Heat and Energy Transfer

Grade Level or Special Area: Sixth Grade, Science
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Length of Unit: 10 lessons, 45 minutes each

I. ABSTRACT

The focus of this unit is to broaden the student's understanding of matter and to introduce them to new content from the *Core Knowledge Sequence*, Sixth Grade, in science. The students will have the opportunity to use and work with the scientific method of inquiry as well as scientific observation. Along with this, the students will also have the benefit of improving their ability to work cooperatively in groups.

II. OVERVIEW

A. Concept Objective(s)
   1. Students understand common properties, forms and changes in matter and energy (CSS, Science 2).

B. Content from the *Core Knowledge Sequence* (p. 154)
   1. States of matter in terms of molecular motion.
   2. Most substances are solid at low temperatures, liquid at medium temperatures, and gaseous at high temperatures.
   3. A change of phase is a physical change (no new substance is produced).
   4. Expansion (adding energy) and contraction (removing energy)-water is a special case: water expands when it changes from a liquid to a solid.
   5. Changing phases: condensation; freezing; melting; boiling. Different amounts of energy are required to change the phase of different substances. Each substance has its own melting and boiling point.
   6. Distillation is the separation of mixtures of liquids with different boiling points.

C. Skill Objectives
   1. Students will use the scientific method of inquiry.
   2. Students will accurately measure temperature using a thermometer.
   3. Students will use appropriate tools and techniques to gather, analyze, and interpret data.
   4. Students will work cooperatively in a group.
   5. Students will write complete sentences using correct spelling, capitalization and punctuation.
   6. Students will take two-column notes (adapted from *Step Up to Writing, also known as Cornell Notes*).

III. BACKGROUND KNOWLEDGE

A. For Teachers
   1. Krimsley, Victor S. *Introductory Chemistry: 2nd Alternate*. Pacific Grove, CA: Brooks/Cole, 1995. ISBN: 0534-253156.
   2. Gundersen, P. Erik. *The Handy Physics Answer Book*. Farmington Hills, MI: Visible Ink Press, 1999. ISBN: 1-57859-058-2
   3. Frank, David Ph. D., Little, J. G., and Miller, S. *Science Explorer; Chemical Building Blocks*. Needham, MA: Prentice Hall, 2000. ISBN: 0-13-434480-4
   4. http://www.Digitalbrain.com or another website that contains information containing definitions and examples of states of matter, physical and chemical changes, and energy transfer.

B. For Students
   1. Writing complete answers from Fourth Grade *Core Knowledge Sequence*, p. 87
   2. Scientific method of inquiry
   3. Physical and chemical change, Grade Five in the *Core Knowledge Sequence*, p. 129

IV. RESOURCES

A. http://www.Digitalbrain.com
B. *Core Knowledge Sequence*. Charlottesville, VA: Core Knowledge Foundation, 1999. ISBN: 1-890517-20-8.
C. Frank, David Ph. D., Little, J. G., and Miller, S. *Science Explorer; Chemical Building Blocks.* Needham, MA: Prentice Hall, 2000. ISBN: 0-13-434480-4.
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V. LESSONS

Lesson One: Matter

A. *Daily Objectives*
   1. Concept Objective(s)
      a. Students understand common properties, forms and changes in matter and energy (CSS, Science 2).
   2. Lesson Content
      a. Students will illustrate the three states of matter and what occurs within each in terms of molecular motion.
   3. Skill Objective(s)
      a. Students will write complete sentences using correct spelling, capitalization and punctuation.
B. *Materials*
   1. *Chemical Building Blocks*, pages 44-48, or another resource that covers the definitions for solids, liquids, and gases
   2. Plain, white paper cut into 3" x 4.75" pieces for diagrams
   3. Colored pencils or thin markers for coloring the diagram
   4. Appendix A: Questions and Rubric, one per student
C. *Key Vocabulary*
   1. Crystalline Solid: the particles form regular, repeating patterns
   2. Amorphous Solid: the particles are not arranged in any particular order
   3. Viscosity: the resistance of a liquid to flow
D. *Procedures/Activities*
   1. Ask the students if to recall from fourth grade what the three states of matter are (solid, liquid, and gas).
   2. Let the students know that we will be learning more about how the states of matter work in our world.

3. Call on students to read pages 44-48, from *Chemical Building Blocks* (or another source that covers the definitions of solids, liquids, and gas).
4. Pass out the plain, white paper and ask the students to draw and label a diagram of the three states of matter in terms of their molecular motion. Their diagrams ought to fill the page and ought to be colored. They may wish to burrito fold (in thirds) their papers in order to have one section for each state of matter. They should also include an example from the "real" world for each state.
5. **Collect and save the student's diagrams for the Culminating Activity.**
6. Either in class, or as homework, have students answer the questions on Appendix A: Questions and Rubric, in complete sentences.

E. *Assessment/Evaluation*
1. Check the diagrams to ensure that each state of matter drawing matches its definition. A rubric is included on Appendix A.
2. Check diagrams for spelling, punctuation, capitalization, and neatness (also on rubric).
3. Grade the questions: 1 point for correct response, 1 point for complete correct spelling within the answer, 1 point for correct capitalization, 1 point for correct punctuation, and one point for using a complete sentence.

Lesson Two: What Makes a Liquid, a Liquid?

