What’s the Matter with Chemistry?

Kentucky Core Content:

SC-M-1.1.2 The chemical properties of a substance cause it to react in predictable ways with other substances to form compounds with different characteristic properties. In chemical reactions, the total mass is conserved. Substances are often classified into groups if they react in similar ways.

SC-M-1.1.3 Chemical elements do not break down during normal laboratory reactions such as heating, exposure to electric currents, or reaction with acids. Elements combine in many ways to produce compounds.

SC-H-1.2.4: The physical properties of compounds reflect the nature of the interactions among its molecules. These interactions are determined by the structure of the molecule, including the constituent atoms.

SC-H-1.2.5: Solids, liquids, and gases differ in the distances between molecules or atoms and therefore the energy that binds them together. In solids, the structure is nearly rigid; in liquids, molecules or atoms move around each other but do not move apart; and in gases, molecules or atoms move almost independently of each other and are relatively far apart.

SC-H-1.3.1: Chemical reactions occur all around us and in every cell in our bodies. These reactions may release or consume energy.

SC-H-1.3.2: Rates of chemical reactions vary. Reaction rates depend on concentration, temperature, and properties of reactants. Catalysts speed up or slow down chemical reactions.

SC-H-1.5.3: Heat is the manifestation of the random motion and vibrations of atoms, molecules, and ions. The greater the atomic motion, the higher the temperature.

Main Ideas:
1. Use inquiry and directed activity to understand and demonstrate the three principal states of matter: solid, liquid, gas.
2. Calculate the density of objects and make predictions about objects’ buoyancy in water.
3. Create a non-Newtonian fluid.
4. Use guided-inquiry activity to demonstrate chemical and physical changes.
5. Graph gas behavior according to Charles’ Law, Boyle’s Law, and other gas laws.

Program of Studies for Kentucky Schools:
Students will:
- use appropriate equipment, tools, techniques, technology, and mathematics in scientific investigations.
- design and conduct different kinds of scientific investigations to answer different kinds of questions.
- analyze properties and changes of properties in matter.
- communicate (e.g. write, graph) designs, procedures, and results of scientific investigations.
- measure and represent (e.g. graph) forces on objects and motions of objects.

Grade Level: 8th Grade Science Class

Teacher Background Needed:
This unit is intended as a supplement to a typical chemistry unit. It highlights the main topics covered above but does not provide a complete overview of basic chemistry. It was created specifically to compliment Prentice Hall’s *Science Explorer: Chemical Building Blocks* but can accompany any chemistry text.

Having a good definition of the three states of matter is important. Being able to differentiate between chemical and physical changes is essential. Instructors should be familiar with the definition of and ways of measuring mass, weight, volume, and density. Viscosity of a fluid, Charles’ Law, Boyle’s Law, and other gas laws should be familiarized.

**Students’ Preconceptions:**
1. Students think of matter as an abstract thing—the “stuff” that makes up the universe. It is hard to solidify a definition.
2. All reactions, whether physical or chemical, can be reversed or undone.
3. Weight and mass are the same thing.
4. The density of an object is how heavy it is. The density of an object changes as size changes (i.e. a large enough chunk of ice would sink).

**Student’s Prior Knowledge:**
1. Objects can be described in terms of the materials they are made of and their physical properties.
2. About 100 different elements have been identified, out of which everything is made.
3. Things can be done to materials to change some of their properties, but not all materials respond the same way to what is done to them.
4. Heating and cooling cause changes in the properties of materials. Most substances can exist as a solid, liquid, or gas depending on temperature.

**Pre-assessment:**
1. Begin each class asking students general questions which will relate to the activity of the day. After the activity, discuss these concepts with the class. Two sets of notes are included with the unit: one “blank” copy that can be used to create overhead transparencies; one “teacher” copy.
2. Give the pre-test assessment before the unit begins. (This is also the final test for the unit.)

**Evidence of Achievement:**
1. Each lesson includes questions that will assess the main idea discussed that day.
2. Final test (Students may be allowed to use any notes they’ve taken in class.)
## What’s the Matter with Chemistry?  
Days 1-3

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<td>Inversely proportional</td>
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<td>Salt</td>
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<td>Powdered coffee creamer</td>
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What’s the Matter with Chemistry?
Pre-Test

Name: ______________________________ Class: __________________

Answer the following questions based on what you know. Do not work with others. There are no right or wrong answers.

