CURRICULUM GUIDE FOR

Solids, Liquids, and Gases

(Based on the STC kit *Solids and Liquids* and Discovery Works *Solids, Liquids, and Gases*)

Wallingford Public Schools
First Grade
Science

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particular unit. These notes should not be replicated for your students; however, you may share some of the content when appropriate for the developmental level of your students.

UNIT SUMMARY

In this unit, children are given the opportunity to observe, describe, and compare the three states of matter. Students will learn the properties that make solids, liquids, and gases unique as well as their commonalities through simple investigations. Students will also explore how matter can change through the application of energy by conducting simple experiments. Students will be expected to justify their rationale for classifying objects in the real world.

STAGE 1- STANDARDS/GOALS

What should students understand, know, and be able to do? Stage one identifies the desired results of the unit including the related state science content standards and expected performances, enduring understandings, essential questions, knowledge and skills.

Enduring Understandings *Insights learned from exploring generalizations via the essential questions. (Students will understand THAT…) K-12 enduring understandings are those understandings that should be developed over time, they are not expected to be mastered over one unit or one year.*	**Essential Questions** *Inquiry used to explore generalizations*
Overarching Enduring Understandings: • Science is the method of observation and investigation used to understand our world. (K-12) • Inquiry is the integration of process skills, the application of scientific content, and critical thinking to solve problems.(K-12) • Matter can be described, organized, and classified for understanding. (K-12) *Unit Specific Enduring Understandings:* • Matter can be classified as a solid, liquid, or gas. • Matter takes up space and has weight/mass. • Matter is made up of particles (molecules/atoms). • Matter can be identified by its properties. • Some matter can change its properties and form through the addition or removal of energy (heat).	• How can you describe a solid, a liquid, or a gas? • What properties of solids, liquids, and gases make them different? • How can matter change from state to state? • How does temperature affect matter? • What things are not made up of matter? • What information about the properties of matter can be gathered by observation? • What common material is affected by magnetism? • How can objects within each state of matter be different?

Knowledge and Skills

What students are expected to know and be able to do

The knowledge and skills in this section have been extracted from Wallingford's K-5 Science Scope and Sequence.

Knowledge

The students will be able to…

K1. Compare and contrast states of matter.
K2. Explain how matter can change through the application of energy (heat).
K3. Classify objects in the environment according to their forms of matter.
K4. Classify objects based on more than one property (texture, color, attraction to magnets, dissolving in water, etc.).
K5. Recognize how scientists gain information about states of matter through observation.

<u>*Skills*</u>

The students will be able to...

S1. Generate appropriate questions such as "why did…?"
S2. Observe and describe commonalities and differences among objects.
S3. Sort and classify objects based on two observable properties.
S4. Predict

- the effect of the addition or loss of heat on solids, liquids, or gases.
- by which property (properties) matter is sorted.
- which solids will dissolve in water.
- which object will be attracted to magnets.
- which object is heavier or lighter when comparing to other matter (feather vs. air, water vs. ice).

S5. Design an investigation to help answer an investigable question.
S6. Conduct simple investigations.
S7. Employ simple equipment and measuring tools.

- Equal arm balance
- Thermometer
- Scales
- Electric hot plate
- Rulers/number lines/yard sticks
- Non-standard measuring devices

S8. Demonstrate safe use of materials.
S9. Organize appropriate and accurate measurements and observations using:

- Graphic organizers
- Picture and bar graphs
- Illustrations and diagrams
- Journaling

S10. Draw conclusions based on data, observations and findings.
S11. Communicate results or information in an appropriate manner using:

- Pictures
- Oral reports
- Journals

Common Misconceptions Children Have

By identifying misconceptions early, teachers can design appropriate lessons to address and change student misconceptions.

- Children tend to think that water is the only liquid that exists. (shampoo, soap, orange juice, ketchup)
- Children believe that the terms gas (such as air) and gasoline are interchangeable.
- Solids are the <u>only</u> forms of matter.
- Liquids are not matter—they have nothing in common with solids.
- Gases are not matter because they are invisible.

- Air does not “exist” because it cannot be seen or smelled. Air and oxygen are the same thing.
- Particles of matter possess properties that we associate with macroscopic matter. For example, gold atoms are shiny and hard, or water molecules are tiny droplets.
- Air does not occupy space.
- Ice is a different substance from water.
- Water disappears as it evaporates; it ceases to exist.
- The amount of water increases when it is frozen (due to ice expansion).
- Pliable solids (such as clay) are not solid.
- Expansion of matter is due to the expansion of the particles, rather than the increase of particle spacing.
- All liquids mix.
- All metals are magnetic

Content Standard(s) *Generalizations about what students should know and be able to do.*	
Content Standards (CSDE Science Framework 2004)	**Primary Expected Performances** (CSDE Science Framework 2004)
Properties of Matter – How does the structure of matter affect the properties and uses of materials? **2.1 – Materials can be classified as solid, liquid or gas based on their observable properties.** • Solids tend to maintain their own shape, while liquids tend to assume the shape of the container and gases fill the entire container.	A18. Describe differences in the physical properties of solids and liquids.
Properties of Matter – How does the structure of matter affect the properties and uses of materials? **3.1 – Materials have properties that can be identified and described through the use of simple tests.** • Heating and cooling cause changes in some of the properties of materials.	B1. Sort and classify materials based on properties such as dissolving in water, sinking and floating, conducting heat and attraction to magnets. B2. Describe the effect of heating on the melting, evaporation, condensation and freezing of water.
Science and Technology in Society – How do science and technology affect the quality of our lives? **1.4 – The properties of materials and organisms can be described more accurately through the use of standard measuring units.** • Various tools can be used to measure, describe and compare different objects	A 17. Estimate, measure and compare the size and weight of different objects and organisms using standard and non-standard measuring tools. (standard tools being rulers or measuring objects that have been

and organisms.	standardized)
Scientific Inquiry	A INQ.1 Make observations and ask questions about objects, organisms and the environment. A INQ.2 Use senses and simple measuring tools to collect data. A INQ.3 Make predictions based on observed patterns.
Scientific Literacy	A INQ.4 Read, write, listen and speak about observations of the natural world. A INQ.5 Seek Information in books, magazines and pictures. A INQ.6 Present information in words and drawings.
Scientific Numeracy	A INQ.7 Use standard tools to measure and describe physical properties such as weight, length and temperature. A INQ.8 Use non-standard measures to estimate and compare the size of objects. A INQ.9 Count, order and sort objects by their properties. A INQ.10 Represent information in bar graphs.

