hands-on
science
and Technology
An Inquiry Approach

Grade 2

Series Editor
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Hands-On Science and Technology, Grade 2
An Inquiry Approach

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Introduction to Hands-On Science and Technology

Program Introduction

Hands-On Science and Technology helps develop students' scientific and technological literacy through active inquiry, problem solving, and decision making. With each activity in the program, students are encouraged to explore, investigate, and ask questions as a means of heightening their own curiosity about the world around them. Students solve problems through firsthand experiences, and by observing and examining objects within their environment. In order for young students to develop scientific and technological literacy, concrete experience is of utmost importance—in fact, it is essential.

The Inquiry Approach to Science and Technology

As students explore science and technology concepts, they should be encouraged to ask questions to guide their own learning. The inquiry model is based on five components:

1. formulating questions
2. gathering and organizing information, evidence, or data
3. interpreting and analyzing information, evidence, or data
4. evaluating information, evidence, or data, and drawing conclusions
5. communicating findings

Using this model, the teacher becomes the facilitator of the learning process, and students initiate questions; gather, organize, interpret, and analyze information; evaluate findings and draw conclusions; and communicate their learning. As such, the process focuses on students' self-reflections as they ask questions, discover answers, and communicate their understanding.

Using an inquiry approach involves beginning with more structured inquiry, and moving to guided inquiry and, finally, open inquiry.

- In structured inquiry, the teacher may provide the initial question and structure the procedures to answer that question. Students follow the given procedures and draw conclusions to answer the given question.
- In guided inquiry, the teacher provides the research question, but students are involved in designing ways to answer the question and communicate their findings.
- In open inquiry, students formulate their own question(s), design and follow through with a developed procedure, and communicate their findings and results. According to Banchi and Bell (2008), "Open inquiry activities are only successful if students are motivated by intrinsic interests and if they are equipped with the skills to conduct their own research study."

In implementing an inquiry approach to science and technology, questions and ideas form the foundation of the teaching and learning process. The following excerpt from the Ontario Literacy and Numeracy Secretariat speaks clearly to this approach:

> While all students ask questions and express interests in world phenomena, it takes creative and responsive teaching to transform wonder into knowledge. To begin, inquiry works best in a classroom in which ideas are placed at the centre. Establishing a culture in which students are encouraged to express ideas but also to respectfully challenge and test one another's ideas is an important first step in the inquiry process. This spirit of inquiry is achieved by welcoming ideas and trusting that even the simplest questions can lead to something greater and not yet evident. Like any good growing system, these questions need time to germinate. Students' ideas can be expressed in many forms (questions, comments, diagrams, pictures, dance, etc.) and serve the important purpose of advancing student understanding of a topic. When the classroom culture is one that views ideas as improvable,

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> students work hard to continuously improve the quality, coherence and utility of ideas—both individually and collectively (Scardamalia 2002).

21st Century Teaching and Learning

In this rapidly changing and globalized world, it is more important than ever to prepare students to lead fulfilling lives, be productive contributors, and thrive in our society. Educators are responding to this challenge through evolving practice that challenges students in engaging and meaningful ways. The **Hands-On Science and Technology** program responds to this challenge by ensuring it reflects best practices that focus on 21st Century Competencies. According to Michael Fullan (2013), these competencies are:

- **Critical thinking:** Critical thinking is the ability to explore problems, weigh alternate solutions, and arrive at solutions. It also involves problem solving and making effective decisions, and applying them to real-world contexts.
- **Communication:** Communication refers to the ability to communicate effectively through reading, writing, speaking, listening, viewing, and representing. It also involves the ability to use a variety of information sources and digital tools.
- **Collaboration:** Collaboration requires the ability to work in teams, learning from and contributing to the learning of others.
- **Creativity:** Creativity involves exploring new ideas, being innovative, and thinking outside the box. Being creative also means looking at novel ideas and finding ways to put ideas into action.
- **Citizenship:** Citizenship involves thinking like a local and a global citizen, considering the values and worldviews of others, and having a genuine interest in solving complex real-world problems that affect human and environmental sustainability.
- **Character:** Character involves specific traits such as perseverance, resilience, and being a life-long learner.

These competencies are the foundation of the inquiry-based approach used in **Hands-On Science and Technology**. As such, teachers take on a facilitation role as students use these skills to explore, investigate, research, design, create, and solve problems in the world around them. To provide a connection between science and technology activities and 21st Century Competencies, each lesson in ***Hands-On Science and Technology, Grade 2*** identifies one or more competencies that teachers may focus on during the activity. This provides teachers with the opportunity to make ongoing links between the science and technology curriculum and 21st century classroom teaching and learning.

The Goals of the Science and Technology Program

Science and technology play fundamental roles in the lives of Canadians. In the introduction to *The Ontario Curriculum, Grades 1–8: Science and Technology* (2007, 3), the Ministry of Education states:

> During the twentieth century, science and technology played an increasingly important role in the lives of all Canadians. Science and technology underpin much of what we take for granted, including clean water, the places in which we live and work, and the ways in which we communicate with others. The impact of science and technology on our lives will continue to grow. Consequently, scientific and technological literacy for all has become the overarching objective of science and technology education throughout the world.

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The Ontario Curriculum identifies three goals that form the foundation of the science and technology program. In keeping with this focus on scientific and technological literacy, these goals are the bases for the lessons in the **Hands-On Science and Technology** program:

Goal 1
to relate science and technology to society and the environment

Goal 2
to develop the skills, strategies, and habits of mind required for scientific inquiry and technological problem solving

Goal 3
to understand the basic concepts of science and technology

Hands-On Science and Technology Strands and Expectations

The Ontario science and technology curriculum for all grade levels is organized into four strands, as follows:

1. Understanding Life Systems
2. Understanding Structures and Mechanisms
3. Understanding Matter and Energy
4. Understanding Earth and Space Systems

Two sets of expectations are listed for each grade in each strand: (1) overall expectations, and (2) specific expectations.

The overall expectations describe, in general terms, the knowledge and skills that students are expected to demonstrate by the end of each grade. There are three overall expectations for each strand in each grade in science and technology.

The specific expectations describe the expected knowledge and skills in greater detail.

NOTE: The overall and specific expectations must all be accounted for in instruction and assessment, but evaluation focuses on the three overall expectations (Ontario Ministry of Education 2010, 38).

The overall and specific expectations for each strand are presented in chart format in the introduction to each unit. Alongside each specific expectation, corresponding lessons are identified.

Hands-On Science and Technology Fundamental Concepts and Big Ideas

Fundamental concepts are key ideas that provide a framework for the acquisition of all scientific and technological knowledge. These concepts also help students to integrate scientific and technological knowledge with knowledge in other subject areas, such as mathematics and social studies. The fundamental concepts addressed in the curriculum for science and technology are:

- matter
- energy
- systems and interactions
- structure and function
- sustainability and stewardship
- change and continuity

Big ideas are the enduring understandings that students carry with them into the future. Big ideas are often transferable to other subjects and to real-life experiences.

The fundamental concepts and big ideas for each grade and strand can be found in a chart in the introduction to each unit of the **Hands-On Science and Technology** program.

