HEAT: THE NOMAD

Grade Level: 6th Grade
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Length of Unit: Five Lessons

I. ABSTRACT

This unit introduces the topic of heat and energy transfer as found in the *Core Knowledge Sequence* for the sixth grade. It explains historical background information to help students build their concept of the significance of heat in daily life. It provides vocabulary to assist the student in verbalizing observations while performing a variety of auditory, visual, and kinesthetic activities chosen to reinforce the topics of conduction, convection, and radiation.

II. OVERVIEW

A. Concept Objectives
   1. Develop an understanding of the importance of heat in our daily lives.
   2. Understand the inter-relationship of physical change and energy transfer.

B. Content from the *Core Knowledge Sequence*
   1. Content identifies and follows the Core Knowledge guidelines on heat and forms of energy transfer for 6th grade.

C. Skill Objectives
   1. Comparing and contrasting and experimentation of movement when heat applied.
   2. Explain movement of heat using vocabulary in lesson.
   3. Using appropriate tools, technologies and measurement units to gather and organize data interpreting and evaluating data in order to formulate conclusions.
   4. Communicating results of their investigations in appropriate ways.
   5. Observe the effects of the addition or absence of heat on the status of matter.
   6. Describe the major differences in the physical properties of water as a solid, liquid and gas.
   7. Know that a change in one or more variables may alter the outcome of an investigation.
   8. Demonstrate an ability to use a thermometer properly and accurately.
   9. Apply information to new situations.
   10. Observing expansion and contraction.
   11. Describe how different matter reacts to an increase or decrease of temperature.
   12. Choose measurement methods and devices according to the level of precision demanded by the problem.
   13. Know that a change in one or more variables may alter the outcome of an investigation.
   14. Demonstrate knowledge of the history of thermometer development.
   15. Using appropriate tools, technologies and measurement units to gather and organize data interpreting and evaluating data in order to formulate conclusions.
   16. Choose measurement methods and devices according to the level of precision demanded by the problem.
   17. Relate heat and energy.
   18. Identify the three states of matter.
   19. Identify how matter is heated by radiation, convection and conduction.
   20. Give examples of heat transfer.
   21. Know that energy can be carried from one place to another by heat flow or by waves including water waves, light and sound, or by moving the objects.
   22. Know that a change in one or more variables may alter the outcome of an investigation.

III. BACKGROUND KNOWLEDGE

A. For Teachers
1. *The New Book of Popular Science,* Grolier International.
2. *The Kingfisher Science Encyclopedia,* Kingfisher Books
3. *Science Matters,* Hazen, Robert M. and Trefil, James
4. *Discover Science,* Scott Foresman and Company
5. *What Your 5th Grader Needs to Know,* Hirsch, E.D.
6. *Physics for Kids, 49 Easy Experiments with Heat,* Wood, Robert W.
7. *How Science Works,* Hann, Judith

B. For Students
1. *Core Knowledge Sequence*- Grade 1: Basic States of Matter
2. *Core Knowledge Sequence*- Grade 4: Basic Terms and Concepts of Electricity
3. *Core Knowledge Sequence*- Grade 5: Matter and Change

IV. RESOURCES

A. Ruf, Albert J. Heat, *The New Book of Popular Science*, Danbury Connecticut; Grolier International 1994. ISBN 0-7172-1220-3
B. *The Kingfisher Science Encyclopedia,* New York, NY: Kingfisher Books, 1991. ISBN 1-85697-842-7
C. Hazen, Robert M. & Trifel, James. *Science Matters.* ISBN 0-385-26108-x
D. Hirsch, E.D., *What Your 5th Grader Needs to Know,* New York, NY; Dell Publishing 1993. ISBN 0-385-31464-7
E. Hann, Judith. Energy, Force, and Motion, *How Science Works,* Pleasantville, New York: The Readers Digest Foundation, 1991. ISBN 0-89577-382-1
F. "Molecules on the Move," CompuServe [On-line]. http://www.galaxy.net/~k12/matter/movemol.html

V. LESSONS

Lesson One: Heat: Let's Get Moving (2-3 days)

A. *Daily Objectives*
1. Concept Objective(s)
   a. Develop an understanding of the importance of heat in our daily lives.
2. Lesson Content
   a. Heat, temperature and movement of atoms
3. Skill Objective(s)
   a. Comparing and contrasting and experimentation of movement when heat applied.
   b. Relate heat and energy.
   c. Explain movement of heat using vocabulary in lesson.
   d. Using appropriate tools, technologies and measurement units to gather and organize data interpreting and evaluating data in order to formulate conclusions.
   e. Communicating results of their investigations in appropriate ways.