A. *Daily Objectives*
1. Students understand common properties, forms and changes in matter and energy (CSS, Science 2).
2. Lesson Content
   a. In liquids, atoms and molecules are more loosely packed than in solids and can move past each other. Liquids change shape readily but resist change in volume.
   b. In solids, atoms and molecules are more tightly packed and can only vibrate. Solids resist change in shape and volume.
3. Skill Objective(s)
   a. Students will use the scientific method of inquiry.
   b. Students will work cooperatively in a group.
   c. Students will write complete sentences using correct spelling, capitalization and punctuation.

B. *Materials*
1. ½ c. of cornstarch and water (Ooblick) per group of three students
2. One copy of Appendix B: Mystery Matter, per student
3. One 3" x 4.75" piece of plain, white paper per student
4. Markers or colored pencils to add color to diagram
5. Appendix B: Mystery Matter

C. *Key Vocabulary*
None

D. *Procedures/Activities*
1. **Before class:** Prepare Ooblick. Pour a box of cornstarch into a large bowl. Gradually add water and stir until the mixture is thick, about the consistency of thick glue. The amount of water needed varies. Add a little at a time**.** **Depending on class size, you may need to make several batches.**
2. Once you are ready for the activity, pour ½ c. mixture into paper cups-one per group of three.
3. With the class, discuss the differentiating characteristics between liquids, solids, and gases.

4. Tell the students that today they will have a mystery substance and they will need to determine what state of matter the substance is.
5. Have groups decide who in their group will be the materials manager, reporter and recorder (defined on Appendix B: Mystery Matter).
6. Have the Material Managers come get cups and Appendix B: Mystery Matter.
7. Allow students to experiment to determine if the substance is a solid, liquid or gas for approximately 15 minutes.
8. Have the Reporters share their findings with the class.
9. Pass out the 3" x 4.75" paper and have students illustrate and explain their findings including the definition of solid and liquid.
10. **Make sure to keep each day's 3" x 4.75" paper for the Culminating Activity.**

E. *Assessment/Evaluation*

1. Students will illustrate the experiment on the 3" x 4.75" paper and write the outcome use of the definitions of solid and liquid. Evaluate based on complete answer, uses definition, neatness, spelling, capitalization and punctuation. Use the rubric in Appendix B: Mystery Matter.

Lesson Three: Gases

A. *Daily Objectives*

1. Concept Objective(s)
   a. Students understand common properties, forms and changes in matter and energy (CSS, Science 2).
2. Lesson Content
   a. Gases are loosely packed atoms and molecules that move independently and collide often. Volume and shape change readily.
3. Skill Objective(s)
   a. Students will follow the scientific method of inquiry.
   b. Students will work cooperatively in a group.

B. *Materials*

1. One plastic, 16 ounce soda bottle per group of four students
2. One container of petroleum jelly
3. ½ package of dry yeast per group
4. One teaspoon of sugar per group
5. One cork that fits the bottle for each group
6. Copy of Appendix C: Experimenting With Gas, per student
7. 3" x 4.75 piece of plain, white paper per student
8. Colored pencils or markers to add color to diagram

C. *Key Vocabulary*

None

D. *Procedures/Activities*

1. Review the activity from yesterday. Define solid and liquid. Ask students to define gas.
2. Tell students that today they will discover if the definition of a gas is accurate.
3. Pass out Appendix C: Experimenting With Gas, and go over the procedures.
4. Allow the students to determine who will be the materials manager, recorder, encourager and reporter (defined in Appendix C: Experimenting With Gas) for the group.
5. Have the materials manager come and get the supplies.
6. Students experiment for approximately 15 minutes.

7. Have the group reporters discuss the results. What caused the cork to pop? Could you see the gas that formed? Where is the gas now? Does it have a definite shape? What about its volume?
8. Pass out the 3" x 4.75" paper. After going over the rubric together, students illustrate the experiment and write and explanation of the results**. Keep these for the Culminating Activity.**

E. *Assessment/Evaluation*
1. Use the rubric in Appendix C: Experimenting With Gas to assess their illustration and explanation of the experiment.

Lesson Four: Chemical and Physical Changes

A. *Daily Objectives*
1. Concept Objective(s)
   a. Students understand common properties, forms and changes in matter and energy (CSS, Science 2).
2. Lesson Content
   a. A change of phase is a physical change (no new substance is produced).
   b. Most substances are solid at low temperatures, liquid at medium temperatures, and gaseous at high temperatures.
3. Skill Objective(s)
   a. Students will write complete sentences using correct spelling, capitalization and punctuation.

B. *Materials*
1. *Chemical Building Blocks*, page17, or information containing physical and chemical changes from http://www.Digitalbrain.com
2. Pages 18 and 22 from *Physical Science* or Appendix D
3. Appendix D: What Kind of Change?
4. Plain, white paper cut to 5" x 5", one per person
5. Colored pencils or thin markers to color the diagram

C. *Key Vocabulary*
1. Physical Change: a change in the form, but not in the substance
2. Chemical Change: one or more substances break apart or combine to form a new substance

D. *Procedures/Activities*
1. Review the information covered up to this point. Ask for student definitions of solid, liquid and gas.
2. Let students know that today they will learn about changing matter. There may be a physical or a chemical change. Have students read either from *Chemical Building Blocks* or another source about chemical and physical changes.
3. Give the students pages 18 and 22 from *Physical Science* or Appendix D.
4. Allow the students to work on the handouts for 15 minutes. Go over the handout as a class.
5. Pass the students a piece of copy paper cut 5" x 5" to write an explanation and illustrate examples of physical and chemical changes.

