and water (H_2O).



Reactants **Products**

KEY:

— = single bond

= = double bond

1. What do the symbols H, C, and O stand for?

2. What does one line stand for?

3. What do the two lines between the oxygen and carbon represent?

4. What are the chemical formulas for the reactants?

5. What are the chemical formulas for the products?

6. Based on Model 1, describe how the bonds around the carbon atom change from reactants to products.

Read This:

During chemical reactions electrons move around and bonds change. For a chemical reaction to occur some bonds must be broken and other bonds must be formed. An input of energy to the system is always required to break a bond. That is why methane must be lit with a match to start the flame burning.

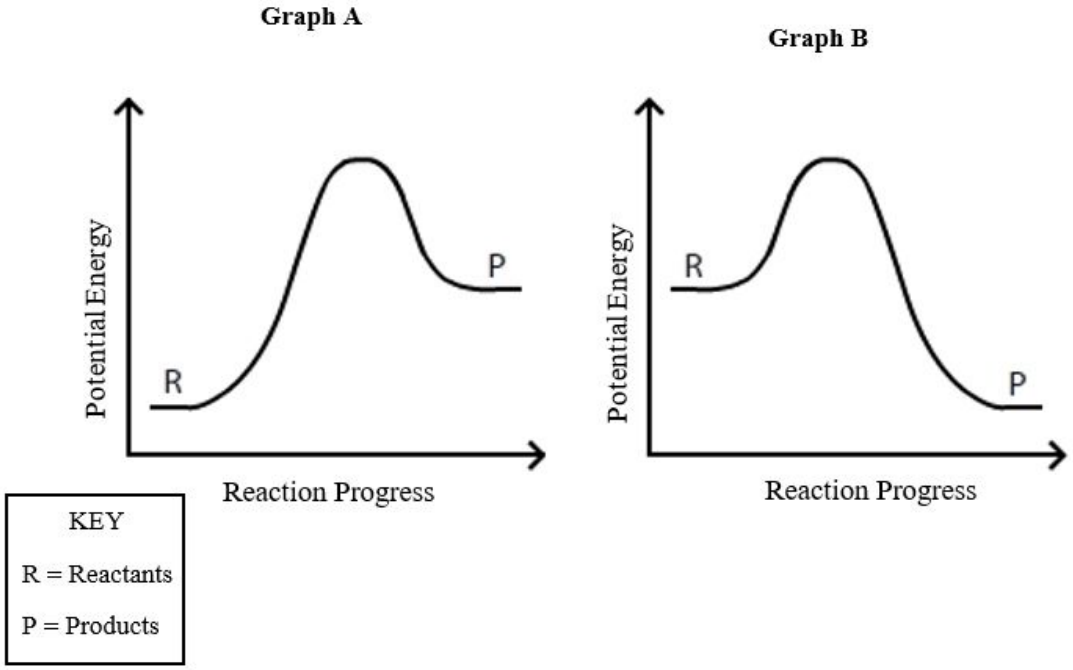
As bonds are formed to make the products energy is released.

7. Identify which bonds are broken in the reaction in Model 1.

8. Identify which bonds are formed in the reaction in Model 1.

9. Describe where the energy will go when the bonds are formed to make the products.

Model 2: Graphs of energy moving in a reaction system



10. What does the x-axis on the graphs in Model 2 represent?

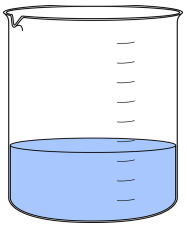
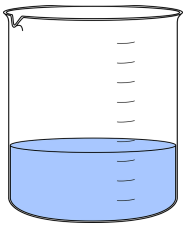
11. What does the y-axis on the graphs in Model 2 represent?

12. On Model 2, for both graphs, label where chemical bonds are **broken**.
13. On Model 2, for both graphs, label where chemical bonds are **formed**.
14. Explain why both graphs have a "bump" in energy rather than just a steady increase or decrease.

15. In which graph, A or B, is more potential energy found in the products?

16. In which graph, A or B, is more potential energy found in the reactants?

Model 3: Diagrams of energy moving in a reaction system

Beaker with Reaction System A	**Beaker with Reaction System B**
	

17. The reaction systems represented by **Graph A** and **Graph B** are shown in the beaker diagrams above. Draw an arrow labeled "energy" on each diagram to show whether energy leaves the beaker and enters the surroundings or vice versa.

Conclusions

18. In System A, is the total energy of the system and surroundings the same before and after the reaction? Explain your answer.

19. Explain which of the graphs in Model 2 represents a chemical reaction that would provide energy to power the steam boat.

Investigation: Steam Boat

Objective: Determine which fuel causes the steam powered boat to travel the greatest distance.

Safety:

- Safety goggles must be worn.
- Exhaust pipes must be completely filled with water and the boat must be placed into the container (while keeping the water in the engine and exhaust pipes) before lighting any fuel. Failure to keep the system full of water will cause permanent damage to the boat engine.

Materials:

- Steam powered boat
- Lighter
- Fuel holder
- Container
- Fuel source you select

Procedure:

1. Choose a fuel that you think will power the boat for the longest distance around a circular container.
2. Measure the mass the fuel holder and your chosen solid fuel. No nut products.
3. Set up the boat in the container as demonstrated by your teacher.
4. Line the boat up at the starting point on the container. Ignite your fuel.
5. Count the number of laps that your boat completes. Include the total number of laps and any completed quarters (as marked on the container).
6. Measure the mass of fuel holder and fuel after running boat.
7. Record the number of laps your boat completed on the your group data table for trial 1.
8. Repeat steps 4-7 two more times for trials 2 & 3.
9. Calculate the average number of laps for the three trials and record the average on the class data table provided by your teacher.
10. Clean up all materials.

Data Table:

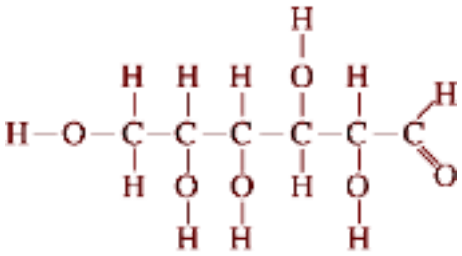
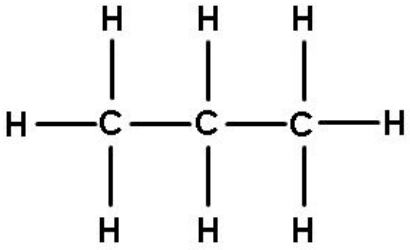
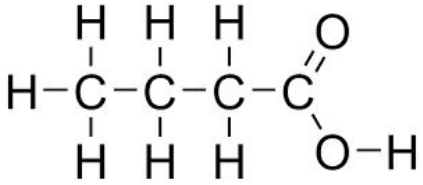
	Trial 1	**Trial 2**	**Trial 3**	
Mass of fuel & holder **before** burning				
Number of laps				
Mass of fuel and holder **after** burning				
Mass of fuel burned				**Average Laps/gram**
$\frac{\text{Laps}}{\text{grams fuel}}$				

Analysis:

1. Refer to class data to answer the following question:

a. Which fuel caused the steam powered boat to travel the greatest distance? Support your answer.

2. Using Model 1 as a reference, create a model showing the combustion reaction of your fuel.

Carbohydrate	Hydrocarbon	Lipid
		

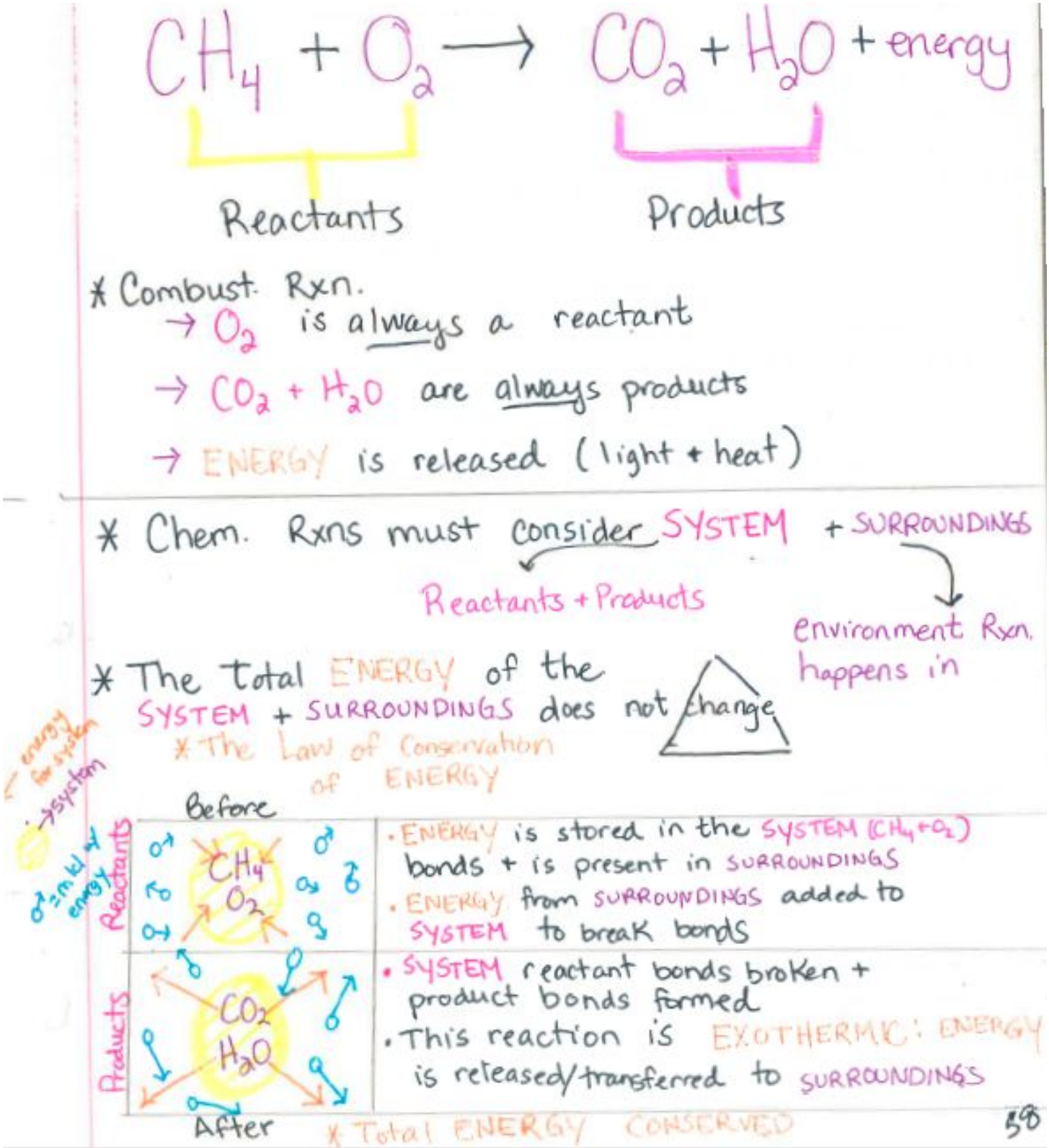
Draw your chemical reaction here:

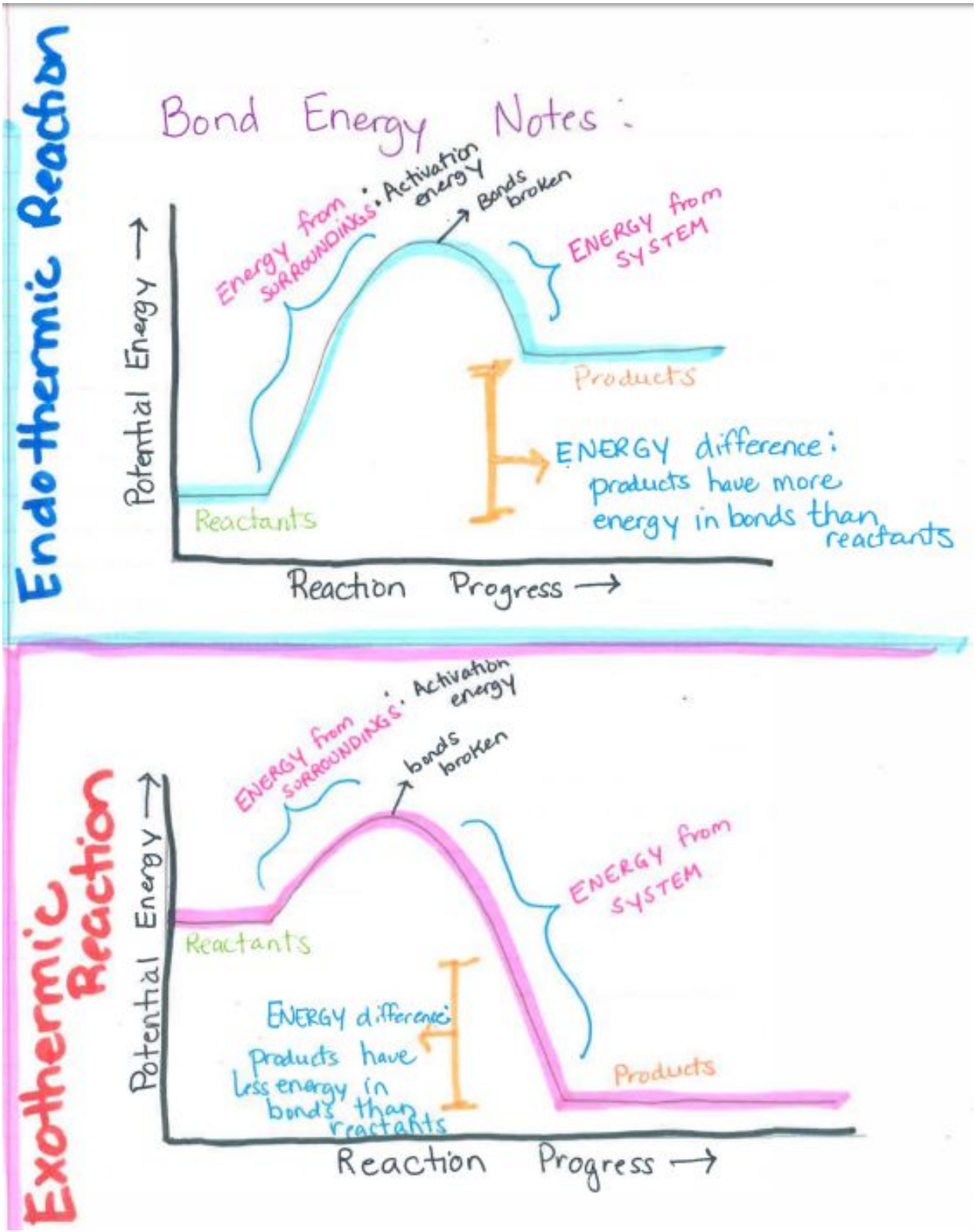
a. Copy the reaction from Model 1 in the space above, but replace the methane (CH_4) molecule with the molecule from the table at the top that matches your fuel type.
b. Draw the correct number of each reactant and product to show that atoms are conserved in the reaction.
c. Label the **reactants** and **products** in the reaction.
c. Identify which bonds are **broken** in the reaction.
d. Identify which bonds are **formed** in the reaction.

3. Use Model 2 as a guide to complete the following:
    a. Sketch an energy graph for a combustion reaction.
    b. Draw a line representing the energy change for the fuel that traveled the greatest distance.
    c. On the same graph, in a different color, include a line for the fuel that traveled the least distance.
    d. For both lines, include labels for the type of fuel, the reactants, and the products.

4. Use questions 17 and 18 as a guide to complete the following:
    a. Create a model showing the energy transfer between the system and surroundings for your boat during the combustion of your fuel.

Bond Energy Notes




Endothermic Reaction
Bond Energy Notes:
Energy from SURROUNDINGS: Activation energy
Bonds broken
ENERGY from SYSTEM
Potential Energy →
Products
Reactants
ENERGY difference: products have more energy in bonds than reactants
Reaction Progress →
Exothermic Reaction
ENERGY from SURROUNDINGS: Activation energy
bonds broken
ENERGY from SYSTEM
Potential Energy →
Reactants
ENERGY difference: Products have Less energy in bonds than reactants
Products
Reaction Progress →

Task: Bonding and Bond Energy

Technical Manual Chapter 1 - Bonding & Bond Energy

For this task you will write the first chapter of the **Operator's Manual** for the Steam-Powered Boat that your team will construct. You don't have to have a design for your heat engine picked out yet, but you do need to pick a fuel that you will burn.

Step 1. Choose a fuel
Select a fuel from the following list:

Carbohydrates	**Hydrocarbons**	**Lipids**
❑ Potato chips	❑ Petroleum jelly	❑ Butter
❑ Wood/paper	❑ Candle wax	❑ Vegetable oil

This first chapter of your manual will explain how the concepts of chemical bonding and bond energy play a role in the operation of a heat engine burning the fuel you have chosen.

This chapter will contain three parts. Each part is described in detail on the following pages.

Part 1: Explanation of the chemical reaction when burning your fuel

For the chemical reaction of your group's chosen fuel, construct an explanation of the burning of the fuel that:

Includes complete chemical equation including correct chemical formulas for products and reactants				
0 - Inadequate	1 - Below	2 - Approaching	3 - Meets	4 - Exceeds
Chemical equation is missing	All chemical formulas are incorrect OR Chemical Equation does not have carbon dioxide	One or more chemical formulas are incorrect. AND One or more reactants or products is in wrong location or missing	One chemical formula is incorrect OR Reactant or product is in wrong location or missing	All requirements are present
Identifies the types of bonds (ionic or covalent) found in each reactant and product				
0 - Inadequate	1 - Below	2 - Approaching	3 - Meets	4 - Exceeds
Did not identify any type of bonds.	All types of bonds identified are incorrect.	Two or more of the bond types are incorrect or missing.	One of the bond types is incorrect or missing.	All bond types are identified correctly.
Explains how the type of bond in each reactant and product is determined based on the numbers of valence electrons and positions on the periodic table.				
0 - Inadequate	1 - Below	2 - Approaching	3 - Meets	4 - Exceeds
Explanation is missing	Explanation not mention anything about valence electrons or position on the periodic table	Explanation has two or more errors in the number of valence electrons or the position on the periodic table	Explanation has one error in the number of valence electrons or the position on the periodic table	Explanation given is correct for all reactants and products

Part 2: Graph of Chemical Reaction Energy

For the chemical reaction of burning your group's chosen fuel, make a graph of the energy of the system as the reaction proceeds.

Critical elements for your graph

- ❑ Horizontal axis labeled correctly
- ❑ Vertical axis labeled correctly
- ❑ Label(s) for energy transfer(s) into and/or out of the system
- ❑ Reactants placed correctly on graph
- ❑ Products placed correctly on the graph
- ❑ Description of the bonds that are breaking during the reaction
- ❑ Description of the bonds that are forming during the reaction.

Make a graph of the energy of the system as the reaction proceeds.				
0 - Inadequate	2 - Below	4 - Approaching	6 - Meets	8 - Exceeds
Graph is missing	Four or more critical elements are incorrect or missing	Two or three of the listed critical requirements are incorrect or missing	One of the listed critical elements is incorrect or missing:	All critical elements are present and correct.

Part 3: Energy of the system

For the chemical reaction of burning your group's chosen fuel:

1. Make two sketches comparing the motion of molecules of the system and surroundings before and after the reaction.
    a. Sketch 1: reactants and the surroundings before the reaction
    b. Sketch 2: products and the surroundings after the reaction
2. Describe the total energy of the system and its surroundings before and after the reaction.

Sketch 1 : Before the reaction				
0 - Inadequate	1 - Below	2 - Approaching	3 - Meets	4 - Exceeds
Sketch is missing	A sketch is present but is missing a majority of the requirements	Missing reactant molecule AND Missing energy or surroundings	Missing reactant molecule Or Missing energy Or Missing surroundings	Shows motion of reactant molecules and the system Describes the total energy of the system and surroundings

Sketch 2 : After the reaction				
0 - Inadequate	1 - Below	2 - Approaching	3 - Meets	4 - Exceeds
Sketch is missing	A sketch is present but is missing a majority of the requirements	Missing product molecule AND Missing energy or surroundings	Missing product molecule Or Missing energy Or Missing surroundings	Shows motion of product molecules and the system Describes the total energy of the system and surroundings

Test: Bonding and Bond Energy **Name:** **Period:**

1. Based on the valence electrons, which of the following elements would likely form an ionic bond with bromine?

   (A) Oxygen

   (B) Calcium

   (C) Phosphorus

   (D) Argon

2. What are the reactants in the chemical equation: $NaCl + AgNO_3 \rightarrow AgCl + NaNO_3$

   (A) AgCl and $NaNO_3$

   (B) NaCl and AgCl

   (C) $AgNO_3$ and $NaNO_3$

   (D) NaCl and $AgNO_3$

3. Which bond(s) is/are formed in the following reaction? Select all that apply. $Na_2S + HCl \rightarrow NaCl + H_2S$

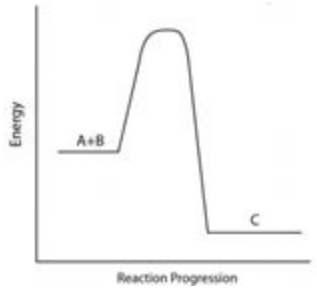
   (A) H —Cl

   (B) H—S

   (C) Na—S

   (D) Na—Cl

4. What happens to the energy of the system over the course of the chemical reaction shown in the energy graph?



   (A) energy enters the system

   (B) energy remains the same

   (C) energy leaves the surroundings

(D) energy leaves the system

5. Which bond(s) is/are broken in the following reaction? Select all that apply. $H_2 + Cl_2 \rightarrow HCl$

   (A) H—H

   (B) H—Cl

   (C) Cl—Cl

   (D) No bonds are broken

6. Which of the following compounds are held together by covalent bonds?

   (A) CO

   (B) Na_3N

   (C) LiF

   (D) $MgCl_2$

7. In a hydrocarbon combustion reaction, energy is released into the surroundings. What happens to the movement of the molecules surrounding the reaction?

