

Science Resource Package: Grade 7

Heat:

Heat Transfer

New Brunswick Department of Education

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Acknowledgements

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Note that at the time of posting, all URLs in this document link to the desired science content. If you observe that changes have been made to site content, please contact Kathy Hildebrand, kathy.hildebrand@qnb.ca, Science Learning Specialist, at the Department of Education.

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Rationale

This resource package models current research in **effective science instruction** and provides an **instructional plan** for one topic selected from the Grade 7 Atlantic Canada Science Curriculum. This curriculum includes STSE (Science, Technology, Society and Environment) outcomes, Skills outcomes, and Knowledge outcomes – all of which are important for building a deep understanding of science and its place in our world.

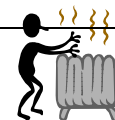
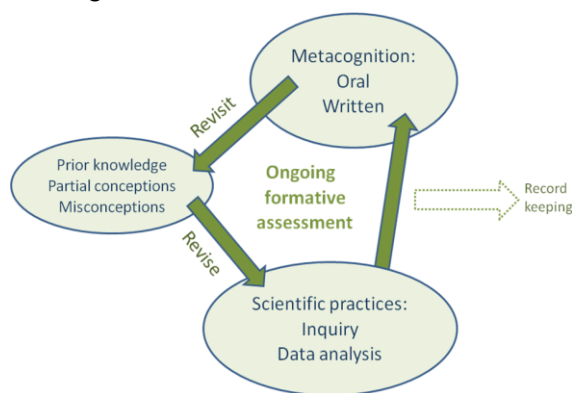
As has been true of our ancestors, we all develop “explanations” about what we observe which may or may not be valid. Once ideas are established, they are **remarkably tenacious** and an alternate explanation rarely causes a shift in thinking. To address these **misconceptions** or alternate conceptions, students must be challenged with carefully selected experiences and discussion.

A key part of this instructional plan is accessing **prior knowledge**. It is recorded in a way that it can and **will be revisited** throughout the topic. The intent is to revise, extend, and/or replace students’ initial ideas with evidence-based knowledge.

Science is not a static body of facts. The process of exploring, revising, extending, and sometimes replacing ideas is central to **the nature of science**. Think of science as an **ongoing evidence-based discussion** that began before our time and that will continue after it. Science is often collaborative, and discussion plays a key role. Students’ learning of science should reflect this as much as possible.

The intent of this instructional plan is to encourage a **constructivist** approach to learning. Students explore an activity, then share, discuss and reflect. The telling of content by the teacher tends to come after, as an extension of the investigation (or experience) explored by the students.

The learning is **organized into cycles**. The partial conceptions and misconceptions are revisited in each cycle so that students’ ideas will be revised. Each cycle will result in deeper and/or extended learning.



Hands-on activities are part of the instructional plan. Inquiry activities tend to be most structured in the first cycle. The teacher provides the question to investigate and gives a procedure to follow. In subsequent cycles, less structure tends to be given. For example, students may be given a question and asked to develop an experimental plan which they then implement. The goal is to **move towards open inquiry** in which students generate a testable question, develop an experimental plan using available materials, implement the plan, record relevant observations, and make reasonable conclusions. The included activities are meant to start this journey.

Discussion and **written reflections** are key parts of the lessons. Discussion (both oral and written) is a vehicle that moves science forward. For example, when scientists publish their evidence and conclusions, other scientists may try to replicate results or investigate the range of conditions for which the conclusion applies. If new evidence contradicts the previous conclusions, adjustments will be required. Similarly, in this instructional plan students first **do**, then **talk**, then **write** about the concept. A section on supporting discussion is included in this resource package.

Assessment tasks are also included in the instructional plan and assess three types of science curricular outcomes: STSE, Skills, and Knowledge. These tasks are meant to be used as tools for letting the teacher and the students know **where they are** in their learning and what the **next steps** might be. For example: Has the outcome been met or is more learning required? Should more practice be provided? Is a different activity needed?

When assessment indicates that outcomes have been met, it will provide **evidence of achievement**. This evidence may be sufficient and further formal testing (paper-pencil tests) may not be required to demonstrate that outcomes have been met.



i Background Information

Prior Knowledge:

Students have learned about the particle theory of matter from the grade 7 mixtures and solutions unit and with changes of state in this unit.

Students have experience with heating registers, radiators, wood stoves, and/or baseboard heaters.

Students have experienced hot handles on cooking pans or stay cool handles.

Students have seen heat waves on the road in the summer.

Common Misconceptions:

“Certain colours of clothing are hotter (or cooler) than others.”

“Heat and temperature are the same thing.”

“Metals are colder than other materials.”

“Radiation refers to cancer therapy and is very dangerous.”

“Conduction refers to electric current and does not apply to heat.”

Did You Know?

Temperature is a measure of how hot or cold something is; the *average* kinetic energy of the particles in a substance.

Thermal energy is the *total* kinetic energy of all the particles in a substance. Heat is thermal energy transferred from one object to another. Heat transfer occurs through conduction, convection and radiation.

In conduction, particles transfer energy by colliding with adjacent particles. If energy is added to a portion of a material, the energy is gradually shared among the particles through collisions and the temperature of the material rises.

In convection, the particles actually move from one place to another. Warm air rising is convection. The warmer air expands (particles are moving more quickly and spread out), the density decreases and it “floats up” through the surrounding air.

In radiation, heat (energy) is carried by electromagnetic waves. Particles (matter) are not involved. Electromagnetic waves can travel through a vacuum. For radiation to give energy to materials, the electromagnetic waves must be absorbed.