1. Which of the following is a characteristic property of an element?
   a. boiling point
   b. shape
   c. volume
   d. weight

2. A cubic centimeter is a unit for measuring:
   a. length
   b. volume
   c. mass
   d. density

3. How is iron usually separated from its ores?
   a. by electrolysis
   b. by panning it
   c. by causing a chemical reaction to take place
   d. by dredging it

4. Which of the following is NOT a characteristic of a compound?
   a. has different properties from the element that formed it
   b. is a pure substance
   c. different samples have different properties
   d. can be represented by a formula

5. The amount of matter in an object is its:
   a. mass
   b. density
   c. volume
   d. length

6. Characteristic properties for a substance:
   a. depend on volume.
   b. depend on temperature.
   c. never change
   d. differ on different planets.

7. A(n) ____________ is a well-blended mixture that appears to be a single substance.
   a. compound
   b. element
   c. pure substance
   d. solution

8. Which of the following is an example of a chemical change?
   a. melting butter
   b. mixing milk and chocolate syrup
   c. breaking glass
   d. burning leaves

9. A liquid has a
a. constant temperature.  
b. definite shape.  
c. crystal structure.  
d. definite volume.

10. Boyle’s Law states that as the pressure of a gas increases, its  
a. volume increases.  
b. temperature increases.  
c. volume decreases.  
d. temperature decreases.

11. A substance which takes the shape and volume of its container is a:  
a. solid.  
b. liquid.  
c. gas.  
d. crystal.

12. Which of the following is an example of a chemical change?  
a. twisting a wire  
b. water freezing  
c. a pond drying up  
d. burning gasoline producing carbon dioxide.

13. As the gas in a rigid container is heated, its  
a. pressure increases.  
b. volume increases.  
c. pressure decreases.  
d. volume decreases.

14. A liquid with a low viscosity  
a. has a definite shape.  
b. flows quickly.  
c. flows slowly.  
d. fills its container.

15. New substances are formed during  
a. physical changes.  
b. condensation.  
c. melting.  
d. chemical changes.

16. An object’s ___________________ is its mass divided by its volume.

17. To find the volume of a rectangular solid, multiply the ____________ × width × height.

18. A pure substance that cannot be broken down into any other substances by chemical means is called a(n) _________________________.

19. Usable amounts of metal that can be removed from a rock is called a(n) ________________.

20. According to Charles’s Law, when the temperature of a gas increases in a flexible container, its ___________________ increases.
What’s the *Matter* with *Chemistry*?
Pre-Test/Post-Test Answer Key

1. A
2. B
3. C
4. C
5. A
6. C
7. D
8. D
9. D
10. C
11. C
12. D
13. A
14. D
15. density
16. length
17. element
18. ore
19. volume
Describing Matter

I. Properties of Matter

- Matter – the “stuff” that makes up everything in the universe.

* Examples of Properties:
  1. Hardness
  2. Texture
  3. Shape
  4. Temperature
  5. Flammability
  6. Size

Three Principal States of Matter

1. Solid
2. Liquid
3. Gas

II. Characteristic Properties

- Characteristic Properties – properties that hold true for a particular kind of matter regardless of what the sample is.
  Note: These properties can be used to identify unknown matter.

- Boiling Point – the temperature at which liquid boils.
- Melting Point – the temperature at which a solid melts.

III. Changes In Matter

- Physical changes – a reaction in which the matter stays the same, but changes in size, shape, or appearance.

  * Examples:
    1. Ice melting into water.
    2. Sugar dissolving in water to form Kool-Aid.
    3. (Have students come up with another example.)

- Chemical changes – a reaction in which substances combine or break apart to form new substances.

  * Examples:
    1. Burning a match.
    2. Heating sugar until it turns into caramel.
    3. (Have students come up with another example.)

- Endothermic – a reaction in which heat is absorbed.
- Exothermic – a reaction in which heat is released as a by-product.

IV. Types of Matter
1. **Pure Substances** – made of only one kind of matter and has definite properties.
   - **Elements** – cannot be broken down into other substances by any physical or chemical means.
   - **Compounds** – a substance made of two or more elements that are CHEMICALLY combined.

2. **Mixtures** – two or more substances that are in the same place but not chemically combined.
   - **Solution** – the “best mixed” mixture; the parts are blended so well that they appear to be a single substance.
Describing Matter

I. Properties of Matter
   - Matter –

   * Examples of Properties:
     1. 
     2. 
     3. 
     4. 
     5. 
     6.

Three Principal States of Matter

4. 
5. 
6.

II. Characteristic Properties
   - Characteristic Properties –

   Note: These properties can be used to identify unknown matter.

   - Boiling Point –
   - Melting Point –

III. Changes In Matter
   - Physical changes –

   * Examples:
     1. 
     2. 
     3.