STAGE 2-DETERMINE ACCEPTABLE EVIDENCE

How will we know if students have achieved the desired results and met the content standards? How will we know that students really understand? Stage two identifies the acceptable evidence that students have acquired the understandings, knowledge, and skills identified in stage one.

Performance Task(s) *Authentic application in new context to evaluate student achievement of desired results designed according to GRASPS.* *(Goal, Role, Audience, Setting Performance, Standards)*	**Other Evidence** *Other methods to evaluate student achievement of desired results.*
<u>The Mystery Substance</u> You are a super scientist/chemist and have been given a "mystery substance" by your boss. Your job is to decide if this substance is a liquid, a solid, or a gas. Use your senses (but not taste!) to help you make your decision. You need to explain to your boss why you think the "mystery substance" is a solid, a liquid, or a gas. Give at least three reasons to defend your answer and remember to be convincing! Your job is on the line! Remember, good scientists don't just guess! Teacher notes: Some possibilities for the "mystery substance" could be: whipped cream, mayonnaise, or jelly. Each child should be given a "mystery substance" in either a small container or a Ziploc bag. Be sure the children do not know what "mystery substance" you are using by removing all identifiable containers. Teachers may choose to do this activity in stations where more than one "mystery substance" may be used or just give out the same "mystery substance" to everyone. Place extra materials such as extra bowls, containers, and spoons on the children's workspace to help them explore. **<u>Kid's Rock Grocery</u>** You have just opened a new kid's grocery store in town called "Children Create Name of Store". As a new store owner, you have come up with a new way to organize the items in your store. Good luck! <u>Teacher notes:</u> • Materials needed: approximately 20 assorted grocery store flyers, glue, scissors, poster/chart paper	• Maintain a science notebook/journal of investigations by both teachers and students • Teacher observations • Generate a Venn diagram or "T" chart to compare the different properties of matter (liquids vs. solids, gases vs. liquids etc.) • Oral interviews • Give rubrics to assess science worksheets and journal writing (incorporate district writing rubric) • Create a flyer for the grand opening of your grocery store. Be sure to include the name of your store and how it is arranged. • Possible writing prompts: - In the book, <u>Bartholomew and the Oobleck</u>, what would you do if you were in Bartholomew's place? - What possible problems would there be if grocery store items were grouped by solids, liquids, and gases? (Possible answers: There would have to be refrigerators in every aisle, soap would be mixed in with foods, customers would not know where to go to look for their items) • If you could invent a "mystery substance", what would it be called, what would it be used for, and would it be a solid, liquid, or gas? • Use a self assessment rubric (such as smiley face or stars).

• Suggested time: 4 lessons (45 minutes each) • Discuss with your class: How can a grocery store be organized differently? Defend your rational. You may need to guide your students toward organizing their store using phases of matter (solids, liquids, and gases). • Before this activity, have students save grocery store flyers. Use a variety of grocery store flyers. • You will need to enlarge (and modify) the template on the next page onto chart paper or poster paper. • Student will have great discussions during this activity, such as: "Should eggs go in the solid aisle or the liquid aisle? Why? • Your class may decide additional aisles are needed such as solid/liquid or liquid/gas aisles. • Some possible pictures that could be used for the "gas aisle" are: hairspray, air freshener, propane, and dust polish. • Children should work in small groups at a table to enrich group discussions.	• Rubric of store format and set-up

Grocery store floor plan

solids

liquids

gases

STAGE 3 – LESSON ACTIVITIES

What will need to be taught and coached, and how should it best be taught, in light of the performance goals in stage one? How will we make learning both engaging and effective, given the goals (stage 1) and needed evidence (stage 2)? Stage 3 helps teachers plan learning experiences that align with stage one and enables students to be successful in stage two. Lesson activities are suggested, however, teachers are encouraged to customize these activities, maintaining alignment with stages one and two.

Teachers should select lesson activities that will best meet the needs of their students and the unit objectives. Each lesson activity is coded with the corresponding knowledge (K) and/or skill (S) objectives that are found in stage one.

Teachers should utilize the <u>STC Solids and Liquids</u> teacher manual for activities that address concepts related to solids and liquids. The <u>Discovery Works</u> teacher manual should be used for lessons that address concepts related to gases.

<u>ESSENTIAL QUESTIONS</u>

Post the essential questions (or some of them) in your classroom to refer back to throughout the unit.

- How can you describe a solid, a liquid, or a gas?
- What properties of solids, liquids, and gases make them different?
- How can matter change from state to state?
- How does temperature affect matter?
- What things are not made up of matter?
- What information about the properties of matter can be gathered by observation?
- What common material is affected by magnetism?
- How can objects within each state of matter be different?

<u>ELICIT PRIOR KNOWLEDGE/ INTRODUCE SCIENCE JOURNAL</u>

<u>Lesson A</u>

Materials needed: science journals, one KWL chart for each state of matter

This is a pre-assessment activity to gain insight into the children's prior knowledge of solids, liquids, and gases. Introduce children to the science journal, discussing the format and doing a first entry for each state of matter. The first journal entry will include having the children write one sentence "I think a solid is…", "I think a liquid is…", and " I think a gas is…" and one question about matter. In whole group, discuss the students' journal entries and record on a KWL chart for each state of matter.

Suggested time: 45 min.

Knowledge and Skills: S1

<u>OBSERVING AND DESCRIBING TWO SOLIDS</u>

<u>Lesson B</u>

Materials needed: steel balls, plastic spoons, magnifying glass, Venn diagram or "T" chart,

science journals.
Students examine and describe two different solids, a spoon and a steel ball. Students will then compare the two solids. Suggested methods of comparison are a Venn diagram or a "T" diagram.
Suggested time: 45 min.
Knowledge and Skills: K4, K5, S2,
Reference information: STC Lesson 1

- *What information about the properties of matter can be gathered by observation?*
- *How can objects within each state of matter be different?*
- *How can you describe a solid?*

<u>OBSERVING PROPERTIES</u>
<u>Lesson C</u>
Materials needed: (**<u>Materials will be used for the next 3 lessons</u>**) For **<u>each student</u>**: science journal, pencil, crayons. For every **<u>two students</u>**: plastic tray, large sheet of paper, black crayon, blue plastic spoon, blue rubber ball, blue wooden cube bead, blue Unifix cube, red wood golf tee, red pipe cleaner, red octagon jewel, red plastic button, Ping-Pong ball, small, white plastic spoon (taster spoon), plastic cup lid, steel ball, steel washer, steel nut, jumbo metal clip, brass washer, bobby pin, acrylic cube, acrylic cylinder, cork, wooden stirrer, and a magnifying glass.