Instructional Plan

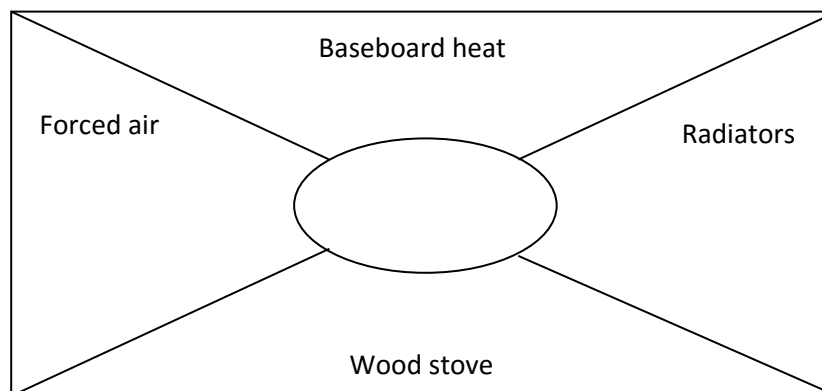
Access Prior Knowledge

Ask: *How is your house heated?*

Divide students into groups according to their home heating method and have each group discuss:


- Where is your heat source (furnace)?
- How does the heat get through your house?
- If heat source is in the basement why is it warmer upstairs on the main floor?
- How is the heat controlled?
- Why isn't your furnace in the attic?

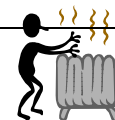
Have groups share to generate a class chart of characteristics common to all heating methods and a list of differences among them. (The discussion tips on pages 19-20 may be helpful.) The commonalities go in the oval and the differences go in each outside section. Keep these “facts” so that they may be revisited and added to in later lessons.



✓ Assessment:

Note the concepts and misconceptions students are expressing. You will need to know these to plan effective questions for subsequent activities and discussions so that students will examine and adjust their alternate conceptions.

 **Post student versions of curricular outcomes on chart paper (see page 22). Inform students that these outcomes will be addressed over the next portion of the unit. Point out to students which outcomes are being addressed in each activity.**



1st Cycle

★ Curriculum Outcomes

- 111-5 Describe the science underlying particular technologies designed to explore natural phenomena, extend human capabilities, or solve practical problems.
- 113-4 Analyze the design of a technology and the way it functions on the basis of its impact on their daily lives.
- 209-1 Carry out procedures controlling the major variables.
- 209-3 Use instruments effectively and accurately for collecting data.
- 210-11 State a conclusion, based on experimental data, and explain how evidence gathered supports or refutes an initial idea.
- 211-2 Communicate questions, ideas, intentions, plans, and results, using lists, notes in point form, sentences, data tables, graphs, drawings, oral language, and other means.
- 308-5 Compare transmission of heat by conduction, convection, and radiation.

Heat Transfer Activity

The 1st and 2nd cycles both involve the heat transfer experiments described below. At this time you need to decide whether you will hold some of these activities back for the 2nd cycle or will just have students do an activity in the 2nd cycle that another group explored previously.

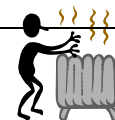
In this activity, each group of students will be exploring a specific type of heat transfer. For example, if you have 6 groups in your class:

Radiation experiments	Convection experiments	Conduction experiments
Group A	Group B	Group C
Group D	Group E	Group F

Have each group of students do one or two experiments. They should not know what type of heat transfer they are investigating. If two groups are exploring the same type of heat transfer, you may give them different investigations.

A variety of explorations will enrich the later discussion. In the post-experiment discussion, students should recognize which other groups had the same or different type of heat transfer. The discussion will lead to the different kinds of heat transfer and their characteristics.

Have students record their observations with words and drawings that will be shared during the class discussion.



Heat: Heat Transfer

✓ Assessment:

During student activity, make notes on outcomes (or parts of outcomes) you observe being addressed. Process skill outcomes are part of the curriculum and should be assessed. Using the observation chart or the checklist (on pages 36-39) on a clipboard may be helpful to you. Develop your own code for quick notes.

A suggested code:

✓ observed and appropriate,
 WD with difficulty,
 RTT refused to try,
 A absent.

This chart may be used on multiple days, using a different coloured pen or pencil each day and putting the date in the corner. You may not have a symbol or note for every child every day. Some teachers like to focus on a group or two each time. However you choose to make note of your observations, you will always have a sense of who you need to take more notice of and who might need extra support. The information will also help you when it is reporting time.

A list of investigations is given below with full descriptions on the indicated pages.

Activities exploring **radiation**:

Page with full description (for students)	Activity	Materials	Anticipated results (for teacher only)
23	Light and Dark Pop Cans	Thermometers Lamp with bulb that gets hot Black and white paint 2 pop cans – one painted black, one white Cooking oil	Dark coloured pop can will have a greater temperature change than the light coloured pop can.
25	Pop Cans With Sand	Dark-coloured Soil Light-coloured sand Or use black and white pop cans with same coloured sand inside Lamp with bulb that gets hot Thermometers Containers for soils	Dark soil will have a higher temperature than light soil when measured in the middle (depth) of the sample
26	Coffee Mug Melting	Coffee mug Piece of chocolate like Hershey's kiss or small	Chocolate will melt slightly – depending on temperature of the



Heat: Heat Transfer

		piece of was Plastic wrap Tape or rubber band to secure wrap to cup Hot water to fill cup	water
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Activities exploring **convection**:

