# Bubbles in the Hot Tub

## A Guide to Getting In and Out of Hot Water

**Including:**

**As a Matter of Fact**
**Particle Play**
**Meet the Heat**
**What Goes Up Must Come Down**
**Technological Treats**
**Making Bubbles in the Hot Tub**

**An Integrated Unit for Grade 7/8**

**Written by:**

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**Length of Unit: approximately: 23.2 hours**

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**An Integrated Unit for Grade 7/8**
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# Task Context

In ***Bubbles in the Hot Tub,*** students take on the role of engineers as they accept a contract to design and build a hot tub for their community pool. Students will need to acquire a working knowledge of heat and fluids in order to successfully design and build (a model of) the hot tub that meets the department of recreation's criteria. In order to gain credibility of their engineering skills, students will be required to complete several micro-projects. The students will need to keep an ongoing project journal for people from their local department of recreation to evaluate at any given time. They will also be required to submit blueprints and prototypes with each of their project submissions.

# Task Summary

***Bubbles in the Hot Tub*** is a Science and Technology unit prepared for teachers of combined 7/8 classes. This unit is designed to engage both grade level students, and allow for the simultaneous teaching of concepts from both curricula. The majority of subtasks and the culminating task will be taught and completed by all students although the assessment for each subtask will be grade specific.

Through drama, demonstrations, and hands-on investigations, students will be introduced to the particle theory. The particle theory will then serve as the foundation for students' explanations and predictions on topics such as temperature, changes in matter, heat transfer (conduction, convection, radiation), and properties of fluids (viscosity, density, buoyancy).

Students will apply their understanding of the buoyancy and density relationship as they create their own hydrometers. Similarily, grade 7 students will apply their knowledge of heat transfer to create their own insulated container, whereas, the grade 8 students will use the concept of hydraulic or pneumatic systems to create a toy.

Throughout the unit, students will be identifying examples in the natural world where heat and fluids are found, including the water cycle. They will consider how society has used and continues to use the characteristics of heat and fluids, and the impact this has on the environment.

# Culminating Task Assessment

Students will complete this performance assessment by applying the knowledge they acquired throughout this unit. All students will be given the challenge of designing and building a model of a hot tub. The grade 7 students will focus their designs on the heating system that will generate hot water for the tub. Additionally, they will make appropriate choices of materials in an effort to prevent heat loss. The grade 8 students will need to design and build a model of the system that will generate and control water movement (whirlpool or current) and effervescence (bubbles).

# Links to Prior Knowledge

Students should be able to identify various forms of energy (light, heat, sound, electricity, chemical, wind, water, nuclear, kinetic, mechanical) as well as the three states of matter (solid, liquid, and gas) and give examples of each state. Based on their knowledge of the properties that are characteristic of each state, students should demonstrate an ability to group materials based on these properties. In addition, the students should effectively describe some changes of state such as melting, freezing, condensation, and evaporation. The first subtask of this unit provides a diagnostic tool for assessing the students' background knowledge on the skills previously outlined.

# Considerations

# Notes to Teacher

Assessment is an integral part of teaching, and this unit has included a variety of strategies to aid the teacher in deciding when to assess, what to observe, and which activities should be recorded in the student's project journal.  In the first subtask, there is a suggestion to the teacher that the project journal could be introduced as a work portfolio for the students who will be the engineers responsible for designing and building a hot tub.  In order for the engineers (students) to gain credibility with their client (the teacher), they will maintain an accurate record of their micro-projects (tasks and activities outlined in the subtasks) which could be assessed at any time.

This unit does not fully embellish the client/engineer analogy.  The teacher may use this theme to whatever extent he or she chooses.  For example, the teacher could introduce the unit by entering the classroom wearing a hard hat and carrying blueprints.  The degree that the analogy is woven through the teaching/learning strategies is left to the individual teacher to decide.

Effective teaching includes a variety of teaching/learning strategies.  This unit explores a range of strategies from direct teaching to learning centres.  Students benefit more from a range of strategies, however, it is equally important to maintain a safe and productive classroom structure.  Teachers may, therefore, substitute an alternative approach to the strategy suggested in order to maintain an effective learning environment.

Teachers have a significant amount of expectations to be examined in their overall plans particularly when teaching in a combined-grade setting.  This unit describes some activities that could easily create a number of cross-curricular connections.  There are activities that relate to expectations in drama, mathematics, health, and visual arts.  Once again, the teacher may wish to further explore these expectations and include them in the appropriate subtask cluster.

**IMPORTANT NOTE:**

**Due to the size of Subtask 2, the last four parts of this subtask (Part D to Part G) are included as blackline masters (BLMs).  Included in Subtask 2 Teaching/Learning strategies are the descriptions and appropriate BLMs that contain the full text of the Teaching/Learning strategies for each of these parts.  Teachers should print these BLMs and consider them to be a continuation of the Teaching/Learning section.**

# Bubbles in the Hot Tub
## A Guide to Getting In and Out of Hot Water An Integrated Unit for Grade 7/8

**1 As a Matter of Fact**
The students will classify and discuss the concepts of both energy and matter as they participate in a whole group activity called "Who am I?" Through this classification of energy and matter as well as the subsequent discussion concerning these ideas, students will be able to demonstrate their prior knowledge.

**2 Particle Play**
The students will use the particle theory to make predictions and interpret changes in matter. The particle theory will serve as the basis for understanding the behaviour and characteristics (viscosity, density, and buoyancy) of fluids.

**3 Meet the Heat**
In this subtask, students will utilize their skills of inquiry and analysis to investigate the various forms of heat transfer (i.e., conduction, convection, and radiation). Through hands-on experimentation and problem-solving situations, students will discover that heat is transferred differently through particles of various substances. This knowledge of heat exchange will enable the students to make decisions about heating systems in their culminating task.

**4 What Goes Up Must Come Down**
Students will observe a demonstration that simulates the water cycle. The class will record their observations and relate them to the transfer of heat energy. A set of discussion points will enable students to associate this topic with their prior knowledge of the particle theory and density. As an extension, they will explore other natural changes of state.

**5 Technological Treats**
The students will gain an understanding of the operations of hydraulic and pneumatic systems and their applications in the real world. This new knowledge will then be used by the students to construct a hydraulic or pneumatic toy that could be used by younger children. To apply their understanding of insulators and conductors, the pupils will construct an insulated container that will minimize heat transfer.

**6 Making Bubbles in the Hot Tub**
Students will complete this performance assessment by applying the knowledge they acquired throughout this unit. All students will be given the challenge of designing and building a model of a hot tub. The grade 7 students will focus their designs on the heating system that will generate hot water for the tub. Additionally, they will make appropriate choices of materials in an effort to prevent heat loss. The grade 8 students will need to design and build a model of the system that will generate and control water movement (whirlpool or current) and effervescence (bubbles).



40 mins

## Description

The students will classify and discuss the concepts of both energy and matter as they participate in a whole group activity called "Who am I?" Through this classification of energy and matter as well as the subsequent discussion concerning these ideas, students will be able to demonstrate their prior knowledge.

## Expectations

7s56 A – compare the motions of particles in a solid, a liquid, and a gas using the particle theory;
7s59 – describe the effect of heating and cooling on the volume of a solid, a liquid, and a gas;
8s33 A – compare qualitatively the densities of solids, liquids, and gases;
8s41 – explain the effects of changes in temperature on the density of solids, liquids, and gases, and relate their findings to the particle model of matter;
7s67 – use appropriate vocabulary, including correct science and technology terminology, to communicate ideas, procedures, and results (e.g., state the boiling and freezing points of water, room temperature, and body temperature in degrees Celsius; correctly use the terms heat conductor and heat insulator);
8s50 – use appropriate vocabulary, including correct science and technology terminology, to communicate ideas, procedures, and results (e.g., use terms such as flow rate, viscosity, compressibility, fluid, density, pneumatics, hydraulics);

### Groupings

Students Working As A Whole Class
Students Working Individually

### Teaching / Learning Strategies

Classifying
Discussion
Prompts

## Assessment

**Part A "Classifying Energy and Matter Using the BLM Prompts"**
**Part B "Discussion of Matter"**

1. When students are prompted to group themselves into the two categories of energy and matter, the teacher should note whether the students know the differences between these two concepts and if they can explain them (i.e.: matter takes up space and has mass).
2. Some discussion questions and answers the teacher may want to consider in order to assess the students' prior knowledge are:
a) How are a book, a puddle, and the air alike? (All forms of matter)
b) How are they different? (They are three different states of matter-solid, liquid, and gas.)
c) When we classify the "mystery matters," how do we know which group they belong in? (Students' responses should include some discussion of particles and density and how these factors relate to the different states of matter.)
d) Can a liquid become a solid or a gas? (Yes. To change the form of matter, listen for responses that include freezing, melting, or boiling.)
3. The anecdotal notes should include the teacher's observations of the students' ability to discuss the questions and answers. This should include the number of students who appear to have some

knowledge on the topic as well as the depth and details of their answers.

### Assessment Strategies
Performance Task
Questions And Answers (oral)

### Assessment Recording Devices
Anecdotal Record

## Teaching / Learning

**Part A: Classifying Energy and Matter Using the BLM Prompts**

1. As a diagnostic tool for assessing the background knowledge of the students, the class will participate in a whole group activity called "Who am I?"
2. Using **blackline master (BLM) 1.1 Game Labels**, each student will receive a label on their back. In order to identify the label they have been given, the students will need to ask members of the class questions that may only be answered with a "yes" or "no" response.
3. Students will then sort themselves (perhaps with some guidance using the prompts: Energy and Matter) into two groupings. After the students have identified the two categories, the class can focus on the topic of matter and further divide this group into three areas, using the prompts: Solids, Liquids, and Gases

**Part B: Discussion of Matter**

A class discussion will follow the classification activity previously outlined. The teacher can use the labels that the students had in the game or make a second set. Once the labels have been sorted and displayed, the students will classify four or more "mystery" substances (i.e., gelatin, sand, ketchup, bubbles) and the teacher can begin to assess their knowledge of the particle theory, density, and how this may change with heating or cooling.

**Part C: Classifying Matter at Home**

The teacher will distribute a notebook to each student in the class. This notebook will become the student's project journal that will be used throughout the unit. As a first assignment, students will demonstrate their knowledge of matter by classifying objects from home.

1. The teacher will distribute a notebook (a duo-tang or folder could be an alternative) to each student. The students will be responsible for maintaining this "project journal" throughout the unit.
2. As an introduction to the project journal, the teacher should briefly describe the culminating task of building a hot tub to the students and explain that during the unit there will be a series of subtasks, activities, and assignments that will prepare them for this final assignment. The project journal will be a resource for the students as they gain the necessary skills for their final design challenge. In addition, the project journal can also be used as a work portfolio for the engineers (students) to gain credibility with their hot tub client (the teacher) by keeping an on-going record of their micro-projects which could be collected at any given time.
3. Students will demonstrate their ability to classify matter by categorizing 15 things in their homes into the three states of matter. (They must find at least two for each category.)
4. Students can record this homework assignment in their project journal as the first entry.

## Adaptations

To support those special needs students who may require support with the organization or synthesis of the information reviewed in this subtask, the teacher may create a worksheet that outlines the three states of matter. Under each category the teacher could include a definition and a few examples.

## Resources

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|---|---|
| **BLM 1.1: Game Labels** | BLM1A1.cwk |
| **Let's Wonder About Science: Solids, Liquids, and Gases** | Patten, J.M. |
| **The Wayland Library of Science and Technology: The Nature of Matter** | Lafferty, Peter |
| **Physical Science for Children: All About Solids, Liquids and Gases** | Library Video Company |

## Notes to Teacher

The teacher determines the students' prior knowledge of energy and matter.

Through observation and discussion, the teacher determines the students' familiarity with the three states of matter (solids, liquids, and gases) and ways to distinguish between these states referring to the notion of particles and density.

Using data collected during initial assessment, the teacher determines any necessary pre-teaching and/or adaptations to expectations for the class as a whole and/or particular individuals.

## Teacher Reflections



## Description

The students will use the particle theory to make predictions and interpret changes in matter. The particle theory will serve as the basis for understanding the behaviour and characteristics (viscosity, density, and buoyancy) of fluids.

## Expectations

7s52 • demonstrate understanding that heat is a result of molecular motion;

7s55 A – distinguish between the concept of temperature and the concept of heat (e.g., temperature is a measure of the average kinetic energy of the molecules in a substance; heat is thermal energy that is transferred from one substance to another);

7s56 A – compare the motions of particles in a solid, a liquid, and a gas using the particle theory;

7s59 A – describe the effect of heating and cooling on the volume of a solid, a liquid, and a gas;

7s61 A – describe the effect of heat on the motion of particles and explain how changes of state occur (e.g., from a liquid into a gas or vapour);

7s67 – use appropriate vocabulary, including correct science and technology terminology, to communicate ideas, procedures, and results (e.g., state the boiling and freezing points of water, room temperature, and body temperature in degrees Celsius; correctly use the terms heat conductor and heat insulator);

7s69 A – communicate the procedures and results of investigations for specific purposes and to specific audiences, using media works, written notes and descriptions, charts, graphs, drawings, and oral presentations (e.g., use a diagram to illustrate convection in a liquid or a gas).

8s41 – explain the effects of changes in temperature on the density of solids, liquids, and gases, and relate their findings to the particle model of matter;

8s42 A – predict the effect of applying external pressure on the behaviour of fluids;

8s50 – use appropriate vocabulary, including correct science and technology terminology, to communicate ideas, procedures, and results (e.g., use terms such as flow rate, viscosity, compressibility, fluid, density, pneumatics, hydraulics);

8s52 A – communicate the procedures and results of investigations for specific purposes and to specific audiences, using media works, written notes and descriptions, charts, graphs, drawings, and oral presentations (e.g., create a table to show the relationship between the buoyant force and size of object);

7s53 • identify, through experimentation, ways in which heat changes substances, and describe how heat is transferred;

8s29 • demonstrate an understanding of the properties (e.g., viscosity) and the buoyant force of fluids;

### Groupings

Students Working As A Whole Class
Students Working In Pairs
Students Working Individually
Students Working In Small Groups

### Teaching / Learning Strategies

Direct Teaching
Improvisation
Experimenting
Learning Log/ Journal

## Assessment

**Part A "A Particle Play"**
The drama and overhead work will provide ample opportunity for questions and answers. The teacher will record information gathered as anecdotal comments.

**Part B "Particle Proof - Investigations"**
Students will record their thinking in their notebooks. While individual teachers may use their own criteria to assess notebooks, a Project Journal Assessment rubric is included.

**Part C "Particle Proof - Demonstrations"**
Students will record their thinking in their notebooks. While individual teachers may use their own criteria to assess notebooks, a Project Journal Assessment rubric is included.

**Part D "Feeling Hot Hot Hot"**
The BLMs that are completed by the students can serve as a type of quiz. The most important questions on each are #3 and #4. Pay careful attention to what students are writing when they use the particle theory to explain their thinking. The Viscosity Rubric is included for evaluation purposes.

**Part E "How Slow Can You Go?"**

8s38 – describe the relationship between the mass, volume, and density of solids, liquids, and gases, using the particle theory;
8s39 A – compare fluids in terms of their compressibility or incompressibility (e.g., gases versus liquids);
7s65 – formulate questions about and identify needs and problems related to heat (e.g., interactions involving energy transfers), and explore possible answers and solutions (e.g., identify the steps that could be followed to test the effectiveness of the heating system in a home that uses solar energy);
7s66 – plan investigations for some of these answers and solutions, identifying variables that need to be held constant to ensure a fair test and identifying criteria for assessing solutions;
7s68 – compile qualitative and quantitative data gathered through investigation in order to record and present results, using diagrams, flow charts, frequency tables, bar graphs, line graphs, and stem-and-leaf plots produced by hand or with a computer (e.g., plot a graph showing the decrease in temperature of various liquids from identical initial temperatures);
8s48 A – formulate questions about and identify needs and problems related to the properties of fluids, and explore possible answers and solutions (e.g., design a fair test to determine whether oil, water, or glycerol

Use a checklist to record understanding as students respond to questions about particle theory and viscosity. The Particle Theory Explanation Rubric is a useful set of criteria for leveling student responses.

**Part F "Soup Can Racers"**
The BLM 2.15 "Calculating Density" will be evaluated on both concept and accuracy. See Density Rubric.

**Part G "It's all Greek to Me"**
Oral questions and answers will serve as the basis for evaluation. Anecdotal records will be kept.

### Assessment Strategies
Questions And Answers (oral)
Learning Log
Response Journal
Quizzes, Tests, Examinations

### Assessment Recording Devices
Anecdotal Record

## Teaching / Learning **Suggested Time: 80 min**

### Part A: A Particle Play

Students will engage in a drama depicting the "lives" of particles. Both volume and heat energy are increased and decreased as students identify their "particle point of view" while moving through the three states of matter. A set of overheads and the creation of a diagram help students record in their project journals what they have experienced in the classroom. This play will act as a mnemonic device throughout the unit.

1. Students will become particles (matter) for the play. The room will act as a container for the particles as they begin to move around the room (See Notes to Teacher for important safety considerations). Begin by asking the students to move around the room on your command. Students should keep moving and try to visit as many places in the room as possible. Have them move for a 10-second interval. Survey students by asking check-up questions such as:
How many areas of the room were you able to get to in the allotted time?
Was it easy to move?
How close are they to other particles?
Do they have enough space to move?

Repeat this again now that all students get the idea. Reduce the space by using your superhuman teacher strength to slowly push two walls in your classroom towards the particles thereby reducing the amount of space the particles have to move (about half the original space). Have the students move about for another 10-second interval. Again ask the check-up questions. Next, push two or three walls to compact the students so that they are pretty much shoulder to shoulder. Allow them another 10 seconds to move. Ask the check-up questions again. This entire process should be reversed as you make the room larger, and then reversed again as you make the room smaller.

2. Students are now informed of an imaginary knob that the teacher will be turning. The knob is connected to a heat source under the floor. Enough heat will be added to bring the temperature of the floor up to 150$^{o}$C.

The students are asked how they will respond. Agreement is reached that they will respond by hopping up and down as the temperature rises. Turn on the imaginary knob. Stop them after a few seconds and comment how they now seem to be taking up more space than before but that is okay because the walls are moveable should they need to be. Ask check-up questions again. Discuss with students how they would respond to still higher temperatures. Now add more heat to bring the temperature up to 250°C and then to 350°C. As always, finish with the check-up Questions. You can now reverse the process as you remove heat to see how the particles perform.

3. Inform the students that all particles of the same substance are attracted to each other. Ask students to suggest items that are attracted to each other (i.e., magnets).

4. Using the overhead projector and transparencies made from BLM 2.1 to BLM 2.7, review what the students did in the classroom. As you add each transparency on top of the previous one, you want to ask questions that are answered on the next transparency (i.e., when **BLM 2.1** is on the projector you would ask what these diagrams represent--our drama--and can students connect them to the states of matter. Which one would be solid, liquid, gas? How do you know? Then set **BLM 2.2** transparency over top of the **BLM 2.1** transparency)

5. Having worked through the transparencies, some follow-up questions about the diagram should be asked to assess the students' understanding. Students either copy the entire diagram into their notebook from the overhead, add the text to **BLM 2.9,** or they are provided with **BLM 2.8**.

## Part B: Particle Proof - Investigations Suggested Time: 60 min

This includes a series of hands-on investigations allowing the students an opportunity to demonstrate and use their acquired knowledge of the particle theory. Students will be able to correctly predict the effect of increasing and decreasing the volume and heat energy.

### Marshmallows

1. You should turn on the electric kettle that has the water in it so that it will be ready when needed. Each pair of students is given a 60 cc syringe. Instruct the students to use the fleshy part of their thumb or finger to seal off the syringe thereby creating a closed system. Introduce the idea that sealing the system and pushing in the plunger compresses the space inside (reducing the volume) and pulling out the plunger increases the space inside (increasing the volume). Hold up a miniature marshmallow and ask students if they know what it is made of. Offer each pair of students two or three miniature marshmallows. Students are to remove the plunger and place a miniature marshmallow into the syringe. Then, have the students carefully replace the plunger leaving the maximum amount of space in the syringe. Before they begin, ask for predictions as to what will happen if they seal off the syringe and push the plunger in. Let them experiment to find out if they were right. Debrief why this outcome occurred (see Notes to Teacher). Next, have students make predictions about what will happen if the amount of space were increased. Remove the first marshmallow and have them insert a fresh marshmallow. This time, set-up the syringe so that there is a minimum of air surrounding the marshmallow before it is sealed with the thumb. By pulling out the plunger students will observe the effect of increasing the amount of volume on the particles of air.

### Liquid versus Gas

2. Students will compare the compressibility of a common liquid (water) and a common gas (air). Again students will seal off their syringes using the fleshy part of their thumbs (see Notes to Teacher).

### Boiling Water in a Syringe

3. **Safety Note: Due to the nature of this investigation, it is to be done as a demonstration. If students participate, they must be careful not to compress the water when they should be**

**increasing the volume. There are also rubber safety caps which can be purchased for the tips of the syringes. These are relatively inexpensive and the rubber seal helps prevent hot water trickling out while setting up.**
Students will consider water boiling in a kettle. Using the particle theory diagram from Part A, they will describe where on the continuum a boiling liquid would be (at the boiling point, identified by B.P. on **BLM 2.8**). Some particles have begun to make the change in state yet others are still to follow. Students are asked to predict what continuous heat energy would eventually do to this water (evaporate all the liquid/boil dry the kettle). What would a reduction of heat energy do? (stop boiling and begin to cool) Unplug the kettle (stop adding heat energy). Using **BLM 2.8**, students are reminded of the move to the right and the small shift to the left (just prior to the boiling point) when the water is removed from the kettle. The big question: Without increasing heat energy, is there another way to shift this water to the right of the boiling point? (yes, by increasing the volume) Ask if a student can think of how.... Remind students what they used earlier to increase volume. Finally, have each pair of students draw out of the boiling water a small amount (10-20cc). Teach them how to carefully bleed out the air so that only hot water remains (see Notes to Teacher for a description of bleeding a syringe). Students must again seal off the end of the syringe and through pulling back on the plunger, they will boil water in the syringe.

Students will record all three investigations in their project journals. For each, they are to include a title, diagram, and an explanation--***using the particle theory***--of what they observed.

**Part C: Particle Proof - Demonstrations** **Suggested Time: 60 min**

This activity includes a series of demonstrations allowing the students an other opportunity to demonstrate and use their knowledge of the particle theory. Using several teacher demonstrations, students will dispell popular misconceptions as they become further aware of the effects of heating and cooling on the three states of matter. These demonstrations include: microwaving water balloons and an imploding can.

**Water Balloons**
1. **Safety Note: Students should be encouraged to not touch the microwave and stay a safe distance back (in case it leaks). Instruct them NOT TO TRY THIS AT HOME! Using a microwaveable plate/dish may make it easier to remove the heated balloon without touching it.**
Set up two identical water balloons (no bigger than grapefruits). Show the class both to be identical. Place one in a microwave. Ask the class for predictions ***using the particle theory*** of what might happen when the balloon in the microwave undergoes two minutes of heating on high power. Microwave on high for approximately two minutes (see notes). Compare the two balloons by holding the other balloon near the one in the microwave. The water balloon in the microwave can be very hot so it is best left to cool without being removed.

**Imploding Can**
2. **Safety Note: As per the Be Safe! document, DO NOT USE alcohol burners, camping stoves, portable bottled gas burners, or hot air paint strippers to heat the can.**
Begin by setting up a 250 mL beaker with 2-3 cm of room temperature water in it. Take an empty pop can and rinse it out. Put 1 cm of water in the bottom of the can and heat it with a heat source (bunsen burner or hot plate). Once the water has boiled for 30 seconds, remove the can with a pair of tongs or oven mitts, invert the can over a container to dispose of the hot water and swiftly drop the can (still inverted) into the beaker with water. The can will either instantly implode or will suck the water up into the can making it appear that the water has vanished.

Students will record all three demonstrations in their project journals. For each, they are to include a diagram and an explanation--using the particle theory--of what they observed.

**IMPORTANT NOTE:**

**Due to the size of this subtask, the remaining four parts of Subtask 2 (Part D to Part G) are included as blackline masters. Listed below are the descriptions and appropriate BLMs that contain the full text of the Teaching/Learning strategies for each part. Teachers should print these and consider them to be a continuation of this section.**

**Part D: Feeling Hot Hot Hot** **Suggested Time: 80 min**

Students will be introduced to the misnomers of heat vs. temperature and mass vs. weight. Students will experiment with liquids as they explore factors affecting the rate of temperature change. The ensuing discussion will identify and explain heat capacity in the states of matter and within our environment.
**The Teaching/Learning strategies for Part D are found on BLM 2.19.**

**Part E: How Slow Can You Go?** **Suggested Time: 80 min**

Revisiting the particle play, students review the liquid state as these particles are asked to "flow." Viscosity is identified and students predict how the addition of heat energy affects the viscosity of a liquid. Students can put their predictions to the test as they are provided the opportunity to "prove it."
**The Teaching/Learning strategies for Part E are found on BLM 2.20.**

**Part F: Soup Can Racers** **Suggested Time: 120 min**

Students take part in a race using various types of soup. If the volume of soup in each can is the same, then why do some cans travel faster than others? Students will be challenged to discover the secret that lies under the lid of the fastest can. Once they get the "scoop on soup," students will be able to identify the concept of density. Further investigations and the creation of a density tower help students apply their knowledge as they choose and explain, either a natural (ocean water vs. fresh water) or unnatural density change in the world around them.
**The Teaching/Learning strategies for Part F are found on BLM 2.21.**

**Part G: It's All Greek to Me** **Suggested Time: 80 min**

The warm-up activity of blowing bubbles into a glass of water will launch this part of the subtask that links density to buoyancy. Students are introduced to the work of Archimedes and the work he did with respect to density and buoyancy. Students will have an opportunity to experiment with foil boats and student-created hydrometers. The relationship between density and buoyancy will be drawn and the connections to the real world context of pools and safety devices (i.e., PFDs) will be made.
**The Teaching/Learning strategies for Part G are found on BLM 2.22.**

## Adaptations

**Part A "A Particle Play"**
Providing a copy of either the template or the diagram is one accommodation for students with special needs.

**Part B "Particle Proof - Investigations"**
The boiling water in a syringe should be performed as a teacher demonstration for students who have fine motor challenges.

**Part C "Particle Proof - Demonstrations"**
Having students with special needs focus on the demonstrations and less on the notetaking should help them better remember and understand the concept. Photocopying another student's notes can be very helpful.

**Part D "Feeling Hot Hot Hot"**
Heat capacity is perhaps one of the hardest concepts for students with special needs to grasp. Multiple

analogies will help strengthen understanding.

**Part E "How Slow Can You Go?"**
Pair special needs students with peers who will offer support during this investigation.

**Part F "Soup Can Racers"**
Pair special needs students with peers who will offer support during this investigation.

**Part G "It's All Greek to Me"**
Provide special needs students with pencils that already have a scale on them.

## Resources

| | |
|---|---|
| **Project Journal Assessment** | |
| **Viscosity Rubric** | |
| **Density Rubric** | |
| **BLM 2.1: Transparency #1** | BLM2A1.cwk |
| **BLM 2.2: Transparency #2** | BLM2A2.cwk |
| **BLM 2.3: Transparency #3** | BLM2A3.cwk |
| **BLM 2.4: Transparency #4** | BLM2A4.cwk |
| **BLM 2.5: Transparency #5** | BLM2A5.cwk |
| **BLM 2.6: Transparency #6** | BLM2A6.cwk |
| **BLM 2.7: Transparency #7** | BLM2A7.cwk |
| **BLM 2.8: Particle Theory (complete)** | BLM2A8.cwk |
| **BLM 2.9: Particle Theory (student template)** | BLM2A9.cwk |
| **BLM 2.10: Rate of Temperature Change** | BLM2D1.cwk |
| **BLM 2.11: Heat Capacity** | BLM2D2.cwk |
| **BLM 2.12: As Slow as...Molasses** | BLM2E1.cwk |
| **BLM 2.13: Homework Investigation, Viscosity** | BLM2E2.cwk |
| **BLM 2.14: Soup Can Racers** | BLM2F1.cwk |
| **BLM 2.15: Calculating Density** | BLM2F2.cwk |
| **BLM 2.16: Density Changes** | BLM2F3.cwk |

| | |
|---|---|
| **BLM 2.17: Pencil Hydrometers** | BLM2G1.cwk |
| **BLM 2.18: Buoyancy** | BLM2G2.cwk |
| **BLM 2.19: Teaching / Learning Part D** | BLM2D.cwk |
| **BLM 2.20: Teaching / Learning Part E** | BLM2E.cwk |
| **BLM 2.21: Teaching / Learning Part F** | BLM2F.cwk |
| **BLM 2.22: Teaching / Learning Part G** | BLM2G.cwk |
| **Be Safe! Ontario Edition** | Science Teachers' Association of Ontario |
| **Second Voyage of the Mimi Expedition#4 "The Incredible Shrinking Head"** | Sunburst Communications |
| **mini marshmallows** | 3 or more/student |
| **liquids of varying viscosities** | |
| **various cans of soup (same volume/size)** | |
| **washers, nuts, bolts, or screws** | 10 |
| **graduated cylinders (plastic)** | 1 |
| **hot water** | |
| **cold water** | |
| **ice** | |
| **molasses** | |
| **modelling clay** | |
| **syringes** | 60cc. |
| **electric kettle** | 1 |
| **syringe plugs** | |
| **beakers** | |
| **hot plates** | 1 |
| **thermometers** | |
| **inclined planes** | |
| **ruler/metre stick** | |

| | |
|---|---|
| **Triple Beam Balance** | 1 |
| **clear plastic cups** | 1 |
| **straws** | 1 |
| **buckets** | 6 |
| **exercise hoops** | 1 |
| **rubber caps for syringes** | 1 |

## Notes to Teacher

**Part A "A Particle Play"**

**Safety Note:** Areas such as the gymnasium or outdoors not only provides for a larger physical area to complete the play, but it can help students connect their science classes to other curricula. For the safest classroom environment, the floor area should be relatively free of objects such as wastebaskets, student backpacks, and chairs. It is a good idea to have the students store their backpacks under their tables and then ask them to push in their chairs and stand behind them. Students should also be given instructions about the manner that they will be moving around the classroom. No running, pushing, or touching anything/anybody.