   (A) The molecules surrounding the reaction will slow down

   (B) The molecules surrounding the reaction will move faster

   (C) The molecules surrounding the reaction will split apart

   (D) The molecules surrounding the reaction will join together

8. What type of bond would calcium and chlorine make?

   (A) metallic

   (B) hydrogen

   (C) covalent

   (D) ionic

9. Which of the following compounds is held together by ionic bonds?

   (A) SO_2

   (B) $MgCl_2$

   (C) CH_4

   (D) NH_3

10. Based on the valence electrons, which of the following elements would likely form a covalent bond with bromine?

    (A) Argon

    (B) Nickel

    (C) Oxygen

    (D) Calcium

11. Which of the following is required to break bonds?

    (A) the addition of a catalyst

    (B) the combustion of a molecule

    (C) the input of energy from the surroundings

    (D) the release of energy to the system and surroundings

12. What are the products in the chemical equation: $NaCl + AgNO_3 \rightarrow AgCl + NaNO_3$

    (A) NaCl and AgCl

    (B) $AgNO_3$ and $NaNO_3$

    (C) NaCl and $AgNO_3$

    (D) AgCl and $NaNO_3$

13. What type of bond would nitrogen and oxygen make?

    (A) metallic

    (B) covalent

    (C) ionic

    (D) hydrogen

14. What happens to the overall energy of the system and surroundings during a chemical reaction?

    (A) decreases

    (B) increases

    (C) stays the same

OAK HARBOR PUBLIC SCHOOLS

UNIT 5:
MASS CONVERSION

Return to Table of Contents

Unit 5: Mass Conservation

Standard:

HS-PS1-8: Develop models to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay. (fission, fusion, radioactive decay)

Model:

Question: What happens to a piece of flash paper when it burns?

Materials:

- Flash paper
- Electronic balance
- Watch glass

Procedure:

Place watch glass on electronic balance
Tare balance with watch glass
Add flash paper to watch glass
Students observe mass of paper
Light the paper on fire
Complete drawing and questions on the worksheet

Learning Objective:

I can communicate my existing ideas about conservation of mass.

Engage:

ADI Physical Science Lab 4: Conservation of Mass including Investigation Proposal C

Learning Objective:

I can design an investigation to determine if mass is conserved in a chemical reaction.

Explore:

1. Kesler Stations: Balancing Chemical Equations
2. POGIL Relative Mass and the Mole
3. POGIL Mole Ratios

Learning Objectives:

I can recognize whether a chemical equation is balanced or not.
I can relate balanced equation the law of conservation of mass.
I can use the mole to convert from atoms to grams.
I can calculate the mass of any component of a reaction, given any other component.
I can relate balanced equation the law of conservation of mass.

Explain:

1. cK-12 Chemical Equations
2. cK-12 Balancing Equations
3. cK-12 Molar Mass
4. cK-12 Avogadro's Number
5. cK-12 Conversions Between Moles and Atoms
6. cK-12 Conversions Between Moles and Mass
7. cK-12 Conversions Between Mass and Number of Particles
8. cK-12 Mole Ratios
9. cK-12 Mass-Mole and Mole-Mass Stoichiometry
10. cK-12 Mass-Mass Stoichiometry
11. Law of Conservation of Matter Notes
12. Balancing Equations Notes
13. Conversion Notes
14. Balancing and Mole Graphic Organizer Review
15. Stoichiometry Notes

Learning Objectives:

I can recognize whether a chemical equation is balanced or not.
I can relate balanced equation the law of conservation of mass.
I can use the mole to convert from atoms to grams.
I can calculate the mass of any component of a reaction, given any other component.
I can relate balanced equation the law of conservation of mass.

Extend/Elaborate:

1. Bottle Rocket Investigation

   Materials:
   - Piezo electric bottle launcher system
   - Uniform size and shape plastic beverage bottles
   - Hydrogen tank or source of hydrogen
   - Large sink

   Procedure
   Students predict what ratio of hydrogen to air will move the rocket farthest along the floor.

Show students how to collect air by displacement of water from a bottle.
Students develop an investigation to determine to test their prediction.

2. ADI Chemistry Lab 14: Molar Relationships

   Student Challenge: What are the Identities of the Unknown Compounds?

   Learning Objective:

   I can identify unknown substances using molar masses.

3. Revisit Model

   Include the following:
   - Conservation of matter
   - Conservation of mass

   Learning Objective:

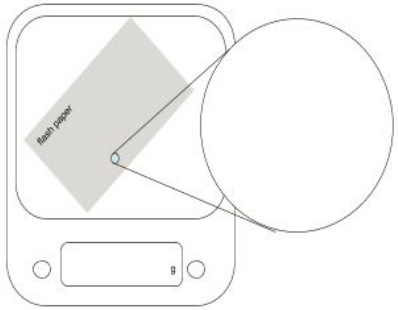
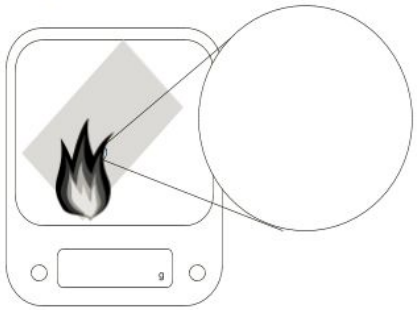
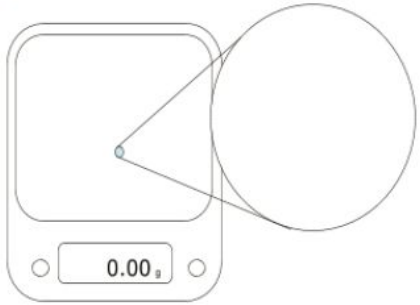
   I can revise a model to add detail about conservation of mass in chemical reactions.

Evaluate:

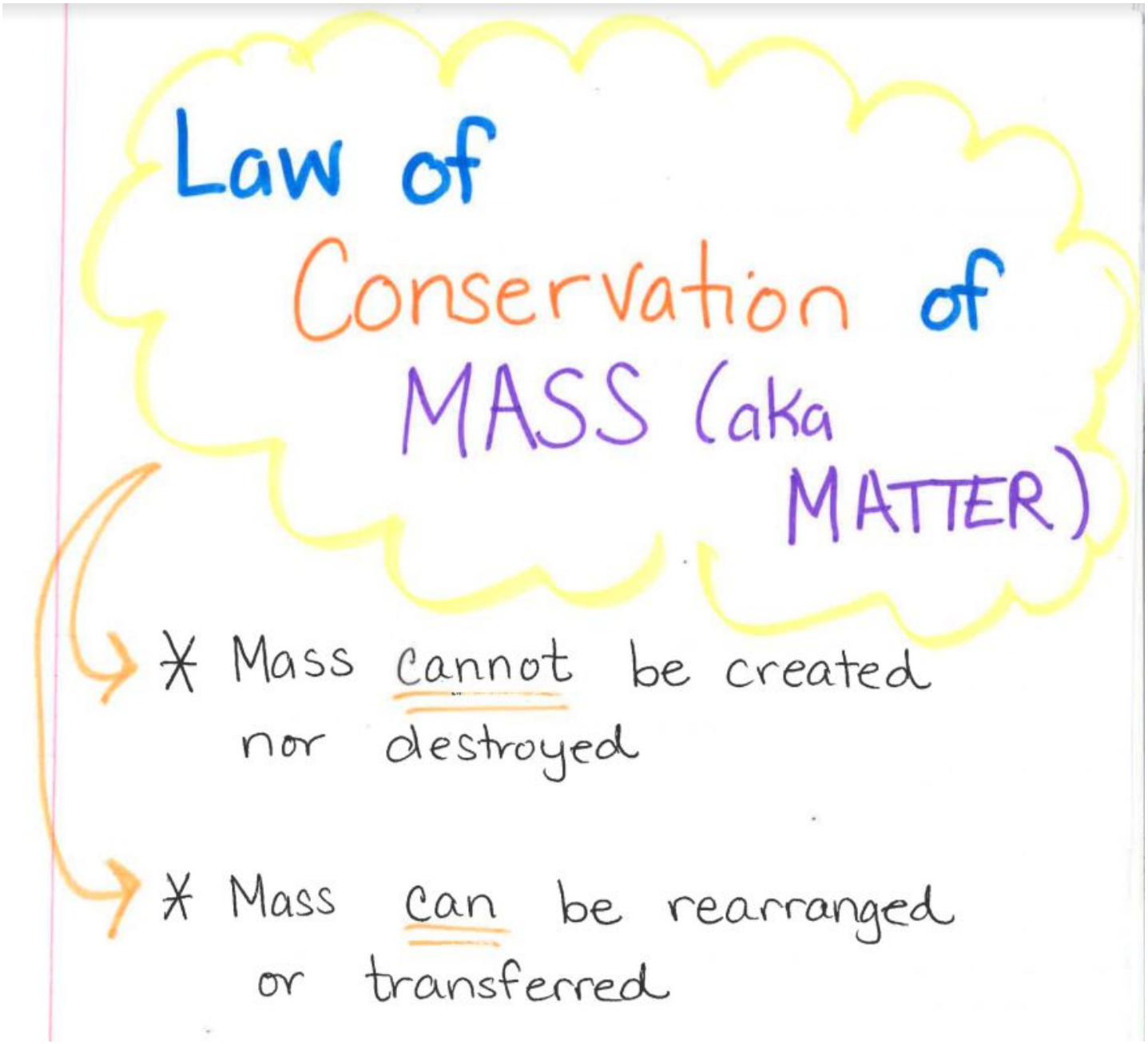
1. Task Task Answers
2. Test

Name:_____ Partner's Name:_____ Period:_____

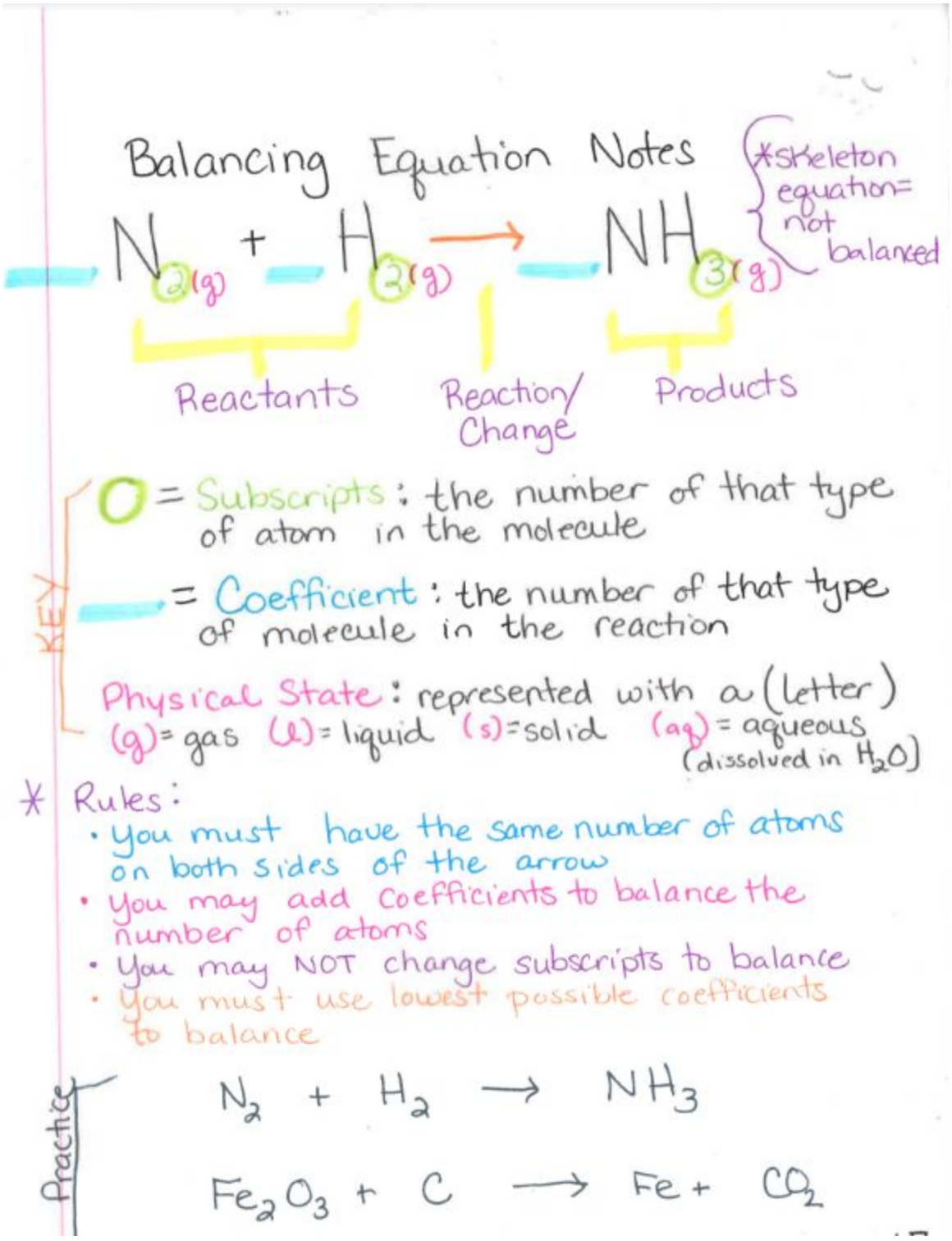
What happens to a piece of flash paper when it burns?

For each picture in the sequence, fill in the numbers on the scale. In the zoom-in views, draw what you would see on the molecular level.		
Before 	During 	After 
Explain what the reading on the scale indicates about the paper? Explain how your zoom-in drawing is related to the mass of the paper shown on the scale.	Explain any changes in the mass of the paper. Explain how your drawing is related to any changes of mass shown on the scale.	Explain why the number on the scale is now zero. Explain how your zoom-in drawing provides evidence that mass was conserved.

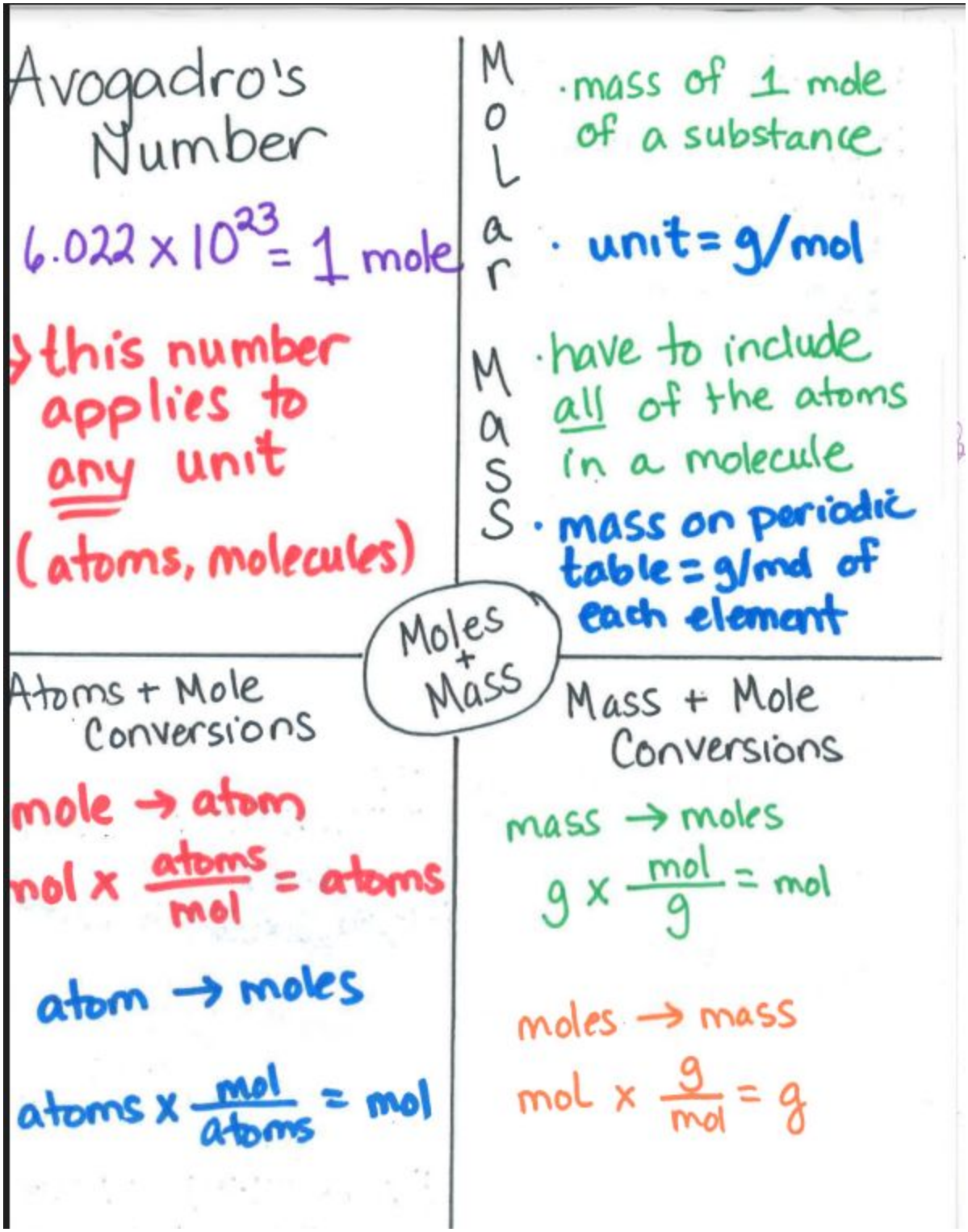
Law of Conservation of Matter Notes



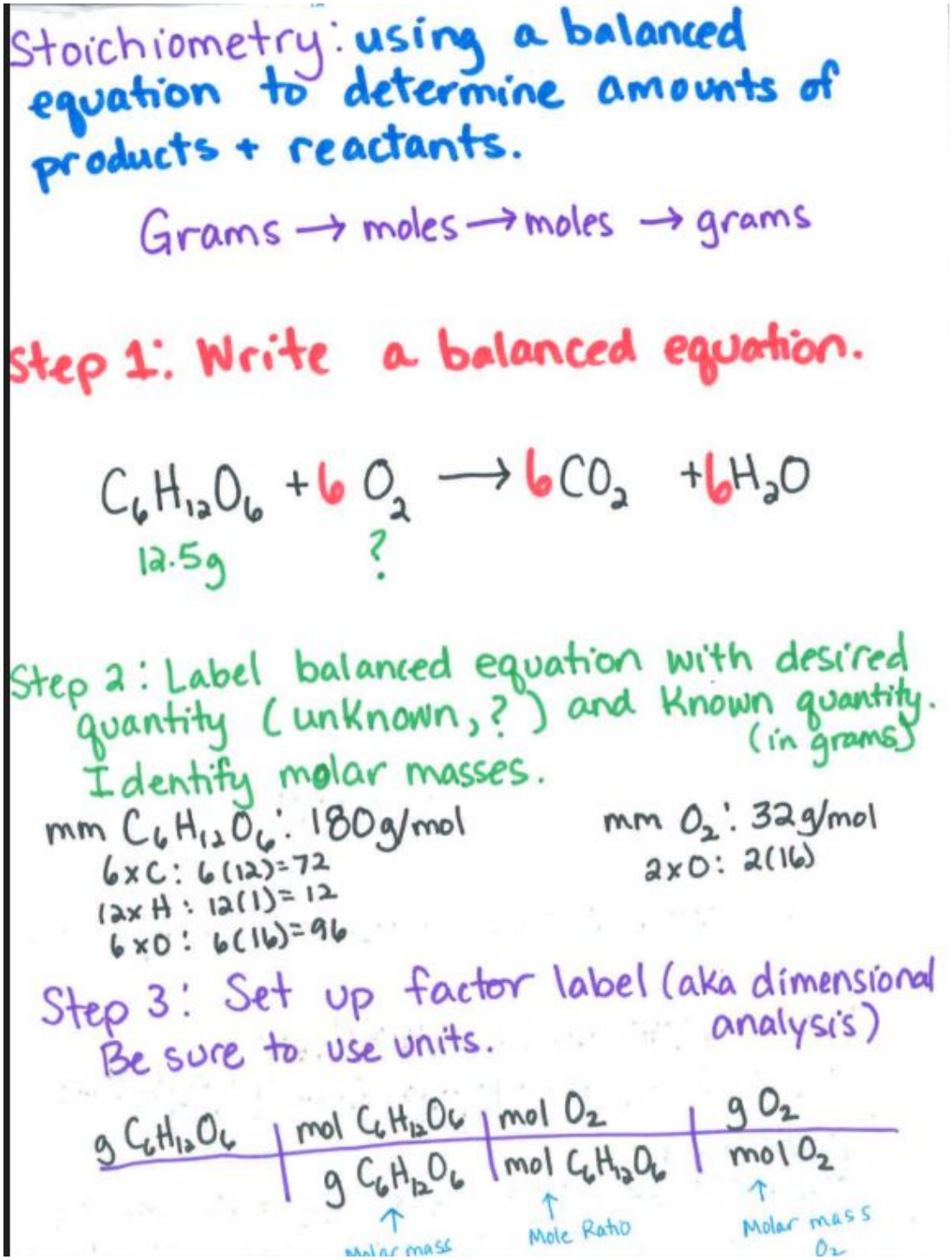
Balancing Equations Notes



Conversion Notes



Stoichiometry Notes



Balancing and Mole Graphic Organizer and Review

What is the law of Conservation of Matter?

What is Avogadro's number and what does it represent?

How are atomic mass and Avogadro's number related?

Balance the Equation: $C_3H_8 + O_2 \rightarrow CO_2 + H_2O$

Balance the Equation: $HSiCl_3 + H_2O \rightarrow H_{10}Si_{10}O_{15} + HCl$

Balance the Equation: $C_7H_9 + HNO_3 \rightarrow C_7H_6(NO_2)_3 + H_2O$

Fix the Balancing: $2C_2H_6 + 3O_2 \rightarrow 4CO_2 + 6H_2O$

How many atoms of Platinum are in 20.0g Pt?

How many grams are equal to 5.44×10^{25} atoms of Cobalt?

Bottle Rocket Investigation

Question: How does the ratio of H_2 to O_2 affect the distance a bottle rocket travels?

Hypothesis:

Materials:

Procedure:

1.

Data:

Distance Traveled (in m) versus Ratio of Hydrogen:Oxygen

Ratio	Trial 1 (m)	Trial 2 (m)	Trial 3 (m)	Average (m)

Conclusion:

Bottle Rocket Lab Report Rubric

Attribute	Evidence	1 point each
Question	Question includes both manipulated and responding variables to be examined in the investigation.	**NA**
Hypothesis	Must answer the given investigative question including the effect of the manipulated variable on the responding variable and indicate of the effect. (ie. will increase, will decrease)	
	Prediction Reason This part of the hypothesis is a reasonable explanation of the process that produces the change in the responding variable	
Materials	A list of the **required materials** needed to perform the procedure must be listed in this section. (be sure to include instruments needed to measure the responding variable)	**NA**
Procedure	**Controlled Variables** At least two controlled (kept the same) variables must be identified by highlighting in green.	
	Only one manipulated (changed) variable is identified by highlighting in pink.	
	The **responding (dependent) variable** is identified by highlighting in yellow.	
	Record Measurements: How measurements are recorded is identified by highlighting in blue.	
	Repeated trials. Plan for including multiple trials is identified by highlighting in orange.	
	Logical Steps: The steps of the procedure are detailed enough to repeat the procedure effectively. This should be a numbered list. Indicate which steps to repeat as part of the procedure.)	**NA**
Data	A data table for the manipulated and responding variables	**NA**
	The data table shows data for repeated trials	
	The table shows averages calculated from all repeated trials	
Conclusion	A conclusive statement is given—Answer the investigative question. Describe the effect of the Manipulated Variable on the Responding Variable.	