Page with full description (for students)	Activity	Materials	Anticipated results (for teacher only)
27	Coloured Ice	Ice cubes with food colouring Warm water Clear container	The ice cubes dissolve and a trickle of food colouring will sink to the bottom of the container.
28	Convection Boxes	Similar to p. 246 in text but made with cardboard and tape Cardboard box Scissors Candles Unscented incense or damp paper/paper towel to smoulder Tape	Smoke should be pulled through the chimney above the candle, into the box, and come out the other chimney
29	Hot and Cold Water	Large jar with cold water Small jar with hot water and food colouring String or tong to lower small jar into large jar	Hot water with food colouring should rise to the top of the jar and stay until it cools down to a temperature closer to the cold water



Heat: Heat Transfer

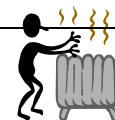
Some video clips of other convection experiments you might want to show or have students try can be found at <http://piers.wikispaces.com/Convection+Videos>

Activities exploring **conduction**:

Page with full description (for students)	Activity	Materials	Anticipated results (for teacher only)
30	Butter Melting	Hot water bath Metal spoon Plastic spoon Wooden spoon or popsicle stick Butter Container with hot water	The butter will fall off metal object before those of other materials due to its ability to conduct heat.
31	Pick a Stirrer	Similar to p. 245 of text Equal lengths of plastic from a pen Pieces of copper wire Long iron nail Wooden pencil	The metal should feel hotter than other materials when left in hot water for same length of time.
32	Window	Piece of tin foil larger than hand Piece of Newspaper larger than hand Cold window or piece of glass on top of ice cubes	Hands get colder with foil than with newspaper
33	Melting Wax	Candle Conductometer Wax Metal thumbtacks	The metal spokes will conduct heat at different rates. The wax will melt and the tacks fall off at different times.

Some video clips of other conduction experiments you might want to show or have students try can be found at

<http://piers.wikispaces.com/Conduction+Videos+and+Experiments>



Reflection: Class Discussion

- Have students share their observations about heat transfer and their thoughts (conclusions). See teacher's note about encouraging classroom talk on pages 19-20.
- Ask: *Which other groups did an activity with heat transfer kind of like yours? Which had different heat movement from yours? Can students list the attributes or characteristics of each sort of heat movement?*

Discussion about heat moving through solids and liquids, heat moving through air and water, heat that can be felt from a distance in all directions should lead to characteristics. You may wish to give names to the types of heat transfer at this time - conduction, convection, radiation.

- Ask: *How does your investigation of heat movement compare to heating a house? Which is it most like?* Add information to the chart made in the Accessing Prior Knowledge activity on page 4. Revise the information already there as necessary.

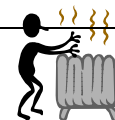
Reflection: Journaling

Describe how your heat experiment is shows the same kind of heat transfer as one method of home heating.

✓ **Assessment:**

Journal entries should not receive a score or mark. A positive comment followed by a question to refocus attention or suggest the next step in learning is very effective.

When reading the journal entries, note which students are able to identify the characteristics of heat transfer in common.



2nd Cycle

★ Curriculum Outcomes

- 111-5 Describe the science underlying particular technologies designed to explore natural phenomena, extend human capabilities, or solve practical problems.
- 113-4 Analyze the design of a technology and the way it functions on the basis of its impact on their daily lives.
- 209-1 Carry out procedures controlling the major variables.
- 209-3 Use instruments effectively and accurately for collecting data.
- 210-11 State a conclusion, based on experimental data, and explain how evidence gathered supports or refutes an initial idea.
- 211-2 Communicate questions, ideas, intentions, plans, and results, using lists, notes in point form, sentences, data tables, graphs, drawings, oral language, and other means.
- 308-5 Compare transmission of heat by conduction, convection, and radiation.

Heat Transfer Activity Part 2

Have students carry out experiments of a different sort of heat transfer than they explored in the 1st Cycle, to give them more first-hand experience.

✓ Assessment:

On observation chart (or other record), note how students are performing on the skill outcomes.

Reflection: Class Discussion

- Have a class discussion that revisits and elaborates on the discussion about heat transfer at the end of the first cycle.

Ask questions like: *How did the heat transfer in your activity today differ from that in your other activity? Can you say in more detail how the movement of heat happens?*

- Summarize the three types of heat transfer and introduce the vocabulary (if not done already): radiation, convection, conduction.
- A great analogy for heat transfer is how to get a note to the back of the school bus:
 - Pass it person to person (conduction)
 - Get up and carry it to the back (convection)
 - Crumple it into a ball and throw it to the back (radiation)
- Revisit the class chart made in the Accessing Prior Knowledge activity on page 4. Revise the information already there as necessary. Add further information.



Heat: Heat Transfer

The sites below may help review and consolidate student understanding. These videos can be used to support the discussion or to support the information students put in their layered books (see Reflection activity below).

http://www.wisc-online.com/objects/index_tj.asp?objID=SCE304

This is an excellent site with animated explanations and examples of the three methods of heat transfer. The link doesn't seem to work but the URL may be copied and pasted and that will work.

http://www.metacafe.com/watch/898995/impressive_convection_demonstration/

This site provides a clip called "Impressive Convection Demonstration" where the shadow of the rising air from a candle is seen in a dark room (shadow is created using light from a projector).

<http://www.youtube.com/watch?v=QBVMm9i-pvo&feature=related> provides a clip of convection with a coloured ice cube placed in warm water.