As the students work through the drama, pay careful attention to the way they move as you slide the walls of the class together, and how they answer your check-up questions.

Later, as you work through the set of overheads, you will need to help the students make the jump from using the word 'space' to 'volume.' Additionally you will also help them begin to use 'heat energy' and 'temperature' correctly. You can introduce the idea of kinetic energy. '**B.P**.' stands for Boiling Point and '**F.P**.' stands for Freezing Point. When questioning the students' understanding, it needs to be stressed that although the diagram appears to have only three places that matter can exist, it is really more of a continuum. There are infinite places on the continuum where particles might find themselves (within and in between the boxes). It should also be stressed that increasing heat energy and volume moves a substance to the right on the continuum whereas decreasing volume and heat energy moves a substance to the left on the continuum. Changing heat energy or volume enough could lead to a change in state.

When using the transparencies you may want to make the 'Particle Theory Diagram (complete)' into a transparency and then use this as transparency #8. The advantage of this is that the stack of seven transparencies becomes difficult to read due to their thickness.

**Timesaver Tip:** Providing students with a copy of the template or completed diagram will require considerably less time than having them copy their own.

**Part B "Particle Proof - Investigations"**

**Timesaver Tip:** You may choose to do only two of the three investigations if time does not allow for all of them.

### Marshmallows

Smaller syringes will also work but larger ones are better.

The marshmallow will shrink in the syringe when the syringe is compressed. Closer observation shows marshmallows as having air pockets in them. This air is a gas and the air particles are fairly far apart (like in Part A). There is quite a bit of space between the air particles and they can be squished together rather easily. This is the same reason why gases are compressible. The marshmallow goo simply envelopes the air pockets and along with the air, gets squished together (appears to shrink). If you would like to view an excellent video of this same idea, watch ***Expedition #4 The Incredible Shrinking Head*** from ***The Second Voyage of the Mimi*** series. In this video, an extruded polystyrene head among other items is placed into a hyperbaric chamber.

### Liquid Versus Gas

Remind students that using the syringes as squirt guns is not allowed. The idea of using the fleshy part of your thumb to seal the syringe works quite well. By simply pressing on the tip of the syringe with your thumb, you can create a very good seal. If your school has access to syringe caps then this is even better. They are rather inexpensive and invaluable. If using a rubber cap, students should still use their thumbs or fingers to hold the cap in place.

### Boiling Water in a Syringe

**Safety Note:** Due to the nature of this investigation this must be done as a demonstration. If students participate, they must be careful not to compress the water when they should be increasing the volume.

There are also rubber safety caps which can be purchased for the tips of the syringes. These are relatively inexpensive and the rubber seal helps prevent hot water trickling out while setting up.
The "bleeding out" of a syringe describes the process of filling a syringe up with a liquid and then getting all the air pockets (bubbles) out. Simply take a syringe with plunger pressed completely in and place the tip into a liquid. Pull back on the plunger while keeping the tip of the syringe submerged. Fill the syringe with a little more than the desired amount of liquid. Remove the syringe from the liquid and hold it so that the tip is pointing up and the body of the syringe is on a 70$^{o}$ to 80$^{o}$ angle from the floor. Tap the side of the syringe to move air bubbles to the tip of the syringe. CAREFULLY and SLOWLY compress the syringe to squeeze just the air out of the syringe. A little of the liquid trickling out is normal. Exercise caution if the liquid is hot or dangerous.

**Part C "Particle Proof - Demonstrations"**

**Water Balloons**

**Safety Note:** It is best to **try this out ahead of time** because there are many variables the least of which is the power of the microwave. The point of this demonstration is to show thermal expansion. When there is a noticeable difference between the two balloons, it is time to stop.

**Imploding Can**

This demonstration is a memorable one for teachers and students.
Finding the right tongs is something that should be done ahead of time. You may have to bend a cheaper pair or use oven mitts instead.

**Part D "Feeling Hot Hot Hot"**

This activity demonstrates the subjectiveness of describing things as hot, warm, or cold. It helps students realize the need for a quantitative measurement of how hot something is. The data collected in the BLMs can easily be assigned as a graphing assignment with temperature and time on the axes.

**Safety Notes:**

**1. Cautiously set up the warm water so as not to injure or scald anyone. Students may have a lower tolerance for warm water, so err on the side of caution.**

**2. Oil can reach very high temperatures very quickly. An appropriate thermometer that can withstand the high temperatures must be used. Keep a close eye on the oil and exercise extreme caution when working near the oil. After identifying that the oil reaches temperatures near 100$^{o}$C, turn off the heat source to allow the oil to cool. DO NOT attempt to move it until it has returned to room temperature. Be sure to have a fire extinguisher and fire blanket nearby. Use this opportunity to review fire safety routines with the class.**

**Background**

The three temperature scales listed in the Teaching/Learning Strategies are the Celsius, Fahrenheit, and Kelvin scales. The Celsius scale is based upon the boiling and freezing points of water. The range between these has been divided into 100 equal intervals. This is why some people and texts refer to the Celsius scale as centigrade. The Fahrenheit scale has the same range divided into 180 equal intervals. The Kelvin scale has the same magnitude as does the Celsius scale but the two temperatures differ by 273.15 degrees.
Below is a comparison of the three scales:

| | | | |
|---|---|---|---|
| **Boiling point of water..............................** | **373.15$^{o}$K..................** | **100$^{o}$C........................** | **212F** |
| **Normal body temperature (human)....** | **310.15$^{o}$K..................** | **37$^{o}$C........................** | **98.6$^{o}$F** |
| **Freezing point of water.........................** | **273.15$^{o}$K..................** | **0$^{o}$C.......................** | **32$^{o}$F** |
| **Absolute Zero........................................** | **0$^{o}$K.................** | **-273.15$^{o}$C..................** | **-459.67$^{o}$F** |

**Part E "How Slow Can You Go?"**

1. Set up the inclined plane as a demonstration for the class. By using syringes you can attain equal amounts of liquids and dispensing them in a fair manner becomes much easier using syringes. Suggested liquids are corn syrup, milk, tomato soup, water, tea, honey, oil. The ramp that you will use can be

improvised from a cutting board or even a classroom shelf.
2. For the experiment have on hand: molasses, hot water, cold water, ice, test tubes, syringes, inclined plane, and beakers.

**Part F "Soup Can Racers"**
Suggested size of soup can is the standard 284 mL. Any flavour of soup works well. Bean with bacon tends to be very fast. Using elastics or tape around the ends can help the cans run straighter. Some type of release mechanism like a metre stick or large book ensures a fair start. The longer the inclined plane, the more obvious the results will be.
If there are a limited number of balances, then the massing of the soup cans may be done as a demonstration by calling individuals up to the front to find the mass of their team's can.

**Part G "It's all Greek to Me"**
The masses used in the aluminum boat challenge can be everything from coins to washers, to weights. The liquids used with **BLM 2.17** could include: glycerin, oil, water, a saturated solution of salt water, corn syrup, maple syrup, juice, rubbing alcohol, or sunscreen.

## Teacher Reflections

## Description

In this subtask, students will utilize their skills of inquiry and analysis to investigate the various forms of heat transfer (i.e., conduction, convection, and radiation). Through hands-on experimentation and problem-solving situations, students will discover that heat is transferred differently through particles of various substances. This knowledge of heat exchange will enable the students to make decisions about heating systems in their culminating task.

## Expectations

7s53 A • identify, through experimentation, ways in which heat changes substances, and describe how heat is transferred;

7s57 A – explain how heat is transmitted by conduction, convection, and radiation in solids, liquids, and gases (e.g., conduction: a pot heating on a stove; convection: a liquid heating in the pot; radiation: the air being warmed by heat from the element);

7s58 A – describe how various surfaces absorb radiant heat;

7s65 A – formulate questions about and identify needs and problems related to heat (e.g., interactions involving energy transfers), and explore possible answers and solutions (e.g., identify the steps that could be followed to test the effectiveness of the heating system in a home that uses solar energy);

7s66 – plan investigations for some of these answers and solutions, identifying variables that need to be held constant to ensure a fair test and identifying criteria for assessing solutions;

7s67 A – use appropriate vocabulary, including correct science and technology terminology, to communicate ideas, procedures, and results (e.g., state the boiling and freezing points of water, room temperature, and body temperature in degrees Celsius; correctly use the terms heat conductor and heat insulator);

7s68 A – compile qualitative and quantitative data gathered through investigation in order to record and present results, using diagrams, flow charts, frequency tables, bar graphs, line graphs, and stem-and-leaf plots produced by hand or with a computer (e.g., plot a graph showing the decrease in temperature of various liquids from identical initial temperatures);

7s69 A – communicate the procedures and results of investigations for specific purposes and to specific audiences, using media works, written notes and descriptions, charts, graphs, drawings, and oral presentations (e.g., use a diagram to illustrate convection in a liquid or a gas).

7s73 A – identify different forms of energy that can be transformed into heat energy (e.g., mechanical, chemical, nuclear, or electrical energy);

7s76 – explain why heat energy is considered to be the final or end form of energy transformation;

7s78 A – identify and describe steps that can be taken to conserve energy (e.g., using insulation) and the

### Groupings

Students Working In Small Groups
Students Working Individually
Students Working In Pairs

### Teaching / Learning Strategies

Experimenting
Inquiry
Technology
Learning Centres

## Assessment

**Part A "Convection Connection"**

The students will have plenty of opportunities to demonstrate their understanding of basic concepts through the observation and conclusion questions in BLM 3.1. (Use Investigation Assessment rubric).

**Part B "Conduction Craze"**

As the students rotate through the centres, the teacher will make observations using the Investigation Assessment rubric. The first three activities give the students opportunities to demonstrate their understanding of heat transfer and to communicate their knowledge of the material through graphing and writing activities. The fourth centre, "Thought Experiments" (BLM 3.5), will provide the teacher with assessment data for the fourth category on the rubric, which is relating science and technology to the world outside of the class.

**Part C "Reacting to Radiation"**

Once again this activity provides the teacher with opportunities to assess the understanding of knowledge and the communication of required information using the Investigation Assessment rubric.

reasons for doing so (e.g., rising fuel costs);

7s79 A – identify the components of a system that are designed to transfer heat energy (e.g., in a room, a house, or a shopping centre) and describe methods for conserving energy within that system.

8s50 A – use appropriate vocabulary, including correct science and technology terminology, to communicate ideas, procedures, and results (e.g., use terms such as flow rate, viscosity, compressibility, fluid, density, pneumatics, hydraulics);

8s51 A – compile qualitative and quantitative data gathered through investigation in order to record and present results, using diagrams, flow charts, frequency tables, graphs, and stem-and-leaf plots produced by hand or with a computer (e.g., accurately measure and record the density of different liquids using a hydrometer);

8s52 A – communicate the procedures and results of investigations for specific purposes and to specific audiences, using media works, written notes and descriptions, charts, graphs, drawings, and oral presentations (e.g., create a table to show the relationship between the buoyant force and size of object);

**Part D "Household Heating Systems "**
In this activity, the teacher will use a checklist (BLM 3.9) to assess the students understanding of the concepts.

### Assessment Strategies
Observation
Learning Log
Questions And Answers (oral)

### Assessment Recording Devices
Checklist
Rubric

## Teaching / Learning

**Part A: Convection Connection** **Suggested Time: 40 min**

Students will explore convection as the transfer of heat energy in the movement of particles. An important consideration is that this movement or exchange of heat energy usually occurs in gases and liquids. The students will visualize, through investigation, convection columns or cells when heat is applied to a soap, water, and dye solution.

1. Briefly review with the class a few points from Subtask 2 regarding the particle theory. For example, the teacher may ask, "What happens to the particles in a liquid as heat is added?" "What happens to the density of the liquid as heat is added?" The students should understand that the particles move and vibrate, thus the space in between the particles increases and the liquid becomes less dense.
2. Organize students into groups of four to conduct the investigation.
3. Distribute copies of **BLM 3.1** to all students.
4. Read the problem orally with the class and discuss its meaning.
5. Students will complete the hypothesis section of the handout explaining how the convection cells will travel if they feel that they will be able to visualize this motion.
6. Have the students conduct the investigation in their groups of four.

**Safety Note: Remember that as a precaution, the students must wear safety goggles. Students will also need to be careful using the hot plates.**

7. As the students complete the procedure, the teacher will guide them through the things to look for to complete the observations section of the sheet (see subtask notes).
8. After cleanup has taken place, the students will complete the conclusion and application portions of the investigation. The students should be encouraged to elaborate their thoughts on the questions and reflect upon them in their project journal.

**Part B: Conduction Craze** **Suggested Time: 80 min**

In this activity, students will conceptualize that conduction is the transfer of heat energy from atom to atom within a particular substance. Some substances such as copper, silver, and steel will conduct heat energy much more effectively than other substances such as wood, paper, and extruded polystyrene. Through a series of centres, the students will investigate different substances and compare their ability to conduct heat.

1. On the blackboard, the teacher will create a T-chart. On one side of the T-chart have the students list examples of materials they think will conduct heat well and on the other side have them list materials they think will not conduct heat very well. Later, the teacher can label them as conductors and insulators. This will serve as an advance organizer for the students as they visit each of the activity centres.
2. Separate students into four equal-sized groups for rotating through the centres that will be set up throughout the class.
3. Give each student copies of **BLM 3.2** to **BLM 3.5** to complete as they visit each centre.
4. Review safety considerations for the activities, particularly those that deal with heat sources.

**Safety Note: The students must be reminded of the dangers of using boiling hot water. Caution needs to be taken when pouring the boiling hot water from the kettle. Students should also be wearing safety goggles for eye protection.**

5. Students should be given approximately 20 minutes at each centre and they should be reminded to carry a pencil with them so that they can complete the observations and conclusions for each investigation as they are working.
6. After students have visited each of the centres, the teacher will have the students return to their seats and will hold a general discussion about some of the concepts that the students dealt with during the activity.
7. Unfinished work and the line graph for **BLM 3.4** will be given as a homework assignment.

**Part C: Reacting to Radiation** **Suggested Time: 60 min**

Radiation involves the movement of heat energy as waves, such as infrared or ultraviolet waves from the sun. This movement travels in all directions and can move through solids, liquids, gases, and even space. The students will explore this form of heat energy transmission by conducting an investigation to determine the radiant energy transfer in solids and liquids and how various colours help absorb this radiant energy.

1. The teacher reviews the difference between conduction and convection heat transfer (i.e., conduction is the actual transfer of heat through the kinetic energy or movement of atoms in one substance to another, while convection is the movement of the particles in cells or columns in a particular substance, usually liquids or gas).
2. The teacher has a lamp with a 60 or 100 W bulb in the class that is plugged in and turned on.

**Safety Note: The students should be warned not to touch the lamp or put any flammable materials near the lamp.**

3. The teacher invites a student volunteer to put their hand to the side of the bulb, but not touch it. The student should be able to feel the heat from the lamp. The teacher asks the students if this is an example of convection or conduction. Some students may respond that the air is conducting heat from the lamp. The teacher should respond by telling the students that conduction usually involves the movement of atoms in solid substances. It can't be convection because that is fluid motion in columns or cells that rise up. Therefore, it must be radiant energy. The teacher tells the students that they will be investigating radiant energy transfer in today's experimentation.
4. Distribute copies of **BLM 3.6** to all students.
5. Have the students conduct the investigation in groups of four ensuring that safety precautions are being followed.
6. After cleanup has taken place, the students will complete the conclusion and application portions of the investigation. The graph can be assigned as homework. The students will also be expected to complete their project journal and write their thoughts about radiant energy.

**Part D: Household Heating Systems** **Suggested Time: 40 min**

Using **BLM 3.7** and **BLM 3.8**, the students will have the opportunity to analyse a model of a house and determine different types of heat transfer within it. The students will identify the components of the system (model) that are important for heat transfer (e.g., duct work, furnace, insulation, etc.)

1. The teacher discusses with the students how homes retain their heat. The teacher may ask questions like, "What kinds of heating systems are there in houses?" "How can homes be made to be more energy efficient?" "What materials are used in houses that make them more energy efficient?" The teacher could also take this opportunity to discuss with students how and why heat energy is the final or end form of energy transformation since the energy is eventually lost through the movement of particles.
2. After the discussion, the students will be given a copy of **BLM 3.7** and **BLM 3.8**.
3. The students will work with a partner and they will analyse the model home on **BLM 3.7**. The students are to look for different types of heat transfer in the home. An example of something the teacher may point out is that the furnace (forced-air gas) is on the second floor. Why would it be put there? What advantage is there to having the rock bed under the solarium on the north side of the house?
4. Then the students will complete the questions on **BLM 3.8**. Each student is to complete their own sheet after discussion with their partner.
5. The teacher can use the checklist **BLM 3.9** as an assessment tool for addressing some of the expectations for heat transfer.

## Adaptations

1. The teacher may choose to do some of the investigations as demonstrations for students with fine motor challenges.

2. Students with learning disabilities could use a tape recorder as an accommodation to do their observations, conclusions, and the application sections of the investigations rather than writing and drawing what they see.

3. ESL students should be paired or grouped with students who have strong language and communication skills to help demonstrate some of the key concepts through the demonstration of the investigation.

4. Discuss with special education staff, individual student needs and any other accommodations that may need to be provided for particular students.

5. Use the Teacher Companion section of the Ontario Curriculum Planner for other accommodations for students with particular exceptionalities.

## Resources

**Investigation Assessment**

| | |
|---|---|
| **BLM 3.1: Convection Connection** | BLM3A1.cwk |
| **BLM 3.2: Conduction Craze: Marshmallow Madness** | BLM3B1.cwk |
| **BLM 3.3: Conduction Craze: An "Ice"olated Incident** | BLM3B2.cwk |
| **BLM 3.4: Conduction Craze: Ice Savers** | BLM3B3.cwk |
| **BLM 3.5: Conduction Craze: Thought Experiments** | BLM3B4.cwk |

| | |
|---|---|
| **BLM 3.6: Reacting to Radiation** | BLM3C1.cwk |
| **BLM 3.7: The Energy Efficient Home** | BLM3D1.pdf |
| **BLM 3.8: Household Heating Systems** | BLM3D2.cwk |
| **BLM 3.9: Expectation Checklist** | BLM3D3.cwk |
| **It's Canada** | |
| **aluminum pie-pan** | 1 |
| **water** | |
| **dye** | |
| **liquid hand soap or shampoo** | 1 |
| **20 cm pieces of wood** | 1 |
| **20 cm glass rods** | 1 |
| **20 cm pieces of plastic** | 1 |
| **20 cm pieces of metal** | 1 |
| **large marshmallows** | 5 |
| **steel wool** | 1 pkg |
| **ice** | 1 bag |
| **extruded polystyrene cups** | 1 |
| **plastic cups** | 1 |
| **paper cups** | 1 |
| **construction paper** | |
| **sand** | |
| **gluesticks** | 1 |
| **safety goggles** | 1 |
| **hot plates** | 1 |
| **kettle** | 1 |
| **250 mL beakers** | 4 |

## Bubbles in the Hot Tub

220 mins

| | |
|---|---|
| **test tubes** | 1 |
| **candles** | 1 |
| **barbecue igniter** | 1 |
| **graduated cylinders 50 mL** | 3 |
| **stopwatches** | 1 |
| **graduated cylinders 100 mL** | 6 |
| **thermometers** | 6 |
| **scissors** | 1 |

## Notes to Teacher

**Part A "Convection Connection"**

This investigation can also be done as a demonstration by the teacher with help from volunteers, if there are not enough materials or apparatus. As the solution boils, the pearly metallic appearance disappears because the particles of the shampoo are less dense, so they "boil off" sooner than the more dense water particles. The dye is added to the solution so that the convection columns or cells are more visible. This investigation works best with hot plates that have coil elements rather than flat ceramic elements because the direct heat transfer from the coils is more visible at the bottom of the pie-pans. The important teaching point regarding convection is that the movement in columns or cells is the transfer of heat energy as the heated liquid moves from one location to another. This can be related to the students' prior knowledge of the particle theory.

**Safety Note: Remember that, as a precaution, the students must wear safety goggles. Students will also need to be careful using the hot plates.**

**Part B "Conduction Craze"**

The teacher should have the materials set up in four distinctive areas of the classroom. Activities two and four involve ice (water), so setting up with a sink nearby may be a consideration.

**Activity 1.** Students should realize that the metal skewer conducts the heat most effectively, therefore it may be too hot to hold. The marshmallow on the metal skewer should slide down if it conducts the most heat. The plastic also conducts the heat and the particles will likely separate more quickly causing the material to become less rigid. The wood does not conduct the heat well, therefore it would likely be a good choice for the marshmallow toasters.

Conduction, therefore, is the transfer of heat energy when two or more substances are in contact with each other.

**Safety Note: The students must be reminded of the dangers of using boiling hot water. Caution needs to be taken when pouring the boiling hot water from the kettle. Students should also be wearing safety goggles for eye protection.**

**Activity 2.** To promote the safe handling of materials, teachers should have the students clamp the test tube on a retort stand. The glass test tube is not an effective conductor of the heat energy, so the test tube does not heat up at the bottom, therefore the ice remains in the bottom of the test tube. If students were to use cotton balls instead of steel wool, the ice would likely still remain.

**Activity 3.** The extruded polystyrene should be the cup that keeps the ice the longest and should be the material that most students select as being the best insulator. The teacher may raise concerns and hold a discussion about the use of extruded polystyrene and the environmental concerns about non-biodegradable materials. Perhaps, extruded polystyrene may not be the best choice.

**Activity 4.** Encourage the students to elaborate their thoughts on these topics and to relate them to their prior knowledge from previous activities.

A. The brick conducts the radiant heat from the sun more effectively than the vinyl siding. It may remain warm for a few hours.

B. The metal hand shovel and the plastic hand grips of the pruning shears would be the same temperature, but the metal is a good conductor and it would feel colder to the hand than the plastic.

C. The ice buildup is not good for the efficiency of the freezer. The ice serves as an insulator and the freezer cooling unit has to work harder to keep the freezer at a constant temperature.

D. The concrete floor is transferring heat away from the person. The neighbour could put electric heater coils into the concrete (this would be expensive) or they could build a subfloor.

**Part C "Reacting to Radiation"**

As a variation, the teacher may use alternate substances such as sugar or salt for the solid particles. It is important to have a sunny day to do this investigation otherwise the amount of radiant energy that can be measured will be negligible. As an alternative, the teacher may choose to use heat lamps if the weather does not cooperate.

**Safety Note: The students should be warned not to touch the lamp or put any flammable materials near the lamp.**

**Part D "Household Heating Systems"**
Discussion Guidelines: Homes will retain their heat more effectively if properly insulated. Building codes in different regions regulate the insulation factors that are to be achieved in new homes. Also, homes may have improved windows and doors that make the home more energy efficient. Homes may have gas, oil, electric, coal, or wood heating systems. Heat energy is considered the final or end form of heat transfer. The website listed under resources, www.its-canada.com/reed, provides some great floorplans and energy-efficient designs that take all types of heat transfer into consideration.

## Teacher Reflections



40 mins

## Description

Students will observe a demonstration that simulates the water cycle. The class will record their observations and relate them to the transfer of heat energy. A set of discussion points will enable students to associate this topic with their prior knowledge of the particle theory and density. As an extension, they will explore other natural changes of state.

## Expectations

7s67 A – use appropriate vocabulary, including correct science and technology terminology, to communicate ideas, procedures, and results (e.g., state the boiling and freezing points of water, room temperature, and body temperature in degrees Celsius; correctly use the terms heat conductor and heat insulator);

7s69 – communicate the procedures and results of investigations for specific purposes and to specific audiences, using media works, written notes and descriptions, charts, graphs, drawings, and oral presentations (e.g., use a diagram to illustrate convection in a liquid or a gas).

7s70 – recognize heat as a necessity for the survival of plants and animals;

7s71 – explain how the heating and cooling of the earth's surface produces air movement that results in all weather effects (e.g., convection currents);

7s72 A – describe the water cycle as a process of energy transfer involving convection and radiation;

7s75 – describe and explain issues related to heat pollution, including both positive and negative aspects (e.g., industrial processes and generation of electricity cause heat pollution of large bodies of water);

8s50 – use appropriate vocabulary, including correct science and technology terminology, to communicate ideas, procedures, and results (e.g., use terms such as flow rate, viscosity, compressibility, fluid, density, pneumatics, hydraulics);

8s52 – communicate the procedures and results of investigations for specific purposes and to specific audiences, using media works, written notes and descriptions, charts, graphs, drawings, and oral presentations (e.g., create a table to show the relationship between the buoyant force and size of object);

8s55 A – describe situations in which the density of a substance changes naturally (e.g., molten lava as it cools; air when mirages form) or is intentionally altered (e.g., air in a hot-air balloon; cream when it is churned and cooled);

### Groupings

Students Working As A Whole Class
Students Working In Pairs

### Teaching / Learning Strategies

Demonstration
Learning Log/ Journal
Think / Pair / Share

## Assessment

**Part B: "Think/Pair/Share Some Thoughts About the Water Cycle"**

1. Students will record their observations of the demonstration using the appropriate science terminology. (The teacher should use the vocabulary that the students are to be recording in their project journals.)
2. Students will describe the water cycle as a process of energy transfer.
3. Students should exhibit an ability to relate the demonstration in class to the water cycle as it occurs naturally in the environment (i.e., electical heat in the kettle relates to the heat energy from the sun) as well as reflect on other naturally occurring changes in density.

### Assessment Strategies

Learning Log

### Assessment Recording Devices

Rating Scale

## Teaching / Learning

**Part A: Demonstrate Raining in Class**

**Safety Note: Teachers are reminded to exercise caution when handling water or water vapour at a high temperature.**

Using a kettle with boiling water, a baking pan with ice, an empty pie plate, and **BLM 4.1**, the teacher will demonstrate the water cycle. Setup the materials as described below and shown in **BLM 4.1**.

1. Bring water to a boil so the water vapour is rising.
2. Hold the baking tin with the ice above the water vapour and on a slight angle.
3. Place the pie plate under the lower end of the baking tin.
4. Students will record their observations in their project journal.

**Part B: Think/Pair/Share SomeThoughts About the Water Cycle**

Students will independently respond to the following points in their project journal then share their responses first with a partner and then with the whole group.

1. Reflect on the water cycle as a process of energy transfer that involves convection and radiation. (How is liquid water transformed into a gas and back into liquid water?)
2. Compare this demonstration to the natural environment. Draw the water cycle. Reflect on how weather patterns are created (i.e., how the heating and cooling of the Earth's surface produces air movement). What effect does pollution have on this natural cycle?
3. What if the sun wasn't there? Would the same cycle still exist? What would happen to plants and animals?
4. Are there other situations in which the density of substance changes naturally? (Molten lava as it cools; air when mirages form.)
5. How does the water cycle relate to the particle theory?

## Adaptations

The teacher could provide a template of the demonstration and the water cycle for the special needs students who would benefit from the support of a visual aid. The vocabulary could be listed and the students could match the words to the pictures provided.

## Resources

 **BLM 4.1 Water Cycle Setup** — BLM4A1.cwk

 **The Amazing Water Book** — Seed, Deborah

 **Bill Nye The Science Guy "Water Cycle/Oceanography"** — Magic Lantern Communications

## Notes to Teacher

Teachers may look for connections to the grade 8 water systems expectations.

This subtask could be eliminated if the teacher is concerned about condensing the time spent completing this unit particularly if the expectations are being explored in another unit of study.

In Part A, "Demonstrating Raining in Class," students should be observing and recording the process of changing water from a liquid (in the kettle) to a gas (the steam/water vapour) which is called evaporation. In addition, the students should note the change of the gas (water vapour) back into a liquid, as the water vapour cools when it touches the pan of ice. The students should record this change as condensation.

Are there any gaps in students' ability to record their observations and reflections using the appropriate vocabulary and what is being expected in the assessment scale?

Can the students, independently, make the connections between the demonstration in class and the natural environment through the Think/Pair/Share process, or is more guidance required?

## Teacher Reflections

# Technological Treats
**Subtask 5**

## Bubbles in the Hot Tub
**A Guide to Getting In and Out of Hot Water** **An Integrated Unit for Grade 7/8** **380 mins**

## Description
The students will gain an understanding of the operations of hydraulic and pneumatic systems and their applications in the real world. This new knowledge will then be used by the students to construct a hydraulic or pneumatic toy that could be used by younger children. To apply their understanding of insulators and conductors, the pupils will construct an insulated container that will minimize heat transfer.