B. *Materials*
1. Glass beaker: 500 ml, 100 ml
2. Copies of Appendix A for each student
3. Copy of Appendix B
4. Construction paper 9 X 13 (red, yellow, and orange)
5. Markers
6. Thermometers: Celsius, Fahrenheit
7. Food coloring
8. Time piece with second hand
9. Copy of Appendix C for teacher

10. Copies of Appendix D for each student (for assessment)

C. *Key Vocabulary*
   1. Heat: the flow of energy from warmer matter to cooler matter
   2. Thermal energy: energy of the movement of particles that form an object
   3. Temperature: measures how fast object particles are moving
   4. Degree: unit of measurement of temperature
   5. Kinetic energy: matter that is moving
   6. Potential energy: any matter that possesses the ability to exhibit energy but stores it for future use
   7. Heat transfer: the flow of heat from warmer objects to cooler ones

D. *Procedures/Activities*
   1. Provide vocabulary page (Appendix A), and construction paper to each student. Discuss vocabulary (1-6) and as a class write down responses.
   2. Using construction paper, prepare notebook cover for the study of heat.
   3. Using pictures of vocabulary words, decorate the notebook cover for unit study of heat.
   4. Hand out Appendix B. Prepare class to perform “Molecules on the Move” activity.
   5. Students will observe that the food coloring in the hot water mixes more rapidly than the food coloring in the cooler water because of the molecular movement in the water.
   6. Put 300 ml of cold water in the beaker. Let it sit on the desk a few minutes until the water seems still.
   7. Add 1 drop of food color. Do not stir. Ask student what happens to the mixture. Then ask if there would be a difference if the water were hot.
   8. Rinse the beaker, and then put 300 ml of hot water in it. Let it sit on the desk a few minutes until the water seems still.
   9. Add 1 drop of food color. Do not stir or shake. Ask the students what happens.
   10. Discuss the outcome of the experiment and assist students in reaching the proper conclusion using vocabulary.
   11. Optional activity for future clarification is found in Appendix C. Please read ahead of time to assess whether or not this is appropriate before evaluation of students.

E. *Assessment/Evaluation*
   1. Provide a copy of Appendix D for each student.
   2. Complete individually to exhibit an understanding of heat and the types of energy discussed in Lesson One.

Lesson Two: Heat and Its Change of State (1 day)

A. *Daily Objectives*
   1. Concept Objective(s)
      a. Develop an understanding of the importance of heat in our daily lives.
   2. Lesson Content
      a. States of matter: solid, liquid and gas
   3. Skill Objective(s)
      a. Identify the three states of matter.
      b. Observe the effects of the addition or absence of heat on the status of matter.
      c. Describe the major differences in the physical properties of water as a solid, liquid and gas.
      d. Know that a change in one or more variables may alter the outcome of an investigation.

B. *Materials*
   1. Copies of Appendix E for each student
   2. Ice
   3. Pan

4. Heat source

C. *Key Vocabulary*
   1. Liquid: has a fixed volume, but takes on the shape of the container
   2. Solid: has a fixed shape and volume, atoms are in a regular arrangement
   3. Gas (vapor): assumes the shape and volume of its container
   4. Change-of-state: when the addition or removal of heat energy alters matter
   5. Sublimation (ex. Carbon dioxide [dry ice], iodine): solids that are heated and turn directly into a gas without ever becoming a liquid

D. *Procedures/Activities*
   1. Provide Appendix E for each student. Brainstorm in groups of 2-3 "What we know about the three states of matter."
   2. Regroup and as a class define "what we want to know," using vocabulary words 7-13 from Appendix A.
   3. Prepare class experiment using ice, pan and heat source.
   4. Place ice cube in pan and DO NOT HEAT. Explain the molecular structure of a solid.
   5. Students should then observe the ice melting, changing from a solid to a liquid. Discuss the molecular structure of a liquid.
   6. Place pan on heat source. Begin heating melted ice until it is boiling. Discuss the molecular structure of a gas (vapor).
   7. Complete "what we learned" on KWL handout as a class.