Students examine a variety of different solids and classify and sort them by the properties of color and shape. The students will write the science journal entry in response to: What did you learn about solids today? (i.e. Some solids can be_____). For the list of materials, see pg. 27 and 39-41 in STC as well.
Suggested time: 45 min.
Knowledge and Skills: K4, K5, S2, S3, S6
Reference Information: STC Lesson 2

- *What information about the properties of matter can be gathered by observation?*
- *What properties of solids, liquids and gases make them different?*
- *How can objects within each state of matter be different?*

<u>TESTING SOLIDS WITH A MAGNET</u>
<u>Lesson D</u>
Materials needed: <u>Same materials in Lesson C</u>.
Students will investigate which solids are attracted to magnets and those that are not **<u>in pairs</u>**. Children use the same materials as in the <u>Observing Properties</u> lesson. The students will write in their science journals the response to, "What did you discover about solids and their magnetic properties today? Are all solids magnetic? Why or why not?" **<u>Integration of math</u>**: Are nickels, pennies, dimes, quarters, half-dollars and dollar coins magnetic? A "T-chart" should be used for discussion at the end of the lesson for magnetic and non-magnetic solids.
Suggested time: 45 min.
Knowledge and Skills: K4, S2, S3, S4, S6, S8, S9, S10
Reference Information: STC Lesson 7

- *What common materials are affected by magnetism?*
- *What properties of solids, liquids, and gases make them different?*

THE SOLID SORTING GAME
Lesson E
Materials needed: Same materials in Lesson C and D.
Students will sort a set of solids into groups on the basis of a property of their choice. Students will then guess by which property their partner sorted the solids. Then, their partner will sort the solids once again, this time by a different property. The students will write in their science journals in response to, "How did your partner sort the solids? Why do you think they did that?"
Suggested time: 45 min.
Knowledge and Skills: K4, K5, S2, S3, S4, S8
Reference Information: STC Lesson 8

- *What properties of solids, liquids, and gases make them different?*
- *How can objects within each state of matter be different?*

OBSERVING AND DESCRIBING TWO LIQUIDS
Lesson F
Materials needed: glass of water, cups, white glue, cups of water, magnifying glass, science journals
Before the STC lesson 10, introduce liquids to students using a glass of water.
Students are to draw the glass of water and write in response to "Is water a solid, liquid or a gas? Why do you think that?" Then introduce the cups of water and glue to each pair of children. Students will use the Venn Diagram in their science journals to compare the glue and the water. They must also explain whether glue is a solid, liquid or a gas?
STC Lesson 10, then has students investigate two different liquids, white glue and water. They observe, describe, and compare the two liquids and discuss the similarities and differences.
Suggested time: 45 min
Knowledge and Skills: K1, K5, S2, S6, S8, S9
Reference Information: Introduce liquids and STC Lesson 10

- *What properties of solids, liquids, and gases make them different?*
- *What information about the properties of matter can be gathered through observation?*
- *How can you describe a liquid?*

VISCOSITY
Lesson F-1 (extension of Lesson F)
Materials needed: white glue, water, plastic tray, and science journals
Suggested time: 45 min
Knowledge and Skills: K1, K5, S1, S2, S6, S8, S9, S10
Reference information: STC Lesson 13
Students will discover which liquid is more viscous, glue or water. Viscosity is the resistance of a liquid to flow. The students will predict which liquid will be more viscous in their science journals and offer evidence as to why?

INVESTIGATING LIQUIDS
Lesson G
Materials needed: white glue, water, oil, red shampoo, green shampoo, corn syrup, magnifying glass, science journals

Students observe and compare the feel of these six liquids. Students will place a drop of each liquid on wax paper and look through a hand lens. Record findings in journal. Discuss the findings.
Suggested time: 45 min.
Knowledge and Skills: K1, K4, K5, S2, S3, S8, S9
Reference Information: STC Lesson 11

- *What properties of solids, liquids, and gases make them different?*
- *What information about the properties of matter can be gathered through observation?*
- *How can objects within each state of matter be different?*
- *How can you describe a liquid?*

Teacher note: Teachers may choose to combine lesson 12, Flowing Liquids, with this lesson. If so, time will be extended to roughly 1 hour and 15 min.

VISCOSITY
Lesson G-1 (extension of Lesson G)
Materials needed: white glue, water, red shampoo, green shampoo, oil, corn syrup, wax paper, and science journals
Suggested time: 15 minutes
Knowledge and Skills: K1, K5, S1,S2,S6,S8,S9,S10
Reference information: STC Lesson 13
Race each liquid to determine which liquid is more viscous. Students will predict which liquid is the most viscous and the least viscous. Students will record their findings and compare the liquids to one another. Students will place the liquids in order from the most viscous to the least.

MIXING LIQUIDS
Lesson H
Miscibility: the ability of liquid to mix with another liquid
Materials needed: white glue, water, oil, red shampoo, green shampoo, oil, corn syrup, science journal
Give any two liquids above to a small group of students. Students will write their prediction of what will happen when they pour one liquid into the other liquid in science journal before conducting the experiment. The students will test their predictions and record their findings in the journal. Discuss the results and the relationship of real world oil spills.
Suggested time: 45 min.
Knowledge and Skills: K1, K3, S1, S6, S10, S11
Reference Information: STC Lesson 14

- *What properties of solids, liquids, and gases make them different?*
- *How can objects within each state of matter be different?*

THERE'S ALWAYS ROOM FOR JELL-O
Lesson I
Materials needed: three boxes of Jell-O, hot water, bowl, mixing spoon, plates, plastic spoons
Students will explore how the addition or removal of heat energy can change matter from state to state. By using Jello-O, children investigate how Jell-O begins as a powder (solid) and when hot water is added, it dissolves (liquid). Then, when Jell-O is cooled, it turns back into a solid.

Likewise, when Jell-O is a solid, it can be turned back into a liquid by adding hot water. Discuss with the students how matter can change when heat is added or taken away.

Suggested time: This lesson will need to be done either over the course of one or two school days to allow time for the Jell-O to turn from a liquid to a solid.

Knowledge and Skills: K1,K2, K3, K5, S1, S2, S4, S6, S7

- *What properties of solids, liquids, and gases make them different?*
- *What information about the properties of matter can be gathered through observation?*
- *How can you describe a solid and a liquid?*
- *How does heat affect matter?*

Teacher notes: When the package of Jell-O is first opened, it looks like a powder. The powder is actually a "flowing solid" but it can be classified as a solid because the individual grains of powder are teeny, tiny little solids.