E. *Assessment/Evaluation*
1. Grade the handouts for correct responses-one point each
2. Use the rubric in Appendix D: What Kind of Change? to evaluate the students' illustrations and explanations. **Keep these for the Culminating Activity.**

Lesson Five: Temperature Makes a Difference

A. *Daily Objectives*
   1. Concept Objective(s)
      a. Students understand common properties, forms and changes in matter and energy (CSS, Science 2).
   2. Lesson Content
      a. Heat and temperature are defined by how vigorously atoms are moving and colliding.
      b. Energy can be transferred in three ways: conduction, convection, or radiation.
   3. Skill Objective(s)
      a. Students will take two-column notes (adapted from *Step Up to Writing, also known as Cornell Notes*).

B. *Materials*
   1. Information on conduction, convection and radiation from http://www.Digitalbrain.com
   2. Lined paper
   3. Appendix E: Temperature Makes a Difference

C. *Key Vocabulary*
   1. Conduction: warmer particles passing some of their warmth onto cooler particles
   2. Convection: particles move taking their heat with them
   3. Radiation: energy given off by something

D. *Procedures/Activities*
   1. Let the students know that today is a note-taking day. Have the students get out lined notebook paper. Fold it the long way about three inches from the left edge, or fold right side to the left at the pink margin line.
   2. On the top line, centered, have students write: HEAT and ENERGY TRANSFER.
   3. On the left side of the paper, students will write the main ideas.
   4. On the right side of the fold, next to corresponding main ideas, students will write the supporting details in abbreviated, bullet form. Call on students to read a paragraph at a time from the article from http://www.Digitalbrain.com or another source that contains this information. Model the appropriate note taking on the overhead (Appendix E: Temperature Makes a Difference).

E. *Assessment/Evaluation*
   1. Look over the student's note taking. Student work will vary. Just check for correct format (main ideas on the left, subtopics on the right and understandable abbreviations).

Lesson Six: Radiation, Convection or Conduction?

A. *Daily Objectives*
   1. Concept Objective(s)
      a. Students understand common properties, forms and changes in matter and energy (CSS, Science 2).
   2. Lesson Content
      a. Energy is transferred by conduction, convection or radiation
   3. Skill Objective(s)
      a. Students will use the scientific method of inquiry.
      b. Students will work cooperatively in a group.
      c. Students will accurately measure temperature on a thermometer.

d. Students will write complete sentences using correct spelling, capitalization and punctuation.

B. *Materials*
1. Appendix F: Convection or Conduction?
2. Three small, clear, plastic cups per group of three
3. One measuring cup per group of three
4. One c. hot water per group
5. One c. room temperature water per group
6. One c. cold water per group
7. One piece of 5" x 10" of plain, white paper per student
8. One thermometer per group

C. *Key Vocabulary*
None

D. *Procedures/Activities*
1. Conduct a general review of conduction, convection, and radiation from yesterday's notes.
2. Have the students move into groups of three and determine who will be the reader, materials manager and reporter for each group.
3. Have the materials manager come and get the materials and Appendix F: Convection or Conduction.
4. Discuss the directions on the handout and state the expectations for the group behavior and participation.
5. Allow the students 15 to 20 minutes to conduct the experiment.
6. Pass out the white 5" x 10" paper. Instruct the students to fold it in half width wise, and then open it up. Fold the left edge to the center crease. Fold the right edge to the center crease (Now you have four sections and it opens like shutters).
7. On one section students draw a picture of the result from the hot water cup. Next to it (on the next section), have the students explain the temperature and results using proper spelling, capitalization, punctuation and sentence structure. Repeat for the other two cups.

E. *Assessment/Evaluation*
1. Observe the experiments. Use the rubric in Appendix F: Convection or Conduction? for the explanation and illustration-**remember to keep these.**

Lesson Seven: Expansion and Contraction

A. *Daily Objectives*
1. Concept Objective(s)
   a. Students understand common properties, forms and changes in matter and energy (CSS, Science 2).
2. Lesson Content
   a. Expansion is adding heat energy to a substance, which causes the molecules to move more quickly and causes the substance to expand.
   b. Contraction is when a substance loses heat energy, the molecules slow down, and the substance contracts.
3. Skill Objective(s)
   a. Students will use the scientific method of inquiry.
   b. Students will use their observation skills to record what the see in the demonstration.
   c. Students will work cooperatively in a group.
   d. Students will write complete sentences using correct spelling, capitalization and punctuation.

B. *Materials*

1. One or two rubber balloons (the kind you would use for helium)
2. A hot plate or a Bunsen burner with ring stand, iron ring, clamp and wire gauze
3. Container for boiling water
4. Tongs to hold the heated flask
5. Extra tongs in case the others get too hot
6. Goggles for you to wear during the demonstration
7. Ice water in a dishpan
8. Metal cooking thermometer
9. Dropper
10. ½ c. of soapy water
11. Medium-sized Erlenmeyer or Florence flask (125-to 500-mL)
12. Heat resistant gloves
13. Appendix G: Balloon in a Bottle, one per student
14. One 5" x 10" piece of plain white paper per student

C. *Key Vocabulary*

1. Expansion: adding heat energy to a substance, which causes the molecules to move more quickly and causes the substance to expand
2. Contraction: when a substance loses heat energy, the molecules slow down, and the substance contracts

