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Grade Two

Exploration of Liquids

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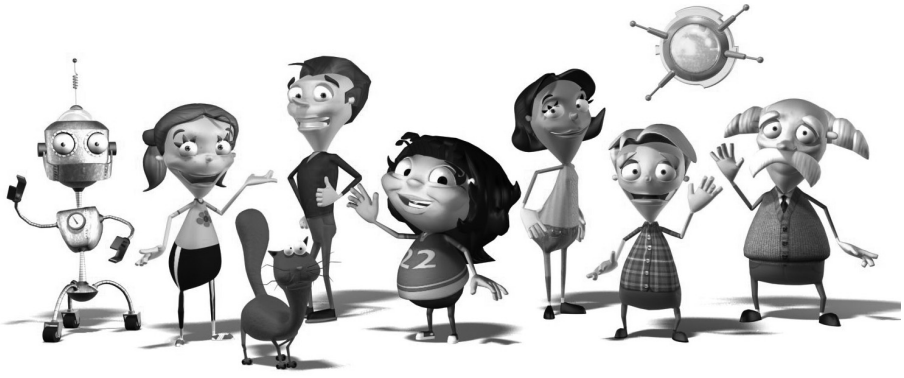

Exploration of Liquids

Before You Begin

Students have a natural fascination with water, the most pervasive liquid in their environment. Through these activities, students are given the opportunity to build on experiences they have had with water and other liquids in and out of the classroom. They explore the nature of liquids and their interactions with various materials. They examine the phase changes of water (freezing, melting and evaporating) and investigate the process of liquid evaporation. Most significantly, students develop an appreciation for the importance of water in their lives.

Topic A: Exploration of Liquids

(Suggested time: 4-6 weeks)

Several weeks before beginning this unit, materials need to be gathered. Many of these items could be collected by the students. Send a note home in advance, requesting sponges, fabric samples and any of the materials you need. This will also help create interest in the unit.

It is appropriate to teach this unit at any time of year. Many of the activities can be completed outside in the spring or fall so that spills become less of a concern.

Background Information

To understand what makes liquids unique, we must first look at liquid in the context of all three phases of matter. The amount of *kinetic energy* (i.e., energy of motion) the molecules of a substance has determines whether the substance is in the solid, liquid or gaseous state. In the *solid* state, the molecules of a substance are held in place by intermolecular forces of attraction and have very little, if any, freedom to move about. Their kinetic energy levels are quite low. If the solid is heated, the energy thus imparted to the substance breaks the intermolecular forces and allows the molecules to begin moving about within the substance. The temperature the substance must reach to break the intermolecular forces is called the substance's *melting point*. The resulting fluidity of the molecules within the mass of the substance is the primary characteristic of the *liquid* state of matter. When a liquid is heated, it eventually reaches its *boiling point*, the temperature at which molecules have enough energy to break completely away from the liquid and take off on their own. In this state of dissociation and high molecular kinetic energy, the substance is said to be a *gas* or *vapour*.

Evaporation takes place when molecules gain enough energy to escape from the surface of a liquid below its boiling point. The rate of evaporation (i.e., the number of molecules escaping over a given period of time) increases as the temperature of the liquid increases and as the ability of the surrounding air to carry off the gas molecules increases. The warmer and drier the air is, and the faster it blows across the surface of a liquid, the faster the gas molecules are removed from the vicinity of the surface and the faster the liquid evaporates. Just consider how much longer a wet footprint remains visible on the sidewalk on a cool, humid day than on a dry, windy day.

As we have seen, changing a substance from one phase to another is a matter of adding or subtracting energy. As the molecules of a substance gain kinetic energy and an increased freedom to move about, the property of the substance changes from solid to liquid to gas. The reverse phase changes occur if energy is taken away. As the temperature of a gas drops, it turns to liquid at a specific temperature called its *point of condensation* (the same temperature as its boiling point) and upon further cooling turns to a solid at its *freezing point* (the same temperature as its melting point). These points of phase transition are different for every substance. For example, the temperature at which the phase change between solid and liquid occurs for water is, by definition, 0°C at sea level. Its liquid/gas phase change occurs at 100°C. By contrast, the isopropyl alcohol used in rubbing alcohol melts (or freezes) at –89.5°C and boils (or condenses) at 82.4°C. Iron must reach 1535°C to melt and 3000°C to boil.