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Hands-On Science and Technology Program Principles

- Effective science and technology programs involve hands-on inquiry, problem solving, and decision making.
- The development of students' skills, attitudes, knowledge, and understanding of Science, Technology, Society, and the Environment (STSE) issues form the foundation of the science and technology program.
- Children have a natural curiosity about science and the world around them. This curiosity must be maintained, fostered, and enhanced through active learning.
- Science and technology activities must be meaningful, worthwhile, and relate to real-life experiences.
- The teacher's role in science and technology education is to facilitate activities and encourage critical thinking and reflection. Children learn best by doing, rather than by just listening. Instead of simply telling, the teacher, therefore, should focus on formulating and asking questions, setting the conditions so that students ask their own questions, and helping students to make sense of the events and phenomena they have experienced.
- Science and technology should be taught in conjunction with other school subjects. Themes and topics of study should integrate ideas and skills from several core areas whenever possible.
- The science and technology program should encompass, and draw on, a wide range of educational resources, including literature, nonfiction research material, audio-visual resources, and technology, as well as people and places in the local community.
- The science and technology program should be infused with knowledge and worldviews of Indigenous peoples, as well as with other diverse multicultural perspectives.
- Assessment of student learning in science and technology should be designed to focus on performance and understanding, and should be conducted through meaningful assessment techniques carried out throughout each unit of study.

Infusing Indigenous Perspectives

Indigenous peoples are central to the Canadian context, and it is important to infuse their knowledge into the learning experiences of all students. The intentional integration of Indigenous knowledge in the **Hands-On Science and Technology** series helps to address the Calls to Action of the Truth and Reconciliation Commission of Canada (2015), particularly the call to "integrate Indigenous knowledge and teaching methods into classrooms" (clause 62) and the call for "building student capacity for intercultural understanding, empathy, and mutual respect" (clause 63).

Indigenous peoples of the past depended on the natural environment to survive. The environment shaped their way of life: geography, vegetation, climate, and natural resources of the land determined the ways they survived. By observing the land and its animal inhabitants, the environment also taught them to survive. The traditional territories of the First Nations and Métis peoples cover Ontario, and many Inuit have moved to urban centres in the province. The worldviews of these peoples and their approaches and contributions to science and technology are now being acknowledged and incorporated into educational programs. It is also important to recognize the diversity of Ontario's Indigenous peoples and to focus

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on both the traditions and contemporary lives of the Indigenous communities in your area. Contact personnel in your school district—Indigenous consultants and/or those responsible for Indigenous education—to find out what resources (e.g., people, books, videos) are available to you and your students.

In incorporating Indigenous perspectives, it is important to value Traditional Ecological Knowledge (TEK). TEK has been defined as:

> …the knowledge base acquired by indigenous and local people over many hundreds of years through direct contact with the environment. It includes an intimate and detailed knowledge of plants, animals, and natural phenomena, the development and use of appropriate technologies for hunting, fishing, trapping, agriculture, and forestry and a holistic knowledge, or "worldview" which parallels the scientific disciplines of ecology (Inglis 1993).

Indigenous peoples developed technologies and survived on this land for millennia because, in part, they were good scientists. They used observation and experimentation to refine their technologies such as building canoes and tipis and discovering food-preservation techniques. As such, TEK serves as an invaluable resource for students and teachers of science and technology.

Throughout the **Hands-On Science and Technology** program, there are many opportunities to incorporate culturally appropriate teaching methodologies from Indigenous worldviews. First Peoples Pedagogy indicates that making connections to the local community is central to learning (First Nations Education Steering Committee 2016). As one example, both Elders and Métis Senators offer a wealth of knowledge that can be shared with students. Consider inviting an Elder or a Métis Senator as a guest into the classroom in connection with specific topics being studied (as identified within the given lessons throughout the unit). An Elder or a Métis Senator can guide a nature walk, share stories and experiences, share traditional technologies, and help students understand Indigenous peoples' perspectives of the natural world. Elders and Métis Senators will provide guidance for learners and opportunities to build bridges between the school and the community. Here are a few suggestions about working with Elders and Métis Senators:

- Some Indigenous keepers of knowledge are more comfortable being called "Knowledge Keepers" than "Elders" or "Métis Senators." Be sensitive to their preferences.
- It is important to properly acknowledge any visiting Elders and Métis Senators and their knowledge, as they have traditionally been and are recognized within Indigenous communities as highly esteemed individuals. There are certain protocols that should be followed when inviting an Elder or a Métis Senator into your classroom. The Lakehead District School Board has protocols available at: <https://www.lakeheadschools.ca/aboriginal-education/>.
- It is especially important to connect with Indigenous peoples and Elders and Métis Senators in your local area, and to study local issues related to Indigenous peoples in Ontario. Consider contacting Indigenous education consultants within your local school district or with the Ontario Ministry of Education to access referrals. Also, consider contacting local Indigenous organizations for referrals to Elders and Métis Senators, and other knowledge keepers. Such organizations may also be able to offer resources and opportunities for field trips and land-based learning.

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Cultural Connections

To acknowledge and celebrate the cultural diversity represented in Canadian classrooms, it is important to infuse cultural connections into classroom learning experiences. It is essential for teachers to be aware of the cultural makeup of their class, and to celebrate these diverse cultures by making connections to curricular outcomes. In the same way, it is important to explore other cultures represented in the community and beyond, to encourage intercultural understanding and harmony.

Throughout the **Hands-On Science and Technology** program, suggestions are made for connecting science and technology topics to cultural explorations and activities.

Land-Based Learning

Land-based learning replaces the classroom walls with the natural land. For all students, land-based learning offers firsthand opportunities to observe, explore, and investigate the land, waters, and atmosphere of the natural world. Land-based learning promotes a healthy interplay between society and nature and helps students envision a world where there is meaningful appreciation and respect for our natural environment—an environment that sustains all life forms. Many lessons in ***Hands-On Science and Technology, Grade 2*** incorporate land-based learning activities, whether it be a casual walk around the neighbourhood to examine trees or a more involved exploration of local waterways. When land-based learning connections are made in ***Hands-On Science and Technology, Grade 2*** lessons, the following icon is used:

Technology

Digital learning, or learning with information and communication technology (LwICT), is an important component of any classroom. As such, technological supports available in schools—including digital cameras, computers/tablets, interactive whiteboards (IWB), projectors, document cameras, audio-recording devices, and even calculators—can be used with and by students to enhance their learning experiences. When technology connections are made in ***Hands-On Science and Technology, Grade 2*** lessons, the following icon is used:

Sustainability

The **Hands-On Science and Technology** program provides numerous opportunities for students to investigate issues related to sustainable development. Asking students the following question can often help to clarify for them what is meant by sustainability: "Is there enough for everyone, forever?" Exploring sustainability also connects to Indigenous worldviews about respecting and caring for the Earth. The three pillars of sustainability are the environment, society, and the economy. When sustainability links are made in ***Hands-On Science and Technology, Grade 2*** lessons, any or all of the sustainability pillars may be the focus of this connection, and are identified by the following icon:

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they use the competencies during the inquiry process. For this purpose, teachers may project a copy of the **21st Century Competencies Reflection** template, on page 29, and complete it as a class, using words and pictures to communicate students' reflections. A completed **Sample 21st Century Competencies Reflection** is included on page 30.