D. *Procedures/Activities*

1. Let the students know that they will be observing three ways to try to get a balloon in a bottle. They will need to use systematic observation in order to be able to illustrate and explain today's experiment for the Culminating Activity.
2. During the experiment, students ought to be completing Appendix G: Balloon in a Bottle.
3. Stretch the balloon several times. Stretch the mouth of the balloon over the mouth of the flask. Ask the students what is inside the balloon (air).
4. Put the flask into the hot water in the pan-which is on the heat source. Use tongs to keep from burning yourself. Leave the flask in the water for three minutes.
5. On their handout, ask students to illustrate what occurred.
6. Set the balloon in cold water-**briefly** (about 30 seconds). Ask the students what is happening to the balloon now. Is it in the flask yet? (No)
7. Heat the flask by holding it with tongs over the heat source for about five minutes. The balloon should NOT be on the flask. Students should write down what they observe during this time.
8. Measure and record the temperature of the air in the flask.
9. Remove the flask, and wearing heat resistant gloves, put the balloon on the flask. Students record their observations.
10. Put the flask **briefly** (about 30 seconds), into the cold water. Students record their observations. Has the balloon gone into the flask yet? (a little bit) What is the heat causing the balloon to do and why?
11. Use a dropper and put ten drops of soapy water into the flask. Put enough plain water into the flask to cover the bottom (about 1/8 of an inch).
12. Put the flask into hot water and allow the water in the flask to come to a boil and steam (**use tongs to hold the flask**). Do not let the flask boil dry.
13. Using tongs, remove flask from heat. Put on gloves and put the balloon on the flask. Students write down their observations.
14. Set the flask down and allow cooling to room temperature. Students record their observations (balloon ought to be completely in the flask).

15. Put the flask over the heat source and gently warm. What happens to the balloon now? What caused the balloon to go into the flask? (it cooled down dramatically-contraction) What caused it to partially inflate? (warmth-expansion)
16. For homework: pass out the 5" x 10" piece of paper. Have students fold it as they did in Lesson Six. Students illustrate and write explanation of today's experiment. They ought to be written using the vocabulary from today, and in complete sentences, using correct spelling, capitalization, and punctuation. This activity is adapted from *Investigating Solids, Liquids, and Gases with Toys* by Terrific Science Press.

E. *Assessment/Evaluation*
1. Use the rubric in Appendix G: Balloon in a Bottle, for student illustration and explanation. **Keep this page for the Culminating Activity**. Look at student observations for completion and accuracy.

Lesson Eight: A Change of Phase

A. *Daily Objectives*
1. Concept Objective(s)
   a. Students understand common properties, forms and changes in matter and energy (CSS, Science 2).
2. Lesson Content
   a. Different amounts of energy are required to change the phase of different substances.
   b. Each substance has its own melting and boiling point.
   c. The freezing point and boiling point of water is 0 degrees Celsius, and 100 degrees Celsius.
3. Skill Objective(s)
   a. Students will use the scientific method of inquiry.
   b. Students will accurately measure temperature.
   c. Students will use appropriate tools and techniques to gather, analyze, and interpret data.
   d. Students will work cooperatively in a group.

B. *Materials*
1. 1 ounce of each, per group:
   a. Nail polish remover
   b. 70% ethyl alcohol solution
   c. 90%-100% isopropyl alcohol
   d. 70% isopropyl alcohol (rubbing alcohol)
   e. Perfume
   f. Water
   g. Cologne
   h. After-shave lotion
   i. Pre-shave lotion
   j. Cooking oil
   k. Vanilla flavor or extract
   l. Mouthwash
2. Masking tape and marker for labels
3. One dropper bottle for each test liquid
4. Approximately 50 cotton swabs
5. For class use: one bottle of rubbing alcohol
6. Per group:

a. Alcohol or cooking thermometer (which reads between 0-30 degrees Celsius
b. Lump of clay (about 1/8 cup)
c. A cotton ball for each test liquid

7. Appendix H: Differences in Temperature, one per student
8. One plain, white paper, cut to 5" x 5", squares per student

C. *Key Vocabulary*

1. Distillation: the separation of mixtures with different boiling points

D. *Procedures/Activities*

1. Review with class the definition of evaporation (*Core Knowledge Sequence*, Grade 2, page 59).
2. Rub a cotton ball saturated with water on the board. Repeat with one dipped in rubbing alcohol. Have students observe which one evaporates quicker. Ask: When something evaporates is it gone? (No, it becomes a gas.)
3. Tell the students that the purpose of the investigation they have today is to demonstrate that different substances have various temperatures where they change phase.
4. Pass out Appendix H: Differences in Temperature
5. Go over the directions and group behavior and participation expectations.
6. Discuss findings. Which liquid cooled off the most? Which cooled off the least?
7. Define distillation for the students and give them examples of its uses (medicines, determining the liquids in a mixture). Tell them the boiling and freezing points for water.
8. On the plain white paper, have students transfer the data from Appendix H: Differences in Temperature. Fold from corner to corner and crease; open. Then fold opposite corners; open. Fold in half length-wise; open. Now fold the top point of the folded triangle and the bottom point of the folded triangle to the center of the square (this should make a pop-out page).

E. *Assessment/Evaluation*

1. Look over each group's handout. This activity is adapted from *Investigating Solids, Liquids, and Gases with Toys* by Terrific Science Press.
2. Use the rubric in Appendix F: Differences in Temperature to evaluate student's work on the culmination project. **Remember to keep this page.**

Lesson Nine: Review

A. *Daily Objectives*

1. Concept Objective(s)
   a. Students understand common properties, forms and changes in matter and energy (CSS, Science 2).
2. Lesson Content
   a. Students understand the states of matter in terms of molecular motion.
   b. Most substances are solid at low temperatures, liquid at medium temperatures, and gaseous at high temperatures.
   c. A change of phase is a physical change (no new substance is produced).
   d. Expansion (adding energy) and contraction (removing energy)-water is a special case: water expands when it changes form a liquid to a solid.
   e. Changing phases: condensation; freezing; melting; boiling. Different amounts of energy are required to change the phase of different substances. Each substance has its own melting and boiling point.
   f. Distillation is the separation of mixtures of liquids with different boiling points.

