Chemistry: Reactions

The Self-Warming/Cooling Device

The following learning activities were backwards planned to facilitate the development of students' knowledge and skills for mastery of this NGSS Performance Expectation. Not all of the dimensions and CCSS are covered in the following activities and teachers are encouraged to address them where possible.

MS-PS1-6 Matter and its Interactions

Students who demonstrate understanding can:

MS-PS1-6. **Undertake a design project to construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes.*** [Clarification Statement: Emphasis is on the design, controlling the transfer of energy to the environment, and modification of a device using factors such as type and concentration of a substance. Examples of designs could involve chemical reactions such as dissolving ammonium chloride or calcium chloride.] [*Assessment Boundary: Assessment is limited to the criteria of amount, time, and temperature of substance in testing the device.*]

The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices

Constructing Explanations and Designing Solutions

Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific knowledge, principles, and theories.

- Undertake a design project, engaging in the design cycle, to construct and/or implement a solution that meets specific design criteria and constraints.

Disciplinary Core Ideas

PS1.B: Chemical Reactions

- Some chemical reactions release energy, others store energy.

ETS1.B: Developing Possible Solutions

- A solution needs to be tested, and then modified on the basis of the test results, in order to improve it. *(secondary)*

ETS1.C: Optimizing the Design Solution

- Although one design may not perform the best across all tests, identifying the characteristics of the design that performed the best in each test can provide useful information for the redesign process - that is, some of the characteristics may be incorporated into the new design. *(secondary)*
- The iterative process of testing the most promising solutions and modifying what is proposed on the basis of the test results leads to greater refinement and ultimately to an optimal solution. *(secondary)*

Crosscutting Concepts

Energy and Matter

- The transfer of energy can be tracked as energy flows through a designed or natural system.

Connections to other DCIs in this grade-band:
MS.PS3.D

Articulation of DCIs across grade-bands:
HS.PS1.A ; **HS.PS1.B** ; **HS.PS3.A** ; **HS.PS3.B** ; **HS.PS3.D**

Common Core State Standards Connections:

ELA/Literacy -

RST.6-8.3	Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks. (MS-PS1-6)
WHST.6-8.7	Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration. (MS-PS1-6)

Lesson 1

What is Inside?

Background: An atom is _______________________________________ that makes up all matter (stuff). An atom is extremely small and can currently only be seen with an atomic force microscope, which magnifies an atom up to one million times. So scientists have never seen the inside of an atom. Yet, we know a lot of information about an atom. What it looks like, its size, its mass, and what its composition is (or what it is made of). How can scientists know so much about something they cannot see?

Your job: You and your group will be given a box that contains an unknown object inside. You must develop a plan to learn as much about the object you can. Then, using your data, make an educated guess (hypothesis) about what the object inside the box is.

To get started, list some properties that objects have that can help identify it. Then, make a plan for testing that property. Finally, record your observations/outcome of the test (this is your data you will use to build your conclusion).

Property	How will I test this property?	Observations/Outcome

Now, analyze your results and do your best to conclude about what the object is inside the box. You can organize your thoughts like this if you choose:

What do I know about the object: 1)____

2)____

3)____

4)____

` 5)____

6)____

What don't I know about the object: 1)____

2)____

3)____

4)____

` 5)____

6)____

If allowed, what other tests could you perform on the box to find out more information about the object?

____
____
____
____

What do you conclude the object is? ____

Explain your reasoning:

____
____
____
____

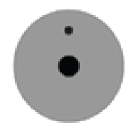
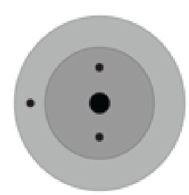
The object is ____

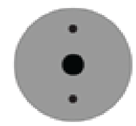
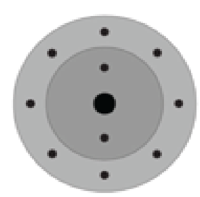
Lesson 2

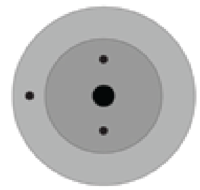
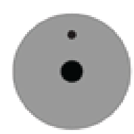
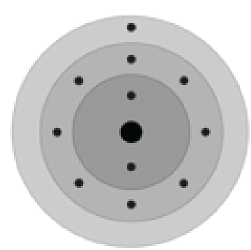
Table: Sub-Atomic Particles
Protons, Electrons, & Neutrons

Name of sub-atomic particle in an atom	How many are there?	Where are they located in an atom? (Location)	Charge	Size (compared to other particles)
PROTON				
ELECTRON				
NEUTRON				

Draw and label the hydrogen atom	Draw and label the Lithium atom:	Draw and label the Helium atom:

The atom you are looking for has **1** Proton in its Nucleus.	Atomic Number **1** HYDROGEN (H) Atomic Mass 1.01 **H**
The atom you are looking for has **1** Electron surrounding its Nucleus.	The atom you are looking for has this Energy Level Model: 
The atom you are looking for has **0** Neutrons (usually) in its Nucleus.	The atom you are looking for has **1** Electron on the **First** Energy Level.
The atom you are looking for has **1** fewer Proton than Helium (He).	The atom you are looking for is **directly above** the atom with this Energy Level. 
The atom you are looking for has **2** fewer Electrons than Lithium (Li).	The atom you are looking for is the only atom with only **1** Electron in the **First** Energy Level.

The atom you are looking for has **2** Protons in its Nucleus.	Atomic Number **2** HELIUM (He) Atomic Mass 4.00 **He**
The atom you are looking for has **2** Electrons surrounding its Nucleus.	The atom you are looking for has this Energy Level Model: 
The atom you are looking for has **2** Neutrons (usually) in its Nucleus.	The atom you are looking for has **2** Electrons on the **First** Energy Level and no other electrons.
The atom you are looking for has **1** more Proton than Hydrogen (H).	The atom you are looking for is **directly above** the atom with this Energy Level. 
The atom you are looking for has **2** fewer Electrons than Beryllium (Be).	The atom you are looking for is the only atom with only **2** Electrons in the First Energy Level and no other electrons on any other level.

The atom you are looking for has **3** Protons in its Nucleus.	Atomic Number **3** LITHIUM (Li) Atomic Mass 6.94 **Li**
The atom you are looking for has **3** Electrons surrounding its Nucleus.	The atom you are looking for has this Energy Level Model: 
The atom you are looking for has **4** Neutrons (usually) in its Nucleus.	The atom you are looking for has **2** Electrons on the **First** Energy Level and **1** Electron on the **Second** Energy Level.
The atom you are looking for has **3** fewer Protons than Carbon (C).	The atom you are looking for is **directly below** the atom with this Energy Level. 
The atom you are looking for has **2** fewer Electrons than Boron.	The atom you are looking for is **directly above** the atom with this Energy Level. 

The atom you are looking for has

4

Protons in its Nucleus.

Atomic Number **4**
BERYLLIUM (Be)
Atomic Mass 9.01

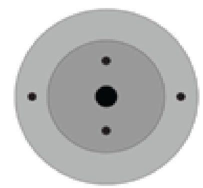
Be

The atom you are looking for has

4

Electrons surrounding its Nucleus.

The atom you are looking for has this Energy Level Model:



The atom you are looking for has

5

Neutrons (usually) in its Nucleus.

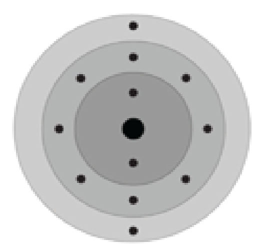
The atom you are looking for has
2 Electrons on the **First** Energy Level and
2 Electrons on the **Second** Energy Level.

The atom you are looking for has

4

fewer Protons than Oxygen (O).

The atom you are looking for is **directly above** the atom with this Energy Level.

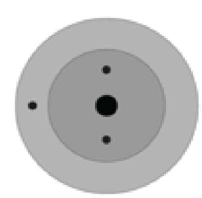


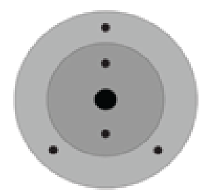
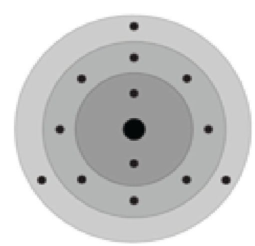
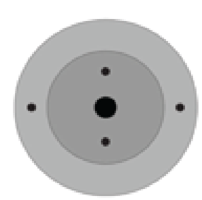
The atom you are looking for has

3

fewer Electrons than Nitrogen (N).

The atom you are looking for is **directly to the right** of the atom with this Energy Level.



The atom you are looking for has **5** Protons in its Nucleus.	Atomic Number **5** Boron (B) Atomic Mass 10.81 **B**
The atom you are looking for has **5** Electrons surrounding its Nucleus.	The atom you are looking for has this Energy Level Model: 
The atom you are looking for has **6** Neutrons (usually) in its Nucleus.	The atom you are looking for has **2** Electrons on the **First** Energy Level and **3** Electrons on the **Second** Energy Level.
The atom you are looking for has **4** more Protons than Hydrogen (H).	The atom you are looking for is **directly above** the atom with this Energy Level. 
The atom you are looking for has **3** more Electrons than Helium (He).	The atom you are looking for is **directly to the right** of the atom with this Energy Level. 

The atom you are looking for has

6

Protons in its Nucleus.

Atomic Number **6**
Carbon (C)
Atomic Mass 12.01

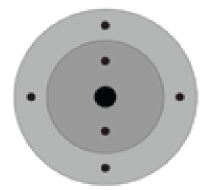
C

The atom you are looking for has

6

Electrons surrounding its Nucleus.

The atom you are looking for has this Energy Level Model:



The atom you are looking for has

6

Neutrons (usually) in its Nucleus.

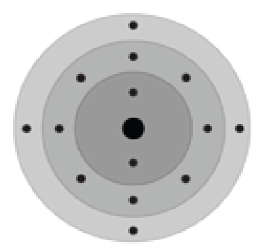
The atom you are looking for has
2 Electrons on the **First** Energy Level and
4 Electrons on the **Second** Energy Level.

The atom you are looking for has

1

more Proton than Boron (B).

The atom you are looking for is **directly above** the atom with this Energy Level.

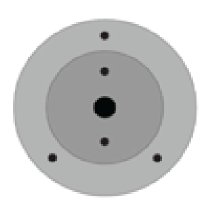


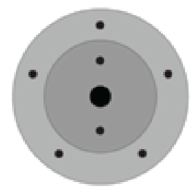
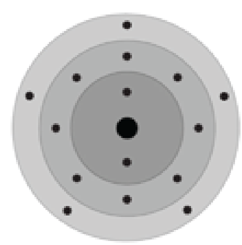
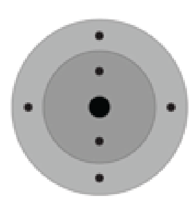
The atom you are looking for has

3

more Electrons than Lithium (Li).

The atom you are looking for is **directly to the right** of the atom with this Energy Level.



The atom you are looking for has **7** Protons in its Nucleus.	Atomic Number **7** Nitrogen (N) Atomic Mass 14.01 **N**
The atom you are looking for has **7** Electrons surrounding its Nucleus.	The atom you are looking for has this Energy Level Model: 
The atom you are looking for has **7** Neutrons (usually) in its Nucleus.	The atom you are looking for has **2** Electrons on the **First** Energy Level and **5** Electrons on the **Second** Energy Level.
The atom you are looking for has **3** fewer Protons than Neon (Ne).	The atom you are looking for is **directly above** the atom with this Energy Level. 
The atom you are looking for has **1** fewer Electron than Oxygen (O).	The atom you are looking for is **directly to the right** of the atom with this Energy Level. 

The atom you are looking for has

8

Protons in its Nucleus.

Atomic Number **8**
Oxygen (O)
Atomic Mass 16.00

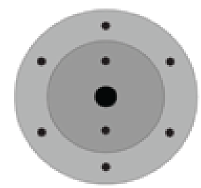
O

The atom you are looking for has

8

Electrons surrounding its Nucleus.

The atom you are looking for has this Energy Level Model:



The atom you are looking for has

8

Neutrons (usually) in its Nucleus.

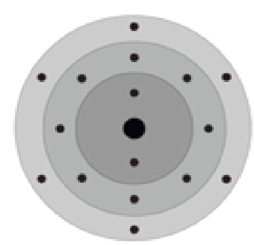
The atom you are looking for has
2 Electrons on the **First** Energy Level and
6 Electrons on the **Second** Energy Level.

The atom you are looking for has

2

more Protons than Carbon (C).

The atom you are looking for is **directly above** the atom with this Energy Level.

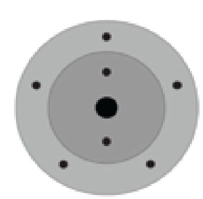


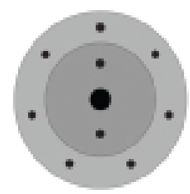
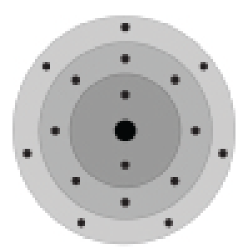
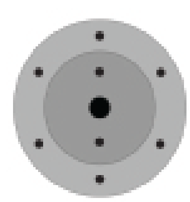
The atom you are looking for has

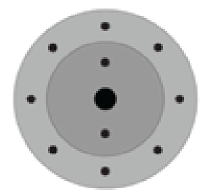
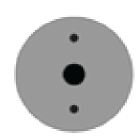
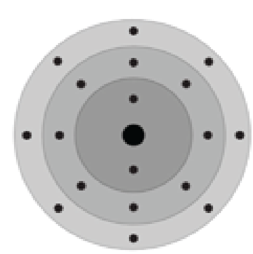
6

more Electrons than Helium (He).

The atom you are looking for is **directly to the right** of the atom with this Energy Level.



The atom you are looking for has **9** Protons in its Nucleus.	Atomic Number **9** Fluorine (F) Atomic Mass 18.99 **F**
The atom you are looking for has **9** Electrons surrounding its Nucleus.	The atom you are looking for has this Energy Level Model: 
The atom you are looking for has **10** Neutrons (usually) in its Nucleus.	The atom you are looking for has **2** Electrons on the **First** Energy Level and **7** Electrons on the **Second** Energy Level.
The atom you are looking for has **1** fewer Proton than Neon (Ne).	The atom you are looking for is **directly above** the atom with this Energy Level. 
The atom you are looking for has **2** more Electrons than Nitrogen (N).	The atom you are looking for is **directly to the right** of the atom with this Energy Level. 

The atom you are looking for has **10** Protons in its Nucleus.	Atomic Number **10** Neon (Ne) Atomic Mass 20.18 **Ne**
The atom you are looking for has **10** Electrons surrounding its Nucleus.	The atom you are looking for has this Energy Level Model: 
The atom you are looking for has **10** Neutrons (usually) in its Nucleus.	The atom you are looking for has **2** Electrons on the **First** Energy Level and **8** Electrons on the **Second** Energy Level.
The atom you are looking for has **8** more Protons than Helium (He).	The atom you are looking for is **directly below** the atom with this Energy Level. 
The atom you are looking for has **2** more Electrons than Oxygen (O).	The atom you are looking for is **directly above** of the atom with this Energy Level. 