	Data from the data table to prove the conclusive statement is given — quote data from the LOWEST condition tested	
	Data from the data table to prove the conclusive statement is given — quote data from the HIGHEST condition tested	
	Explanatory language is used to connect or compare the supporting data to a correct conclusion—use words like “highest” and “lowest”	
	A scientific explanation for the observed results is given – explain why or how the MV caused the change in the RV.	
	Total	**/14**
	Percentage	

Guiding Question: What are the Identities of the Unknown Compounds?

Bag #1= .125 mol Bag #2= .0500 mol Bag #3= .0100 mol

Your Task

You will be given three sealed bags. Each bag will be filled with a different powder. Your task will be to identify the powder in each bag. The unidentified powders could be any of the following compounds:

- Sodium hydrogen carbonate, $NaHCO_3$
- Sodium carbonate, Na_2CO_3
- Sodium chloride, NaCl

Materials

You may use any of the following materials during your investigation: Sealed plastic bags of unknown compounds, Empty plastic bag, Electronic balance, Periodic table, calculator

Task: Mass Conservation

Technical Manual Unit 5 - Mass Conservation

For this task you will write the second chapter of the **Operator's Manual** for the Steam-Powered Boat that your group will construct. You don't have to have a design for your heat engine picked out yet, but you do need to analyze the combustion reaction that your fuel undergoes in your engine.

This chapter will include three parts described below:

Part 1: Balancing equations and explaining conservation of mass

A. Write a balanced chemical equation for the combustion of the fuel you will use in your steam-powered boat.

0 - Inadequate	1 - Below	2 - Approaching	3 - Meets	4 - Exceeds
Chemical equation is missing	All chemical formulas are incorrect OR Chemical Equation is missing either a product or reactant	One or more chemical formulas are incorrect. AND One or more of products or reactants are not correctly balanced	One chemical formula is incorrect OR One or more of products or reactants are not correctly balanced	All requirements are present

B. Use the numbers of each type of atom in the reactants and products to explain whether mass is conserved during the reaction.

0 - Inadequate	1 - Below	2 - Approaching	3 - Meets	4 - Exceeds
Did not identify if mass is conserved.	Incorrectly identifies if mass is conserved AND Does not support claim using numbers of atoms in products and reactants	Incorrectly identifies if mass is conserved OR Does not support claim using numbers of atoms in products and reactants	Correctly identifies if mass is conserved, but one or more of the atoms is incorrect.	Correctly identifies if mass is conserved and all numbers and types of atoms are correctly identified.

Part 2: Calculating molar mass and mole conversions

A. Determine and list the molar mass of each product and reactant.				
0 - Inadequate	1 - Below	2 - Approaching	3 - Meets	4 - Exceeds
Determination of molar mass is missing	Three of the molar masses are incorrect	Two of the molar masses are incorrect	One of the molar masses is incorrect	All requirements are present and correct
B. Calculate the number of grams of water in ____ moles of water. (Your instructor will give you the number of moles).				
1 - Point - Units	1 - Point -Data	1 - Point - Relationship	1 -Point - Substitution	1 - Point - Solution
Correct units are used throughout the calculation and in the final answer	Identifies all known and unknown variables	**All units are used throughout calculation** **Dimensional analysis**	Substitution of all variables is correct	Final answer is correct
C. Calculate the number of molecules of oxygen present in ____ grams of oxygen. (Your instructor will give you the number of grams).				
1 - Point - Units	1 - Point -Data	1 - Point - Relationship	1 -Point - Substitution	1 - Point - Solution
Correct units are used throughout the calculation and in the final answer	Identifies all known and unknown variables	**All units are used throughout calculation** **Dimensional analysis**	Substitution of all variables is correct	Final answer is correct

Part 3: Applying Stoichiometry

A. Calculate how many grams of carbon dioxide will be produced from ____ grams of your fuel. (Your instructor will give you the number of grams).				
1 - Point - Units	1 - Point -Data	1 - Point - Relationship	1 -Point - Substitution	1 - Point - Solution
Correct units are used throughout the calculation and in the final answer	Identifies all known and unknown variables	**All units are used throughout calculation** **Dimensional analysis**	Substitution of all variables is correct	Final answer is correct

Values and Answers for Task Unit 5

Set	Moles of Water (Part 2B)	Grams of Water		Grams of Oxygen (Part 2C)	Molecules of Oxygen	Grams of Hydrocarbon (C_3H_8) Part 3	Grams of CO_2 produced		Grams of lipid ($C_4H_8O_2$) Part 3	Grams of CO_2 produced		Grams of carbohydrate ($C_6H_{12}O_6$) Part 3	Grams of CO_2 produced
A	0.5	9.01		5	9.41E+22	5	14.97		5	9.99		5	7.33
B	1.5	27.03		10	1.88E+23	10	29.94		10	19.98		10	14.66
C	2	36.04		15	2.82E+23	15	44.91		15	29.97		15	21.99
D	2.5	45.05		20	3.76E+23	20	59.88		20	39.96		20	29.31
E	3	54.06		25	4.70E+23	25	74.85		25	49.95		25	36.64
F	3.5	63.07		30	5.64E+23	30	89.82		30	59.94		30	43.97
G	4	72.08		35	6.58E+23	35	104.79		35	69.93		35	51.30
H	4.5	81.09		40	7.53E+23	40	119.76		40	79.92		40	58.63
I	5	90.1		45	8.47E+23	45	134.72		45	89.91		45	65.96
J	5.5	99.11		50	9.41E+23	50	149.69		50	99.90		50	73.28
K	6	108.12		55	1.03E+24	55	164.66		55	109.89		55	80.61
L	6.5	117.13		60	1.13E+24	60	179.63		60	119.88		60	87.94
M	7	126.14		65	1.22E+24	65	194.60		65	129.87		65	95.27
N	7.5	135.15		70	1.32E+24	70	209.57		70	139.86		70	102.60
O	8	144.16		75	1.41E+24	75	224.54		75	149.85		75	109.93
P	8.5	153.17		80	1.51E+24	80	239.51		80	159.84		80	117.26
Q	9	162.18		85	1.60E+24	85	254.48		85	169.83		85	124.58
R	9.5	171.19		90	1.69E+24	90	269.45		90	179.82		90	131.91
S	10	180.2		95	1.79E+24	95	284.42		95	189.81		95	139.24
T	10.5	189.21		100	1.88E+24	100	299.39		100	199.80		100	146.57

Test: Mass Conservation **Name:** **Period:**

1. What is the law of conservation of matter as it applies to chemical reactions?
    a. The sum of the masses of the products is equal to the sum of the masses of the reactants.
    b. The amount of matter destroyed must equal the amount of matter created.
    c. Mass is conserved during reactions by some elements changing into different elements.
    d. The amount of each atom remains constant but the overall mass of the system may change.

2. What is the meaning of the word "mole" in chemistry? (Check **all** that are correct)

    ☐ Avogadro's number of anything

    ☐ an abbreviation for the word molecule

    ☐ 6.02×10^{23} things

    ☐ a unit of mass in the SI system

    ☐ the number of atoms in 1 gram of any substance

3. What needs to be done to the following equation to make it demonstrate the Law of Conservation of Mass? $CH_4 + O_2 \rightarrow CO_2 + H_2O$

    a. This equation already follows the Law of Conservation of Mass.
    b. Add 2 hydrogen atoms (product) and 1 oxygen atom (reactant).
    c. Add coefficients to some of the compounds to balance the number of atoms.
    d. Remove 2 hydrogen atoms (reactant) and 1 oxygen atom (product).

4. What is the mass of one mole of water (H_2O)?

    a. 3 g/mol
    b. 17 g/mol
    c. 18 g/mol
    d. 16 g/mol

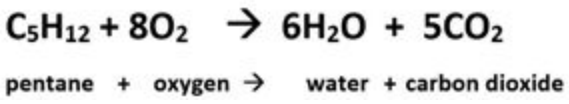
5. How many molecules of carbon dioxide (CO_2) are in one mole of carbon dioxide?

    a. 6.02×10^{23} molecules
    b. 2.3×10^{6} molecules
    c. 44 molecules
    d. 12 molecules
    e. 3 molecules

6. How many molecules are in 6 grams of carbon dioxide (CO_2)?

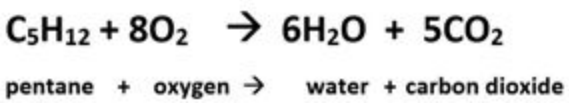
    a. 6.02×10^{23} molecules
    b. 8.2×10^{22} molecules
    c. 44 molecules
    d. 6000 molecules

7. Refer to the diagram below. How many moles of carbon dioxide (CO_2) will be produced from 2 moles of pentane (C_5H_{12})?



    a. 1
    b. 5
    c. 6
    d. 8
    e. 10

8. Refer to the diagram below. How many grams of carbon dioxide (CO_2) will be produced from 100 grams of pentane (C_5H_{12})?



    a. 305 g CO_2
    b. 44 g CO_2
    c. 220 g CO_2
    d. 500 g CO_2

9. Which reaction shows a conservation of mass?

    a. $2KClO_3 \rightarrow 2KCl + 3O_2$
    b. $H_2 + O_2 \rightarrow H_2O$
    c. $Na + H_2O \rightarrow NaOH + H_2$
    d. $Fe + CuSO_4 \rightarrow 2Cu + FeSO_4$

OAK HARBOR PUBLIC SCHOOLS

UNIT 6:
CARBON CYCLING
AND CLIMATE CHANGE

Return to Table of Contents

Unit 6: Carbon Cycling and Climate Change

Standards:

HS-LS2-5: Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere.
HS-ESS2-6: Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.
HS-ESS3-5: Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems.
HS-ESS3-6: Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity

Model:

Question: Why is the sea ice melting so quickly?

Procedure:

Show the following video once through before passing out the model and replay it while students have the model in front of them.

Learning Objective:

I can communicate my existing ideas about effects of increasing CO_2 levels.

Engage:

Investigating Carbon Dioxide Activity

Materials:

- Dry ice
- Beral pipettes with tips cut off
- Plyers
- Plastic container
- Water

Explore:

1. CO_2 Engineering Design Challenge

   Procedure:

   - As a class, brainstorm processes/activities that generate CO_2.
   - Reduce list to processes that can be measured in a class period using the Vernier probes.
   - Students will then conduct their investigation in groups and complete the challenge handout as a group.

Learning Objectives:

I can explain how the concentration of gases are measured.
I can design a method to measure gas concentration.

2. Carbon and the Climate Activity

Learning Objectives:

I can describe the exchange of carbon between organisms and the environment.
I can describe the role of storing carbon in organisms as part of the carbon cycle.
I can describe the contribution of photosynthesis and cellular respiration to the exchange of carbon within and among the biosphere, atmosphere, hydrosphere and geosphere.

3. The Habitable Planet: Carbon Cycle

Learning Objectives:

I can identify how photosynthesis and combustion influence the amount of atmospheric carbon
I can identify and describe the relevant components of each of the Earth systems modeled in a given computational model.
I can use a computational representation of Earth systems to illustrate and describe relationships among at least two of Earth's systems , including how changes in one aspect can drive changes in another
I can use evidence from a computational model to describe how human activity could affect the relationships between Earth's systems

Explain:

1. cK-12 The Carbon Cycle - Advanced
2. cK-12 Carbon Cycle and Climate
3. Carbon Cycle Notes
4. Spheres Notes
5. Carbon Cycling and Climate Change Stations
6. EPA Ice Core data analysis

Learning Objectives:

I can describe the exchange of carbon between organisms and the environment.
I can describe the role of storing carbon in organisms as part of the carbon cycle.
I can describe the contribution of photosynthesis and cellular respiration to the exchange of carbon within and among the biosphere, atmosphere, hydrosphere and geosphere.

Extend/Elaborate:

1. **Revisit Model**

   Revise your explanation to including the following:

   - Spheres
   - Greenhouse gases
   - Radiation
   - temperature

   Learning Objective:

   I can revise a model to add detail about the effects of increasing CO_2 levels.

2. Forecasting Practice
3. Review

   Learning Objective:

   I can analyze geoscience data and the results from the global climate model to make an evidence-based forecast of the current rate of global or regional climate change and the associated future impacts on Earth systems.

Evaluate:

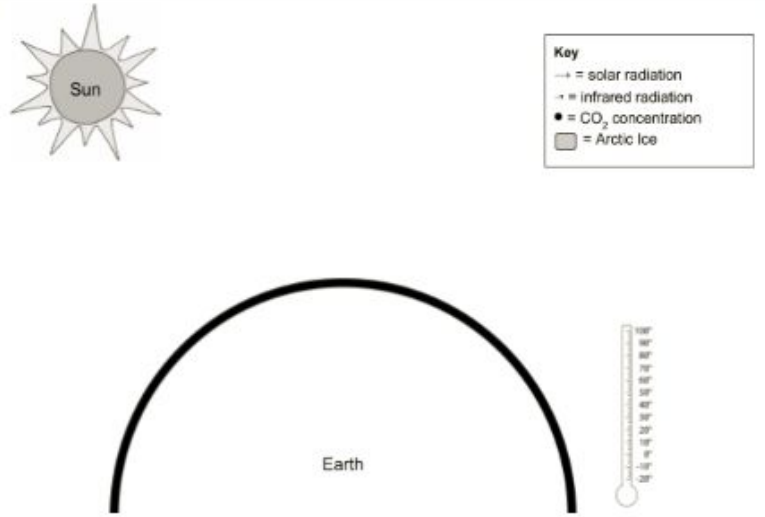
1. Task
2. Test

Name:_____ Name:_____ Period:_____

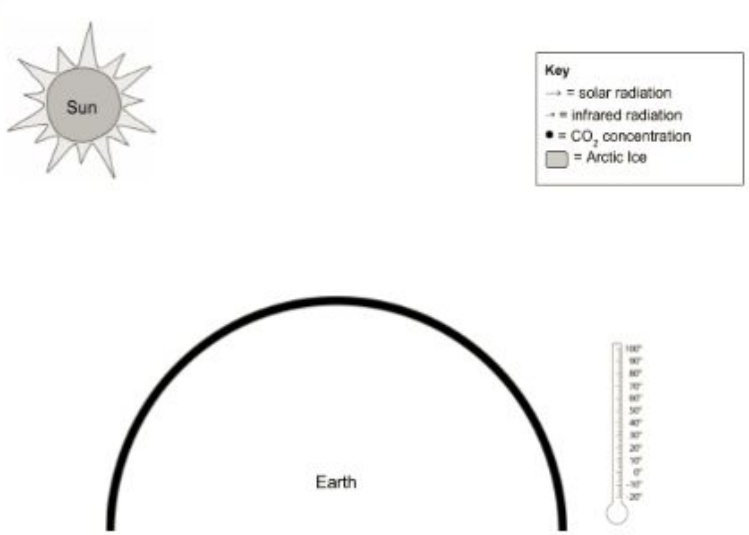
Why is the sea ice melting so quickly?

Complete the drawings below to show how CO_2 concentration, radiation, temperature, and arctic ice surface area have changed over time.

1900



2018



Explain what has caused the changes in your drawings:

Investigating Carbon Dioxide

Carbon Dioxide (CO_2) has been the focus of much of our learning this quarter. By now you have learned that CO_2 is a product of many combustion reactions that are important to humans. Later in this unit, we will also learn how CO_2 plays a very important role in Earth's atmosphere. But what exactly is carbon dioxide? Can you smell it? Can you taste it? Can you see it? In this activity, you will begin to explore some of the properties of carbon dioxide.

Part 1: Thinking About CO_2

✎ Answer each of the following questions individually.

1. What is CO_2? Have you ever seen CO_2? If so, what does it look like? If not, why not?

2. What forms or physical states can CO_2 exist in? Do these other forms have names?

3. Is CO_2 lighter than air, heavier than air or the same as air? How do you know?

Once all group members have answered the questions above, gather as a group and review your roles and responsibilities. Discuss your answers to the questions above within your group. On a whiteboard, summarize your group's answers to each question. Prepare to share your answers with the class.

Part 2: Exploring Properties of CO_2

Essential Question: What are some interesting properties of CO_2?

Your teacher will demonstrate some properties of solid carbon dioxide and demonstrate how to handle the substance safely.

✎ Record any observations you find interesting and any important safety notes here:

Part 3: Investigating Physical States of CO_2

Essential Question: Is it possible to observe CO_2 in all three physical states?

Your teacher will demonstrate how to conduct the experiment. Watch carefully and prepare to begin the procedure.

Conduct the experiment as instructed, performing the duties of your role in the group.
You must wear safety goggles during the entire experiment!

Reflection Questions

1. Note what was happening in the pipet at the following moments during the demonstration.

✎ a. When the solid CO_2 was first enclosed in the pipet

✎ b. When the pressure stabilized

✎ c. When the solid CO_2 was covered by the liquid carbon dioxide

✎ d. When the pressure in the pipet was released

✎ 2. Why is it rare to observe CO_2 as a liquid?

CO_2 Engineering Challenge:

Design and build a method/procedure/apparatus to measure an increase in CO_2 concentration caused by a CO_2 generating process.

The Task

1. As a team, discuss and agree upon a process that will generate CO_2 (must be able to do within the confines of the classroom).

   ✎ ***Record the process here***

2. Think about how to protect the CO_2 sensor from flame/heat/fluid or any other entity that will damage it. What design difficulties does your process create?

   ✎ ***Record design difficulties here***

3. As a team, design your method/procedure/apparatus that will be used to measure the increase in CO_2 concentration. On a whiteboard draw a sketch of your design.

   Insert a photo of your whiteboard sketch here

4. Build a prototype based on your design.

   Insert a photo of your prototype here

5. Use the CO_2 sensor to get a baseline reading before you start your process. In Graphical Analysis, Export an image of your data.

   Insert exported baseline (Before) graph here

6. Start your CO_2 generating process. Use the CO_2 sensor to record the increase in CO_2 concentration. In Graphical Analysis, Export an image of your data.

   Insert exported CO generating process (During/After) graph here

7. Did you measure an increase in CO_2? ***Yes/No*** Justify your answer using data from your Before graph and your During/After Graph

   ✎ ***Justification using data from graphs***

8. What areas/steps/materials would you change from your original design? Why?

   ✎ ***Design changes here with explanations for each change***

The Habitable Planet: Carbon Cycle

This lab uses a robust model of the carbon cycle to give you an intuitive sense for how carbon circulates through the atmosphere, biosphere, oceans, and crust. This model is similar to ones presented by the Intergovernmental Panel on Climate Change. It allows you to experiment with how human input to the cycle might change global outcomes to the year 2100 and beyond. One particularly relevant human impact is the increase in atmospheric CO_2 levels. Between the years 1850 and 2015, atmospheric concentrations have risen from 290 parts per million (ppm) to over 400 ppm - a level higher than any known on Earth in more than 30 million years.

Part 1: Play with simulation

Open up the simulation

Leave the scale sliders at the default settings

Run the simulation by clicking the Run Decade button.

1. What year does the simulation indicate that we will run out of oil and gas?

2. What year does the simulation indicate that we will run out of coal?

3. What happens to the atmospheric CO2 concentration after this?

4. Where does the simulation show all the carbon ends up in year 2500?

Part 2: Projecting Atmospheric Carbon using different rates of fossil fuel consumption.

Open up the simulation

Your group is assigned _____% change of fossil fuel use per year.

Leave the Net Deforestation rate at 1 GT per year

Run the simulation by clicking the Run Decade button.
Record the numbers in the data table below:

Year	Total Atmospheric Carbon PPM
2010	391
2020	
2030	
2040	
2050	
2060	
2070	
2080	
2090	
2100	

Place a screenshot of your graph here Screenshot on chromebook -
Hold these three keys down at the same time: CTRL + SHIFT + ☐II

Part 3: Projecting Atmospheric Carbon using different Net deforestation rates

Open up the simulation

Your group is assigned a Net Deforestation Rate of _____ GT

Set the change in fossil fuel use per year to **0%**

Run the simulation by clicking the Run Decade button.
Record the numbers in the data table below:

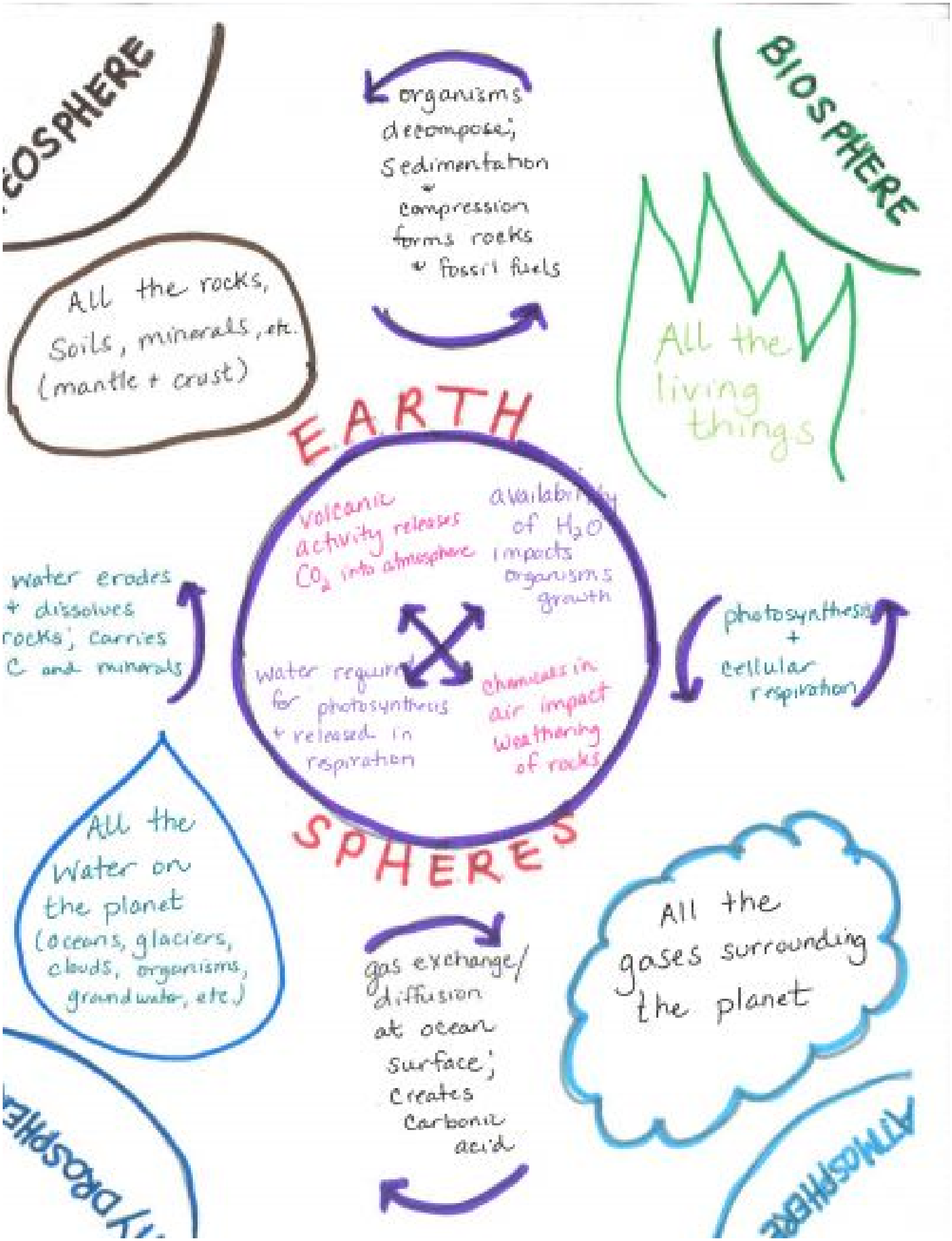
Year	Total Atmospheric Carbon PPM
2010	391
2020	
2030	
2040	
2050	
2060	
2070	
2080	
2090	
2100	

Place a screenshot of your graph here Screenshot on chromebook -
Hold these three keys down at the same time: CTRL + SHIFT + ☐II

Be ready to share out your results.