E. *Assessment/Evaluation*
   1. Students will identify the three states of matter and correlating molecular action using Appendix E for evaluating.

Lesson Three: How Heat Travels (3-4 days)

A. *Daily Objectives*
   1. Concept Objective(s)
      a. Understand the inter-relationship of physical change and energy transfer.
   2. Lesson Content
      a. Evaluate the three types of heat transfer
   3. Skill Objective(s)
      a. Identify how matter is heated by radiation, convection, and conduction.
      b. Give examples of heat transfer.
      c. Know that energy can be carried from one place to another by heat flow or by waves including water waves, light and sound, or by moving the objects.

B. *Materials*
   1. Copies of Appendix G for each student
   2. Copper wire (large, about the size of a pencil)
   3. Large candles (at least 2)
   4. Hot plate
   5. Two pans with insulated handle (one a shallow rectangular pan with handle)
   6. Eggs (2)
   7. Hot cocoa (enough for one cup per student)
   8. Metal spoons (one each student)
   9. Hot cups (one for each student)
   10. Three jars with lids
   11. Hand drill with bits
   12. Thermometer
   13. Aluminum foil
   14. Black paint and brush
   15. Stop watch

16. Modeling clay
17. Tap water
18. White drawing paper (2 pieces per student)

C. *Key Vocabulary*
1. Conduction: flow of heat energy from one molecule to the next
2. Convection: flow of energy that occurs when warm liquid or gas rises
3. Radiation: energy waves that can travel through empty space
4. Insulator: material that does not conduct heat or electricity very well

D. *Procedures/Activities*

DAY 1: CONDUCTION
1. Provide handout (Appendix G) to have students record observations of the following experiment using vocabulary page. (see vocabulary 13-17)
2. Heat the hot plate with the pan on it to prepare for cooking the egg. The students should share that the violently moving molecules on the burner bump into those of the pan causing them to move.
3. Discuss why the handle (insulator) does not get hot using vocabulary and background knowledge.
4. Fry the egg and continue the activity by leading the class in a discussion of movement caused by heating the molecules in the pan, thereby heating the molecules in the egg demonstrating conduction.
5. To conclude the class and evaluate the lesson, provide a sheet of paper and prepare to serve students hot cocoa by boiling water and making hot cocoa for each student. Place a metal spoon in each cup. Immediately proceed to evaluation #1 at this point.

DAY 2: CONVECTION
1. To present the concept of <u>convection</u>, begin by filling a shallow rectangular pan half full of water. Place the bottom of one end of the pan on heated hot plate.
2. Continue explanation: The water at that end will become warm by conduction. It will expand as it warms and travels up because the pressure above is less than if it traveled along the bottom (trying to move into dense molecules). The water above will be heated by convection (see definition of convection). At the top, warm water flows until it reaches the other end of the pan. Meanwhile, the cold water at the bottom moves to the warm end, where water is warmer and less dense. This completes the circle of convection known as convection current. (Talk about a radiator heating a home and wind created from the convection of warm, moist air). Now refer immediately to #2 on evaluation.
3. At this juncture have students light a candle, blow out, then describe and explain the rising smoke (carried by air warmed by burning candle).

DAY 3: RADIATION
1. To describe <u>radiation</u> first review vocabulary. Take class outside on a sunny day. Sit or stand in the sunshine. Feel immediate warmth. Discuss why warmth is NOT conduction or convection. Discuss why it can only be radiation. Discuss the effects of radiation heat on a car parked in summer sun.
2. Select three students to prepare three jars as follows: wrap one in aluminum foil, paint another black, and leave the other one clear.
3. Select three students make a small hole in the lid of each jar using a drill; this will allow students to put a thermometer inside the jar without removing the lid.
4. Select two students to fill each jar ¾ full of tap water. (Make sure you start with the same temperature water in each jar.)
5. Place them in the sunshine. Cover the holes in the lid using the modeling clay.