3. Skill Objectives
    a. All covered in unit.

B. *Materials*
1. Appendix I: Tic-Tac-Toe Review

C. *Key Vocabulary*
None

D. *Procedures/Activities*
1. Assign students to a partner. They should be similar in their knowledge of the subject matter.
2. Pass out Appendix I: Tic-Tac-Toe Review to each pair of students.
3. Go over the rules of the game: In order to mark an "X" or an "O," the students must first answer a review question correctly. The questions may be read in any order. Students take turns reading and answering questions. The game is played until all the questions have been answered correctly.
4. Once students have played about 30 minutes, review as a class. Let them know that there will be a test next science period.

E. *Assessment/Evaluation*
1. Teacher observation

Lesson Ten: Test

A. *Daily Objectives*
1. Concept Objective(s)
    a. Students understand common properties, forms and changes in matter and energy (CSS, Science 2).
2. Lesson Content
    a. Students understand the states of matter in terms of molecular motion.
    b. Most substances are solid at low temperatures, liquid at medium temperatures, and gaseous at high temperatures.
    c. A change of phase is a physical change (no new substance is produced).
    d. Expansion (adding energy) and contraction (removing energy)-water is a special case: water expands when it changes form a liquid to a solid.
    e. Changing phases: condensation; freezing; melting; boiling. Different amounts of energy are required to change the phase of different substances. Each substance has its own melting and boiling point.
    f. Distillation is the separation of mixtures of liquids with different boiling points.
3. Skill Objective(s)
    a. Students will take a test over the content covered in this unit.

B. *Materials*
1. Appendix J: Unit Test

C. *Key Vocabulary*
None

D. *Procedures/Activities*
1. Pass out the tests to the students.
2. Allow them the period to take the test.
3. Collect and grade the tests.

E. *Assessment/Evaluation*
1. Grade the test according to the point values written on the test.

VI. CULMINATING ACTIVITY

A. The students will make a book reflecting the content covered in this unit. See Appendix K: Making a Book, for complete directions (idea adapted from *American Reform*, National Core Knowledge Conference, 2002).

VII. HANDOUTS/WORKSHEETS

A. Appendix A: Questions and Rubric
B. Appendix B: Mystery Matter
C. Appendix C: Experimenting With Gas
D. Appendix D: What Kind of Change?
E. Appendix E: Temperature Makes a Difference
F. Appendix F: Convection or Conduction?
G. Appendix G: Balloon in a Bottle
H. Appendix H: Differences in Temperature
I. Appendix I: Tic-Tac-Toe Review
J. Appendix J: Unit Test
K. Appendix K: Making a Book
L. Appendix L: Rubric for Book

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Appendix A

Answer the following questions in complete sentences. You will be graded for your answer, punctuation, capitalization, spelling and whether or not your answer is in a complete sentence.

1. Describe how the particles are arranged in a solid.

_____

_____

_____

2. Explain how the arrangement of the particles in a liquid allows it to have a definite volume, but not a definite shape.

_____

_____

_____

3. The particles in a gas give it no definite volume and no definite shape; why?

_____

_____

_____

Rubric for diagram

Illustration clearly shows the molecular structure for a:					
Gas	1	2	3	4	5
Solid	1	2	3	4	5
Liquid	1	2	3	4	5
The labeling is in complete sentences, with correct mechanics:					
Gas	1	2	3	4	5
Solid	1	2	3	4	5
Liquid	1	2	3	4	5
The illustrations are neatly done and color is added:					
Gas	1	2	3	4	5
Solid	1	2	3	4	5
Liquid	1	2	3	4	5
Includes and example of each:					
Gas	1	2	3	4	5
Solid	1	2	3	4	5
Liquid	1	2	3	4	5

1=Missing 2=Needs improvement 3=Okay, could be better
4=Nice! 5=Wow!

Appendix B
Mystery Matter

Materials Manager: Get materials and puts them away. This person also makes sure that items are used appropriately and respectfully.
Reporter: It is the responsibility of this person to share with the class the information obtained by the group.
Recorder: This person is responsible for documenting information that is agreed on by the group. This ought to be done neatly to that anyone could read it.

	Yes	No
Does the mystery matter have a definite shape and volume?	☐	☐

Notes (circumstances that it does or does not):

_____

_____

Does the mystery matter have a definite volume, but changes shape?	☐	☐

Notes (circumstances that it does or does not):

_____

_____

Does the mystery matter have no definite volume or definite shape?	☐	☐

Notes (circumstances that it does or does not):

_____

_____

Rubric for Diagram and Explanation

Uses the definition of a solid	1	2	3	4	5
Uses the definition of a liquid	1	2	3	4	5
Is clear on the process of the experiment	1	2	3	4	5
Neatly done	1	2	3	4	5
Correct mechanics and uses complete sentences	1	2	3	4	5

1=Missing 2=Needs improvement 3=Okay, could be better
4=Nice! 5=Wow!

Appendix C
Experimenting with Gas

Materials Manager: Get materials and puts them away. This person also makes sure that items are used appropriately and respectfully.
Reporter: It is the responsibility of this person to share with the class the information obtained by the group.
Recorder: This person is responsible for documenting information that is agreed on by the group. This ought to be done neatly to that anyone could read it.
Encourager: The responsibility of this person is to make sure in a polite manner that every person in the group is doing their share.