## Expectations
8s47 – design and construct a model of a common device that uses pneumatic or hydraulic systems (e.g., dentist's chair, automobile hoist);

8s48 – formulate questions about and identify needs and problems related to the properties of fluids, and explore possible answers and solutions (e.g., design a fair test to determine whether oil, water, or glycerol has the greatest viscosity);

8s49 – plan investigations for some of these answers and solutions, identifying variables that need to be held constant to ensure a fair test and identifying criteria for assessing solutions;

8s50 – use appropriate vocabulary, including correct science and technology terminology, to communicate ideas, procedures, and results (e.g., use terms such as flow rate, viscosity, compressibility, fluid, density, pneumatics, hydraulics);

8s51 A – compile qualitative and quantitative data gathered through investigation in order to record and present results, using diagrams, flow charts, frequency tables, graphs, and stem-and-leaf plots produced by hand or with a computer (e.g., accurately measure and record the density of different liquids using a hydrometer);

8s52 – communicate the procedures and results of investigations for specific purposes and to specific audiences, using media works, written notes and descriptions, charts, graphs, drawings, and oral presentations (e.g., create a table to show the relationship between the buoyant force and size of object);

8s57 – compare the way fluids function in living things with the way they function in manufactured devices (e.g., compare the human circulatory system and a fuel pump);

8s59 – describe some effects of technological innovations related to hydraulics and pneumatics (e.g., getting water from a tap rather than a well results in a reduced need for manual labour; using automatic transmissions rather than mechanical linkages results in greater efficiency);

8s61 – identify industries in which the principles of fluid dynamics play a central role (e.g., aeronautics, shipping).

7s53 • identify, through experimentation, ways in which heat changes substances, and describe how heat is transferred;

### Groupings
Students Working As A Whole Class
Students Working In Pairs
Students Working In Small Groups
Students Working Individually

### Teaching / Learning Strategies
Field Trip
Map Making
Demonstration
Discussion

## Assessment
**Part A "Hydraulics vs. Pneumatics: A Compressing Situation"**
The teacher will use the Project Journal Assessment rubric from subtask 2 to assess the work the students have completed on hydraulics and pneumatics. The Venn diagram and notes will allow the teacher to assess the students' understanding of basic concepts and communication of required knowledge.

**Part B "A Trip to the Boiler Room"**
Once again the teacher may choose to use the Project Journal Assessment rubric for this activity.

**Part C "Keep the Heat"**
There is a rubric designed for this activity titled "Assessment of Design Activities." The teacher will assess the students' performance on inquiry and design skills, communication of required knowledge, and relating science to the world outside the school. At the conclusion of the design activity, the students will also be expected to complete a self-assessment. The self-assessment will include a rating scale for the students to use to reflect upon their own learning experience in this subtask.

**Part D "Design and Do: Making a**

| | |
|---|---|
| 7s54 | • explain how the characteristics and properties of heat can be used, and identify the effect of some of these applications on products, systems, and living things in the natural and human-made environments. |
| 7s63 | – identify systems that are controlled by sensory inputs and feedbacks (e.g., a thermostat); |
| 7s64 A | – design and build a device that minimizes energy transfer (e.g., an incubator, a Thermos flask). |
| 7s65 A | – formulate questions about and identify needs and problems related to heat (e.g., interactions involving energy transfers), and explore possible answers and solutions (e.g., identify the steps that could be followed to test the effectiveness of the heating system in a home that uses solar energy); |
| 7s66 | – plan investigations for some of these answers and solutions, identifying variables that need to be held constant to ensure a fair test and identifying criteria for assessing solutions; |
| 7s67 | – use appropriate vocabulary, including correct science and technology terminology, to communicate ideas, procedures, and results (e.g., state the boiling and freezing points of water, room temperature, and body temperature in degrees Celsius; correctly use the terms heat conductor and heat insulator); |
| 7s68 | – compile qualitative and quantitative data gathered |

**Hydraulic or Pneumatic Device"**
There is a rubric designed for this activity titled "Assessment of Design Activities." The teacher will assess the students' performance on inquiry and design skills, communication of required knowledge, and relating science to the world outside the school. At the conclusion of the design activity, the students will also be expected to complete a self-assessment using **BLM 5.8**. The self-assessment includes a rating scale for the students to use to reflect upon their own learning experience in this subtask.

### Assessment Strategies
Performance Task
Learning Log
Self Assessment
Questions And Answers (oral)

### Assessment Recording Devices
Rating Scale
Rubric

## Teaching / Learning

**Part A: Hydraulics vs. Pneumatics: A Compressing Situation** **Suggested Time: 60 min**

In an activity to understand the operating principles and the differences in hydraulics and pneumatic devices, students will have the opportunity to analyse a variety of examples of these fluid-powered systems. Using either **BLM 5.1** and **BLM 5.2** or the actual fluid-powered devices that may be obtained, the students will compare and contrast hydraulic and pneumatic systems (i.e., compressibility). The students will also draw parallels between the hydraulic systems and human vascular system through the illustration of a Venn Diagram.

1. In an introductory discussion, the teacher will ask the students if they can identify systems that use fluids under pressure. After some examples are generated, the teacher should clarify the point that systems that employ liquids such as water and oil are called **hydraulic systems** while those that use air or other gases under pressure are called **pneumatic systems**.
2. As a demonstration, the teacher will attach a syringe to a 30 cm piece of tubing. Then the teacher will open the plunger of another syringe and attach that syringe to the other end of the tubing. Demonstrate that by applying a force to the input cylinder (the open one), the reacting cylinder will move from a closed position to an open position. The teacher will ask the students whether this is a hydraulic or pneumatic system (pneumatic). The teacher will then detach the opened cylinder, push in the plunger and fill it up with water. Now the water-filled syringe is re-attached to the tube and the plunger is depressed to demonstrate the reaction on the other cylinder. The teacher will again ask the students whether this is a hydraulic or pneumatic system (hydraulic).
3. In another demonstration, the teacher takes an empty syringe, opens the plunger, and seals the end with either the fleshy part of their thumb (as described in Subtask #2 part B) or by using a syringe cap. The teacher indicates the volume of air in the cylinder (e.g., 30 cc). Have the students predict how much of the volume can be compressed by pushing down the plunger with the other end sealed. Likely, you will be able

to decrease the volume by as much as 50%. Repeat the demonstration with water in the syringe. Now have the students make predictions. This time the volume cannot be significantly reduced. Have the students draw on their prior knowledge of the particle theory to explain this. Students should also respond in writing in their project journal.
4. The teacher will provide students with **BLM 5.1** to **BLM 5.4**. Have the students work with a partner to review the examples of hydraulic and pneumatic systems. Students should identify each system as hydraulic or pneumatic and look for similarities and differences in these systems. The teacher may have the students make some reflections in their project journals about hydraulic and pneumatic systems and perhaps draw diagrams of an example of each type of system.
5. On **BLM 5.3**, the teacher will guide the students through analysing the hydraulic pump and the human heart. After careful consideration and analysis, the students will complete the Venn Diagram on **BLM 5.4**. Some of the similarities that should go in the middle of the Venn Diagram are the idea that both systems have a pump, they both have a liquid pumped through (hydraulic), there are valves to regulate the flow of the fluids, and there is a distinct direction of fluid flow.
6. The Venn diagrams will be collected by the teacher for assessment.
7. The students will be required to write down some of the key concepts they were introduced to in their project journal.

**Part B: A Trip to the Boiler Room** **Suggested Time: 80 min**

Students take a field trip to "Boiler Room" to observe heat transfer systems as well as fluid-powered or pressured systems. Of particular interest to the grade 7 students will be how heat is generated and transmitted throughout the school. The grade 8 students will focus their attention on hydraulic and pneumatic systems. If taking the boiler trip as a class is not possible, sharing a videotaped trip to a boiler room that the teacher has visited makes an excellent alternative. For an even richer experience, some district school boards may have a plant services department that is able to make a presentation to the class. Newer schools may use heating/cooling sytems that feature highly technological controls of the system (i.e., computers, sensors, pneumatics, and hydraulics).

1. The teacher is encouraged to check with Board Policy, the school's principal, and the Board's Health and Safety Officer before proceeding with this aspect of the subtask. Once the necessary precautionary measures have been taken, the teacher will take the students into the school's "boiler room." The teacher may consider having additional staff or parent volunteers on hand to help supervise the students. The students should also be arranged into smaller groups (perhaps 6 students) to travel safely through the boiler room.
**Safety Note: Remind the students not to touch any of the equipment or apparatus in the boiler room. This is strictly a "hands off" experience.**
2. The grade 7 students will be instructed to look for examples of heat transfer (conduction, convection, and radiation) and systems that play an important role in transferring that heat (i.e., boiler, ducts, insulated materials, etc.). The grade 8 students will investigate what types of fluid-powered systems are employed in the boiler room (i.e., hydraulic pumps, air compressors, pneumatic thermostats, etc.).
3. If possible, have the head custodian be a guest speaker and point out the systems in the school that deal with fluids and heat. This person would likely be more knowledgeable about the school's heating system and could also field any questions the students may pose. The custodian or teacher could point out systems that are controlled by sensory inputs or feedbacks, for example, a thermostat or regulating device, and instruments that have specialized features for measuring temperature. Perhaps the custodian or teacher could indicate to the students some of the systems that require lubrication to make them run more efficiently and help them reduce mechanical heat transfer.
4. The students will be expected to write down their thoughts and responses in their project journals. Instruct the students to make diagrams of some of the systems they observed on the field trip such as sensory input devices like thermostats. The students could create questions about some of the systems they observed in the boiler room and come up with possible answers or solutions if their questions led to

problems.

**<u>Part C: Keep the Heat</u>** **Suggested Time: 120 min**

In an effort to design a system that minimizes the transfer of heat energy, the students will design and construct an insulated container that will keep heat in a bottle. With their knowledge of transfer of heat energy, the students will determine what material they would like to use and what tools are necessary for the construction of the insulated container. Furthermore, the students will construct the model and conduct tests by measuring the temperature in the insulated container over a given period of time.

1. The teacher will tell the students that their expectation is to design and build a device that minimizes energy transfer. Review what types of materials reduce heat transfer (insulators). Then give the students a copy of **BLM 5.5** which outlines the task context.
2. The students, working in groups of four, will be given a glass bottle. Try to make the bottles a consistent size. One litre vegetable juice bottles work well.
3. The students will then be given an opportunity to look at a wide range of materials to choose from in order to insulate their insulated container. Possible materials may include larger plastic bottles or containers, plastic grocery bags, cotton baton, extruded polystyrene pieces (packing extruded polystyrene), sand or salt. The teacher could indicate to the students to link to their prior knowledge on density when selecting appropriate materials for this challenge.
4. Before construction begins, the students are to draw up blueprints of their proposed model. The blueprints are to be completed in pencil and are to include measurements. This blueprint design must be approved by the teacher before construction begins.

**<u>Safety Note</u>: When using utility knives, remind the students to cut away from themselves and to cut on an appropriate cutting surface. Students should use clamps to fasten materials before using the utility knives to cut. Students should also be wearing safety goggles for eye protection.**

5. The students will construct their insulated container model according to their blueprint design.

**<u>Safety Note</u>: The students must be reminded of the dangers of using boiling hot water. Caution needs to be taken when pouring the boiling hot water from the kettle. Funnels can be used to pour the water into the bottles carefully.**

6. After construction has been completed, the students are to conduct a test that determines how well their insulated container minimizes the transfer of heat energy (see **BLM 5.6**). Then the pupils record the temperature of the water in the insulated container at 5-minute intervals for a 25-minute duration.
7. To conclude the activity have the students construct a graph from the data they accumulated in their chart and have them report on their design challenge in their project journal. The students are to answer the following questions:
    1. How well did your insulated container minimize the transfer of heat?
    2. What would you change in your design if you had the opportunity to construct another model?
8. The project journals will be collected for assessment.

**<u>Part D: Design and Do: Making a Hydraulic or Pneumatic Device</u>** **Suggested Time: 120 min**

In this subtask, the students will design and construct a children's toy that operates using hydraulic and/or pneumatic systems. Possibilities may include using syringes to make a closed hydraulic or pneumatic system (e.g., a puppy coming out of the dog house) or using a bicycle air pump to make an object "lift off" safely. The students will then have the chance to showcase their toys with classmates.

1. If media resouces are available, the teacher could arrange to show a video titled ***Discovering Fluid Power: Hydraulics and Pneumatics at Work in Your World***. This would serve as a good lead into the construction of hydraulic and pneumatic systems. The teacher could provide the students with catalogues (if possible) from department stores. The students are to find examples of toys that utilize or could be modified

to employ a fluid-powered system. Some possibilities may include a jack-in-the-box or a water spraying device.
2. Give the students a copy of **BLM 5.7** that provides the task context for this micro-project. Discuss with the students that the expectation is that they are to design and build a device that uses pneumatic or hydraulic systems.
3. The students, working in groups of four, are to decide on a toy they would like to build and then draw up blueprints of their proposed model. The blueprints are to be completed in pencil and are to include measurements. This blueprint design must be approved by the teacher before construction begins.
4. The model toy is not to exceed 0.5 m in length, width, or height.
5. The students will construct their fluid toy model according to their blueprint design.
6. Completion of the project journal will be an expectation as students report their successes and difficulties during the construction of the model.
7. The students will briefly demonstrate their model to their classmates discussing how they came up with the idea and perhaps describing the process they underwent.

## Adaptations

1. For the field trip to the boiler room activity, preparations may need to be made ahead of time to ensure that a student with special needs (i.e., confined to a wheelchair) can be accommodated to experience this part of the subtask. If not physically possible, perhaps video-recording the experience would be a suitable option.

2. Accommodations may be required for students lacking fine motor skills in the use of glue guns, hand drills, or other types of equipment in the design activities.

3. ESL students should be paired or grouped with students who have strong language and communication skills to help demonstrate some of the key concepts through the demonstration of the investigation.

4. Discuss individual student needs and any other accommodations that may need to be provided for particular exceptional pupils with special education staff.

5. Use the Teacher Companion section of the Ontario Curriculum Planner for other accommodations for students with particular exceptionalities.

## Resources

**Assessment of Design Activites**

| | |
|---|---|
| **BLM 5.1: Hydraulics and Pneumatics #1** | BLM5A1.cwk |
| **BLM 5.2: Hydraulics and Pneumatics #2** | BLM5A2.cwk |
| **BLM 5.3: Hydraulics and Pneumatics #3** | BLM5A3.cwk |
| **BLM 5.4: Venn Diagram** | BLM5A4.cwk |
| **BLM 5.5: Keep the Heat #1** | BLM5B1.cwk |
| **BLM 5.6: Keep the Heat #2** | BLM5B2.cwk |
| **BLM 5.7: Testing Toy Technology** | BLM5C1.cwk |
| **BLM 5.8: Student Self-Assessment** | BLM5D1.cwk |

| | |
|---|---|
| **Discovering Fluid Power: Hydraulics and Pneumatics at Work in Your World** | Fluid Power Educational Foundation |
| | |
| **How Stuff Works** | |
| **water** | |
| **glass bottles 1 L** | 1 |
| **plastic pop bottles 2L** | 1 |
| **extruded polystyrene packing chips** | |
| **salt** | |
| **sand** | |
| **cellulose tape** | |
| **masking tape** | |
| **cardboard boxes** | |
| **plastic grocery bags** | |
| **syringes** | 4 |
| **tubing** | 30 cm length |
| **kettle** | 1 |
| **thermometers** | 1 |
| **beakers 1 L size** | 1 |
| **oven mitts** | 1 pair |
| **safety goggles** | 1 pair |
| **funnels** | 1 |

## Notes to Teacher

**Part A "Hydraulics vs. Pneumatics: A Compressing Situation"**

The teacher may consider having the students do the demonstrations with the syringes in small groups if enough materials are available. Doing it as a demonstration would be a much faster way of illustrating the concepts, but having the students complete the activity would allow them to feel the differences in terms of compressibility between the water and air.
A great website to visit for an Internet experience with some fluid-powered systems is: www.howstuffworks.com.

**Part B "A Trip to the Boiler Room"**

The teacher must take the necessary steps in advance to ensure the boiler room visit is something that can be done in their school. Permission forms should not be necessary, but the teacher must check with Board Policy, the school's principal, and the Board's Health and Safety Officer before proceeding with this aspect of the subtask.
**Safety Note: Remind the students not to touch any of the equipment or apparatus in the boiler room. This is strictly a "hands off" experience.**

**Part C "Insulated Container Be Another Way"**

Although a suggested list of materials is given in the teaching/learning strategies, the teacher can add or substitute any other available materials they feel would be suitable for this activity. If the teacher does not feel comfortable with the students pouring the boiling water, the teacher can do this step for each group.
**Safety Note: The students must be reminded of the dangers of using boiling hot water. Caution needs to be taken when pouring the boiling hot water from the kettle. Funnels can be used to pour the water into the bottles carefully. When using utility knives remind the students to cut away from themselves and to cut on an appropriate cutting surface. Students should use clamps to fasten materials before using the utility knives to cut. Students should also be wearing safety goggles for eye protection.**

**Part D "Design and Do: Making a Hydraulic or Pneumatic Device"**

The teacher could ask students to bring in catalogues or flyers from department or toy stores ahead of time. As a possible extension to this activity, the teacher may consider bringing the toys to some of the younger primary students in the school and have the 7/8 students demonstrate how these toys function.
**Safety Note: When using utility knives, remind the students to cut away from themselves and to cut on an appropriate cutting surface. Students should use clamps to fasten materials before using the utility knives to cut.**

## Teacher Reflections

## Description

Students will complete this performance assessment by applying the knowledge they acquired throughout this unit.  All students will be given the challenge of designing and building a model of a hot tub.  The grade 7 students will focus their designs on the heating system that will generate hot water for the tub.  Additionally, they will make appropriate choices of materials in an effort to prevent heat loss.  The grade 8 students will need to design and build a model of the system that will generate and control water movement  (whirlpool or current) and effervescence (bubbles).

## Expectations

7s54 A • explain how the characteristics and properties of heat can be used, and identify the effect of some of these applications on products, systems, and living things in the natural and human-made environments.

7s55 A – distinguish between the concept of temperature and the concept of heat (e.g., temperature is a measure of the average kinetic energy of the molecules in a substance; heat is thermal energy that is transferred from one substance to another);

7s57 A – explain how heat is transmitted by conduction, convection, and radiation in solids, liquids, and gases (e.g., conduction: a pot heating on a stove; convection: a liquid heating in the pot; radiation: the air being warmed by heat from the element);

7s64 A – design and build a device that minimizes energy transfer (e.g., an incubator, a Thermos flask).

7s67 A – use appropriate vocabulary, including correct science and technology terminology, to communicate ideas, procedures, and results (e.g., state the boiling and freezing points of water, room temperature, and body temperature in degrees Celsius; correctly use the terms heat conductor and heat insulator);

7s78 A – identify and describe steps that can be taken to conserve energy (e.g., using insulation) and the reasons for doing so (e.g., rising fuel costs);

7s79 A – identify the components of a system that are designed to transfer heat energy (e.g., in a room, a house, or a shopping centre) and describe methods for conserving energy within that system.

8s31 A • describe how knowledge of the properties of fluids can help us to understand and influence organisms in the natural world, and to design and operate technological devices and to evaluate how efficiently different devices make use of these properties.

8s39 A – compare fluids in terms of their compressibility or incompressibility (e.g., gases versus liquids);

8s42 A – predict the effect of applying external pressure on the behaviour of fluids;

8s47 A – design and construct a model of a common device that uses pneumatic or hydraulic systems (e.g., dentist's chair, automobile hoist);

8s50 A – use appropriate vocabulary, including correct science and technology terminology, to

### Groupings

Students Working Individually
Students Working In Pairs

### Teaching / Learning Strategies

Model Making
Research
Learning Log/ Journal

## Assessment

**Assessing the Model Hot Tubs**

Teachers can use the rubric provided to assess the final product and the report which the students will outline in their project journals.  During the design and building process, teachers should observe, listen, and record the behaviour of the students as they apply the knowledge acquired in the subtasks of this unit to the culminating task at the end.   In addition,  teachers should record the students' ability to explain such decisions as their selection of supplies or the placement of the materials in their models as they make their presentations to other students.

### Assessment Strategies

Classroom Presentation
Performance Task
Learning Log

### Assessment Recording Devices

Rubric
Anecdotal Record

communicate ideas, procedures, and results (e.g., use terms such as flow rate, viscosity, compressibility, fluid, density, pneumatics, hydraulics);

8s60 A – identify some design features (e.g., of aircraft, cars, submarines) and explain how the design makes use of one or more of the properties of fluids;

7s69 – communicate the procedures and results of investigations for specific purposes and to specific audiences, using media works, written notes and descriptions, charts, graphs, drawings, and oral presentations (e.g., use a diagram to illustrate convection in a liquid or a gas).

7s68 – compile qualitative and quantitative data gathered through investigation in order to record and present results, using diagrams, flow charts, frequency tables, bar graphs, line graphs, and stem-and-leaf plots produced by hand or with a computer (e.g., plot a graph showing the decrease in temperature of various liquids from identical initial temperatures);

8s52 – communicate the procedures and results of investigations for specific purposes and to specific audiences, using media works, written notes and descriptions, charts, graphs, drawings, and oral presentations (e.g., create a table to show the relationship between the buoyant force and size of object);

8s51 – compile qualitative and quantitative data gathered through investigation in order to record and present

## Teaching / Learning

**Researching and Creating a Model Hot Tub**

1. Students will be given a design challenge, outlined on **BLM 6.1** and **6.2**.
2. Independently or with a partner, students will research any information and materials that will be necessary in order to design and build a model hot tub. The focus for grade 7 students is how to heat the water in the most efficient manner and prevent heat loss by choosing the appropriate materials. Grade 8 students will be creating their designs with the emphasis on the movement of water, how and where it enters or exits the tub, location, and number of jets, as well as how these jets will provide either an air or water massage.
3. To begin, students should review the information which they have recorded in their project journals and apply some of the key concepts to their designs.
4. Other resources can be researched in order to create their designs. (See "Resources" listed for some ideas.)
5. Each student will collect the materials necessary to build their models and complete their project with an explanation of their work in their project journals.
6. Students could present their models in a classroom "show case." They could invite other classes to view their displays and make brief presentations to small groups or individuals.

NOTE: Teachers may wish to have students use a planning template or model (i.e., S.P.I.C.E. or S.C.A.M.P.E.R. see Subtask Notes for more detail)

## Adaptations

1. Accommodations may be required for students lacking fine motor skills in the use of glue guns, hand drills, or other types of equipment in the design activities.

2. ESL students should be paired or grouped with students who have strong language and communication skills to help demonstrate some of the key concepts through the demonstration of the investigation.

3. Discuss individual student needs and any other accommodations that may need to be provided for particular exceptional pupils with special education staff.

4. Use the Teacher Companion section of the program for other accommodations for students with particular exceptionalities.

## Resources

**Gr. 7 Culminating Task Rubric**

**Gr. 8 Culminating Task Rubric**

**BLM 6.1: Grade 7 Challenge** BLM6A1.cwk

**BLM 6.2: Grade 8 Challenge** BLM6A2.cwk

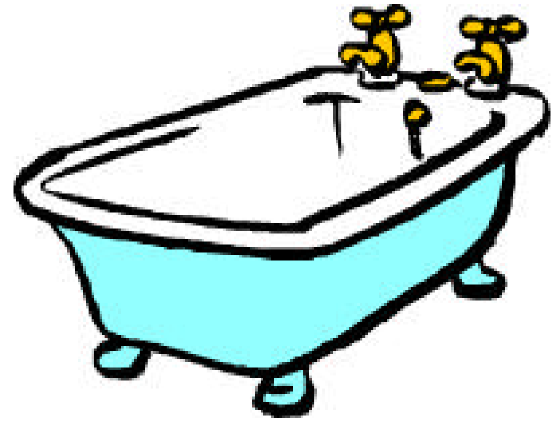
**C.G. Air Systems**

## Notes to Teacher

Using a planning model or template will provide direction for students who have difficulty getting started. While numerous models exist (many can be found within technology textbooks) the S.P.I.C.E. model is listed below.

**S.P.I.C.E.**
**S**ituation
**P**roblem
**I**nvestigation
**C**onstruction
**E**valuation

## Teacher Reflections



# Appendices

## Bubbles in the Hot Tub

### A Guide to Getting In and Out of Hot Water

**Resource List:**

**Black Line Masters:**

**Rubrics:**

**Unit Expectation List and Expectation Summary:**

## Rubric

- ☐ **Assessment of Design Activites** **ST 5**
  2
  A rubric that can be used to assess student performance on the design and construction of the thermos and the fluid powered toy.
- ☐ **Density Rubric** **ST 2**
  2
- ☐ **Gr. 7 Culminating Task Rubric** **ST 6**
  2
- ☐ **Gr. 8 Culminating Task Rubric** **ST 6**
  2
- ☐ **Investigation Assessment** **ST 3**
  2
- ☐ **Project Journal Assessment** **ST 2**
  2
- ☐ **Viscosity Rubric** **ST 2**
  2

## Blackline Master / File

- ☐ **BLM 1.1: Game Labels** **ST 1**
  BLM1A1.cwk
- ☐ **BLM 2.1: Transparency #1** **ST 2**
  BLM2A1.cwk
  This BLM is designed to be made into a transparency. It is 1 of 7 to be used with this subtask.
- ☐ **BLM 2.10: Rate of Temperature Change** **ST 2**
  BLM2D1.cwk
  This BLM is intended to be usd with Subrtask 2, Part D
- ☐ **BLM 2.11: Heat Capacity** **ST 2**
  BLM2D2.cwk
  This BLM is intended to be usd with Subrtask 2, Part D
- ☐ **BLM 2.12: As Slow as...Molasses** **ST 2**
  BLM2E1.cwk
  This BLM is to be used with subtask #2, part E
- ☐ **BLM 2.13: Homework Investigation, Viscosity** **ST 2**
  BLM2E2.cwk
  To be used with Subtask #2 part E
- ☐ **BLM 2.14: Soup Can Racers** **ST 2**
  BLM2F1.cwk
  To be used with Subtask #2 part F
- ☐ **BLM 2.15: Calculating Density** **ST 2**
  BLM2F2.cwk
  To be used with Subtask #2 part F
- ☐ **BLM 2.16: Density Changes** **ST 2**
  BLM2F3.cwk
  To be used with Subtask #2 part F
- ☐ **BLM 2.17: Pencil Hydrometers** **ST 2**
  BLM2G1.cwk
  To be used with Subtask #2 part G
- ☐ **BLM 2.18: Buoyancy** **ST 2**
  BLM2G2.cwk
  To be used with Subtask #2 part G
- ☐ **BLM 2.19: Teaching / Learning Part D** **ST 2**
  BLM2D.cwk
  These are the Teaching Learning Strategies for Subtask 2, Part D.
- ☐ **BLM 2.2: Transparency #2** **ST 2**
  BLM2A2.cwk
  This BLM is designed to be made into a transparency. It is 2 of 7 to be used with this subtask.
- ☐ **BLM 2.20: Teaching / Learning Part E** **ST 2**
  BLM2E.cwk
  These are the Teaching Learning Strategies for Subtask 2, Part E.
- ☐ **BLM 2.21: Teaching / Learning Part F** **ST 2**
  BLM2F.cwk
  These are the Teaching Learning Strategies for Subtask 2, Part F.
- ☐ **BLM 2.22: Teaching / Learning Part G** **ST 2**
  BLM2G.cwk
  These are the Teaching Learning Strategies for Subtask 2, Part G.
- ☐ **BLM 2.3: Transparency #3** **ST 2**
  BLM2A3.cwk
  This BLM is designed to be made into a transparency. It is 3 of 7 to be used with this subtask.
- ☐ **BLM 2.4: Transparency #4** **ST 2**
  BLM2A4.cwk
  This BLM is designed to be made into a transparency. It is 4 of 7 to be used with this subtask.
- ☐ **BLM 2.5: Transparency #5** **ST 2**
  BLM2A5.cwk
  This BLM is designed to be made into a transparency. It is 5 of 7 to be used with this subtask.
- ☐ **BLM 2.6: Transparency #6** **ST 2**
  BLM2A6.cwk
  This BLM is designed to be made into a transparency. It is 6 of 7 to be used with this subtask.
- ☐ **BLM 2.7: Transparency #7** **ST 2**
  BLM2A7.cwk
  This BLM is designed to be made into a transparency. It is 7 of 7 to be used with this subtask.
- ☐ **BLM 2.8: Particle Theory (complete)** **ST 2**
  BLM2A8.cwk
  This BLM will serve as a reference throughout the investigations the students will complete. You may choose to hand this out at the end of the overhead work. This BLM can also be used as transparency #8 replacing the pile of 7 transparencies.
- ☐ **BLM 2.9: Particle Theory (student template)** **ST 2**
  BLM2A9.cwk
  This template may be used to maximize efficiency of Part A.

☐ **BLM 3.1: Convection Connection** **ST 3**
BLM3A1.cwk
This BLM is to be used with Subtsk #3, Part A.

☐ **BLM 3.2: Conduction Craze: Marshmallow Madness** **ST 3**
BLM3B1.cwk
This BLM is to be used with Subtsk #3, Part B.

☐ **BLM 3.3: Conduction Craze: An "Ice"olated Incident** **ST 3**
BLM3B2.cwk
This BLM is to be used with Subtsk #3, Part B.

☐ **BLM 3.4: Conduction Craze: Ice Savers** **ST 3**
BLM3B3.cwk
This BLM is to be used with Subtsk #3, Part B.

☐ **BLM 3.5: Conduction Craze: Thought Experiments** **ST 3**
BLM3B4.cwk
This BLM is to be used with Subtsk #3, Part B.

☐ **BLM 3.6: Reacting to Radiation** **ST 3**
BLM3C1.cwk
This BLM is to be used with Subtsk #3, Part C.

☐ **BLM 3.7: The Energy Efficient Home** **ST 3**
BLM3D1.pdf
This BLM is to be used with Subtsk #3, Part D.

☐ **BLM 3.8: Household Heating Systems** **ST 3**
BLM3D2.cwk
This BLM is to be used with Subtsk #3, Part D.

☐ **BLM 3.9: Expectation Checklist** **ST 3**
BLM3D3.cwk
This BLM is to be used with Subtsk #3, Part D.