6. Select five students to take the temperature of each jar every three minutes for 15 minutes, record on Appendix G. (Make sure to replace the modeling clay after each reading.)
7. Which one of the jars heats up the fastest? (Black) Which one of the jars heats up the slowest? (Foil)
8. Explain how the one with foil reflected the heat radiation and the black one absorbed the heat radiation.
9. Use a Venn diagram to review conduction, convection and radiation.

E. *Assessment/Evaluation*
1. In paragraph form have each student write in their own words, why their cup of cocoa is an example of conduction
2. Arrange students in groups of two. Handout drawing paper. Draw a picture of an everyday use of convection currents. Groups will present to the class for discussion.

Lesson Four: Contraction and Expansion (1-2 days)

A. *Daily Objectives*
1. Concept Objective(s)
   a. Understand the inter-relationship of physical change and heat.
2. Lesson Content
   a. Expansion and contraction of molecules with the addition or absence of heat
3. Skill Objective(s)
   a. Apply information to new situations.
   b. Observing expansion and contraction.
   c. Describe how different matter reacts to an increase or decrease of temperature.
   d. Choose measurement methods and devices according to the level of precision demanded by the problem.
   e. Know that a change in one or more variables may alter the outcome of an investigation.

B. *Materials*
1. One meter (about 1 yard) of copper wire
2. Large iron bolt
3. Candle
4. Matches
5. Glass jars with screw top lids (i.e. jelly jars, canning jars)
6. Available refrigeration
7. Bucket for very warm water
8. One roll of masking tape

C. *Key Vocabulary*
1. Expansion: to become larger in size
2. Contraction: to become smaller in size

D. *Procedures/Activities*

DAY 1
1. Prepare room for demonstration activity using the copper wire, iron bolt, candle and matches. Handout Appendix G for writing hypothesis, observation and conclusion.
2. Wrap one end of the wire around the bolt. Attach the other end to a desktop so that the bolt swings freely above the floor.
3. Light the candle and hold it midway down the wire so that the wire heats. Do not touch the wire or bolt after heating.
4. Wait a few minutes. Students will see that the bolt reaches the floor.
5. Ask the class to formulate a hypothesis to explain why this happened. Lead them to understand that heat caused the molecules in the wire to expand lengthening the wire.

DAY 2

1. Prepare activity using jars, bucket and water.
2. Refrigerate jars (as many as possible, suggest one jar per 2-3 students) for a minimum of 30 minutes.
3. Have each group attempt to remove the lid from the jar. Students should be unable to remove lid or should have difficulty in removing. This is due to contraction of the glass and metal lid.
4. Then, have them immerse jars in a bucket of hot water. Again have students attempt to remove the lid from the jar.
5. Students should find it easier to remove the lid after immersion, not before. This is due to the expansion of the material.
6. Discuss the way metal and glass expands and contracts differently. Metal expands more and moves away from grooves on glass allowing the lid to be removed easily.

E. *Assessment/Evaluation*

1. Mark a large circle on the floor of the classroom with tape.
2. Tell the students that they are to represent molecules in a metal ball.
3. Tell them to demonstrate the movement of molecules when the ball is cool. (They should move slowly and stay within the circle, no expansion.)
4. Tell them that the ball is getting hotter and have them demonstrate what is happening to the molecules. (They should move faster and take up some space outside the circle—representing expansion.)
5. Then, say that the ball is getting cooler. (The students should begin to move slower and come back within the circle.)
6. Call on students observing the demonstration to explain each step by verbalizing what happens to the molecules and the ball. Students should observe, for example, that molecules begin moving with introduction of thermal energy. They bump into other molecules causing them to move and redirecting their own paths. With reduction of thermal energy the opposite response is expected.

Lesson Five: Let's Learn About Thermometer (2 days)

A. *Daily Objectives*

1. Concept Objective(s)
    a. Understand the inter-relationship of physical change and energy transfer.
2. Lesson Content
    a. Types of thermometers, measuring heat
3. Skill Objective(s)
    a. Demonstrate an ability to use a thermometer properly and accurately.
    b. Demonstrate knowledge of the history of thermometer development.
    c. Using appropriate tools, technologies and measurement units to gather and organize data interpreting and evaluating data in order to formulate conclusions.
    d. Choose measurement methods and devices according to the level of precision demanded by the problem.
    e. Know that a change in one or more variables may alter the outcome of an investigation.