Materials:

- ✓ 1 16 oz. soda bottle
- ✓ A dab of petroleum jelly
- ✓ 1 teaspoon of sugar
- ✓ A cork to fit your bottle

Procedure:
Pour yeast into the bottle
Fill the bottle ½ full of warm water
Add the sugar
Put your thumb over the bottle opening and shake vigorously

Questions:

What is the definition of a gas? _____

_____

Did you create a gas? _____

_____

How do you know? _____

_____

Did everyone in the group perform their duty? Who did well and who needs to improve?

_____

_____

Rubric

Uses the definition of a gas:	1	2	3	4	5
Is clear on the process of the experiment	1	2	3	4	5
Neatly done	1	2	3	4	5
Correct mechanics and complete sentences	1	2	3	4	5

1=Missing 2=Needs improvement 3=Okay, could be better
4=Nice! 5=Wow!

Appendix D
What Kind of Change?

There is something that gets molecules in matter moving enough to cause changes in states of matter. It is either adding or subtracting HEAT. Describe what is occurring with heat in each example on your won piece of paper.

The Kool-Aid you poured into paper cups last night are now popsicles.
You had a pan full of water on the stove to make tea. Now it is almost gone.
The wet jeans that your mom hung out to dry are now stiff and very cold.
The cold butter you put on your pancakes is now runny.

A physical change is a change of shape, color or state. A chemical change involves a chemical reaction. On a separate sheet of paper, write the condition and the type of change. Use complete sentences.

glass breaking	mowing the lawn	burning leaves
a rusting wagon	metal that is rotting	frying an egg
melting butter	freezing ice cream	water evaporating
cheese growing mold	using bleach to whiten clothes	
adding salt to water to gargle with		adding milk to cereal
hammering two pieces of wood together		blackening marshmallows

Rubric for Diagram

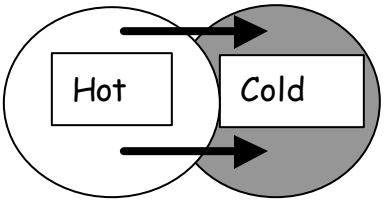
Uses the definition of physical change	1	2	3	4	5
Uses the definition of chemical change	1	2	3	4	5
Neatly done	1	2	3	4	5
Correct mechanics and complete sentences	1	2	3	4	5

Appendix E
Temperature Makes a Difference

Heat Transfer — Hot ⟶ Cold

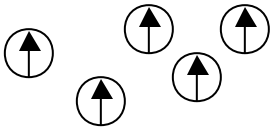
Conduction

Hot part (icals) pass heat to cooler part.
- Best: solids
- Not great: liquids
- Rare: gases



Convection

Part. Move, take heat w/ them
- Best: Liquids and gases
- Not great: solids



Evaporation

Type of radiation.
- *gases: more energy than liquid
- * energy obtained by object liquid is on
- * liquid picks up this energy

Radiation

Many forms
*electromagnetic radiation
- -light
- -infrared
- -can feel it
- -all objects give off infrared red.

*absorbed by dark objects
*reflected

Insulation

*No heat passes through
*Good: wood, plastic, glass and air

Appendix F
Convection or Conduction?

Materials Manager: Get materials and puts them away. This person also makes sure that items are used appropriately and respectfully.
Reporter: It is the responsibility of this person to share with the class the information obtained by the group.
Recorder: This person is responsible for documenting information that is agreed on by the group. This ought to be done neatly to that anyone could read it.

Materials:
*Convection or Conduction handout
*three clear plastic cups
*one measuring cup
*thermometer
*small bottle of food coloring
*one piece of plain white paper per person

Temperature	Observation
Hot	
Room	
Cold	

Directions:
*Pour one cup of cold water into one of the plastic cups.
*Pour one cup of hot water into another of the plastic cup.
*Pour one cup of room temperature water into the third plastic cup.
*Put the thermometer into the room temperature cup for one minute, record the temperature.
*Put the thermometer into the cold water cup for one minute. Record the temperature.
*Put the thermometer into the hot cup for one minute. Record the temperature.
*Put three drops of food coloring into each cup. One member of the group should observe one of the cups for 2 minutes.

What is happening, conduction or convection? How do you know?

In which cup did the color disperse the quickest? Why?

Rubric for Diagram and Explanation

Uses the definition of conduction:	1	2	3	4	5
Uses the definition of convection:	1	2	3	4	5
Process of experiment is clear :	1	2	3	4	5
Neatly done:	1	2	3	4	5

1=Missing 2=Needs improvement 3= Okay, could be better 4=Nice! 5=Wow!

Appendix G
Expansion and Contraction

Description of Balloon-Flask Situation	Draw you observations of the balloon…		
Balloon placed on unheated flask filled with air, flask heated and allowed to cool	On cool flask	While heating	After cooling
Balloon placed over heated flask, allowed to cool	Heated flask- No balloon	On heated flask	After cooling
Balloon placed over flask, filled with water vapor, allowed to cool.	Heated flask-	On heated flask with	After cooling

Rubric for Diagram and Explanation

Uses the definition of expansion: 1 2 3 4 5

Uses the definition of contraction: 1 2 3 4 5

Process of experiment is clear : 1 2 3 4 5

Neatly done: 1 2 3 4 5

Correct mechanics and complete sentences: 1 2 3 4 5

1=Missing 2=Needs improvement 3= Okay, could be better 4=Nice! 5=Wow!