☐ **BLM 4.1 Water Cycle Setup** **ST 4**
BLM4A1.cwk
This is to be used to aid the teacher in setting up.

☐ **BLM 5.1: Hydraulics and Pneumatics #1** **ST 5**
BLM5A1.cwk
This BLM is to be used with Subtask #5, Part A.

☐ **BLM 5.2: Hydraulics and Pneumatics #2** **ST 5**
BLM5A2.cwk
This BLM is to be used with Subtask #5, Part A.

☐ **BLM 5.3: Hydraulics and Pneumatics #3** **ST 5**
BLM5A3.cwk
This BLM is to be used with Subtask #5, Part A.

☐ **BLM 5.4: Venn Diagram** **ST 5**
BLM5A4.cwk
This BLM is to be used with Subtask #5, Part A.

☐ **BLM 5.5: Keep the Heat #1** **ST 5**
BLM5B1.cwk
This BLM is to be used with Subtask #5, Part B.

☐ **BLM 5.6: Keep the Heat #2** **ST 5**
BLM5B2.cwk
This BLM is to be used with Subtask #5, Part B.

☐ **BLM 5.7: Testing Toy Technology** **ST 5**
BLM5C1.cwk
This BLM is to be used with Subtask #5, Part C.

☐ **BLM 5.8: Student Self-Assessment** **ST 5**
BLM5D1.cwk
This BLM is to be used with Subtask #5, Part D.

☐ **BLM 6.1: Grade 7 Challenge** **ST 6**
BLM6A1.cwk

☐ **BLM 6.2: Grade 8 Challenge** **ST 6**
BLM6A2.cwk

## Print

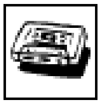
☐ **Be Safe! Ontario Edition** **Unit**
Science Teachers' Association of Ontario
1-800-461-2264
A health and safety reference for science and technology curriculum: GRADES 1-8. This excellent resource is produced by the Science Teachers' Association of Ontario and covers specific safety considerations for the elementary teacher. There is an entire chapter on heating and burning.

☐ **Be Safe! Ontario Edition** **ST 2**
Science Teachers' Association of Ontario
1-800-461-2264
A health and safety reference for science and technology curriculum: GRADES 1-8. This excellent resource is produced by the Science Teachers' Association of Ontario and covers specific safety considerations for the elementary teacher. There is an entire chapter on heating and burning.

☐ **Let's Wonder About Science: Solids, Liquids, and Gases** **ST 1**
Patten, J.M.
ISBN 1-55916-126-4

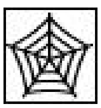
☐ **The Amazing Water Book** **ST 4**
Seed, Deborah
ISBN 1-55074-003-2

☐ **The Wayland Library of Science and Technology: The Nature of Matter** **ST 1**
Lafferty, Peter
ISBN 1852108479

## Media

- ☐ **Bill Nye The Science Guy "Water Cycle/Oceanography"** **ST 4**
  Magic Lantern Communications
  1995 Walt Disney
- ☐ **Discovering Fluid Power: Hydraulics and Pneumatics at Work in Your World** **ST 5**
  Fluid Power Educational Foundation
  ph# (414) 778-3364
- ☐ **Physical Science for Children: All About Solids, Liquids and Gases** **ST 1**
  Library Video Company
  ISBN 1-57225-291-X
  Designed for younger students
- ☐ **Second Voyage of the Mimi Expedition#4 "The Incredible Shrinking Head"** **ST 2**
  Sunburst Communications
  1988
  A fantastic video where various items such as a styrofoam head, lightbulbs, balloons and a basket ball are placed into a hyperbaric chamber. Pressure is added and then restored.



## Website

- ☐ **ST 5**
  http://www.thermos.com/history
  This site offers a timeline of details in the development of the thermos or insulated bottle.
- ☐ **C.G. Air Systems** **ST 6**
  http://www.cgair.com
- ☐ **How Stuff Works** **ST 5**
  http://www.howstuffworks.com
  A fantastic website that allows students to interactively test different systems and find out more information about how things work, particularly technology.
- ☐ **It's Canada** **ST 3**
  http://www.its-canada.com/reed
  This great site gives examples of house floor plans and energy efficient house plans.

## Material

- ☐ **20 cm glass rods** **ST 3**
  1
  per group
  Could use glass stir sticks
- ☐ **20 cm pieces of metal** **ST 3**
  1
  per group
  Could use metal skewers ot butter knives.
- ☐ **20 cm pieces of plastic** **ST 3**
  1
  per group
  Could use plastic cutlery.
- ☐ **20 cm pieces of wood** **ST 3**
  1
  per group
  Could use pencils
- ☐ **aluminum pie-pan** **ST 3**
  1
  per group
- ☐ **cardboard boxes** **ST 5**
- ☐ **cellulose tape** **ST 5**
- ☐ **cold water** **ST 2**
  per group
- ☐ **construction paper** **ST 3**
  Have at least three different colours.
- ☐ **dye** **ST 3**
  per class
  Various colours
- ☐ **extruded polystyrene cups** **ST 3**
  1
  per group
- ☐ **extruded polystyrene packing chips** **ST 5**
- ☐ **glass bottles 1 L** **ST 5**
  1
  per group
  Vegetable juice bottles would be ideal.
- ☐ **gluesticks** **ST 3**
  1
  per group
- ☐ **graduated cylinders (plastic)** **ST 2**
  1
  per group
  Glass ones tend to break as students drop in washers or nuts.
- ☐ **hot water** **ST 2**
  per group
- ☐ **ice** **ST 2**
  per group
- ☐ **ice** **ST 3**
  1 bag

- ☐ **large marshmallows** **ST 3**
  5
  per group
- ☐ **liquid hand soap or shampoo** **ST 3**
  1
  per class
  Must have glycol stearate, glycol distearate or glycerol stearate as an ingredient.
- ☐ **liquids of varying viscosities** **ST 2**
- ☐ **masking tape** **ST 5**
- ☐ **mini marshmallows** **ST 2**
  3 or more/student
  per pair
  white or coloured
  Cutting up the larger size does not work well.  Avoid over using the same marshmallow as it will lose it's pliability and not work as well
- ☐ **modelling clay** **ST 2**
- ☐ **molasses** **ST 2**
  per group
- ☐ **paper cups** **ST 3**
  1
  per group
- ☐ **plastic cups** **ST 3**
  1
  per group
- ☐ **plastic grocery bags** **ST 5**
  per class
- ☐ **plastic pop bottles 2L** **ST 5**
  1
  per group
- ☐ **salt** **ST 5**
- ☐ **sand** **ST 3**
  fine grains and preferrably dry
- ☐ **sand** **ST 5**
- ☐ **steel wool** **ST 3**
  1 pkg
  per class
- ☐ **various cans of soup (same volume/size)** **ST 2**
- ☐ **washers, nuts, bolts, or screws** **ST 2**
  10
  per group
  The thicker washers work best.  The ones with the greater masses tend to work better for students
- ☐ **water** **ST 3**
  per class
- ☐ **water** **ST 5**

## Equipment / Manipulative

- ☐ **250 mL beakers** **ST 3**
  4
  per group
- ☐ **barbecue igniter** **ST 3**
  1
  per class
  A candle could be substituted if unavailable.
- ☐ **beakers** **ST 2**
- ☐ **beakers 1 L size** **ST 5**
  1
  per group
- ☐ **buckets** **ST 2**
  6
  per class
- ☐ **candles** **ST 3**
  1
  per group
- ☐ **clear plastic cups** **ST 2**
  1
  per person
- ☐ **electric kettle** **ST 2**
  1
  per class
- ☐ **exercise hoops** **ST 2**
  1
  per person
  look in the gym storage area for these.
- ☐ **funnels** **ST 5**
  1
  per group
- ☐ **graduated cylinders 100 mL** **ST 3**
  6
  per group
- ☐ **graduated cylinders 50 mL** **ST 3**
  3
  per group
- ☐ **hot plates** **ST 2**
  1
  per class
- ☐ **hot plates** **ST 3**
  1
  per group
- ☐ **inclined planes** **ST 2**
- ☐ **kettle** **ST 3**
  1
  per class
- ☐ **kettle** **ST 5**
  1
  per class



- ☐ **oven mitts** **ST 5**
  1 pair
  per group
- ☐ **rubber caps for syringes** **ST 2**
  1
  per person
  These are available at a Science equipment supplier.
- ☐ **ruler/metre stick** **ST 2**
- ☐ **safety goggles** **ST 3**
  1
  per person
- ☐ **safety goggles** **ST 5**
  1 pair
  per person
- ☐ **scissors** **ST 3**
  1
  per group
- ☐ **stopwatches** **ST 3**
  1
  per group
- ☐ **straws** **ST 2**
  1
  per person
- ☐ **syringe plugs** **ST 2**
- ☐ **syringes** **ST 2**
  60cc.

  per pair
  The larger the better. Size: 20cc is the smallest that could work without making a mess of the marshmallow inside. 60 cc is best.
- ☐ **syringes** **ST 5**
  4
  per group
  Can use various sizes (10cc, 30cc, 50cc)
- ☐ **test tubes** **ST 3**
  1
  per group
- ☐ **thermometers** **ST 2**
- ☐ **thermometers** **ST 3**
  6
  per group
  long glass type
- ☐ **thermometers** **ST 5**
  1
  per group
- ☐ **Triple Beam Balance** **ST 2**
  1
  per group
  Any type of balance will do. It must be able to distinguish mass by grams.
- ☐ **tubing** **ST 5**
  30 cm length
  per group

Energy Labels:

# LIGHT
# HEAT
# MECHANICAL
# SOUND
# ELECTRICAL
# CHEMICAL
# WIND
# NUCLEAR
# KINETIC

Solid Labels:

# SOAP
# PLATE
# BASEBALL
# RUBBER DUCKY
# STAMP
# BOOK
# STAIRS
# TOWEL
# PENCIL
# MAPLE TREE

Liquid Labels:

# WATER
# MILK
# CHOCOLATE SYRUP
# APPLE JUICE
# MOLASSES
# COLA
# COFFEE
# VEGETABLE OIL
# SUNSCREEN

Gas Labels:

# AIR

# OXYGEN

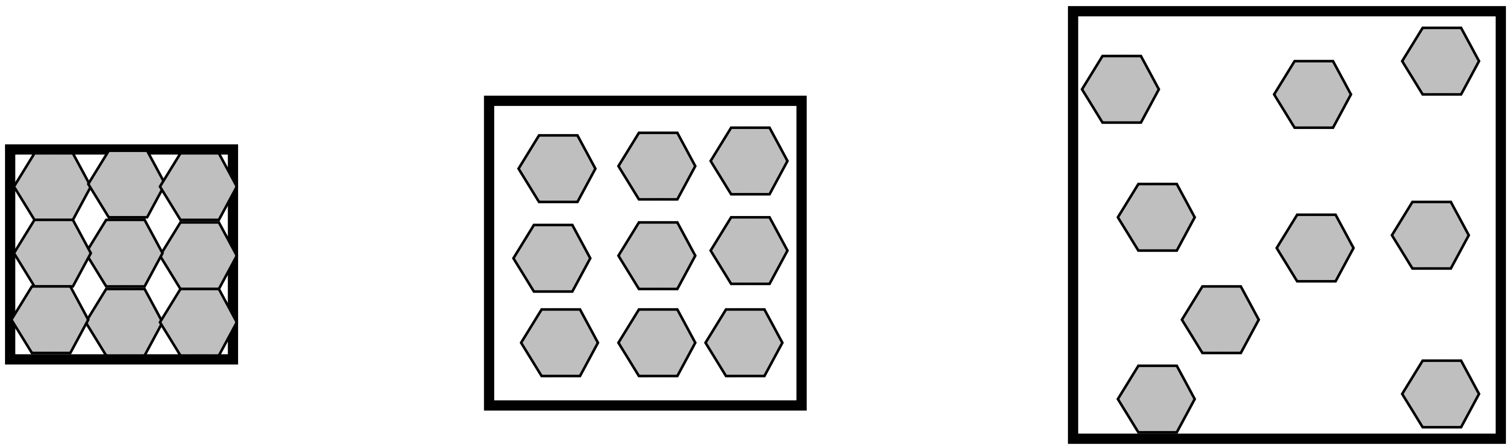
# NITROGEN

# CARBON MONOXIDE

# HELIUM

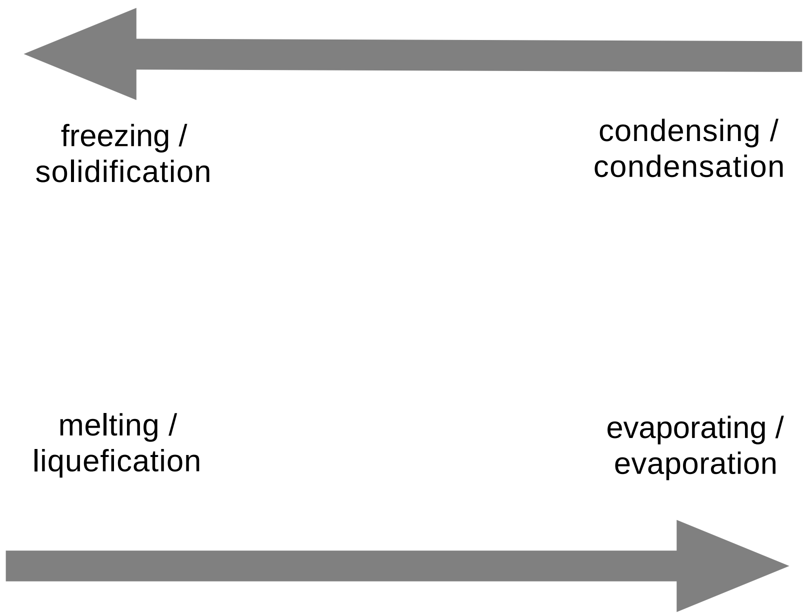
# CARBON DIOXIDE

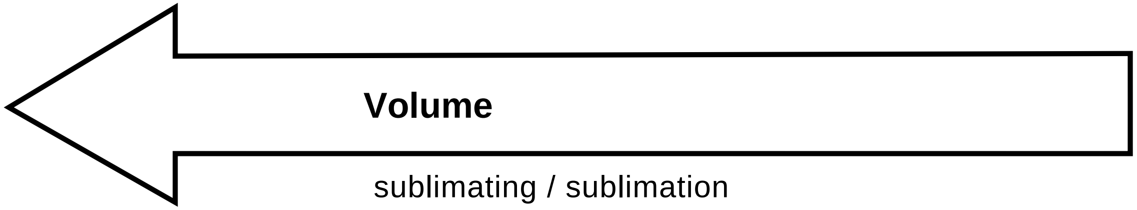
# HYDROGEN



**Solid** **Liquid** **Gas**

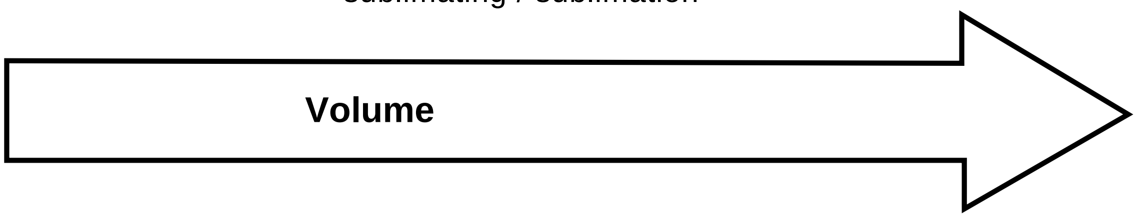
# Particle Theory


freezing / solidification
condensing / condensation
melting / liquefication
evaporating / evaporation




sublimating / sublimation

sublimating / sublimation



*Decreasing* and **Heat ENERGY**

*Increasing* and **Heat ENERGY**

*Decreasing*

*Increasing*

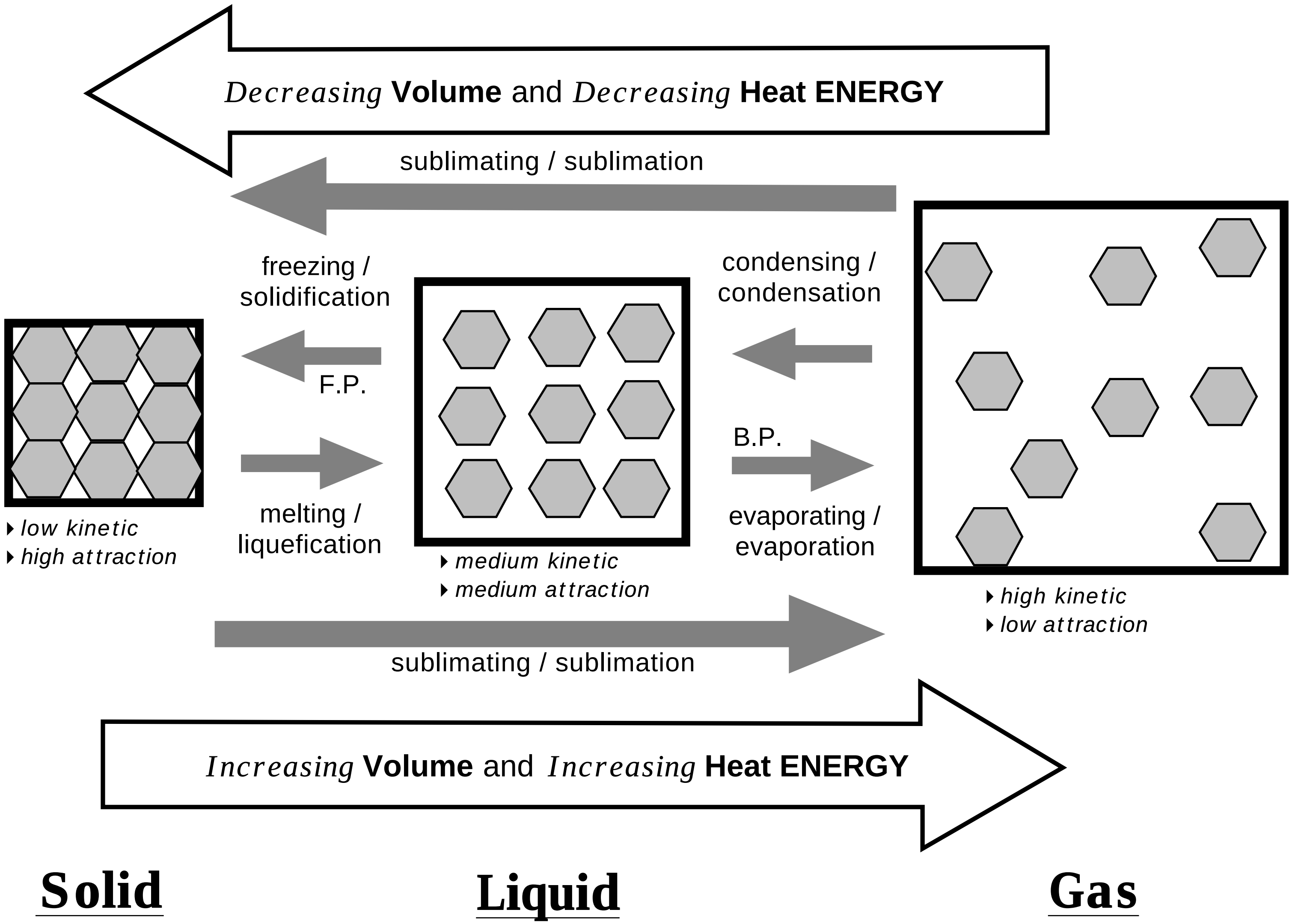
F.P.

B.P.

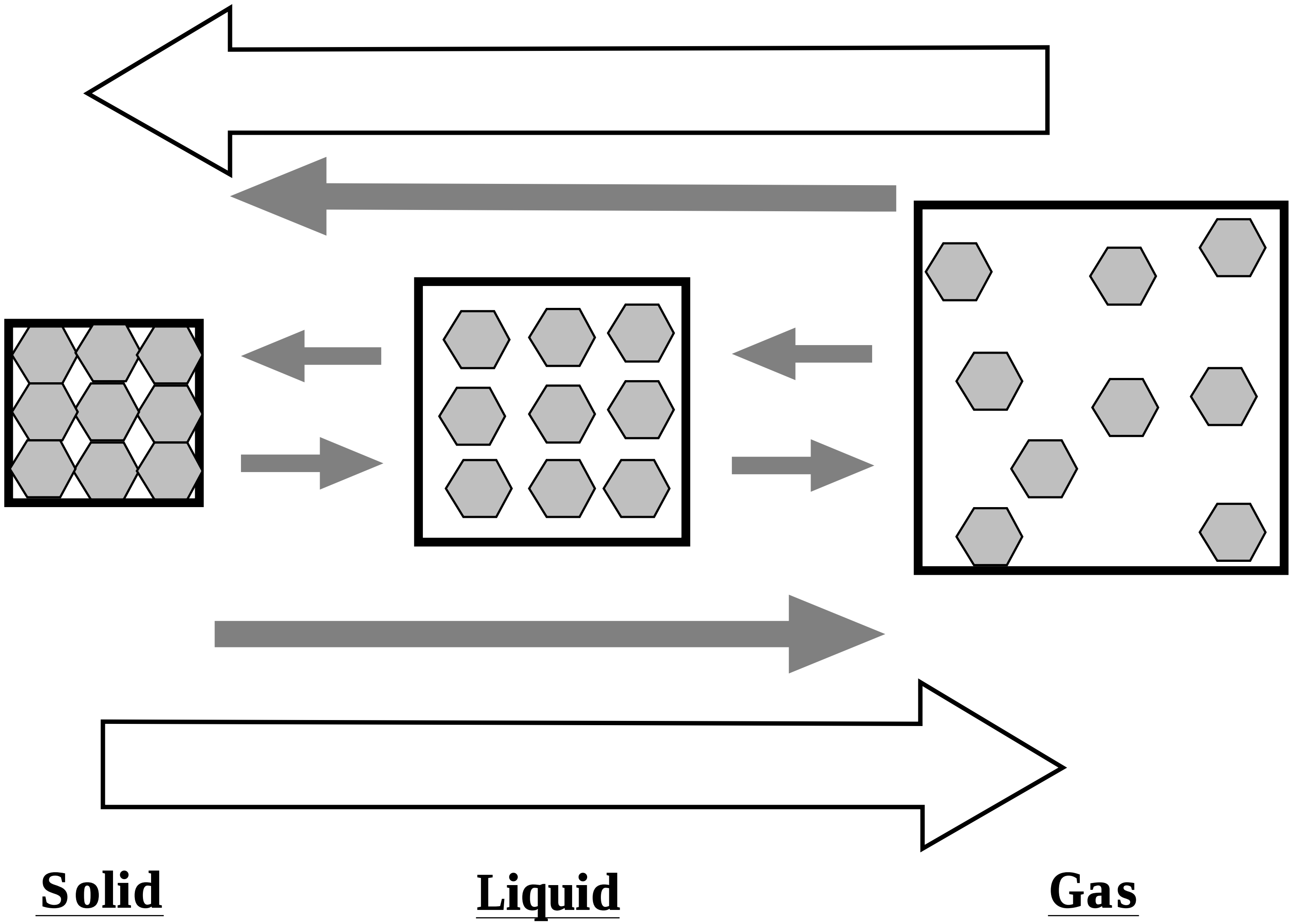
- *low kinetic*
- *high attraction*

- *medium kinetic*
- *medium attraction*

- *high kinetic*
- *low attraction*




# Particle Theory

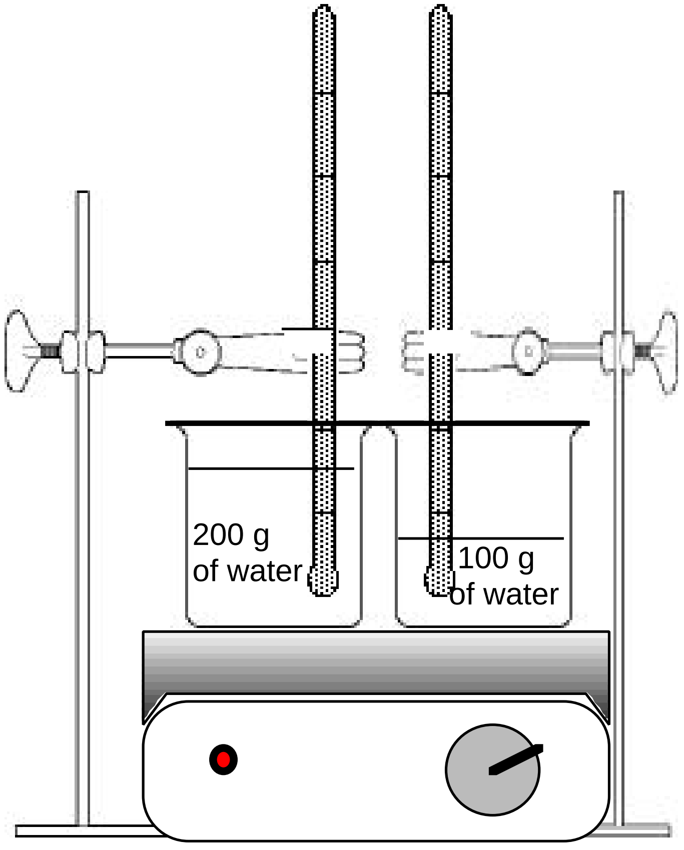



# Particle Theory

# Rate of Temperature Change

Name:_________________

Date: __________________




Complete the chart using your observations.

| | 100 grams of water | 200 grams of water |
|---|---|---|
| Initial Temperature | | |
| Final Temperature | | |
| Elapsed Time | | |
| Rate of Change degrees/min. | | |
| Time to Return to Initial | | |

## Questions

1. Which mass of water heated up and cooled down faster?

2. Which mass of water had a greater rate of change?

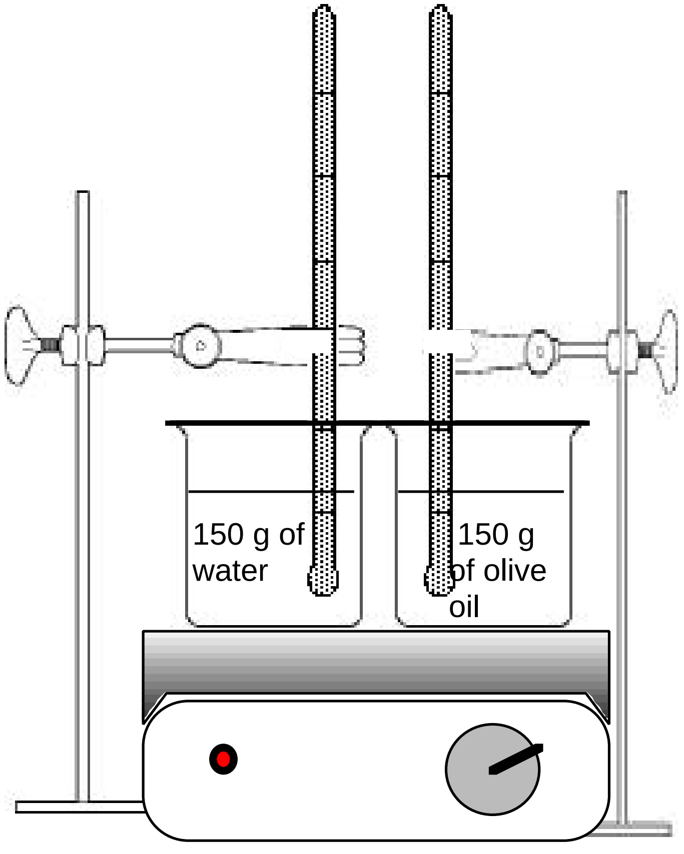
3. What can you conclude from this?

4. Use particle theory to explain the difference observed in the rates of temperature change.

# Heat Capacity

Name:_________________

Date: _________________




Complete the following chart using your observations.

| | 150 grams of water | 150 grams of olive oil |
|---|---|---|
| Initial Temperature | | |
| Final Temperature | | |
| Elapsed Time | | |
| Rate of Change degrees/min. | | |
| Time to Return to Initial T | | |

## Questions

1. Which liquid heated up and cooled down faster?

2. Which liquid had a greater rate of change?

3. What can you conclude from this investigation?

4. Use particle theory to explain the difference observed in the rates of temperature change.

# As Slow as...Molasses

Name: ___________
Date: _______________

Think you know how to increase or decrease the viscosity of a liquid?

# Prove It!

Using the materials listed below, you are to design an experiment to prove what can be done to increase or decrease the viscosity of molasses.