The atom you are looking for has

11

Protons in its Nucleus.

Atomic Number **11**
Sodium (Na)
Atomic Mass 22.99

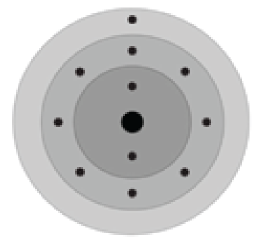
Na

The atom you are looking for has

11

Electrons surrounding its Nucleus.

The atom you are looking for has this Energy Level Model:



The atom you are looking for has

12

Neutrons (usually) in its Nucleus.

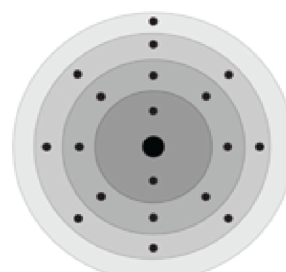
The atom you are looking for has
2 Electrons on the **First** Energy Level,
8 Electrons on the **Second** Energy Level, and
1 Electron on the **Third** Energy Level.

The atom you are looking for has

2

fewer Protons than Aluminum (Al).

The atom you are looking for is **directly above** the atom with this Energy Level.

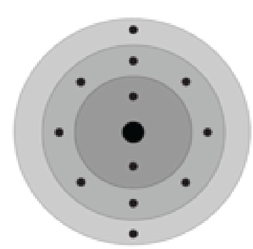


The atom you are looking for has

3

more Electrons than Oxygen (O).

The atom you are looking for is **directly to the left** of the atom with this Energy Level.



The atom you are looking for has

12

Protons in its Nucleus.

Atomic Number 12
Magnesium (Mg)
Atomic Mass 24.31

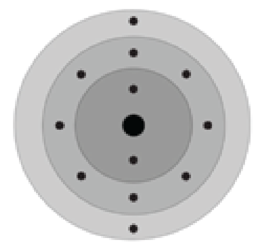
Mg

The atom you are looking for has

12

Electrons surrounding its Nucleus.

The atom you are looking for has this Energy Level Model:



The atom you are looking for has

12

Neutrons (usually) in its Nucleus.

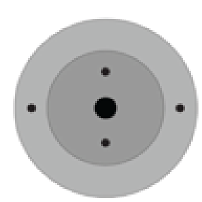
The atom you are looking for has
2 Electrons on the **First** Energy Level,
8 Electrons on the **Second** Energy Level, and
2 Electrons on the **Third** Energy Level.

The atom you are looking for has

10

more Protons than Helium (He).

The atom you are looking for is **directly below** the atom with this Energy Level.

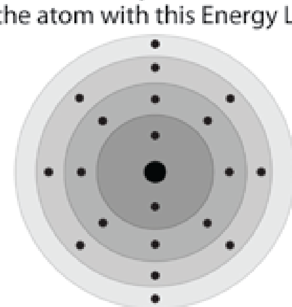


The atom you are looking for has

8

more Electrons than Beryllium (Be).

The atom you are looking for is **directly above** of the atom with this Energy Level.



The atom you are looking for has

13

Protons in its Nucleus.

Atomic Number **13**
Aluminum (Al)
Atomic Mass 26.98

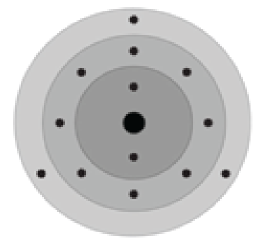
Al

The atom you are looking for has

13

Electrons surrounding its Nucleus.

The atom you are looking for has this Energy Level Model:



The atom you are looking for has

14

Neutrons (usually) in its Nucleus.

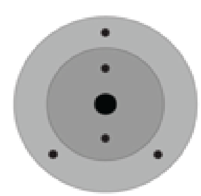
The atom you are looking for has
2 Electrons on the **First** Energy Level,
8 Electrons on the **Second** Energy Level, and
3 Electrons on the **Third** Energy Level.

The atom you are looking for has

8

more Protons than Boron (B).

The atom you are looking for is **directly below** the atom with this Energy Level.

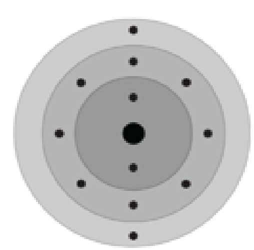


The atom you are looking for has

5

more Electrons than Oxygen (O).

The atom you are looking for is **directly to the right** of the atom with this Energy Level.



The atom you are looking for has

14

Protons in its Nucleus.

Atomic Number **14**
Silicon (Si)
Atomic Mass 28.09

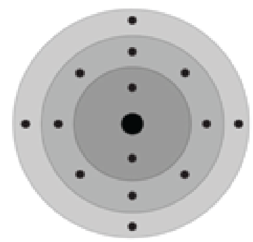
Si

The atom you are looking for has

14

Electrons surrounding its Nucleus.

The atom you are looking for has this Energy Level Model:



The atom you are looking for has

14

Neutrons (usually) in its Nucleus.

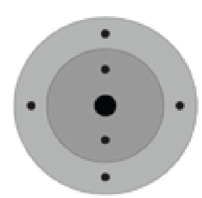
The atom you are looking for has
2 Electrons on the **First** Energy Level,
8 Electrons on the **Second** Energy Level, and
4 Electrons on the **Third** Energy Level.

The atom you are looking for has

3

fewer Protons than Chlorine (Cl).

The atom you are looking for is **directly below** the atom with this Energy Level.

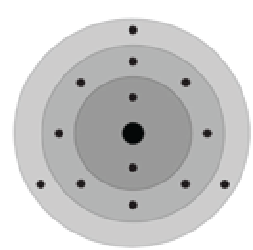


The atom you are looking for has

2

more Electrons than Magnesium (Mg).

The atom you are looking for is **directly to the right** of the atom with this Energy Level.



The atom you are looking for has

15

Protons in its Nucleus.

Atomic Number **15**
Phosphorous (P)
Atomic Mass 30.97

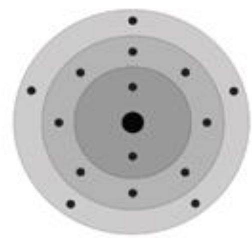
P

The atom you are looking for has

15

Electrons surrounding its Nucleus.

The atom you are looking for has this Energy Level Model:



The atom you are looking for has

16

Neutrons (usually) in its Nucleus.

The atom you are looking for has
2 Electrons on the **First** Energy Level,
8 Electrons on the **Second** Energy Level, and
5 Electrons on the **Third** Energy Level.

The atom you are looking for has

8

more Protons than Nitrogen (N).

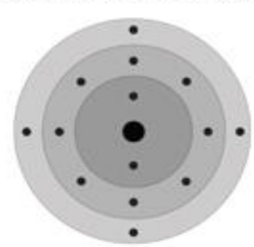
The atom you are looking for is **directly below** the atom with this Energy Level.

The atom you are looking for has

3

fewer Electrons than Argon (Ar).

The atom you are looking for is **directly to the right** of the atom with this Energy Level.



The atom you are looking for has

16

Protons in its Nucleus.

Atomic Number 16
Sulfur (S)
Atomic Mass 32.07

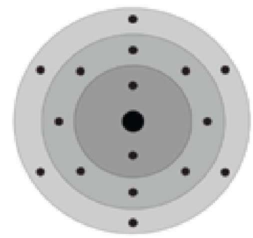
S

The atom you are looking for has

16

Electrons surrounding its Nucleus.

The atom you are looking for has this Energy Level Model:



The atom you are looking for has

16

Neutrons (usually) in its Nucleus.

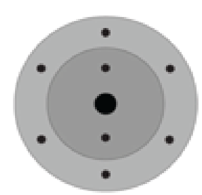
The atom you are looking for has
2 Electrons on the **First** Energy Level,
8 Electrons on the **Second** Energy Level, and
6 Electrons on the **Third** Energy Level.

The atom you are looking for has

10

more Protons than Carbon (C).

The atom you are looking for is **directly below** the atom with this Energy Level.

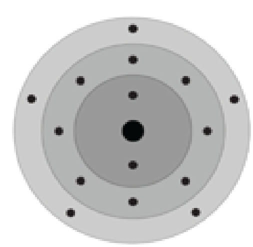


The atom you are looking for has

6

more Electrons than Neon (Ne).

The atom you are looking for is **directly to the right** of the atom with this Energy Level.



The atom you are looking for has

17

Protons in its Nucleus.

Atomic Number **17**
Chlorine (Cl)
Atomic Mass 35.45

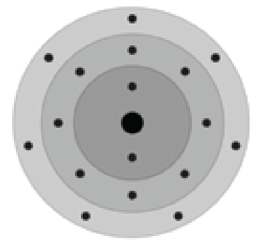
Cl

The atom you are looking for has

17

Electrons surrounding its Nucleus.

The atom you are looking for has this Energy Level Model:



The atom you are looking for has

18

Neutrons (usually) in its Nucleus.

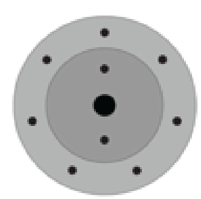
The atom you are looking for has
2 Electrons on the **First** Energy Level,
8 Electrons on the **Second** Energy Level, and
7 Electrons on the **Third** Energy Level.

The atom you are looking for has

3

fewer Protons than Calcium (Ca).

The atom you are looking for is **directly below** the atom with this Energy Level.

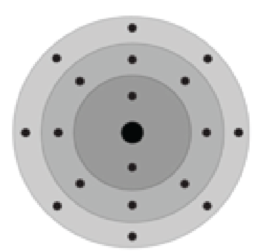


The atom you are looking for has

8

more Electrons than Fluorine (F).

The atom you are looking for is **directly to the left** of the atom with this Energy Level.



The atom you are looking for has

18

Protons in its Nucleus.

Atomic Number **18**
Argon (Ar)
Atomic Mass 39.95

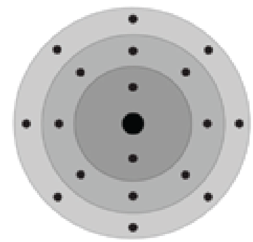
Ar

The atom you are looking for has

18

Electrons surrounding its Nucleus.

The atom you are looking for has this Energy Level Model:



The atom you are looking for has

22

Neutrons (usually) in its Nucleus.

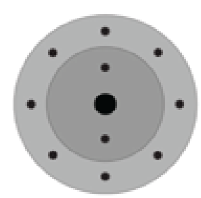
The atom you are looking for has
2 Electrons on the **First** Energy Level,
8 Electrons on the **Second** Energy Level, and
8 Electrons on the **Third** Energy Level.

The atom you are looking for has

7

more Protons than Sodium (Na).

The atom you are looking for is **directly below** the atom with this Energy Level.

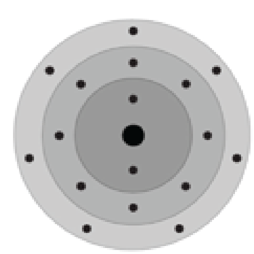


The atom you are looking for has

8

more Electrons than Neon (Ne).

The atom you are looking for is **directly to the right** of the atom with this Energy Level.



The atom you are looking for has

19

Protons in its Nucleus.

Atomic Number **19**
Potassium (K)
Atomic Mass 39.10

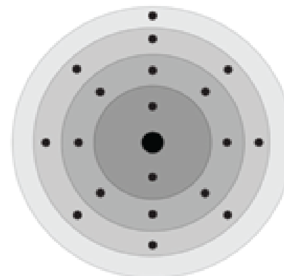
K

The atom you are looking for has

19

Electrons surrounding its Nucleus.

The atom you are looking for has this Energy Level Model:



The atom you are looking for has

20

Neutrons (usually) in its Nucleus.

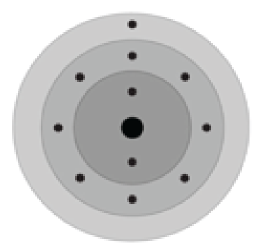
The atom you are looking for has
2 Electrons on the **First** Energy Level,
8 Electrons on the **Second** Energy Level,
8 Electrons on the **Third** Energy Level, and
1 Electron on the **Fourth** Energy Level.

The atom you are looking for has

4

more Protons than Phosphorous (P).

The atom you are looking for is **directly below** the atom with this Energy Level.

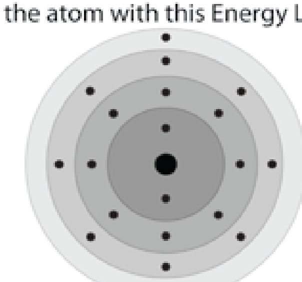


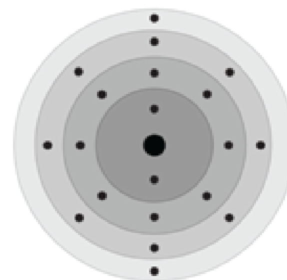
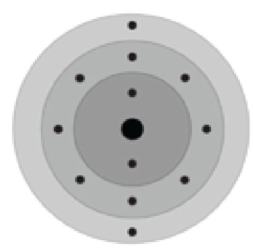
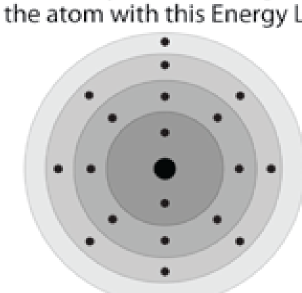
The atom you are looking for has

18

more Electrons than Hydrogen (H).

The atom you are looking for is **directly to the left** of the atom with this Energy Level.



The atom you are looking for has **20** Protons in its Nucleus.	Atomic Number **20** Calcium (Ca) Atomic Mass 40.08 **Ca**
The atom you are looking for has **20** Electrons surrounding its Nucleus.	The atom you are looking for has this Energy Level Model: 
The atom you are looking for has **20** Neutrons (usually) in its Nucleus.	The atom you are looking for has **2** Electrons on the **First** Energy Level, **8** Electrons on the **Second** Energy Level, **8** Electrons on the **Third** Energy Level, and **2** Electrons on the **Fourth** Energy Level.
The atom you are looking for has **8** more Protons than Magnesium (Mg).	The atom you are looking for is **directly below** the atom with this Energy Level. 
The atom you are looking for has **2** more Electrons than Argon (Ar).	The atom you are looking for is **directly to the right** of the atom with this Energy Level. 