NOTE: Since no lesson addresses all six competencies, teachers can focus specifically on those covered in a lesson. Students can then explore the meaning of those skills at a deeper level.

Another component of assessment *as* learning utilizes the **21st Century Competencies Student/Teacher Reflection** template, which is found on page 33. This is completed by students at the end of the unit, in order to encourage them to reflect on how they have used the competencies. Students record their reflections in the rectangles on the template, and teachers provide descriptive feedback in the outer ovals.

NOTE: Depending on their literacy level, students may complete the assessment in various ways. For example, the sheets may be used as guides for oral conferences between teacher and student, or an adult may act as a scribe for the student, recording their responses. Alternatively, students may complete the sheets independently or with guidance and support as needed.

NOTE: This descriptive feedback from teachers may also be considered assessment ***for*** learning. Even though this feedback is provided at the end of the unit, students will consider the anecdotal comments as they continue to develop their 21st Century Competencies.

Students should also be encouraged to reflect on their cooperative group work skills, as these are directly related to 21st Century Competencies, as well as to the skills scientists use as they collaborate in team settings. For this purpose, a **Cooperative Skills Self-Assessment** template is on page 34.

Student reflections can also be done in many ways other than by using these templates. For example, students can do the following:

- Interview one another to share their reflections on science and technology.
- Write an outline or brief script and make a video reflection.
- Create an electronic slide show with an audio recording of their reflections.

Assessment *of* Learning

Assessment *of* learning provides a summary of student progress related to the accomplishments of the learning goals at a particular point in time. It is important to gather a variety of assessment data to draw conclusions about what a student knows and can do. As such, consider collecting student products, observing processes, and having conversations with students. Teachers should also consider which student work is formative and which is summative. Only the most recent and consistent evidence should be used.

Assessment *of* learning suggestions are provided with the culminating lesson of each unit of the **Hands-On Science and Technology** program. Teachers may use the **Anecdotal Record** template, on page 26, the **Individual Student Observations** template, on page 27, and the **Rubric**, on page 36, to record student results.

Always assess a student's individual accomplishments, not group work. However, you may assess how an individual student works within a group. Such skill development includes the ability to listen to others respectfully, share ideas, and participate actively in the inquiry process. For this purpose, use

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The Hands-On Science and Technology Assessment Plan

The **Hands-On Science and Technology** program provides a variety of assessment tools that enable teachers to build a comprehensive and authentic daily assessment plan for students. Based on current research about the value of quality classroom assessment (Davies 2011), suggestions are provided for authentic assessment, which includes assessment *for* learning, assessment *as* learning, and assessment *of* learning.

Ontario's policy on assessment is outlined in the document *Growing Success: Assessment, Evaluation, and Reporting in Ontario Schools* (see: <www.edu.gov.on.ca/eng/policyfunding/success.html>). The document (2010) outlines a fundamental shift in the roles of teachers and students in the learning process:

> In a traditional assessment paradigm, the teacher is perceived as the active agent in the process, determining goals and criteria for successful achievement, delivering instruction, and evaluating student achievement at the end of a period of learning. The use of assessment for the purpose of improving learning and helping students become independent learners requires a culture in which student and teacher learn together in a collaborative relationship, each playing an active role in setting learning goals, developing success criteria, giving and receiving feedback, monitoring progress, and adjusting learning strategies. The teacher acts as a "lead learner," providing support while gradually releasing more and more responsibility to the student, as the student develops the knowledge and skills needed to become an independent learner.

The primary purpose of assessment is to improve student learning. Assessment *for* learning provides students with descriptive feedback and coaching for improvement. Assessment *as* learning helps students self-assess by developing their capacity to set their own goals, monitor their own progress, determine their next steps in learning, and reflect on their learning. Assessment *of* learning is summative in nature and is intended to identify student progress in relation to learning expectations. The challenge for educators is to integrate assessment seamlessly with other learning goals. The Ontario assessment model uses the following process:

- **Establish learning goals from curriculum expectations.** Lessons include learning goals in student-friendly language that have been developed from curriculum expectations. These learning goals are shared with students and used to guide instruction.
- **Develop success criteria.** These descriptors are written in student-friendly language to help students understand what successful learning looks like. Criteria can be established by the teacher, using assessment task exemplars of student work, or by using the Achievement Chart from *The Ontario Curriculum, Grades 1–8: Science and Technology* (2007, 26–27). Success criteria can also be determined in collaboration with students.
- **Provide descriptive feedback.** In conversations with students, identify what criteria they have and have not met, and provide any needed instruction. At this stage, teachers work with students to identify next steps to determine how students may improve. This may include differentiating instruction.
- **Use information for peer and self-assessment.** Students assess their own work and the work of others to determine what still needs to be done.
- **Establish individual goals.** Students determine what they need to learn next and how to get there.

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The **Hands-On Science and Technology** program provides assessment suggestions, rubrics, and templates for use during the teaching/learning process. These suggestions include tasks related to assessment *for* learning, assessment *as* learning, and assessment *of* learning.

Assessment *for* Learning

It is important for teachers to assess students' understanding before, during, and after a lesson. The information gathered helps teachers determine students' needs and then plan the next steps in instruction. Students may come into class with misconceptions about science and technology concepts. By identifying what they already know, teachers can help students make connections and address any challenging issues.

To assess students as they work, use the assessment *for* learning suggestions provided with many of the activities.

While observing and conversing with students, teachers may use the **Anecdotal Record** template and/or the **Individual Student Observations** template to record assessment *for* learning data.

- **Anecdotal Record:** To gain an authentic view of a student's progress, it is critical to record observations *during* lessons. The **Anecdotal Record** template, on page 26, provides the teacher with a format for recording individual or group observations.
- **Individual Student Observations:** When teachers wish to focus more on individual students for a longer period of time, consider using the **Individual Student Observations** template, on page 27. This template provides more space for comments and is especially useful during conferences, interviews, or individual student performance tasks.

Assessment *as* Learning

It is important for students to reflect on their own learning in relation to science and technology. For this purpose, teachers will find a **Student Self-Assessment** template, on page 31, as well as a **Student Reflections** template on page 32.

In addition, the **Science and Technology Journal**, on page 28, will encourage students to reflect on their own learning. Teachers can copy several sheets for each student, cut the sheets in half, add a cover, and bind the sheets together. Students can then create their own title pages for their journals. For variety, you may also have students use the blank reverse side of each page for other reflections, such as drawing or writing about:

- new science and technology challenges
- favourite science and technology activities
- real-life experiences with science and technology
- new terminology
- new places explored during investigations

Students may also journal in other ways, such as by adding notes to their portfolios, or by keeping online science and technology blogs or journals to record successes, challenges, and next steps relating to the learning goals.

NOTE: This Science and Technology Journal template is provided as a suggestion, but journals can also be made from simple notebooks or recycled paper.

Another component of assessment *as* learning involves opportunities for students to reflect on their use of 21st Century Competencies. During each lesson, teachers should spend time discussing and reflecting on the competencies being focused on. The intent here is to enhance students' understanding of how and when

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Unit 3

Properties of Liquids and Solids

Introduction

In this unit, students are introduced to the properties of liquids and solids. When they examine materials in the world around them, they become aware of a wide variety of similarities and differences in the properties of those materials; for example, the way the materials look, feel, sound, or change.