Carbon Cycle Notes

Spheres Notes



Carbon Cycling and Climate Change Stations

Write It! #1

1. Go to https://goo.gl/xj8XAv
2. Click play on the video
3. Answer questions from cards on your lab sheet

Write It! #2

Which color represents the highest CO_2 concentration? Which represents the lowest?

Write It! #3

During which months do you see the highest CO_2 concentration? Explain why that may be.

Write It! #4

What locations did you observe the largest amounts of CO_2 concentration? Explain why this is.

Assess It! #1

Due to human activities:

a. There is more carbon dioxide in the atmosphere today than in the past
b. There is change in the carbon dioxide levels, but not due to human activities
c. There is less carbon dioxide in the atmosphere today than in the past
d. There is no change in carbon dioxide levels

Assess It! #2

How is the atmosphere like a greenhouse?

a. Greenhouse gases reflect sunlight like the walls of a greenhouse
b. Water vapor condenses into clouds like droplets condense on greenhouse walls
c. Greenhouse gases trap heat like the walls of a greenhouse
d. None of the above

Assess It! #3

____ in the atmosphere absorb and emit radiation within the thermal infrared range.

a. Greenhouse gases
b. Greenhouse effect
c. Biofuel
d. None of the above

Assess It! #4

What happens when greenhouse gas levels in the atmosphere increase?

a. Nothing
b. The atmosphere traps more heat
c. The atmosphere traps less heat
d. None of the above

Read It! #1

List the major human actions that contribute to increases in atmospheric CO_2.

Read It! #2

What do greenhouse gases do?

Read It! #3

How can we help to solve the problem of climate change?

a. Reducing fossil fuel use
b. Planting more trees
c. Both A and B
d. None of the above

Watch It! #1

1. Go to https://goo.gl/WGM1Rj
2. Click play on the video
3. Answer questions from cards on your lab sheet

Watch It! #2

How do plants remove carbon from the atmosphere?
(A) Photosynthesis
(B) Animals eat them
(C) They die and decay

Watch It! #3

What happens when phytoplankton take in carbon through photosynthesis?
(A) It is stored forever.
(B) They can release it through respiration or it can move up the food chain.
(C) It is turned into oxygen.

Watch It! #4

The ocean is a carbon sink. What does this mean?

Watch It! #5

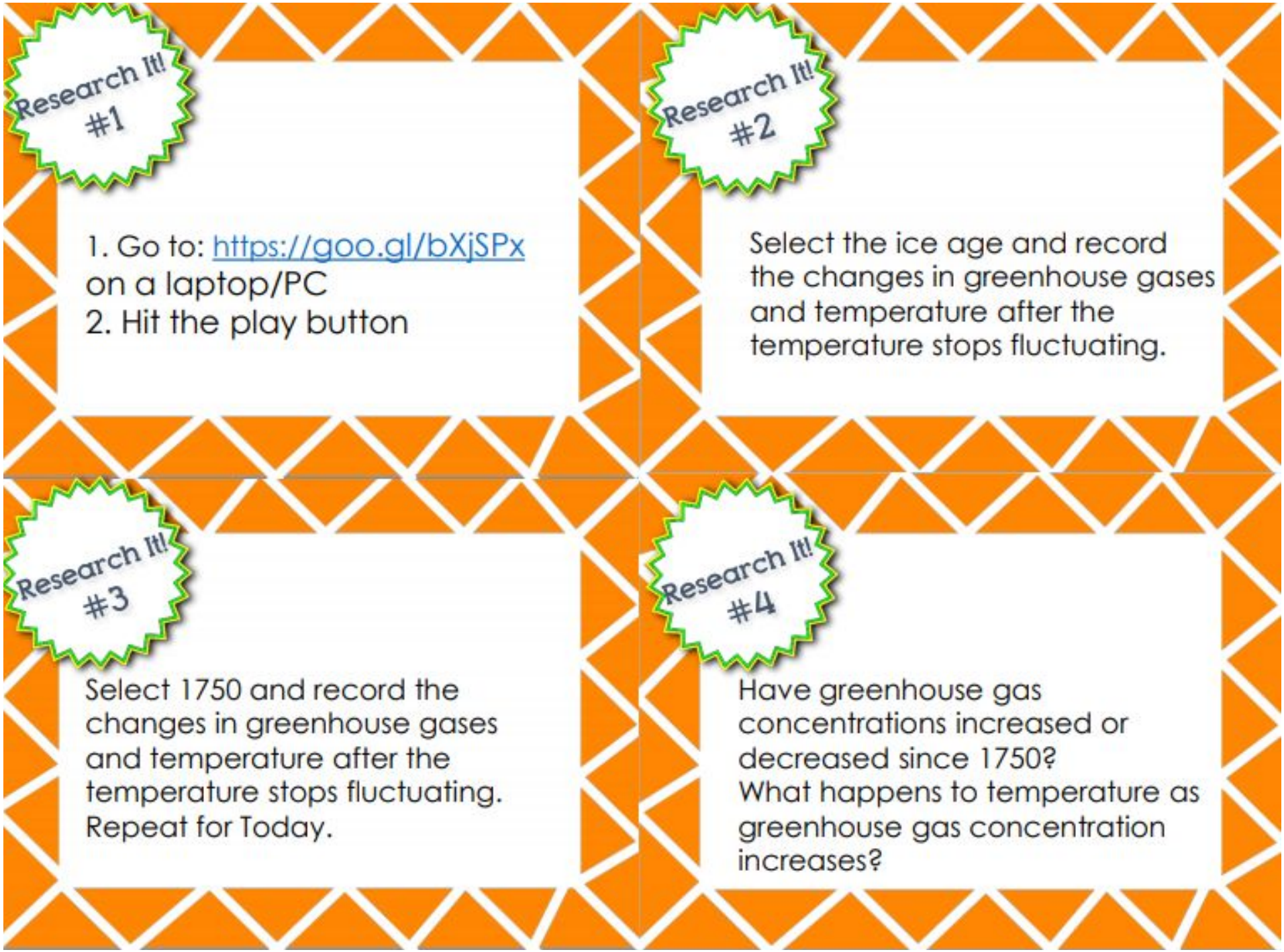
How does the amount of carbon in the atmosphere currently compare to the historic level of carbon in the atmosphere?
(A) Much higher
(B) Slightly higher
(C) About the same

Watch It! #6

How does NASA monitor changes in Earth's climate systems and ecology?
(A) Satellites
(B) Spies
(C) Magic
(D) Submarines

Watch It! #7

What happens as the oceans heat up?


Research It!
#1
1. Go to: https://goo.gl/bXjSPx
on a laptop/PC
2. Hit the play button
Research It!
#2
Select the ice age and record the changes in greenhouse gases and temperature after the temperature stops fluctuating.
Research It!
#3
Select 1750 and record the changes in greenhouse gases and temperature after the temperature stops fluctuating. Repeat for Today.
Research It!
#4
Have greenhouse gas concentrations increased or decreased since 1750?
What happens to temperature as greenhouse gas concentration increases?

Explore It! #1

1. Go to https://goo.gl/5f2Wsi
2. **Explore** all of the controls in the simulation for about 2 minutes. Click on different things and figure out what each one does.

Explore It! #2

Discuss with your partners and decide on a brief (1-2 sentences) summary of what the simulation does and shows.

Explore It! #3

Select CO_2 and move the slider on the flashlight all the way to the right.
Record observations in the table.

Explore It! #4

Given the results from the table, explain why CO_2 is labeled a greenhouse gas.

Illustrate It!
#1

Make a diagram of the Greenhouse Effect

Include:

- Sun
- Earth
- Atmosphere
- Labeled greenhouse gases
- Arrows showing electromagnetic energy interactions
  - visible light
  - Infrared
  - Ultraviolet

Explore It!

Task Card #2: _____

_____

Task Card #3:

	Microwave	Infrared	Visible Light	Ultraviolet
CO_2				

Task Card #4: _____

_____

Write It!

Task Card #2:

_____

_____

Task Card #3:

_____

_____

Task Card #4:

_____

_____

Carbon Cycling & Climate Change Name_____

Illustrate It!

Assess It!

#1 ____ #2 ____

#3____ #4 ____

Watch It!

Task Card #2: _____ Task Card #3: _____

Task Card#4:_____

_____

Task Card #5: _____ Task Card #6: _____

Task Card #7: _____

_____

Carbon Cycling & Climate Change Name_____

Read It!

Task Card #1: _____

_____

Task Card #2: _____

_____

Task Card #3: _____

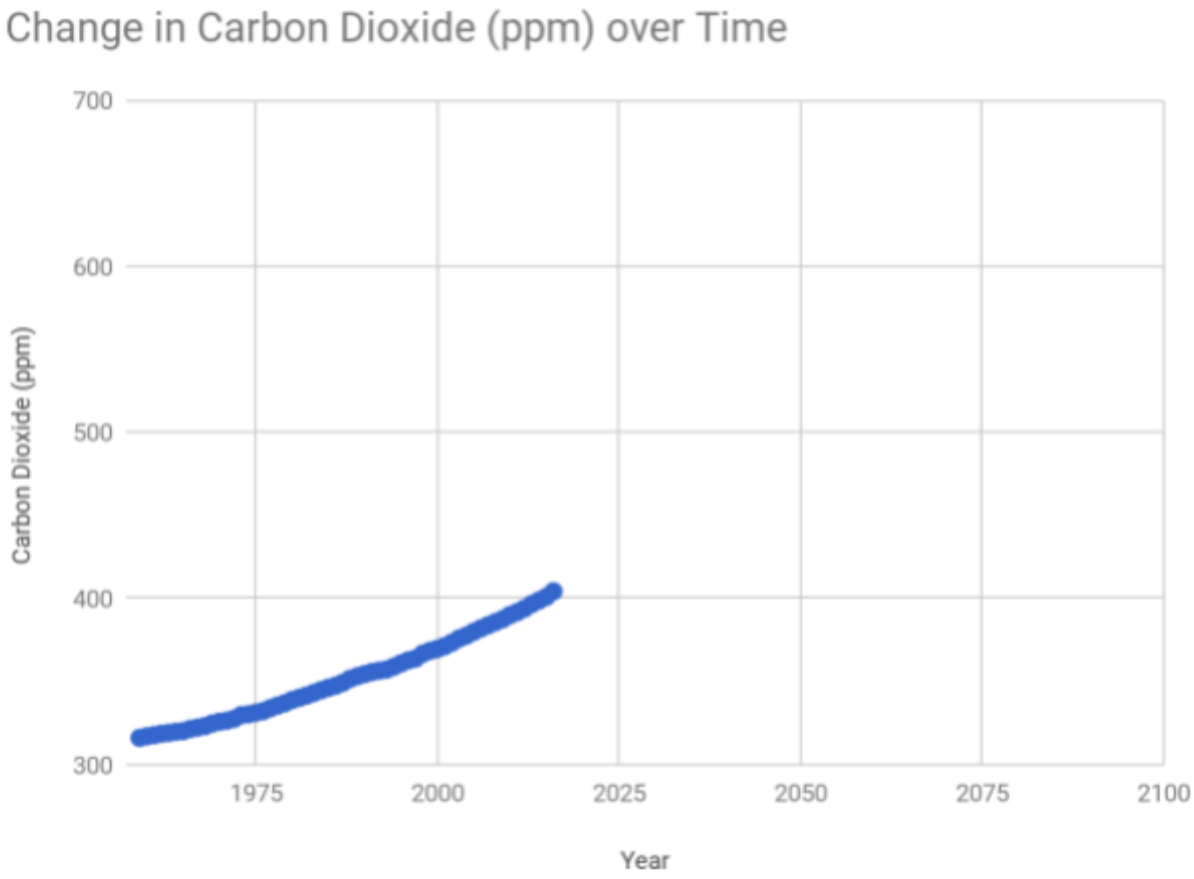
Research It!

	CO_2 Concentration	CH_4 Concentration	N_2O Concentration	Temperature (°F)
Ice Age				
1750				
Today				

Task Card #4: _____

_____

Forecasting Practice



1) How has the amount of CO_2 (ppm) changed over time? Include relevant data in your explanation.

2) On the above graph, sketch what you think the line would look like if the trend continues.
3) Based on your sketch, what will the CO_2 (ppm) be in 2038?

4) Based on your sketch, what will the CO_2 (ppm) be in 2063?

5) Based on your sketch, what will the CO_2 (ppm) be in 2100?

6) Explain the reasoning to justify your forecasts for questions 2-4.

Review

Vocabulary

Geosphere -

Atmosphere -

Hydrosphere -

Biosphere -

Fossil fuel -

Carbon sink -

Cellular respiration -

Photosynthesis -

Conservation of Mass Law -

Greenhouse effect -

Greenhouse gas -

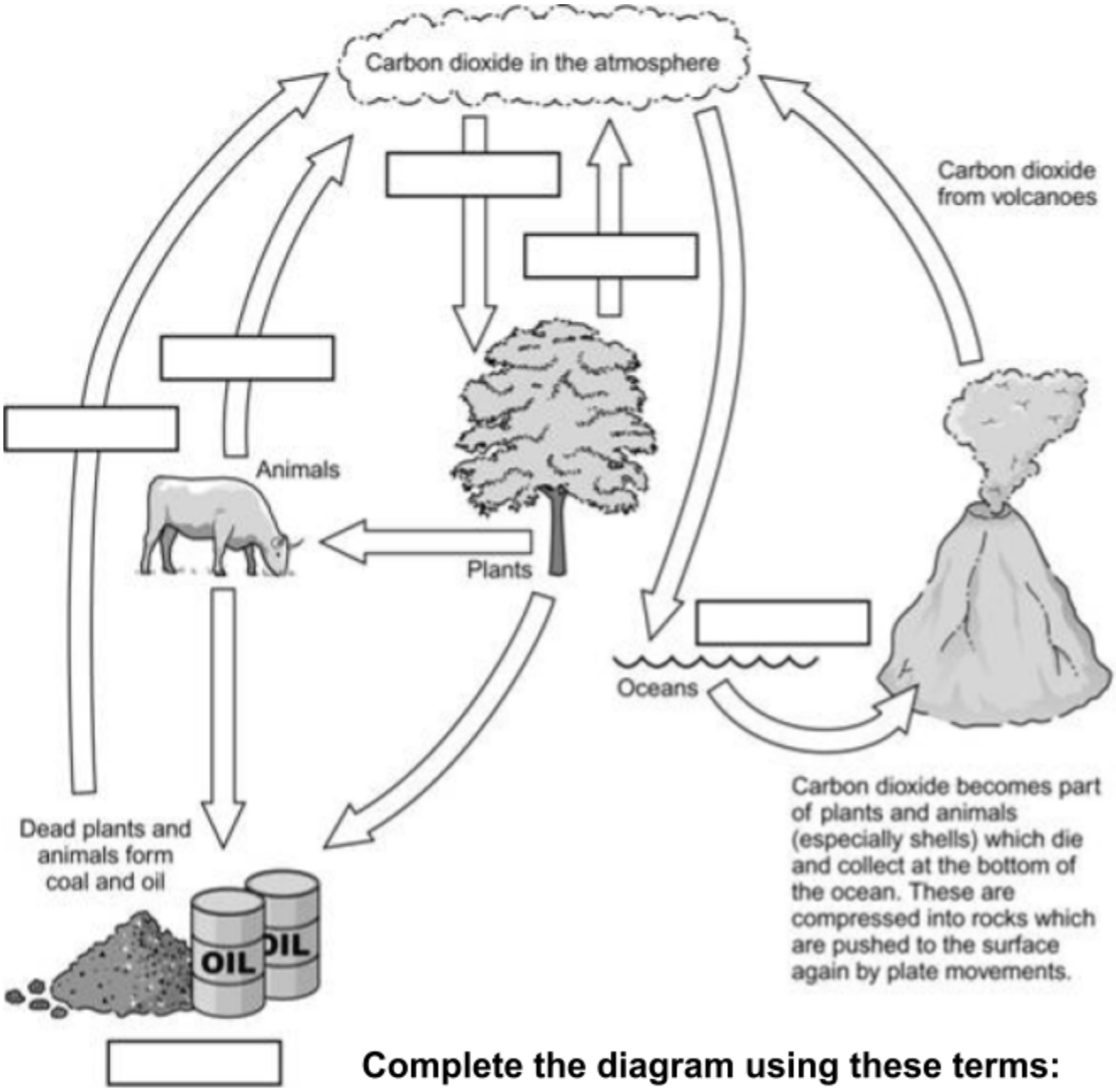
Conceptual Questions

What role does the Conservation of Mass Law play in the carbon cycle?

What has happened to carbon dioxide concentration in the atmosphere changed over time?

What effect has this change had on the climate and why?

What processes move carbon from one earth system to another?



Complete the diagram using these terms:

FUELS COMBUSTION PHOTOSYNTHESIS

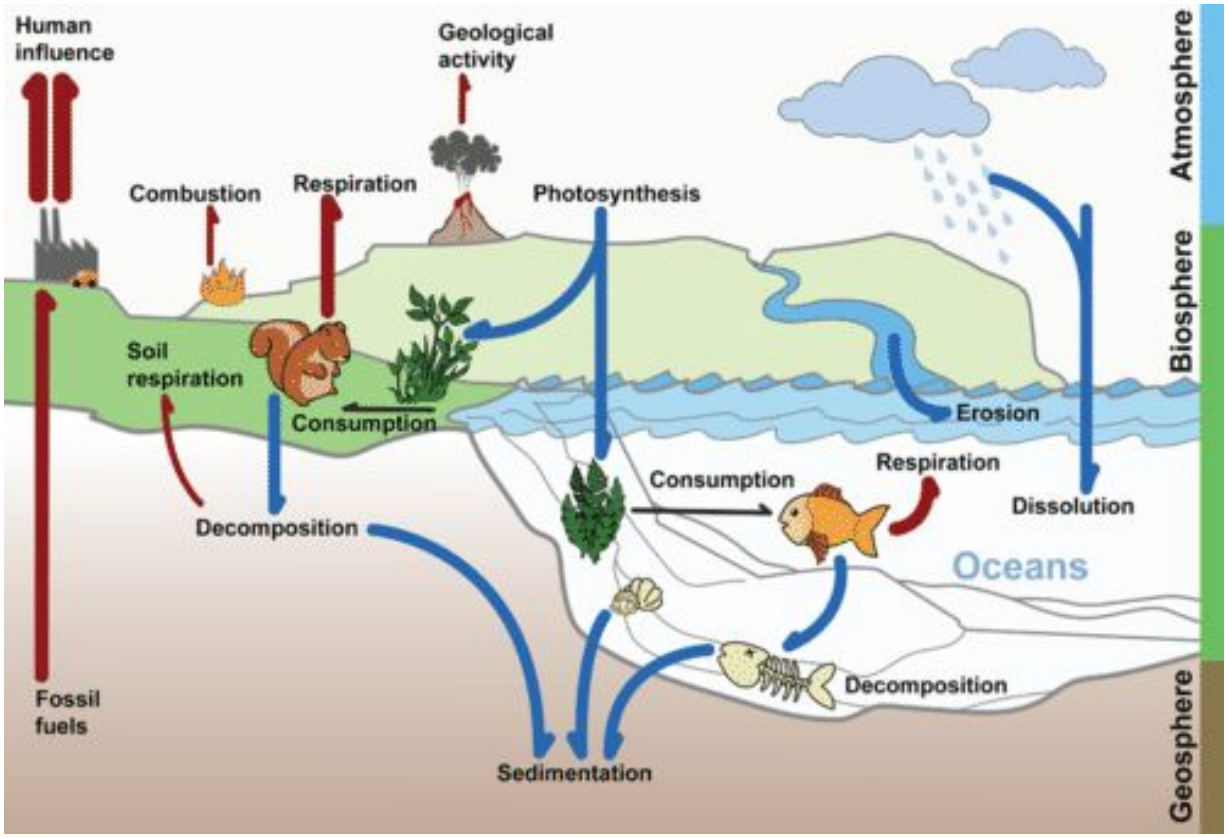
DISSOLVING RESPIRATION

Task: Carbon Cycling and Climate Change

Technical Manual Chapter 5 - Carbon Cycling and Climate

For this task you will write the fifth chapter of the Operator's Manual for the Steam-Powered Boat that your team will construct.