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Lesson 2

Name:________________
Date:________________
Period:________________

Atomic Structure

Engage

How would you define an **atom** using 8 words or less? ____
____

Class definition of an ATOM: ____
____

How does the smallest piece of the material you were given relate to the definition of what an atom is?
____
____
____

Explore: My 1st drawings of atoms with labels:

This is an atom of the element ____________________	This is an atom of the element ____________________

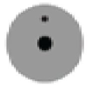
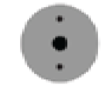
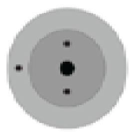
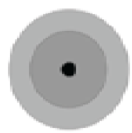
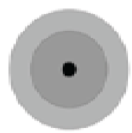
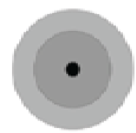
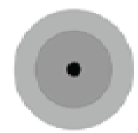
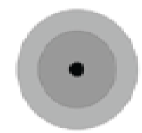
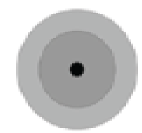
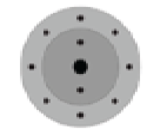
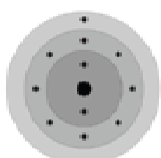
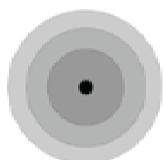
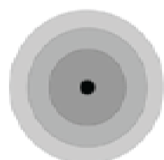
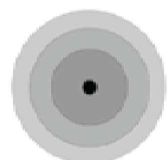
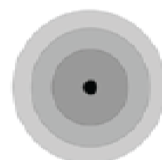
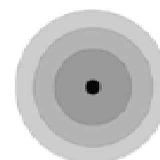
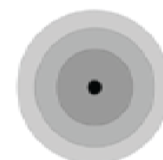
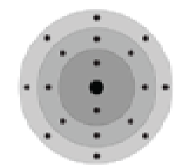
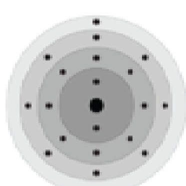
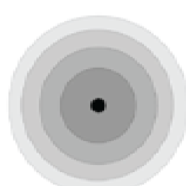
My 2nd revised drawing of atoms with labels:

This is an atom of the element ____________________	This is an atom of the element ____________________

Compare and contrast the atoms of you two elements. How are they the same and how are they different?
____
____
____
____
____

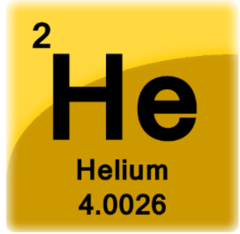
ENERGY LEVELS
ELEMENTS 1–20

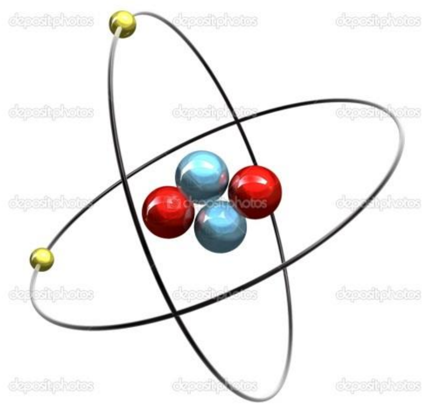
Complete each energy level model by drawing the correct number of electrons in their corresponding energy levels.

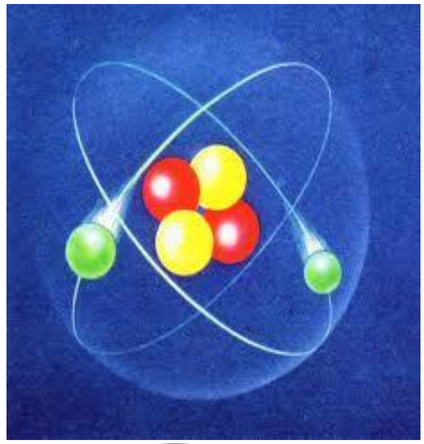
HYDROGEN 1  1.01							**HELIUM** 2  4.00
LITHIUM 3  6.94	**BERYLLIUM** 4  9.01	**BORON** 5  10.81	**CARBON** 6  12.01	**NITROGEN** 7  14.01	**OXYGEN** 8  16.00	**FLUORINE** 9  19.00	**NEON** 10  20.18
SODIUM 11  22.99	**MAGNESIUM** 12  24.31	**ALUMINUM** 13  26.98	**SILICON** 14  28.09	**PHOSPHORUS** 15  30.97	**SULFUR** 16  32.07	**CHLORINE** 17  35.45	**ARGON** 18  39.95
POTASSIUM 19  39.10	**CALCIUM** 20  40.08						