Students will develop their understanding of properties of materials through the investigation of solids and liquids. They will investigate ways in which solids and liquids interact, and will learn some materials exist in solid and liquid states. Students will also learn it is important to take into consideration the various properties of solids and liquids when designing and building objects.

Planning Tips for Teachers

- Students are given many opportunities throughout the unit to participate in hands-on activities, and will experience more than if teachers merely demonstrate the learning for them. Small working groups of three or four students are the most productive and beneficial way to manage hands-on activities. Students also learn from each other when working in these cooperative groups. Assign each student a role in the cooperative group:
  - **leader**: makes sure everyone in the group has an opportunity to share ideas and opinions
  - **recorder**: records the group's ideas and research findings on activity sheets or charts
  - **reporter**: reports the group's ideas, findings, or answers back to the class
  - **gopher** ("go-for"): collects and returns all the materials needed for each activity

  Teachers who choose to manage classroom activities in this way need to be sure to collect enough materials for each group. For this unit, collect the following:
  - several large containers that will hold liquids (e.g., basins, pails, buckets, water tables)
  - various liquids (e.g., water, vinegar, vegetable oil, syrup, liquid detergent)
  - many solid objects made of various materials, including metal (e.g., spoons, paper clips), wood (e.g., pencils, building blocks), plastic (e.g., lids, toys), Styrofoam (e.g., cups, packing peanuts), wax (e.g., candles, honeycombs [beeswax]), glass (e.g., bottles, marbles), and cork (e.g., bulletin boards, coasters)
  - pictures of solids and liquids from magazines, calendars, and websites
  - books and magazines about matter. Include as many different genres as possible—fiction, nonfiction, comic books, weird-fact books, riddle books, poetry books. These reading materials will become part of a learning centre as a "Solids and Liquids" library, where students can refer to them during activities, research, and choice time.

NOTE: Teachers should be sure to check the readability of the books they provide, and are encouraged to provide a number of books representing a range of reading levels, all with good text structures and visuals.

- Review Resources for Students, on page 267, and order any books needed for upcoming lessons from the school, community, or education library.
- Review the various learning centre activities throughout the unit, and arrange for any necessary materials ahead of time.
- As you conclude a lesson and move on to the next one, keep all charts and displays created during the lesson, as well as activity sheets and other work done. These are often referred to again in subsequent lessons, and

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all charts and other materials created in this unit are used in the concluding lesson, which is a final inquiry project.

- Consider recording each lesson's guided inquiry question (e.g., on a sentence strip) for display throughout related investigations
- Develop a Makerspace centre. Classroom Makerspaces are usually designed as centres where students learn together and collaborate on do-it-yourself projects. Students are given the opportunity to work with a variety of age-appropriate tools, as well as everyday and recycled materials. Additionally, arts-and-crafts are often integrated into Makerspace offerings.

  For this unit, set up a Makerspace centre in your classroom that encourages informal learning about solids and liquids. Include general materials, such as those listed in the Introduction to ***Hands-On Science and Technology, Grade 2***, as well as unit-specific materials, including solids objects made of different materials (e.g., wood, plastic, cloth, metal, rock), as well as containers of liquids. Include measuring cups, funnels, siphons, prisms, Styrofoam balls or packing peanuts, and magnifiers.

SAFETY NOTE: Ensure all solids and liquids at the centre are safe to use with students. Also consider student allergies when selecting supplies for the centre.

Do-it-yourself projects may include anything related to the concepts within this unit. Projects that students might initiate include (but are not limited to):

- putting a few liquids and a few solids (to act as pollution/garbage) into a basin with water and design a contraption to "clean" the water (ties in the global perspective, and promotes 21st century competencies of character and citizenship)
- adding a little detergent (e.g., dishwashing soap) to a mixture of oil and water, to see what effect it has
- creating a new product/device out of recycled solids, to reuse those products and to prevent those products from going to the landfill
- creating a mould (using plastic wrap/cardboard, for example) to create a new type of ice cube shape
- designing and construct devices that are buoyant in water, and test these devices with coins or weights
- using LEGO to recreate the international symbols of safety
- using LEGO to create a new science safety symbol of their own
- designing a container that can hold a solid, liquid, or gas
- creating a puppet play demonstrating the states of matter
- creating public service announcements to bring attention to water issues
- creating something that will slow down the melting process of a snowball/ice (This would be good with *Sadie and the Snowman*.)
- making a rainbow

Literacy connections that might inspire projects include:

- *Sadie and the Snowman* by Allen Morgan
- *Water Can Be* by Laura Purdie Salas
- *A Drop of Water: The Story of Water on Our Planet* by Walter Wick
- *The Drop in My Drink: The Story of Water on Our Planet* by Meredith Hoope

As inquiry questions are posed with each lesson, you will find these questions inspire other do-it-yourself projects related to the unit. Students may determine solutions to these questions through the creating they

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do at the Makerspace centre. Remember to not direct the learning here; simply create conditions for learning to happen.

Indigenous Worldviews

Teachers are reminded of the value of incorporating Indigenous perspectives and worldviews into lessons whenever possible. These include having a respectful relationship with nature, with an intention to sustain natural resources for generations to come; the belief that all life—plant, animal, and human—is equal and depends upon one another for survival; and the idea that humans have special relationships with animals, which are seen as teachers, guides, and companions (and are also key to human survival).

This unit of ***Hands-On Science and Technology, Grade 2*** provides an opportunity for students to focus more on having a respectful relationship with the environment, with humans needing to be aware of environmental changes for safety reasons, such as thin ice (solid vs. liquid) or rain causing flash floods. As well, Indigenous teachings about solids and liquids would focus not only on the properties of each state but also on how each can impact our daily lives (e.g., water contributing to life, or the properties of solid materials used for survival as in shelter, clothing).

For more information about incorporating Indigenous perspectives, refer to Introduction to ***Hands-On Science and Technology, Grade 2***, on page 5.

Science and Technology Vocabulary

Throughout the unit, teachers should use, and encourage students to use, vocabulary such as:

- *buoyancy, change of state, dissolve, float, freeze, liquid, mass/weight, melt, opaque, property, sink, solid, substance, thick, thin, translucent, transparent, viscosity*

In lesson 1, students start a Science and Technology Glossary in which they record new vocabulary introduced throughout the unit. Also in lesson 1, teachers create a class word wall for the unit. The word wall can be created on a bulletin board or simply on a sheet of poster paper, so as not to take up too much space. On the bulletin board or poster paper, record new vocabulary as it is introduced throughout the unit. Ensure the word wall is placed in a location where all students can see it and access the words.

Teachers should consider including vocabulary related to scientific inquiry skills. Vocabulary related to scientific inquiry skills include terms such as:

- *access, ask, brainstorm, collect, compare, connect, consider, construct, cooperate, create, describe, develop, estimate, explain, explore, find, follow, graph, identify, improve, investigate, measure, observe, order, plan, predict, recognize, record, repeat, research, respond, select, sequence, test*

These terms might be displayed in the classroom as they relate to inquiry skills used throughout the year. Students can then brainstorm which skills they are using as they work through particular lessons.They could also discuss what the skill looks and sounds like as they explore and investigate.