   - Chemical changes –

   * Examples:
     1. 
     2. 
     3.

   - Endothermic –
   - Exothermic –

IV. Types of Matter
3. **Pure Substances** –
   - **Elements** –
   - **Compounds** –

4. **Mixtures** –
   - **Solution** –
Reactions in a Bag
Adapted from http://www.lessonplanspage.com

Topic/Question:
Introduction to chemical and physical reactions. Guided-inquiry activity to demonstrate the difference between the two.

Core Content/National Standards:

SC-H-1.3.1: Chemical reactions occur all around us and in every cell in our bodies. These reactions may release or consume energy.
SC-H-1.3.2: Rates of chemical reactions vary. Reaction rates depend on concentration, temperature, and properties of reactants. Catalysts speed up or slow down chemical reactions.
SC-H-1.5.3: Heat is the manifestation of the random motion and vibrations of atoms, molecules, and ions. The greater the atomic or molecular motion, the higher the temperature.

Objectives:
Students will perform two experiments: one demonstrating a chemical change, the other a physical change. In this lesson students will:
- Predict whether a chemical or physical reaction will occur
- Be able to cite evidence of a chemical reaction occurring
- Differentiate between endothermic and exothermic processes
- Differentiate between chemical and physical reactions

Materials:
Each group:
- 1 permanent marker
- 3 spoons (Tsp. size)
- 1 measuring cup with 1 cup and ½ cup measurements
- Water source

Each student:
- 2 plastic Ziploc sandwich bags
- 3 Tsp. Ammonium nitrate
- 2 Tsp. Calcium chloride
- 1 Tsp. Sodium bicarbonate (baking soda)

Procedure/Time:
Activity Time: 1 class period (approximately 50 minutes)

Procedure:
Instructor
Prior to class:
1. Pour a little of each chemical into its own container for easier access.
   Give one set of the three chemical containers to each group.
During class:
  - Although step-by-step instructions are included on the student worksheet, guiding students through the procedure ensures that the experiment is done correctly and without wasted materials.
  - Throughout the experiment prompt students with questions:
    - Can you predict what will happen in this experiment based solely on the chemicals used? (Some students may recognize the more common uses of some of the chemicals.)
    - Will this be a chemical or physical reaction?
    - How will you know/How can you tell?
    - How do the two experiments differ?
  - Discuss questions on the student worksheet with individual groups as the experiment progresses.
  - To conclude the activity, read through the Sum It Up section of the worksheet to ensure that students understand what is happening in each experiment and can differentiate between the two types. Allow students to fill in the blanks aloud for the class.

Students
  - Allow students to work through the directions on the student handout. Guide the class as necessary to keep them on task. Make sure that they answer the review questions as they complete each experiment. These will be used for discussion later.

Assessment:
  - Student worksheet:
    - Reactions in a Bag
Warning: The following experiments involve chemicals which, if used improperly, could be harmful to your health. Please exercise caution when handling them.

Experiment #1

Procedure:
1. Take 1 plastic baggie. Using a marker label it “#1.”
2. Place 3 spoonfuls of Ammonium nitrate directly into the plastic bag.
3. Quickly pour 1 cupful of water into the bag of Ammonium nitrate, and seal the bag (try to remove excess air before sealing the bag).
4. Gently squeeze the bag to mix the solid and water.

Assessment:
Answer the following questions based on the experiment you just performed.

1. What happens when water is added to the Ammonium nitrate?

2. Is there any evidence that a reaction is taking place?

3. Did this experiment demonstrate a physical or chemical reaction?

Experiment #2

Procedure:
1. Take 1 new plastic baggie. Using a marker label it “#2.”
2. Place 2 spoonfuls of Calcium chloride directly into the plastic bag.
3. Place 1 spoonful of Sodium bicarbonate (baking soda) into the bag. Seal the bag, shake it, and see if a reaction takes place.
4. Add ½ cupful of water to the bag. Remove excess air and seal the bag.
5. Tilt the bag back-and-forth to mix the chemicals.
6. Observe the reaction. If the bag gets tight due to pressure, open the seal to release the pressure then reseal it.

Assessment:
Answer the following questions based on the experiment you just performed.

1. How was this experiment different than the one before?

2. Did a noticeable reaction occur before the water was added?

3. Why does the bag inflate?

4. Does the reaction get hot or cold initially?

5. Does the reaction get hot or cold after 1 minute?

6. Did this experiment demonstrate a physical or chemical reaction?

7. What observations did you make which justify your answer?
Sum it up

Use the word bank given to complete the following paragraphs. A word may be used twice.