B. *Materials*

1. Appendix G
2. LCD watch
3. Two thermometers (mercury or alcohol)
4. Two pieces of folded cardboard
5. Two rubber bands
6. Large glass jar

7. Window and/or sunny day

C. *Key Vocabulary*
1. Thermometer: an instrument that uses alcohol, a crystal, or mercury to measure the temperature of an object
2. Pyrometer: a device that measures very high temperatures
3. Seger Cone: small pyramid shaped cones made of clay and salt which melt after being at a certain temperature for a length of time

D. *Procedures/Activities*

DAY 1
1. Hand out Appendix I with historical information on reading types of thermometers.
2. Read this as a class.
3. Display LCD watch with liquid crystals.
4. Generate a discussion by asking questions like: How do you use a thermometer at home? What is the movement of heat from the body to a thermometer's liquid called? (Convection). What is the body's normal temperature? (37 degrees Celsius or 98.6 degrees Fahrenheit). Do thermometers measure heat or temperature? (Temperature).

DAY 2
1. Teacher demonstration using Appendix J (prepared ahead of time).
2. Need two thermometers, two pieces of folded cardboard, two rubber bands, large jar, and window.
3. Students will observe while the teacher explains to them how to mount the thermometers with rubber bands to the cardboard.
4. Place one mounted thermometer inside a jar and the other thermometer standing nearby on a windowsill with the cardboard side facing the sun so light does not shine on the thermometer.
5. Let them both stand for a few minutes.
6. The thermometer in the jar should read much higher because the sun's rays warm the objects that they strike (radiation).
7. The jar was warmed and this warmed the air surrounding it.
8. The thermometer not in the jar was also warmed, but small air currents carried surrounding heat up (convection).

E. *Assessment/Evaluation*
1. Guest Speaker (School Nurse): students will ask questions provided by teacher, for guiding questions.

VI. CULMINATING ACTIVITY

A. As a culmination of this unit the teacher will take the students on a field trip to a pottery shop. This will show how heat transfer is related to a career.

B. Have students write a creative story about convection and air currents. Students should pretend that they are kites and explain how air currents and convection relate to their ability to stay in the air. Upon completion students will share their stories with the class.

VII. HANDOUTS/WORKSHEETS

A. Appendix A: Vocabulary List

B. Appendix B: Molecules on the Move Experiment (two pages)

C. Appendix C: Measuring the Rate of Heat Loss

D. Appendix D: Assessment Activity

E. Appendix E: Phase Changes Worksheet

F. Appendix G: Science Experiment Form

G. Appendix H: Background Information

H. Appendix I: Historical Information on Thermometers

VIII. BIBLIOGRAPHY

A. Hann, Judith. Energy, Force, and Motion, *How Science Works,* Pleasantville, New York: The Readers Digest Foundation, 1991. ISBN 0-89577-382-1

B. Hazen, Robert M. & Trifel, James. *Science Matters.* ISBN 0-385-26108-x

C. Heat and Energy. *Discover Science.* Glenview, Illinois: Scott Foresman and Company, 1989. ISBN 0-673-42075-2

D. Hirsch, E.D., *What Your 5th Grader Needs to Know,* New York, NY; Dell Publishing 1993. ISBN 0-385-31464-7.

E. "Molecules on the Move," CompuServe [On-line]. http://www.galaxy.net/~k12/matter/movemol.shtml

F. Ruf, Albert J. Heat, *The New Book of Popular Science*, Danbury Connecticut; Grolier International 1994. ISBN 0-717-1220-3

G. *The Kingfisher Science Encyclopedia,* New York, NY: Kingfisher Books, 1991. ISBN 1-85697-842-7

Appendix A

ENERGY, HEAT AND ENERGY TRANSFER VOCABULARY

1. Heat

2. Thermal energy

3. Degree

4. Kinetic Energy

5. Potential Energy

6. Heat Transfer

7. Temperature

8. Liquid

9. Solid

10. Gas (vapor)

Appendix A, continued

11. Change of state

12. Sublimation

13. Conduction

14. Convection

15. Radiation

16. Insulator

17. Expansion

18. Contraction

19. Thermometer

20. Pyrometer

21. Seger Cone

Appendix B
Molecules on the Move Experiment

HYPOTHESIS

What happens to the movement of molecules in a substance when the substance is heated?