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Unit Overview

Fundamental Concepts	Big Ideas
Energy Matter	■ Materials that exist as liquids and solids have specific properties. ■ Liquids and solids interact in different ways. ■ Some liquids and solids can be harmful to us and the environment.

Overall Expectations

By the end of Grade 2, students will:

1. Assess ways in which the uses of liquids and solids can have an impact on society and the environment.
2. Investigate the properties of and interactions among liquids and solids.
3. Demonstrate an understanding of the properties of liquids and solids.

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2 What Are Solids and Liquids?

Information for Teachers

Solids, liquids, and gases are the three basic states of matter.

Solids usually retain their shape because they consist of tightly packed particles. Solids can be broken but are not very compressible, due to the rigid and close arrangement of their particles.

Liquids also have a very close arrangement of particles. This means they are also not very compressible. However, the particles in a liquid move around more. Because of this, liquids do not retain their shape but take the shape of the container they are in. Liquids can be poured, and can often splash and form droplets.

The particles in a gas move around even more, and have a lot of space between them. Gases diffuse (spread out) quickly and will take the shape of any container. They are also compressible, due to the large amount of space between particles.

21st Century Competencies

Critical Thinking and **Communication**: Students will compare and contrast various liquids and solids, and develop a list of properties for each. Then, they will be asked to examine materials that may have properties of both liquids and solids (e.g., sand), and decide how best to classify them.

Materials

- water bottle (Fill with water, and cap.)
- two empty jars
- chart paper
- markers
- Activity Sheet: Which Are Solids and Which Are Liquids? (3.2.1)
- clear plastic containers or jars with lids (Fill with liquids [e.g., water, dish soap, syrup, vinegar, oil] Label each jar with the name of the liquid.)
- clear plastic jars with lids (Fill with small solid items [e.g., buttons, stones, erasers, coins, nails, washers, tiles] Label each jar with the name of the solid.)
- more solids (e.g., building blocks, LEGO, books, pencils, crayons)
- magnifying glasses
- glue
- scissors
- computer or table with Internet access
- Learning-Centre Task Card: Sorting and Graphing Solids and Liquids (3.2.2)
- Learning-Centre Activity Sheet: Sorting and Graphing Solids and Liquids (3.2.3)
- Pictograph Symbols (Make several copies of the sheet.) (3.2.4)
- sticky notes
- concept web (from lesson 1)
- Science and Technology Glossary (3.1.4)

Activate

Give students 30 seconds to locate an item in the classroom that they are able to hold in one hand.

After 30 seconds, have each student display their item and explain what the object is made of. Ask:

- Are all of these objects solids?
- Are any of the items liquids?

Now, display the water bottle. Ask:

- What is inside the bottle?
- Is water a solid or a liquid?
- How do you know that water is a liquid?

Have students share their ideas. Then, introduce the guided inquiry question: **What are solids and liquids?**

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2

Action: Part One

Divide the class into working groups. Provide each group with a variety of solids and liquids (e.g., building blocks, LEGO, books, pencils, crayons; jars containing water, dish soap, vinegar, oil). Allow students time to manipulate and discuss the materials. Then, ask:

- How can you sort these items into groups?

Distribute a copy of Activity Sheet: Which Are Solids and Which Are Liquids? (3.2.1), and have students use it to record their sorting. Students may use the terms *solid* and *liquid* as their sorting rules, or they may use *liquid* and *not liquid* or *solid* and *not solid*.

Activity Sheet
Directions to students:
Sort the objects by recording them on the sorting mat as solids or liquids (3.2.1).

Action: Part Two

As a class, discuss the sorting activity. Ask:

- How did you sort the items?
- If you identified some of the objects as solids, how do you know they are solids?
- How are solids different from liquids?

Discuss the properties of solids by having students stack (or pile up) some solid objects. Place a solid object into one empty jar, and pour a liquid into another jar. Ask:

- How are solids and liquids different from each other?
- How are solids and liquids similar to each other?

Connect the activity to what students know about the senses. Ask:

- What does your sense of sight tell you about solids?
- Can you hear a liquid? (when it is being poured, splashed, or swished)
- Which liquids can you smell?
- Which solids feel rough? Sharp? Soft?

Divide a sheet of chart paper into two columns, and title the first column "Solids." Have students brainstorm a list of solids, and record these in the first column. Title the second column "Properties of Solids." Explain the term *property* is another word for *characteristic*. Have students describe, in their own words, some of the properties of solids.

On another sheet of chart paper, make two columns. Title the first column "Liquids," and have students brainstorm a list of liquids. Ask students to explain which liquids they use in their homes, and how they use them.

Title the second column of the chart "Properties of Liquids." Have students describe, in their own words, some of the properties of liquids.

Display these charts in the classroom throughout the rest of the unit to help students identify different types of matter.

Action: Part Three 

Have students learn about igloos as a means of exploring the solid state of water. They are made of compacted snow, use a dome shape for strength, and use a rising spiral for construction purposes. The following video shows Inuit building an igloo. Go to: <www.youtube.com/watch?v=R-x5QOSqP3E>.

After watching the video, pose the following questions for review and further inquiry and research:

- Why is snow better than ice for building an igloo?
- Why do you use a circle for the shape?

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- Why do you use a rise spiral pattern to build the igloo?
- How does the dome shape make the igloo strong?
- How does an igloo—made of snow—allow those inside to stay warm?

Further exploration of snow can consider the following questions:

- What type of snow is best for making snowballs? Snowmen?
- When does snow squeak and why?
- Does snow have to melt to disappear?

Learning Centre

At the learning centre, provide clear plastic jars (labelled, with lids) filled with liquids (e.g., water, dish soap, syrup, vinegar, oil) and clear plastic jars (labelled, with lids) filled with small solid items (e.g., buttons, stones, erasers, coins, nails, washers, tiles). Also, provide magnifying glasses, glue, scissors, a copy of the Learning-Centre Task Card: Sorting and Graphing Solids and Liquids (3.2.2), copies of the Learning-Centre Activity Sheet: Sorting and Graphing Solids and Liquids (3.2.3), and copies of the Pictograph Symbols (3.2.4).

Have students record on the activity sheet the name of each item (both solids and liquids), examine each item, then identify with a check mark whether it is a solid or a liquid. Finally, ask students to count the number of solids and liquids and create a pictograph of their results.

Consolidate and Debrief

- Revisit the guided inquiry question: **What are solids and liquids?** Have students share their knowledge, provide examples, and ask further inquiry questions.
- Add to the concept web as students learn new concepts, answer some of their own inquiry questions, and ask new inquiry questions.
- Add new terms, including *solid* and *liquid*, and illustrations to the class word wall. Also, include the words in other languages, as appropriate.
- Have students add new terms, illustrations, and definitions to their Science and Technology Glossary (3.1.4). When possible, encourage them to add words in other languages, including Indigenous languages, reflective of the class population.

Assessment for Learning

Through individual conferences, have students sort a variety of objects as solids and liquids. Ask them to explain the properties of each. Have students provide additional examples of both solids and liquids from everyday life. Use the Individual Student Observations sheet, on page 27, to record results.