Word Bank

- physical
- chemical
- heat
- endothermic
- exothermic

In experiment #1, the process of making the cold pack is not a __________________ reaction but merely the __________________ act of dissolving. When ammonium nitrate is dissolved in water, the process is __________________, thus producing the cold pack.

In experiment #2, the process of making the hot pack is a ______________ reaction. We know this because the formation of a ______ occurs. When the chemicals react, a temperature change occurs and ______ is produced. This by-product is evidence of an __________________ reaction.
Elements from Earth

- **Mass** - the amount of matter in a substance

\[
\text{Mass} \\
\text{Density} = \frac{\text{Mass}}{\text{Volume}}
\]

**Note:** Density is a CHARACTERISTIC PROPERTY that can be used to identify unknown substances.

- **Ore** - any rock that contains a metal or other economically useful material

* To obtain an element from its compound, it is necessary to cause a chemical reaction to take place.

Example:
1. Iron from its ore.
2. Copper from its compound by electrolysis.

* Sometimes a physical change is all that’s needed to separate an element from its mixture.

Example:
1. Panning for gold.
2. Dredging for gold.
Elements From Earth

- Mass-

\[
\text{Density} = \frac{\text{Mass}}{\text{Volume}}
\]

**Note:** Density is a CHARACTERISTIC PROPERTY that can be used to identify unknown substances.

- Ore-

* To obtain an element from its compound, it is necessary to cause a chemical reaction to take place.

Example: 1.
2.

* Sometimes a physical change is all that’s needed to separate an element from its mixture.

Example: 1.
2.
Density of Candy Bars

**Topic/Question:**
Review of density, volume, and mass. Extrapolation as to how density affects buoyancy in water.

**Core Content/National Standards:**

**Program of Studies for Kentucky Schools:** Students will:
- use appropriate equipment, tools, techniques, technology, and mathematics in scientific investigations.
- design and conduct different kinds of scientific investigations to answer different kinds of questions.
- analyze properties and changes of properties in matter.

**Objectives:**

Students will:
- Make predictions based on prior knowledge about which candy bar will have the largest volume, mass, and density.
- Use a balance to measure mass.
- Use a ruler to measure volume.
- Calculate the density of each candy bar based on their previous measurements.

**Materials:**

**Each group:**
1 balance (with gram measurements)

**Each student:**
1 ruler
1 Minis Twix bar
1 Fun-size Snacks Snickers bar
1 Fun-size Snacks 3 Musketeers
1 Hershey’s Nugget
1 Fun-size Snacks Milky Way bar

**Procedure/Time:**

**Activity Time:** 1 class period (approximately 50 minutes)

**Procedure:**

**Instructor**

Prior to class:
- Fill a large clear jar or cylinder with water. A 1000 ml graduated cylinder works well since it is large enough to be seen from most anywhere in the classroom.

During class:
- Before the class begins individual work, demonstrate how to measure mass with the balance, how to measure volume with the ruler, and how to calculate density based on those measurements.
Prompt students to answer the prediction questions before they begin measuring.

After all groups have completed their measurements, ask each group to share their conclusion results.

The Challenge Question: Based on the fact that the density of water is 1.0 g/cm³ which of the candy bars would float in water? After students have made their predictions, take one of each type of candy bar and drop it into the cylinder of water. Were the students’ predictions correct? Why/why not?

**Students**

Instructions are given on the student worksheet as to how to complete the lab activity.

As students finish measuring a candy bar (i.e. they have calculated the mass, volume, and density for it) they may eat that piece of candy.

**Teacher Tip:** In order for measurements to be accurate students must remove the candy from its wrapper. To maintain cleanliness, you may want to give each student a paper plate or paper towel to place their candy while they measure.

**Assessment:**

- Student Worksheet:
  
  **Density of Candy Bars**
Density of Candy Bars

Useful formulas

Volume = Length x Width x Height

\[ \text{Mass} \]

\[ \text{Density} = \frac{\text{Mass}}{\text{Volume}} \]

* Don’t forget to include units for your measurements!

Think about it

Make predictions about the following activity based on what YOU think. There are no right or wrong answers to this section.

1. Which candy bar will have the largest volume? ______________________

2. Which candy bar will have the largest mass? ______________________

3. Which candy bar do you think will be the densest? ______________________

   Why? _______________________________________________________________

Collecting data

Complete the following chart by measuring the mass (in grams) and volume (in cm\(^3\)) of each type of candy bar. Then calculate each of their densities.