See Appendix D for "Changing Matter Using Jell-o Recipe Book". This can be used to review parts of a story and how things are sequenced in a story...Every story has a beginning, middle and an end...well a recipe has a series of steps similar to a story:. a beginning, (gathering items) a middle, (combining and cooking) and an end (the end result or finished product).

<u>FLOWING SOLIDS</u>

Lesson I -1 (Extension activity for Lesson I)

Materials needed: oatmeal, salt, solid object

Elicit prior knowledge of Jell-O lesson: Jell-O starts as a "flowing" solid (powder). Compare and contrast the oatmeal and salt. Discuss why they are classified as a "flowing" solid. Now show a solid object. Compare and contrast the solid object with the "flowing" solids using a Venn diagram in their journal.

Suggested time: 15 minutes

Knowledge and skills: K1,K4,K5,S2,S10,S11

Reference Information: Jell-O Lesson I

<u>AIR TRAPPING</u>

<u>Lesson J</u>

Materials needed: small, medium, large plastic bags, copy worksheet D42 and D43, chart paper

Students will fill three different sized plastic bags with air to show that air takes up the space in the bag. The amount of air will vary depending on the size of the bag. After "trapping" air in the bags, students will discuss properties of a gas and record on a piece of chart paper.

Suggested time: 45 min.

Reference Information: See worksheet D42 and D43 (Discovery Works)

- *How do you know there is a gas in your bag?*
- *How did the air change when it was put into bags of different sizes?*
- *How can you describe a gas?*

<u>BALLOONS, HELIUM VS. AIR</u>

<u>(optional lesson)</u>

Materials needed: helium balloon, air-filled balloon, "T" chart/Venn diagram

Students will observe how a gas can fill a solid. Students will each blow up a balloon. Students will then observe the similarities and differences between a helium filled balloon and an air filled balloon. Using a “T” chart or a Venn diagram, students will record their findings. This lesson can be done as a whole group demonstration
Suggested time: 15 min
Knowledge and Skills: K1, K2, S1, S2, S4, S6, S10, S11

- *How can objects within each state of matter be different?*
- *Does gas have weight?*
- *What information about the properties of gas can be gathered by observation?*

SAFETY CONSIDERATIONS:

- Do not allow students to inhale helium from balloons.
- Do not use latex balloons if a student is allergic to latex.

BUBBLE MANIA
Lesson K
Materials needed: liquid bubbles, bubble wands, trays, paper towels
Students will explore how a gas can fill a liquid. Students will blow bubbles to demonstrate that air (gas) is taking up space.
Suggested time: 25 min.
Knowledge and Skills: K2, S1
Reference Information: Discovery Works Lesson 4

- *What information about the properties of gas can be gathered by observation?*
- *Why are bubbles different sizes?*
- *What differences did you find between the bubbles you made and the balloons?*

Teacher notes: You may want to compare bubbles to the balloon the students blew up. How are they alike? How are they different? Record or discuss answers.

IS IT A SOLID OR A LIQUID? (MAKING OOBLECK)
Lesson L
Materials needed: 1 box of corn starch, 1 bowl, water (1/8 cup per 1/4 cup of corn starch), spoon, wax paper
Oobleck is a substance made with corn starch and water. It has properties of both a solid and a liquid. Make Oobleck with your children and have them take a stance whether or not it is a solid or a liquid. Students will explain (oral or written) their reasons for classifying the Oobleck.
Suggested time: 45-60 min.
Knowledge and Skills: K1, K2, K3, K4, K5, S3, S8, S10, S11
Spread waxpaper on the table. Mix corn starch and water in bowl. (You may want to mix it with your hands so that you can feel the texture better.) Put about a ¼ cup of Oobleck into plastic bags for each student.

- *What properties of solids and liquids make them different?*
- *How can matter change from state to state?*
- *What information about the properties of matter can be gathered through observation?*
- *What properties of Oobleck are evident through observation?*

LITERATURE RESOURCES

These literature resources have been purchased to supplement the kit and our housed in each elementary school library.

Physical Science Literature Circle/Guided Reading Sets (6 copies per school)

Solid, Liquid, or Gas?, Fay Robinson
It Could Still Be Water, Allan Fowler
Air is All Around You, Franklin Branley
Bubble, Bubbles, Appelt

Physical Science Read Aloud (1 copy per school)

Bartholomew and the Oobleck, Dr. Suess
The Boy with the Helium Head, Phyllis R. Naylor
Emmett's Snowball, Ned Miller
How is A Crayon Made?, Oz Charles

Poster Big Book

Solids, Liquids and Gases, Discovery Works

Other Suggested Resources Your Library May Have

The Snowman video (Book is written by Raymond Briggs)
Solids, Liquids, and Gases – States of Matter and How They Change, Scholastic

Materials List
Solids, Liquids, and Gases – Grade 1

Revised December 2004
(Based on the STC Solids and Liquids Kit)

Expendable Materials	Reusable Materials	Reusable Materials
3 boxes Jell-o		25 goggles
1 box waxed paper	30 black crayons	30 hand lens
100 9oz. plastic cups wide mouth	1 crayon of each color: White, brown, copper, blue, red, peach, silver	Plastic bags: 10 large 10 medium 10 small
100 lids 9 oz.	25 plastic containers	1 container salt
30 straws	15 golf tees	1 small box oatmeal
30 resealable plastic bags	15 colored plastic spoons	
30 wood stir stick	15 large corks	
5 post it note pads	15 rubber balls	
1 bottle **green** shampoo	15 blue unifix cubes	1 Teachers Guide –*Solids and Liquids,* STC
1 bottle veg. oil	15 lg. plastic buttons	1 Teacher Guide – *Solids, Liquids, and Gases,* Discovery Works
1 bottle **red** shampoo	15 steel nuts	
1 bottle light corn syrup	15 acrylic cubes	25 Student journals - photocopied and bound
1 bottle white glue	15 blue wood cube beads	
5 post it notes	15 red octagon beads	
1 box corn starch	15 ping pong balls	
1 box food coloring	15 steel balls	
25 plastic teaspoons	15 acrylic cylinders	
25 small plastic cups (3 oz)	25 bubble wands	
25 eye droppers	10 bottles bubbles	
25- 9" balloons	15 red pipe cleaners	
	15 jumbo paper clips	
	15 bobby pins	
	15 large washers	
	15 brass washers	
*Teachers Provide:	30 magnets	
Mayo, jelly or cream	15 blue sq. sponge	
Paper towels	15 metal buttons	
	15 rulers w/ grooves in center	