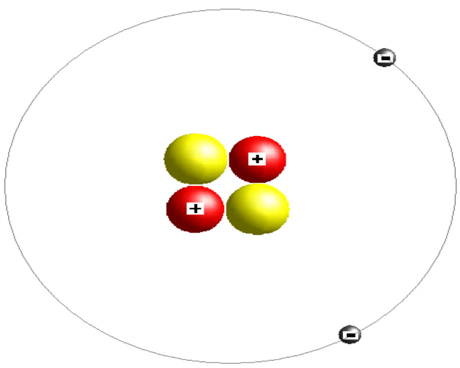
Lesson 2

The Helium Atom

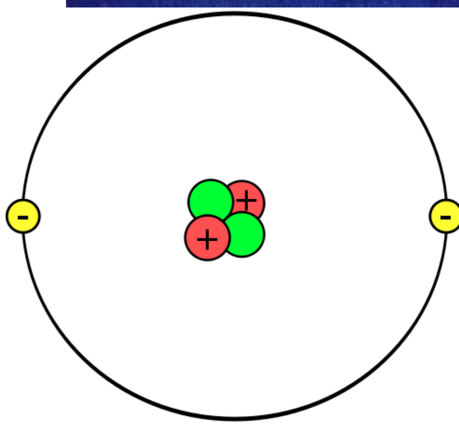


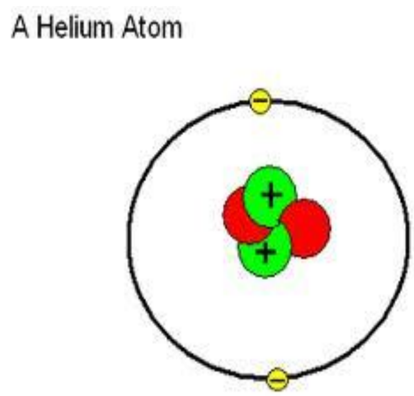


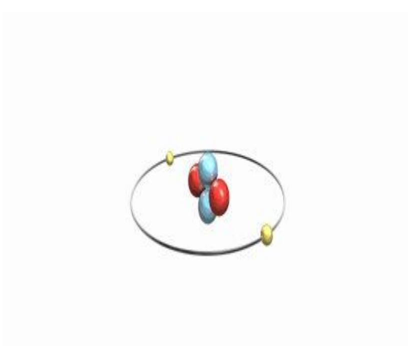


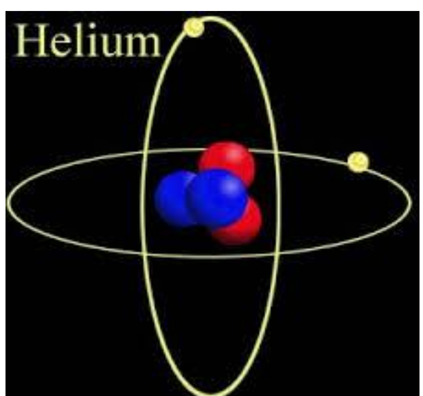


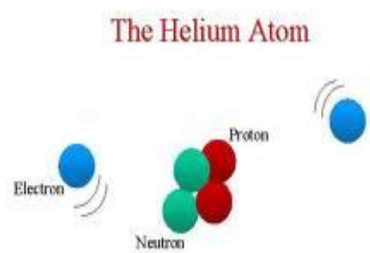
Helium atom

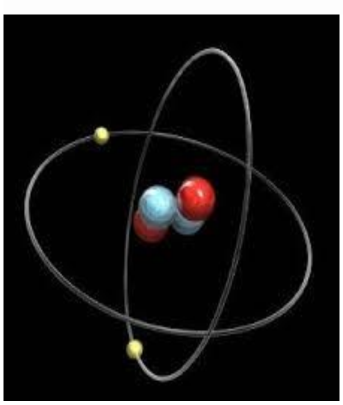


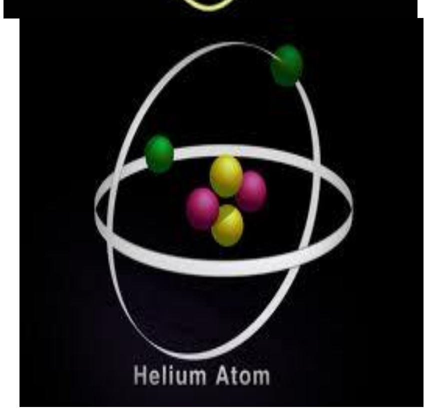


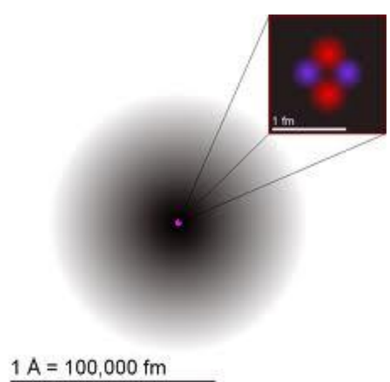






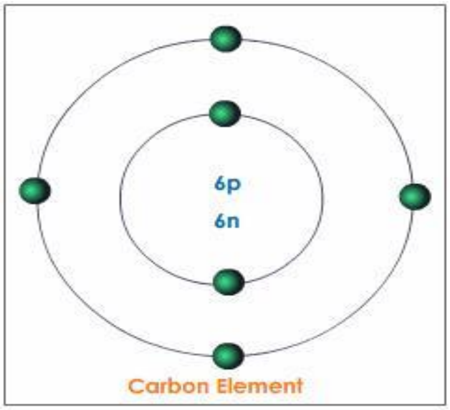


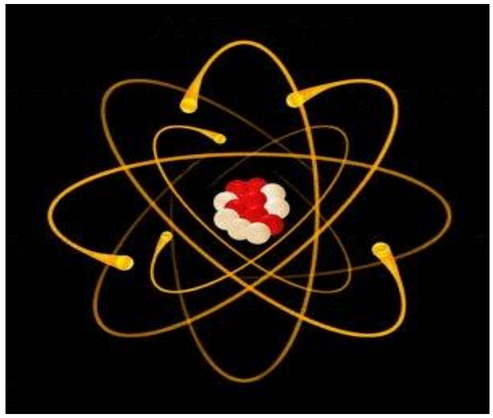


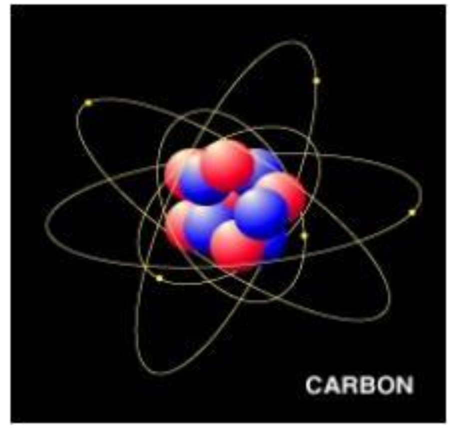


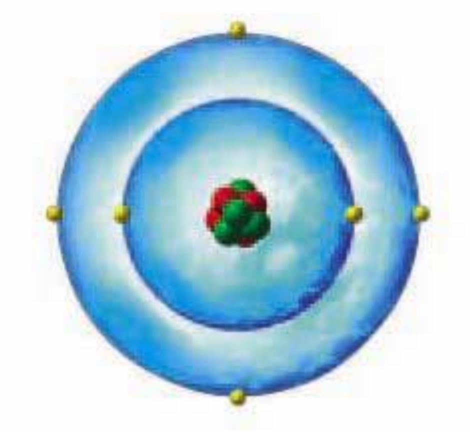
The Carbon Atom

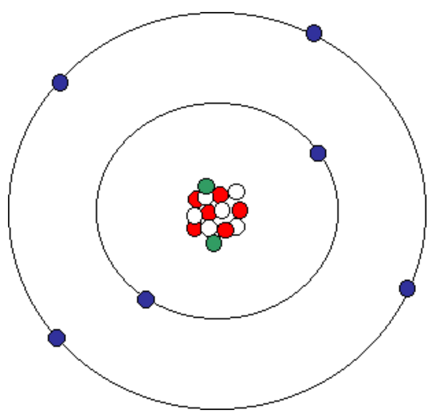
6
C
Carbon
12.0

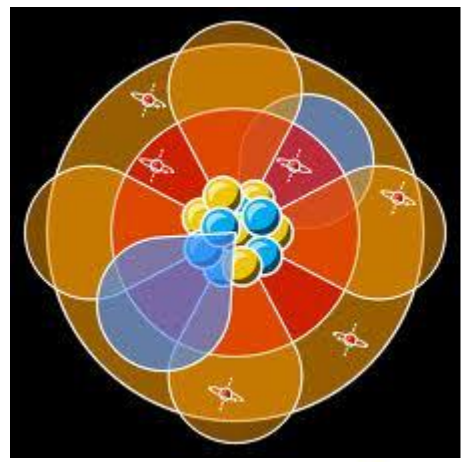


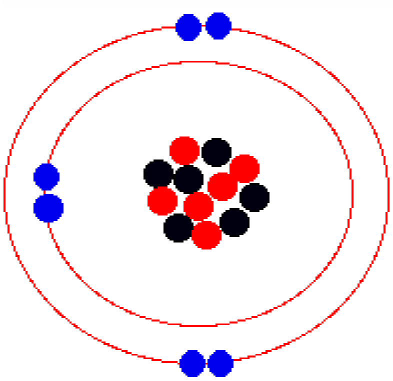


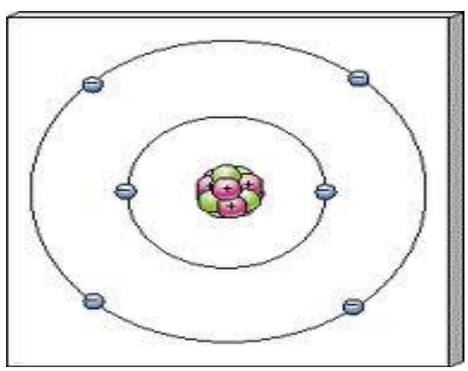


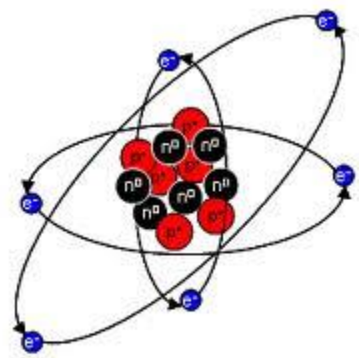


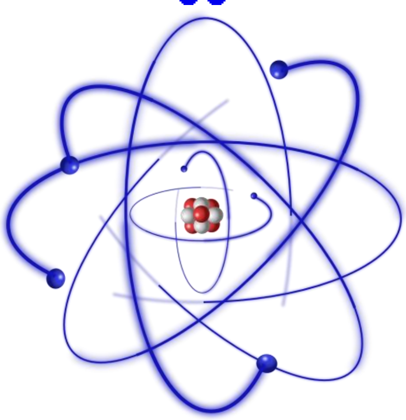


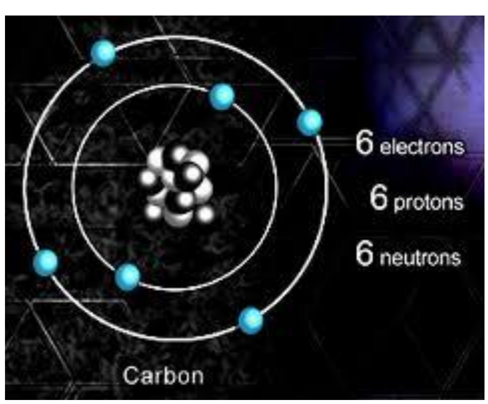






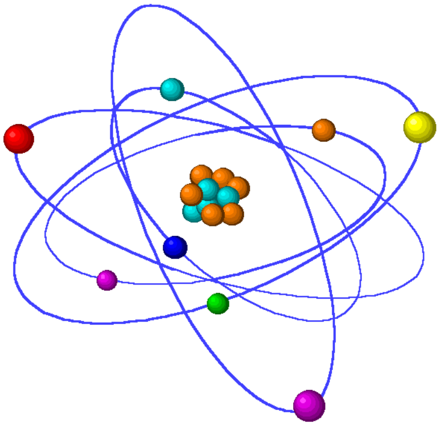


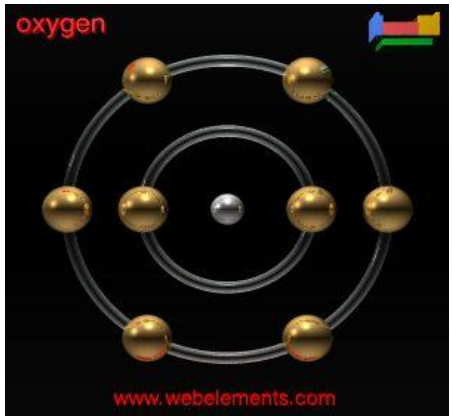


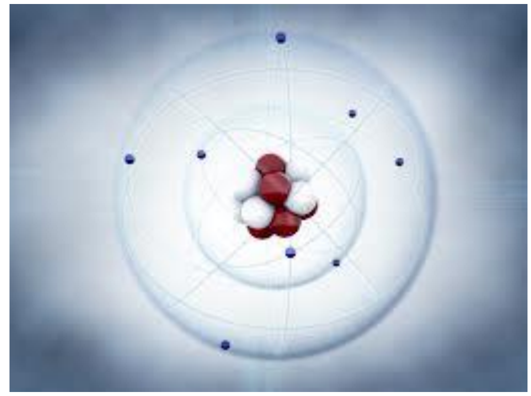


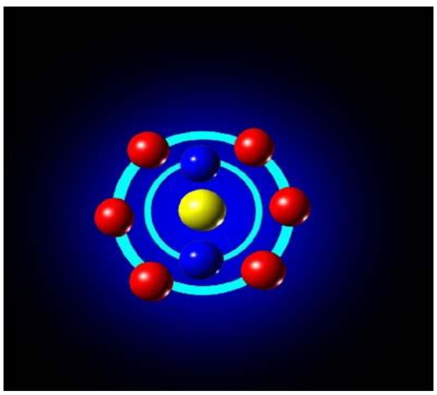
The Oxygen Atom

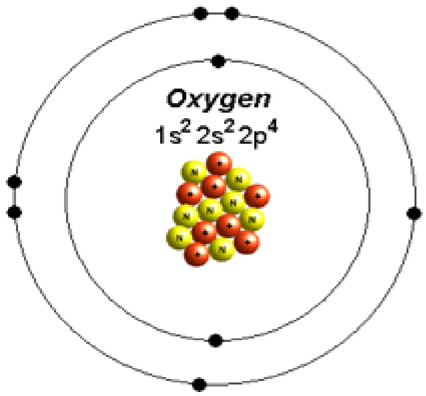
8
O
Oxygen
15.999

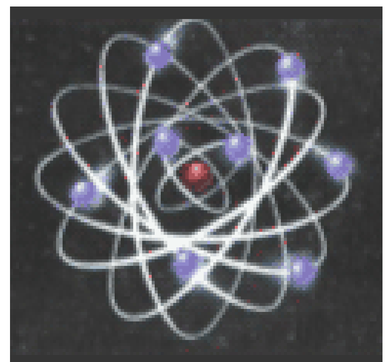


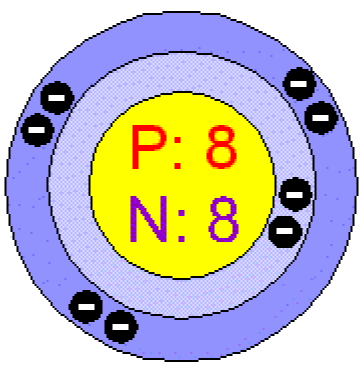


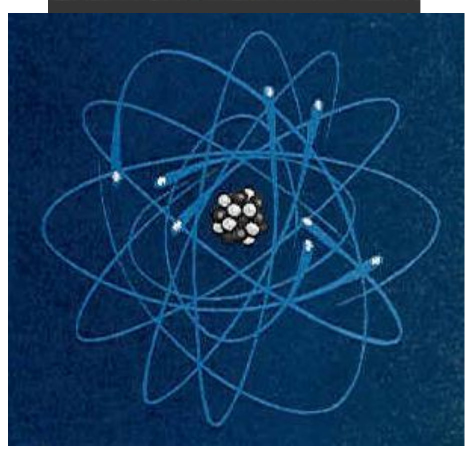


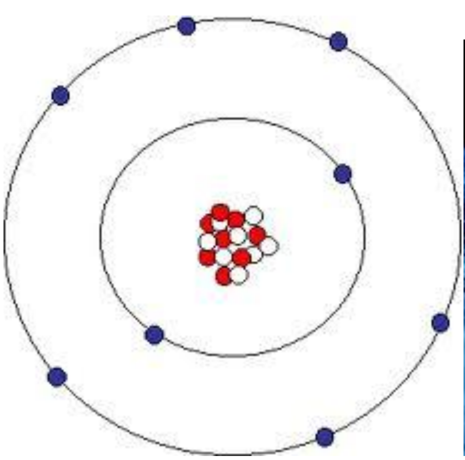


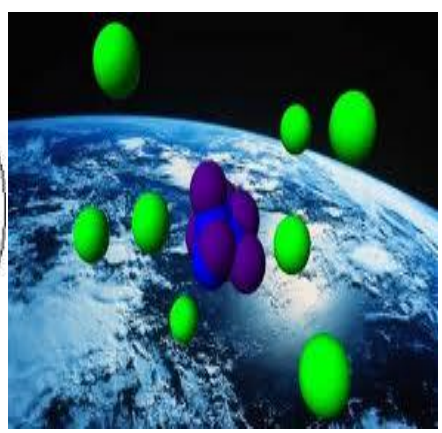


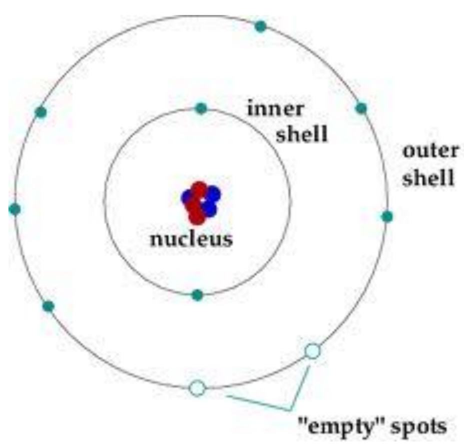












Lesson 2

Word Bank:

1) proton

2) neutron

3) electron

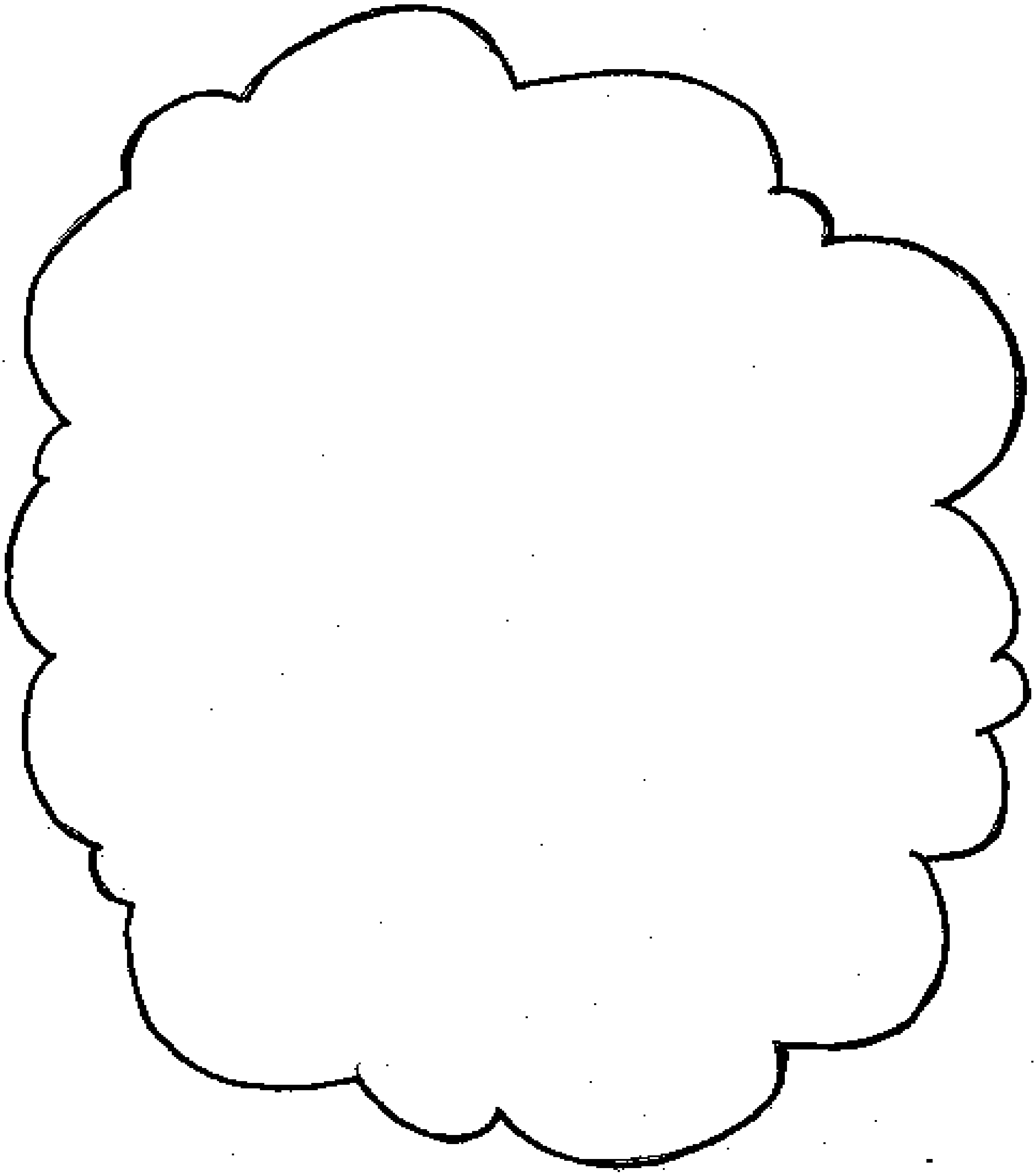
4) electron cloud

5) electron orbit or shell

6) nucleus

Lesson 3

Electron Cloud



Name of Element	Number of protons	Number of electrons	Number of neutrons

Lesson 3

Name:_________________
Date:_________________
Period:_________________

Periodic Table Trends and Patterns in Atomic Configuration

ENGAGE: If you were building an atom with the following supplies which items would you choose to build the atom. For example, if I were building an atom out of types of houses: mansions (6 bedrooms or more), 3 bedroom house, apartment (2 bedrooms), studio apartment (1 room), which would be best to represent the protons, neutrons, and electrons.

Example: Protons would be ___________________ Drawing:
Neutrons would be ___________________
Electrons would be ___________________

Now choose and label which objects you would use from the following lists to represents the sub-atomic particles.

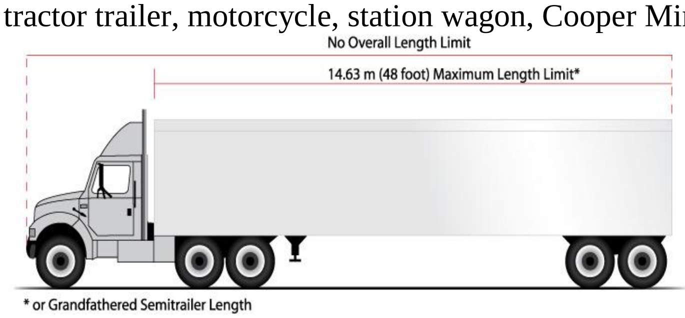
FRUITS: apples, oranges, lemons, pineapples, limes, cherries






AUTOMOBILES: four-door car, two-door car, tractor trailer, motorcycle, station wagon, Cooper Mini







Which fruits did you choose to represent each subatomic particle? Why? Which autos did you choose? Why?

____
____
____
____

EXPLORE/EXPLAIN

Draw the first three elements' atoms from Period 2:

Element Name: Element Symbol:	Element Name: Element Symbol:	Element Name: Element Symbol:

Analysis Question:
1) What are the trend(s) or pattern(s) you notice with the atoms in the same period? ______________________

____
____
____
____
____

Draw the first three elements' atoms from Group 1:

Element Name: Element Symbol:	Element Name: Element Symbol:	Element Name: Element Symbol:

Analysis Question:
2) What are the trend(s) or pattern(s) you notice with the atoms in Group 1?____________________________

____
____
____
____
____

ELABORATE:

3) How would you compare/contrast elements in the same group? Are they more or less similar to each other compared to elements in other groups? How do their properties compare? Explain your answer.

____
____
____
____
____

Lesson 4

Name:______________________
Date:______________________
Period:______________________

Modeling Compounds and Molecules

Engage/Explore:

Directions: In groups, you must construct models for the compounds and molecules listed below. (Note: you should use relative sizes for different atoms, if materials are available.) First, using the subscript, count the number of atoms of each element present in the compound or molecule. Then, make a model using appropriate materials, and finally make a diagram of your model, including labels to identify the different elements.

Water: H_2O	Calcium Chloride: $CaCl_2$
Sodium Bicarbonate: $NaHCO_3$	Magnesium Sulfate: $MgSO_4$
Acetic Acid: $C_2H_4O_2$	Ammonia Chloride: NH_4Cl
Citric Acid: $C_6H_8O_8$	Sulfuric Acid: H_2SO_4

Name:____________________
Date:____________________
Period:____________________

Building Molecular Models

DIRECTIONS: Write the molecular formula for each of the following compounds, then count how many atoms are in each compound, next build and draw the molecular compounds.