**Materials**

- molasses
- hot water
- cold water
- ice
- test tubes
- syringes
- inclined plane beakers
- other items (get your teacher's permission)

**What is your plan?**

___________________________________________________________

___________________________________________________________

___________________________________________________________

___________________________________________________________

___________________________________________________________

___________________________________________________________

**Observations** (draw a labeled diagram in the box)

(use the space below for a chart and/or description of what happened)

Conclusion: (what you found out)

____________________________________________________________

____________________________________________________________

# Homework Investigation

Name: ___________

## Viscosity

Date: ___________

Get an adult helper and look for liquids in your home. Make a list of those you found. Rate each liquid as having:

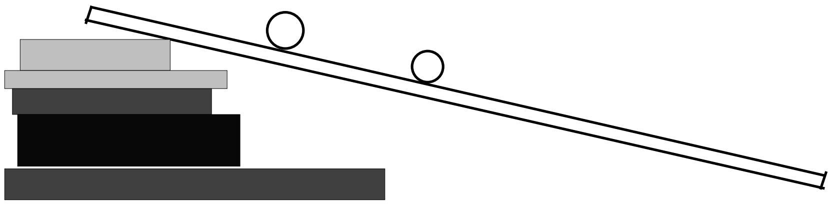
**5 - very high viscosity**
**4 - high viscosity**
**3 - medium viscosity**
**2 - low viscosity**
**1 - very low viscosity**

| Name of Liquid | Viscosity (circle one) |
| --- | --- |
| ______________________________ | 1 2 3 4 5 |
| ______________________________ | 1 2 3 4 5 |
| ______________________________ | 1 2 3 4 5 |
| ______________________________ | 1 2 3 4 5 |
| ______________________________ | 1 2 3 4 5 |
| ______________________________ | 1 2 3 4 5 |

# Soup Can Racers

Name:__________________

Date: _________



| Team Name (Soup) | Ranking (1=fastest) | /olume | Mass (grams) | Density (g/mL) |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

$$\text{Density} = \frac{\text{Mass}}{\text{Volume}}$$

# Calculating Density

Name: _______________

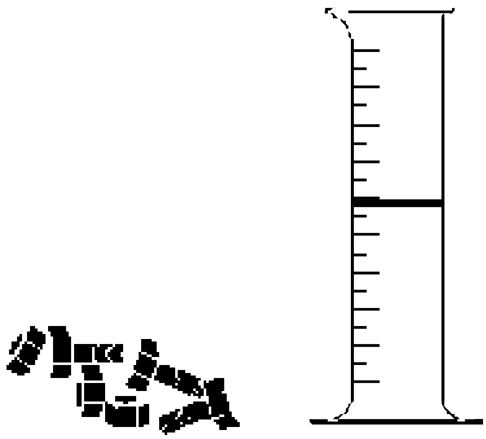
Date: ________________

Your teacher will supply you with 10 identical items. They could be bolts or washers or something else. You need to measure and calculate the density of these items.

**Purpose:** To calculate the density of an item.

**Hypothesis:**

**Apparatus:**
- plastic graduated cylinder
- balance
- 10 identical items (washers, bolts, etc.)



**Method:**
1. Begin by using a graduated cylinder to measure the volume of 5 of the items (not sure how?...Think of Archimedes).
2. Use a balance to measure the mass of the 5 items.
3. Repeat steps 1 and 2, using all 10 items.
4. Record your measurements in the table below and use this information to calculate the density of the items.
5. Can you predict the density of only 1 of these? How about 100 of these?

**Observations:**

| | Mass (grams) | Displaced Volume of Water (mL) | Density of Items (g/cm3 ) |
|---|---|---|---|
| 5 Items | | | |
| 10 Items | | | |

**Conclusions:**

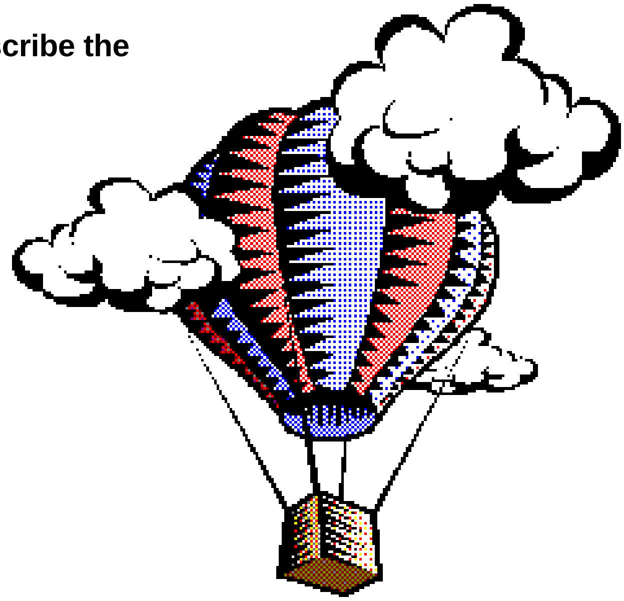
# Density Changes

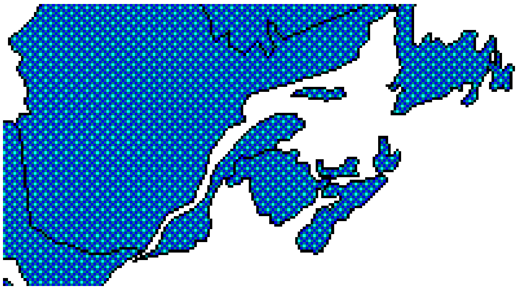
Name: ____________

Date: ____________

**In the space provided, use the particle theory to describe the changes in density.**

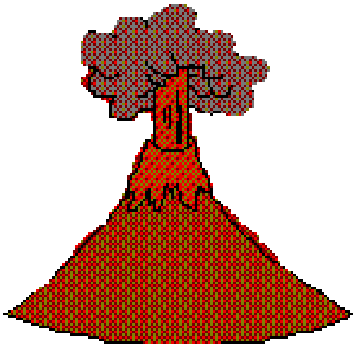
1. A hot air balloon rises high up into the air and later descends back to Earth. Describe the air in this balloon.





2. The water in the St. Lawrence River empties into the Atlantic Ocean. Describe the water.

3. Molten lava pours out and down the outside of a volcano's cone, eventually reaching a nearby ocean. Describe the lava.

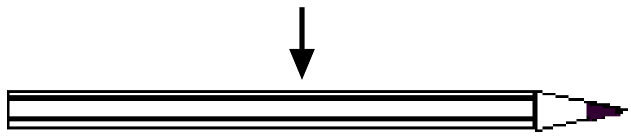


# Pencil Hydrometers

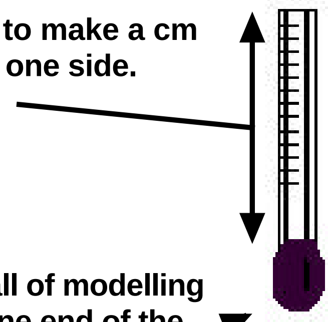
Name: ___________________

Date: ____________________

1. Cut pencil in half.

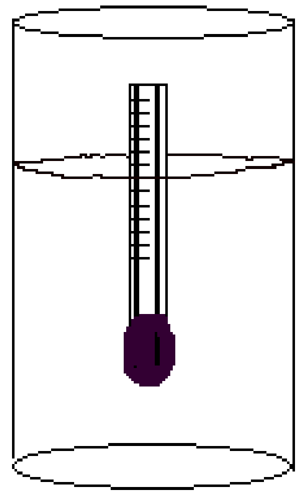


2. Use ink to make a cm scale on one side.



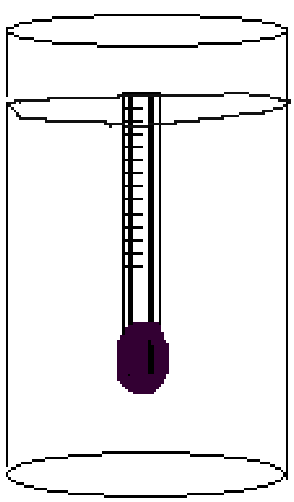
3. Add a ball of modelling clay to one end of the pencil.

4. Adjust the mount of modelling clay so that the hydrometer floats vertically and extends above the water line.



5. TEST IT OUT!

| Liquid | # of cm above surface of liquid | Ranking (1= most dense) |
|---|---|---|
| Mystery | 2 cm | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |

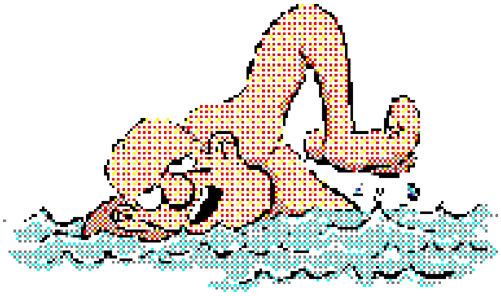


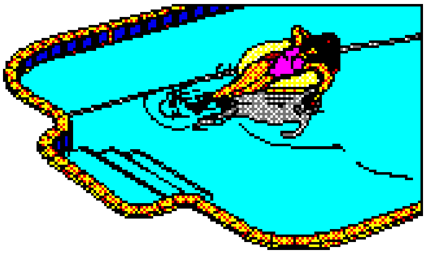
Mystery Liquid

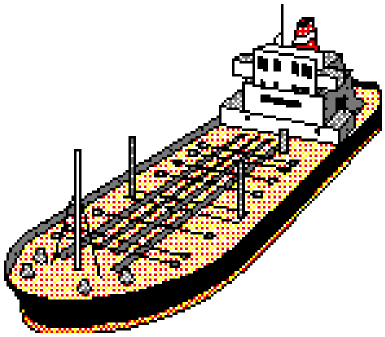
# Buoyancy

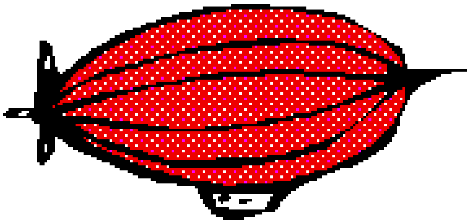
Name: ___________________

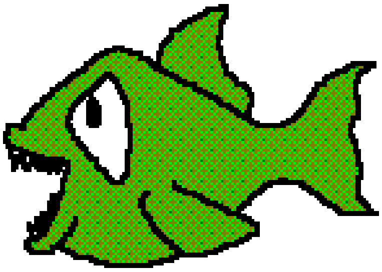
Date: ___________________



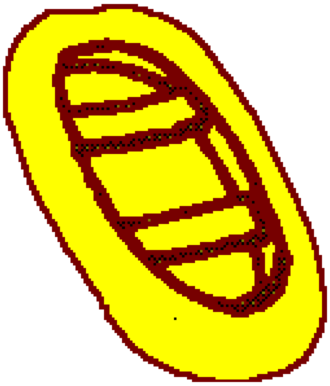


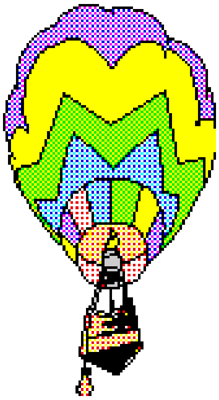


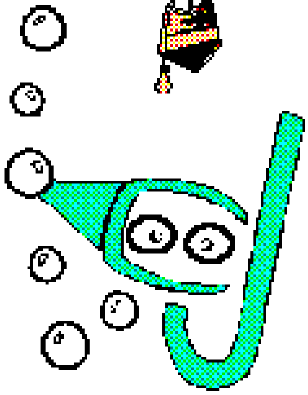


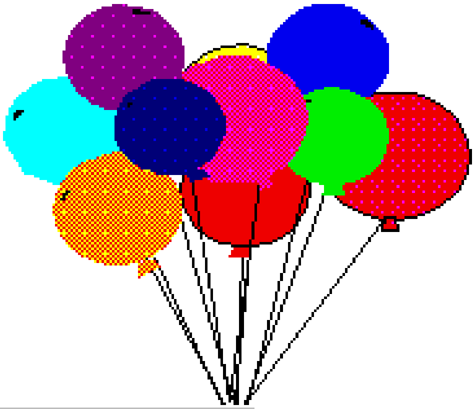


**Pick 2 examples of buoyancy on this page. On the back of this paper explain how increasing and decreasing the force of gravity would affect the buoyancy of your choice. What would happen if there were no gravity at all?**









Make a list of as many buoyant objects that can be found around or near a pool as possible.

# Bubbles in the Hot Tub - Subtask 2

**Part D "Feeling Hot Hot Hot"**
**Teaching Learning Strategies**
**Suggested Time: 80 min**

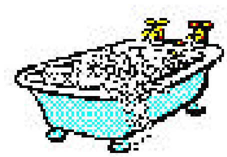
Students will be introduced to the misnomers of heat vs. temperature and mass vs. weight. Students will experiment with liquids as they explore factors affecting the rate of temperature change. The ensuing discussion will identify and explain heat capacity in the states of matter and within our environment.

1. **Safety Note: Cautiously set up the warm water so as not to injure or scald anyone. Students may have a lower tolerance for warm water, so err on the side of caution.**
Prior to this lesson, set up six buckets of water. Three buckets will contain cold water and three buckets will contain very warm water. A large supply of medium temperature water needs to be on hand (you could use a clean garbage pail or aquarium tank). Begin the lesson by asking students to compare a typical day in July with one in December. Point out that your answer will depend upon where you live. Have students think back to the summer that has passed and ask them how many people felt that it was a "hot" summer. There are bound to be a range of responses and that is good because it illustrates the point that a "hot" day is subjective. Now divide the class into small groups (six groups in total). Have the students in three groups place their right hand into the buckets with warm water and the other three groups of students will place their right hands in the buckets with cold water in them. Ask the students whether their bucket has hot or cold water in it. The students should agree that because they each have different water in their buckets they have different answers. Now introduce the medium temperature water and have everyone agree that all of that water must be the same temperature. Take six samples (in containers) from this source and place it near the bucket they still have their hands in. Ask students one at a time to remove their hand from the current bucket and then dip it into the new container of water. Once they have done this they are to go back to their seat without talking and write down in their project journals whether the new sample felt hot or cold.
Initiate a discussion as to why the difference of opinion and hence the need for a quantitative way to describe heat. Introduce the Celsius (centigrade), Fahrenheit, and Kelvin scales. Refer back to the particle play from part A of this subtask. Ask students how particles react to the addition of heat energy.
Share with students that particles are unlike humans as they do not react to heat in a subjective manner. They react only one way for every temperature. In other words, if we could measure their reaction to heat energy we would for sure understand how

truly hot something is.  This is exactly what temperature does.  **"Temperature is the average kinetic energy of the particles in a substance."**  Explain to the class that a common misunderstanding is that heat is temperature and this is not true.  **Heat is a form of energy that moves from matter that is hot to matter that is cold.**  The amount of particle movement (in the matter) caused by adding heat energy is measured by temperature.  Remind them that similarly in earlier grades they would have learned that mass and weight are also not the same thing.  **(Mass is the amount of matter-particles--in an object and weight is the gravitational pull on that object).**

2.  **Safety Note:  Oil can reach very high temperatures very quickly.  An appropriate thermometer that can withstand the high temperatures must be used.  Keep a close eye on the oil and exercise extreme caution when working near the oil.  After identifying that the  oil reaches temperatures above 100$^{o}$C, then turn off the heat source to allow the oil to cool.  DO NOT attempt to move it until it has returned to room temperature.  Be sure to have a fire extinguisher and fire blanket nearby. Use this opportunity to review fire safety routines with the class.**
Students will now consider the factors that affect temperature change.  By setting up the equipment as shown on **BLM 2.10** Rate of Temperature Change and **BLM 2.11** Heat Capacity,   students will compare the rise and fall in the temperature between different masses of water and the rise and fall in the temperature of equal masses of different liquids (olive oil and water).  Students will complete the worksheets and add these to their project journals.

3.  Provide students with a story about people going to the beach in the summer. Many students may have already experienced going to a beach and you will be able to draw on those experiences.  If some students have not experienced a beach, a similar story of walking on the grass and sidewalk will also work.  Ask students about their experiences in the morning, noon, and at sunset.  Focus questions on the temperature of the water and sand.
Share with students that it is the tremendous heat capacity of water that requires it to take so much longer to heat up than the sand.  Not only does it happen on a daily basis but also over months and seasons.  The water slowly heats up in the spring and early summer until a large lake feels warm around the middle of the summer. Beach sand feels warm most summer days and cool most summer nights because sand heats up quickly and releases that heat quickly.  The water stays at  more constant overall temperature.
Similarly,  the middle of a lake will freeze last in the winter while the shoreline which touches the water (has a much lower heat capacity) will freeze early as will the water touching it.



# Bubbles in the Hot Tub - Subtask 2

**Part E "How Slow Can You Go?"**
**Teaching Learning Strategies**
**Suggested Time: 80 min**

Revisiting the particle play, students review the liquid state as these particles are asked to "flow." Viscosity is identified and students predict how the addition of heat energy affects the viscosity of a liquid. Students can put their predictions to the test as they are provided the opportunity to "prove it!"

1. Begin the class with a demonstration of several liquids racing down an inclined plane (see subtask notes). Students are to predict the winner, observe the race, and look back on their predictions. Use liquids that are obvious winners or losers as well as some that are too close to call. Ask them to record in their science journals why they think one liquid was faster than the other. Share the students' ideas with the rest of the class.

2. Students again set up the liquid state of the particle play and move about. Customize the imaginary container they are in by making a hole in it (this is best represented by opening the classroom door into the hallway). The particles react as they flow (walk) out of the room towards the gravitational force that exists in the hallway. Draw attention to the speed at which they (as particles) were able to exit the room. Their speed represents the liquids' "flow rate." Ask what things would affect the flow rate. Point out that particles may also be different shapes and/or sizes and this can affect the rate at which they flow. Introduce some hoops that students will hold around their waists as they leave the room. Try it. Did particle size speed up or slow down their flow rate? What other factors could affect their flow rate? (Size of the opening, a force behind them pushing them out...) They might suggest that the movement of the particles might affect the flow rate. If they don't, ask them who in the room could beat you at a 100 m race? Whatever the answer, ask them "Why?" The response will be something along the line of one person is faster than the other. In other words one is moving faster than the other. If a group of particles are moving faster than another group, we say that they are at a higher temperature (remember..average kinetic..). How can we speed up particle movement? Like athletes, it takes...energy! More specifically, heat energy! So, in addition to particle size, temperature also affects viscosity.

Introduce the term **viscosity**. Viscosity describes a fluid's resistance to flow. The greater the viscosity, the greater the resistance to flow, or in this case, the particles leave the room more slowly.
How can we decrease the viscosity of a liquid? By increasing the particle movement, otherwise known as increasing the temperature. As the particles get heated up, their kinetic energy increases, they move further apart, there is less attraction between particles and they flow more easily. How do we increase the viscosity of a liquid? (opposite scenario)

2. Students are instructed to design an experiment using molasses, hot water, and ice cubes to prove their predictions. Use the **BLM 2.12**. See a list of materials in subtask notes to have on hand.

3. Distribute **BLM 2.13** for homework.

# Bubbles in the Hot Tub - Subtask 2

## Part F "Soup Can Racers"
## Teaching Learning Strategies
## Suggested Time:  120 min

Students take part in a race using various types of soup.  If the volume of soup in each can is the same, then why do some cans travel faster than others?   Students will be challenged to discover the secret that lies under the lid of the fastest can.   Once they get the "scoop on soup," students will be able to identify the concept of density. Further investigations  and the creation of a density tower help students apply their knowledge as they choose and explain, either a natural (ocean water vs. fresh water) or unnatural density changes in the world around them.

1.  Students are placed into teams of five or six at the beginning of science class. While the last lesson looked at viscosity (resistance to flow) and how slow liquids move, this lesson will begin by looking at how fast liquids can move.  The teams will be "Racing Teams" and the racing vehicles will be cans of soup.  For fairness, each can will need to have the same volume of soup.   See the subtask notes for suggestions about which types of soup work best.  Elastics or masking tape may be added to the ends of the can to help them roll in a straight line.   Race the cans of soup two at a time.  Have as many run offs as necessary to be able to put them in order from the fastest to the slowest.  When results have been recorded on **BLM 2.14**, ask for suggestions as to why one can was faster than the others (after all, they were the same shape, same volume, same start).  The suggestion may be made that the contents were different.  By measuring the mass of the cans, you can further illustrate this point.

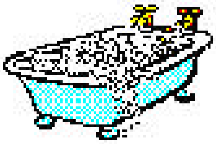
2.  Return again to the particle play.  Begin again with the class demonstrating the liquid state of matter.  Section off 1 mL (about 1/3 of the class).  Ask the students outside the mL to take a step back from the mL boundaries.  Remind the class that one way we measure liquids is by the volume (space), in this case 1 mL.  Another way to measure a liquid is by its mass.  Mass means the amount of matter packed into something.  Because particles are too small to count we use a balance to measure how much mass there is.  For today's particle play, each particle will have an individual mass of 1 gram and we can count them.  What is the mass of this liquid? How much space does it take up?  Perhaps the liquid is water.  Now add some salt particles to the water.  The salt particles are much smaller than the water particles and they easily slip into the spaces between the water particles (add four more students into the liquid).  The salt particles each have a mass of 0.25 grams.  What is the mass of the liquid now?  What would be the mass of this water in outer space?

Won't the mass change? What is the volume? How does this particle play relate to the different masses of soup? Have them return to their seats. The final column on **BLM 2.14** can now be filled in as density. Density is calculated by dividing the mass by the volume.

3. Explain that the mass and volume have a relationship and that the word to describe that relationship is density. Students are given **BLM 2.15**. In groups they will calculate the density of either washers, nuts, bolts, screws, or coins. They will use a total of 10 items per group. All 10 must be identical. The BLM will guide them through their investigation.

4. Display three different liquids (water with food colouring, vegetable oil, glycerin) that you have already calculated the density for. Place an equal amount of each into a large graduated cylinder. Have students observe what has happened and determine if there is a pattern. They should identify that the denser liquid sank to the bottom and the liquid with the least density floated to the top. Have them record this in their project journal. To this graduated cylinder, add several classroom found items that have a density between two of the liquids. These objects when placed into the column will sink through one liquid and float on top of the liquid directly beneath. Notice that different objects float on some liquids yet sink in others. Set this aside to look at again next day.

5. Using **BLM 2.16**, students use the particle theory to explain a density change. When taking up this activity the teacher should help students make some generalizations about the density of solids, liquids, and gases.



# Bubbles in the Hot Tub - Subtask 2

**Part G "It's All Greek to Me"**
**Teaching Learning Strategies**
**Suggested Time:  80 min**

The warm-up activity of blowing bubbles into a glass of water will launch this part of the subtask that links density to buoyancy.  Students are introduced to the work of Archimedes and the work he did with respect to density and buoyancy.   Students will have an opportunity to experiment with foil boats and student created hydrometers. The relationship between density and buoyancy will be drawn and the connections to the real world context of pools and safety devices (i.e., PFDs) will be made.

1.  Begin by having students blow bubbles into a clear glass of water.   Ask students to describe the bubbles.  What are they made of?  Where are they going?   Why? Provide syringes for students to use instead of blowing with straws.  From the earlier work, students should  be able to make a "most of the time" observation that gases tend to be less dense than liquids.

2.  Last lesson, the students learned that the density of a substance affects whether it will float in another substance.  In this lesson, students are introduced to the Greek scientist Archimedes.  There are numerous accounts of Archimedes available and you can share one of these with the class.  The Greek scientist Archimedes was asked by the king to determine if the king's crown was made of pure gold. Archimedes knew that if he could calculate the density of a supposed gold crown it would be the same as a sample of pure gold.  Finding the mass was easy but the volume was tricky because of the shape.  Ask the students if they can think of a way to measure the volume  of an irregular shape.  (Some will connect back to the Calculating Density lesson.)  When Archimedes got into a tub of water, it overflowed and he realized he had a way of determining the volume and hence, the density.  The crown turned out to be not pure gold.  This solution got Archimedes thinking about the water that was displaced and after some experimenting, he put forth what is now known as Archimedes principle.  **"The buoyant force acting on an object is equal to the weight of the fluid displaced by the object."**  In simpler terms, If you want something that would normally sink in a certain fluid to float, then you need to have it displace enough fluid (with a greater mass than the weight of the object) so that the object will float.  This is exactly how steel (more dense than water) boats float.

3. Pairs of students are given a piece of aluminum foil and are asked to make it into a boat that will float and hold the greatest mass. Set up several tubs of water around the room for the testing of their creations. Have students record their observations in their project journals.

4. Remind and show students the density tower that was assembled last day. Some objects, despite their shapes, were more buoyant in some liquids than in others. So it is not just the shape of the object that affects its buoyancy. It is also the density of the liquid as well as the density of the object. This is the guiding principle behind a hydrometer. Students now make and calibrate a pencil hydrometer as explained on the **BLM 2.17**. Having made the pencil hydrometer, students are to use it to compare the density of various liquids. Students will predict what will happen if any of the liquids are mixed together. See the subtask notes for suggested liquids to use.

5. Students complete **BLM 2.18**. This BLM allows them to demonstrate their knowledge that buoyant forces would not exist if it were not for gravity. They make a list of buoyant objects found around a pool.

# Convection Connection

Name:_________________

Date: _________________

**PROBLEM:**

Can fluid motion and convection columns be visualized?

**HYPOTHESIS:**

_______________________________________________

_______________________________________________

_______________________________________________

**MATERIALS:**

aluminum pie-pan, hot plate, dye (any colour), tap water, liquid hand soap or shampoo with a pearly or metallic appearance (look for glycol stearate or glycol distearate on the label), safety goggles.

**PROCEDURE:**

1. Fill the pie-pan between 1/2 to 3/4 full of tap water and add about 30 mL of hand soap.
2. Gently stir the soap and water solution so as not to create bubbles. Stir until the soap is mixed throughout the solution.
3. Add a few drops of dye to the solution to darken it.
4. Let your soap solution settle for 1 minute so that there is very little fluid motion.
5. Plug in the hot plate and place it on a low setting.
6. Carefully place the pie-pan on top of the heating element.
7. As the solution approaches the boiling point, carefully watch what happens to the pearly metallic luster of the solution.
8. Draw a diagram to demonstrate what you observed.
9. After a while, remove the pie-pan from the heat source and place it on a cool flat surface. Make careful observations as to what happens next.
10. Clean up all materials as per teacher instructions.

**OBSERVATIONS:**

1. Describe what happens to the pearly metallic luster of the solution as it approaches the boiling point. ________________________________________

_______________________________________________

_______________________________________________

2. Illustrate the convection columns you observed as the solution reached the boiling point.

## CONCLUSION:

1. Describe how the convection cells travelled from the bottom of the solution to the top?

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

2. Why do you think the dye was added to the solution?

______________________________________________________________________

______________________________________________________________________

## APPLICATION:

1. Relate this movement of fluid to what you already know about the particle theory of matter?

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

2. Where else have you seen fluid motion similar to this when heat is added to different substances?

______________________________________________________________________

______________________________________________________________________

**Conduction Craze** Name:________________

Marshmallow Madness Date: ________________

## Activity 1

As you know, roasting marshmallows is a favourite summer outdoor activity that many people enjoy. A company that produces cookware utensils has asked you and your group to determine what material should be used in making marshmallow roasters. Assume the utensil would not be held directly in the fire, but close enough to roast the tantalizingly tasty treat. Your group must test four different materials before making a decision.

**PROBLEM:**
What material would serve as the best material for making marshmallow roasting utensils?

**MATERIALS:**
20 cm pieces of wood (could use pencils or skewers), plastic or plastic straws, glass, metal (could use butter knife), water, kettle, marshmallows, and 250 mL beaker.

**PROCEDURE:**
1. Place a marshmallow at the end of a 20 cm piece of each substance.
2. Place the other end in a 250 mL beaker of boiling hot water.
3. Carefully observe what happens to the marshmallow at the end of each material.
4. Clean up all materials before rotating to the next centre.

**OBSERVATIONS:**
_______________________________________________________________

_______________________________________________________________

_______________________________________________________________

**CONCLUSION:** What type of material would you suggest the company use for their marshmallow roasting utensils? Is there a possible combination of materials that could be used? What material conducted the heat from the water most quickly?

_______________________________________________________________

_______________________________________________________________

_______________________________________________________________

_______________________________________________________________

**Conduction Craze** Name:_________________

An "Ice"olated Incident Date: _________________

## Activity 2

**PROBLEM:**
Can you insulate a substance such as ice?

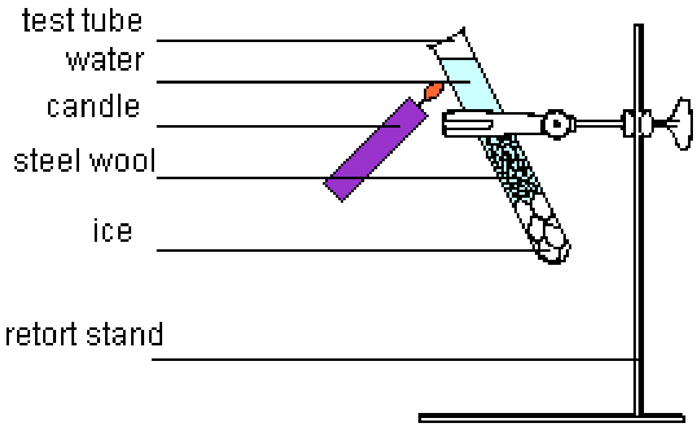
**MATERIALS:**
test tube, water, steel wool, ice (broken into smaller pieces), candle or other open flame such as a barbecue igniter (check school board policy), safety goggles, clamps, retort stand.

**PROCEDURE:**
1. Put some ice in the bottom of a test tube.
2. Put some steel wool in the test tube on top of the ice to keep the ice at the bottom.
3. Fill the test tube up with water.
4. Place the test tube in clamps on a retort stand and heat the top of the test tube with an open flame.
5. Clean up materials before rotating to the next centre.

**OBSERVATIONS:**
_______________________________________________________________________________
_______________________________________________________________________________
_______________________________________________________________________________

**CONCLUSION:**
Why does the ice remain at the bottom of the test tube even though the water is boiling at the top end of the test tube? How would your results compare if you had used cotton fibre instead of the steel wool?

_______________________________________________________________________________
_______________________________________________________________________________
_______________________________________________________________________________



**Conduction Craze** Name:__________________

Ice Savers Date: __________________

## Activity 3

A local hockey arena is having difficulty keeping the ice from melting on warmer days. They decide to line the ice with a material to help insulate it. Your group has been asked for input based on findings from this investigation. Using extruded polystyrene, plastic, and paper cups conduct an experiment to determine which material the arena should use to line the ice.