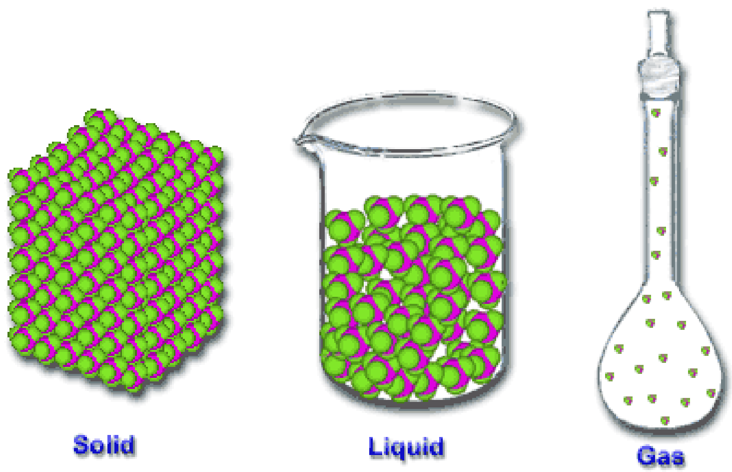
Safety Considerations:
- DO NOT eat science materials.
- Use caution with hot water.

TEACHER BACKGROUND NOTES

These science content background notes were created for teacher use only. We anticipate that these notes will provide you, the teacher, with some useful background as you facilitate inquiry activities for your students. These notes are not meant to be an overview of the unit, but as background information for you that go beyond the content of this particular unit. These notes should not be replicated for your students; however, you may share some of the content when appropriate for the developmental level of your students.

GASES, LIQUIDS, AND SOLIDS

Gases, liquids and solids are all made up of atoms, molecules, and/or ions, but the behaviors of these particles differ in the three phases. We can express these states of matter pictorially. Of course, the molecules are shown millions of times their actual size:



http://www.ilpi.com/msds/ref/vapor.html (12/04)

- Particles in a:
  - gas are well separated with no regular arrangement.
  - liquid are close together with no regular arrangement.
  - solid are tightly packed, usually in a regular pattern.
- Particles in a:
  - gas vibrate and move freely at high speeds.
  - liquid vibrate, move about, and slide past each other.
  - solid vibrate (jiggle) but generally do not move from place to place.

The following table summarizes properties of gases, liquids, and solids and identifies the microscopic behavior responsible for each property.

Some Characteristics of Gases, Liquids and Solids and the Microscopic Explanation for the Behavior		
gas	**liquid**	**solid**
• assumes the shape and volume of its container • particles can move past one another	• assumes the shape of the part of the container which it occupies • particles can move/slide past one another	• retains a fixed volume and shape • rigid - particles locked into place
• compressible • lots of free space between particles	• not easily compressible • little free space between particles	• not easily compressible • little free space between particles
• flows easily • particles can move past one another	• flows easily • particles can move/slide past one another	• does not flow easily • rigid - particles cannot move/slide past one another

http://www.chem.purdue.edu/gchelp/liquids/character.html (12/04)

MATTER IS THE STUFF AROUND YOU

Anything that takes up space or has a mass of any kind is matter. Everything you can touch is made of matter. If it is made of anything, that anything is matter. Everything you will learn about Chemistry will all be based on how matter reacts and combines.

Matter has many properties. It can have **PHYSICAL** properties like different densities, melting points, boiling points, freezing points, color or smells. There are also **CHEMICAL** properties that define matter. A good example of chemical properties is the way elements combine with each other in reactions. The big thing to remember... Matter can change in two major ways, physically and chemically.

http://www.chem4kids.com/files/matter_intro.html

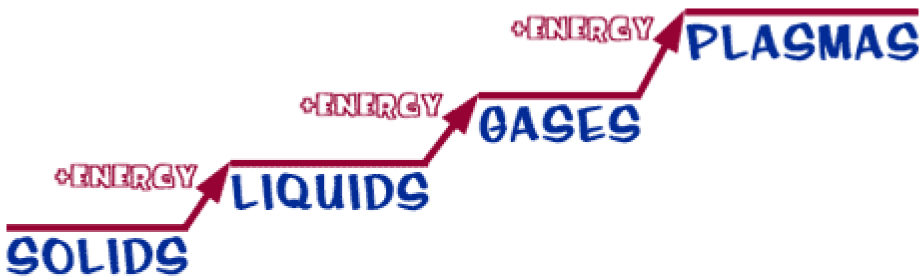
NON-EXAMPLES OF MATTER

Things that are not examples of matter include shadows, feelings, thoughts, colors, concepts, religion, and sound is a vibration of matter not an example of matter. Energy such as sound and light are not matter.

STATES OF MATTER

There are four main **STATES** of matter. SOLIDS, LIQUIDS, GASES, and PLASMAS. Each of these states is also known as a **PHASE**. **ELEMENTS** and compounds can move from one phase to another phase when special physical forces are present (**** physical, not chemical ****). One example of those forces is **TEMPERATURE**. When temperature changes, the phase can change. Generally as the temperature rises, matter moves to a more active state.

Phase describes a **PHYSICAL** state of matter. The key word to notice is physical, because things only move from one phase to another by physical means. If energy is added (like increasing the temperature or increasing pressure) or if energy is taken away (like freezing something or decreasing pressure) those are physical changes. Those kinds of forces change states of matter.



One compound or element can move from phase to phase, but still be the same substance. You can see water vapor over a boiling pot of water. That vapor (or gas) can condense and become a drop of water. If you put that drop in the freezer, it would become a solid. No matter what phase it was in, it was always water. It always had the same chemical properties. On the other hand... A chemical change would change the way the water acted, eventually making it not water, but something completely new.

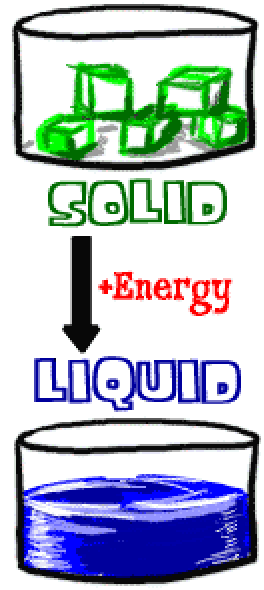
http://www.chem4kids.com/files/matter_states.html (12/04)

CHARACTERISTICS OF SOLIDS

Solids can be made up of many things. They can have **ELEMENTS** or compounds inside. They can also be made up of mixtures, or combinations of different elements and compounds. Most of the solids you see are mixtures. Most rocks are mixtures of many elements and compounds. Concrete is a good example of a man-made solid mixture.