1) Methane:	**6) Formic acid:**
2) Butane:	**7) Isobutane:**
3) Acetic acid:	**8) Methanol:**
4) Ethanol:	**9) Propane:**
5) Ethyne:	**10) Ethene:**

Name:______________________
Date:______________________
Period:______________________

Building Molecular Compounds

Directions: 1) List the name of each element and how many atoms are present
2) Label each as a molecule, compound, or bot

H_2O: Water	**O_2: Oxygen**	**NH_3 :Ammonia**
HNO_3 : Nitric Acid	**CH_4: Methane**	**NO_2 :Nitrogen Dioxide**
CO_2: Carbon dioxide	**H_2CO_3: Carbonic Acid**	**H_2SO_4: Sulfuric Acid**
C_3H_8: Propane	**C_8H_{18}: Octane**	**$C_6H_8O_7$: Citric Acid**

1) How would your model be different if you built: **$2O_2$ or $5O_2$** Draw a picture:
Explain____

____

2) What is the difference between a subscript and coefficient?

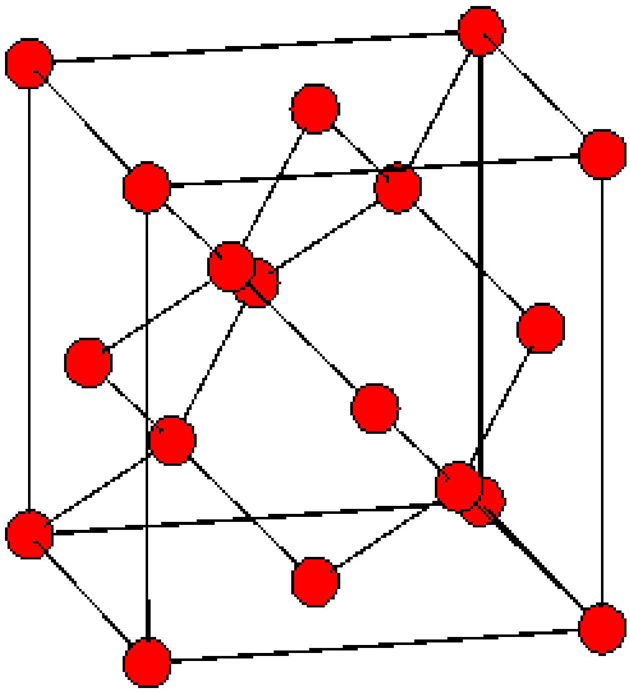
____

____

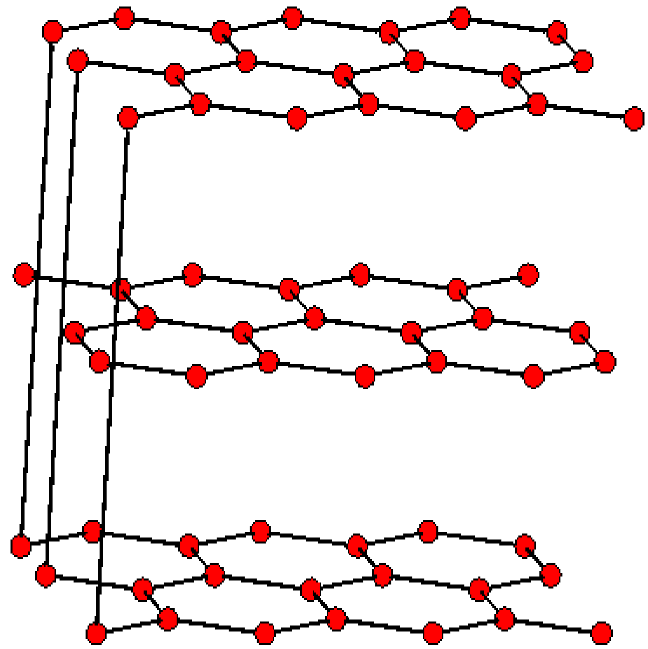
Lesson 4

Molecular Structure images:

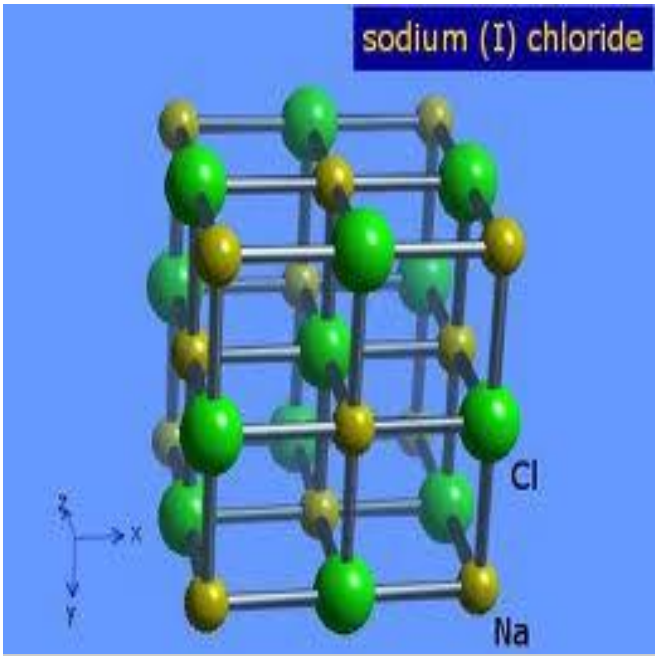
Diamond: cubic structure, C_{18}



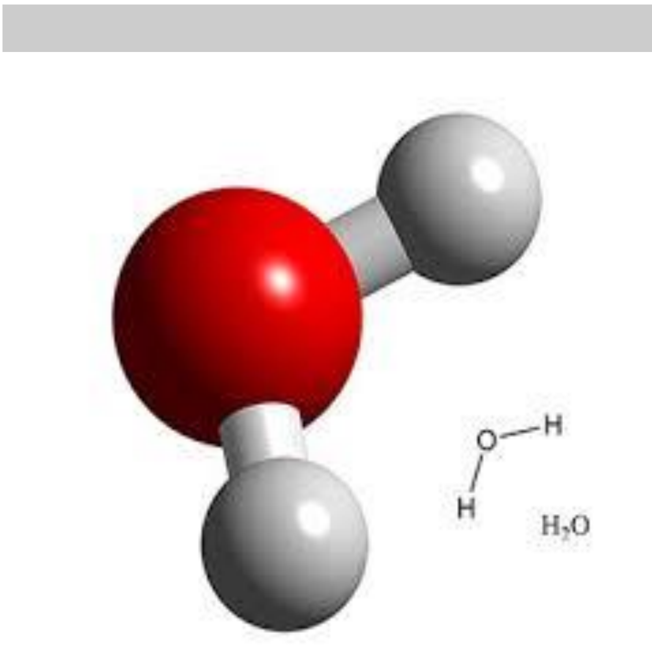
Grapite: hexagonal structure, C_{64}



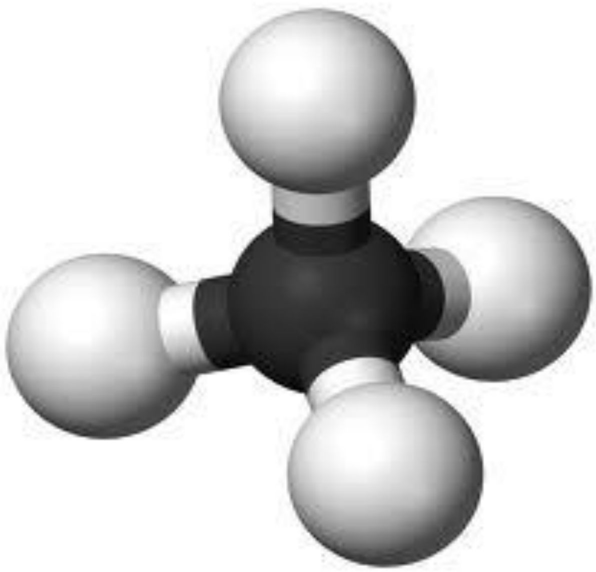
Salt: Many cubic NaCl molecules together



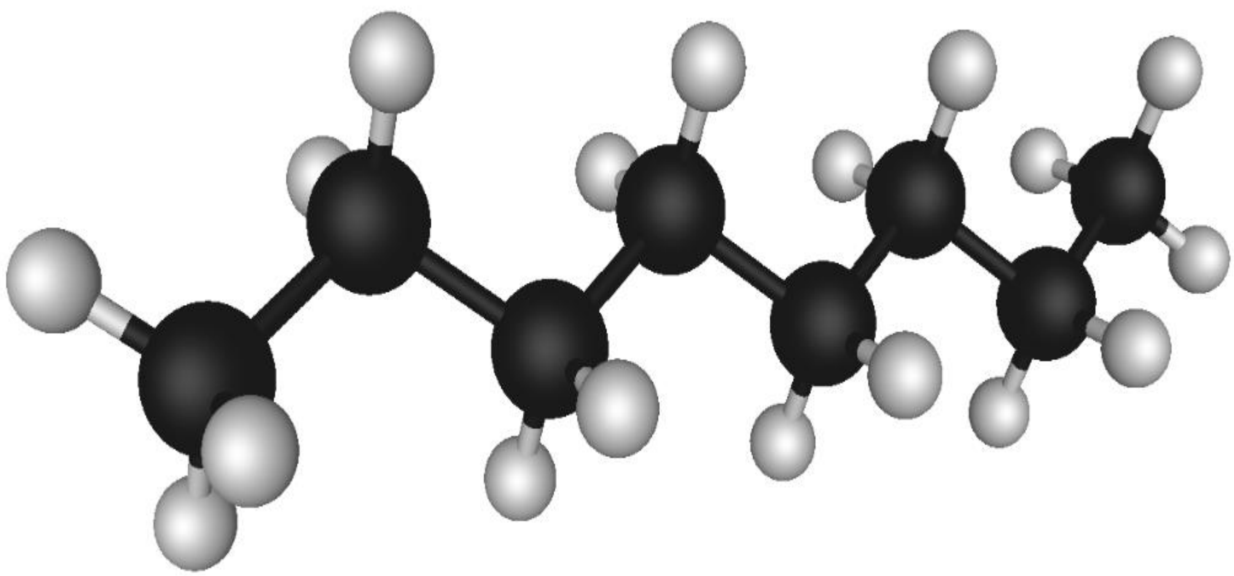
Water: H_2O (one molecule)

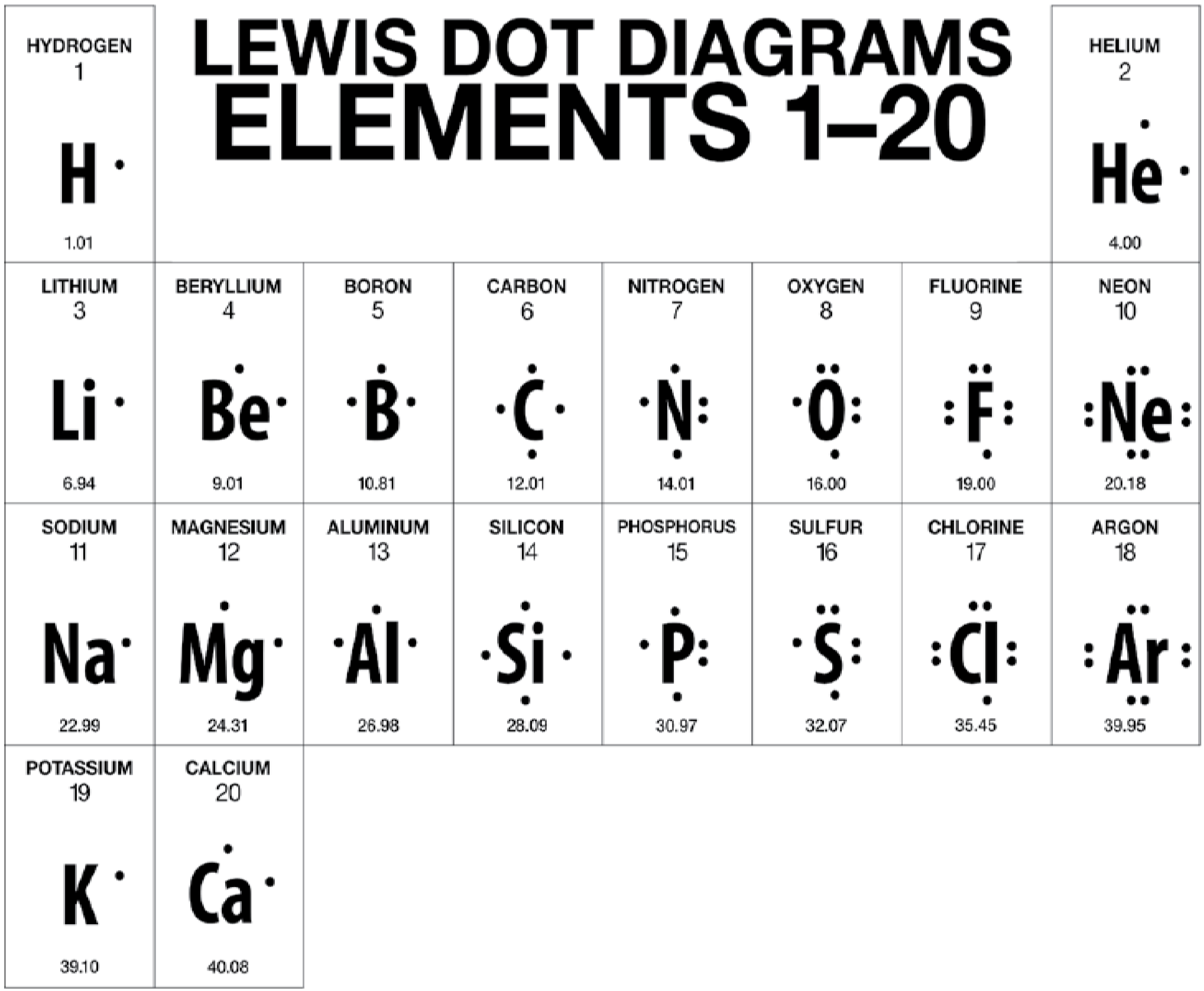


Hydrocarbon: CH_4 Methane



Hydrocarbon: C_8H_{18} Octane





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Lesson 5

Name:________________
Period:________________
Date:________________

Comparing Properties of Elements and the Compounds They Make

Engage: In groups, analyze the elements for physical (and chemical) properties used to identify the element. Record these properties in your data table; these properties will then be compared to the compounds we will use later in the unit. Eventually, we will be able to answer, "Do properties change when elements make compounds?"

How are these elements different? How can we tell elements apart? Brainstorm in your group (remember lesson 1) properties we can use to tell things apart.

Properties used to identify elements: 1)____________________________ 4)____________________________
2) ____________________________ 5)______________________________
3) ____________________________ 6)______________________________

Now analyze and research each element's individual properties and record them in the data table.