Another characteristic that varies from substance to substance is the ease with which it flows in the liquid state. There is a special term used to describe a liquid's resistance to flow: *viscosity*. The more viscous a liquid is,

the less easily its molecules move past one another and the slower it flows. Molasses, for example, is far more viscous than vinegar. In general, liquids become less viscous as their temperature increases. Certain liquids known as thixotropic fluids also become less viscous when they are stirred. Printer's ink and paint are two examples.

A liquid's ability to flow is easy to observe, as is its ability to bead. Have you ever noticed how liquid mercury forms into spheres (or "beads") when it's on the loose? Or have you ever wondered why water forms drops? The secret lies at the surface of the liquid, where the liquid molecules tend to attract one another and resist the spread of the liquid. This resistance to spread is called the liquid's *surface tension*, a property that varies in strength depending on the molecular make-up of the liquid. Sometimes the surface tension of a liquid can be decreased by mixing it with another substance called a *surfactant*. Detergent is a surfactant, or surface-acting agent, which decreases the surface tension of water, thereby increasing water's ability to spread, wet and thus dissolve other substances.

The best way to observe the beading that results from surface tension is to pour a small amount of liquid on a smooth, non-porous surface, such as a stainless steel counter. If you choose a porous surface instead, like a paper towel, another phenomenon associated with surface tension might sabotage your experiment. *Capillarity* is the tendency of some liquids, such as water, to travel into and along the inside surface of small-diameter cavities. The liquid is drawn inside by its surface tension and the adhesion between its molecules and the molecules of the substance forming the cavity: the smaller the cavity diameter, the farther the liquid travels into the hollow. This is the principle behind *absorbency*. Materials that have numerous small cavities, or pores, in their surface are far more capable of absorbing liquids than materials with fewer or larger surface pores. *Waterproofing* is a process that fills and closes the pores of a surface, whereas making an object *water-repellent* involves giving its surface a degree of water resistance while leaving the pores open.

Interestingly, some liquids are waterproof. They simply will not mix with water to form solutions. We've all heard the saying, "Oil and water don't mix." The two liquids stubbornly go their own ways, settling out with the denser liquid (water) forming a layer below the less dense liquid (oil). There are also many other combinations of liquids that refuse to mix. Such liquids are said to be *immiscible*, as opposed to *miscible* liquids, which happily combine. In some cases it is possible to force immiscible liquids to come together in a mechanical mixture of one liquid inside the other called an *emulsion*. Mayonnaise is a good example of an emulsion of oil and vinegar. As anyone who has made salad dressing knows, oil and vinegar are immiscible liquids. However, if you add an egg to the recipe and thoroughly stir the three ingredients together, the egg acts as an

emulsifying agent, preventing the two liquids from separating out. Emulsifying agents work their magic by surrounding small droplets of one of the two immiscible liquids. The liquid trapped in the droplets can't flow back together, so the droplets remain suspended in the other liquid, usually producing a cloudy fluid.

Water's properties are used as the standard against which the properties of other liquids are measured. This is not surprising given water is the most abundant liquid in our environment and the most important to our well-being and survival. Water makes up 50 to 95% of the weight of any functioning living system and it provides a suitable habitat for numerous organisms!

While Alberta currently has plentiful sources of fresh water, many other areas of the world are facing serious water conservation issues due to drought, pollution and insufficient resources to meet increasing demands. Southern California, for example, is populated with millions of people who depend on water supplies piped in from considerable distances. As the population grows, so too does the demand for water. In an effort to make the most of a finite resource, residents of Southern California cut back on water consumption in various ways, especially in years of drought. For example, lawns are watered only once per week, toilets are designed to minimize water usage and the water tap is not left on while people brush their teeth. It should be noted that resource-conscious people, even in water-rich parts of the world such as Alberta, follow these same practices in order to maintain existing water supplies.

Chemical pollution is an entirely different issue threatening the quality of water supplies around the world. Strict regulations governing the direct dumping of chemical wastes into waterways are enforced in many countries. Nonetheless, in recent years lakes in many areas of North America have experienced increased acidity due to run-off from acid rain produced downwind of sulfur-emitting smoke stacks. Even the relatively pure water held in remote Arctic snow contains traces of industrial pollutants. Awareness of how our actions impact the environment, and following good water management practices, are our best strategies for ensuring the availability of clean water supplies for the future.