This chapter will include three parts described below:



Part 1: Use the Carbon Cycle Diagram to show how carbon atoms in your combustion reaction move through Earth systems

A. Label all locations where the carbon in your fuel comes from.

0 - Inadequate	1 - Below	2 - Approaching	3 - Meets	4 - Exceeds
Missing where your carbon in your carbon-containing reactant comes from	Incorrectly identifies at least one location that carbon from your carbon-containing reactant comes from		Correctly identifies at least one location that carbon from your carbon-containing reactant comes from	Correctly identifies more than one location that carbon from your carbon-containing reactant comes from

B. Label all locations that the carbon in your products goes.

0 - Inadequate	1 - Below	2 - Approaching	3 - Meets	4 - Exceeds
Missing where your carbon in your carbon-containing product goes	Incorrectly identifies at least one location that carbon from your carbon-containing product goes		Correctly identifies at least one location that carbon from your carbon-containing product goes	Correctly identifies more than one location that carbon from your carbon-containing product goes

C. Explain how the diagram shows that your combustion reaction obeys the Law of Conservation of Matter.

0 - Inadequate	1 - Below	2 - Approaching	3 - Meets	4 - Exceeds
Missing explanation of how model demonstrates conservation of mass	Incorrectly describes law of conservation of mass	Law of conservation of mass is stated with no discussion of model	Correctly explains how model demonstrates conservation of mass without giving specific examples from model	Correctly explains how model demonstrates conservation of mass citing specific examples from model

Part 2: Explain how an increase in CO_2 in the atmosphere affects an Earth System

Choose one Earth system (other than the atmosphere):

- ❏ Hydrosphere/Cryosphere
- ❏ Biosphere
- ❏ Geosphere

A. Identify a component of that system that is affected by an increase of CO_2 in the atmosphere.

0 - Inadequate				1 point
Missing the identification of a component of system that is affected by an increase of CO_2				Identifies a component of a system that is affected by an increase of CO_2

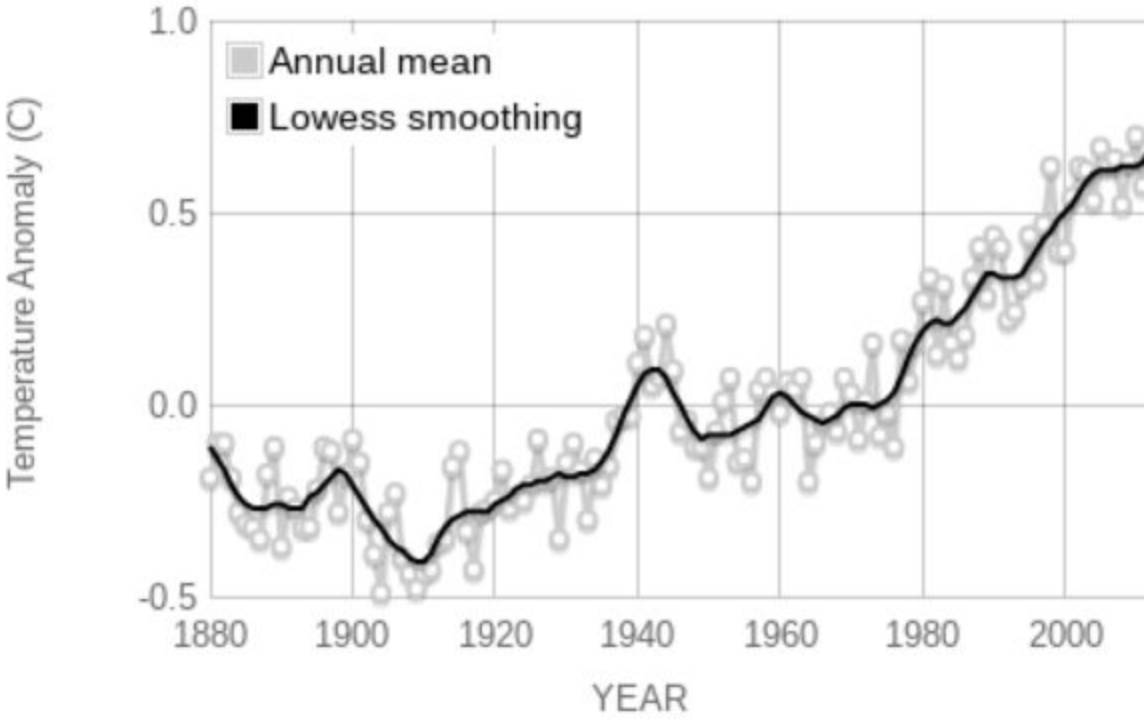
B. Explain how the increase in CO_2 in the atmosphere will affect the identified component.

0 - Inadequate	1 - Below	2 - Approaching	3 - Meets	4 - Exceeds
Missing an explanation of how an increase in CO_2 will affect the component	Incorrectly identifies how the increase in CO_2 will affect the component	States how the increase in CO_2 in the atmosphere will affect the component, does not include explanation OR States how the increase in CO_2 will affect the component but the explanation is incorrect	Correctly explains how the increase in CO_2 in the atmosphere will affect the component	Correctly explains how the increase in CO_2 in the atmosphere will affect the component citing specific examples/ locations for the affect

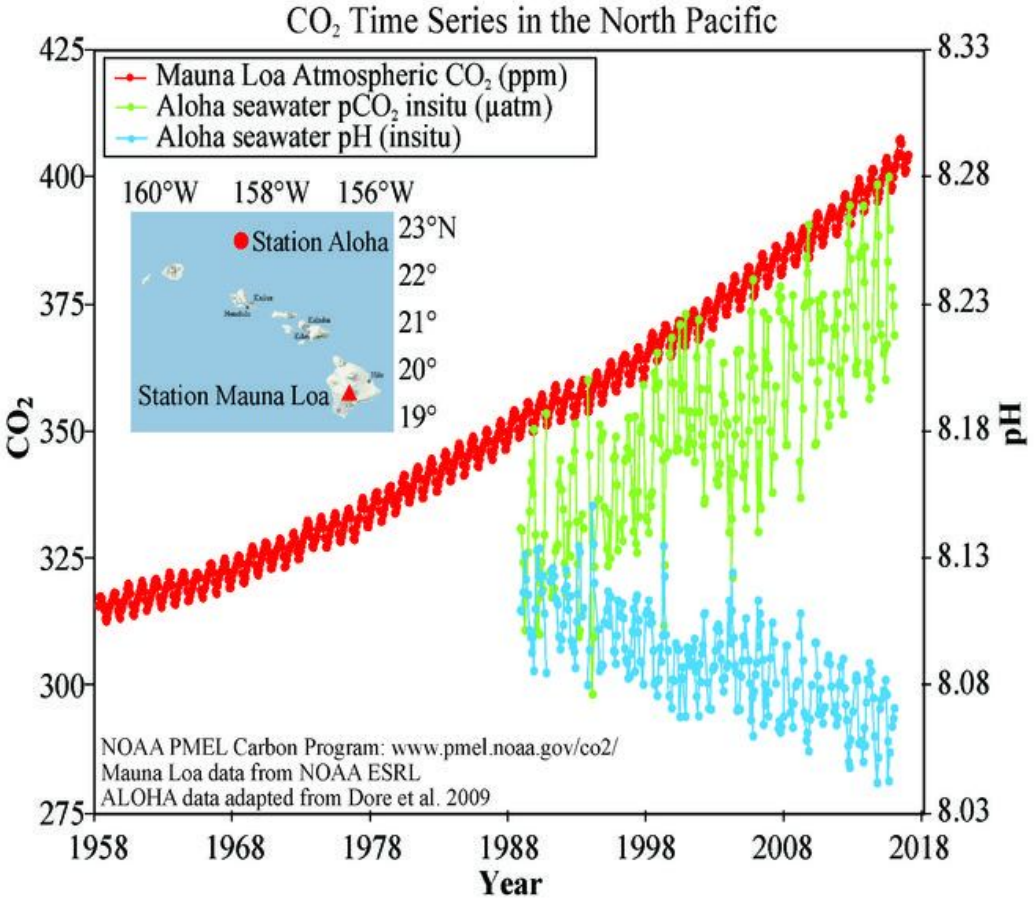
Part 3:

Choose **one** parameter:

- ❑ Temperature



- ❑ pH



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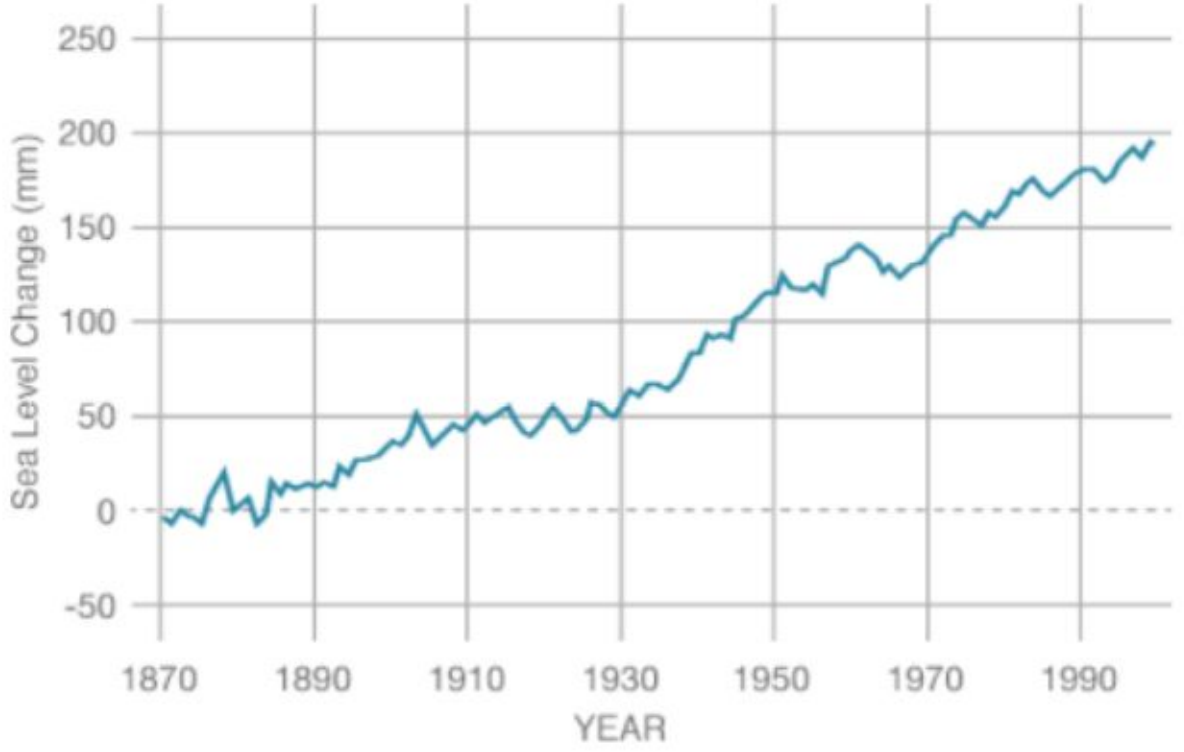
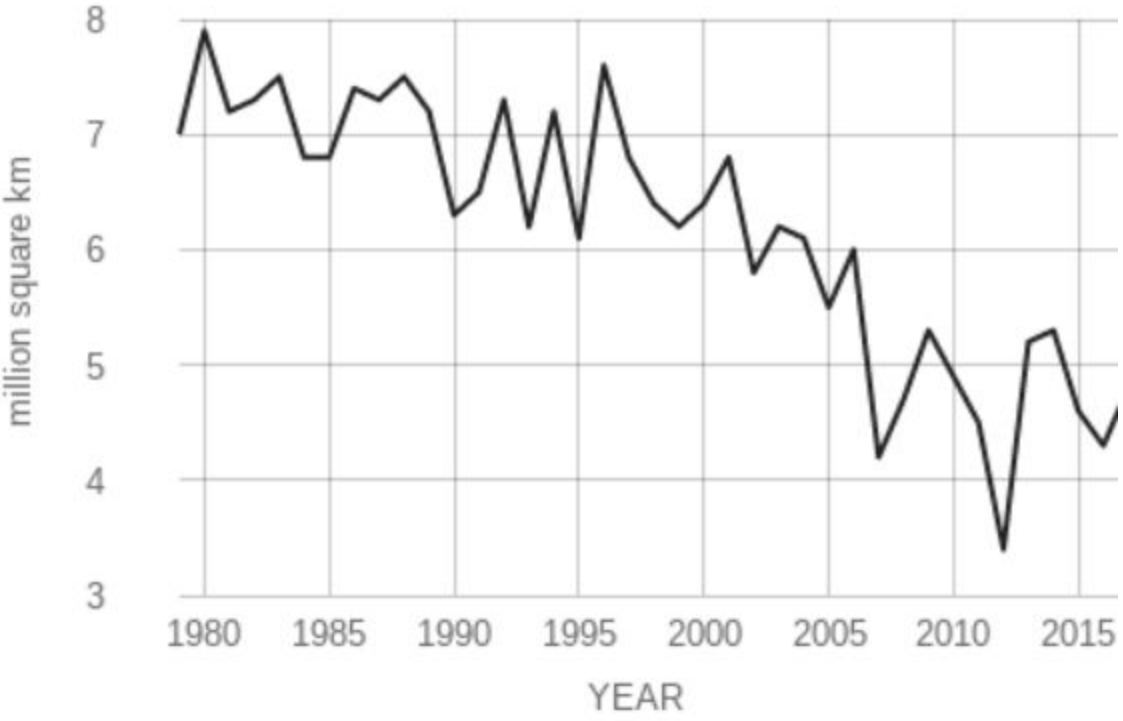
Ref: J.E. Dore et al, 2009. Physical and biogeochemical modulation of ocean acidification in the central North Pacific. *Proc Natl Acad Sci USA* **106**:12235-12240.

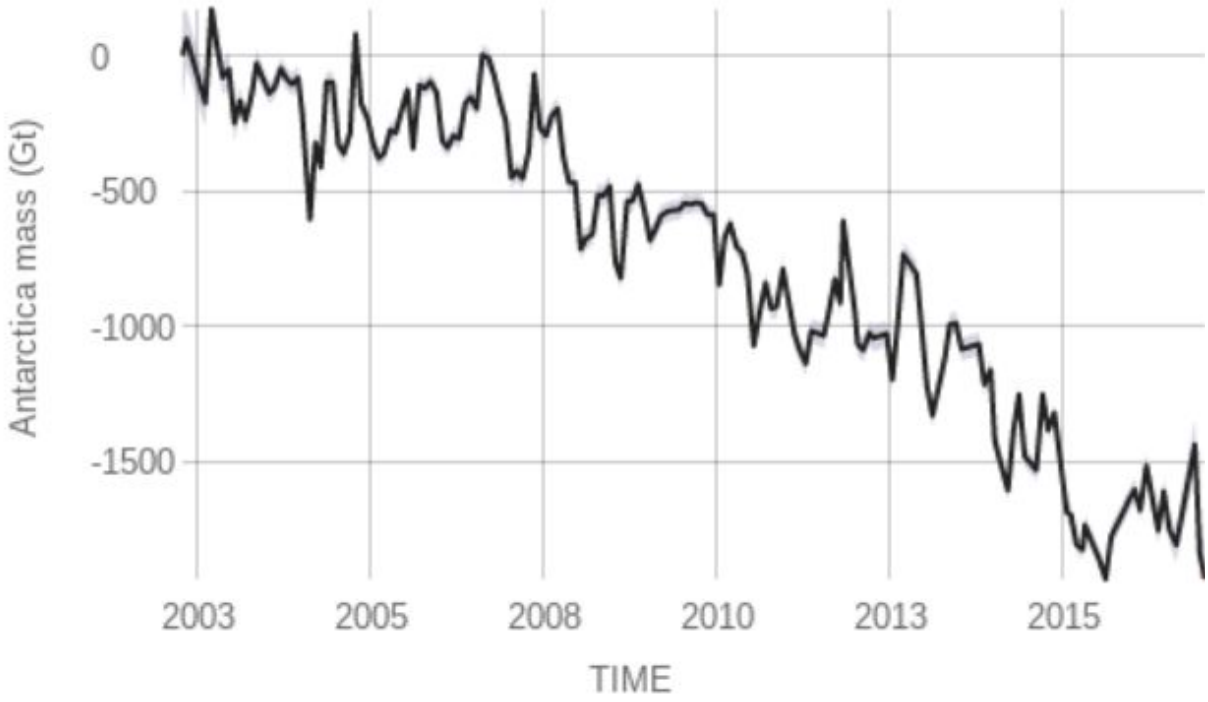
- ❏ Sea level



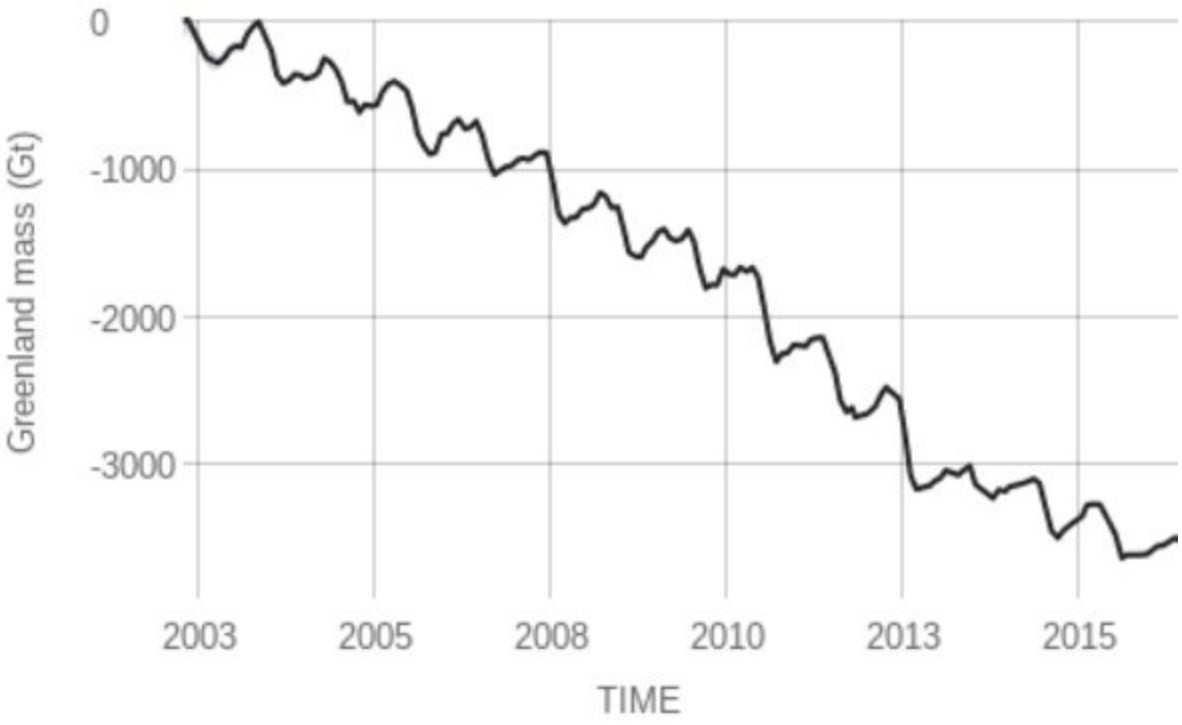
- ❏ Ice Volume (choose only one of the below)
  - ❏ Arctic Ice Volume



❑ Antarctic Ice Volume



❑ Greenland Ice Volume



A. Using the graph supplied with your chosen parameter, explain how your chosen parameter has changed over time.

0 - Inadequate	1 - Below	2 - Approaching	3 - Meets	4 - Exceeds
Missing explanation and data on how chosen parameter has changed over time	Data that is irrelevant is presented/ data is missing completely AND/OR Explanation is incorrect / explanation is missing	Data presented without any explanation of what data represents or explanation is incorrect.	Explanation of how Earth system has changed over time. Explanation includes data that is not applicable or data is missing.	Detailed explanation of how Earth system has changed over time. Explanation includes relevant data.

B. Based on the graph, forecast what your chosen parameter will be in 20, 100, and 1000 years.

0 - Inadequate	1 - Below	2 - Approaching	3 - Meets	4 - Exceeds
Missing claim for the state of chosen parameter	Makes an inaccurate claim about the state of the chosen parameter in 20, 100, and 1000 years.	Makes an accurate claim about the state of the chosen parameter in one of the three time frames (20, 100 or 1000 years).	Makes an accurate claim about the state of the chosen parameter in two of the three time frames (20, 100 and 1000 years).	Makes an accurate claim about the state of the chosen parameter in 20, 100, and 1000 years.

C. Explain the reasoning to justify your forecast.

0 - Inadequate	1 - Below	2 - Approaching	3 - Meets	4 - Exceeds
Missing reasoning to justify forecast	Includes a justification that is inaccurate or irrelevant to forecast	Includes vague reasoning to justify forecast	Includes logical reasoning, but only refers to general trends in data to justify forecast	Includes a mathematical or graphical basis (extrapolation) to justify forecast

D. Describe how the effects on your chosen parameter are either reversible or irreversible.

0 - Inadequate	1 - Below	2 - Approaching	3 - Meets	4 - Exceeds
Missing description of whether the effects on parameter are reversible or irreversible.	Incorrectly identifies if the effects on the chosen parameter are reversible.	Correctly identifies if the effects on the chosen parameter are reversible.	Correctly identifies if the effects on the chosen parameter are reversible AND describes how.	Correctly identifies if the effects on the chosen parameter are reversible AND describes how using a major chemistry concept.

Test: Carbon Cycling and Climate Change **Name:** **Period:**

1. Which of the following are features of the biosphere?

   a) solid, molten rock, sediment, continents, and mountains
   b) rivers, lakes, oceans and glaciers
   c) wind, air, oxygen
   d) plants, animals

2. Which earth system receives carbon dioxide from cellular respiration and has it removed by photosynthesis?

   a) geosphere
   b) hydrosphere
   c) atmosphere
   d) biosphere

3. Where is carbon stored in the hydrosphere?

   a) in plants as carbohydrates
   b) in the earth as hydrocarbons
   c) in oceans as dissolved carbon dioxide
   d) in the air as a gas

4. What was the source of carbon in the candle wax (hydrocarbon) that fueled the steam powered boat?

   a) from ancient decayed plants and animals
   b) from carbon dioxide in the atmosphere
   c) cellular respiration in animals
   d) photosynthesis in plants

5. How does mass conservation in the Carbon Cycle contribute to the Greenhouse Effect?

   a) When carbon is removed from the geosphere it enters the atmosphere.
   b) When carbon atoms are destroyed heat energy on in the geosphere increases.
   c) More carbon atoms are created in the atmosphere than can be destroyed in the hydrosphere.
   d) Carbon atoms created during photosynthesis build up in the atmosphere.

6. What is one way carbon is stored in Earth systems?

   a) Carbohydrates in the biosphere are transformed into hydrocarbons that are trapped in layers of the geosphere.
   b) Bacteria on the roots of plants move carbon from the atmosphere into the tissues of organisms in the biosphere.
   c) Decomposition stores carbon in the rotten tissues of trees, plants, and other organisms.
   d) Precipitation from the atmosphere deposits carbon into the hydrosphere in lakes and oceans.

7. Why is carbon dioxide a greenhouse gas?

    a) it transmits most solar radiation but reflects infrared.
    b) it reflects most solar radiation but transmits infrared.
    c) carbon dioxide is heavier than air.
    d) carbon dioxide molecules release energy to the atmosphere.

8. What variable does the graph most likely show changing over time?

    a) Total mass of ice in glaciers and ice caps
    b) Average global sea level
    c) pH level of ocean water
    d) Concentration of carbon dioxide in the atmosphere

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UNIT 7:
REACTION RATES

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Unit 7: Reaction Rates

Standard:

HS-PS1-5: Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs.

Model:

Question: How does temperature affect the reaction rate of a glow stick?

Materials:

- 2 Glowsticks
- 2 thermometers
- Beaker of 80°C water
- Beaker of ice water

Learning Objective:

I can communicate my existing ideas about effects of temperature on reaction rate.