<http://www.youtube.com/watch?v=wz6wzOtv6rs> is a link to a "Eureka video about radiation.

<http://www.youtube.com/watch?v=77R4arwD8G8&feature=related> is a link to a "Eureka" video about conduction. There is also a clip about convection, but the explanation is all based on density and buoyancy which may be too much information for grade 7.

The Bill Nye video "Heat" is a good summary video. It can be found at <http://learning.aliant.net/school/index.asp> Type heat into the search box. When you click on the picture, the video will start with a table of contents to the right of it. Note that you can click on any part of the contents list to go to that portion. There is no need to view the entire video. (You need to register to use the videos on the Aliant site. Registration is free. If you try to watch the video without logging in, you are prompted to do so.)



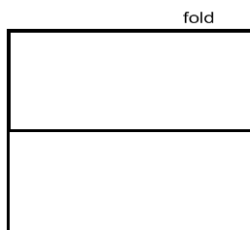
Reflection: Individual

Have students summarize what they know about the three types of heat transfer in a layered book. They may create these in conjunction with watching the videos above.

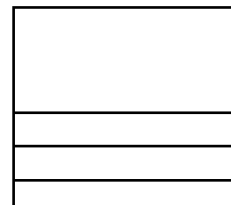
Layered book instructions:



Fold one sheet of paper unevenly so there is a flap

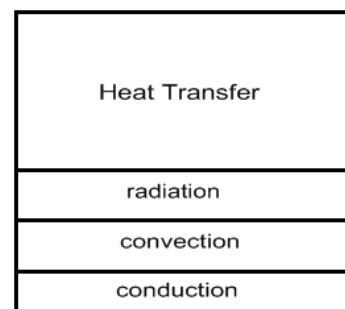


Fold a second sheet more unevenly



Place the folds inside each other to create 4 layers.

- The top flap can be labelled: Heat Transfer.
- The second layer has notes and diagrams about the transfer of heat by radiation.
- The third layer would have notes and diagrams about the transfer of heat by convection.
- The fourth layer would have notes and diagrams about the transfer of heat by conduction.



✓ **Assessment:**

Notice if students have a good understanding of the three types of heat transfer: radiation, convection, conduction.

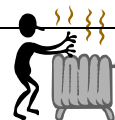
Options for storing foldables:

- in a large zippered plastic bag. The bag can be hole-punched and put inside a duotang or binder. A strip of duct tape folded over the left edge of the bag before punching the holes will keep the bag from ripping
- glue into notebooks or duotangs
- display them on bulletin boards



✓ Assessment:

Your parents wish to put a heater in your swimming pool. Where should the heater be placed in the pool to heat the pool evenly and use the least amount of electricity? Explain.





3rd Cycle

✦ Curriculum Outcomes

- 111-5 Describe the science underlying particular technologies designed to explore natural phenomena, extend human capabilities, or solve practical problems.
- 209-1 Carry out procedures controlling the major variables.
- 209-3 Use instruments effectively and accurately for collecting data.
- 210-10 Identify potential sources of error in data while investigating how various surfaces absorb radiant heat.
- 210-11 State a conclusion, based on experimental data, and explain how evidence gathered supports or refutes an initial idea.
- 210-12 Identify and evaluate potential applications of findings.
- 211-2 Communicate questions, ideas, intentions, plans, and results, using lists, notes in point form, sentences, data tables, graphs, drawings, oral language, and other means.
- 308-6 Describe how various surfaces absorb radiant heat.

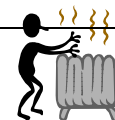
Colour and Radiant Heat Transfer Activity

Note that if the rubric is to be used for assessing student work, it should be given to students and discussed **before** the investigation. Examples of previous experimental write ups should be displayed. If this is new to students, the process should be modeled by the teacher several times before expecting students to complete one independently.

Materials:

- Empty pop cans
- Thermometers
- Light (at least 100W incandescent bulb)
- Ruler
- Different coloured paints
- Aluminum foil, Construction paper, Different types of cloth
- Insulating materials (Styrofoam, cotton balls, foam rubber, etc.)
- Cooking oil
- Tape or rubber bands

- Ask students to reflect on what was done in the Light and Dark Pop Cans experiment (see page 23) *What was observed and why? What other kind of things could be tested using the same apparatus?* Have students come up with testable questions. Record these on chart paper.



Heat: Heat Transfer

Questions may involve different colours of can, different types of insulation, different materials around can, varying the distance between can and lamp, shiny or dull surfaces (flat, eggshell, semi-gloss and glossy paint work well), and so on.

Materials can be presented to students to determine the possible variables that can be tested, or can be gathered after discussion depending on suggestions from class.

- Ask students to select or write a question and plan an experiment which will test their question. Are the materials available? How many cans will be required (might be limited by number of thermometers) and how are they prepared? Do they need a control can?
- Have students carry out their investigation.

✓ **Assessment:**

On observation chart (or other record), note how students are performing on the skill outcomes.

Reflection

- Activity should be written up as a lab report, with particular focus on presentation of results (suggest using graphs, table, etc. to make data collected more clear) and discussion of results (what does it all mean in terms of content learned in previous cycles)
- Have students self-assess their write up before handing it in to you. Give students the guidelines (see “got it” column) and ask them to comment on how well their work meets each criteria. The third column will be for you to give feedback (see sheet on page 35).

✓ **Assessment:**

Note if students are able to write up a lab report or if mini-lessons on specific parts of the report are needed. The following rubric may be helpful.