<table>
<thead>
<tr>
<th>Candy</th>
<th>Mass (g)</th>
<th>Volume (cm(^3))</th>
<th>Density (g/cm(^3))</th>
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</thead>
<tbody>
<tr>
<td>Twix</td>
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<td></td>
</tr>
<tr>
<td>Snickers</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 Musketeers</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hershey's Nuggets</td>
<td></td>
<td></td>
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<tr>
<td>Milky Way</td>
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</tr>
</tbody>
</table>

Conclusions

Answer the following questions based on the calculations you just made.
1. Which candy bar had the largest volume? ____________________________

2. Which candy bar had the largest mass? ____________________________

3. Which candy bar is the densest? _________________________________
   Why do you think this is so? _________________________________

Challenge:

The density of water is approximately 1 g/cm³. If placed in a cup of water, which of the candy bars would float? Why?
Solids, Liquids, and Gases

To define solids, liquids, and gases, you need to examine their properties. The states of matter are defined not by what they are made of, but mainly by whether or not they hold their volume and shape.

- **Solid** – has a definite volume and a definite shape.
  - **Crystalline Solids** – solids that are made up of crystals.
    - Examples: Salt, sugar, sand, and snow
  - **Amorphous Solids** – solids whose particles are not arranged in a regular pattern.
    - Examples: Plastics, rubber, and glass

- **Liquid** – has a definite volume but takes on the shape of its container.
  - **Fluid** – “a substance that flows”
  - **Viscosity** – the resistance of a liquid to flowing.

- **Gases** – has neither a definite volume nor shape.

<table>
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<tr>
<th></th>
<th>Solid</th>
<th>Liquid</th>
<th>Gases</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Volume</strong></td>
<td>Definite</td>
<td>Definite</td>
<td>Varies</td>
</tr>
<tr>
<td><strong>Shape</strong></td>
<td>Definite</td>
<td>Varies</td>
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Solids, Liquids, and Gases

To define solids, liquids, and gases, you need to examine their properties. The states of matter are defined not by what they are made of, but mainly by whether or not they hold their volume and shape.

- **Solid** –
  - **Crystalline Solids** –
    - Examples: Salt, sugar, sand, and snow
  - **Amorphous Solids** –
    - Examples: Plastics, rubber, and glass

- **Liquid** –
  - **Fluid** –
    - **Viscosity** –

- **Gases** –

<table>
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<th></th>
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<th>Gases</th>
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</thead>
<tbody>
<tr>
<td><strong>Volume</strong></td>
<td>Definite</td>
<td>Definite</td>
<td>Varies</td>
</tr>
<tr>
<td><strong>Shape</strong></td>
<td>Definite</td>
<td>Varies</td>
<td>Varies</td>
</tr>
</tbody>
</table>
**Solids, Liquids, & Gases**
Activities adapted from *Janice VanCleave’s 201 Awesome Experiments*

**Topic/Question:**
Examines the definition of solid, liquid, and gas. Demonstrates the difference in particles of a solid verses particles of a liquid. Guided-inquiry activity to create a non-Newtonian fluid. Open-inquiry activity to design an experiment proving that gas is not just empty space.

**Core Content/National Standards:**

**SC-H-1.2.4:** The physical properties of compounds reflect the nature of the interactions among its molecules. These interactions are determined by the structure of the molecule, including the constituent atoms.

**SC-H-1.2.5:** Solids, liquids, and gases differ in the distances between molecules or atoms and there the energy that binds them together. In solids, the structure is nearly rigid; in liquids, molecules or atoms move around each other but do not move apart; and in gases, molecules or atoms move almost independently of each other and are relatively far apart.

**Objectives:**
Students will:
- Observe the difference in particles of a solid verses particles of a liquid.
- Create a non-Newtonian fluid.
- Formulate a testable hypothesis and demonstrate the logical connections between the scientific concepts guiding a hypothesis and the design of an experiment.

**Materials:**
During this lesson students will actually perform three separate activities. To prevent confusion, give out materials one activity at a time.

**Each group:**
1 + 1 ≠ 2:
- 1 measuring cup (1 cup size)
- 1 1-quart jar or container
- 1 cup of sugar
- 2 cups of water
- Masking Tape

**Sticky Sand:**
- 1 bowl (standard size)
- 1 plastic spoon
- ½ cup cornstarch
- 4 spoonfuls of water
- 1 pair of scissors

**Gases:**
- 1 balance
- 1-meter stick
2 balloons
Tape

Note: For the Gases activity also include various items that they students may or may not use. By supplying unusual items you will find that students may create unconventional experiments.

Procedure/Time:
Activity Time: Approximately 1 class period (55 minutes)

Procedure:
Instructor:
Prior to Class:
- Have materials for each activity gathered together by group.
- The Sticky Sand activity can get quite messy so you may want to gather paper towels and clean up materials.