First let's explain that characteristics are the traits or features that something might have. One characteristic of a solid is that it might be hard. That idea is pretty straight forward. One of the main characteristics of solids is that they hold their own shape. So if you put a solid in a container it won't change its shape... No matter how much you move or slide it around. You can even grind a solid up so that it fills up a container. If you look at the powder under a microscope you will still see little tiny solids that you couldn't change. You know that liquids are different because if you put a liquid into a container it will fill it up as much of the container as it can.

In the same way that a solid holds its shape the atoms inside of a solid are not allowed to move around much. This is a physical characteristic of all solids. It happens no matter how small the pieces are. The atoms in liquids and gases move around in all directions. The solid atoms and molecules are trapped in their places. The atoms still spin and the electrons still move but the entire atom doesn't go anywhere. They just kind of jiggle in place.



Scientists use something called a **FREEZING POINT** to measure when a liquid turns into a solid. There are physical effects that can change the freezing point. Pressure is one of those effects. When the pressure surrounding a substance goes up the freezing point also goes up. That means it's easier to freeze the substance at higher pressures. When it gets colder, most solids shrink in size. There are a few which expand but most shrink.

http://www.chem4kids.com/files/matter_solid.html (12/04)

CHARACTERISTICS OF LIQUIDS

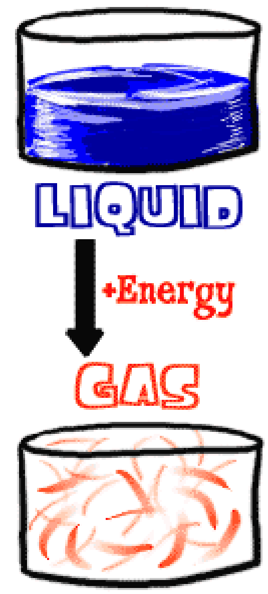
Liquids are an in-between phase of matter. They are right between solids and gases. One characteristic of a liquid is that it fills the shape of any container. So you pour some water in a cup. It fills up the bottom of the cup first and then fills the rest. It also takes the shape of the inside of the cup. It starts filling at the bottom because of **GRAVITY**. When it is in that cup it also has a flat surface. That's because of gravity too.

One other characteristic of liquids is that they are very hard to **COMPRESS**. When you compress something you take a certain amount and force it in a smaller space. Solids are tough to compress too but gases are easy. When you compress something you squeeze it so the atoms in the substance are closer together. When pressure goes up... Substances are compressed. Liquids already have their atoms close together so it's hard to push them even closer.

How do you change ice into liquid water? What you need is some **ENERGY**. Atoms in a liquid have more energy than the atoms in a solid. The easiest energy around is probably heat. There is a magic temperature for every substance called the **MELTING POINT**. When a solid reaches the temperature of its melting point... It can become a liquid. For water the temperature has to be a little over zero degrees Celsius. If you were salt, sugar or wood your melting point would be higher than water.

So solids need more energy. The reverse is true if you are a gas. You need to lose some energy from your very excited gas atoms. The easy answer is to lower the surrounding temperature. When the temperature drops, energy will be sucked out of your gas atoms. When you get to the **CONDENSATION POINT**, that's the temperature when you become a liquid. If you were the steam of a boiling pot of water and you hit the wall, the wall would be so cool that you would quickly become a liquid.

EVAPORATION



Sometimes a liquid can be sitting there and its molecules will become a gas. That's called **EVAPORATION**. You might be wondering how that can happen when the temperature is low. It turns out that all liquids can evaporate at room temperature and pressure. Evaporation is when there are atoms or molecules escaping from the liquid and turning into a vapor. You see... Not all of the molecules in a liquid actually have the same energy. The energy you can measure is really an **AVERAGE** of all the molecules. There are always a few molecules with a lot of energy and some with barely any energy at all. It is those with a lot of energy that build up enough power to become a gas and leave the liquid. When it leaves it has evaporated.

http://www.chem4kids.com/files/matter_liquid.html (12/04)

CHARACTERISTICS OF A GAS

Gas is everywhere. There is something called the **ATMOSPHERE**. That's a big layer of gas that surrounds the Earth. Gases are random groups of atoms. There are solids where atoms and molecules are really compact. Liquids have them a little more spread out. But gases are really, really spread out and the atoms and molecules are full of **ENERGY**, bouncing around constantly.

One of the physical characteristics is that a gas can fill a container of any size or shape. Think about a balloon for a minute. No matter what shape you make the balloon it will be completely filled with the gas. The atoms and molecules are spread equally throughout the entire balloon. Liquids can only fill the bottom of the container while gases can fill it entirely.

You need energy to become a gas. The atoms in a gas have more energy than the atoms in solids and liquids. The easiest way to think of energy is to think of temperature. When you increase the temperature of a system you are pouring energy into that system.

When you want to be a gas you usually start out as a liquid. If you add energy to a liquid the atoms get all excited. When you boil water the steam you see is small water droplets being carried by the rising water gas/vapor. You can also find water vapor in fog and clouds. The special temperature when a liquid becomes a gas is called the **BOILING POINT**. When you cool a gas it liquefies. When a gas becomes a liquid the speed and energy in the molecules drop and **ATTRACTION** forces allow the molecules to group together.

You might hear the term **VAPOR**. Vapor and gas mean the same thing. The word vapor is used to describe gases that are usually found as liquids (like water). A compound like CO_2 is usually a gas, so it described that way. But water (H_20) is usually found as a liquid at room temperature. So when it becomes a gas scientists use the term vapor.

http://www.chem4kids.com/files/matter_gas.html (12/04)

WHAT IS PLASMA?

Plasma is one of four states of matter. The other three states of matter are solid, liquid, and gas. The term "plasma" has nothing to do with blood plasma. Plasma, the least familiar state of matter to us here on Earth, is actually the most common form of matter in the universe.

Plasma makes up 99% of all visible matter in our universe. Although naturally occurring plasma is rare on Earth, there are many man-made examples. Inventors have used plasma to conduct electricity in neon signs and fluorescent bulbs. Scientists have constructed special chambers to experiment with plasma in laboratories.