Heat: Heat Transfer

Got it	Nearly there	Not yet
Question is stated clearly and in a testable form	Question is clear but not in a testable form.	Question is unclear .
Materials list includes all necessary and appropriate items.	Materials list incomplete .	Materials list incomplete and contains unnecessary items.
Written steps are detailed and in sequential order . Steps are detailed enough that variables are controlled . Procedure could be replicated .	Some steps are unclear or missing and/or steps are out of order . Missing some details that would control one or more variables during the replication.	Steps are not accurate or there is not enough detail to replicate procedure.
Data is recorded in detail in an organized manner with titles and headings; necessary units are included.	Data is recorded, more detail needed or difficult to interpret ; necessary units may be missing.	Data is not complete and organized .
Discussion of results/ Conclusion relates to question and is based on data from the experiment.	Discussion of results/ Conclusion relates to the question but data is not referred to or data does not support statements.	Discussion of results/ Conclusion missing or does not relate to question
Spelling and grammar errors are absent or rare .	Some spelling and grammar errors .	Spelling and grammar errors common .

- Ask students to present their results to the rest of the class and then discuss. This is a good time to talk about variables – have students identify the variables as each experiment is discussed. Which were controlled? Identify the dependent and independent variables. What changes might have improved the procedure?
- Create a class list of facts about radiation and temperature. Give the opportunity for students to add to the radiation portion of their foldable.
- Ask students: *What are some other possible testable questions arising from our work?* This is a great way to show students the nature of science even if it is not possible to take the time to try these. (Testing one or more of the questions could be an extension activity.)
- Revisit the class chart made in the Accessing Prior Knowledge activity on page 4. Ask: *Can we add to or revise information on this chart?*



 **4th Cycle****✦ Curriculum Outcomes**

- 111-5 Describe the science underlying particular technologies designed to explore natural phenomena, extend human capabilities, or solve practical problems.
- 113-4 Describe how a technology associated with heat has affected lives.
- 210-12 Identify and evaluate potential applications of findings.

Heat Transfer in the Real World

Have students discuss in pairs, preparing a list to share.

- *When is it useful to have heat transfer quickly?*
- *When is it useful for heat to be conserved (not transferred)?*

Have pairs join with another pair to share ideas and add to their lists.

Have groups of 4 join with another to share ideas and add to their lists.

Examples of applications include: Thermos bottles, insulated houses, new windows, solar panels, heat pumps for houses, heating pools, cooking on a stove and in the oven, clothes dryers, convection ovens, ocean currents (Gulf stream) and climate.

 **Think like a scientist**

Asking good questions is an important skill in science. Initially students will need support. Model the skill with the whole class and students will begin to have the confidence to contribute. After some practice, students will be able to generate questions successfully individually.

Present students with a situation and ask them to generate questions that could be investigated scientifically. (These situations and questions do not have to be limited to those that can be done in a classroom.)

Situation:

Convection ovens are increasingly found in homes as well as restaurants. They cook food faster, more evenly, and at a lower temperature than regular electric ovens.

Write a question concerning how convection ovens achieve these results that could be investigated scientifically.



 **Reflection: Discussion or Journal**

Why do parents say . . .

“Don’t hold the fridge door open.”

“Decide what you want before you open the fridge door.”

“Don’t hold the house door open.”

“Don’t turn up the heat, put on a sweater”

✓ Assessment:

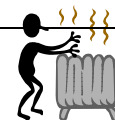
How could one use a wood stove to explain the transmission of heat by radiation, conduction, and convection?

or

Predict how convection currents form in your classroom when the heat is turned up. Sketch your prediction.

or

If you need to cook jam for 30 minutes, stirring constantly, what kind of spoon would you choose? Explain.



Supporting Class Discussion

No one person is as smart as all of us together.

Page Keeley, in the book “Science Formative Assessment” (2008), uses the analogy of ping-pong and volleyball to describe discussion interaction. Ping-pong represents the back and forth question-answer pattern: the teacher asks a question, a student answers, the teacher asks another question, a student answers, and so on. Volleyball represents **a different discussion pattern**: the teacher asks a question, a student answers, and other students respond in succession; each building upon the previous student’s response. Discussion continues until the teacher “serves” another question.

A “volleyball” discussion encourages **deeper student engagement** with scientific ideas. Students state and **give reasons** for their ideas. Through the interaction, ideas may be challenged and clarified. Extensions and applications of ideas may arise as well. Discussions should **avoid the personal** and always revolve around **ideas, explanations and reasons**. The goal is for students to achieve better understanding.

Share the ping-pong and volleyball analogies with your students. Good discussion **takes practice**. You and your students will improve. Many teachers find discussion works best if all students can see each other, such as in a circle, at least until they become accustomed to listening and responding to each other.

As the teacher, you will need to:

- establish and maintain a respectful and supportive environment;
- provide clear expectations;
- keep the talk focused on the science;
- carefully orchestrate talk to provide for equitable participation.

It is important to **establish discussion norms** with your class. Your expectations may include:

- Everyone has a right to participate and be heard.
- Everyone has an obligation to listen and try to understand.
- Everyone is obliged to ask questions when they do not understand.
- The speaker has an obligation to attempt to be clear.

At first, discussions are apt to seem somewhat artificial. Initially, a bulletin board featuring cartoon talk bubbles with suggested sentence starters may be helpful.

I respectfully disagree . . .

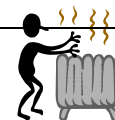
I had a different result . . .

Could you show how you got that information?

When I was doing ____, I found that . . .

Even though you said ____, I think . . .