Elementary Science Program of Studies

General and Specific Learner Expectations

The following general and specific learner expectations have been taken directly from the 1996 Elementary Science Program of Studies. The specific learner expectations (SLEs) are referred to by number in the second column of the activities table.

General Learner Expectations

Students will be able to:

- Describe some properties of water and other liquids, and recognize the importance of water to living and non-living things.
- Describe the interaction of water with different materials, and apply that knowledge to practical problems by drying, liquid absorption and liquid containment.

Specific Learner Expectations

Students will be able to:

1. Recognize and describe characteristics of liquids:
   - recognize and describe liquid flow
   - describe the shape of drops
   - describe the surface of calm water
2. Compare water with one or more other liquids such as cooking oil, glycerine or water mixed with liquid detergent. Comparisons may be based on characteristics such as colour, ease of flow, tendency of drops to form a ball shape (bead), interactions with other liquids and interactions with solid materials.
3. Compare the amount of liquid absorbed by different materials; for example, students should recognize that some forms of paper are very absorbent but that other forms of paper are not.
4. Evaluate the suitability of different materials for containing liquids. Students should recognize that materials such as writing paper and unglazed pottery are not waterproof and would not be suitable as containers, but that waxed paper and glazed pottery are waterproof and could be used in constructing or lining a liquid container.
5. Demonstrate an understanding that liquid water can be changed to other states:
   - recognize that, on cooling, liquid water freezes into ice, and that on heating, it melts back into liquid water with properties the same as before
   - recognize that on heating, liquid water may be changed into steam or water vapour, and that this change can be reversed on cooling
   - identify samples in which water is changed from one form to another

6. Predict that water in open containers will decrease due to evaporation, but the water level in closed containers will not decrease.
7. Predict that a wet surface will dry more quickly when exposed to wind or heating, and apply this understanding to practical situations such as drying of paints, clothes and hair.
8. Recognize that water is a component of many materials and of living things.
9. Recognize human responsibilities for maintaining clean supplies of water, and identify actions that are taken to ensure that water supplies are safe.

Cross-curricular Connections

Mathematics

• Measure capacity, graphing, estimating.

Music

• Tap bottles with varying amounts of liquids and compare pitch.

Social Studies

• Explore water in the community.

Drama

• Illustrate water movement in nature through movement exercises.

Language Arts

• Compose from a story pattern (for example, "I Like Boats," *Innovations in Science Level 2: Waterways, Teaching Notes*, p. 27).
• Read and discuss stories and poems about bodies of water and boats.
• Record vocabulary and writing sentences into booklets regarding discoveries made about water.
• Develop a list of sounds that water makes.

Children's Alternative Frameworks

Children sometimes hold beliefs about the properties of liquids and the interaction of liquids that are not consistent with current scientific knowledge such as:

• Water disappears when it evaporates.
• Ice is something different from water.
• All liquids mix.
• Light objects float on water while heavy ones do not.
• Objects that float on water float on any liquid.

Activities

Classroom teachers have identified the following activities that address the Specific Learner Expectations (SLEs) in the Program of Studies. The list is not prescriptive and teachers may select activities that are most appropriate for their students.

Activities have been listed under two headings: Key Activities and Extension Activities. Key activities are supported by authorized resources and identify "powerful and practical" means for achieving learner expectations. Extension activities represent alternative ways of achieving or supporting learner expectations.

Key Activities

Key Activity	SLE	Print Resources	Essential Materials	Comments
Exploring with a variety of liquids and containers	2	*Explorations in Science, Level 2, Water, Water Everywhere (Free Exploration)*, p. 6 *Explorations in Science, Level 2, Wet and Wonderful (Free Exploration)*, p. 6 *Innovations in Science, Level 2, Waterways (The Ways of Water)*, p. 5	water table or tubs, variety of containers (including squeeze bottles and containers with punctured holes), variety of objects that float and others that sink, sieves, funnels, fabric swatches	This activity can be set up in a station approach with different materials and liquids at each station. Monitoring the activity will provide insight into the students' initial ideas about liquids.
Observing water drops and comparing how they move on different surfaces	1, 2	*Explorations in Science, Level 2, Wet and Wonderful (Water Drops)*, p. 13	thick paintbrush, straws, pipe cleaners, eye droppers, bowl of water, wax paper, aluminum foil, newsprint, sandpaper, plastic	Have students add dish soap to their water to see if drops still move the same on each of the surfaces. The investigation should also be tried with liquids other than water. Extension: How many drops of water can fit on a penny?