Enhance

- Many students may believe a solid object is always hard. In fact, many solids, when in very small pieces, can be poured like liquids. Also, although solids like sand and sugar take the shape of their container, they also tend to "stack up" when they are poured onto a flat surface, whereas liquids spread out into a thin layer. Have students work with a variety of solids such as salt, sugar, sand, uncooked rice, aluminum foil, and Plasticine. Each will, generally, take on the shape of the container it is in. Have students use a magnifying glass to examine the "small pieces." They may notice there is air space between the small solid pieces, which retain their shape. When students examine liquid through a magnifying glass, they will not find air spaces. Pose a question and turn this into a short, independent inquiry. For example:
  - Is sugar/salt/sand a solid or a liquid?

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Then, students can explore the substance, design their own inquiry, and come up with an answer, supported by evidence.

- Have students learn more about the characteristics of solids by manipulating and changing them, while also making aesthetically pleasing products. For this activity, you will need the following:
  - chalk (various colours)
  - something to crush chalk (e.g., mortar and pestle, small rock, ice cream scoop, heavy spoon)
  - small, narrow jar with lid
  - salt
  - bowl

  Place a handful of salt and a piece of chalk in a bowl. "Mash" the chalk into the salt until it produces the desired colour. Pour the coloured salt into the jar. Now, colour other batches of salt by crushing and adding chalk. Add to the jar. Tilt the jar or stir the contents with a pencil to create interesting designs in the coloured salt. Fill the jar to the top to prevent further salt from shifting, and secure the lid tightly.
- Have students investigate solids and liquids in their homes—in refrigerators and cupboards. Distribute a copy of Enhance Activity Sheet: What Is in My Fridge?/What Is in My Cupboards (3.2.5) to each student.

NOTE: This is a two-page activity sheet.

- Access the interactive activity Solids & Liquids, in the Grade 2, Unit 3 folder of the ***Hands-On Interactive for Science and Technology, Grade 2*** download. Find this download at: <www.portageandmainpress.com/product/hands-on-interactive-for-science-and-technology-grade-2/>.
- Have students continue their do-it-yourself projects at the Makerspace centre.

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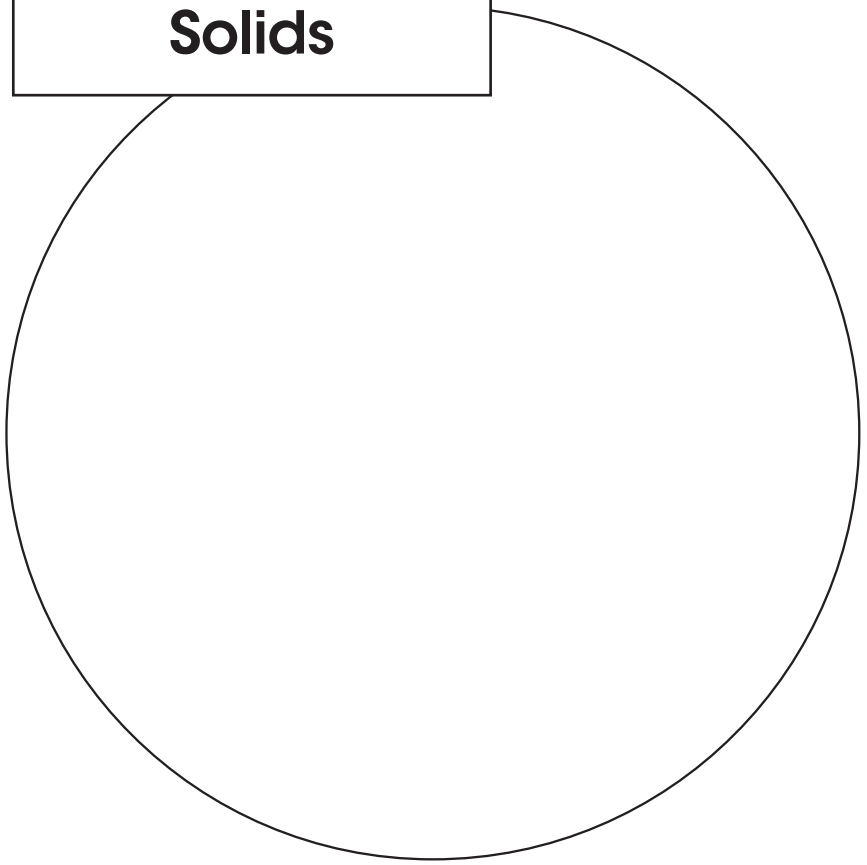
Date: _____ **Name:** _____

280 – 3.2.1

Which Are Solids and Which Are Liquids?

Solids

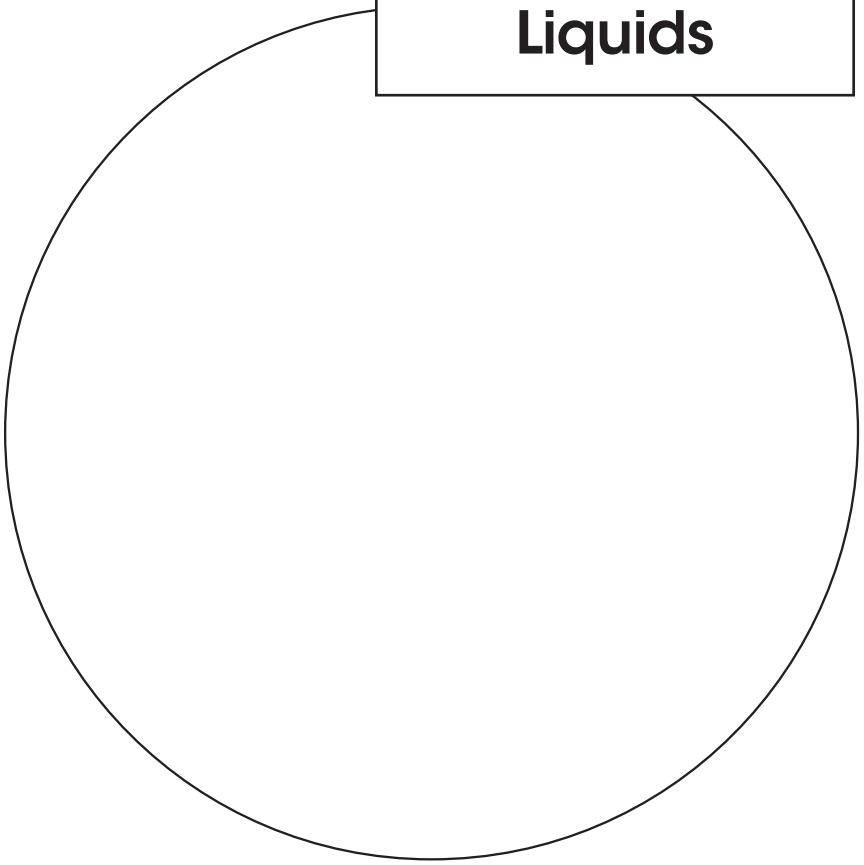


How do you know these are solids?

_____

_____

Liquids



How do you know these are solids?

_____

_____

Sorting and Graphing Solids and Liquids

Today you are a scientist!