**PROBLEM:**
What material would help insulate ice, so that it would not melt as quickly?

**MATERIALS:**
extruded polystyrene, glass cup, plastic and paper cups, ice cubes of similar size, four small graduated cylinders, stopwatch or other time measuring device.

**PROCEDURE:**
1. Place an ice cube in each cup.
2. Start the stopwatch. After a five-minute interval, pour the water that has melted in each cup out and into a graduated cylinder.
3. Record the amount of water that comes out of each cup.
4. Repeat steps 3 and 4 for two more five-minute intervals.
5. Clean up materials before rotating to the next station.

**OBSERVATIONS:**

| Materials | 5 minutes | 10 minutes | 15 minutes | Total |
|---|---|---|---|---|
| Polystyrene | | | | |
| Plastic | | | | |
| Glass | | | | |
| Paper | | | | |

**CONCLUSION:**
What material would you suggest the arena use to line the ice? Give reasons for your proposal, using the appropriate vocabulary to back up your rationale.

________________________________________________________________

________________________________________________________________

________________________________________________________________

________________________________________________________________

**APPLICATION:**
Use data from your observations chart to make a line graph that shows which substance was better at insulating the ice in the cup.

**Conduction Craze** Name:_________________

Thought Experiments Date: _________________

## Activity 4

Discuss the following situations with your group members and try to solve the problems by applying what you know about the transfer of heat by conduction. A reminder that materials that transfer heat well by conduction are called **conductors**, while materials that do not conduct heat efficiently through their atoms are called **insulators**.

**A.** It is 9:00 p.m. on a warm July night. The sun set at 8:36 p.m. Two houses sit side by side; one with white vinyl exterior siding, the other with red clay brick finishing. You touch each house to find that the red clay brick house feels much warmer to your hand than the white vinyl sided house. Why is this so?

______________________________________________

______________________________________________

______________________________________________

**B.** It is a mid October morning. A light dusting of snow had fallen overnight. You had helped clean out the garden the previous night and left some tools outside. While picking up a metal hand shovel, you observe that it feels much colder than the plastic hand grips of the pruning shears. Is the metal hand shovel really colder than the pruning shears? How can you explain this?

______________________________________________

______________________________________________

______________________________________________

**C.** A large layer of ice about 3 cm in thickness has built up in your freezer. Do you think this is good for the energy efficiency of your freezer? Explain why or why not.

______________________________________________

______________________________________________

______________________________________________

**D.** Your neighbour has complained that the concrete floor in his basement is almost always cold. He just installed new carpeting and under-padding, but the floor still seems cold. Why is this so? What could the neighbour have done to avoid this problem?

______________________________________________

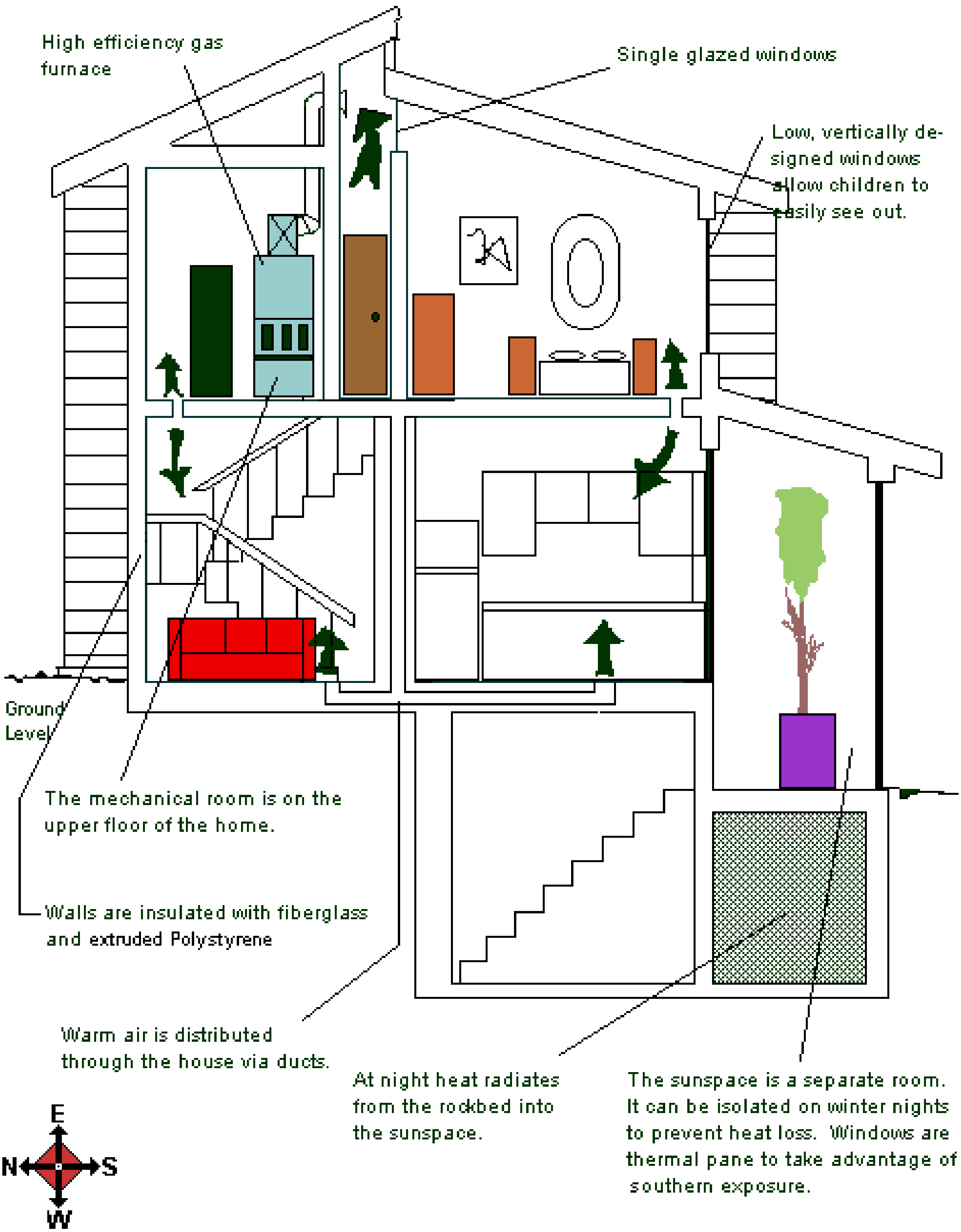
______________________________________________

______________________________________________

# The Energy Efficient Home

Name: ________________

Date: ________________



# Household Heating Sytems

Name:_______________

Date: _______________

1. Identify examples of convection, conduction, and radiation in the model energy efficient home.

________________________________________

________________________________________

________________________________________

________________________________________

2. Identify the components in the home that are important for heat transfer.

________________________________________

________________________________________

________________________________________

3. Suggest ways in which one could conserve more energy in this home. Why would one want their home to be more energy efficient?

________________________________________

________________________________________

________________________________________

________________________________________

4. Think of ways your own living space could be more energy efficient.

________________________________________

________________________________________

________________________________________

# CHECKLIST FOR SPECIFIC EXPECTATIONS

| Student | – identify and describe steps that can be taken to conserve energy (e.g., using insulation) and the reasons for doing so (e.g., rising fuel costs). | – identify the components of a system that are designed to transfer heat energy (e.g., in a room, a house, or a shopping centre) and describe methods for conserving energy within that system. | – formulate questions about and identify needs and problems related to heat (e.g., interactions involving energy transfers), and explore possible answers and solutions. |
|---|---|---|---|
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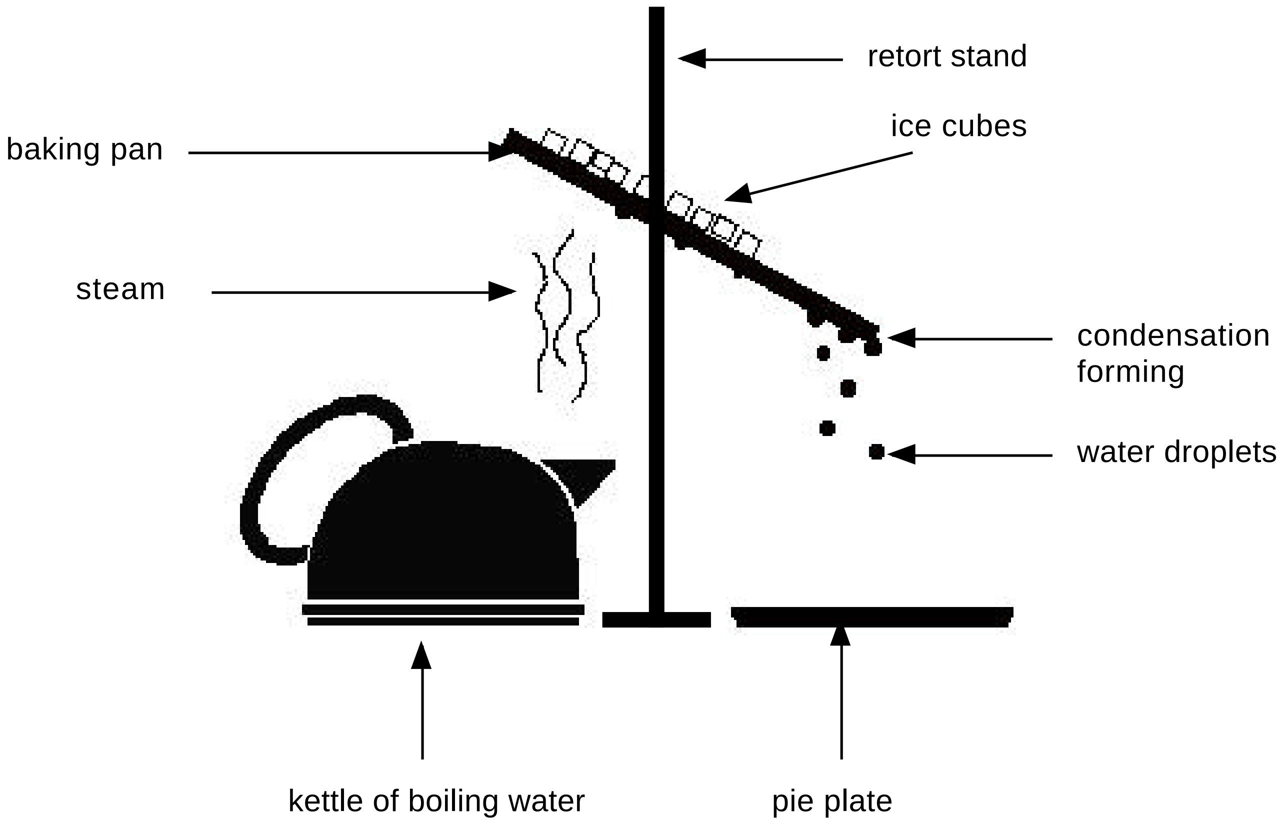
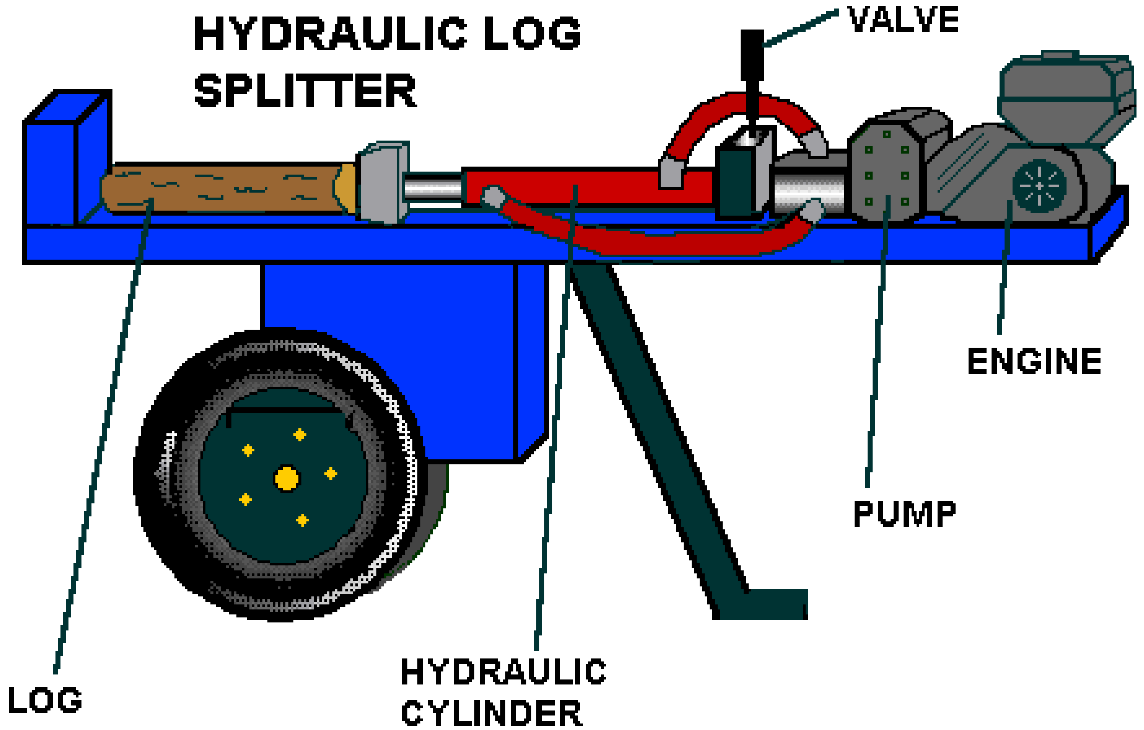
# Water Cycle Demonstration
# Teacher Setup



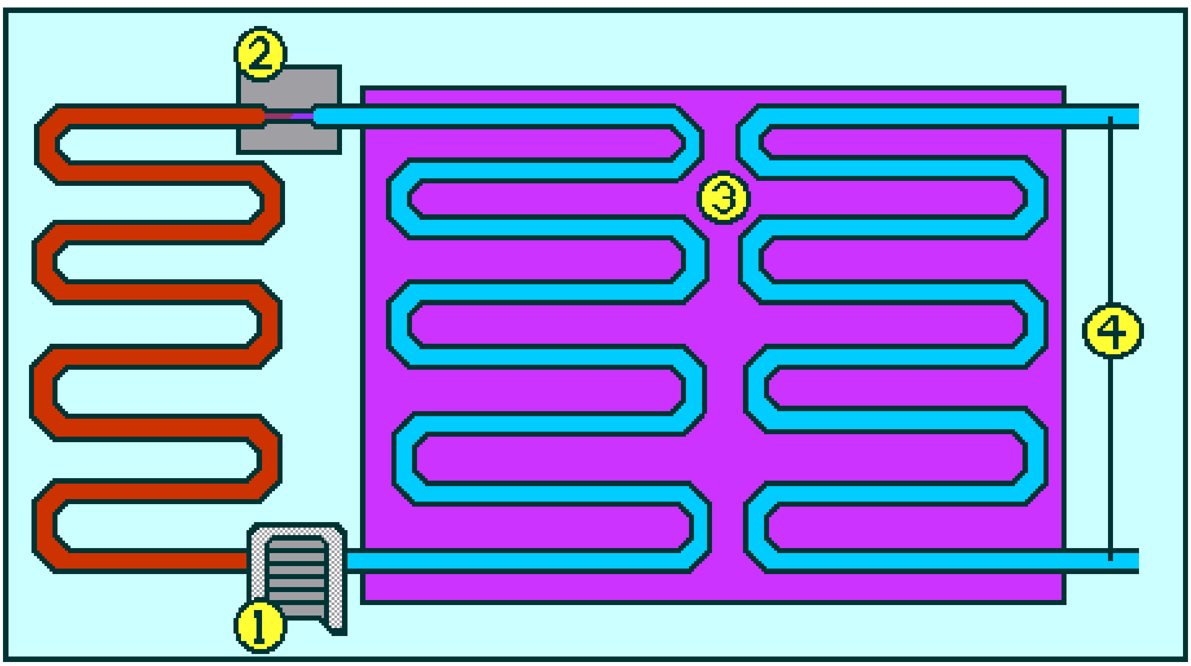

Note: Pouring the water that collects in the pie plate back into the kettle completes the cycle. Ask the students if they know what part of the cycle this represents (runoff).

**Safety Note: Exercise caution when working near the steam. Tongs and clamps are excellent devices to avoid being scalded. Securely attach the baking pan to a retort stand. Clamp the pie plate to the table. Students should stay back a safe distance to avoid being burned by splashes made by the drops of water hitting the pie plate.**

Name:________________________ Date: ________________



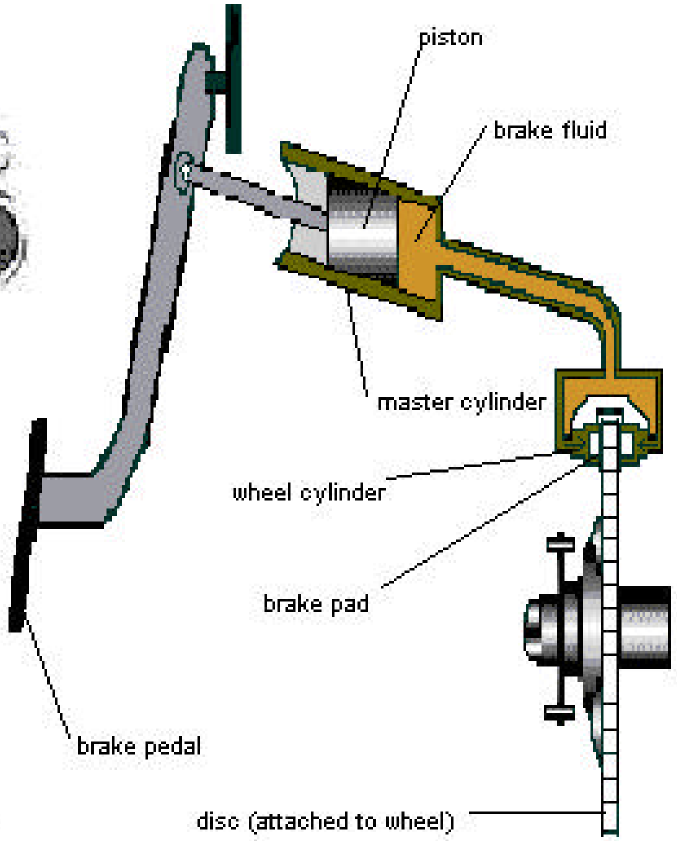

## AIR CONDITIONING UNIT




1. COMPRESSOR
2. EXPANSION VALVE
3. HEAT EXCHANGER
4. CHILLED WATER TO BUILDING

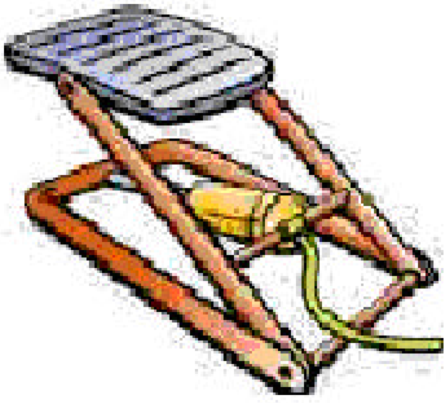
Name: ______________________ Date: ______________

## HYDRAULIC BRAKE SYSTEM




**BLOOD PRESSURE**

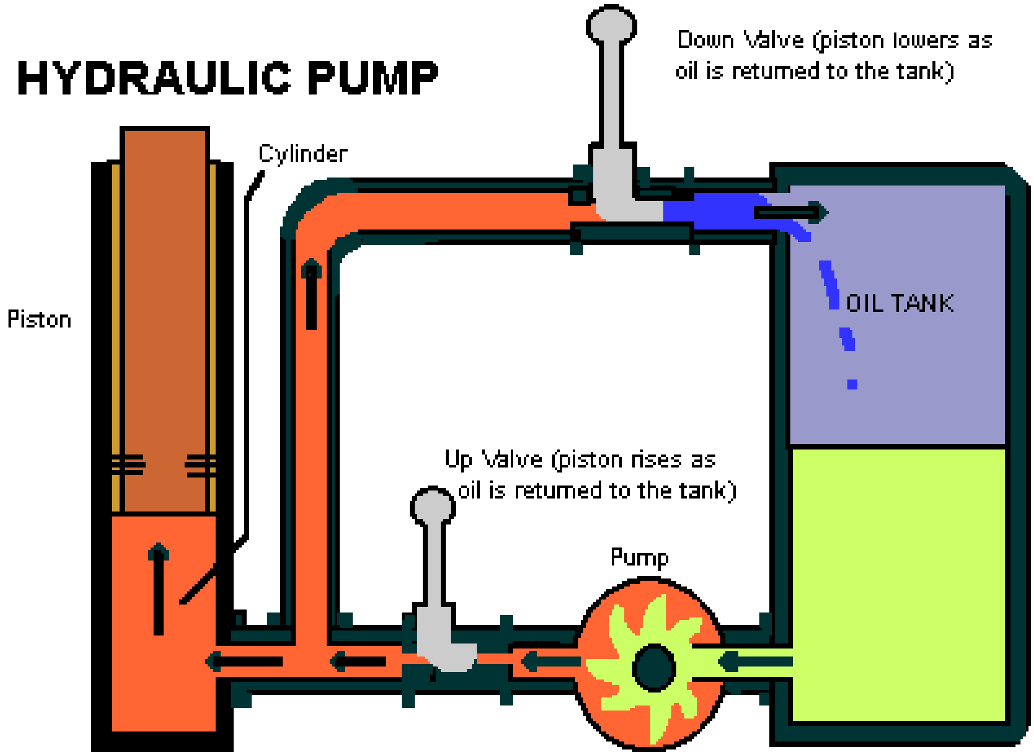
**JACKHAMMER**



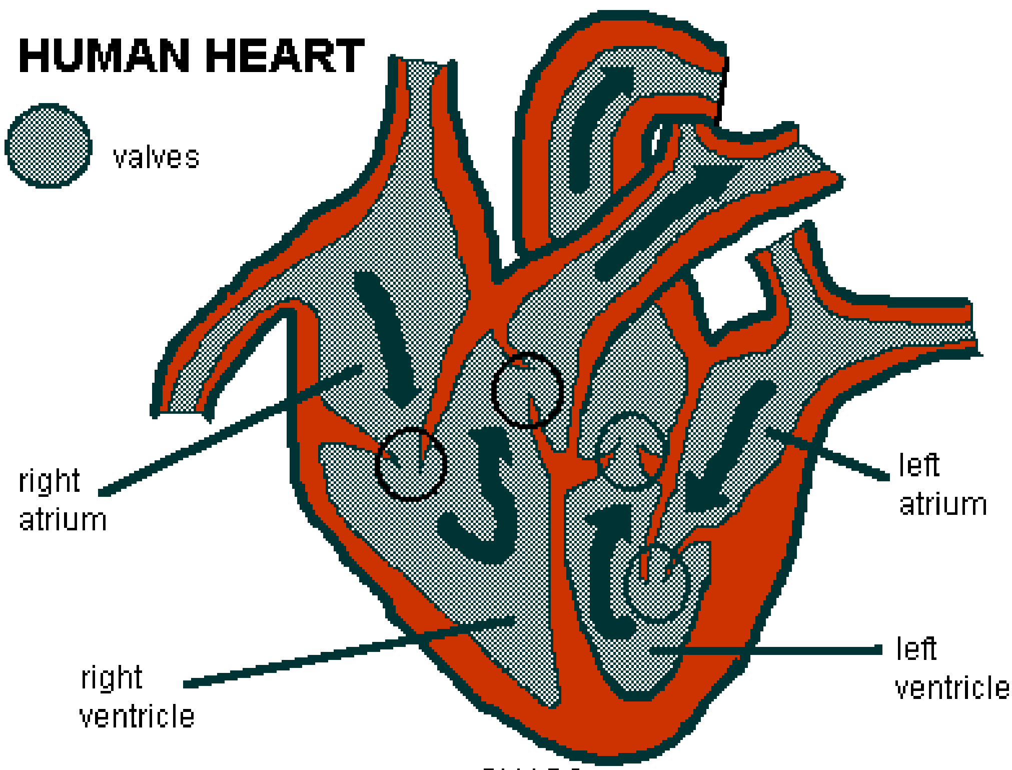
**FOOT PUMP (BICYCLE)**

Name:_______________________ Date: _______________

## HYDRAULIC PUMP




## HUMAN HEART

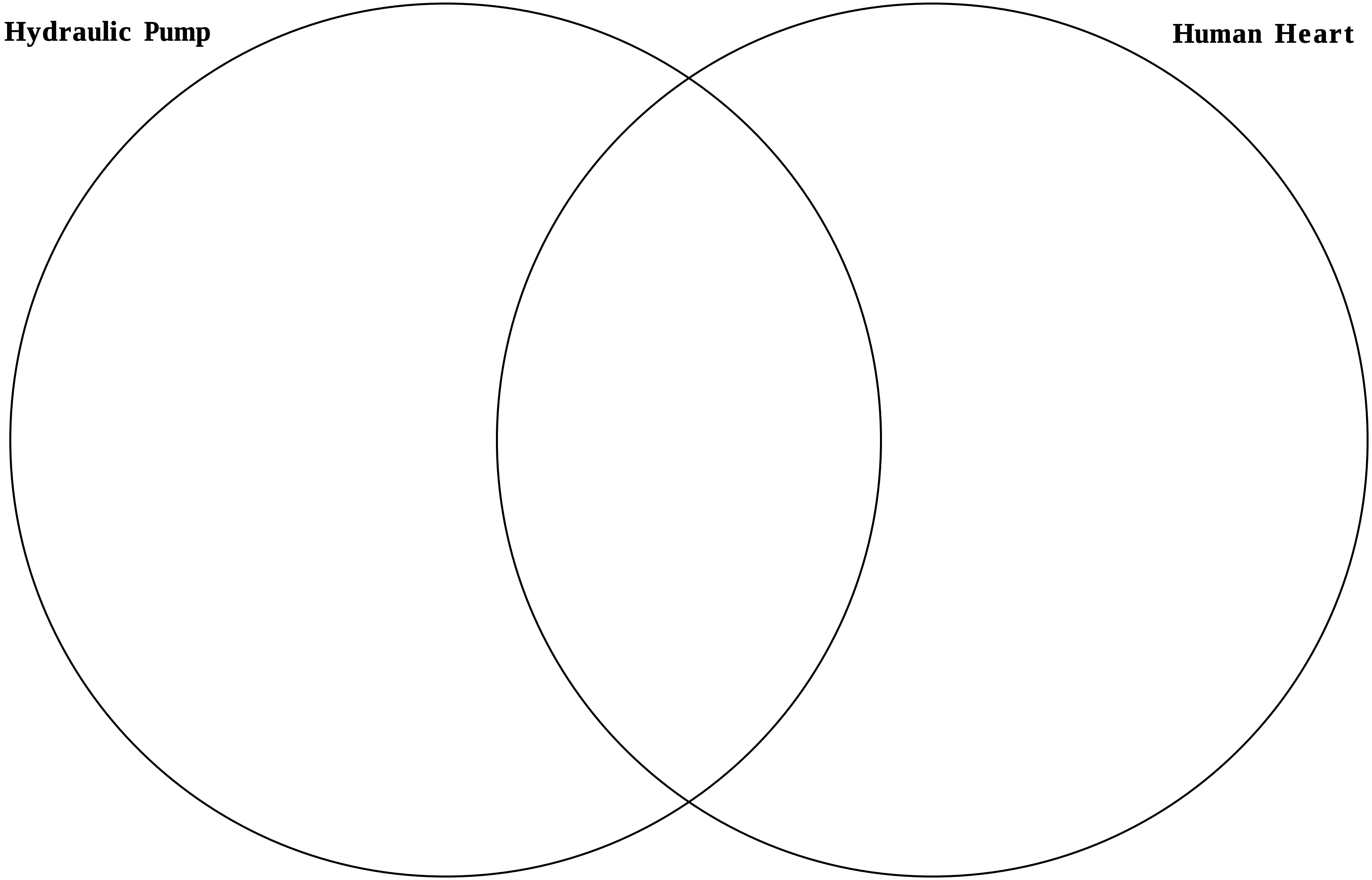



BLM 5.3

# VENN DIAGRAM

Name:______________

Date: ______________



# Keep the Heat

Name:_________________

Date: _________________

Part #1

**SCENARIO:**
There is a shortage of stainless steel and the manufacturers of insulated containers need your help. Your cracker-jack team of engineering experts has been selected to develop a new type of insulated bottle that will be produced during this stainless steel shortage. You must plan your blueprints carefully and construct the insulated container from a wide variety of available materials. Remember to consider conduction heat transfer when building your insulated container. The future of long lasting hot chocolate, coffee, and steaming hot soup lunches is in your hands.

**POSSIBLE MATERIALS:** larger plastic bottles or containers (could use 2 litre pop bottles), cotton baton, fibreglass insulation (use gloves to handle), extruded polystyrene pieces (packing chips), sand, or salt.

**CRITERIA:**
1. The bottle needs to be insulated with other materials to try to keep the heat in the container.
2. The insulated container must be a practical working model (i.e., there cannot be any loose parts and the design must be something that could be produced).
3. The design can be no larger than 40 cm in length, width, or height.

# Keep the Heat

Name:_________________

Date: _________________

Part #2

**MATERIALS:** kettle, thermometers, 1 litre beakers or graduated cylinders, water, oven mitts, safety goggles, insulated container.

**PROCEDURE:**

1. Using the kettle, boil water.
2. Wearing the oven mitts and safety goggles, measure 750 mL of the hot water with the beaker or graduated cylinder. Be very careful with the hot water.
3. Pour 750 mL of the water into your insulated container.
4. Seal the insulated container with a lid and wait 5 minutes.
5. Measure and record the temperature of the water after 5 minutes.
6. Repeat step 5 every 5 minutes for a 25-minute duration.
7. Clean up all materials and apparatus.