Plasma is relatively rare on Earth, occurring only in lightning discharges and in artificial devices like fluorescent lights. Plasma is everywhere in our space environment, however. Examples include:

- The aurora, or northern lights, flickering in the uppermost reaches of Earth's atmosphere.
- The solar wind generates an immense sheet of electrical current that spirals like a ballerina's skirt as the Sun rotates.
- The Sun itself, all other stars in our galaxy, and colossal exploding jets from distant galaxies.

http://www.spacescience.org/ExploringSpace/PlasmaStateOfMatter/1.html (12/04)

Another example of plasma that you may have seen is a neon sign. Just like a fluorescent light, neon signs are glass tubes filled with gas. When turned on the electricity flows through the tube. The electricity charges the gas, possibly neon, and creates a plasma inside of the tube. The plasma glows a special color depending on what kind of gas is inside.

You also see plasma when you look at stars. They aren't easy to find if you live in a big smoggy city. Look hard. Stars are big balls of gases at really high temperatures. The high temperatures charge up the atoms and create plasma. Stars are another good example of how the temperature of plasmas can be very different. Fluorescent lights are cold compared to really hot stars. But still… They are both forms of plasma.

http://www.chem4kids.com/files/matter_plasma.html

IS JELL-O A SOLID OR LIQUID?

A gel is formed when molecules bond with neighbors in long, interlaced chains. The result is a material with a measure of strength and some rigidity, but which is also flexible. The molecules are not, however, held rigidly next to each other, as in a true solid. We believe that if you were to leave a block of jell-o, for example, sitting on a tabletop for a long time, it would flow under the influence of gravity. Instead of being a solid, jelly or jam should instead be thought of more as very **viscous (thick) liquids.**

VISCOSITY

Viscosity is a measure of a fluid's resistance to flow. It describes the internal friction of a moving fluid. A fluid with large viscosity resists motion because its molecular makeup gives it a

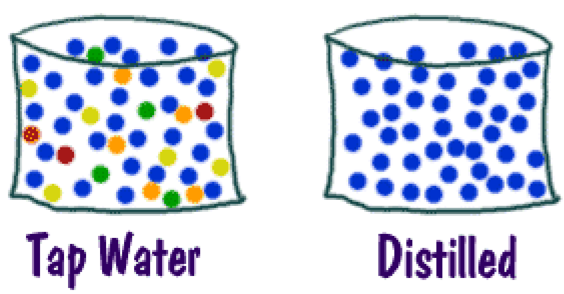
lot of internal friction. A fluid with low viscosity flows easily because its molecular makeup results in very little friction when it is in motion. Gases also have viscosity, although it is a little harder to notice it in ordinary circumstances.
http://www.princeton.edu/~gasdyn/Research/T-C_Research_Folder/Viscosity_def.html

Liquids with a high viscosity include corn syrup, shampoo, maple syrup, molasses, silly putty, jell-o, and butter. Liquids with a lower viscosity include water and rubbing alcohol.

WHAT METALS ARE MAGNETIC?

Objects that are made up of iron, cobalt, or nickel have magnetic properties. Common objects such as keys, nails, screws, fasteners, etc. are often made up of a combination of elements that have and do not have magnetic properties. Alloys (mixture of different metals) can have magnetic properties of they contain some iron, cobalt or nickel.

MIXTURES



Mixtures are usually how you find things in nature. Rocks, the ocean, just about anything you find. They are substances held together by **PHYSICAL FORCES**, not chemical.

When you see distilled water, it's a pure substance which means that there are just water molecules in the liquid. A mixture would be a glass of water with other things dissolved inside, maybe salt. Each of the substances in that glass of water keeps the original chemical properties. So if you have some dissolved substances, you can boil off the water and still have those dissolved substances left over. It will take a higher temperature to melt the salt.

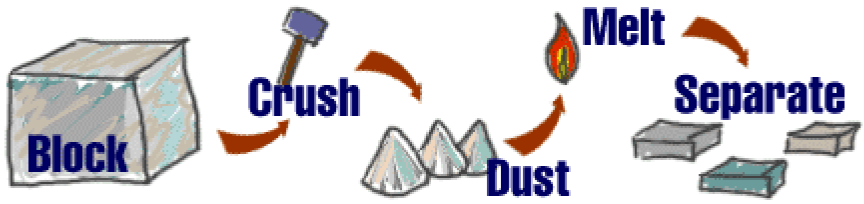
MIXTURES ARE EVERYWHERE

There are an infinite amount of mixtures. Anything you can combine is a mixture. Think of everything you eat. Just think about how many cakes there are. Each of those cakes is made up of a different mixture.

Solutions are also mixtures. If you put sand into a glass of water it is considered to be a mixture. You can always tell a mixture because each of the substances can be separated from the group in different physical ways. You can always get the sand out of the water by filtering the water away.

CONCRETE AND SALT WATER

Two classic examples of mixtures are concrete and salt water. You can see them both being made everyday. Concrete is a mixture of lime (CaO)/cement, water, sand, and other ground-up rocks and solids. All of these are mixed together. Workers then pour the concrete into a mold and the concrete turns into a solid (because of the cement solidifying) with the separate pieces inside. While the cement hardening might be a chemical reaction... The rocks and gravel are held in place by physical forces and used for added strength. The rocks and gravel are not chemically bonded to the cement. The gravel is also not evenly distributed, there are still pieces here and there. The concentrations change from area to area. Salt water is a little different. First, it's a liquid. Second, it's an ionic solution. the salt is broken up into sodium (Na) and chloride (Cl) ions in the water.



Now you might be wondering why concrete and salt water are not new compounds when they are all mixed together. The special thing is that the basic parts can still be removed by physical forces. You can take the solid concrete and grind it up again. The individual components can then be separated and you can start all over. Salt water is even easier. All you have to do is boil the water off and the salt is left over, just like when you started.