1. Look at the items in each jar, but do not open them!
2. In the first column of the chart on the activity sheet, record the name of the item(s) found in each jar.
3. For each jar, show whether the item inside is a solid or a liquid by putting a check mark in the correct column.
4. Review your chart, and count how many jars are holding solids and how many are holding liquids. Record your numbers at the bottom of the chart.
5. On the back of your chart, make a pictograph of your results. Use the pictograph symbols—a LEGO block for each jar of solids and a water droplet for each jar of liquid. Cut out the number of symbols that you need of each, and glue these onto your pictograph.
6. Once you have graphed your data, record three sentences about the information on your graph.

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Date: _____ **Name:** _____

Sorting and Graphing Solids and Liquids

Object	Solid	Liquid
Total _____	**Total** _____	**Total** _____

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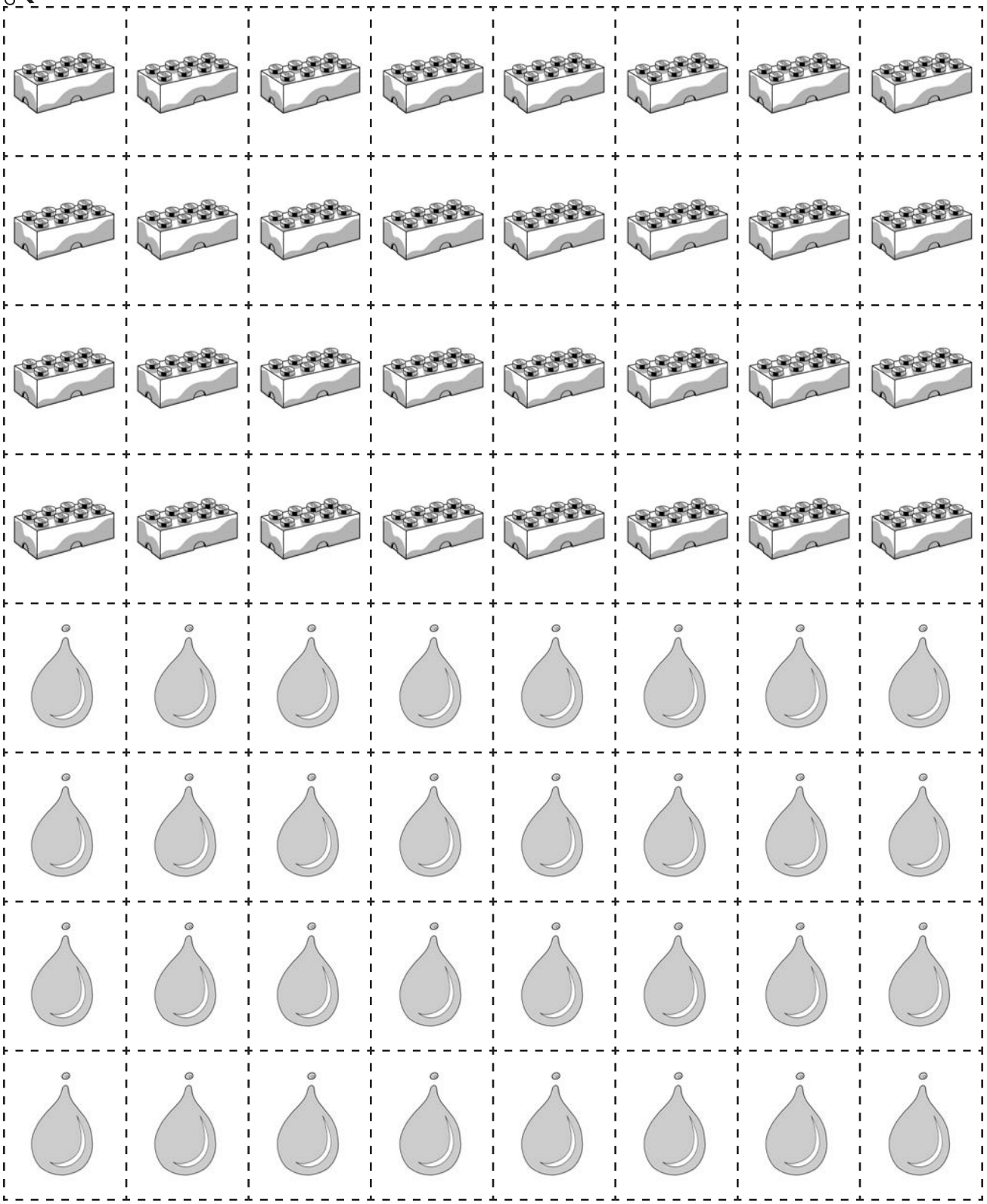
Pictograph Symbols



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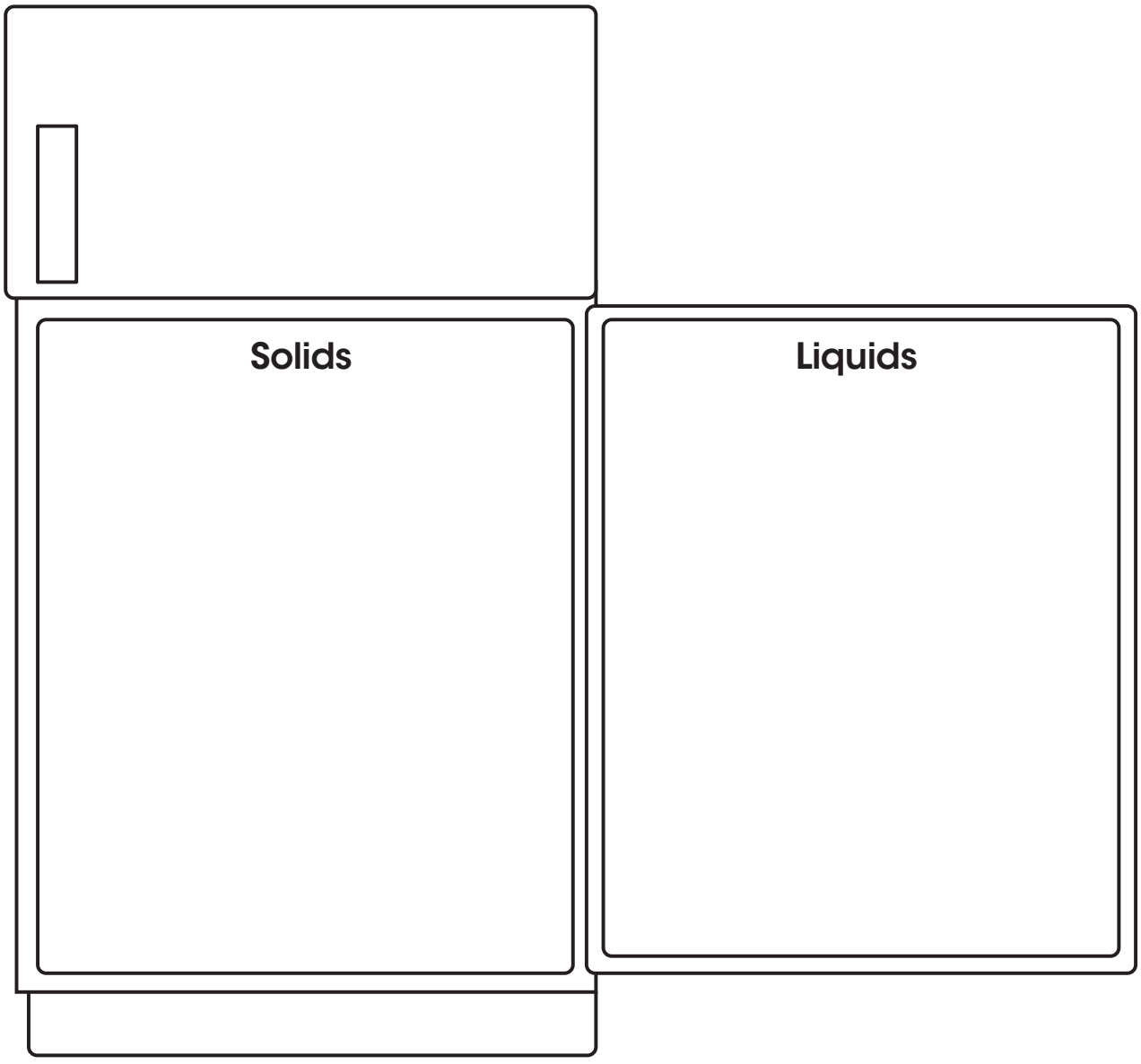
Date: _____ **Name:** _____