<u>Elements to research:</u> Carbon, Hydrogen, Oxygen, Calcium, Chlorine, Nitrogen, Sodium, Magnesium, Sulfur, Iron

Table 1: Element properties

Element Name and Symbol							

Extra: Which elements are in the same group? ________________________ and __________________________
________________________ and ___________________________

Is there a trend or pattern in the properties of these elements that are in the same group? Are properties the same, similar, or completely different (not even close to each other)? _____________________________________

Explore: Now, in groups analyze and research the same properties of the compounds these elements form (these compounds will be used later in the self-warming clothing project. Remember our focus question: "Do properties change when elements make compounds?"

<u>Compounds to research:</u> **H_2O, $C_2H_4O_2$, Fe_3C, $C_6H_8O_7$, $CaCl_2$, NH_4Cl, $NaHCO_3$, $MgSO_4$**

Table 2: Compounds' properties

Compound Name and chemical formula							

Compare and contrast three compounds' properties (ones you might use in the final project) with the elements' properties that compose the compounds. Are the properties the same? Are the properties similar? Are the properties completely different? Give evidence for your conclusion (use the specific properties of the elements and compounds to defend your answer).

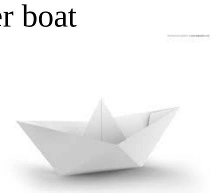
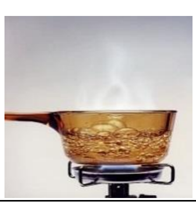
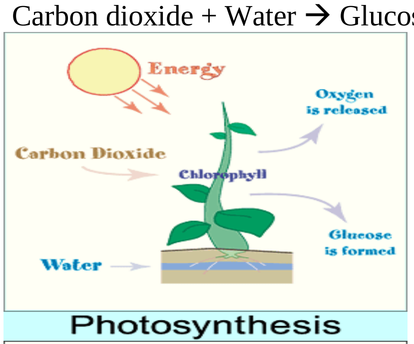
Lesson 6

Name: ___________________
Date:___________________
Period:___________________

Physical vs. Chemical Changes

Directions: Categorize each of these changes as a physical change, a chemical change, or both. Use the definitions of physical change and chemical change to prove/justify your choice.

Engage:

Change	Physical change, Chemical change or both	Justify your choice
Ice melting: Ice → Water 		
Apple → Iron oxide (brown) and apple  		
Wood (+ fire) → Smoke and ash  		
Paper → paper boat 		
Water → Water vapor  		
Carbon dioxide + Water → Glucose + Oxygen 		

Explain/Explore:

Example:

1) Burning a candle: paraffin wax (fuel) + Oxygen gas → Carbon dioxide + Water

Chemical Equation: $2C_{30}H_{62} + 91O_2 \rightarrow 60CO_2 + 62H_2O$

What are the reactants when a candle burns? ____________________________

What are the products when a candle burns? ____________________________

What type of change is this? ____

What is the evidence for this type of change?____________________________

____

Table-Evidence or proof of a chemical change or physical change:

Evidence for a Chemical Change	Evidence of a Physical Change

Now analyze the changes from the previous activity to: 1) identify the reactants and products, 2) determine if a new substance has formed and 3) support with evidence (proof) the formation of a new substance.

Change	Type of change	Reactants	Products	Evidence for change
Melting ice: Ice (+heat)→ Liquid water H_2O(solid) → H_2O(liquid)				
Apple browning: Polyphenol oxidase + oxygen → dioxobenzene + water $C_6H_4(OH)_2 + O_2 \rightarrow C_6H_4O_2 + H_2O$				
Wood burning (cellulose): Cellulose + Oxygen → Carbon dioxide + water $C_6H_{10}O_5 + O_2 \rightarrow CO_2 + H_2O$				
Piece of Paper → Paper boat Cellulose → Cellulose $C_6H_{10}O_5 \rightarrow C_6H_{10}O_5$				
Boiling water: Water (+heat) → Water vapor H_2O(liquid) → H_2O(gas)				
Photosynthesis: Carbon dioxide + Water → Glucose + Oxygen $CO_2 + H_2O \rightarrow C_6H_{12}O_6 + O_2$				

Lesson 7

Name:___________________
Date:___________________
Period:___________________

Investigating Temperature Change in a Chemical Reaction

Engage

Directions: Students build a model of water (chemical formula = H_2O). Next, count the atoms and draw your model labeling the following: hydrogen atoms, oxygen atom, chemical bond

Name of compound: water Chemical formula: Number of hydrogen atoms = Number of oxygen atoms = Number of chemical bonds	Diagram with labels:	How would you draw $2H_2O$?

What holds the atoms in water together?____
Does it take energy to hold atoms together? ____
Do you think energy is needed to form a chemical bond? ____
What happens to energy when a chemical bond breaks?"____

Explore

In our final project, you must design a self-warming/cooling device or object. In order to complete this activity, you and your group must design an experiment to decide which chemicals are best to use in your final project. Your group must design your experiment to answer the following guiding questions:

1. Does a chemical change or physical change occur? What is the evidence?
2. Is energy released or absorbed?
3. How much energy is released or absorbed?
4. Would this be a possible reaction you could use in you final project?

You and your group must decide which chemicals to use. You will design an experiment in which you mix two chemicals to investigate if it is a chemical reaction and if energy is released or absorbed. The chemicals available to use in your self-warming/cooling device are:

Solids	**Liquids**
Sodium Bicarbonate Ammonia chloride Magnesium sulfate Calcium Chloride	Acetic acid Water Citric acid solution

Which chemicals will you and your group design an experiment for? 1)________________________________
2)________________________________

Now you and your group will design your own experiment to perform and share your results with the class.

Designing an Experiment: (Your teacher will go over any limitations you will have during the experiment.)

Purpose: Will mixing _________________________ and _______________________ be a chemical or physical change? Will energy be released or absorbed during the change? (Will mixing the two chemicals produce a temperature change to be used in self-warming/cooling device?)

Hypothesis: If I mix ______________________________ and ____________________________, then ________
____
____

Materials: List of everything you will use in your experiment

Procedure: Step by step directions to follow to complete the experiment (should be a numbered list).
When designing your experiment, make sure you keep in mind the following ideas:

- What is the safety equipment you'll need?
- What type of containers?
- How will you know if a chemical reaction has occurred?
- How will you know if there is a change in temperature? How will you measure a temperature change?
- How much of the chemicals will you use? How will you measure the amount of chemicals?

Results:
Data Table 1:

Reactant(s)	Product(s)	Observations	Type of change	Evidence	Reactant temperature	Product temperature	Exothermic or endothermic

After analyzing all the results from the class's experiments, you and your group need to choose the chemicals you will use for your final project. Students will have one more chance to experiment with these chemicals in order to ensure results are accurate and finalize their choice.

Conclusion:
Explain which chemicals you will choose to use. Then, using your data (results of experiments) justify your choice.

____
____
____
____
____
____
____
____

Reflection: What type of object or device can you use your choice of chemicals to warm or cool? Brainstorm ideas and how you would use the chemicals? This will be used for you final project.

Lesson 8

Name:___________________
Date:___________________
Period:___________________

Mass in a Chemical Reaction

Engage: Discussion questions:

1) What happens to energy during chemical reactions? ____
____
____

2) What causes the change in energy? ____
____
____

3) What is always produced during a chemical reaction? ____
____
____

4) What is mass? ____
____

5) Predict what happens to mass during a chemical reaction? Give a reason for your answer. ________________
____
____
____

6) If you think mass changes during a chemical reaction, where does it go? If you think mass stays the same, how do you get a new substance at the end of a chemical reaction? ______________________________________
____
____
____

Explore: Design experiment to see if mass changes in a chemical reaction

Purpose Question: When baking soda and vinegar are mixed, how does the mass of reactants compare with the mass of the products?

Hypothesis: If I mix ___________________________ and _______________________________, then the mass of the reactants will ______________________________________compared to the mass of the products.

Materials:

Procedure: List the steps of your experiment to test if mass changes in a chemical reaction. Students should keep in mind: 1) How will measure mass? 2) What unit will you use to measure mass?

Results:

Number of trial	**Mass of**	**Mass of**
Trial 1		
Trial 2		
Trial 3		
Trial 4		

Conclusion: Base on your results (and other groups' results), what is your conclusion to the purpose question? Students must use data as evidence to justify their conclusion.

____

____

____

____

Explain:

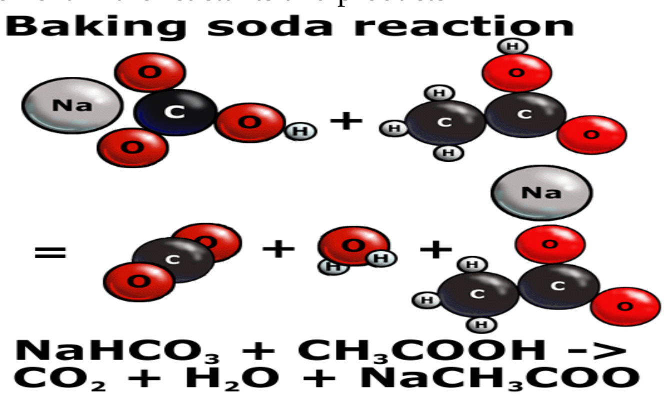
Chemical Equation for Baking soda and vinegar:

1) Label the reactants and products in the chemical equation.
2) Count the atoms of each element in the reactants and products

$$NaHCO_3 + CH_3COOH \rightarrow CO_2 + H_2O + NaCH_3COO$$

Model version of reaction for Baking soda and vinegar:

1) Label the reactants and products in the model of the chemical reaction
2) Count the atoms of each element in the reactants and products



Analysis Questions:

1) How do the atoms of each element in the reactants compare with the atoms of each element in the products?

____

____

2) Based on your answer to #1, what can you infer about the mass of the reactants and products in the reaction?

____

____

3) In an experiment, why might the mass of reactants and mass of products be what is expected?

____

____

____

Lesson 9

How do coefficients affect building models?

What is the difference between a subscript and a coefficient? ____
____
____
____

Construct the following models with coefficients and then draw you models below:

Water: $2H_2O$	Water: $4H_2O$
Oxygen gas: $4O_2$	Acetic Acid: $2C_2H_4O_2$

Now choose one of the chemical equations below to model and draw. First, make sure it is balanced.

1) $Fe + 2C_2H_4O_2 \rightarrow Fe(CH_3COO)_2 + H_2$

2) $MgSO_4 + H_2O \rightarrow H_2SO_4 + MgO$

3) $CHCOOH + NaHCO_3 \rightarrow CHCOOHNa + H_2O + CO_2$

4) $CaCl_2 + H_2O \rightarrow CaO + 2HCl$

5) $3NaHCO_3 + C_6H_8O_7 \rightarrow C_6H_5Na_3O_7 + 3CO_2 + 3H_2O$

Matching reactants to products

Calcuim Chloride and Water $CaCl_2 + H_2O$	Calcium Oxide and Hydorchloric Acid $CaO + 2HCl$
Magnesium Sulfate (Epsom Salt) and Water $MgSO_4 + H_2O$	Magnesium Oxide and Sulfuric Acid $MgO + H_2SO_4$
Ammonia Chloride and Water $NH_4Cl + H_2O$	Ammonia and chlorine and Nitric Acid $NH_4 + Cl + H_2O$
Citric Acid and Baking Soda $C_6H_8O_7 + 3NaHCO_3$	Sodium citrate and carbon dioxide and water $C_6H_5Na_3O_7 + 3CO_2 + 3H_2O$

Vinegar and Baking Soda $C_2H_4O_2$ + $NaHCO_3$	Sodium Acetate and water and carbon dioxide CH_3COONa + H_2O + CO_2
Ammonia Chloride + Water NH_4Cl + H_2O	Ammonia and chlorine and water NH_4 + Cl + H_2O

Lesson 10

Modeling of Chemical Reactions

Your Assignment: With a partner, research a chemical reaction that we investigated in class. You should focus on the chemical reaction that you are planning to use for your final project. You must then find the balanced chemical equation, make a model showing how the equation follows the conservation of mass, explain the reaction you chose, and present it to the class.

The reaction we will model is: ____

Your poster project must include the following:

Written part:

1) Show five chemical equations, how to balance them, and justification of equation being balanced.
2) What reaction did you chose? Why is it important? Explain what elements and /or molecular compounds are involved? (Include element names and chemical names, also common names if applicable)
3) How do you know it was a chemical reaction? (What is the evidence that proves a chemical change has occurred?)
4) Is energy absorbed or released during the reaction? Explain
5) A written explanation of how your model shows the conservation of mass is being followed. Use of vocabulary (atoms, molecular compounds, subscript, coefficient, reactant, product, Law of conservation of mass, exo/endothermic, etc.)

Poster part: (sketch of plan must be approved by teacher before materials can be received)

6) Name of the molecules, compounds, and elements involved in your reaction. (Must have different objects to represent the different elements)

7) A model representing the balanced chemical equation (with a key that explains the model) with proof of a balanced chemical equation.

Presentation part:

8) You and your partner must present and explain poster to class
9) Your presentation must be organized and follow a logical sequence (order)
10) Your presentation must show a clear understanding of the conservation of mass and your chemical reaction
11) Your presentation must contain information from the written part of your project

Example of model part of the poster: (missing here is the information)

Lesson 11 & 12

Exothermic and Endothermic Reactions

Purpose: To produce an exothermic reaction that will be used in a self-warming piece of clothing.

Hypothesis: If I ____,
then ____
____

Materials: __________________________ __________________________ __________________________
__________________________ __________________________ __________________________
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Chemical	Amount of chemical

Procedure:
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Revisions for Procedure:

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Table: Create a data table to record your results; make sure all data has a space to be recorded and there is space to record other groups' results as well.

Guiding thoughts: What must you measure during the experiment?

Conclusion: Restate your hypothesis and use your data to prove or disprove your hypothesis. Use your data as justification/evidence of your conclusion. Based on the results of yours and other groups' experiments, you should now make a final choice of chemicals to use for the final project based on the data collected during the experiments.

Lesson 13

Design of self-warming/cooling device

Your Job: You and your group are in charge of using chemicals to make a self-warming/cooling device for people to use. You can design any type of device, but your design must use the chemicals to heat or cool it in safe way. Your device can be for any situation where it might be useful: everyday use, military, skiing, hiking, fishing, boating, etc.

Your Assignment: You and your group must design (and construct) a device that uses a chemical process to warm or cool itself. Then, you must present your device (and design) to the class. The presentation must include:

1) the device (or poster design of device) which can be used (at least once) to demonstrate how it warms/cools itself

2) A diagram of your device with labels and measurements

3) A written explanation/advertisement of: who will use your device? how your device works? Why is your device useful? A slogan or name for your device.

Your presentation must address the following:

- What will your device be used for? Why is it needed? What problem does your device solve?
- How did you choose the chemicals to be used? What was your process? (Include data from experiments)
- What materials did you use to build your device and why?
- What problems might still need to be worked out before a device like this might actually be used?
- What type of other invention might your device lead to in the future?
  What was most challenging about the design process?