During Class:
- Keep students on task and flowing smoothly from one activity to the next. If given free reign students will spend all of class playing with their “sticky sand.”
- Read the passage included on non-Newtonian fluids to give students a better understanding on what they have just made.
- Give students ample time to guess and check as to how to create an experiment that will work. After students complete the Gases activity have them discuss aloud with the class their experiments and expected results.

Students:
- Instructions are given on the student worksheet as to how to complete the lab activities.
- Allow the students to take home some “sticky sand” in a baggie if they wish. They may have to add more water to hydrate the substance later.

Assessment:
- Student worksheet:

   Solids, Liquids, and Gases
1 + 1 ≠ 2

1. Pour 1 cup water into the jar. Mark the water level with masking tape.
2. Pour a 2nd cup of water into the jar. Mark the water level with masking tape.
3. Empty the jar.
4. Pour 1 cup of sugar into the jar. Take note of the level of the sugar.
5. Add 1 cup of water.

Does the solution in the jar come to the same level as 2 cups of water? ______________
Describe how the arrangement of particles in sugar and water may explain this result. _______

______________________________________________________________________________
______________________________________________________________________________

Sticky sand

1. Add ½ cup of cornstarch to the bowl.
2. Slowly add 4 spoonfuls of water. Stir well as you add.
3. Once the water and cornstarch are well mixed, complete the following table, performing the “Actions” in order.

<table>
<thead>
<tr>
<th>Action</th>
<th>What happens?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Squeeze the sand.</td>
<td></td>
</tr>
<tr>
<td>Shape it into a ball.</td>
<td></td>
</tr>
<tr>
<td>Open your hand.</td>
<td></td>
</tr>
<tr>
<td>Gently tap the sand with a spoon.</td>
<td></td>
</tr>
<tr>
<td>Try to cut it as you pour it into the bowl.</td>
<td></td>
</tr>
</tbody>
</table>

“Sticky Sand” is an example of a _________________________________. It is a matter whose _______________________________ (thickness) increases when pressure is applied to it.

Gases
Many gases, such as air, are not visible. Design an experiment that would test the hypothesis that a gas is not just empty space.

**Materials:**
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________

**Procedure:**
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________

**Expected Conclusion:**
What will happen when your experiment is performed? ______________________________
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________

How does this illustrate that gas is not just empty space? __________________________
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
Non-Newtonian Fluids

After students have completed the “Sticky Sand” activity, this passage should be read aloud to the class. The answers to the fill-in-the-blank summary question accompanying the activity are found here.

You have just made what is known as a “non-Newtonian” fluid. In the 1700s, Sir Isaac Newton described the properties of ideal fluids. He said that an ideal fluid would have a constant viscosity, or resistance to flow, at a given temperature. Your experiment proved that your ooze is a non-Newtonian fluid because it has the properties of both a liquid and a solid and reacts to stress with increased thickness (viscosity).

Quicksand is another non-Newtonian fluid. That means the more you struggle against it – or try to “cut” through it – the more resistant it gets. Which explains why you shouldn’t struggle violently if you ever happen to fall into it! (While we’re on the subject, the best thing to do if you fall into quicksand is to swim out slowly.)
Graphing the Gas Laws

Topic/Question:

Core Content/National Standards:
Programs of Studies for Kentucky Schools: Students will:
• communicate (e.g. write, graph) designs, procedures, and results of scientific investigations.
• measure and represent (e.g. graph) forces on objects and motions of objects.

Objectives:
Students will:
o Graph three main gas laws (e.g. Charles’ Law, Boyle’s Law)
o Differentiate between directly proportional and indirectly proportional graphs.

Materials:
Each student: 
1 Graphing student worksheet

Procedure/Time:
Activity Time: 30 minutes

Procedure:
Instructor:
Prior to Class:
o Included in this lesson are illustrations of Charles’ Law, Boyle’s Law, and the law of the Relationship of Pressure and Temperature. You may want to make overhead transparencies of these images to include for better understanding.
During Class:
o Work through the handout on the overhead so students have guidance. Begin by giving an example of each type of graph. Review what is needed to make a graph complete (e.g. title, axis labels, etc.).
o The data to be graphed is tabled beside of each axis.
o In the conclusion section, students should state the respective gas law associated with the graph, as well as, whether the graph is inversely or directly proportional.