What Is in My Fridge?



I know these are solids because

_____

_____

_____

I know these are liquids because

_____

_____

_____

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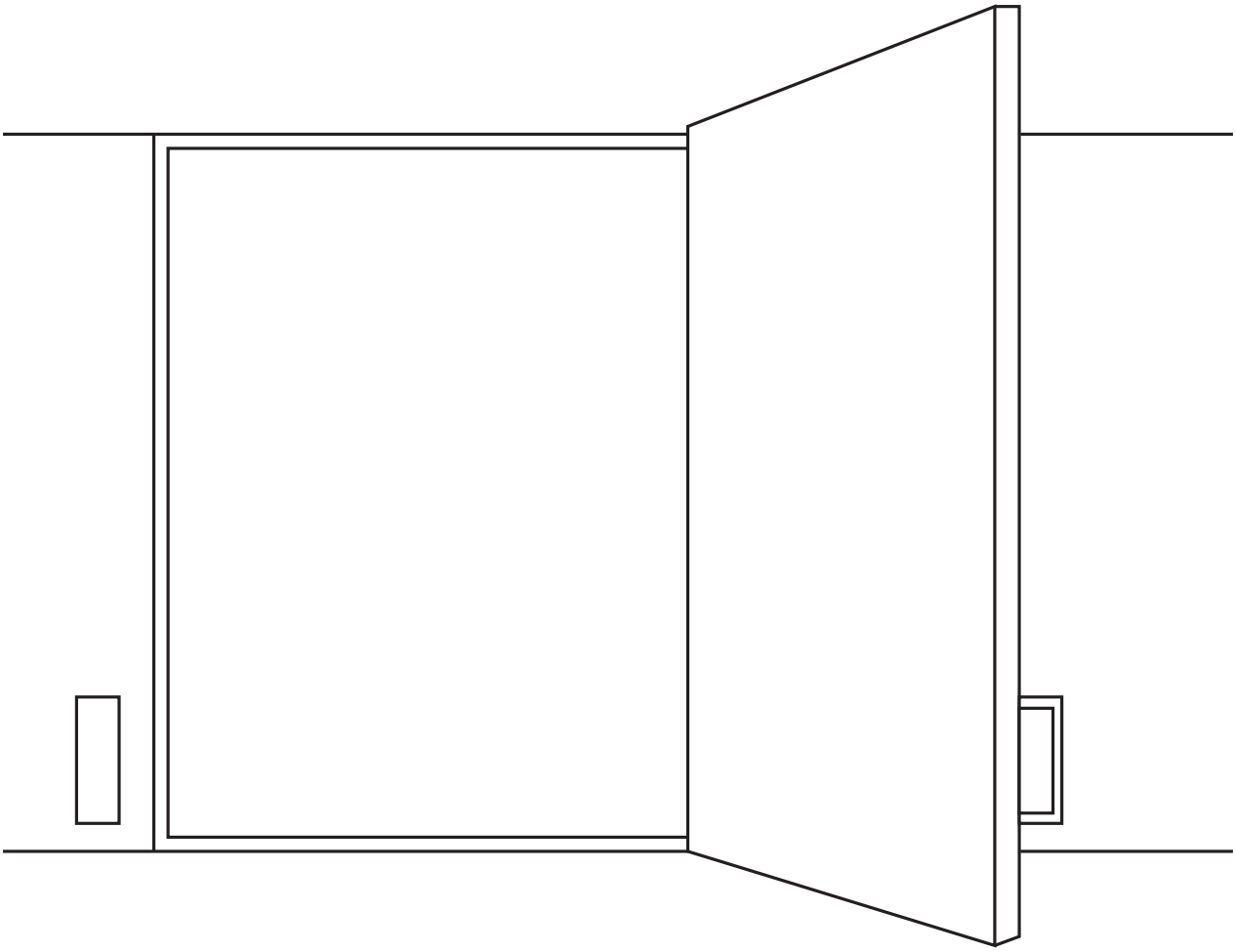
Date: _____ **Name:** _____

What Is in My Cupboards?



Choose two solids and two liquids and explain how each one is used in your home.

Liquid: _____

Liquid: _____

Solid: _____

Solid: _____

One question I have about solids or liquids: _____

_____

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Appendix

Images in this appendix are for the Image Banks referenced in the lessons. Corresponding full-page, high-resolution images can be printed or projected for the related lessons, and are found on the Portage & Main Press website at: <www.portageandmainpress.com/product/HOSTBANKGR2/>. Use the password **LEARNINGCENTRE** to access the download for free.

Unit 3: Properties of Liquids and Solids

Lesson 12: How Can I Design an Object That Floats?

Canoes and Kayaks

1. Algonquin Canoe

An Algonquin canoe made by William and Mary Commanda using etched "winter bark" to provide the decorated outer surface.

2. Inuit Umiak

A small Inuit umiak made from sealskin stretched over a frame.

3. Kwakwaka'wakw Canoe

A massive Kwakwaka'wakw dugout canoe from Fort Rupert, Vancouver Island

4. Gwitch'in Canoe

A northern-style Gwitch'in bark canoe from the Athabaskan region.

5. Hunting Kayak

A sleek hunting kayak from western Greenland.

6. Salish canoe

A short dugout canoe used for close harvesting in the intertidal areas.

Image Credits:

1 – Algonquin Bark Canoe. Courtesy of the Canadian Canoe Museum and Michael Cullen.

2 – Umiak. Courtesy of the Canadian Canoe Museum and Michael Cullen.

3 – Dugout Canoe. Courtesy of the Canadian Canoe Museum and Michael Cullen.

4 – Gwitch'in bark canoe. Courtesy of the Canadian Canoe Museum and Michael Cullen.

5 – Western Greenland Hunting Kayak. Courtesy of the Canadian Canoe Museum and Michael Cullen.

6 – Salish clam canoe. Courtesy of the Canadian Canoe Museum and Michael Cullen.

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About the Contributors

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