The data I have recorded in my notebook is different from what you shared. I found . . .



Heat: Heat Transfer

It is helpful if **teacher questions refer to a big idea** rather than specifics. (Could humans and chickens move their bones without muscles?) Questions should be phrased so that anyone can enter into the conversation. Opinion questions are especially good for this (What do you think . . . ? How do you think . . . ? What if . . . ? Why . . . ?).

Provide plenty of **wait time** for students. Students give more **detailed and complex answers** when given sufficient wait time. Allow wait time after student responses. When students are engaged and thinking, they need time to process other responses before contributing. If the discussion is not progressing, have students engage in **partner talk**. Partner talk enables the teacher the opportunity to insert “overheard” ideas.

Helpful teacher prompts:

1. What outcome do you predict?
2. Say more about that.
3. What do you mean by . . . ?
4. How do you know?
5. Can you repeat what ____ said in another way?
6. Does anyone agree or disagree with . . . ?
7. Does anyone want to add to or build on to . . . ?
8. Who understands ____’s idea and can explain it in their own words?
9. Let me see if I have got your idea right. Are you saying . . . ?
10. So you are saying that . . .
11. What evidence helped you to think that?
12. Okay, we do not agree. How does each position fit the evidence? What else could we find out?

References:

Keeley, Page (2008). *Science Formative Assessment*. Thousand Oaks, CA: Corwin Press and Arlington, VA: NSTA Press

Michaels, Sarah, Shouse, Andrew W., and Schweingruber, Heidi A. (2008). *Ready, Set, SCIENCE!* Washington, DC: The National Academies Press



Materials List

Various containers (for water and soil)
Thermometers
Lamp with bulb that gets hot
Paint for pop cans (black, white, other colours)
Empty pop cans
Cooking oil
Dark-coloured soil
Light-coloured sand
Coffee mug
Piece of chocolate like Hershey's kiss
Plastic wrap
Tape or rubber band
Food colouring
Cardboard box
Candles
Unscented incense or damp paper/paper towel to smoulder
String or tongs (to lower small jar into large jar)
Metal spoon
Plastic spoon
Wooden spoon or popsicle stick
Butter
Pieces of copper wire
Long iron nail
Tin foil
Newspaper
Cold window (or piece of glass on top of ice cubes)
Different coloured paints
Different types of cloth
Variety of Insulating materials (Styrofoam, cotton balls, foam rubber, etc.)

Grade 7 Science kits given to schools in 2009 contain:

2 tweezers/forceps
2 flashlights with batteries
2 magnet wands
8 magnifying glasses/hand lenses
8 pipettes/droppers
50 slides
50 cover slips
1 conductometer
8 thermometers



Student Version of Outcomes

111-5 Explain heat transfer in heating systems in houses.

113-4 Describe how heating technologies has affected lives.

209-1 Carry out procedures controlling the major variables.

209-3 Use instruments accurately for collecting data.

210-10 Identify potential sources of error in data while investigating heat.

210-11 Make conclusions, based on data, and explain how the data relates to the initial question.

210-12 Relate how experiments involving colour and heat absorption can be applied to the real world.

211-2 Communicate questions, ideas, intentions, plans, and results using a variety of means.

308-5 Compare transfer of heat by conduction, convection, and radiation.

308-6 Explain how colour and texture of surfaces affects heat absorption.



Light and Dark Pop Cans

(similar to activity described on page 243 of SCIENCEPOWER 7 resource)

Materials

- 2 aluminum can (same size)
- Paint (black, white) or another way to change the color of each can to black or white
- Light Source – at least 100W incandescent (must give off a lot of heat)
- 2 thermometers or temperature probes (one for each can)
- Stopwatch or time source

Procedure

- Fill the cans with equal amounts of cooking oil.
- Place a thermometer or temperature sensor in each can, making sure that the bulb is in the oil.
- Record the initial temperature of each sample in the data table.
- Place the cans at equal distances from the heat lamp and record the time (or start the stopwatch).
- After 1 minute, record the temperature of each can.
- Repeat for at least 15 minutes, or longer if possible.

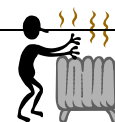
Explain what you observed and propose an explanation for why.



Recording chart

	White Can (Temperature)	Black Can (Temperature)
Starting Temperature		
1 min		
2 min		
3 min		
4 min		
5 min		
6 min		
7 min		
8 min		
9 min		
10 min		
11 min		
12 min		
13 min		
14 min		
15 min		

Write your conclusions about the effect of color on heat absorption.



Pop Cans with Sand

Materials

2 aluminum cans (same size) – one painted black and one white, both filled with soil

OR

Dark soil and light-coloured sand in separate, open containers

Light Source – at least 100W incandescent (must give off a lot of heat)

2 thermometers or temperature probes (one for each can)

Stopwatch or time source

Procedure

- Fill the cans with equal amounts of sand.
- Place a thermometer or temperature sensor in each can, making sure that the bulb is in the soil.
- Record the initial temperature of each sample in the data table.
- Place the cans at equal distances from the heat lamp and record the time (or start the stopwatch).
- After 1 minute, record the temperature of each can.
- Repeat for at least 15 minutes, or longer if possible.

Explain what you observed and propose an explanation for why.

i Teacher note: The same recording sheet can be used as for the Light and Dark Pop Cans activity.