Directly proportional—As one variable of the graph gets larger in value, the other variable of the graph also gets larger in value.
Inversely proportional—As one variable of the graph gets larger in value, the other variable of the graph gets smaller in value.
o After completing the first graph on the overhead (with help from the class), allow students to complete the remaining graphs on their own. Monitor the class to provide individual assistance.
o After the class has completed the graphs work through them on the overhead so students can check their work.
Students:
  - Follow the example your instructor will give you on how to complete the student worksheet.

Assessment:
  - Student worksheet:
    
    Graphing
Graphing

Name: ______________________________
Class: ____________

Types of graphs

Line Graphs
Bar Graphs (histograms)
Pie Graphs
Line/Bar Graph…What You Need!

• Title
• X / Y axis labeled WITH UNITS
• Appropriate Scaling on axis
• Appropriate Graph

Pressure and Temperature

<table>
<thead>
<tr>
<th>Temperature (°C)</th>
<th>Pressure (kPa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>8</td>
</tr>
<tr>
<td>5</td>
<td>11</td>
</tr>
<tr>
<td>10</td>
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<tr>
<td>15</td>
<td>17</td>
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<tr>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>25</td>
<td>23</td>
</tr>
</tbody>
</table>

Conclusion: _____________________________________________________________
________________________________________________________________________
## Temperature and Volume: Charles’s Law

<table>
<thead>
<tr>
<th>Temperature (°C)</th>
<th>Volume (ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>50</td>
</tr>
<tr>
<td>10</td>
<td>52</td>
</tr>
<tr>
<td>20</td>
<td>54</td>
</tr>
<tr>
<td>30</td>
<td>56</td>
</tr>
<tr>
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<tr>
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<td>66</td>
</tr>
<tr>
<td>90</td>
<td>67</td>
</tr>
<tr>
<td>100</td>
<td>69</td>
</tr>
</tbody>
</table>

Conclusion: _____________________________________________________________
________________________________________________________________________

## Pressure and volume: Boyle’s Law

<table>
<thead>
<tr>
<th>Volume (ml)</th>
<th>Pressure (kPa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>60</td>
</tr>
<tr>
<td>90</td>
<td>67</td>
</tr>
<tr>
<td>80</td>
<td>75</td>
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<td>86</td>
</tr>
<tr>
<td>60</td>
<td>100</td>
</tr>
<tr>
<td>50</td>
<td>115</td>
</tr>
<tr>
<td>40</td>
<td>127</td>
</tr>
</tbody>
</table>

Conclusion: _____________________________________________________________
________________________________________________________________________
Charles's Law

"Prentice Hall Teaching Resources Science Explorer: Chemical Building Blocks"
2 Boyle's Law

"Prentice Hall Teaching Resources Science Explorer: Chemical Building Blocks"
3 Relationship of Pressure and Temperature

Low temperature

High temperature
Fun Chemistry
Magic Solution activity adapted from Janice VanCleave’s 201Awesome Experiments

Topic/Question:
Can chemistry be fun? Can we blow something up? (Student inspired lesson on density and how surface area affects the speed of a chemical reaction.)

Core Content/National Standards:
**SC-H-1.2.4:** The physical properties of compounds reflect the nature of the interactions among its molecules. These interactions are determined by the structure of the molecule, including the constituent atoms.

**SC-H-1.3.2:** Rates of chemical reactions vary. Reaction rates depend on concentration, temperature, and properties of reactants. Catalysts speed up or slow down chemical reactions.

Objectives:
Students will perform two activities targeted at a review of density and chemical reactions. In this lesson students will:
- Make conclusions as to how the density of a solution will affect the buoyancy of an object in it.
- Discover that changing the surface area of matter may speed up a reaction

Materials:
**Magic Solution:**
- Each group:
  - 2 large clear cups (plastic party cup size)
  - 1 spoon
  - 2 eggs
  - ¾ cupful of water
  - 1 spoonful of milk
  - 4 spoonfuls of salt

**Flaming Creamer:**
- Each student:
  - 1 paper plate
  - 1 small cup (approx. 4 ounces)
  - 1 cupful of powdered coffee creamer
  - 2 matches (at least)

Procedure/Time:
**Activity Time:** Approximately 40 minutes

Procedure:
**Instructor:**
- Prior to Class:
  - For easier access to the salt, you may want to pour some into a shallow open container.

  During Class:
o Directions are given on the student worksheet as to how the Magic Solution activity is performed. You may want to walk the class through the steps together to prevent one group from completing the activity ahead of others and ruining the “magic.”

o The Flaming Creamer activity should be performed in a well-ventilated area. I suggest opening the windows to minimize the smell of sulfur from the matches.

o Have the students wear safety glasses during the activity.