____

____

____

MATERIALS AND EQUIPMENT

- 1 beaker
- food coloring
- water

LAB SAFETY AND PROTOCOL

____

____

____

PROCEDURE

1. Put 300 ml of cold water in the beaker. Let it sit on the desk a few minutes until the water seems still.

2. Add 1 drop of food coloring. Do not stir or shake the beaker.

   What happens to the food coloring (and why)?

____

____

____

3. Do you think there would be any differences if the water were hot (and why)?

___

___

___

4. Try it. Rinse the beaker, then put 300 ml of hot water in it. Let it sit on the desk a few minutes until the water seems still.

5. Add 1 drop of food coloring. Do not stir or shake the beaker.

What happens?

___

___

___

CONCLUSION

What happens to the movement of molecules in a substance when that substance is heated?

___

___

___

Appendix C

Name ______________________________________

MEASURING THE RATE OF HEAT LOSS

PURPOSE: Measure the cooling rates of different volumes of water

MATERIALS: 500 ml beaker or large jar, 100 ml beaker or very small jar, 2 Celsius thermometers, hot tap water, clock

PROCEDURES:
1. Fill the large beaker or jar with hot tap water.

2. Fill the small beaker or jar with hot tap water.

3. Place both beakers or jars on a flat surface a few centimeters apart.

4. Quickly place a thermometer in each beaker or jar. Immediately read the temperature on each thermometer. Record the temperature on the chart.

5. Leave the thermometers in the beakers. Keep track of the time with the clock. Record the temperature of each water sample every minute for the next 15 minutes.

CONCLUSION

1. What was the temperature of the water in each beaker at first? After 7 minutes? 15 minutes?

2. How does the amount of water effect how fast the water loses heat?

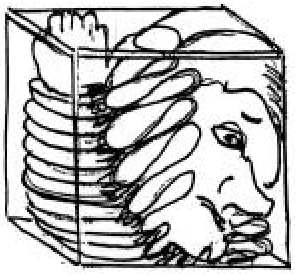
Appendix C, continued

RECORD YOUR RESULTS

	Large Beaker	Small Beaker
0 minutes	___________	___________
1 minute	___________	___________
2 minutes	___________	___________
3 minutes	___________	___________
4 minutes	___________	___________
5 minutes	___________	___________
6 minutes	___________	___________
7 minutes	___________	___________
8 minutes	___________	___________
9 minutes	___________	___________
10 minutes	___________	___________
11 minutes	___________	___________
12 minutes	___________	___________
13 minutes	___________	___________
14 minutes	___________	___________
15 minutes	___________	___________

Appendix D

Label each picture with the appropriate vocabulary word from this Lesson's list:



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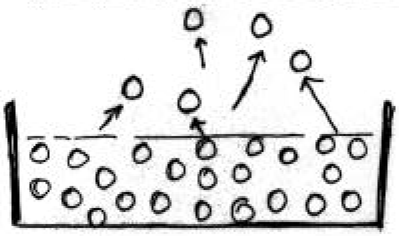
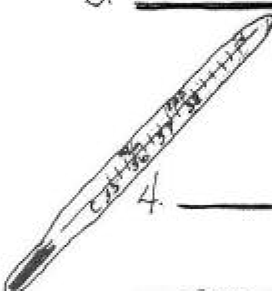
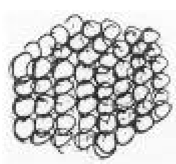
2 ____________________