Coffee Mug Melting

Materials

Coffee mug
Plastic wrap
Small pieces of chocolate such as Hershey kisses or small chocolate eggs
Bucket or saucepan
Aluminum foil
Hot water

Procedure

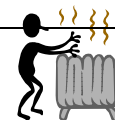
- Fill up hot water in a coffee mug almost till the top. Carefully cover the top with plastic wrap till it is snug and tight, tape the overhanging wrap around the cup if possible.
- Place the mug inside a bucket/saucepan.
- Carefully place an unwrapped Hershey kiss on top of the plastic wrap.
- After 5 minutes, check the condition of the chocolate, has it slightly melted?
- Repeat the procedure, but instead of the plastic wrap, cover the coffee mug with aluminum foil, making sure that the shinier side of the foil faces the hot water. And use a new chocolate.
- Repeat the procedure with newspaper taped to the top of the mug. Observe if any melting occurs.

Which of the plastic wrap, foil or newspaper produced the most dramatic result? Explain why that may be.

Also, think about how the shiny side of the foil may affect the results that you see. Do you think you would get the same results with the foil the other way?

Final tip: you can probably eat the chocolate from the plastic wrap and the foil experiments, but the chocolate from the newspaper experiment may not be clean. Throw it away.

Teacher note: Instead of chocolate a small piece of candle wax could be used.



Coloured Ice

Materials

Glass or jar

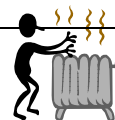
Hot water

Ice cube (freeze water dyed with dark food colouring)

Procedure

- Fill a tall glass or jar about $\frac{3}{4}$ full with warm water.
- Add a food-coloured ice cube and observe.

Draw a picture of what you observe and propose a possible explanation.



Convection Boxes

Convection Boxes – there are several ways to make these boxes.

Possibilities:

Rectangular fish tank with a lid (out of wood or cardboard) that fits over the tank and can be easily removed and replaced. Must be either taped or a snug fit to prevent air from moving under it into the box.

Cardboard or wooden box - laying on its side so open space faces out.

The tops must have:

2 holes for chimneys, each hole approx. 5 cm from the edge of the box.

2 “chimneys” that fit into the lid. Chimneys can be made from hard plastic tubes (e.g. plumbing pipes of about 2 inch diameter) or toilet paper rolls.

It will be easier to see the smoke if the inside back of the container is painted black.

Procedure

- Place a candle under one of the chimneys. Make sure the flame is more than 10 cm away from the chimney, particularly if you are using cardboard chimneys.
- Light the candle.
- Replace the lid and leave the box for about 2 minutes. Or, if using a wooden box, cover the front opening with plastic wrap and tape in place.
- Using a stick of unscented incense or smouldering paper towel, hold it over the chimney opposite from the one over the candle. What happens to the smoke?

Draw a picture of what you observe and write a possible explanation.

📌 **Teacher note:** The link below provides a full write-up of the activity. It also includes one further step that illustrates temperature inversions, but this is not a requirement for this unit.

<http://www.airinfnow.org/pdf/CurriculaConvectionWithGraphic.PDF>



Hot and Cold Water

Materials:

Kettle or heat source to heat water (water does not have to be boiling. It just needs to be hotter than the water it will be submerged in).
Large beaker or jar (1L or larger) such as a pickle or olive jar
Small beaker or baby food jar, or paper cup (may need to be weighted so it will rest on the bottom of the large jar)
Tongs or string or glove
Food colouring (darker colours work better)
Plastic Wrap

Procedure:

- Heat approximately 50 mL of water. Fill the small cup or baby food jar with the hot water and add a few drops of food colouring. Fasten plastic wrap over the top of the container and poke a hole in it.
- Using the tongs or by tying string around the mouth of the jar, carefully lower the hot water into the large jar of cool water.
- Observe what happens to the hot water versus cold water over a period of 5 minutes.

① Teacher note (not to be given to students including the picture): the greater the difference in temperature between the large jar and the small container, the faster you will see mixing of the water over time. Also you could have the students observe for 5 minutes and then check again after another 20 minutes or so.



Butter Melting

(Taken from the Grade 7 Atlantic Canada Science Curriculum document p.58)

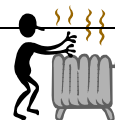
Materials

Metal spoon
Plastic spoon
Wooden spoon
Butter
Container of hot water

Procedure

- Put a small amount of butter a similar distance up the spoons.
- Place them into a container of hot water.
- Observe which spoon melted the butter the fastest.
- Rank each of the materials.

Explain why the butter melted at different speeds.



Pick a Stirrer

Materials

Plastic (pen tube) }
Copper wire } of similar length
Long iron nail }
Wooden craft stick }
Cup or beaker of very hot water

Procedure

- Pour very hot water into the beaker.
- Place one end of each sample in the hot water. Wait for 1 minute.
- Use the inside of your wrist to touch the top of each sample to determine which is warmest. Remove it from the cup and record your findings. Leave other samples in for 1 more minute.
- Repeat step 3 until you have ranked all of the materials.

Explain why different materials heated up at different rates.



Window Activity

Materials

- Aluminum foil
- Newspaper
- Cold glass window (or piece of glass on top of ice cubes)

Procedure

- Put a piece of aluminum foil larger than your hand (about 25 cm by 25 cm) over a cold glass window. Put your hand on the foil to feel the temperature.
- Repeat the same step with a piece of newspaper and also with your bare hand (only for a few seconds).

Note when your hand felt coldest and when it felt the least cold. Propose a possible explanation for why.



Melting Wax

Materials

Candle
Conductometer
Wax
Metal thumb tacks

Procedure

- Stick metal thumb tacks to the ends of the conductometer spokes using a small amount of melted wax. (Your teacher may have already done this).
- Hold the conductometer over the candle so the flame is heating the center hub.
- Record what happens.