**RECORDING:**

| **Time** | **5 minutes** | **10 minutes** | **15 minutes** | **20 minutes** | **25 minutes** |
|---|---|---|---|---|---|
| **Temperature** | | | | | |

# Testing Toy Technology

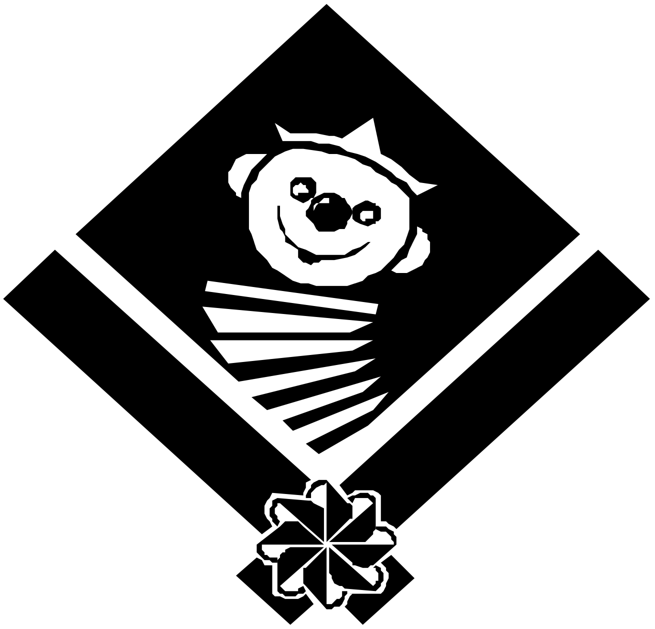
Name:_________________

Date: _________________

**SCENARIO:**
Once again your expert engineering staff has been called into action. The latest craze in children's toy technology is fluid-powered toys. After conducting some research, your group has been challenged to develop a toy that operates principally from a hydraulic or pneumatic system. The toy must be something that can operate safely and not cause personal harm. Perhaps, you may consider a toy that can be used in a swimming pool or hot tub.

**POSSIBLE MATERIALS:** syringes, tubing, cardboard boxes, rubber, plastic containers, wood, paper, thread spools, marbles, straws, tape, glue, scissors (many possibilities).

**CRITERIA:**
1. The model must be no larger than 50 cm in length, width, or height.
2. The toy must have a fluid-powered system of some type, be it hydraulic or pneumatic system.
3. The toy must be something that has aesthetic value, so it would be something children would want to play with.
4. The model must be functional.



# Student Self-Assessment

Name:___________

Date: __________

**Circle the corresponding number for each statement.**

**1 - Needs Improvement    2 - Fair    3 - Good    4 - Very Good    5 - Excellent**

1. In this subtask, some of the concepts include understanding basic operating principles of hydraulic and pneumatic systems. Rate your understanding of these operating principles. **1 2 3 4 5**

2. In this subtask, it was very important to apply the important design skills and strategies to construct the thermos and the hydraulic/ pneumatic toy. Rate your performance on these design skills. **1 2 3 4 5**

3. While presenting your design activities to classmates, it is very important to use communication skills to relate your knowledge. Rate your ability to communicate effectively with your classmates and teacher. **1 2 3 4 5**

4. What activity did you find the most interesting in this subtask?

______________________________________________

______________________________________________

______________________________________________

5. What part of the subtask did you find the most difficult or challenging?

______________________________________________

______________________________________________

______________________________________________

6. If you were to change anything you did in this subtask, what would it be and why?

______________________________________________

______________________________________________

______________________________________________

# Hot Tub Challenge

Name: __________________

## Grade 7 Culminating Task

Date: _______________

Whether you live in a big city or a small town, most people have some place to go to get a good workout. Many people in your community use the recreation centre as they exercise with friends. Your local recreation department understands the value of keeping your community healthy. They would like to attract more people to use the recreation centre facilities. The Recreation Department has surveyed your community and they now feel that installing a "hot tub" near the swimming pool will attract more people. They would like someone from your community to design and build the hot tub.

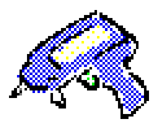
Your teacher has submitted your name (as well as others) to take on the task of designing and building the hot tub. The knowledge of heat transfer demonstrated in your project journal makes you a perfect candidate for this job.

# The Challenge

## Design It!

You are to design a hot tub for the local recreation centre. Your design must demonstrate a complete knowledge of heat transfer. The blueprints you submit must include the heating system that you will use to make the water hot. Your overall design and choice of materials to be used for the full-sized tub will also be carefully considered. ***Remember: once you get the heat in the water, you don't want to lose it.***

## Build It!



You are to build a model of your hot tub. It need not work but it must be 3-dimensional. Your model should be built from materials found around your home. However, it does not have to be built from the same materials that you chose in the full-sized design. Building a working model is also acceptable.

It is expected that you will use a variety of information to influence your design. You are expected to work on this project outside of classroom time. However, you will have an additional ____ classes to work on this. On the day that it is due, be prepared to share it with the rest of the class.

**You will need to submit:**

- your design blueprint (include annotations)
- your 3D model
- reflections on what you would do differently next time

# The Hot Tub Challenge is due: ___________

# Hot Tub Challenge

Name: ___________________

Grade 8 Culminating Task

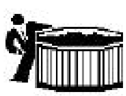
Date: ________________

Whether you live in a big city or a small town, most people have some place to go to get a good workout. Many people in your community use the recreation centre as they exercise with friends. Your local recreation department understands the value of keeping your community healthy. They would like to attract more people to use the recreation centre facilities. The Recreation Department has surveyed your community and they now feel that installing a “hot tub” near the swimming pool will attract more people. They would like someone from your community to design and build the hot tub.

Your teacher has submitted your name (as well as others) to take on the task of designing and building the hot tub. The knowledge of fluids, pneumatics, and hydraulics demonstrated in your project journal makes you a perfect candidate for this job.

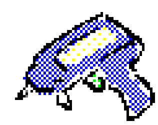
## The Challenge

### Design It!



You are to design a hot tub for the local recreation centre. Your design must demonstrate a complete knowledge of fluids including pneumatics and hydraulics. The blueprints you submit must include a system that will generate and control water movement (whirlpool or current) and effervescence (bubbles).

### Build It!



You are to build a model of your hot tub. It need not work but it must be 3-dimensional. Your model should be built from materials found around your home. However, it does not have to be built from the same materials that you chose in the full-sized design. Building a working model is also acceptable.

It is expected that you will use a variety of information to influence your design. You are expected to work on this project outside of classroom time. However, you will have an additional ____ classes to work on this. On the day that it is due, be prepared to share it with the rest of the class.

**You will need to submit:**

- your design blueprint (include annotations)
- your 3D model
- reflections on what you would do differently next time

## The Hot Tub Challenge is due: ___________

Student Name:_________________________
Date:______________________

# Project Journal Assessment

**for use with Subtask 2 : Particle Play**

from the Grade 7/8 Unit: **Bubbles in the Hot Tub**

## Expectations for this Subtask to Assess with this Rubric:

**7s56** – compare the motions of particles in a solid, a liquid, and a gas using the particle theory;

**7s59** – describe the effect of heating and cooling on the volume of a solid, a liquid, and a gas;

**7s61** – describe the effect of heat on the motion of particles and explain how changes of state occur (e.g., from a liquid into a gas or vapour);

**8s39** – compare fluids in terms of their compressibility or incompressibility (e.g., gases versus liquids);

**8s52** – communicate the procedures and results of investigations for specific purposes and to specific audiences, using media works, written notes and descriptions, charts, graphs, drawings, and oral presentations (e.g., create a table to show the relationship between the buoyant force and size of object);

| Category/Criteria | Level 1 | Level 2 | Level 3 | Level 4 |
|---|---|---|---|---|
| **Understanding of the particle theory 7/8** | – shows a limited understanding of the particle theory<br>– demonstrates significant misconceptions<br>– gives explanations showing limited understanding of the concepts | – shows some understanding of the particle theory<br>– demonstrates minor misconceptions<br>– gives partial explanations | – shows good understanding of the particle theory<br>– demonstrates no significant misconceptions<br>– usually gives complete or nearly complete explanations | – shows thorough understanding of the particle theory<br>– demonstrates no misconceptions<br>– always gives complete explanations |
| **Communication of required knowledge (diagrams) 7/8** | – communicates with little clarity, precision, and neatness<br>– rarely uses appropriate labels and annotations | – communicates with some clarity, precision, and neatness<br>– sometimes uses appropriate labels and annotations | – generally communicates with clarity, precision, and neatness<br>– usually uses appropriate labels and annotations | – consistently communicates with clarity, precision, and neatness<br>– consistently uses appropriate labels and annotations |
| **Communication of required knowledge (written) 7/8** | – communicates with little clarity and precision<br>– rarely uses appropriate science and technology terminology and units of measurement | – communicates with some clarity and precision<br>– sometimes uses appropriate science and technology terminology and units of measurement | – generally communicates with clarity and precision<br>– usually uses appropriate science and technology terminology and units of measurement | – consistently communicates with clarity and precision<br>– consistently uses appropriate science and technology terminology and units of measurement |
| | | | | |

**Student Name:**__________________________
**Date:**________________________

# Viscosity Rubric

**for use with Subtask 2 : Particle Play**

from the Grade 7/8 Unit: **Bubbles in the Hot Tub**

## Expectations for this Subtask to Assess with this Rubric:

**7s56** – compare the motions of particles in a solid, a liquid, and a gas using the particle theory;

**7s61** – describe the effect of heat on the motion of particles and explain how changes of state occur (e.g., from a liquid into a gas or vapour);

**8s48** – formulate questions about and identify needs and problems related to the properties of fluids, and explore possible answers and solutions (e.g., design a fair test to determine whether oil, water, or glycerol has the greatest viscosity);

**8s49** – plan investigations for some of these answers and solutions, identifying variables that need to be held constant to ensure a fair test and identifying criteria for assessing solutions;

**8s52** – communicate the procedures and results of investigations for specific purposes and to specific audiences, using media works, written notes and descriptions, charts, graphs, drawings, and oral presentations (e.g., create a table to show the relationship between the buoyant force and size of object);

| Category/Criteria | Level 1 | Level 2 | Level 3 | Level 4 |
|---|---|---|---|---|
| **Understanding of particle theory** | – shows understanding of few of the basic concepts (kinetic energy, attraction between, space between, volume of)<br>– demonstrates significant misconception<br>– explanations show limited understanding of the concepts | – shows understanding of some of the basic concepts (kinetic energy, attraction between, space between, volume of)<br>– demonstrates minor misconceptions<br>– gives partial explanations | – shows understanding of most of the basic concepts (kinetic energy, attraction between, space between, volume of)<br>– demonstrates no significant misconceptions<br>– refers to the location on the continuum | – shows understanding of all of the basic concepts (kinetic energy, attraction between, space between, volume of)<br>– demonstrates no misconceptions<br>– defines the location and direction of movement on the continuum |
| **Communication of ideas** | – communicates with little clarity and precision<br>– rarely uses appropriate particle theory terminology | – communicates with some clarity and precision<br>– sometimes uses appropriate particle theory terminology | – generally communicates with clarity and precision<br>– usually uses appropriate particle theory terminology | – consistently communicates with clarity and precision<br>– consistently uses appropriate particle theory terminology |
| **Inquiry and design skills** | – applies few of the required design skills<br>– shows little awareness of the safety procedures<br>– uses equipment, and materials correctly only with assistance | – applies some of the required design skills<br>– shows some awareness of safety procedures<br>– uses equipment, and materials correctly with some assistance | – applies most of the required design skills<br>– usually shows awareness of safety procedures<br>– uses equipment, and materials correctly with only occasional assistance | – applies all (or almost all) of the required design skills<br>– consistently shows awareness of safety procedures<br>– uses equipment, and materials correctly with little or no assistance |
| | | | | |

**Student Name:**_________________________
**Date:**_______________________

# Density Rubric

**for use with Subtask 2 : Particle Play**

from the Grade 7/8 Unit: **Bubbles in the Hot Tub**

## Expectations for this Subtask to Assess with this Rubric:

**7s56** – compare the motions of particles in a solid, a liquid, and a gas using the particle theory;

**7s59** – describe the effect of heating and cooling on the volume of a solid, a liquid, and a gas;

**8s37** – determine, through experimentation, the mass-to-volume ratio of different amounts of the same substance (e.g., copper pennies);

**8s48** – formulate questions about and identify needs and problems related to the properties of fluids, and explore possible answers and solutions (e.g., design a fair test to determine whether oil, water, or glycerol has the greatest viscosity);

**8s49** – plan investigations for some of these answers and solutions, identifying variables that need to be held constant to ensure a fair test and identifying criteria for assessing solutions;

| Category/Criteria | Level 1 | Level 2 | Level 3 | Level 4 |
|---|---|---|---|---|
| **Understanding of density** | – shows little understanding of density<br>– demonstrates significant misconception<br>– gives explanations showing limited understanding of the concepts | – shows some understanding of density<br>– demonstrates minor misconceptions<br>– gives partial explanations<br>– refers to the particle theory | – shows a good understanding of density<br>– demonstrates no significant misconceptions<br>– correctly refers to the particle theory | – shows a complete understanding of density<br>– demonstrates no misconceptions<br>– uses the particle theory to back up their ideas |
| **Accuracy of results** | – the calculations are inaccurate<br>– demonstrates multiple errors<br>– uses incorrect units of measure or no units at all | – the calculations are fairly accurate<br>– demonstrates some errors<br>– uses units of measure appropriate to density but not for a solid (g/mL) | – most of the calculations are accurate to two decimal places<br>– demonstrates no significant errors<br>– uses appropriate units of measure ($g/cm^3$) | – all of the calculations are accurate to two decimal places<br>– demonstrates no errors<br>– uses correct units of measure ($g/cm^3$) |
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# Investigation Assessment

**for use with Subtask 3 : Meet the Heat**

from the Grade 7/8 Unit: **Bubbles in the Hot Tub**

**Student Name:**__________________________
**Date:**________________________

## Expectations for this Subtask to Assess with this Rubric:

**7s53** • identify, through experimentation, ways in which heat changes substances, and describe how heat is transferred;

**7s57** – explain how heat is transmitted by conduction, convection, and radiation in solids, liquids, and gases (e.g., conduction: a pot heating on a stove; convection: a liquid heating in the pot; radiation: the air being warmed by heat from the element);

**7s58** – describe how various surfaces absorb radiant heat;

**7s78** – identify and describe steps that can be taken to conserve energy (e.g., using insulation) and the reasons for doing so (e.g., rising fuel costs);

**8s52** – communicate the procedures and results of investigations for specific purposes and to specific audiences, using media works, written notes and descriptions, charts, graphs, drawings, and oral presentations (e.g., create a table to show the relationship between the buoyant force and size of object);

| Category/Criteria | Level 1 | Level 2 | Level 3 | Level 4 |
|---|---|---|---|---|
| **Understanding of heat transfer** | – shows understanding of few of the basic concepts of heat transfer<br>– demonstrates significant misconceptions<br>– gives explanations showing limited understanding of the concepts | – shows understanding of some of the basic concepts of heat transfer<br>– demonstrates minor misconceptions<br>– gives partial explanations | – shows understanding of most of the basic concepts of heat transfer<br>– demonstrates no significant misconceptions<br>– usually gives complete or nearly complete explanations | – shows understanding of all of the basic concepts of heat transfer<br>– demonstrates no misconceptions<br>– always gives complete explanations |
| **Communication of required knowledge (graphing)** | – communicates with little clarity and precision<br>– rarely uses appropriate science and technology terminology and units of measurement | – communicates with some clarity and precision<br>– sometimes uses appropriate science and technology terminology and units of measurement | – generally communicates with clarity and precision<br>– usually uses appropriate science and technology terminology and units of measurement | – consistently communicates with clarity and precision<br>– consistently uses appropriate science and technology terminology and units of measurement |
| **Communication of required knowledge (written)** | – communicates with little clarity and precision<br>– rarely uses appropriate science and technology terminology and units of measurement | – communicates with some clarity and precision<br>– sometimes uses appropriate science and technology terminology and units of measurement | – generally communicates with clarity and precision<br>– usually uses appropriate science and technology terminology and units of measurement | – consistently communicates with clarity and precision<br>– consistently uses appropriate science and technology terminology and units of measurement |
| **Relating of science and technology to each other and to the world outside the school (thought experiments)** | – shows little understanding of connections between science and technology in familiar contexts<br>– shows little understanding of connections between science and technology and the world outside the school | – shows some understanding of connections between science and technology in familiar contexts<br>– shows some understanding of connections between science and technology and the world outside the school | – shows understanding of connections between science and technology in familiar contexts<br>– shows understanding of connections between science and technology and the world outside the school | – shows understanding of connections between science and technology in both familiar and unfamiliar contexts<br>– shows understanding of connections between science and technology and the world outside the school, as well as their implications |

# Assessment of Design Activites

**for use with Subtask 5 : Technological Treats**
from the Grade 7/8 Unit: **Bubbles in the Hot Tub**

**Student Name:**___________________________
**Date:**_______________________

## Expectations for this Subtask to Assess with this Rubric:

**7s64** – design and build a device that minimizes energy transfer (e.g., an incubator, a Thermos flask).

**7s65** – formulate questions about and identify needs and problems related to heat (e.g., interactions involving energy transfers), and explore possible answers and solutions (e.g., identify the steps that could be followed to test the effectiveness of the heating system in a home that uses solar energy);

**8s44** – compare liquids and air in terms of their efficiency as transmitters of force in pneumatic and hydraulic devices.

**8s45** – design and build devices that use pneumatic or hydraulic systems;

**8s51** – compile qualitative and quantitative data gathered through investigation in order to record and present results, using diagrams, flow charts, frequency tables, graphs, and stem-and-leaf plots produced by hand or with a computer (e.g., accurately measure and record the density of different liquids using a hydrometer);

| Category/Criteria | Level 1 | Level 2 | Level 3 | Level 4 |
|---|---|---|---|---|
| **Inquiry and design skills (Insulated Container Construction)** | – applies few of the required skills and strategies<br>– shows little awareness of the safety procedures<br>– uses tools, equipment, and materials correctly only with assistance | – applies some of the required skills and strategies<br>– shows some awareness of safety procedures<br>– uses tools, equipment, and materials correctly with some assistance | – applies most of the required skills and strategies<br>– usually shows awareness of safety procedures<br>– uses tools, equipment, and materials correctly with only occasional assistance | – applies all (or almost all) of the required skills and strategies<br>– consistently shows awareness of safety procedures<br>– uses tools, equipment, and materials correctly with little or no assistance |
| **Inquiry and design skills (hydraulic or pneumatic toy)** | – applies few of the required skills and strategies<br>– shows little awareness of the safety procedures<br>– uses tools, equipment, and materials correctly only with assistance | – applies some of the required skills and strategies<br>– shows some awareness of safety procedures<br>– uses tools, equipment, and materials correctly with some assistance | – applies most of the required skills and strategies<br>– usually shows awareness of safety procedures<br>– uses tools, equipment, and materials correctly with only occasional assistance | – applies all (or almost all) of the required skills and strategies<br>– consistently shows awareness of safety procedures<br>– uses tools, equipment, and materials correctly with little or no assistance |
| **Communication of required knowledge (both design activities)** | – communicates with little clarity and precision<br>– rarely uses appropriate science and technology terminology and units of measurement | – communicates with some clarity and precision<br>– sometimes uses appropriate science and technology terminology and units of measurement | – generally communicates with clarity and precision<br>– usually uses appropriate science and technology terminology and units of measurement | – consistently communicates with clarity and precision<br>– consistently uses appropriate science and technology terminology and units of measurement |
| **Relating of science and technology to each other and to the world outside the school (both design activities)** | – shows little understanding of connections between science and technology in familiar contexts<br>– shows little understanding of connections between science and technology and the world outside the school | – shows some understanding of connections between science and technology in familiar contexts<br>– shows some understanding of connections between science and technology and the world outside the school | – shows understanding of connections between science and technology in familiar contexts<br>– shows understanding of connections between science and technology and the world outside the school | – shows understanding of connections between science and technology in both familiar and unfamiliar contexts<br>– shows understanding of the connections between and the implications of science and technology and the world outside |

# Gr. 7 Culminating Task Rubric

**for use with Subtask 6 : Making Bubbles in the Hot Tub**
from the Grade 7/8 Unit: **Bubbles in the Hot Tub**

**Student Name:**_________________________
**Date:**______________________

## Expectations for this Subtask to Assess with this Rubric:

**7s54** • explain how the characteristics and properties of heat can be used, and identify the effect of some of these applications on products, systems, and living things in the natural and human-made environments.

**7s57** – explain how heat is transmitted by conduction, convection, and radiation in solids, liquids, and gases (e.g., conduction: a pot heating on a stove; convection: a liquid heating in the pot; radiation: the air being warmed by heat from the element);

**7s64** – design and build a device that minimizes energy transfer (e.g., an incubator, a Thermos flask).

**7s67** – use appropriate vocabulary, including correct science and technology terminology, to communicate ideas, procedures, and results (e.g., state the boiling and freezing points of water, room temperature, and body temperature in degrees Celsius; correctly use the terms heat conductor and heat insulator);

**7s79** – identify the components of a system that are designed to transfer heat energy (e.g., in a room, a house, or a shopping centre) and describe methods for conserving energy within that system.

| Category/Criteria | Level 1 | Level 2 | Level 3 | Level 4 |
|---|---|---|---|---|
| **Understanding of basic concepts** **(understand heat is transmitted by conduction, convection, and radiation in solids, liquids, and gases)** | – shows understanding of few of the basic concepts relating to heat transfer<br>– demonstrates significant misconceptions<br>– gives explanations showing limited understanding of the concepts | – shows understanding of some of the basic concepts relating to heat transfer<br>– demonstrates minor misconceptions<br>– gives partial explanations | – shows understanding of most of the basic concepts relating to heat transfer<br>– demonstrates no significant misconceptions<br>– usually gives complete or nearly complete explanations | – shows understanding of all of the basic concepts relating to heat transfer<br>– demonstrates no misconceptions<br>– always gives complete explanations |
| **Inquiry and design skills** **(design and build a device that minimizes energy transfer)** | – applies few of the required skills and strategies<br>– shows little awareness of the safety procedures<br>– uses tools, equipment, and materials correctly only with assistance | – applies some of the required skills and strategies<br>– shows some awareness of safety procedures<br>– uses tools, equipment, and materials correctly with some assistance | – applies most of the required skills and strategies<br>– usually shows awareness of safety procedures<br>– uses tools, equipment, and materials correctly with only occasional assistance | – applies all (or almost all) of the required skills and strategies<br>– consistently shows awareness of safety procedures<br>– uses tools, equipment, and materials correctly with little or no assistance |
| **Communication of required knowledge** **(use appropriate vocabulary including correct science and technology terms to communicate ideas, procedures, and results)** | – communicates with little clarity and precision<br>– rarely uses appropriate science and technology terminology and units of measurement | – communicates with some clarity and precision<br>– sometimes uses appropriate science and technology terminology and units of measurement | – generally communicates with clarity and precision<br>– usually uses appropriate science and technology terminology and units of measurement | – consistently communicates with clarity and precision<br>– consistently uses appropriate science and technology terminology and units of measurement |
| **Relating of science and technology to each other and to the world outside the school** **(identify and describe steps that can be taken to conserve energy)** | – shows little understanding of connections between science and technology in familiar contexts<br>– shows little understanding of connections between science and technology and the world outside the school | – shows some understanding of connections between science and technology in familiar contexts<br>– shows some understanding of connections between science and technology and the world outside the school | – shows understanding of connections between science and technology in familiar contexts<br>– shows understanding of connections between science and technology and the world outside the school | – shows understanding of connections between science and technology in both familiar and unfamiliar contexts<br>– shows understanding of the connections between and the implications of science and technology and the world outside |

**Student Name:_______________________**
**Date:_____________________**

# Gr. 8 Culminating Task Rubric

**for use with Subtask 6 : Making Bubbles in the Hot Tub**
from the Grade 7/8 Unit: **Bubbles in the Hot Tub**

## Expectations for this Subtask to Assess with this Rubric:

**8s31** • describe how knowledge of the properties of fluids can help us to understand and influence organisms in the natural world, and to design and operate technological devices and to evaluate how efficiently different devices make use of these properties.

**8s42** – predict the effect of applying external pressure on the behaviour of fluids;

**8s47** – design and construct a model of a common device that uses pneumatic or hydraulic systems (e.g., dentist's chair, automobile hoist);

**8s50** – use appropriate vocabulary, including correct science and technology terminology, to communicate ideas, procedures, and results (e.g., use terms such as flow rate, viscosity, compressibility, fluid, density, pneumatics, hydraulics);

**8s60** – identify some design features (e.g., of aircraft, cars, submarines) and explain how the design makes use of one or more of the properties of fluids;

| Category/Criteria | Level 1 | Level 2 | Level 3 | Level 4 |
|---|---|---|---|---|
| **Understanding of basic concepts** **(knowledge of the properties of fluids and how they can help design and operate technological devices and evaluate how efficiently different devices make use of these properties)** | – shows understanding of few of the basic concepts relating to the properties and their use in technological devices<br>– demonstrates significant misconceptions<br>– gives explanations showing limited conceptual understanding | – shows understanding of some of the basic concepts relating to the properties and their use in technological devices<br>– demonstrates minor misconceptions<br>– gives partial explanations | – shows understanding of most of the basic concepts relating to the properties and their use in technological devices<br>– demonstrates no significant misconceptions<br>– usually gives complete or nearly complete explanations | – shows understanding of all of the basic concepts relating to the properties and their use in technological devices<br>– demonstrates no misconceptions<br>– always gives complete explanations |
| **Inquiry and design skills** **(design and construct a model of a common device that uses pneumatic or hydraulic systems)** | – applies few of the required skills and strategies<br>– shows little awareness of the safety procedures<br>– uses tools, equipment, and materials correctly only with assistance | – applies some of the required skills and strategies<br>– shows some awareness of safety procedures<br>– uses tools, equipment, and materials correctly with some assistance | – applies most of the required skills and strategies<br>– usually shows awareness of safety procedures<br>– uses tools, equipment, and materials correctly with only occasional assistance | – applies all (or almost all) of the required skills and strategies<br>– consistently shows awareness of safety procedures<br>– uses tools, equipment, and materials correctly with little or no assistance |
| **Communication of required knowledge** **(use appropriate vocabulary, including correct science and technology terminology, to communicate ideas, procedures, and results)** | – communicates with little clarity and precision<br>– rarely uses appropriate science and technology terminology and units of measurement | – communicates with some clarity and precision<br>– sometimes uses appropriate science and technology terminology and units of measurement | – generally communicates with clarity and precision<br>– usually uses appropriate science and technology terminology and units of measurement | – consistently communicates with clarity and precision<br>– consistently uses appropriate science and technology terminology and units of measurement |
| **Relating of science and technology to each other and to the world outside the school** **(identify some design features and explain how the design makes use of one or more of the properties of fluids)** | – shows little understanding of connections between science and technology in familiar contexts<br>– shows little understanding of connections between science and technology and the world outside the school | – shows some understanding of connections between science and technology in familiar contexts<br>– shows some understanding of connections between science and technology and the world outside the school | – shows understanding of connections between science and technology in familiar contexts<br>– shows understanding of connections between science and technology and the world outside the school | – shows understanding of connections between science and technology in both familiar and unfamiliar contexts<br>– shows understanding of the connections between and the implications of science and technology and the world outside the school |