Engage:

Reactions Rates Demonstrations: whoosh bottle, cornstarch explosion, elephant toothpaste

Learning Objective:

I can make careful observations of scientific demonstrations.

Explore:

ADI Chemistry: Reaction Rates

Learning Objectives:

I can collect and analyze data on reaction rates.
I can infer factors that impact reaction rate of a chemical reaction from analyzing data.

Explain:

1. cK-12 Temperature and Temperature Scales
2. cK-12 Chemical Reaction Rates
3. cK-12 Collision Theory
4. cK-12 Activation Energy
5. cK-12 Factors Affecting Reaction Rates
6. cK-12 Catalysts
7. cK-12 PLIX Factors Affecting Reaction Rate

8. Chemical Reaction Notes

Learning Objectives:

I can describe how the colliding of molecules can break and form new bonds.
I can describe how changing temperature will affect reaction rate.
I can describe how changing the surface area will affect reaction rate.
I can describe how changing the concentration will affect reaction rate.
I can describe the relationship between kinetic energy of molecules and rate of collisions.

Extend/Elaborate:

Revisit Model

Include the following in your revised explanation:

- Number and force of collisions of particles
- Rate of reactions in different temperatures

Learning Objectives:

I can revise a model to add detail about the effects of temperature on reaction rate.

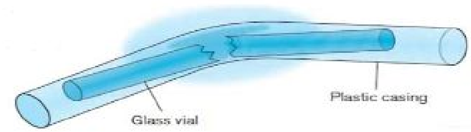
Evaluate:

1. Task
2. Test

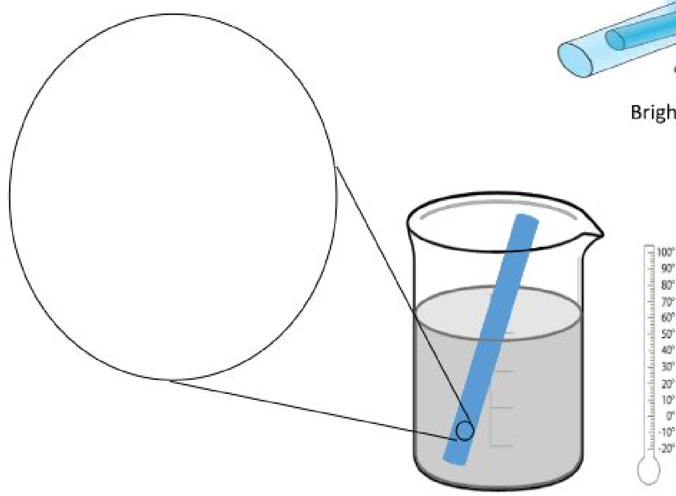
Name:______________________________ Name:____________________________________ Period:________

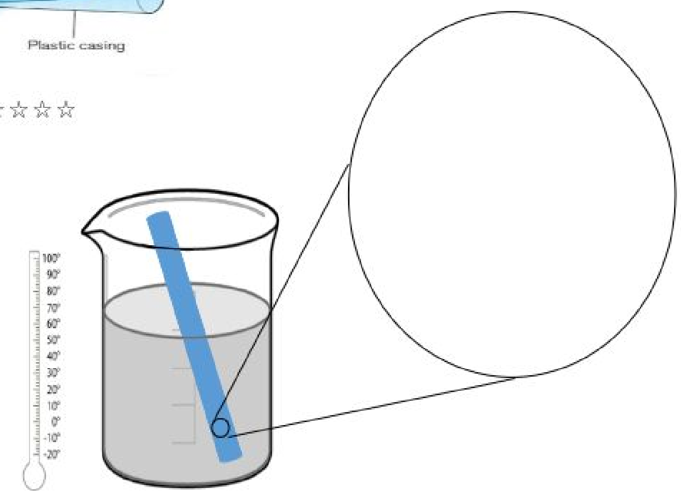
How does temperature affect the reaction rate in a glow stick?

Complete the drawings below to show how temperature affects brightness and molecules in the glow stick reaction.



Brightness: ☆ ☆ ☆ ☆ ☆ ☆ ☆ ☆





Brightness: ☆ ☆ ☆ ☆ ☆ ☆ ☆ ☆

Brightness: ☆ ☆ ☆ ☆ ☆ ☆ ☆ ☆

Explain what causes the molecules to be different in your zoom-in drawings.

Reaction Rates Demonstrations

<table>
<tr><td colspan="2">Elephant Toothpaste
Observations:

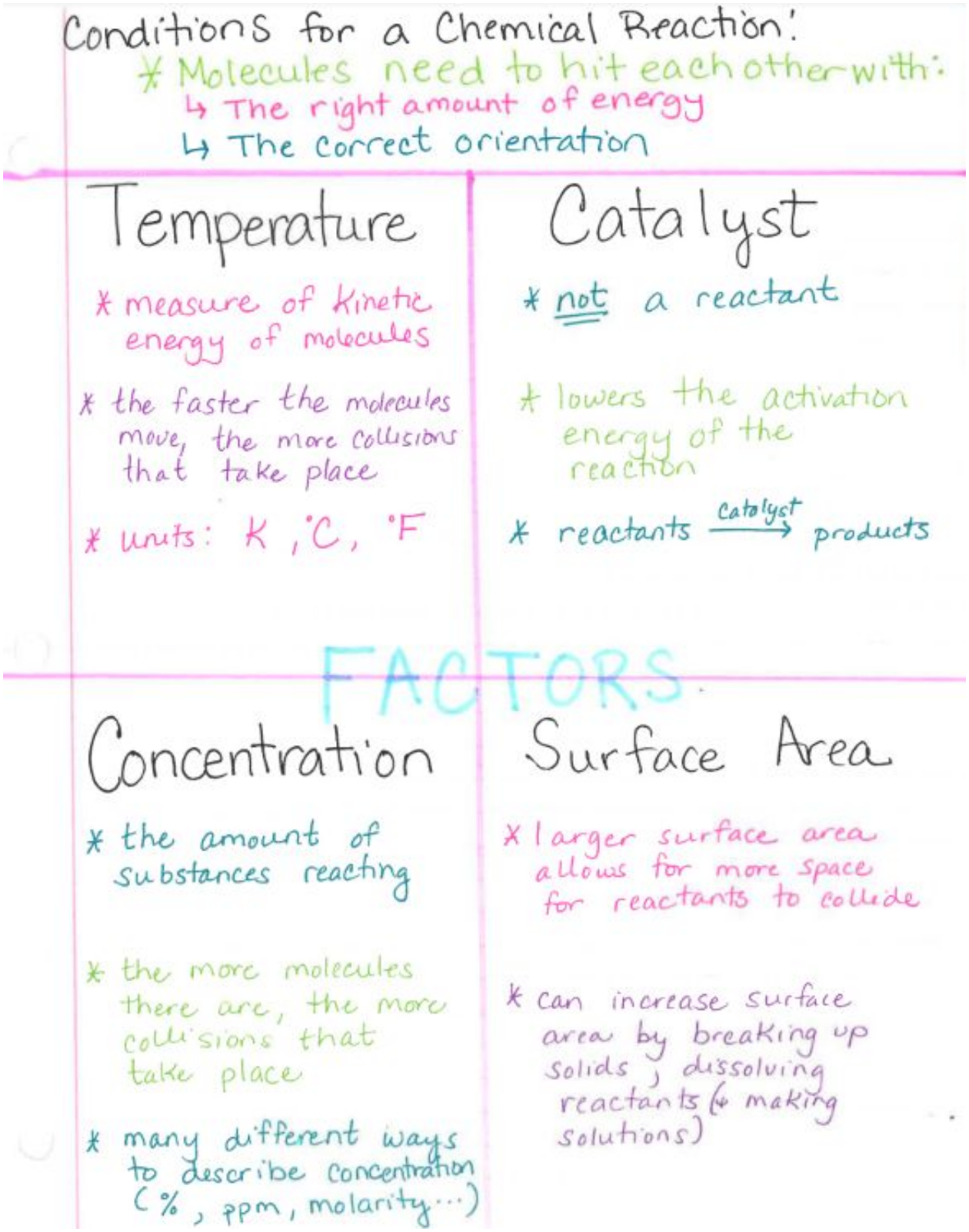
First Factor Impacting Reaction Rate =

Second Factor Impacting Reaction Rate =</td></tr>
<tr><td>Cornstarch Explosion
Observations:

Factor Impacting Reaction Rate =</td><td>Whoosh Bottles
Observations:

Factor Impacting Reaction Rate =</td></tr>
</table>

Chemical Reaction Notes



Task: Reaction Rates

Reaction Rate Investigation

You will work in groups to investigate how to change the rate of a chemical reaction. Your teacher will provide you a list of reactions to choose from.

Select one of the following investigations:

Concentration Procedure	Temperature Procedure	Surface Area Procedure
Question: How does increasing the concentration of water affect the reaction rate of an effervescent tablet? **Materials** • effervescent tablets x9 • vinegar • tap water • 250 mL beaker • timer **Procedure:** 1. Fill the beaker with 200 mL of tap water. Record the concentration of water to vinegar in the data table as 100% water. 2. Using the timer, drop one effervescent tablet into the beaker and measure how long it takes for the reaction to stop. 3. Record the time of the reaction in the data table. 4. Empty the beaker and repeat steps 1-3 two more times. Record the time of the reactions for trials 2 and 3. 5. Fill the beaker with 150 mL of tap water and 50 mL of vinegar. Record the	**Question:** How does increasing the temperature of a solution affect the reaction rate of an effervescent tablet? **Materials** • effervescent tablets x9 • hot plate • ice water • tap water • thermometer • 250 mL beaker • timer **Procedure:** 1. Fill the beaker with 200 mL of ice water. Record the temperature of the water in the data table. 2. Using the timer, drop one effervescent tablet into the beaker and measure how long it takes for the reaction to stop. 3. Record the time of the reaction in the data table. 4. Empty the beaker and repeat steps 1-3 two more times. Record the time of the reactions for trials 2 and 3. 5. Fill the beaker with 200 mL of tap water. Record the	**Question:** How does increasing the surface area of the effervescent tablet affect the reaction rate of an effervescent tablet with water? **Materials** • effervescent tablets x9 • graduated cylinder • tap water • 250 mL beaker • timer **Procedure:** 1. Fill the beaker with 200 mL of tap water. 2. Using the timer, drop one unbroken effervescent tablet into the beaker and measure how long it takes for the reaction to stop. Reaction has stopped once bubbles are no longer formed. 3. Record the time of the reaction in the data table as trial 1. 4. Empty the beaker and repeat steps 1-3 two more times. Record the time of the reactions for trials 2 & 3. 5. Fill the beaker with 200 mL of tap water.

concentration of water in the data table as 75% water.

6. Using the timer, drop one effervescent tablet into the beaker and measure how long it takes for the reaction to stop.
7. Record the time of the reaction in the data table.
8. Empty the beaker and repeat steps 5-7 two more times. Record the time of the reactions for trials 2 and 3.
9. Fill the beaker with 100 mL of tap water and 100 mL of vinegar. Record the concentration of water in the data table as 50% water.
10. Using the timer, drop one effervescent tablet into the beaker and measure how long it takes for the reaction to stop.
11. Record the time of the reaction in the data table.
12. Empty the beaker and repeat steps 9-11 two more times. Record the time of the reactions for trials 2 and 3.

temperature of the water in the data table.

6. Using the timer, drop one effervescent tablet into the beaker and measure how long it takes for the reaction to stop.
7. Record the time of the reaction in the data table.
8. Empty the beaker and repeat steps 5-7 two more times. Record the time of the reactions for trials 2 and 3.
9. Fill the beaker with 200 mL of tap water. Place the beaker on the hot plate and heat the water. Remove the beaker from the hot plate once it has reached 50 °C. Record the temperature of the water in the data table.
10. Using the timer, drop one effervescent tablet into the beaker and measure how long it takes for the reaction to stop.
11. Record the time of the reaction in the data table.
12. Empty the beaker and repeat steps 9-11 two more times. Record the time of the reactions for trials 2 and 3.

6. Take one effervescent tablet and break into several pieces. Pieces should be larger, do not completely turn into a powder.
7. Using the timer, drop one broken effervescent tablet into the beaker. be sure to include all of the pieces from the effervescent tablet. Measure how long it takes for the reaction to stop.
8. Record the time of the reaction in the data table for trial 1.
9. Empty the beaker and repeat steps 5-7 two more times. Record the time of the reactions for trials 2 &3.
10. Fill the beaker with 200 mL of tap water.
11. Using the mortar and pestle, completely grind one effervescent tablet. Once completely ground, the tablet should look like a fine powder.
12. Using the timer, drop one completely ground effervescent tablet into the beaker. Make sure to have all of the powder from the tablet. Measure how long it takes for the reaction to stop.
13. Record the time of the reaction in the data table as trial 1.
14. Empty the beaker and repeat steps 9-11 two more times. Record the time of the reactions for trials 2 & 3.

Part 1:

1A: Create a data table that includes the following conditions:

- Table includes three conditions
- Repeated trials present
- Averages for each condition correct
- Table includes labels with units

1B: Create a graph showing the relationship between the two variables that includes:

- Graph includes title
- X and Y axis labeled
- Scatterplot of manipulated vs responding variables (using average values)
- Best fit line

Part 2: Reaction Rate Explanation

Write the equation for the chemical reaction used in part 1 here:

Explain how you changed the rate of the reaction. In your explanation be sure to do all of the following:

- Identify a variable that could change the reaction rate.
- Explain what has to happen for two molecules to react in terms of kinetic energy.
- Explain what has to happen for two molecules to react in terms of orientation.
- Explain the effect of changing the variable on collisions between atoms/molecules.

Draw a before and after picture of the atoms/molecules interacting.

Your after picture should include a representation of the effects of the changing variable.

Task Rubric

Learning Evidence	1 point
Part 1A	
Table includes three conditions	
Repeated trials present	
Averages for each condition correct	
Table includes labels with units	
Part 1B	
Graph includes title	
X and Y axis labeled	
Scatterplot of averages	
Best fit line	
Part 2	
Identify a variable that could change the reaction rate.	
Explain what has to happen for two molecules to react in terms of kinetic energy.	
Explain what has to happen for two molecules to react in terms of orientation.	
Explain the effect of changing the variable on collisions between atoms/molecules.	
Draw a before and after picture of the atoms/molecules interacting. Your after picture should include a representation of the effects of the changing variable.	
Total	/13

Test: Reaction Rate **Name:** **Period:**

1. What effect does increasing the number of collisions between molecules have on the reaction rate?
    a. the reaction rate increases
    b. the reaction rate stays the same
    c. the reaction rate decreases

2. As the surface area of a solid reactant increases, what happens to the rate of reaction?
    a. decreases because of a decrease in collision frequency
    b. decreases because of an increase in the activation energy
    c. increases because of an increase in collision frequency
    d. increases because of a decrease in the activation energy

3. The probability of bonds breaking during a collision of molecules depends on which of the following?
    a. the kinetic energy of the collision must be sufficient to break the bond
    b. the bond must be ionic so that electrons can be transferred
    c. the thermal energy must be great enough to form the new bond
    d. the molecules polarity must be opposite

4. What factor(s) affect the rate of a chemical reaction? **Select all correct responses.**

    ○ Size of reaction container

    ○ Temperature of reactants

    ○ Presence of a catalyst

    ○ Molar mass of products

    ○ Density of reactants

    ○ Concentration of reactants

5. How does a catalyst increase the rate of a chemical reaction?

    a. creates more reactants
    b. gets used up instead of a reactant
    c. lowers the activation energy
    d. increases the number of molecules colliding

6. How can the frequency of collisions be increased? **Select all correct responses.**

    ○ Decreasing the concentration of the reactant particles

    ○ Increasing the concentration of the reactant particles

    ○ Increasing the temperature of the reaction

    ○ Decreasing the temperature of the reaction

7. What is one way to increase the surface area of a reactant?

    a. add heat energy to the reactants
    b. add a catalyst
    c. remove some reactant
    d. crush solid reactant into smaller pieces

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UNIT 8:
EQUILIBRIUM

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Unit 8: Equilibrium

Standard:

HS-PS1-6: Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium.

Model:

Question: What happens when you shake the test tube?

Materials:

- Test tubes with lids
- Methylene blue solution 1%
- Dextrose (8 g/300 mL water)
- Potassium hydroxide (10g)
- Distilled water
- Flask
- Balance

Procedure:

Follow Flinn's procedure to make a batch solution to then pour into test tubes for each pair of students. Solution will last a couple hours depending on number of times shook.

Learning Objective:

I can communicate my existing ideas about modeling equilibrium reactions.

Engage:

1. POGIL: Equilibrium
2. POGIL Lab: Equilibrium Shift

Learning Objectives:

I can describe a stress involving a change to one component of an equilibrium system affects the other components.
I can describe how changing the concentration of one of the components of the equilibrium system will change the rate of reaction.

Explore:

1. Equilibrium Virtual Activity
2. Living by Chemistry: How Dynamic Activity

Learning Objective:

I can describe how both the forward and reverse reactions in a system at equilibrium are occurring at the same rate.

Explain:

1. cK-12 Reversible Reaction
2. cK-12 Chemical Equilibrium
3. cK-12 Le Châtelier's Principle
4. cK-12 Effect of Concentration
5. cK-12 Effect of Temperature
6. cK-12 Effect of Pressure
7. Equilibrium Notes

Learning Objective:

I can describe stressors and effects to equilibrium systems.

Extend/Elaborate:

Revisit Model

Use the words from the following word bank in your explanations of the phenomena:

- Equilibrium
- Shift
- Stressor
- Reactants
- Products

Answer the following as well:
If this was an endothermic reaction, heat as a reactant, how could you shift the equilibrium to the right?

Learning Objective:

I can revise a model to add details about equilibrium reactions.

Evaluate:

1. Task
2. Test

Name:_____ Name:_____ Period:_____

What happens when you shake the test tube?

Record your observations at each of the times shown below:

Before shaking:	Immediately after shaking:	Two minutes after shaking:
		

Use the following words and symbols to describe what you think is happening to cause what you observed:

Colorless Solution **Blue Solution** O_2 ← → +

How does your chemical equation explain the changes you observed?	What questions do you have? What information do you need to understand this phenomena?

Equilibrium Virtual Activity

So far, we have learned that chemical reactions involve reactants turning into products, with the arrow in the chemical equation always pointing from left to right (⇒). We know that the reaction continues until all the reactants have been transformed into products. But it turns out that many chemical reactions are actually **reversible** - meaning they go both directions. Reactants transform into products *and* products transform into reactants. These reactions have a arrows pointing both forward and backward (⇄). At the start of a reversible process, the reaction proceeds toward the formation of products. Then, as soon as some product molecules are formed, the reverse process begins to happen and reactant molecules are formed from product molecules.

A special state of back and forth reaction, called **chemical equilibrium,** happens when the rates of the forward and reverse reactions are equal. This process can be described like the movement of skiers at a busy ski resort where the number of skiers carried up the mountain on a chair lift is equal to the number coming down on the slopes. Although there is a constant transfer of skiers, the number of people at the top and the number at the bottom of the slope do not change once equilibrium is established.

However, when a **stressor** (changes to the system) is applied to a reaction, the **equilibrium** will be disrupted. The rates will no longer be equal and products or reactants will begin piling up in greater numbers. In response to this stress, the chemical reaction will proceed in such a way to adjust the rates and establish a new **equilibrium**.

PURPOSE: To explore the effects different **stressors** have on equilibrium.

PROCEDURE:

Each part below includes a chemical equation, a description of the colors of the reactants and products, and a link to a photo of the substances before and after some stressor has been applied. For each reaction:

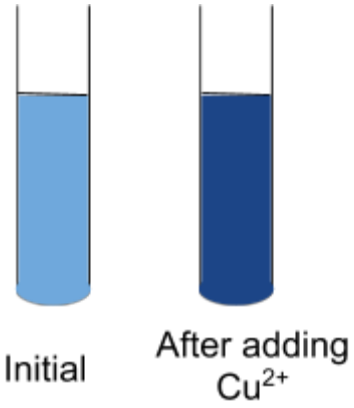
1) Click the link to see the effect of a **stressor** on **chemical equilibrium**.
2) Based on your observations, answer the question about the shift that the reaction undergoes in response to the **stressor**.

Example:

$Cu^{+2} + 4\ NH_3 \rightleftarrows Cu(NH_3)_4^{+2}$

light blue dark blue

1. How does increasing the Cu^{2+} concentration shift the chemical reaction?



Answer:

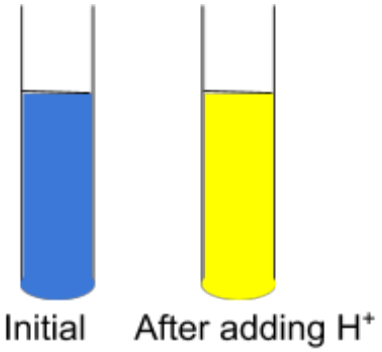
Part 1: Concentration

A.

$HIN_{(aq)} \rightleftarrows H^+ + IN^-$

Yellow Blue

2. How does increasing the H+ concentration shift the chemical reaction?

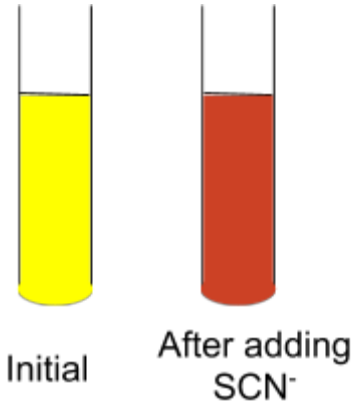


B.

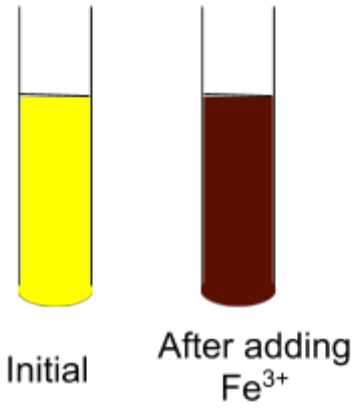
$Fe^{3+} + SCN^- \rightleftarrows FeSCN^{2+}$

Pale yellow Red

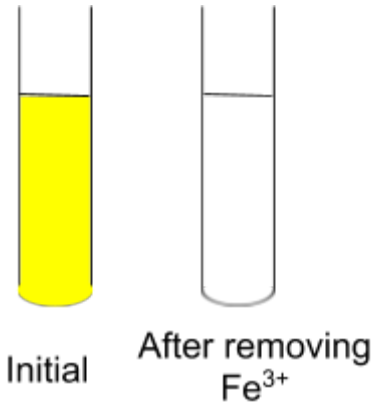
1. How does increasing the SCN^- concentration shift the reaction?