Links to Self-warming and cooling devices

Carbon nanotubes used for self-warming material:

http://gizmodo.com/5888248/carbon-nanotube-coated-fibers-could-one-day-lead-to-self+heating-clothing

7 essential self warming pieces of clothing:
http://gizmodo.com/5963672/7-essential-self+heating-garments-to-keep-you-warm-this-winter

Japan invention:

http://japanexpose.blogspot.com/2011/07/japanese-invent-self-heating-clothing.html

Columbia's version:

http://www2.macleans.ca/2012/02/16/columbias-circuit-breaker-softshell-a-jacket-with-a-heater/#more-240342

Hypothermia Articles to Use

Baby Born on Frozen Street Declared Dead, Revives

GIRL WAS BORN ON FREEZING TORONTO SIDEWALK

By Rob Quinn, Newser Staff

Posted Feb 20, 2013 2:34 AM CST

NEWSER) – Two alert police officers are credited with saving the life of a baby girl who was wrongly declared dead after being born outside in freezing temperatures in Toronto. The girl's mother had attempted to walk to a hospital in temperatures around zero Fahrenheit, but she didn't make it and ended up giving birth on a frigid sidewalk, the *Toronto Star* reports. Hospital staff tried to revive the newborn, but she was declared dead and covered with a sheet. Two police officers waited with the body for the coroner to arrive and after almost two hours, one of them spotted movement under the sheet.

The officer felt for a pulse and alerted medical staff, who confirmed the baby was alive. She is now in stable condition, along with her 20-year-old mother. Doctors believe that the frigid temperatures could have slowed the newborn's heart close to stopping, while preserving brain function. "Hypothermia can mimic death," an expert tells the *Globe and Mail*, which notes that it is "a critical tenet of emergency medicine that you’re not dead until you’re warm and dead." The hospital says it is reviewing "all aspects of care" involved in the incident, including the "extensive resuscitation efforts" when the baby first arrived there.

Article 2:

Stories >> Hypothermia

Sailing is unlike almost any other activity, in that one does not come into sailing with apprehension and slowly graduate to comfort with experience. Just the opposite. Sailors who are really good, know everything about boats, and have thousands of hours at sea are continually and unshakably terrified while on the ocean. Not because they don't know what they're doing, but because they know the ocean so well as to fear it deeply, regardless of how conditions may initially appear. Novices, on the other hand, usually proceed with an affect which is considerably more blithe. As Brian Toss once said, there are only three types of sea-faring sailors — dead, novices, and pessimists. I knew this, but not well enough.

My friend Fritz and I had recently come into a small 15' hobie cat. We didn't really have a place to keep it, so we resolved to try anchoring it out. The idea being that we'd see whether we could set up a semi-permanent anchor mooring close to shore to keep it on, and then just paddle a windsurfing board out there every time we wanted to sail it. In the mean time we'd parked it, on top of a trailer, in a random Bayview side-street.

After work one day, we both hurried down to the boat launch with plans to get the hobiecat anchored out. We had two anchors, and the strategy was for me to sail the hobiecat out with one anchor, while Fritz would row the Sea Louse out with the other anchor. The sun was about an hour away from setting, and it seemed a little windy, but we were really only traveling 200 yards over to drop the anchor, and the wind didn't seem that terrible.

I sailed off the dock, around the pier, and into view of the anchor spot. As soon as I came out from behind the protection of the pier, I was hit with the full force of the wind, and realized for the first time that it was probably blowing a strong 20 to 25 knots. The hobiecat was incredibly light, and was moving amazingly fast, but was also fairly difficult to maneuver in those conditions. I immediately realized that the wind was too strong for our operation, and decided to head back to intercept Fritz.

I had mis-rigged part of the hobiecat, and as a result it took me a while to get it turned around. Before I could head back, Fritz came rowing around the pier, was suddenly hit by the entire strength of the wind, and was blown out into the bay. I sailed past him and suggested that we should just head back, but he was having trouble rowing steadily, and after a few more passes, it was clear that he wasn't making much headway. I began to get worried that the sun would set, that he'd get blown out into the bay in the dark, and that nobody would be able to find him since he didn't have a light.

The wind was howling relentlessly, and the sun was already nudging below the horizon. Seeing that things were beginning to get serious, I tacked over with the intention of picking Fritz up and either towing or abandoning the Sea Louse. As I was shifting my weight over from the tack, a huge gust of wind hit the boat and instantly capsized it. The suddenness of it was unbelievable, as if I was on a tiny model made of paper which someone had simply flicked with their finger; I didn't even have time to register that it was happening. I landed in the water, felt the shock of intense cold run through my system, and gasped as I clambered onto one of the overturned hulls. The wind was blowing so hard that it effectively pinned the boat down, preventing me from righting it, and eventually turtling it completely.

In disbelief, I took stock of where this simple operation — moving a small boat 200 yards — had left me. My phone was dead from the initial water impact, I could see Fritz way off in the distance but didn't know if he could see me, there were no other boats out on the water, no other people on shore, and the last bit of twilight was beginning to fade. I had a life jacket, but was wearing soaked cotton clothing and had no light or radio. Even if there had been anyone around, yelling would have been useless, as the wind would have immediately scattered my cries.

I looked in the direction I was being blown, with the vague hope that I'd end up somewhere reasonable. I wasn't drifting across towards the Oakland side of the bay, but both out and down towards the south. I tried to do the math. I was pretty wet, and in those temperatures, knew that it wouldn't be long before that started to effect my ability to function. I didn't know if or when Fritz would call for help, if he'd even make it back himself, or whether anyone would find me in the dark.

The severity (and stupidity) of my situation was not lost on me. Like anyone, I'd occasionally seen stories about people who drowned in the bay, or succumbed to hypothermia on a local hike. I had always wondered how those kinds of things had been possible, and I realized that this was exactly how it happened. A series of small mistakes and bad decisions left the people in those stories exactly where I was: drifting through freezing water in the dark. I knew very well that in 50 degree water I had 30 to 60 minutes before I lost consciousness from hypothermia.

There was a pier a few thousand yards upwind of me. I looked back downwind, and again contemplated the absolute inky darkness of my current trajectory. How long would I make it before hypothermia? Probably not long enough, it occurred to me. Should I try swimming to the pier? Every second I hesitated brought me slightly further from it. I noticed that I'd already started shivering.

Time passed, and it became clear that there were no other boats on the water, much less a boat that would actually see me. I decided swimming to the pier was the last option that I had any agency over. My only other option was to float with my partially submerged vessel and hope that someone found me before hypothermia did, but my hope of that had largely faded with the sunset. I reasoned that if I tried swimming for it, but didn't make it and became separated from the boat, I'd be well on my way to dead within minutes for sure. So as a precaution, I resolved to swim directly upwind from the boat, such that I'd have a better chance of floating back downwind to be reunited with it.

The bay is ice cold, and even though I was partially submerged, sliding all the way off the hull of the boat was so overwhelmingly frigid that it knocked the wind out of me. I started swimming upwind towards the lights of the pier, still wearing my life jacket and all of my clothing. The wind-waves kept hitting me in the face, and I swallowed a lot of water. I'm a strong swimmer and grew up swimming competitively, but it's only possible to swim through the cold for so long before your body shuts down. After 20 minutes, my boat was quite a ways downwind of me, but the pier didn't appear much closer.

I took stock again. The same wind which had capsized my boat was still whipping over the water. The cold had sapped my strength, I was having difficulty continuing to move my arms, and I realized that I wasn't going to make it to the pier. Floating alone in the dark, with the icy waves washing over my head in that utterly relentless way that is specific to the ocean, I felt the hypothermia really start to set in, and realized that I was probably going to die. I was mostly overwhelmed by the sheer stupidity of it. After all the impossible single-handed passages I had made, all of the freight trains that I'd ridden through freezing nights, all the times that I'd found myself in dangerous situations, been shot at, or embarked on obviously dangerous projects, it seemed absurd that I was going to drown a mere 3,000 yards away from the shore; the final result of what should have been a simple 10 minute operation.

There was also the slowness of it. It wasn't as if I had been shot with a bullet or hit by a bus, suddenly dead. This was something completely different: a slow, inevitable, and extremely lonely series of events that I was being dragged through over the course of an hour. It was strange to think that these were all moments which nobody else would ever know about. I shuddered with the thought of Jim Gray or Joshua Slocum, both people I admired who were lost at sea, and realized that they each must have had their moments like this one. All alone with the inhospitable and uncaring ocean, slowly undergoing the realization that this was it.

The pier clearly out of my reach and the hypothermia clock ticking, I decided to try making it back to the boat. Although I'd been swimming directly upwind, the boat was some ways off from directly downwind of me. I realized that the underwater sail was probably catching the current from the ebbing tide, moving it horizontally away from me. As I swam and drifted back towards it, it became clear that I would very likely end up missing it. I knew that if I got blown downwind of it, I'd never be able to reach it again, and that this was my last chance to catch it.

Strangely, I could feel myself drawn towards the temptation of giving up, even though I knew failure meant certain death. In hindsight, I think it's because the act of giving up feels so similar to the sensation of success, at least in a superficially immediate way. I had been imagining making it to the pier, and had pictured the sense of release that I'd experience when collapsing on dry land. Giving up bears a deceptive resemblance, in that it offers a similar sense of release which comes with letting go and ceasing to try. I had to remind myself that they're not the same.

I looked again at my trajectory in relation to the boat, and realized that it was now or never. I knew that my life was at stake, and that I had to summon every ounce of my strength in order to make one final sprint towards the boat. I gave it everything I had, moving my arms in the general form that I knew one made while swimming, even though I could no longer feel them or sense that they were actually propelling me through the water. I looked up just as I was drifting past the stern of the boat, reached out at the very last second, and barely caught hold of a small bit of line that was trailing off the submerged rudder.

I pulled myself onto the hull again, almost vomited, and noticed that I was starting to get tunnel vision, presumably on the path to blacking out completely. My body was shivering hard, but I knew that I was slightly better off with the boat than I was floating freely. I realized that now, without a doubt, there was nothing else I could do. I continued to marvel at and be frustrated by the stupidity of it all. I wondered how long it would be before I blacked out, and how much longer before my heart would stop.

Time passed, and even though my thoughts were now coming slowly, I started trying to work through questions of how I should position myself such that I wouldn't be face down in the water when I blacked out. I tied a line around my wrist so that I would stay with the boat wreckage once I was no longer conscious.

My vision was hazy, but through the darkness, I saw the mast-head light for a moored tugboat flash on. Then its running lights came on. I knew that I was probably invisible, but this was the first other vessel I had seen during the whole time I'd been out, and suddenly it felt like I had a chance again. Even though they were upwind of me, I screamed as loudly as I could, which turned out to be not much more than a dull moan. I tried to wave my unresponsive arms. They started heading in my direction, and I summoned everything I had in order to lift my arms up, knowing that they could easily just pass right by me or even run me over without ever even noticing.

Against all odds, they happened to see me.

Getting me out of the water was another 15 minute process, since I was nearly-dead weight and wasn't much use. When they'd finally gotten a rope under my arms and were pulling me up the side of the boat, I got wedged in the row of tires that typically line a tug. All I needed to do was put my leg out and push off from the side of the boat's hull, but I couldn't do it.

I was so far gone that I never really saw the name of the boat or the faces of my rescuers. I only remember the floor of the engine room, where they carried me to be near the heat of the engine. Eventually I ended up in a hospital, where I was heated until I stopped shaking and regained full consciousness. When they brought me in my core temperature was so low that the digital thermometers wouldn't register it.

And now I'm fine, with only a few bruises and some rope burn. But the past few days have been colored by the knowledge that I shouldn't be alive. There was absolutely no reason for that tug to have seen me, and just dumb luck that it was there at all. It's strange to think that I really should have died out there, and that all of this should be happening without me. I don't know what I'll do now, but I do know that I have re-learned my fear of the ocean, and that there's no such thing as a "short trip."(Fritz made it back without incident, had no idea that I was in trouble, and was hours away from calling anyone.)

Article 3:

Toronto baby's story similar to past hypothermia cases

The Canadian Press

Posted: Feb 19, 2013 6:52 PM ET

A drop in core temperature due to exposure to severe cold can slow the metabolism so much that a person can appear to be dead, say doctors, who believe that was likely the case with a newborn girl who had been declared dead on the weekend but "came back" to life.

The infant was born on a Toronto sidewalk Sunday after her mother went into labour while walking to the hospital. Mother and child were rushed to Humber River Hospital for treatment but the baby had no apparent vital signs and was declared dead.

About 90 minutes later, two police officers standing by the infant while waiting for the coroner to arrive suddenly noticed that a sheet covering the tiny body was moving.

The newborn was alive.

The officer found a pulse and alerted doctors. The baby girl was transferred to the Hospital for Sick Children, where she was in fair condition Tuesday, meaning she is conscious and may have minor complications, but has a favourable outlook.

Dr. Jamie Hutchison, an intensive care physician at Sick Kids, said the newborn likely had hypothermia — a condition in which the body is rapidly cooled, leading to a dramatic slowing of metabolism, which in some cases can mimic death.

"That would be the most likely reason," Hutchison, who was not involved in the newborn's care but conducts hypothermia research, said Tuesday.

"And that's because the body requires a certain temperature for metabolism to occur. So with each degree drop in temperature, the metabolism of every organ slows."

Whether hypothermia occurs in a child or adult, once their body temperature drops below a certain threshold, the person appears to be comatose, he said. And if they get cold enough, the heart beat will slow and weaken so much that they have no perceptible pulse.

"They're not dead, but they appear that way," Hutchison said.

The phenomenon has given rise to a saying in medical practice: "A patient isn't declared dead until they're warm and dead."

"That's what the mantra is now — you don't give up until the patient's warm and declared dead," said Gary Sieck, an expert in hypothermia at the Mayo Clinic in Rochester, Minn.

In other words, medical practitioners shouldn't assume a patient exposed to frigid temperatures is dead because their body is cold.

Survival after severe hypothermia

There are many examples of people who had severe hypothermia and were resuscitated with CPR and techniques to gradually warm their blood and organs, Sieck said. Many eventually recovered, even after many hours of being in a state mimicking death.

Perhaps the most famous example in Canada is the case of Erika Nordby of Edmonton, dubbed the "Miracle Baby." In the middle of the night in February 2001, the then 13-month-old crawled outside of the house where she was sleeping with her mother. She was wearing only a diaper and T-shirt. The temperature was -24 C.

When she was found outside in a snowbank at least two hours later, Erika's body temperature had plunged to 16 C; her toes were frozen together and her heart had stopped. It took a medical team 90 minutes to get her heart beating again.

But three days later, though Erika was suffering from severe frostbite, there were no signs of other physical injury or the brain damage that's typical of having the oxygen supply off for a long period of time.

In some instances, hypothermia can be beneficial: it can be induced in patients who have had a stroke or heart attack in a bid to significantly lower the metabolism and limit damage to the brain.

"This is where the therapeutic effect of being cold comes in," said Hutchison. "Because the brain's metabolism is slowed ... it actually protects the brain from damage."

Therapeutic hypothermia, as it's called, is also used for patients who have suffered traumatic brain or spinal cord injury.