Key Activity	SLE	Print Resources	Essential Materials	Comments
Comparing the properties of water to a variety of other liquids	2	*Explorations in Science, Level 2, Wet and Wonderful (Comparing Liquids)*, p. 12 *Explorations in Science, Level 2, Wet and Wonderful (Comparing Water and…)*, p. 11	transparent containers with lids, water and other liquids such as honey, vinegar, cooking oil, juice, syrup, stir sticks	The students use their senses in this activity. **Do not use liquids that are unsafe to taste, smell or touch.**
		Innovations in Science, Level 2, Waterways (Layered Liquids), p. 15	water table or tubs of water, clear plastic cups, vegetable oil, small objects	
		The Art and Science Connection: Hands-on Activities for Primary Students (Tolley) *(Investigating and Creating with Liquids)*, p. 7	5-10 jars with water-tight lids containing liquids of various colours and thickness, 5-10 objects ranging from hard to soft (for example, pillow, rock, marshmallow, clay), straws, empty jars of various sizes, liquid tempera paint, white construction paper	Extension into Art: Students observe, compare and classify objects while discussing and becoming familiar with properties of liquids. Students engage in the creation of abstract designs using liquid tempera paints.
		Explorations in Science, Level 2, Water, Water Everywhere (Liquid to Liquid), p. 22	water, variety of other liquids (detergent, syrup, glycerin, milk, cooking oil), small transparent containers	Containers should be labelled and students cautioned not to taste.
		Explorations in Science, Level 2, Water, Water Everywhere (Sugar in Water), p. 18	plastic cups, sugar cubes, stir sticks	
		Explorations in Science, Level 2, Water, Water Everywhere (What Dissolves?), p. 19	plastic cups, teaspoons, variety of household substance	
Exploring how oil and water interact	2	*Explorations in Science, Level 2, Water, Water Everywhere (They're Like Oil and Water)*, p. 21	water, cooking oil, food colouring, clear containers with tight lids	
		Windows on Beginning Science: Water and Ice (Westley) *(Oil Bubbles)*, p. 18	food colouring, cooking oil, clear plastic cups, water, stir sticks, clear jar with tight lid or cork	

Key Activity	SLE	Print Resources	Essential Materials	Comments
Demonstrating evaporation and condensation using a kettle and a cold plate. (This activity is also recommended as an extension for the Hot and Cold Temperature unit.)	5	*Explorations in Science, Level 2, It's Raining, It's Shining (How Does It Rain?)*, p. 17	kettle, pie plate, ice cubes	This should be done as a teacher demonstration activity due to the use of hot water. Identification of safe practices for handling hot resources should be emphasized with the students.
Exploring evaporation of water from a variety of surfaces	5, 6, 7	*Explorations in Science, Level 2, Water, Water Everywhere (Where Does It Go?)*, p. 10	pails, water, paintbrushes	The amount of water used will determine how much time is needed for this activity.
		Explorations in Science, Level 2, Water, Water Everywhere (Here Today, Gone Tomorrow?), p. 12	clear containers with lids, masking tape	
		Windows on Beginning Science: Water and Ice (Westley) *(Water Painting)*, p. 30	paintbrushes, water, pails	
Comparing ice and water	5	*Explorations in Science, Level 2, Wet and Wonderful (Water and Ice)*, p. 20	paper cups, water, trays	
		Explorations in Science, Level 2, Wet and Wonderful (Ice to Water), p. 21	ice cubes, paper cups	
		Windows on Beginning Science: Water and Ice (Westley) *(Ice Is Nice)*, p. 44	small paper cups, water, food colouring	
Investigating the speed of drying and the conditions that affect it	7	*Explorations in Science, Level 2, Water, Water Everywhere (Wet and Dry)*, p. 13	containers of water, eye droppers, fabric samples	Emphasis should be placed on establishing a fair test.
		Explorations in Science, Level 2, Water, Water Everywhere (All Over the Place), p. 14	pieces of cloth, eye droppers, water	
		Windows on Beginning Science: Water and Ice (Westley) *(Wash Day)*, p. 32	fabric sample, clothesline, clothespins, washtubs of water	