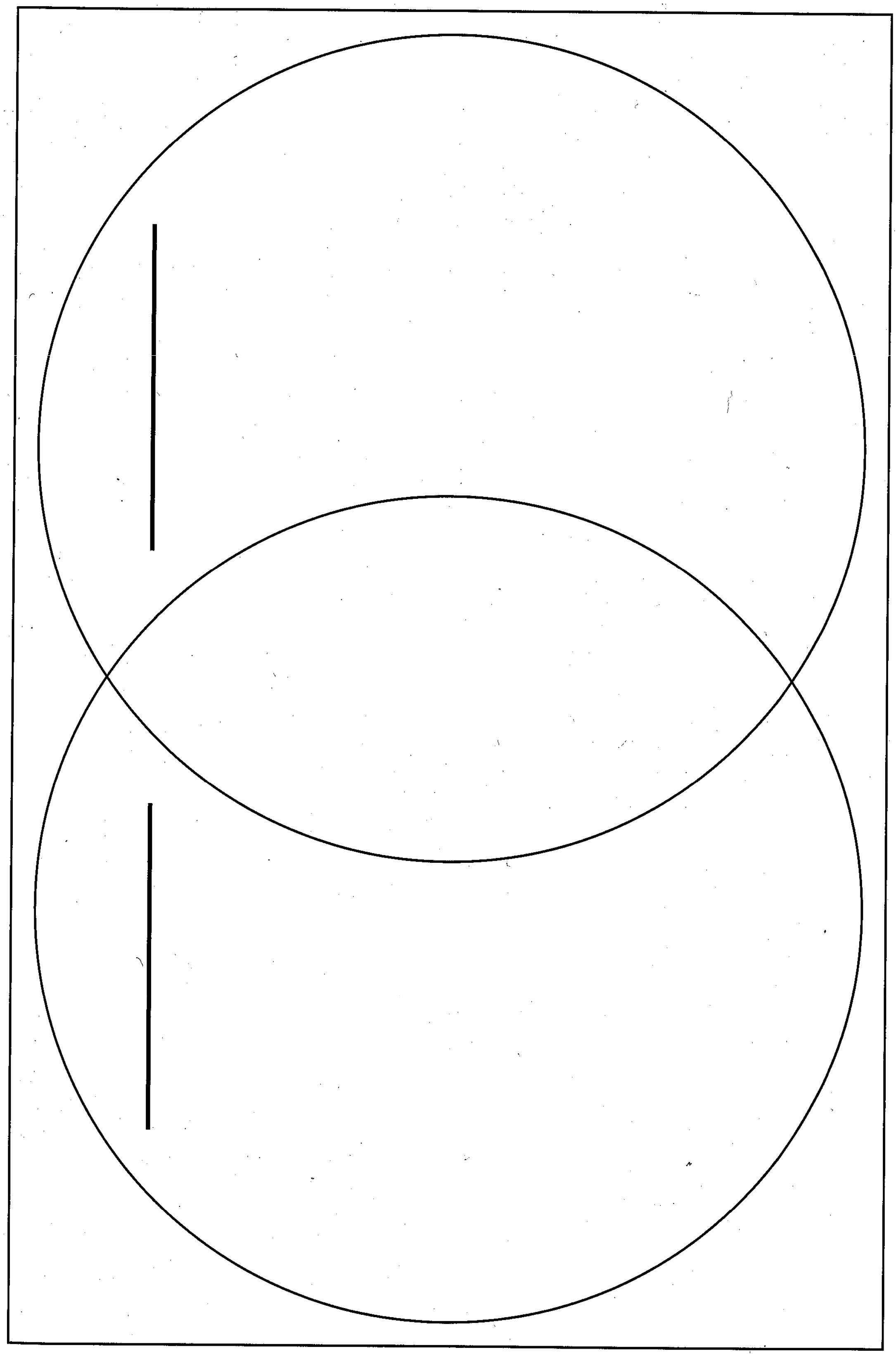
The thing to remember about mixtures is that you start with some pieces, combine them, and then you can do something to pull those pieces apart again. You wind up with the same molecules (in the same amounts) that you started with.

http://www.chem4kids.com/files/matter_mixture.html (12/04)

Blackline Master

Venn Diagram

Name: Date:



STC® / *Solids and Liquids*

Journal-Entry Sheet

Date:

Record Sheet 7–A

Name: ________________________________

Date: ________________________________

Testing Solids with a Magnet

Is the solid attracted to the magnet?

Yes	No

Changing matter using Jell-O!

1

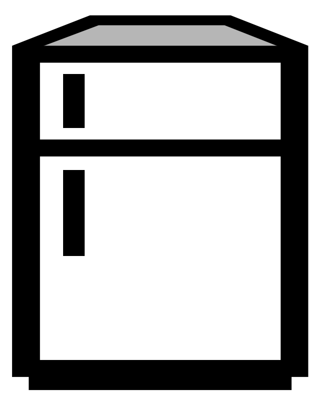
First we add hot water to the Jell-O powder and stir.

 and  makes 

2

Then we stir in the cold water and take away the heat by placing the Jell-O in the refrigerator.

Add cold water 

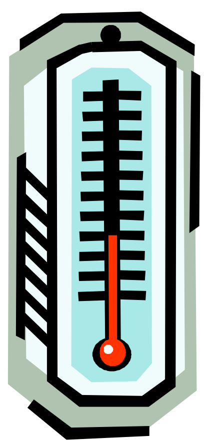
and place in the 

3

Then we eat! How did the Jell-O change back into a liquid in our mouths?

4

Changing Matter



Name: ____________________

INSTITUTE·FOR·INQUIRY
A DESCRIPTION OF INQUIRY
Appendix A

At the *Exploratorium Institute for Inquiry* our work in science education is deeply rooted in the belief that human beings are natural inquirers and that inquiry is at the heart of all learning. The work that we do with educators is designed to give them an opportunity to personally experience the process of learning science through inquiry. Our hope is that this experience will stimulate their thinking about how to create classrooms that are supportive environments for children's inquiry.

Inquiry is an approach to learning that involves a process of exploring the natural or material world, that leads to asking questions and making discoveries in the search for new understandings. Inquiry, as it relates to science education, should mirror as closely as possible the enterprise of doing real science.

The inquiry process is driven by one's own curiosity, wonder, interest or passion to understand an observation or solve a problem.

The process begins when the learner notices something that intrigues, surprises, or stimulates a question—something that is new, or something that may not make sense in relationship to the learner's previous experience or current understanding.

The next step is to take action—through continued observing, raising questions, making predictions, testing hypotheses and creating theories and conceptual models.

The learner must find her or his own pathway through this process. It is rarely a linear progression, but rather more of a back and forth, or cyclical, series of events.

As the process unfolds, more observations and questions emerge, giving occasion for deeper interaction and relationship with the phenomena—and greater potential for further development of understanding.

Along the way, the inquirer collects and records data, makes representations of results and explanations, and draws upon other resources such as books, videos and the expertise or insights of others.

Making meaning from the experience requires reflection, conversations and comparison of findings with others, interpretation of data and observations, and the application of new conceptions to other contexts. All of this serves to help the learner construct new mental frameworks of the world.

Teaching science using the inquiry process requires a fundamental reexamination of the relationship between the teacher and the learner whereby the teacher becomes a facilitator or guide for the learner's own process of discovery and creating understanding of the world.

Map of IFI Inquiry Structure

(3 Phases of Inquiry Diagram)

Appendix B