# Expectation List
Page 1

# Bubbles in the Hot Tub
## A Guide to Getting In and Out of Hot Water An Integrated Unit for Grade 7/8

### Science and Technology---Energy and Control

| | Code | Expectation | Selected | Assessed |
|---|---|---|---|---|
| ☐ | **7s52** | • demonstrate understanding that heat is a result of molecular motion; | 1 | |
| ☐ | **7s53** | • identify, through experimentation, ways in which heat changes substances, and describe how heat is transferred; | 2 | 1 |
| ☐ | **7s54** | • explain how the characteristics and properties of heat can be used, and identify the effect of some of these applications on products, systems, and living things in the natural and human-made environments. | 1 | 1 |
| ☐ | **7s55** | – distinguish between the concept of temperature and the concept of heat (e.g., temperature is a measure of the average kinetic energy of the molecules in a substance; heat is thermal energy that is transferred from one substance to another); | | 2 |
| ☐ | **7s56** | – compare the motions of particles in a solid, a liquid, and a gas using the particle theory; | | 2 |
| ☐ | **7s57** | – explain how heat is transmitted by conduction, convection, and radiation in solids, liquids, and gases (e.g., conduction: a pot heating on a stove; convection: a liquid heating in the pot; radiation: the air being warmed by heat from the element); | | 2 |
| ☐ | **7s58** | – describe how various surfaces absorb radiant heat; | | 1 |
| ☐ | **7s59** | – describe the effect of heating and cooling on the volume of a solid, a liquid, and a gas; | 1 | 1 |
| ☐ | **7s60** | – investigate and identify factors affecting the rate of temperature change (e.g., mass, nature of liquid) using a constant heat source; | | 1 |
| ☐ | **7s61** | – describe the effect of heat on the motion of particles and explain how changes of state occur (e.g., from a liquid into a gas or vapour); | | 1 |
| ☐ | **7s62** | – compare, in qualitative terms, the heat capacities of common materials (e.g., water and aluminum have greater heat capacities than sand and Pyrex); | | 1 |
| ☐ | **7s63** | – identify systems that are controlled by sensory inputs and feedbacks (e.g., a thermostat); | 1 | |
| ☐ | **7s64** | – design and build a device that minimizes energy transfer (e.g., an incubator, a Thermos flask). | | 2 |
| ☐ | **7s65** | – formulate questions about and identify needs and problems related to heat (e.g., interactions involving energy transfers), and explore possible answers and solutions (e.g., identify the steps that could be followed to test the effectiveness of the heating system in a home that uses solar energy); | 1 | 2 |
| ☐ | **7s66** | – plan investigations for some of these answers and solutions, identifying variables that need to be held constant to ensure a fair test and identifying criteria for assessing solutions; | 3 | |
| ☐ | **7s67** | – use appropriate vocabulary, including correct science and technology terminology, to communicate ideas, procedures, and results (e.g., state the boiling and freezing points of water, room temperature, and body temperature in degrees Celsius; correctly use the terms heat conductor and heat insulator); | 3 | 3 |
| ☐ | **7s68** | – compile qualitative and quantitative data gathered through investigation in order to record and present results, using diagrams, flow charts, frequency tables, bar graphs, line graphs, and stem-and-leaf plots produced by hand or with a computer (e.g., plot a graph showing the decrease in temperature of various liquids from identical initial temperatures); | 3 | 1 |
| ☐ | **7s69** | – communicate the procedures and results of investigations for specific purposes and to specific audiences, using media works, written notes and descriptions, charts, graphs, drawings, and oral presentations (e.g., use a diagram to illustrate convection in a liquid or a gas). | 3 | 2 |
| ☐ | **7s70** | – recognize heat as a necessity for the survival of plants and animals; | 1 | |
| ☐ | **7s71** | – explain how the heating and cooling of the earth's surface produces air movement that results in all weather effects (e.g., convection currents); | 1 | |
| ☐ | **7s72** | – describe the water cycle as a process of energy transfer involving convection and radiation; | | 1 |
| ☐ | **7s73** | – identify different forms of energy that can be transformed into heat energy (e.g., mechanical, chemical, nuclear, or electrical energy); | | 1 |
| ☐ | **7s74** | – explain how mechanical systems produce heat (e.g., by friction), and describe ways to make these systems more efficient (e.g., by lubrication); | 1 | |
| ☐ | **7s75** | – describe and explain issues related to heat pollution, including both positive and negative aspects (e.g., industrial processes and generation of electricity cause heat pollution of large bodies of water); | 1 | |
| ☐ | **7s76** | – explain why heat energy is considered to be the final or end form of energy transformation; | 1 | |
| ☐ | **7s77** | – identify the purpose of the specialized features of various instruments that are used to measure temperature (e.g., temperature probes provide accurate continuous readings); | 1 | |
| ☐ | **7s78** | – identify and describe steps that can be taken to conserve energy (e.g., using insulation) and the reasons for doing so (e.g., rising fuel costs); | | 2 |
| ☐ | **7s79** | – identify the components of a system that are designed to transfer heat energy (e.g., in a room, a house, or a shopping centre) and describe methods for conserving energy within that system. | | 2 |

### Science and Technology---Matter and Materials

| | Code | Expectation | Selected | Assessed |
|---|---|---|---|---|
| ☐ | **8s29** | • demonstrate an understanding of the properties (e.g., viscosity) and the buoyant force of fluids; | 1 | |
| ☐ | **8s30** | • investigate the buoyant force and other properties (e.g., viscosity) of fluids, and design and construct pneumatic or hydraulic systems that solve a problem in a given situation; | 2 | |
| ☐ | **8s31** | • describe how knowledge of the properties of fluids can help us to understand and influence organisms in the natural world, and to design and operate technological devices and to evaluate how efficiently different devices make use of these properties. | | 1 |
| ☐ | **8s32** | – compare various liquids in terms of their viscosity (e.g., water, syrup, oil, detergent, ketchup); | 1 | |

## Bubbles in the Hot Tub
**A Guide to Getting In and Out of Hot Water** An Integrated Unit for Grade 7/8

| | Code | Expectation | Selected | Assessed |
|---|---|---|---|---|
| ☐ | **8s33** | – compare qualitatively the densities of solids, liquids, and gases; | 1 | 1 |
| ☐ | **8s34** | – predict how the flow rate (an indicator of viscosity) of different liquids is affected by temperature; | 1 | |
| ☐ | **8s35** | – describe qualitatively the relationship between mass and weight (e.g., the mass of an object is constant but the weight of an object varies as the pull of gravity on the object changes); | 1 | |
| ☐ | **8s36** | – describe qualitatively the relationship between viscosity and density (e.g., with some exceptions, the greater the viscosity, the greater the density); | 1 | |
| ☐ | **8s37** | – determine, through experimentation, the mass-to-volume ratio of different amounts of the same substance (e.g., copper pennies); | | 1 |
| ☐ | **8s38** | – describe the relationship between the mass, volume, and density of solids, liquids, and gases, using the particle theory; | 1 | |
| ☐ | **8s39** | – compare fluids in terms of their compressibility or incompressibility (e.g., gases versus liquids); | | 2 |
| ☐ | **8s40** | – recognize and state the relationship between gravity and buoyancy (e.g., without gravity there is no buoyancy); | 1 | |
| ☐ | **8s41** | – explain the effects of changes in temperature on the density of solids, liquids, and gases, and relate their findings to the particle model of matter; | 2 | |
| ☐ | **8s42** | – predict the effect of applying external pressure on the behaviour of fluids; | | 2 |
| ☐ | **8s43** | – compare different liquids to determine how they alter the buoyant force on a given object; | 1 | |
| ☐ | **8s44** | – compare liquids and air in terms of their efficiency as transmitters of force in pneumatic and hydraulic devices. | | 1 |
| ☐ | **8s45** | – design and build devices that use pneumatic or hydraulic systems; | | 1 |
| ☐ | **8s46** | – design, make, and calibrate a hydrometer and use it to compare the density of water with that of another liquid; | 1 | |
| ☐ | **8s47** | – design and construct a model of a common device that uses pneumatic or hydraulic systems (e.g., dentist's chair, automobile hoist); | 1 | 1 |
| ☐ | **8s48** | – formulate questions about and identify needs and problems related to the properties of fluids, and explore possible answers and solutions (e.g., design a fair test to determine whether oil, water, or glycerol has the greatest viscosity); | 1 | 1 |
| ☐ | **8s49** | – plan investigations for some of these answers and solutions, identifying variables that need to be held constant to ensure a fair test and identifying criteria for assessing solutions; | 1 | 1 |
| ☐ | **8s50** | – use appropriate vocabulary, including correct science and technology terminology, to communicate ideas, procedures, and results (e.g., use terms such as flow rate, viscosity, compressibility, fluid, density, pneumatics, hydraulics); | 4 | 2 |
| ☐ | **8s51** | – compile qualitative and quantitative data gathered through investigation in order to record and present results, using diagrams, flow charts, frequency tables, graphs, and stem-and-leaf plots produced by hand or with a computer (e.g., accurately measure and record the density of different liquids using a hydrometer); | 2 | 2 |
| ☐ | **8s52** | – communicate the procedures and results of investigations for specific purposes and to specific audiences, using media works, written notes and descriptions, charts, graphs, drawings, and oral presentations (e.g., create a table to show the relationship between the buoyant force and size of object); | 3 | 2 |
| ☐ | **8s55** | – describe situations in which the density of a substance changes naturally (e.g., molten lava as it cools; air when mirages form) or is intentionally altered (e.g., air in a hot-air balloon; cream when it is churned and cooled); | 1 | 1 |
| ☐ | **8s56** | – identify substances that are useful because of their viscosity (e.g., sauces, vegetable oil, asphalt, hand lotion); | 1 | |
| ☐ | **8s57** | – compare the way fluids function in living things with the way they function in manufactured devices (e.g., compare the human circulatory system and a fuel pump); | 1 | |
| ☐ | **8s59** | – describe some effects of technological innovations related to hydraulics and pneumatics (e.g., getting water from a tap rather than a well results in a reduced need for manual labour; using automatic transmissions rather than mechanical linkages results in greater efficiency); | 1 | |
| ☐ | **8s60** | – identify some design features (e.g., of aircraft, cars, submarines) and explain how the design makes use of one or more of the properties of fluids; | | 1 |
| ☐ | **8s61** | – identify industries in which the principles of fluid dynamics play a central role (e.g., aeronautics, shipping). | 1 | |

## Expectation Summary

Selected **Assessed**

# Bubbles in the Hot Tub

## A Guide to Getting In and Out of Hot Water An Integrated Unit for Grade 7/8

### English Language

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 7e1 | 7e2 | 7e3 | 7e4 | 7e5 | 7e6 | 7e7 | 7e8 | 7e9 | 7e10 |
| 7e11 | 7e12 | 7e13 | 7e14 | 7e15 | 7e16 | 7e17 | 7e18 | 7e19 | 7e20 |
| 7e21 | 7e22 | 7e23 | 7e24 | 7e25 | 7e26 | 7e27 | 7e28 | 7e29 | 7e30 |
| 7e31 | 7e32 | 7e33 | 7e34 | 7e35 | 7e36 | 7e37 | 7e38 | 7e39 | 7e40 |
| 7e41 | 7e42 | 7e43 | 7e44 | 7e45 | 7e46 | 7e47 | 7e48 | 7e49 | 7e50 |
| 7e51 | 7e52 | 7e53 | 7e54 | 7e55 | 7e56 | 7e57 | 7e58 | 7e59 | 7e60 |
| 7e61 | 7e62 | 7e63 | 7e64 | 7e65 | 7e66 | 7e67 | 7e68 | 7e69 | 7e70 |

### French as a Second Language

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 7f1 | 7f2 | 7f3 | 7f4 | 7f5 | 7f6 | 7f7 | 7f8 | 7f9 | 7f10 |
| 7f11 | 7f12 | 7f13 | 7f14 | 7f15 | 7f16 | 7f17 | | | |

### Mathematics

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 7m1 | 7m2 | 7m3 | 7m4 | 7m5 | 7m6 | 7m7 | 7m8 | 7m9 | 7m10 |
| 7m11 | 7m12 | 7m13 | 7m14 | 7m15 | 7m16 | 7m17 | 7m18 | 7m19 | 7m20 |
| 7m21 | 7m22 | 7m23 | 7m24 | 7m25 | 7m26 | 7m27 | 7m28 | 7m29 | 7m30 |
| 7m31 | 7m32 | 7m33 | 7m34 | 7m35 | 7m36 | 7m37 | 7m38 | 7m39 | 7m40 |
| 7m41 | 7m42 | 7m43 | 7m44 | 7m45 | 7m46 | 7m47 | 7m48 | 7m49 | 7m50 |
| 7m51 | 7m52 | 7m53 | 7m54 | 7m55 | 7m56 | 7m57 | 7m58 | 7m59 | 7m60 |
| 7m61 | 7m62 | 7m63 | 7m64 | 7m65 | 7m66 | 7m67 | 7m68 | 7m69 | 7m70 |
| 7m71 | 7m72 | 7m73 | 7m74 | 7m75 | 7m76 | 7m77 | 7m78 | 7m79 | 7m80 |
| 7m81 | 7m82 | 7m83 | 7m84 | 7m85 | 7m86 | 7m87 | 7m88 | 7m89 | 7m90 |
| 7m91 | 7m92 | 7m93 | 7m94 | 7m95 | 7m96 | 7m97 | 7m98 | 7m99 | 7m100 |
| 7m101 | 7m102 | 7m103 | 7m104 | 7m105 | 7m106 | 7m107 | 7m108 | 7m109 | |

### Science and Technology

| Code | Selected | Assessed | Code | Selected | Assessed | Code | Selected | Assessed | Code | Selected | Assessed | Code | Selected | Assessed | Code | Selected | Assessed | Code | Selected | Assessed | Code | Selected | Assessed | Code | Selected | Assessed | Code | Selected | Assessed |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7s1 | | | 7s2 | | | 7s3 | | | 7s4 | | | 7s5 | | | 7s6 | | | 7s7 | | | 7s8 | | | 7s9 | | | 7s10 | | |
| 7s11 | | | 7s12 | | | 7s13 | | | 7s14 | | | 7s15 | | | 7s16 | | | 7s17 | | | 7s18 | | | 7s19 | | | 7s20 | | |
| 7s21 | | | 7s22 | | | 7s23 | | | 7s24 | | | 7s25 | | | 7s26 | | | 7s27 | | | 7s28 | | | 7s29 | | | 7s30 | | |
| 7s31 | | | 7s32 | | | 7s33 | | | 7s34 | | | 7s35 | | | 7s36 | | | 7s37 | | | 7s38 | | | 7s39 | | | 7s40 | | |
| 7s41 | | | 7s42 | | | 7s43 | | | 7s44 | | | 7s45 | | | 7s46 | | | 7s47 | | | 7s48 | | | 7s49 | | | 7s50 | | |
| 7s51 | | | 7s52 | 1 | | 7s53 | 2 | 1 | 7s54 | 1 | 1 | 7s55 | | 2 | 7s56 | | 2 | 7s57 | | 2 | 7s58 | | 1 | 7s59 | 1 | 1 | 7s60 | | 1 |
| 7s61 | | 1 | 7s62 | | 1 | 7s63 | 1 | | 7s64 | | 2 | 7s65 | 1 | 2 | 7s66 | 3 | 2 | 7s67 | 3 | 3 | 7s68 | 3 | 1 | 7s69 | 3 | 2 | 7s70 | 1 | |
| 7s71 | 1 | | 7s72 | | 1 | 7s73 | | 1 | 7s74 | 1 | | 7s75 | 1 | | 7s76 | 1 | | 7s77 | 1 | | 7s78 | | 2 | 7s79 | | 2 | 7s80 | | |
| 7s81 | | | 7s82 | | | 7s83 | | | 7s84 | | | 7s85 | | | 7s86 | | | 7s87 | | | 7s88 | | | 7s89 | | | 7s90 | | |
| 7s91 | | | 7s92 | | | 7s93 | | | 7s94 | | | 7s95 | | | 7s96 | | | 7s97 | | | 7s98 | | | 7s99 | | | 7s100 | | |
| 7s101 | | | 7s102 | | | 7s103 | | | 7s104 | | | 7s105 | | | 7s106 | | | 7s107 | | | 7s108 | | | 7s109 | | | 7s110 | | |
| 7s111 | | | 7s112 | | | 7s113 | | | 7s114 | | | 7s115 | | | 7s116 | | | 7s117 | | | 7s118 | | | 7s119 | | | 7s120 | | |
| 7s121 | | | 7s122 | | | 7s123 | | | 7s124 | | | 7s125 | | | 7s126 | | | 7s127 | | | 7s128 | | | 7s129 | | | 7s130 | | |
| 7s131 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

### History

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 7h1 | 7h2 | 7h3 | 7h4 | 7h5 | 7h6 | 7h7 | 7h8 | 7h9 | 7h10 |
| 7h11 | 7h12 | 7h13 | 7h14 | 7h15 | 7h16 | 7h17 | 7h18 | 7h19 | 7h20 |
| 7h21 | 7h22 | 7h23 | 7h24 | 7h25 | 7h26 | 7h27 | 7h28 | 7h29 | 7h30 |
| 7h31 | 7h32 | 7h33 | 7h34 | 7h35 | 7h36 | 7h37 | 7h38 | 7h39 | 7h40 |
| 7h41 | 7h42 | 7h43 | 7h44 | 7h45 | 7h46 | 7h47 | 7h48 | 7h49 | 7h50 |
| 7h51 | 7h52 | 7h53 | 7h54 | 7h55 | 7h56 | 7h57 | | | |

### Geography

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 7g1 | 7g2 | 7g3 | 7g4 | 7g5 | 7g6 | 7g7 | 7g8 | 7g9 | 7g10 |
| 7g11 | 7g12 | 7g13 | 7g14 | 7g15 | 7g16 | 7g17 | 7g18 | 7g19 | 7g20 |
| 7g21 | 7g22 | 7g23 | 7g24 | 7g25 | 7g26 | 7g27 | 7g28 | 7g29 | 7g30 |
| 7g31 | 7g32 | 7g33 | 7g34 | 7g35 | 7g36 | 7g37 | 7g38 | 7g39 | 7g40 |
| 7g41 | 7g42 | 7g43 | 7g44 | 7g45 | 7g46 | 7g47 | 7g48 | 7g49 | 7g50 |
| 7g51 | 7g52 | 7g53 | 7g54 | 7g55 | 7g56 | 7g57 | 7g58 | 7g59 | 7g60 |
| 7g61 | 7g62 | 7g63 | 7g64 | | | | | | |

### Health & Physical Education

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 7p1 | 7p2 | 7p3 | 7p4 | 7p5 | 7p6 | 7p7 | 7p8 | 7p9 | 7p10 |
| 7p11 | 7p12 | 7p13 | 7p14 | 7p15 | 7p16 | 7p17 | 7p18 | 7p19 | 7p20 |
| 7p21 | 7p22 | 7p23 | 7p24 | 7p25 | 7p26 | 7p27 | 7p28 | 7p29 | 7p30 |
| 7p31 | 7p32 | 7p33 | 7p34 | 7p35 | 7p36 | 7p37 | 7p38 | 7p39 | 7p40 |
| 7p41 | 7p42 | | | | | | | | |

### The Arts

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 7a1 | 7a2 | 7a3 | 7a4 | 7a5 | 7a6 | 7a7 | 7a8 | 7a9 | 7a10 |
| 7a11 | 7a12 | 7a13 | 7a14 | 7a15 | 7a16 | 7a17 | 7a18 | 7a19 | 7a20 |
| 7a21 | 7a22 | 7a23 | 7a24 | 7a25 | 7a26 | 7a27 | 7a28 | 7a29 | 7a30 |
| 7a31 | 7a32 | 7a33 | 7a34 | 7a35 | 7a36 | 7a37 | 7a38 | 7a39 | 7a40 |
| 7a41 | 7a42 | 7a43 | 7a44 | 7a45 | 7a46 | 7a47 | 7a48 | 7a49 | 7a50 |
| 7a51 | 7a52 | 7a53 | 7a54 | 7a55 | 7a56 | 7a57 | 7a58 | 7a59 | 7a60 |
| 7a61 | 7a62 | 7a63 | 7a64 | 7a65 | 7a66 | 7a67 | 7a68 | 7a69 | 7a70 |
| 7a71 | 7a72 | 7a73 | 7a74 | 7a75 | 7a76 | 7a77 | 7a78 | | |

# Bubbles in the Hot Tub

## A Guide to Getting In and Out of Hot Water An Integrated Unit for Grade 7/8

**Expectation Summary**

Selected **Assessed**

### English Language

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 8e1 | 8e2 | 8e3 | 8e4 | 8e5 | 8e6 | 8e7 | 8e8 | 8e9 | 8e10 |
| 8e11 | 8e12 | 8e13 | 8e14 | 8e15 | 8e16 | 8e17 | 8e18 | 8e19 | 8e20 |
| 8e21 | 8e22 | 8e23 | 8e24 | 8e25 | 8e26 | 8e27 | 8e28 | 8e29 | 8e30 |
| 8e31 | 8e32 | 8e33 | 8e34 | 8e35 | 8e36 | 8e37 | 8e38 | 8e39 | 8e40 |
| 8e41 | 8e42 | 8e43 | 8e44 | 8e45 | 8e46 | 8e47 | 8e48 | 8e49 | 8e50 |
| 8e51 | 8e52 | 8e53 | 8e54 | 8e55 | 8e56 | 8e57 | 8e58 | 8e59 | 8e60 |
| 8e61 | 8e62 | 8e63 | 8e64 | 8e65 | 8e66 | 8e67 | | | |

### French as a Second Language

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 8f1 | 8f2 | 8f3 | 8f4 | 8f5 | 8f6 | 8f7 | 8f8 | 8f9 | 8f10 |
| 8f11 | 8f12 | 8f13 | 8f14 | 8f15 | 8f16 | 8f17 | | | |

### Mathematics

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 8m1 | 8m2 | 8m3 | 8m4 | 8m5 | 8m6 | 8m7 | 8m8 | 8m9 | 8m10 |
| 8m11 | 8m12 | 8m13 | 8m14 | 8m15 | 8m16 | 8m17 | 8m18 | 8m19 | 8m20 |
| 8m21 | 8m22 | 8m23 | 8m24 | 8m25 | 8m26 | 8m27 | 8m28 | 8m29 | 8m30 |
| 8m31 | 8m32 | 8m33 | 8m34 | 8m35 | 8m36 | 8m37 | 8m38 | 8m39 | 8m40 |
| 8m41 | 8m42 | 8m43 | 8m44 | 8m45 | 8m46 | 8m47 | 8m48 | 8m49 | 8m50 |
| 8m51 | 8m52 | 8m53 | 8m54 | 8m55 | 8m56 | 8m57 | 8m58 | 8m59 | 8m60 |
| 8m61 | 8m62 | 8m63 | 8m64 | 8m65 | 8m66 | 8m67 | 8m68 | 8m69 | 8m70 |
| 8m71 | 8m72 | 8m73 | 8m74 | 8m75 | 8m76 | 8m77 | 8m78 | 8m79 | 8m80 |
| 8m81 | 8m82 | 8m83 | 8m84 | 8m85 | 8m86 | 8m87 | 8m88 | 8m89 | 8m90 |
| 8m91 | 8m92 | 8m93 | 8m94 | 8m95 | 8m96 | 8m97 | 8m98 | 8m99 | 8m100 |
| 8m101 | 8m102 | 8m103 | 8m104 | 8m105 | 8m106 | 8m107 | 8m108 | 8m109 | 8m110 |
| 8m111 | 8m112 | 8m113 | 8m114 | 8m115 | 8m116 | 8m117 | 8m118 | 8m119 | 8m120 |
| 8m121 | 8m122 | | | | | | | | |

### Science and Technology

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8s1 | | | 8s2 | | | 8s3 | | | 8s4 | | | 8s5 | | | 8s6 | | | 8s7 | | | 8s8 | | | 8s9 | | | 8s10 | | |
| 8s11 | | | 8s12 | | | 8s13 | | | 8s14 | | | 8s15 | | | 8s16 | | | 8s17 | | | 8s18 | | | 8s19 | | | 8s20 | | |
| 8s21 | | | 8s22 | | | 8s23 | | | 8s24 | | | 8s25 | | | 8s26 | | | 8s27 | | | 8s28 | | | 8s29 | **1** | | 8s30 | **2** | |
| 8s31 | | **1** | 8s32 | **1** | | 8s33 | **1** | **1** | 8s34 | **1** | | 8s35 | **1** | | 8s36 | **1** | | 8s37 | | **1** | 8s38 | **1** | | 8s39 | | **2** | 8s40 | **1** | |
| 8s41 | **2** | | 8s42 | | **2** | 8s43 | **1** | | 8s44 | | **1** | 8s45 | | **1** | 8s46 | **1** | | 8s47 | **1** | **1** | 8s48 | **1** | **1** | 8s49 | **1** | **1** | 8s50 | **4** | **2** |
| 8s51 | **2** | **2** | 8s52 | **3** | **2** | 8s53 | | | 8s54 | | | 8s55 | **1** | **1** | 8s56 | **1** | | 8s57 | **1** | | 8s58 | | | 8s59 | **1** | | 8s60 | | **1** |
| 8s61 | **1** | | 8s62 | | | 8s63 | | | 8s64 | | | 8s65 | | | 8s66 | | | 8s67 | | | 8s68 | | | 8s69 | | | 8s70 | | |
| 8s71 | | | 8s72 | | | 8s73 | | | 8s74 | | | 8s75 | | | 8s76 | | | 8s77 | | | 8s78 | | | 8s79 | | | 8s80 | | |
| 8s81 | | | 8s82 | | | 8s83 | | | 8s84 | | | 8s85 | | | 8s86 | | | 8s87 | | | 8s88 | | | 8s89 | | | 8s90 | | |
| 8s91 | | | 8s92 | | | 8s93 | | | 8s94 | | | 8s95 | | | 8s96 | | | 8s97 | | | 8s98 | | | 8s99 | | | 8s100 | | |
| 8s101 | | | 8s102 | | | 8s103 | | | 8s104 | | | 8s105 | | | 8s106 | | | 8s107 | | | 8s108 | | | 8s109 | | | 8s110 | | |
| 8s111 | | | 8s112 | | | 8s113 | | | 8s114 | | | 8s115 | | | 8s116 | | | 8s117 | | | 8s118 | | | 8s119 | | | 8s120 | | |
| 8s121 | | | 8s122 | | | 8s123 | | | 8s124 | | | 8s125 | | | 8s126 | | | 8s127 | | | 8s128 | | | 8s129 | | | 8s130 | | |
| 8s131 | | | 8s132 | | | 8s133 | | | 8s134 | | | 8s135 | | | 8s136 | | | 8s137 | | | 8s138 | | | 8s139 | | | 8s140 | | |
| 8s141 | | | 8s142 | | | 8s143 | | | 8s144 | | | 8s145 | | | 8s146 | | | 8s147 | | | 8s148 | | | | | | | | |

### History

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 8h1 | 8h2 | 8h3 | 8h4 | 8h5 | 8h6 | 8h7 | 8h8 | 8h9 | 8h10 |
| 8h11 | 8h12 | 8h13 | 8h14 | 8h15 | 8h16 | 8h17 | 8h18 | 8h19 | 8h20 |
| 8h21 | 8h22 | 8h23 | 8h24 | 8h25 | 8h26 | 8h27 | 8h28 | 8h29 | 8h30 |
| 8h31 | 8h32 | 8h33 | 8h34 | 8h35 | 8h36 | 8h37 | 8h38 | 8h39 | 8h40 |
| 8h41 | 8h42 | 8h43 | 8h44 | 8h45 | 8h46 | 8h47 | 8h48 | 8h49 | 8h50 |
| 8h51 | 8h52 | 8h53 | 8h54 | 8h55 | 8h56 | 8h57 | | | |

### Geography

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 8g1 | 8g2 | 8g3 | 8g4 | 8g5 | 8g6 | 8g7 | 8g8 | 8g9 | 8g10 |
| 8g11 | 8g12 | 8g13 | 8g14 | 8g15 | 8g16 | 8g17 | 8g18 | 8g19 | 8g20 |
| 8g21 | 8g22 | 8g23 | 8g24 | 8g25 | 8g26 | 8g27 | 8g28 | 8g29 | 8g30 |
| 8g31 | 8g32 | 8g33 | 8g34 | 8g35 | 8g36 | 8g37 | 8g38 | 8g39 | 8g40 |
| 8g41 | 8g42 | 8g43 | 8g44 | 8g45 | 8g46 | 8g47 | 8g48 | 8g49 | 8g50 |
| 8g51 | 8g52 | 8g53 | 8g54 | 8g55 | 8g56 | 8g57 | | | |

### Health & Physical Education

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 8p1 | 8p2 | 8p3 | 8p4 | 8p5 | 8p6 | 8p7 | 8p8 | 8p9 | 8p10 |
| 8p11 | 8p12 | 8p13 | 8p14 | 8p15 | 8p16 | 8p17 | 8p18 | 8p19 | 8p20 |
| 8p21 | 8p22 | 8p23 | 8p24 | 8p25 | 8p26 | 8p27 | 8p28 | 8p29 | 8p30 |
| 8p31 | 8p32 | 8p33 | 8p34 | 8p35 | 8p36 | 8p37 | 8p38 | 8p39 | 8p40 |
| 8p41 | | | | | | | | | |

### The Arts

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 8a1 | 8a2 | 8a3 | 8a4 | 8a5 | 8a6 | 8a7 | 8a8 | 8a9 | 8a10 |
| 8a11 | 8a12 | 8a13 | 8a14 | 8a15 | 8a16 | 8a17 | 8a18 | 8a19 | 8a20 |
| 8a21 | 8a22 | 8a23 | 8a24 | 8a25 | 8a26 | 8a27 | 8a28 | 8a29 | 8a30 |
| 8a31 | 8a32 | 8a33 | 8a34 | 8a35 | 8a36 | 8a37 | 8a38 | 8a39 | 8a40 |
| 8a41 | 8a42 | 8a43 | 8a44 | 8a45 | 8a46 | 8a47 | 8a48 | 8a49 | 8a50 |
| 8a51 | 8a52 | 8a53 | 8a54 | 8a55 | 8a56 | 8a57 | 8a58 | 8a59 | 8a60 |
| 8a61 | 8a62 | 8a63 | 8a64 | 8a65 | 8a66 | | | | |

# Bubbles in the Hot Tub

**A Guide to Getting In and Out of Hot Water** **An Integrated Unit for Grade 7/8**

## Analysis Of Unit Components

6 Subtasks
105 Expectations
134 Resources
66 Strategies & Groupings

-- Unique Expectations --
58 Science And Tech Expectations

## Resource Types

7 Rubrics
43 Blackline Masters
0 Licensed Software
5 Print Resources
4 Media Resources
4 Websites
37 Material Resources
34 Equipment / Manipulatives
0 Sample Graphics
0 Other Resources
0 Parent / Community
0 Companion Bookmarks

## Groupings

4 Students Working As A Whole Class
5 Students Working In Pairs
3 Students Working In Small Groups
5 Students Working Individually

## Assessment Recording Devices

3 Anecdotal Record
2 Checklist
2 Rating Scale
4 Rubric

## Teaching / Learning Strategies

1 Classifying
2 Demonstration
1 Direct Teaching
2 Discussion
2 Experimenting
1 Field Trip
1 Improvisation
1 Inquiry
1 Learning Centres
3 Learning Log/ Journal
1 Map Making
1 Model Making
1 Prompts
1 Research
1 Technology
1 Think / Pair / Share

## Assessment Strategies

1 Classroom Presentation
5 Learning Log
1 Observation
3 Performance Task
4 Questions And Answers (oral)
1 Quizzes, Tests, Examinations
1 Response Journal
1 Self Assessment