2. How does increasing the Fe^{3+} concentration shift the reaction?



3. How does decreasing the Fe^{3+} concentration shift the reaction?



C. When the concentration of a substance was increased, did equilibrium shift away or towards that side of the reaction?

D. When the concentration of a substance was decreased, did equilibrium shift away or towards that side of the reaction?

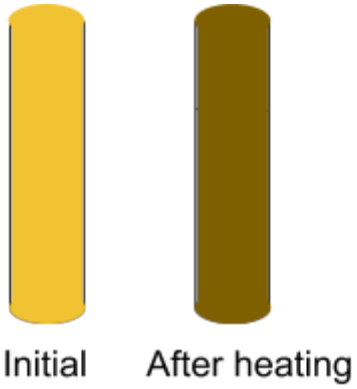
Part 2: Temperature

A.

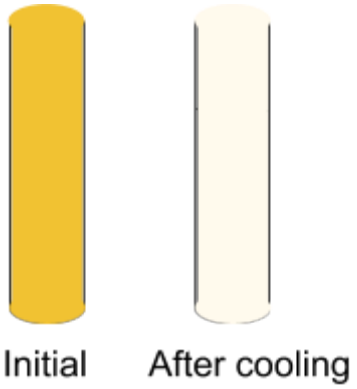
$NO_2 \rightleftarrows N_2O_4$ + heat

Brown Colorless

1. How does increasing the heat shift the reaction?



2. How does decreasing the heat shift the reaction?



B. When the temperature was increased, did equilibrium shift away or towards the side of the reaction that contains the heat?

C. When the temperature was decreased, did equilibrium shift away or towards the side of the reaction that contains the heat?

Part 3: Application

A. $2CrO_4^{2-} + 2H^+ \rightleftarrows Cr_2O_7^{2-} + H_2O$

Yellow Red

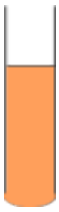
Initially contains both CrO_4^{-2} and $Cr_2O_7^{-2}$

1. Show what would happen if more H^+ was added to the solution.

2. Show what would happen if H^+ was removed from the solution.

B. $Fe^{3+} + SCN^{-} \rightleftarrows FeSCN^{2+} + heat$

Pale yellow Red



3. Show what would happen if the solution was heated:

4. Show what would happen if the solution was cooled:

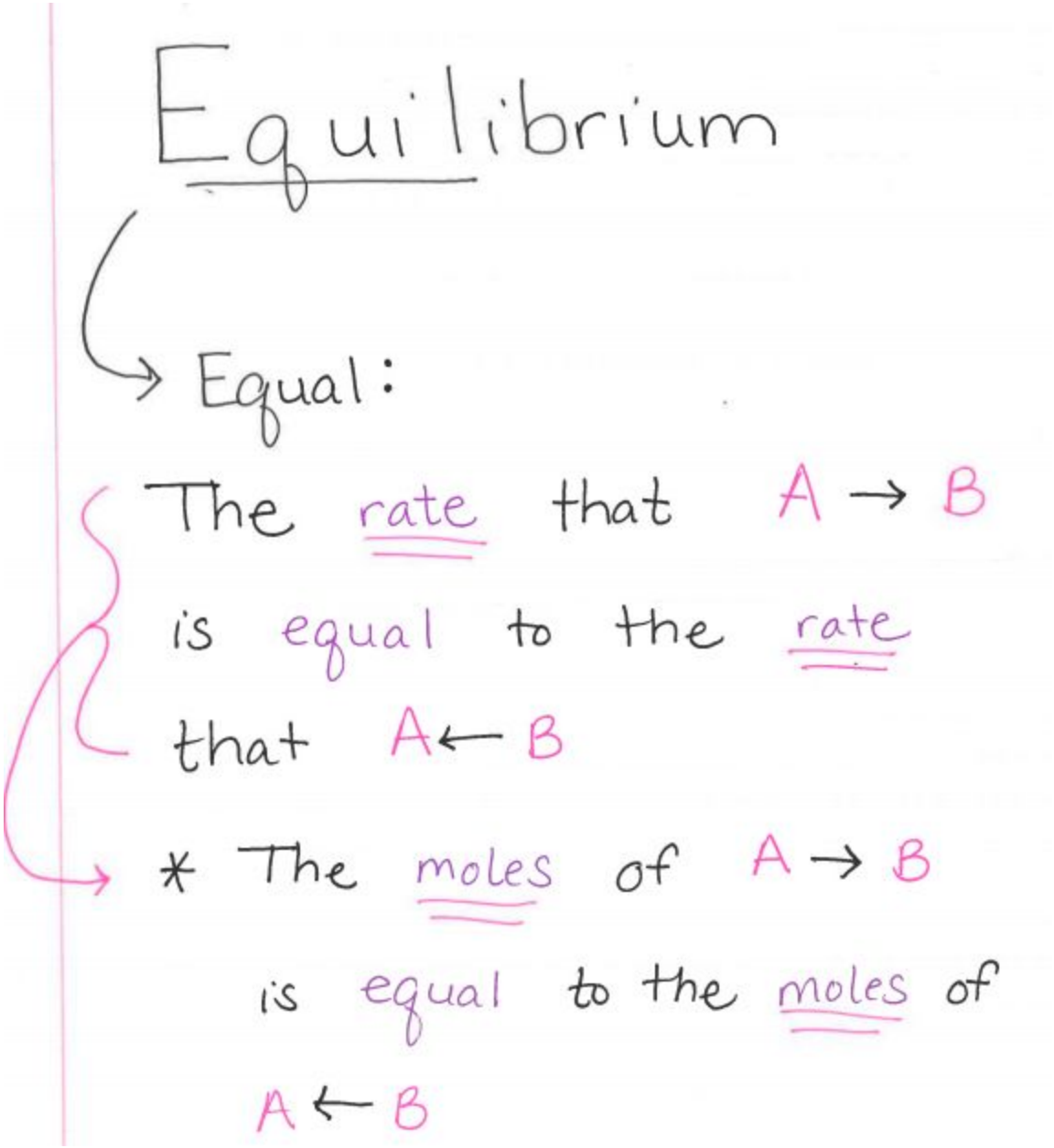
C. Methanol, CH_3OH, can be produced by the reaction of carbon monoxide with hydrogen gas:

$$CO + 2\ H_2 \rightleftarrows CH_3OH + heat$$

In an attempt to maximize the amount of methanol produced a chemist would try to shift the equilibrium to the right. Which of the following would accomplish this?

- heating the mixture
- cooling the mixture
- adding more carbon monoxide
- adding more hydrogen
- removing the methanol as it is formed

Equilibrium Notes



Task: Equilibrium

You are hired as a chemical engineer for Wildcat Chemical Co. The company produces and sells the following chemicals:

- Ammonia, NH_3, for use in cleaning products
- Calcium oxide, CaO, for making cement
- Hydrogen, H_2, for welding
- Methanol, CH_3OH, for use in antifreeze for vehicles

Your boss wants you to figure out a way to increase the amount of one of those chemical being produced **without buying more reactants**.

Your task:

1) Choose one of the chemical reactions
   - ❑ Ammonia: $N_{2(g)} + 3H_{2(g)} \rightleftarrows 2\,NH_{3(g)} + heat$
   - ❑ Calcium Oxide: $CaCO_{3(s)} + heat \rightleftarrows CaO_{(s)} + CO_{2(g)}$
   - ❑ Hydrogen: $CH_{4(g)} + H_2O_{(g)} + heat \rightleftarrows 3H_{2(g)} + CO_{(g)}$
   - ❑ Methanol: $CO_{(g)} + 2H_{2(g)} \rightleftarrows CH_3OH_{(g)} + heat$

2) Describe a change in conditions (stressor) that will produce increased amounts of products at equilibrium.

3) Explain how, on a molecular level, your proposed change will affect other components of the system and result in increased product.

4) Explain why your proposed change is the best solution to increasing the amount of product. Your justification should include cost, energy consumption, or hazardous nature of chemicals.

Task Rubric: Equilibrium

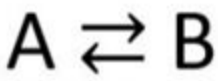
Learning Evidence	1 point
Identifies stressor that can produce more products	
Correctly describes how stressor will impact reaction	
Includes a description of change on the molecular level	
Includes explanation of why the proposed solution is the best option in terms of either cost, energy consumption or hazardous nature of chemicals	
Total	**/4**

Test: Equilibrium **Name:** **Period:**

1. Which of the following are stresses that can be applied to a chemical system? **Select all correct responses.**
   - ○ concentration of reactants and/or products
   - ○ temperature
   - ○ pressure
   - ○ time

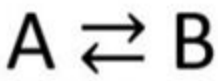
2. According to Le Châtelier's Principle, whenever a stress is applied to a system at equilibrium, the equilibrium shifts in such a way as to do what?
   a. change the rate of reaction
   b. resist the stress applied
   c. undo the effect of the stress imposed
   d. ensure all mass in the system is conserved

3. Imagine starting with 100 molecules of B and no molecules of A. What will happen to the concentrations of A or B as the reaction proceeds?



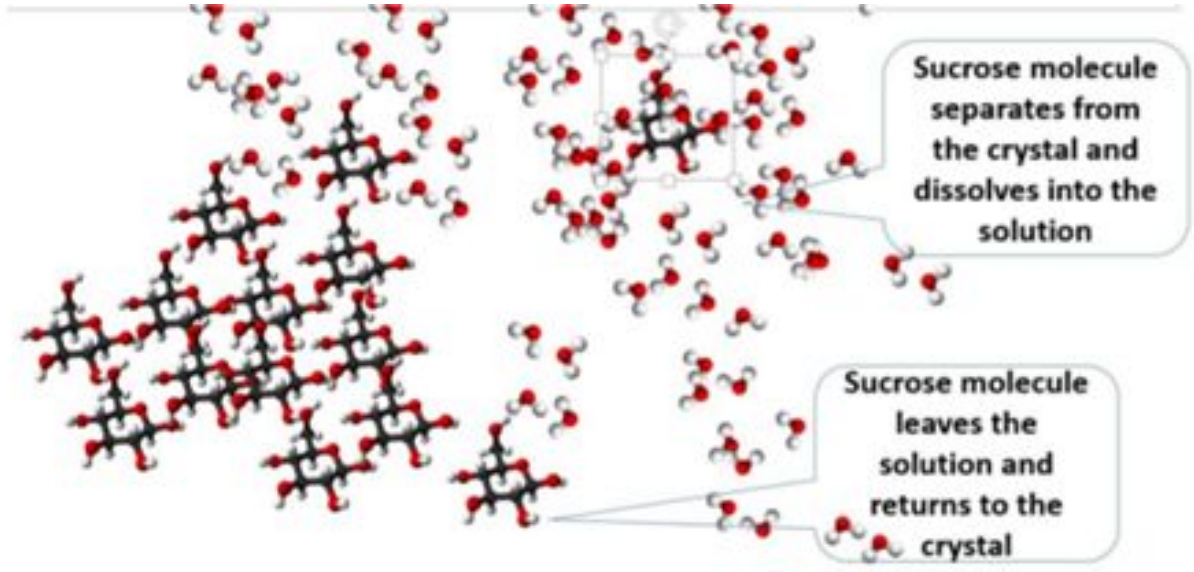
   a. The concentration of A will decrease.
   b. The reaction will not proceed because there are no molecules of chemical A.
   c. The concentration of B will increase.
   d. The concentration of B will decrease

4. What is the significance of the double arrow in the equation below? **Select all correct responses.**



   - ○ There will be equal amounts of A and B at all times.
   - ○ The reaction can take place in both forward and backward direction.
   - ○ The reaction is reversible.
   - ○ When A runs out the reaction will end.

5. The system below is a saturated solution of sugar in water. Sucrose molecules are leaving the sugar crystal and returning to the sugar crystal at the same rate.



   a. There would be no visible sugar in the container.
   b. The sugar in the container would appear to dissolve and reappear.
   c. The solution would have undissolved sugar in the container that appeared to be doing nothing.
   d. The sugar in the solution would appear to get larger in volume

6. Once equilibrium is reached, how do the number of moles of A lost and the number of moles of A gained in one minute compare?

$$A \rightleftarrows B$$

   a. The number of moles of A lost will equal the number of moles of A gained.
   b. The number of moles of A will be zero in both cases.
   c. The reaction will not proceed because there are not any molecules of chemical A.
   d. The number of moles of A lost will be greater than the number of moles of A gained.

7. Consider the reaction below. Which of the following can shift the reaction's position to the left?
   a. Adding product C
   b. Adding reactant A
   c. Decreasing temperature
   d. Removing product D

OAK HARBOR PUBLIC SCHOOLS

UNIT 9:
PROPERTIES OF WATER

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Unit 9: Properties of Water

Standard:

HS-ESS2-5: Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.

Model:

Question: How can you make a cork float in the center of a cup of water for 1 minute without touching the sides?

Materials:

- Corks
- Water
- Plastic cups

Learning Objective:

I can communicate my existing ideas about properties of water on the molecular level.

Engage:

Properties of Water Stations and Directions

Learning Objective:

I can identify different properties of water.

Explore:

Kesler Stations: Properties of Water

Learning Objective:

I can describe properties of water such as: heat capacity, polarity, and density.

Explain:

1. cK-12 Structure of Water
2. cK-12 Structure of Ice
3. cK-12 Physical Properties
4. cK-12 Solute and Solvent
5. cK-12 Dissolving Process
6. Water Properties Note Sheet and Notes

Learning Objective:

I can describe properties of water and why they exist.

Extend/Elaborate:

Revisit Model

For the zoom-in view include:

- Water molecules
- Polar
- H bonds

For the explanation include:

- Cohesion
- Adhesion
- Surface tension
- Density

Learning Objective:

I can revise a model to add details illustrating the properties of water.

Evaluate:

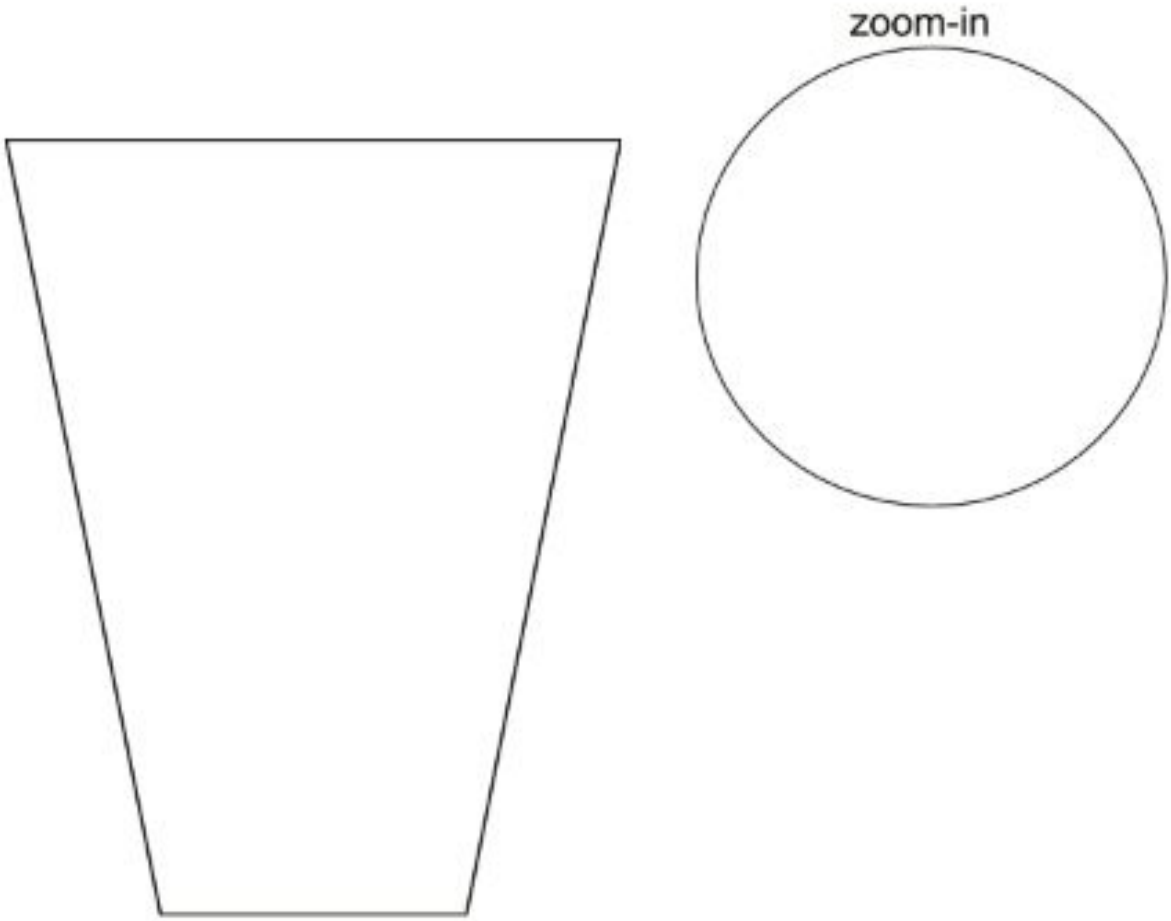
1. Task
2. Test

Water Model

Name:_____ Name:_____ Period:_____

Challenge: Make a cork float and stay in the center of a cup of water for 1 minute without touching the sides.

Draw your solution to the cork float challenge:



Explain why your solution worked:

Properties of Water Stations

One Way Screen **Property**	**Solid vs Liquid Water** **Property**
Baby Oil and Water **Property**	**Water Layers** **Property**

Index Attachment **Property**	**Water Hat** **Property**
Tears in Space **Property**	**Liquid Mountaineering** **Property**

Properties of Water Stations Directions

One Way Screen

CHALLENGE #1: Put water in the jar. Keep the water in the jar after turning it upside down.

CHALLENGE #2: Once you have the jar upside down, try to make a toothpick float to the top of the water without spilling it.

OBSERVATIONS SHEET: Explain how you accomplished the task and why your solution worked.

PROPERTY: What properties of water does this challenge emphasize? (List a minimum of two.)

Solid vs. Liquid Water

DIRECTIONS:

1. Add 40 ml of water to a beaker, and then 30 ml of oil on top of the water. Allow the layers to separate.

2. Add 8-10 drops of food coloring to the surface of the oil without touching the liquid in the beaker. Observe the motion of the food coloring.

3. Place a small piece of blue ice cube gently onto the top of the oil. Observe the ice cube/liquid as it melts.

OBSERVATIONS SHEET: Describe what you are seeing and why.

PROPERTY: What properties of water does this demonstration emphasize? (List a minimum of two.)

Baby Oil and Water

DIRECTIONS:

1. Gently shake the container with the baby oil and blue water.

OBSERVATIONS SHEET: Describe what you are seeing and why.

PROPERTY: What properties of water does this demonstration emphasize? (List a minimum of two.)

Water Layers

CHALLENGE: Make 3 distinct, separate layers of water in the beaker - blue, clear and red.

OBSERVATIONS SHEET: Explain how you accomplished the task and why the water does what we observe.

PROPERTY: What property of water does this demonstration emphasize?

Index Attachment

CHALLENGE: Using a cup, water, and an index card. Get the index card to stick to the opening of the cup while holding it upside down.

OBSERVATIONS SHEET: Explain how you accomplished the task. Explain why your solution works.

PROPERTY: What property of water does this challenge emphasize?

Water Hat

DIRECTIONS: Navigate to

https://www.ngssphenomena.com/water-hat/ Observe the image.

OBSERVATIONS SHEET: Describe what is happening and why.

PROPERTY: What property of water does this demonstration emphasize?

Tears in Space

DIRECTIONS: Navigate to https://www.youtube.com/watch?v=P36xhtpw0Lg

OBSERVATIONS SHEET: Describe what is happening and why.

PROPERTY: What property of water does this demonstration emphasize?

Liquid Mountaineering

DIRECTIONS: Navigate to https://youtu.be/Oe3St1GgoHQ Watch the video.

OBSERVATIONS SHEET: Describe what is happening and why.

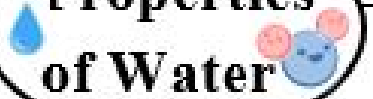
PROPERTY: What property of water does this demonstration emphasize?

Properties of Water Notes

Solubility

Heat Capacity

Properties of Water



"Stickiness"

due to:

leads to:

Density

"Like dissolves like"

Properties of Water

Solubility:

- Water is a polar molecule
- e^- shared unevenly between H and O

- this allows water to pull other polar molecules apart

Heat Capacity

- H_2O has a high heat capacity
- This means H_2O can absorb a lot of energy before liquid turns to gas
- Because of H bonds between molecules

Stickiness

- due to:
  - → Cohesion: water sticks to water
  - → Adhesion: water sticks to other things

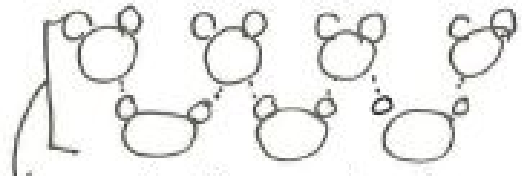
Leads to:

→ surface tension

→ Capillary Action

Density

- Cold liquid water is more dense than hot water
- Solid water (ice) is less dense than liquid water
  - ↳ because of polarity



↳ crystaline structure

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Task: Properties of Water

Properties of Water Investigation

1. Choose a property of water to design and conduct an investigation on:
   - ❏ Surface tension
   - ❏ Density
   - ❏ Heat capacity
   - ❏ Solubility
2. Identify a manipulated variable (what you are changing):
3. Identify a responding variable (what you are measuring):

Question: How does [insert manipulated variable] affect [insert responding variable]?

Hypothesis:
If the [insert manipulated variable] is [choose one - increased/decreased] then the [insert responding variable] will [choose one - increased/decreased] because [insert brief reason for your prediction].