3. ____________________



4. ____________________



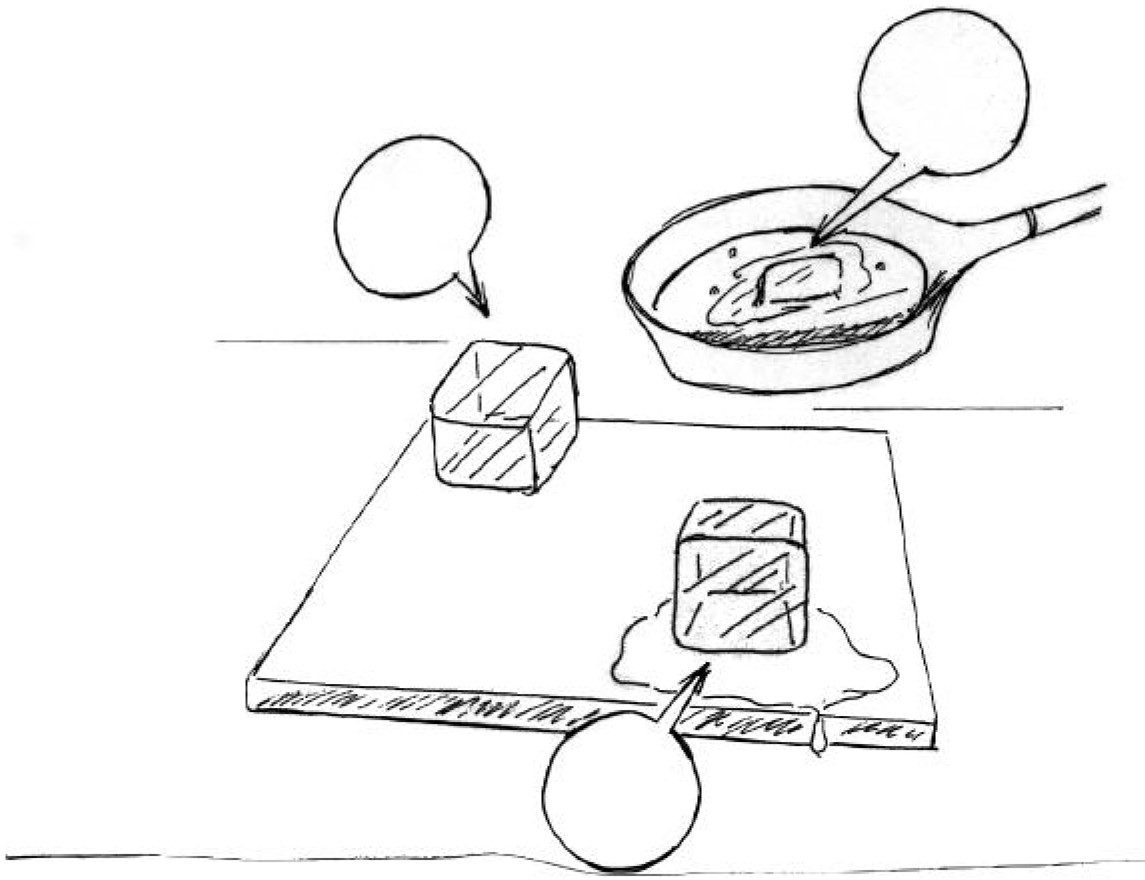
5 ____________________

6. ____________________

Explain your choices on the back in sentences, and short paragraph form.

Appendix E

<u>Phase Changes</u>



1. Label the 3 states of matter.
2. Draw the action of the molecules in the bubbles.

Bonus: Compose a paragraph to explain, in detail, what takes place when a solid changes to a liquid then to a gas. Why does this happen?

Appendix G

Name: ______________________________

SCIENCE EXPERIMENT FORM

I wanted to find out:____

____

I did this experiment:____

____

I used these materials: ________________________ ____________________

________________________ ____________________

________________________ ____________________

These were the steps of the experiment:

1. ____

2. ____

3. ____

4. ____

5. ____

This is what happened: ____

____

____

____

I decided that: ____

____

____

My experiment: ______ answered my question ______ did not answer my question

Appendix H-Heat: The Nomad
Background Information

Lesson One

I. You know how nice a heated room feels on a cold day. You use heat for cooking and to heat water for a bath. You might feel too hot on a summer day. So what exactly is heat? It is matter made of tiny particles that are always moving: kinetic energy – thermal energy. Particles that form your skin are always moving because skin has much thermal energy. Particles in cool water move more slowly because water has little thermal energy. Put your hand in cool water. Fast moving particles in you hand bump against slow moving water particles, making them move faster. Water becomes warmer as the skin particles slow down and cool. Energy from your hand flowed into the water warming it – HEAT—the flow of energy from a warmer object to a cooler object.

II. Temperature measures how fast an object's particles are moving. Two objects with the same temperature can give off different amounts of heat. An object with a higher temperature can give off less heat than an object with a lower temperature. It will depend on the number of molecules in an object. The more molecules the more heat that is given off.