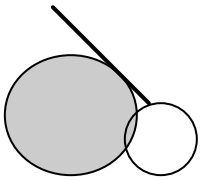
Appendix H
Differences in Temperature

Materials

A container of liquid (all will be circulated): nail polish remover, ethyl alcohol solution,Isopropyl alcohol, rubbing alcohol, perfume, water ,cologne, after-shave, pre-shave lotion, cooking oil, mouthwash
A lump of clay
Six cotton balls
A thermometer
A Dropper

Procedures

Wrap a cotton ball around the bulb of the thermometer.
Using a dropper, drop 10 drops of the liquid onto the cotton ball.
Prop the top end of the thermometer on the lump of clay.
Observe the thermometer for one minute.
Record the lowest temperature reading
Take off the cotton ball and let the thermometer come back to room temperature
Repeat procedure for each liquid.



Liquid	Room Temp.	Lowest Temp.	Amount of Change
Nail Polish Remover			
Ethyl Alcohol			
Isopropyl Alchol			
Rubbing Alcohol			
Perfume			
Water			
Cologne			
After-shave			
Pre-shave			
Cooking oil			
Mouthwash			

Rubric for Diagram and Explanation

Uses the definition of evaporation:	1	2	3	4	5
Uses the definition of temperature:	1	2	3	4	5
Process of experiment is clear :	1	2	3	4	5
Neatly done:	1	2	3	4	5
Correct mechanics and complete sentences:	1	2	3	4	5

1=Missing 2=Needs improvement 3= Okay, could be better 4=Nice! 5=Wow!

Appendix I
Tic-Tac-Toe Review

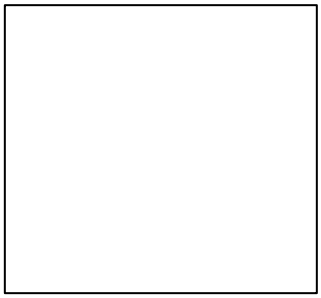
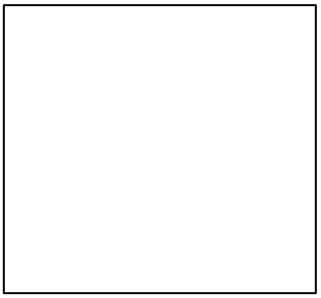
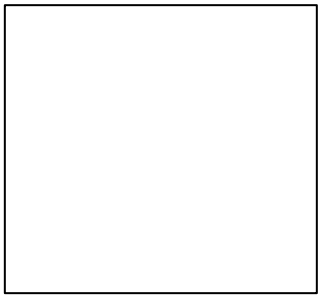
Use your own paper to make a Tic-Tac-Toe grid. Cut out the cards below and mix them up. Decide who will be X's and who will be 0's. X goes first. Draw a card, read it out loud. Answer the question. If you are correct, make your mark. If you don't know the answer, but the other person does, they get to put their mark and it does not count as their turn. Next, it is the other person's turn. The game is over when all the questions are answered. The winner is the person with the most marks.

What are molecules doing in a solid?	What are molecules doing in a liquid?	What are molecules doing in a gas?	Most substances are solid at _____ temperatures.
a.	b.	c.	d.
Most substances are liquid at _____ temperatures.	Expansion _____ energy.	True or False. All substances require the same amount of energy to melt and boil.	Fee Mark
e.	f.	g.	h.
Lose a mark.	Contraction _____ energy.	Free Mark	Most substances are gas at _____ temperatures.
i.	j.	k.	l.
A change of phase is a _____ change.	Name the four changes of phase.	Lose a mark.	A _____ change means that something new was created.
m.	n.	o.	p.

a=vibrate, definite volume and shape b=move freely, definite volume, not shape c=freely move, not definite volume or shape d=low e=normal f=adds g=false h=----- i=-------- j=loses k=------- l=high m=physical n=condensation, freezing, melting, boiling o=---- p=chemical

Appendix J
Test

Illustrate each state of matter and explain what the molecules are doing (1 point for each drawing, 1 point for each complete sentence, 1 point for the temperature, -1 point for each missed spelling, punctuation and capitalization**).**

_____ _____ _____
_____ _____ _____
_____ _____ _____
_____ _____ _____

2. Define chemical change (1 point each: definition and complete sentence. -1 for each mechanics error.).

_____
_____
_____

3. Define physical change (1 point each: definition and complete sentence. -1 for each mechanics error.).

_____
_____

4. Expansion _____ energy, contraction _____energy (1pt. each)

5. List and give examples for the four changes of phases (1 pt. for each state, 1 pt. per example).

_____
_____
_____

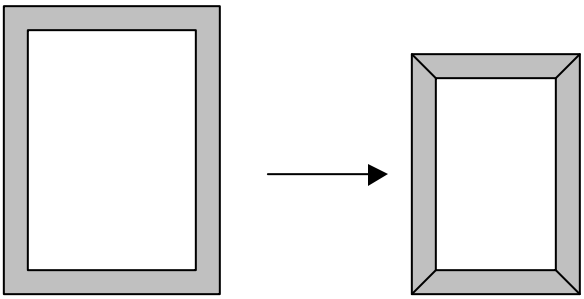
6. What is distillation? Why is this concept important (1 point each: definition and complete sentence. -1 for each mechanics error.)?