Key Activity	SLE	Print Resources	Essential Materials	Comments
Exploring a variety of materials to determine whether they are absorbent or non-absorbent	3	*Explorations in Science, Level 2, Water, Water Everywhere (What Absorbs?)*, p. 15 *Innovations in Science, Level 2, Waterways (Disappearing Act)*, p. 9 *Windows on Beginning Science: Water and Ice* (Westley) *(Soak Ups)*, p. 20	containers of water, absorbent and non-absorbent materials such as paper towel, dish cloth, sponge, foil, packing material, leather eye droppers, cups of coloured water, materials (paper, waxed paper, rubber, aluminum foil, plastic, towel, ceramic tile, styrene foam, cotton, coffee filter), sponge, rain hat	
Investigating a collection of absorbent materials to determine the amount of water they will absorb	3, 4	*Explorations in Science, Level 2, Water, Water Everywhere (How Much Does It Soak Up?)*, p. 16 *Explorations in Science, Level 2, Water, Water Everywhere (Consider the Towel)*, p. 17 *Windows on Beginning Science: Water and Ice* (Westley) *(Color Dips)*, p. 24	containers of water, fabric samples paper towel, dishes of food colouring in various colours diluted with a small amount of water, coffee filters, tissue paper, waxed paper	Students' thinking could be extended to evaluate these materials as to their suitability for containing liquids.
Discovering which materials are waterproof and try to waterproof some that are not	3, 4	*Explorations in Science, Level 2, It's Raining, It's Shining (Rainy Day Wear)*, p. 16	wide variety of materials: fabric samples (including leather), foil, waxed paper, cardboard, plastic, petroleum jelly, oil, flour, paraffin	As students identify waterproof materials, they could also explore constructing containers from these materials and evaluate their suitability for containing liquids.
Learning the importance of water to living things	4, 8	*Explorations in Science, Level 2, Wet and Wonderful (We Use Water)*, p. 10	line master 1	

Extension Activities

Extension Activity	SLE	Print Resources	Essential Materials	Comments
Exploring ways to clean dirty water	9			This SLE could be initiated through the reading of *The Magic School Bus at the Waterworks* (Cole) and followed by a trip to, or a guest speaker from, the local water treatment plant.
Investigating which brand of paper towel or cloth absorbs water best	3	*Explorations in Science, Level 2, Water, Water Everywhere (Which is the Best)*, p. 26	variety of paper towels and absorbent cloth, clear plastic containers, pitchers of water	Discussion can be continued into the area of ecology: the debate of cloth versus paper.
Exploring further how paper absorbs liquid	3	*Explorations in Science, Level 2, Water, Water Everywhere (Soaking Up Colour)*, p. 27	food colouring, water, plastic containers, paper towels	Students can do this activity using coffee filters.
Exploring squeeze bottles and predicting, comparing and measuring the relationship between how hard the bottle is squeezed and how the jet of water travels	1	*Explorations in Science, Level 2, Water, Water Everywhere (Spraying Outdoors)*, p. 24	plastic squeeze bottles with nozzle, pail of water	Try squeeze bottles with various-size nozzles to see if this affects how the water travels.
Exploring ripples on a water surface	1	*Explorations in Science, Level 2, Wet and Wonderful (Disturbing Water)*, p. 14	large bowls, various small objects that float and sink	Have students observe the surface of the water before and after objects are placed in it. Have students note differences in movement.
Making a waterproof invention		*Explorations in Science, Level 2, Water, Water Everywhere (Let's Not Get Wet!)*, p. 25	as required	

Extension Activity	SLE	Print Resources	Essential Materials	Comments
Investigating the surface tension of water and other liquids	2			Some small animals, such as water striders, are supported by the water's skin. Students can discuss or investigate what happens when elements such as soap are introduced into their environment. This SLE is reinforced in the grade 5 topic Classroom Chemistry.
Investigating the three states of water	5			
Collecting information about water in the home and the importance of a clean water supply	8, 9			

Assessment

For a broader discussion of science classroom assessment techniques see *Assessing Student Learning* in the introduction of this publication on p. 15. Good places to begin looking for the unit-related ideas are *Explorations in Science* assessment handbooks, *Innovations in Science* teaching notes, Unit tests and Portfolio ideas, Alberta Education sample tests at **www.education.gov.ab.ca** and Alberta Assessment Consortium at **www.aac.ab.ca**

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