Lesson Two

I. When heat is applied to matter the effect on the matter is "change of state." Matter passes from one state, or phase, to another solid, liquid or gas. Heat applied to a solid causes vibration or movement of the molecules, which causes them to break their bonds that formally forcefully held them together. What was a solid has now become a liquid. Add ice cubes to a liquid. The cubes gradually melt as they absorb heat from the liquid causing the liquid to cool. The opposite is true for liquid to solid. Evaporation, which is the process of passing from a liquid to a gas, occurs when molecules become so active that they break through the surface molecules, escape and are absorbed into the surrounding air.

Lesson Three

I. Just as you move from one place to another in many different ways, Energy (heat transmission) has different ways of moving from warm matter to cool matter. Heat is transmitted in 3 different ways. 1). Conduction is the movement of energy (heat) by moving molecules. Collisions between molecules transfer kinetic energy from one molecule to another. 2). Convection is the transfer of energy by the heated matter moving upward, usually resulting in a circular motion. 3). Radiation is electromagnetic waves, which are able to travel through a space that has no particles.

Lesson Four

I. Heat can alter matter in its temperature, its size or state (phase). Heat causes the movement of molecules in matter to vibrate and move nearby molecules away. This causes those molecules to take up more space so the substance expands. The opposite occurs when matter is cooled. Water expands when it freezes; lakes and ponds freeze from the top down. If water contracted when it froze, the bodies of water would never thaw, resulting in non-existent aquatic life.

Lesson Five

I. The word thermometer is from two Greek words, thermos meaning heat and meter meaning to measure. Hero, a man who lived in Alexandria, invented a forerunner of today's mercury and alcohol thermometers more than 2000 years ago. He attached a thin water filled tube to a glass bulb. Heating the bulb caused the air inside to expand. The expanding air forced the water out of the tube. Hero's work was lost until the Renaissance. When his works were found again several scientists, including Galileo Galilei a famous early 17th century Italian scientist invented a crude instrument called a thermoscope. The thermoscope was based on Galileo's information. It was a glass bulb with a long glass stem. The bulb was heated and the stem was dipped in water contained in another vessel. When the air in the bulb cooled, it contracted, then the water would rise up into the stem. To assemble lesson ahead of time day two, the teacher will provide the display from Appendix J.

Appendix I
Historical Information on Thermometers

1. Thermometer comes from two Greek words: thermos (heat) and meter (measure). Hero, a mad who lives in ancient Alexandria invented a forerunner of today's mercury and alcohol thermometers, more than 2,000 years ago. He connected a thin water filled tube to a glass bulb. Heating the bulb caused the air inside of it to expand. The expanding air forced the water out of the tube. Hero's records were lost until the Renaissance. Once it was found, several scientists, including Galileo, devised thermometers.
2. WHAT IS A THERMOMETER? When somebody takes your temperature, it's measured in DEGREES. The average temperature for humans is 98.6° Fahrenheit (°F) or about 37° Celsius (°C). The Celsius scale is easier to measure with because it is based on measurement of water and is divided into 100 units. Water boils at 100°C (212°F) and freezes at 0°C (32°F).
3. The usual measure for heat is the calorie. CALORIE is defined as the amount of heat that will raise the temperature of 1 gram of water 1° Celsius.
4. Thermometers measure temperature. Placed in your mouth, your body's heat causes the liquid to expand and rise in the tube, the more heat that passes from your body to the liquid, the higher the liquid rises in the glass tube. When the liquid stops expanding, it stops beside a number on the tube. This number is your temperature.
5. Many hospitals use electronic thermometers for quick measurements. Another kind of thermometer is a liquid crystal thermometer. It has special liquid crystals inside. A small change in temperature makes these crystals change color.
6. Lastly, in our study, is a PYROMETER, because thermometers cannot measure very high temperatures, such as those needed to make ceramic pots. The pyrometer can measure temperatures of objects hot enough to glow. Pyrometers measure temperature by the color of an object's glow. Color of glow from an object depends on its temperature. Hot objects glow red. Super-hot objects glow blue-white.
7. FYI-Anders Celsius was a Swedish astronomer who developed the temperature scale. It is often called centigrade. The scale is divided into 100 parts – freezing point at 0°C and boiling point at 100°C. The German physicist Gabriel Fahrenheit is credited with the Fahrenheit scale.