"When accidental hypothermia happens — as in this case — babies are much more resilient to hypothermia," Sieck said of the Toronto baby, whose name has not been released. "But there have been examples of adults who have recovered after many hours of hypothermia."

He cited the case of Danish teenagers whose dragon boat capsized in 2011, throwing them all into the icy water of a fiord. Several of the teens were thought to be dead at the scene, but almost all recovered after specialized treatment in hospital, Sieck said.

It's critical that a person who becomes hypothermic from exposure — for example, after falling through the ice into a lake or river — be given immediate CPR until paramedics arrive, he said.

"Just continuing CPR will provide adequate circulation to keep the tissues alive. It's so important to continue CPR, even though the patient may appear to be dead."

Article 4:

Hypothermia kills...

HYPOTHERMIA: Hypothermia kills people every year, summer and winter. It occurs when your core body temperature drops under 95F. The signs of hypothermia are shivering (which then stops as hypothermia progresses), stumbling, lethargy, poor judgment, lack of manual dexterity (can't button up jacket). You often won't know you have it, because your brain is shutting down. Watch out for each other. Prevention is the key. It often happens when someone is injured and can't travel (can't generate enough heat), and has insufficient clothing. It frequently happens when people repeatedly get into cold water, as when hiking in a stream. A sprained/broken ankle won't kill you. But if hypothermia follows, it can.

Serious hypothermia occurs when the body temperature dips below 90F.

If you see the signs, determine how bad it is. If the person is beginning to get hypothermia, you must get that person warm, quickly, or they will progressively get worse, slump to the ground, then drift into unconsciousness, and potentially die. Be gentle with the person; jerky movements of them may aggravate the situation. Remove wet clothes. Dress them in dry, insulated clothing, put in sleeping bag, use space blankets, build fire. Put heat packs especially on armpits, groin and abdomen (careful not to burn skin). Skin to skin contact may be used if otherwise appropriate.

Most importantly, if symptoms are pronounced, get medical help if possible Do all you can yourself, but professional rescue may be the best chance for the person's survival.

I have seen hypothermia happen in summer on float trips, in summer on Mt. Baldy, AZ during rain and sleet, in summer on small sailboats in water that was not particularly cold, and other times of year. Alcohol ingestion can promote hypothermia.

The person with hypothermia, when recovered, will remember little or nothing of what happened. They will wonder how they got in a sleeping bag, and why their wet clothes are hanging on bushes. Obviously, this is a very delicate situation, but you must get the person warm. Frankly, you must balance that person's need for help with that person's need to not have their privacy violated. This is a tough situation to be in.

Again, prevention is the key. This is why a rain suit (and when needed, ski suit & space blankets) are good to have. A breathable rain suit, alone (or even a cheap vinyl rain-suit), will often prevent hypothermia. Plan for the weather being worse than you thought it would be, and bring gear for that. Pay attention to weather reports. Keep your eyes on each other and if symptoms begin, act early, and save a life.

TALES OF HYPOTHERMIA

1. MT. BALDY; My kids mother, Brenda, (deceased) and my son, Bryan, and me, set out for the top of Mt. Baldy, AZ, with breathable rain-suits, insulated clothing, etc, in monsoon season. We were well equipped. Close to the top, the

horizon to the west turned blue-black with frequent lightning and we turned back. Quickly the sleet and rain were upon us, as we descended. Brenda, a strong hiker, was having fatigue problems. She kept wanting to sit down, and once down, she did not want to get up. Her body temperature was dropping and she was shivering, despite having great clothing and rain-suit. She began to become lethargic. There was no shelter, no starting a fire up there. We had to keep her moving, but she was so tired. Bryan and I would lift her by her arms, get her walking and she would warm up a little, but then she was too tired to go further. As soon as she sat down, she would become lethargic and less responsive. We would haul her up and get her walking. We repeated this all the way to the trailhead where we had a van with a kerosene heater. She slept for 8 hours, and remembered little of the experience. I figured she had the flu, but when she got up, she was perfectly fine. When we got home, we found out she was pregnant with my daughter April (now 19 years old) who hikes with me frequently.

2. WEST CLEAR CREEK; I went backpacking down into West Clear Creek, AZ, and we waterproofed our backpacks so we could throw them in, and swim through the pools of cold water, get out and hike to the next pool, and repeat this process. Of the four of us, one had gotten over the flu, the week before. Or so he thought. After the 40 minute downhill and several pools of about 100 yards, one person (we'll call him Ed) was slowing down. He puked. He kept going. We arrived at our campsite with Ed quivering, frowning, and not feeling good, but he could talk and make sense. Next, I noticed that he could not get his pack open. When I questioned him, he couldn't make sense. That transition happened in about 3 minutes. I told the other 2 about it. One was preparing his fishing rod to go fishing, and he set off saying, "He'll be fine". The other thought I was overreacting; until Ed slumped to the ground, and didn't know his name. The two of us pulled his clothes off and stuffed him in his bag on a camping pad. We hung his wet clothing on the bushes. We put a space blanket on him and kept careful eye, and saw that he was slowly warming up. He slept until morning and felt a little shaky but was otherwise OK. He had no memory of even arriving at that location, and wondered why his clothing was all over the bushes. I don't know how it would have been if he had needed to swim again, in cold water, that next day.

3. LAKE PONTCHARTRAIN, LA; When I was a young man, I took my sister sailing on my 11 foot sailboat (with a mast about 25 feet tall). This boat (board) would almost jump out of the water in a stiff breeze. To be careful, I took life jackets; tied to the mast. (I told you I was young.) About a mile offshore, she fell in, with the wind-speed and clouds increasing. With the boat flying away from her, I kept losing sight of her in the swells. But she could swim. I got the boat turned around and headed toward her, and flew by her. On the second pass, I missed her again, and she was looking bewildered. Not scared, just confused. She was not focused on grabbing hold of the boat or my hand as the boat went by. Now I knew we had a problem. I couldn't untie the life jacket because the boat would have flipped if I had let go of the tiller (the steering stick), and crawled forward to the mast. On the third pass, I released the sail, to flap in the wind. That slowed the boat and I was able to grab her and haul her onboard. She could not help, was unresponsive and didn't know her name. I put a life jacket on her, with swells increasing, and she slumped onto the deck. I put my leg over her to hold her on the boat and headed for shore. Approaching the dock, the squall was passing on, the sun came out, and we were in protected water. This peaceful scene was a sharp contrast to the sudden sharp squall we had just been through. I hauled her onto the dock, in the sun. She warmed up quickly and within an hour she was fine. She remembered nothing.

4. TUBING THE SALT RIVER, AZ; A group of us were tubing the Salt River in midday, in July. A Mom, who was a nurse, was with her 9 year old daughter. We'll call her Sue. Sue was riding on her Mom's lap, mostly out of the water. But she was jumping into the water repeatedly. She began to shiver. Kids shiver all the time. No big deal. Until the sun went behind some clouds and she couldn't hold her head up. She was groggy and she had stopped shivering.

Stopping shivering is a bad sign when the person is unresponsive and cold. Mom and I hauled her into shore to some warm sand and buried her. She perked up quickly and was fine and Mom made her stay in Mom’s lap. No more jumping into the cold water. She couldn’t understand why Mom was so insistent that she stay out of the water because she remembered little of what happened.

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I hope these stories and the information help you to understand hypothermia and remember that prevention is the key, and to recognize and act quickly if hypothermia should occur. A breathable rain suit will prevent most hypothermia (and is also an extra layer of warmth and a windbreaker, should you need it). Be responsible for your own safety.

David A. Feb. 28, 2010 (David gratefully acknowledges help and input from Mona Morstein, N.D.)

Article 5:

Incredible Story of Surviving Hypothermia

CNN.com has an amazing story today about a skier who fell into frigid waters, spending an extended time beneath the surface, only to be pulled out, and eventually revived, and in the process redefining the effects of hypothermia on the human body.

The accident took place back in 1999 in the city of Narvik, Norway. Narvik is a mountain town known for its spectacular views and amazing skiing, which is exactly why Anna Bågenholm chose it as the location to do her medical residency. Back on that fateful day ten years ago, Anna and her friends were skiing off trail when she took a tumble down an ice gully and ended up going head first through a hole in the ice, into the water. Anna's friends immediately went to her aid, but were unable to pull her from the rushing waters. Calling for help, a rescue helicopter was dispatched to retrieve the trapped skier, but by the time it arrived, Anna had been under the ice for more than 80 minutes.

After being airlifted off the ice, the helicopter sped towards the nearest hospital, but Anna showed almost no signs of life. Her body temperature had dropped to just 56º F and her pulse was non-existent. For all intents and purposes, she was dead, and all attempts at CPR proved fruitless.

But the doctors wouldn't give up, and they decided to not declare her dead until her body had completely warmed up. So, they hooked her up to a machine that slowly warmed her blood, and began to raise her body temp. After three hours, her heart began to beat once again, and Anna returned from the dead.

The story is an amazing one that reminds us that we don't know as much about the human body as we'd like to believe some times. It is an incredible machine that is strong and resilient, even beyond or own expectations. Obviously Anna survived this incident, and now leads a completely normal life that includes skiing and being a radiologist at the hospital that saved her life.

Thanks to Jon from The Rest of Everest for sending this my way. Great story!

Article 6:

Hiker beats hypothermia to survive 3 nights in desert

A woman was rescued from the Utah wilderness after spending four days lost. KSL's John Daley reports.

By Miguel Llanos, NBC News

A hiker who returned to the trail where she took a survival course 40 years ago almost didn't make it out alive. Victoria Grover, 59, nearly died of hypothermia in the high desert of southern Utah over the weekend.

Grover told reporters from her hospital bed on Sunday that while she didn't have food she did have water, and figured that could keep her going for days. "The thing I was worried about was hypothermia -- that that was going to kill me," she said.

A physician's assistant from Wade, Maine, Grover had gone to the trail in Dixie National Forest where she took a survival course at Brigham Young University 40 years ago.

What was supposed to be a six-mile day hike turned into a four-day, three-night ordeal that began when it got too dark for Grover to find her way back.

The next day she broke her leg after jumping a four-foot ledge.

"I really wasn't scared until I stopped shivering," she said, "because that was the point where I thought, 'If somebody doesn't find me pretty soon I'm going to die of hypothermia.'"

The lodge where she was staying alerted the local sheriff when she didn't check out as planned, and a search team found her two days later -- suffering from hypothermia.

So what went through her mind during those cold nights where the temperature dipped into the low 30s and the only warmth she had came from a light poncho?

Besides praying, she also "was dreaming of oranges, which is one of my favorite foods," the Associated Press quoted her as saying. "But there are people who can go for weeks and weeks without food in this world. We have it easy in America."

Other websites with stories:

http://www.snowandmud.com/snowmobile-chat-14/hypothermia-frostbite-personal-stories-43463.html

NGSS Modeling the Conservation of Mass Culminating Task Rubric (**Building 2D/3D Model)**

Categories	4	3	2	1
Balanced Chemical Equation	All 5 equations are correctly balanced.	4 out of 5 equations are correctly balanced.	3 out of 5 equations are correctly balanced.	1-2 out of 5 equations are correctly balanced.
Model (Content)	-The 2D/3D model displays an accurate concept of the Law of Conservation of Mass. In a chemical reaction.	One of the components (reactant/products) is inaccurate.	Two of the components (reactant/products) is inaccurate.	The model is incomplete or inaccurate (shows no understanding of Law of Conservation of Mass)
Model Structure	-The 2D/3D model is sturdy (stays together), neat/clean -color-coded or used keys to identify the elements in the equation.	One of the components is missing.	Two of the components is missing.	The model is not presentable/inaccurate.
Written Report (content/relevance)	-Provide evidence/ justification of the Law of Conservation of Mass in the Chemical equation relative to the model. -Vocabulary words are used correctly.	Some of the evidences/ justifications of the Law of Conservation of Mass in the Chemical equation relative to the model is provided, is missing some vocabulary words.	Not enough evidence/ justification of the Law of Conservation of Mass is provided, is missing multiple vocabulary words.	No attempt of providing evidence/justification of Conservation of Mass is provided, no use of content vocabulary word.
Written Report (mechanics)	All words are correctly spelled with no grammatical errors. Concepts follow a logical sequence.	80% of words are correctly spelled with no grammatical errors. Concepts follow a logical sequence.	60% of words are correctly spelled with no grammatical errors. Concepts slightly follows a logical sequence.	Less than 60% of words are correctly spelled. Concepts does not follow a logical sequence.
Presentation/ Communication	Presentation follows a logical sequence using appropriate content and academic language. The presenter should show a clear understanding of the Law of Conservation of Mass.	Presentation follows a logical sequence using appropriate content and academic language. The presenter showed lacks some understanding of the Law of Conservation of Mass.	Presentation does not follow a logical sequence using appropriate content and academic language. The presenter showed minimal understanding of the Law of Conservation of Mass.	Presentation has no logical sequence of appropriate content and academic language. The presenter does not show a clear understanding of the Law of Conservation of Mass.

NGSS Chemistry Culminating Task Rubric (Self-warming/cooling device)

Categories	4	3	2	1
Device: Content • Choice of chemicals • Choice of materials used in device • Real world application	Student justifies choice of chemicals with data, defends choice of materials, and device has a real-world application.	Student justifies choice of chemicals but not completely with data, defends choice of materials, & device has real-world application.	Student does not justify choice of chemicals (or incorrect choice), material choice not fully defended, device has little real-world application	Student does not justify choice of chemicals (or incorrect choice, materials chosen without reason, and device has little or no real-world application
Device/Poster: Design • Construction/revision • Labels • Mixing of chemicals	Device/poster design is complete with all parts labeled, and plan for chemicals to mix is safe and effective.	Device/poster design is complete with all parts labeled, and plan for chemicals to mix is incomplete	Device/poster design is incomplete and plan for chemical to mix is incomplete	Device/poster design is incomplete, no labels, and plan for mixing chemicals is incomplete
Presentation: • What will your device be used for? • Why is it needed? • What problem does your device solve? • How did you choose the chemicals to be used? • What was your process? (Include data from experiments) • What problems might still need to be worked out before a device like this might actually be used? • What type of other invention might your device lead to in the future? • What was most challenging about the design process?	All eight questions completely addressed, with proper use of content vocabulary	6-7 questions completely addressed with proper use of content vocabulary	3-5 questions completely addressed and misuse of or missing 1-3 content vocabulary words	1-2 questions completely addressed and misuse of or missing 4+ content vocabulary words
Presentation/ Communication	Presentation follows a logical sequence using appropriate content and academic language. The presenter should show a clear understanding of chemical reactions. Presenter eye contact and voice level appropriate.	Presentation follows a logical sequence using appropriate content and academic language. The presenter lacks some understanding of chemical reactions. Presenter eye contact and voice level appropriate.	Presentation does not follow a logical sequence using appropriate content and academic language. The presenter shows minimal understanding of chemical reactions. Presenter eye contact and voice level need correcting.	Presentation has no logical sequence of appropriate content and academic language. The presenter does not show a clear understanding of chemical reactions. Presenter eye contact and voice level need correcting.