Materials:
- [insert list of materials used in your investigation]

Procedure:
1. [Insert a series of numbered steps describing the process used in your investigation]

Data:
[Insert a data table that includes trial data and averages]

Conclusion:
[Insert a conclusion to your investigation]

Task Rubric: Properties of Water

Learning Evidence	1 point
Hypothesis includes manipulated and responding variables	
Materials list includes all items necessary to conduct the investigation	
Procedure includes one manipulated variable and one responding variable	
Procedure includes logical steps that could be repeated and produce the same data	
A data table shows the values of the responding variable for each condition of the manipulated variable and average values if multiple trials were conducted.	
The conclusion includes a statement of how the manipulated variable affected the reaction rate.	
The conclusion uses data (average data when available) to support the conclusive statement.	
Total	**/7**

Test: Properties of Water **Name:** **Period:**

1. Which property of water allows for capillary action?
    a. heat capacity
    b. adhesion
    c. solubility
    d. density

2. Water is called a "universal solvent" because it dissolves many compounds. Why does water dissolve so many substances?
    a. because of its low specific heat capacity
    b. because it is polar
    c. because of its high specific heat capacity
    d. because it is liquid

3. Which of the following are special properties of liquid water? **Select all correct responses.**
    - ○ low light transmission
    - ○ strong surface tension
    - ○ higher density than solid water
    - ○ large heat capacity

4. What causes water to form drops when falling from clouds?
    a. cohesion
    b. heat capacity
    c. density
    d. covalent bonding

5. What is the temperature at which water reaches maximum density?
    a. 100 °Celsius
    b. 0 °Celsius
    c. 4 °Celsius
    d. 32 °Fahrenheit

6. Cohesion occurs due to which type of bonding?
    a. ionic
    b. covalent
    c. Double
    d. hydrogen

7. Why is water classified as a polar molecule?
    a. a water molecule has no charge
    b. a water molecule has identical charges at opposite ends
    c. a water molecule has an unequal number of protons and electrons
    d. a water molecule has opposite charges at opposite ends

8. The high heat capacity of water allows it to do what? **Select all correct responses.**
    - ○ boil at higher temperatures than many liquids
    - ○ absorb large amounts of heat energy before the temperature changes
    - ○ float as a solid on its liquid form
    - ○ form additional hydrogen bonds

OAK HARBOR PUBLIC SCHOOLS

UNIT 10:
MANAGING RESOURCES

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Unit 10: Managing Resources

Standards:

HS-ESS3-2: Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.
HS-ETS1-1: Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal

Engage:

Question: What are the costs and benefits of open pit mining as seen in this photo?

Materials:

- Photo of open pit mine

Procedure:
Show students photo of mining operation and identify the natural resources coming from that mine.
Students write and sketch their answers to the question

Learning Objective:

I can communicate my existing ideas about developing, managing, and utilizing energy and mineral resources.

Explore:

1. Cookie Mining Lab
2. Cookie Mining Lab Sheet
3. Cookie Mining CER

Learning Objective:

I can design solutions for developing and managing mineral resources based on cost benefit analysis.

Explain:

1. cK-12 Finding and Mining Ore
2. cK-12 Environmental Impacts of Mining
3. cK-12 Availability of Natural Resources
4. cK-12 Renewable vs Nonrenewable Resources

Learning Objective:

I can identify different types of resources and whether they are reusable.

Extend/Elaborate:

NOVA Poisoned Water Flint Michigan Video

Learning Objective:

I can describe water as a natural resource which is increasingly difficult to obtain.

Evaluate:

Task

Global Challenge: Clean Water for Drinking

Water is a natural resource for many reasons. Water is used in virtually every human activity from manufacturing, to agriculture, to transportation, to energy production. Perhaps one of the most important uses of water is for drinking. A healthy human can survive no more than three days without drinking water.

In a growing number of places, water that is clean and safe is difficult to obtain. A major challenge for your generation will be designing ways to ensure all people have access to clean water for drinking.

In this activity, you will work in groups to evaluate competing design solutions for managing clean drinking water supplies. Your group will conduct research using the online resources listed at the end of this packet.

Part 1: Research

System & Natural Resource involved:

1. What *Earth systems* are involved with obtaining water for drinking?

2. How many people in the world live in areas where obtaining clean water is difficult? What are some of these locations?

3. What are some reasons that clean water is difficult to obtain in the places you listed in question 2?

Costs and Risks:

4. Describe 2 costs of obtaining clean water.

5. Describe 2 risks of obtaining clean water.

6. Describe 2 benefits of obtaining clean water.

Personal Connection:

7. Where does your water supply come from for your home? (If your group members have different water supplies, list them all.)

8. What are the potential risks to your water supply?

Part 2: Evaluating Solutions

Two solutions to providing clean water are reverse osmosis and recycling wastewater. Your group will research each of these possible solutions. You will then choose which solution is the best and conduct a Claim, Evidence, Reasoning process to defend your choice.

Pros and Cons
Identify at least two pros and two cons of reverse osmosis.

Identify at least two pros and two cons of recycling wastewater.

Claim, Evidence and Reasoning
Make a claim for which solution is "best".

Defend your claim using three cited pieces of evidence from your research, pros and cons.

Explain the scientific reasoning for your choice.

Prepare to present the argument for your choice to the class.

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UNIT 11:
PROPERTIES OF SUBSTANCES AND INTERMOLECULAR FORCES

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Unit 11: Properties of Substances and Intermolecular Forces

Standards:

HS-PS1-3: Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.

HS-PS2-6: Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.

Model:

Question: Why does ice melt at different rates if placed on different surfaces?

Materials:

- Flinn ice melting blocks
- Ice
- Infrared thermometer

Learning Objective:

I can communicate my existing ideas about different properties of different materials.

Explore:

1. Structure of Substances Stations and Answer Key
2. Materials and their uses Stations and Answer Key

Learning Objectives:

I can identify why particular substances are used for specific purposes based on their properties.
I can differentiate between properties of metals and nonmetals.
I can describe why materials conduct electricity.

Extend/Elaborate:

Revisit Model

Include the following terms:

- Conductor
- Insulator
- Polymer
- Heat capacity

Learning Objective:

I can revise a model to add details about materials and their properties.

Name:_____ Name:_____ Period:_____

Why does ice melt at different rates if placed on different surfaces?

Complete the drawings, *1 minute* after placing ice on each block, to show how the type of material affects the rate at which ice melts.

 Initial temperature of block: 	 Initial temperature of block: 
Explain what caused the difference in rates:	
What are some uses of plastics?	What are some uses of metals?

Structure of Substances Stations

Write It! #1

Explain why melting points of molecular compounds are generally lower than those of ionic compounds.

Write It! #2

Explain why baby oil doesn't dissolve in water in terms of intermolecular forces.

Write It! #3

Explain how the temperature of salt water be below 0°C and still be liquid.

Assess It! #1

Which of the following statements about melting is true?

A. Melting is a change of state.
B. Melting is a chemical change.
C. Some substances do not melt no matter how hot they become.
D. Melting changes the chemical properties of matter.

Assess It! #2

As the temperature rises, the number of molecules escaping from a liquid surface _____.

A. Decreases
B. Remains constant
C. May increase or decrease depending on the type of the liquid
D. Increases

Assess It! #3

How are intermolecular forces different than intramolecular forces (ionic and covalent bonding)?

A. Intermolecular forces happen within a molecule
B. Intermolecular forces are much stronger than intramolecular forces
C. Intermolecular forces happen between molecules
D. Intramolecular forces happen between molecules

Assess It! #4

Why does water have a higher viscosity than methanol?

A. Intermolecular forces of water are greater than in methanol
B. Intermolecular forces of methanol are greater than in water
C. Intramolecular forces of methanol are greater than in water
D. None of the above

Read It!

Melting Point

Solids are similar to liquids in that both are condensed states, with particles that are far closer together than those of a gas. However, while liquids are fluid, solids are not. The particles of most solids are packed tightly together in an orderly arrangement. The motion of individual atoms, ions, or molecules in a solid is restricted to **vibrational motion** about a fixed point. Solids are almost completely **incompressible** and are the densest of the three states of matter.

As a solid is heated, its particles vibrate more rapidly as the solid absorbs kinetic energy. Eventually, the organization of the particles within the solid structure begins to break down and the solid starts to melt. The **melting point** is the temperature at which a solid changes into a liquid. At its melting point, the disruptive vibrations of the particles of the solid overcome the attractive forces operating within the solid. As with boiling points, the melting point of a solid is dependent on the strength of those attractive forces.

Physical Properties and Intermolecular Forces

The physical state and properties of a particular compound depend in large part on the type of chemical bonding it displays. **Molecular compounds**, sometimes called covalent compounds, display a wide range of physical properties due to the different types of intermolecular attractions such as different kinds of polar interactions. The melting and boiling points of molecular compounds are generally quite low compared to those of **ionic compounds**. This is because the energy required to disrupt the **intermolecular forces** between molecules is far less than the energy required to break the ionic bonds in a crystalline ionic compound. Since molecular compounds are composed of neutral molecules, their electrical conductivity is generally quite poor, whether in the solid or liquid state. Ionic compounds do not conduct electricity in the solid state because of their rigid structure, but conduct well when either molten or dissolved into a solution. The water solubility of molecular compounds is variable and depends primarily on the type of intermolecular forces involved.

Read It! #1

When solids melt, the atoms become separated as the attraction between them _____.

A. Decreases
B. Increases
C. Fluctuates
D. None of the above

Read It! #2

Which of the following are not properties of molecular compounds?

A. Their bonding is weaker than covalent and ionic bonds
B. Hard to break
C. They are packed as closely as their size and shape allow
D. Low melting point

Read It! #3

Intermolecular forces can exist between:

A. Atom
B. Molecules
C. Ions
D. All of the above

Read It! #4

Most polar substances are soluble in water because water molecules are

A. inorganic.
B. covalent.
C. nonpolar.
D. polar.

Watch It! #1

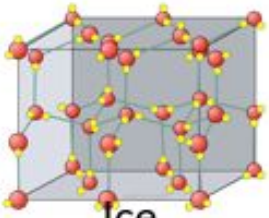
Watch: https://goo.gl/V3oXPz

Watch It! #2

Define viscosity.

Watch It! #3

How are the bonds in solid glass different from solid ice?



Ice

Watch It! #4

Is the Earth's mantle liquid or solid?

Research It! #1

1. Place a test tube with beeswax and a test tube with coconut oil into a hot water bath.
2. Observe which substance melts more quickly.
3. Record Results.

Research It! #2

These two substances are held together by covalent bonds. Which of the substances has stronger intermolecular forces? Support your answer with evidence.

Research It! #3

1. Visit https://goo.gl/vqiPzX
2. Increase the temperature and observe the molecules.
3. The gray molecules have covalent bonds while the red/blue have ionic bonds. Which substance has stronger intermolecular forces?

Research It! #4

Predict whether salt, NaCl, molecules or sugar, $C_6H_{12}O_6$, molecules would melt at a lower temperature.

Explore It! #1

1. Measure **40** mL hot tap water into a 50 mL beaker. Record temperature of water.
2. Add **1** g salt and start a timer to measure how long it takes for the salt to dissolve.
3. Slowly stir solution using glass rod.
4. Record time.

Explore It! #2

1. Measure **40** mL cold water into a 50 mL beaker. Record temperature of water.
2. Add **1** g salt and start a timer to measure how long it takes for the salt to dissolve.
3. Slowly stir solution using glass rod.
4. Record time.

Explore It! #3

Compare your experimental results.

Explore It! #4

From your results infer, how does thermal energy impact the forces of attraction between the salt particles?

Illustrate It! #1

Experiment A

1. Place a piece of Styrofoam into each petri dish.
2. Add **15** drops of water onto the Styrofoam.
3. Describe your results

Illustrate It! #2

Experiment B

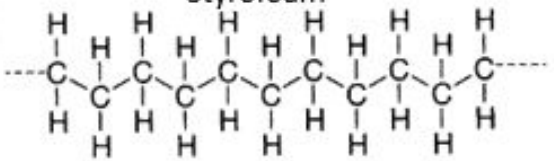
1. Place a piece of Styrofoam into each petri dish.
2. Add **15** drops of acetone onto the Styrofoam.
3. Describe your results

Illustrate It! #3

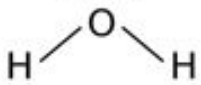
Likes dissolve likes. Based on this which of the two experiments, A or B, follow this rule.

Illustrate It! #4

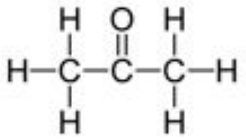
Styrofoam



Water



Acetone



Draw a model of what these two experiments look like on the molecular level.

Properties of Ethyl Alcohol	Weak intermolecular forces
Properties of Water	Strong intermolecular forces
High vapor pressure	High boiling point
Low vapor pressure	Low boiling point

Structure of Substances Name_____

Explore It!

Task Card #1:
Temperature:
Time:

Task Card #2:
Temperature:
Time:

Task Card #3:

Task Card #4:

Organize It!

Write It!

Task Card #1:

_____

_____

Task Card #2:

_____

_____

Task Card #3:

_____

_____

Structure of Substances Name_____

Illustrate It!

Task Card #1:

Task Card #4:

Task Card #2:

Task Card #3:

Assess It!

#1 ____ #2 ____

#3____ #4 ____

Read It!

#1 ____ #2 ____

#3____ #4 ____

Research It!

Task Card #1:

3.

Task Card #2:

Task Card #3:

3.

Task Card #4:

Watch It!

Task Card #2:

_____

_____

Task Card #3:

_____

_____

Task Card #4:

Structure of Substances Name Joey

Explore It!

Task Card #1: hot
Temperature:
Time: ~~15h~~ less

Task Card #2: cold
Temperature:
Time: more

Task Card #3:
the warm/hot water took less time to dissolve

Task Card #4:
the energy from the hot water molecules is able to overcome the intermolecular forces of the NaCl

Organize It!

- Water -
high boiling pt
strong intermolecular
low vapor pressure

-ethyl -
low boiling pt
weak intermolecular
high vapor pressure

Write It!

Task Card #1:
the intermolecular forces between molecular compands are less (not as great) as the intermolecular forces between ionic molecules

Task Card #2:
the intermolecular forces between the baby oil molecules are greater than the intermolecular forces between baby oil + water

Task Card #3:
The salt (ionic compand) has a lower freezing point than H_2O; the change in energy (temp.) required to rearrange molecules is far less for pure water than for a salt solution

Structure of Substances Name Jess

Illustrate It!

A: Water B: Acetone

Task Card #1:

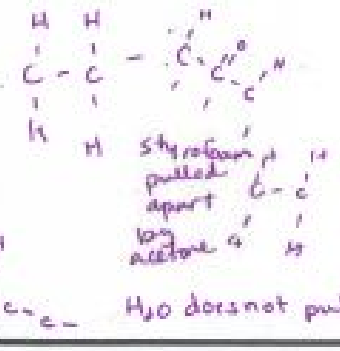
Styrofoam did not dissolve

Task Card #2:

Styrofoam dissolved

Task Card #3:

Task Card #4:



Assess It!

#1 A #2 D

#3 C #4 A

Read It!

#1 A #2 A

#3 B #4 D

Research It!

Task Card #1: Coconut oil melts more quickly

3.

Task Card #2: paraffin has greater intermolecular forces, requires more energy to change physical state

Task Card #3:

3. ionic compounds have greater intermolecular forces

Task Card #4:

$C_6H_{12}O_6$ would melt at a lower temp. b/c it is a covalent molecule

Watch It!

Task Card #2:

Viscosity = resistance to flow

Task Card #3:

amorphous solid- cools down slow quickly from liquid to solid that the molecules can't arrange themselves, molecules can't slide past each other- solid.

Task Card #4:

Solid rock: high pressure creates a scenario where a solid can act like a liquid (over long periods of time)

Materials and their uses Stations

Write It! #1

Give an example of a material that is a good conductor. ___________

What makes this material a good conductor?

Write It! #2

You are a building engineer, what sort of properties do you need to consider when choosing materials for your project?

Write It! #3

Silicon (Si) and germanium (Ge) are semi-conductors, what does this mean?

Assess It! #1

What property of a material is measured by conductivity?

A. How well it dissolves in a solvent.
B. How high the melting and boiling points are.
C. How well an electrical charge can move through the material.
D. How well the material makes polymers.

Assess It! #2

Why are metals good conductors?

A. They have overlapping valence electrons providing an abundance of free electrons.
B. They are malleable (can be hammered into flat sheets)
C. They are ductile (can be pulled into a wired)
D. They usually make covalent bonds.

Assess It! #3

The small, repeating units that comprise a polymer are called _____.

A. Cells
B. Monomers
C. Radicals
D. unimers

Assess It! #4

What is a major disadvantage of artificial polymers?

A. They do not degrade in the environment.
B. They are not useful for very many products.
C. They contain toxic metals.
D. They are expensive to manufacture.

Read It! #1

In solid conductors, why can electrons flow freely through them?

A. positive ions are free
B. protons are free
C. electrons are free
D. negative ions are free

Read It! #2

Why must ionic conductors be in a solution to conduct electricity?

A. ions are free to move
B. protons are free to move
C. electrons are free move
D. water is a great conductor

Read It! #3

Opposite charges _____ and like charges _____

A. repel; repel
B. attract; repel
C. repel; attract
D. attract; attract

Read It! #4

The farther apart two charges are, the force between the charges _____

A. stays the same
B. Increases
C. Decreases
D. the is no force between the charges

Watch It! #1

Watch: https://goo.gl/RR5ntw

Watch It! #2

Define polymer.

Watch It! #3

Give examples of polymers and their uses.

Watch It! #4

What are properties of polymers that make them so useful?

Research It! #1

Experiment A

1. On the table you will find an energy tube pick it up with one hand.
2. Record results.

Research It! #2

Experiment B

1. Now place a hand on either side or hold hands with another person each of you holding one end of the tube.
2. Record results.

Research It! #3

Explain why the results from Experiment A and B are different.

Research It! #4

Watch: https://goo.gl/GpKwiw

Explain how the energy tube is able to conduct electricity using vocabulary from the video.

Explore It! #1

1. Mix 10 mL borax with 50 mL PVA in a Ziploc bag.
2. Mix substances thoroughly until combined.

Explore It! #2

Describe the substance's properties.

Explore It! #3

This substance is an example of a polymer; based on your observations what can you infer about the strength and durability of polymers?

Explore It! #4

How might polymers be used by society?

Illustrate It! Station Directions

Each member of the group will draw a quick sketch on the lab sheet that shows they understand the concept that is being taught.

Use the colored pencils and markers that are provided.

Create a polymer using pop beads.

Draw a model of your polymer. Label monomers, identify bonds and identify the length.

Silicon

conducts electricity

Carbon

does not conduct electricity

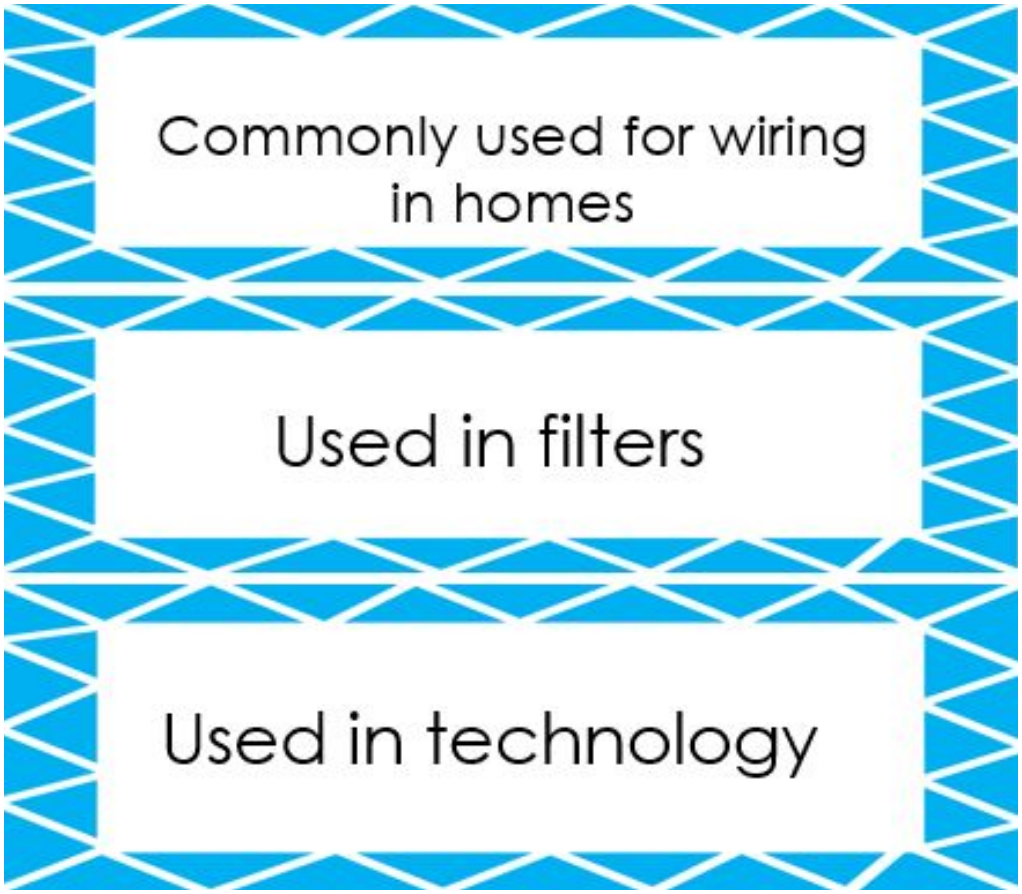
Copper

malleable

lustrous

Not malleable

not lustrous


Commonly used for wiring in homes
Used in filters
Used in technology

Materials and their uses Name_____

Explore It!

Task Card #2:

Task Card #3:

Task Card #4:

Organize It!

Write It!

Task Card #1:

_____

_____

Task Card #2:

_____

_____

Task Card #3:

_____

_____

Materials and their uses Name_____

Illustrate It!

Assess It!

#1 ____ #2 ____

#3____ #4 ____

Read It!

#1 ____ #2 ____

#3____ #4 ____

Research It!

Task Card #1:

Task Card #2:

Task Card #3:

Task Card #4:

Watch It!

Task Card #2:

_____

_____

Task Card #3:

_____

_____

Task Card #4:

Materials and their uses Name Key

Explore It!

Task Card #2:
Solid, malleable, squishy, clear, soft

Task Card #3:
It's flexible, doesn't break apart unless force is applied; moderately strong

Task Card #4:
Plastics

Organize It!

carbon
doesn't conduct
used in filters
not lustrous

copper
used for
wiring in homes
malleable

silicon
used in technology

conducts electricity
lustrous

nonmalleable

Write It!

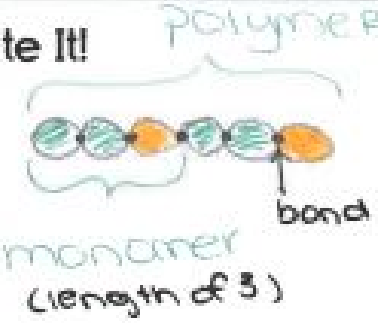
Task Card #1:
Copper is a good conductor because it has mobile electrons.

Task Card #2:
Properties to consider when building arc: durability, strength, insulators, conductivity

Task Card #3:
Semi-conductors conduct electricity only under certain circumstances

Materials and their uses Name_____

Illustrate It!



Assess It!

#1 C #2 A

#3 B #4 A

Read It!

#1 C #2 A

#3 B #4 C

Research It!

Task Card #1: Nothing

Task Card #2: lights up, makes annoying noise

Task Card #3: completing the circut; electrons can flow through

Task Card #4: There are free floating electrons which make them good conductors

Watch It!

Task Card #2:

Huge chains/3D networks of repeating organic units (monomers)

Task Card #3:

Polyethylene: Plastic bottles PEX Pipe: plumbing

Teflon: nonstick surface

Task Card #4:

Strength, elasticity, resilience, recycleable