Explain why different materials heated up at different rates.



Colour and Radiant Heat Transfer Activity

QUESTION:

MATERIALS:

WHAT TO DO:

Plan a new expanded version of the experiment where you can test different variables. Think about what you are measuring and what one thing you want to change to observe the effect.

Think about the materials required including the number of pop cans and thermometers.

Get your plan approved by your teacher.

Place 100ml of cooking oil in each can and then record the temperature in each can for at least 15 minutes. Frequency of observations should be decided by group.

Write up your lab report (see rubric). Pay special attention to how you present the data collected and what you think the results mean.

Results from the different experiments will be shared with the class.



Student Self-assessment

"Got it"	Student self-assessment	Teacher feedback
Question is stated clearly and in a testable form		
Materials list includes all necessary and appropriate items.		
Written steps are detailed and in sequential order . Steps are detailed enough that variables are controlled . Procedure could be replicated .		
Data is recorded in detail in an organized manner with titles and headings; necessary units are included.		
Discussion of results/ Conclusion relates to question and is based on data from the experiment.		
Spelling and grammar errors are absent or rare .		



Observation Chart Sheet

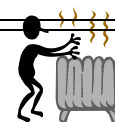
Outcomes:

name	name	name	name	name
name	name	name	name	name
name	name	name	name	name
name	name	name	name	name
name	name	name	name	name
name	name	name	name	name
name	name	name	name	name



Checklist Sheet

Outcomes	Correlations with Cycles	Yes	No
STSE			
111-5 Describe the science underlying heat transfer in solar heating systems and central heating systems in houses	1 st cycle: Mark/record observations through class discussion, class chart; journal entry 2 nd cycle: Mark/record observations through class discussion, class chart 3 rd cycle: Mark/record observations during activity; student write up and presentation 4 th cycle: Mark/record observations during discussion and reflection; assessment questions pg.18		
113-4 Describe how a technology associated with heat has affected lives	1 st cycle: Mark/record observations through class discussion, class chart; journal entry 2 nd cycle: Mark/record observations through class discussion, class chart 4 th cycle: Mark/record observations during discussion and reflection; assessment questions pg.18		
SKILLS			
209-1 Carry out procedures controlling the major variables	1 st cycle: Mark/record observations throughout activity 2 nd cycle: Mark/record observations throughout activity 3 rd cycle: Mark/record observations during activity; student write up		
209-3 Use instruments effectively and accurately for collecting data	1 st cycle: Mark/record observations throughout activity 2 nd cycle: Mark/record observations throughout activity 3 rd cycle: Mark/record observations during activity; student write up		
210-10 identify potential sources of error in data while investigating how various surfaces absorb radiant heat	3 rd cycle: Mark/record observations during activity; student write up and presentation		
210-11 State a conclusion, based on experimental data, and explain how evidence gathered supports or refutes an initial idea	1 st cycle: Mark/record observations during activity and class discussion; journal entry 2 nd cycle: Mark/record observations during activity and class discussion 3 rd cycle: Mark/record observations during activity; student write up and presentation		



Heat: Heat Transfer

210-12 identify and evaluate potential applications of findings	3 rd cycle: Student write up and presentation 4 th cycle: Mark/record observations during discussion and reflection; assessment questions pg.18	
211-2 Communicate questions, ideas, intentions, plans, and results, using lists, notes in point form, sentences, data tables, graphs, drawings, oral language, and other means	1 st cycle: Student product from activity; record/mark observations from class discussion 2 nd cycle: Student product from activity; record/mark observations from class discussion; layered book 3 rd cycle: Student write up and presentation	
KNOWLEDGE		
308-5 Compare transmission of heat by conduction, convection, and radiation	1 st cycle: Mark/record observations during activity and class discussion; journal entry 2 nd cycle: Mark/record observations during activity and class discussion; layered book	
308-6 describe how various surfaces absorb radiant heat	3 rd cycle: Mark/record observations during activity; student write up and presentation	



Observation Checklist

names	111-5 Describe the science underlying heat transfer in solar heating systems and central heating systems in houses	113-4 Describe how a technology associated with heat has affected lives	209-1 carry out procedures controlling the major variables	209-3 Use instruments effectively and accurately for collecting data	210-10 identify potential sources of error in data while investigating how various surfaces absorb radiant heat	210-11 State a conclusion, based on experimental data, and explain how evidence gathered supports or refutes an initial idea	210-12 identify and evaluate potential applications of findings	211-2 Communicate questions, ideas, intentions, plans, and results, using lists, notes in point form, sentences, data tables, graphs, drawings, oral language, and other means	308-5 Compare transmission of heat by conduction, convection, and radiation	308-6 describe how various surfaces absorb radiant heat



Student Record

Outcome goal	Evidence
I can explain the heat transfer involved in home heating systems. (111-5)	
I can explain how heating technologies affect lives. (113-4)	
I can carry out procedures controlling major variables. (209-1)	
I can use instruments accurately for collecting data. (209-3)	
I can identify potential sources of error in investigations. (210-10)	
I can make conclusions based on data and relate them to the original question. (210-11)	
I can relate how experiments involving heat and colour relate to the real world. (210-12)	
I can communicate questions, ideas, plans and results using a variety of means. (211-2)	
I can compare the transfer of heat by conduction, convection and radiation. (308-5)	
I can explain how colour and texture of surfaces affects heat absorption. (308-6)	