**Teacher Tip:** If the egg in the water and salt solution does not float have students add more salt.

**Teacher Tip:** Emphasize to students that only a small amount of creamer should be sprinkled over the flame. If you choose, students may continue the experiment over and over producing a larger fire show each time.

**CAUTION:** Students can create a VERY large fireball from this activity if they pour too much creamer over the flame at once. They must be monitored closely.

**Assessment:**

- Student worksheet:
  
  *Magic and a Fire Show*
Magic Solution

1. Fill both cups ¾ of the way with water.
2. Add a spoonful of milk to one cup.
3. Add 4 spoonfuls of salt to the other cup. Stir.
4. Gently place an egg in each cup.

What happens to the egg in the cup of water and milk? ___________________________
________________________________________________________________________
What happens to the egg in the cup of water and salt? __________________________
________________________________________________________________________
Why do these results occur? ________________________________________________
________________________________________________________________________
________________________________________________________________________

Flaming Creamer

1. Strike a match and attempt to set a light the creamer in the cup.
2. Over the plate provided to you, strike another match and sprinkle a small amount of creamer over the flame.

What happens when you set a flame to the creamer in the cup? __________________
________________________________________________________________________
What happens when you sprinkle creamer over the open flame? _________________
________________________________________________________________________
What physical property of matter is being manipulated here? _________________
What happens if a larger amount of creamer is sprinkled over the flame? ___________
________________________________________________________________________

* When creamer is sprinkled over the flame it has more ____________________________
______________________________ than when in its cup. This speeds up the chemical reaction
taking place and causes the result you see.
What’s the Matter with Chemistry?

Post-Test

Name: _______________________________________  Class: ___________________

Answer the following questions based on what you’ve learned in this unit. Work individually. You may use any notes you have taken in class.

1. Which of the following is a characteristic property of an element?
   a. boiling point  
   b. shape  
   c. volume  
   d. weight

2. A cubic centimeter is a unit for measuring:
   a. length  
   b. volume  
   c. mass  
   d. density

3. How is iron usually separated from its ores?
   a. by electrolysis  
   b. by panning it  
   c. by causing a chemical reaction to take place  
   d. by dredging it

4. Which of the following is NOT a characteristic of a compound?
   a. has different properties from the element that formed it  
   b. is a pure substance  
   c. different samples have different properties  
   d. can be represented by a formula

5. The amount of matter in an object is its:
   a. mass  
   b. density  
   c. volume  
   d. length

6. Characteristic properties for a substance:
   a. depend on volume.  
   b. depend on temperature.  
   c. never change  
   d. differ on different planets.

7. A(n) ____________ is a well-blended mixture that appears to be a single substance.
   a. compound  
   b. element  
   c. pure substance  
   d. solution

8. Which of the following is an example of a chemical change?
   a. melting butter  
   b. mixing milk and chocolate syrup  
   c. breaking glass  
   d. burning leaves

9. A liquid has a
   a. constant temperature.  
   b. definite shape.  
   c. crystal structure.  
   d. definite volume.

10. Boyle’s Law states that as the pressure of a gas increases, its
    a. volume increases.  
    b. temperature increases.  
    c. volume decreases.  
    d. temperature decreases.
11. A substance which takes the shape and volume of its container is a:
   a. solid.  
   b. liquid.  
   c. gas.  
   d. crystal.

12. Which of the following is an example of a chemical change?
   a. twisting a wire  
   b. water freezing  
   c. a pond drying up  
   d. burning gasoline producing carbon dioxide.

13. As the gas in a rigid container is heated, its
   a. pressure increases.  
   b. volume increases.  
   c. pressure decreases.  
   d. volume decreases.

14. A liquid with a low viscosity
   a. has a definite shape.  
   b. flows quickly.  
   c. flows slowly.  
   d. fills its container.

15. New substances are formed during
   a. physical changes.  
   b. condensation.  
   c. melting.  
   d. chemical changes.

16. An object’s ________________ is its mass divided by its volume.

17. To find the volume of a rectangular solid, multiply the ________________ × width × height.

18. A pure substance that cannot be broken down into any other substances by chemical means
   is called a(n) _________________.

19. Usable amounts of metal that can be removed from a rock is called a(n) _________________.

20. According to Charles’s Law, when the temperature of a gas increases in a flexible container,
   its ________________ increases.
What’s the *Matter* with *Chemistry*?
Pre-Test/Post-Test Answer Key

20. A
21. B
22. C
23. C
24. A
25. C
26. D
27. D
28. D
29. C
30. C
31. D
32. A
33. D
34. density
35. length
36. element
37. ore
38. volume