_____
_____
_____

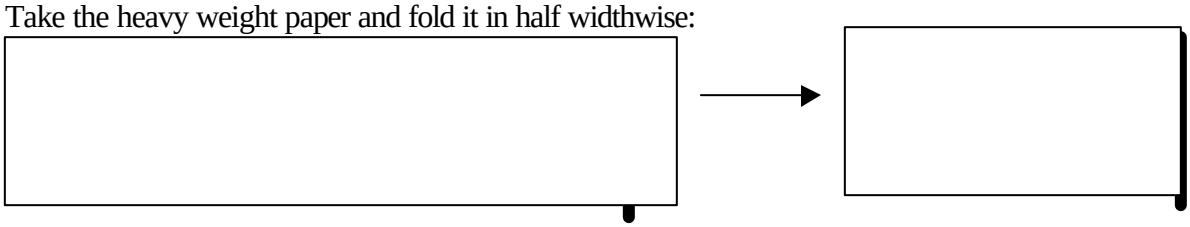
Appendix K
Making a Book

Cut mat board into 3" x 5" rectangles. Each student will need 2 (craft stores sell their scraps inexpensively).
Use nice, heavy weight paper (not construction paper). Cut into 5" x 25" per student.
Cut appropriate gift wrap into 4" x 6"-two per student (this is the outside cover).
One piece of 12" ribbon per student
One glue stick per student

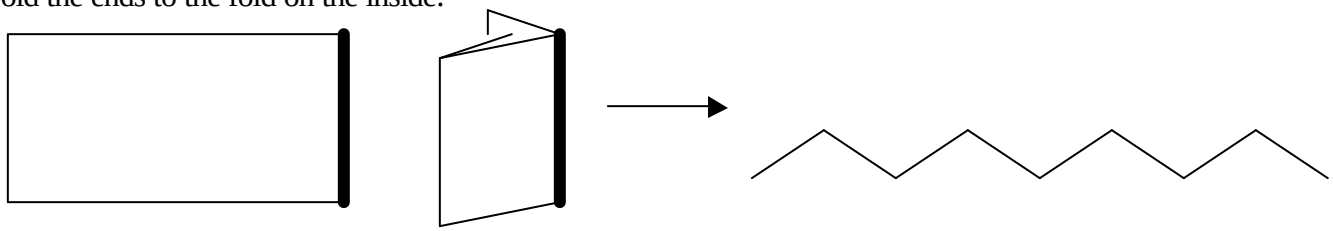
Take the gift wrap and cover each piece of mat board-cover the gift wrap completely with glue stick.



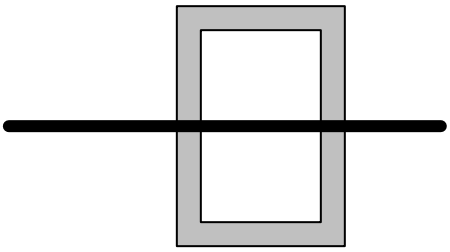
Take the heavy weight paper and fold it in half widthwise:



Fold the ends to the fold on the inside:



Lay the ribbon on one piece of the covered mat board: This will be used to tie the book closed.



Liberally glue the covers to the first and last sections of the folded paper, covering the ribbon and the other matching cover. Use the turned in illustrations to glue into the folds of the book. Use both sides for the book-this is an accordion book. Sections that are not white are for extra information and illustrations.

Appendix L, page 1
Rubric for Book

States of Matter					
Illustrations					
Gas	1	2	3	4	5
Liquid	1	2	3	4	5
Solid	1	2	3	4	5
Labeling (appearance)					
Gas	1	2	3	4	5
Liquid	1	2	3	4	5
Solid	1	2	3	4	5
Examples					
Gas	1	2	3	4	5
Liquid	1	2	3	4	5
Solid	1	2	3	4	5
Mystery Matter					
Definitions					
Gas	1	2	3	4	5
Liquid	1	2	3	4	5
Solid	1	2	3	4	5
Experiment process	1	2	3	4	5
Presentation (appearance)	1	2	3	4	5
Mechanics (spelling, capitals, punctuation, etc.)	1	2	3	4	5
Experimenting with Gas					
Definition	1	2	3	4	5
Experiment process	1	2	3	4	5
Presentation (appearance)	1	2	3	4	5
Mechanics (spelling, capitals, punctuation, etc.)	1	2	3	4	5
What Kind of Change?					
Definitions					
Chemical	1	2	3	4	5
Physical	1	2	3	4	5
Presentation (appearance)	1	2	3	4	5
Mechanics (spelling, capitals, punctuation, etc.)	1	2	3	4	5
Convection or Conduction					
Definitions					
Conduction	1	2	3	4	5
Convection	1	2	3	4	5
Experiment process	1	2	3	4	5
Presentation (appearance)	1	2	3	4	5
Mechanics (spelling, capitals, punctuation, etc.)	1	2	3	4	5

Appendix L, page 2
Rubric for Book

Expansion and Contraction

Definitions					
Expansion	1	2	3	4	5
Contraction	1	2	3	4	5
Experiment Process	1	2	3	4	5
Presentation (appearance)	1	2	3	4	5
Mechanics (spelling, capitals, punctuation, etc.)	1	2	3	4	5

Evaporation

Definition of evaporation	1	2	3	4	5
Uses findings	1	2	3	4	5
Experiment process	1	2	3	4	5
Presentation (appearance)	1	2	3	4	5
Mechanics (spelling, capitals, punctuation, etc.)	1	2	3	4	5

Overall

Presentation (appearance)	1	2	3	4	5
Definitions	1	2	3	4	5
Mechanics (spelling, capitals, punctuation, etc.)	1	2	3	4	5

Totals: 1=_____ 2=_____ 3=_____ 4=_____ 5=_____

Comments: