Science Unit: **Chemistry**

Lesson 1: ***Changing States of Matter (Water)***

School Year:	2015/2016
Developed for:	Sir Wilfred Laurier Elementary School, Vancouver School District
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Grade level:	Presented to grades 3/4/5; appropriate for grades K-7 with age appropriate modifications
Duration of lesson:	1 hour and 20 minutes
Notes:	Another similar lesson on States of Matter is posted on the SRP website here

Objectives

1. Learn that different states of matter are due to different arrangements and energy of the particles.
2. Observe water changing between three states of matter, and understand in terms of the particles.
3. Measure the temperature of water in three states of matter.

Background Information

Understanding the abstract concept of how the arrangement of particles (molecules) change as matter changes between states is challenging. This lesson uses familiar water, along with modelling to visualize what is happening at the particle level, as water changes state.

Vocabulary

Molecules and atoms:	Tiny particles that make up everything around us. Molecules and atoms are too small to see individually, but with enough of them together they make objects we can see. Two or more atoms are bonded together to make a molecule.
Model:	A representation of an object to help understand it, larger or smaller than the object.
States of matter:	The distinct physical forms that matter can take: solid, liquid or gas (plasma is also a state of matter, but not dealt with in this lesson).
Solid:	A state of matter that keeps its shape. The molecules in a solid are packed together.
Liquid:	A state of matter. that changes shape, but whose volume is constant. The molecules in liquids are free to move but remain close to each other.
Gas:	A state of matter that spreads out to fill the container it is in. The molecules in gases are free to move apart from each other.
State change:	A change between any of the states of matter e.g. liquid to gas.

Melting:	To change from the solid to liquid state, when energy is added.
Evaporation:	To change from the liquid to gaseous state, when energy is added.
Condensation:	To change from the gaseous to liquid state, when energy is removed.
Freezing:	To change from the liquid to solid state, when energy is removed.

Materials

- metal cans (one per table group)
- ice, to fill the cans, plus one more per student
- salt, about 2 Tablespoons per can
- electric kettle, preferably with transparent sides
- glass lid or small sheet of glass
- styrofoam cups, (two per table group)
- thermometers (two per table group)
- heat proof tongs
- popcorn and a means for popping it

In the Classroom

Introductory Discussion

Review, or introduce, the states of matter, while asking students to find examples in the classroom. Solids have a fixed shape. Liquids can change shape, but always take up the same amount of space (same volume) so can flow. Gases change shape and fill the space they are in (so change volume).

The particles (molecules or atoms) are arranged differently in different states of matter.

Processes of science that the students will focus on: close observation, accurate drawing of observations, accurate measuring, collecting data, classifying and comparing data, recording results, graphing data, interpreting graphs, inferring.

Safety guidelines: use care when handling a kettle of boiling water. (Mark a "no-kid zone" around the kettle using tape on the floor.)

This lesson plan includes 4 activities:

1. Modelling States of Matter
2. State Changes in Water
3. Measuring Temperature of Water
4. Popcorn Skits

1. Modeling States of Matter

Purpose of Activity:

Students use their bodies to model the relationships between particles in different states of matter.

Methods and Instructions:

1. Tell students that they each represent a molecule. (Molecules are way too small to see, so by making a model of molecules, we can visualize better what molecules are doing in solids, liquids and gases.
2. Show students an ice cube and tell them that in a solid, like this ice cube, the molecules are packed tight, held together by strong bonds. Ask students to model a solid by linking arms with their neighbors, so that they are packed tight together in a group. The individuals can jiggle a little, but the group maintains its shape.
3. Show students how as the solid ice cube gets energy from the air and a warm hand, it starts to melt and become a liquid. As the molecules gain energy, they are still bonded to each other, but more loosely, so they can move around more.
4. Ask students to model a liquid by spreading apart and moving around more, but always touching at least one other student with an outstretched arm. The bonds between molecules break and form continuously, so that the group stays together but can move and change shape, as a liquid does.
5. Show students water boiling in a kettle. As the liquid water gets even more energy the molecules gain enough energy to move completely apart and evaporate to a gas, which we see as bubbles in the liquid water. A gas fills the container it is in. Ask students to break all bonds with each other and run around the room, spreading out to fill the room.
6. Students can be asked to become a liquid again “condensation”, then a solid “freezing”.

2. State Changes in Water

Purpose of Activity:

To observe water changing state, while understanding the arrangement of the particles in each case.

Methods and Instructions:

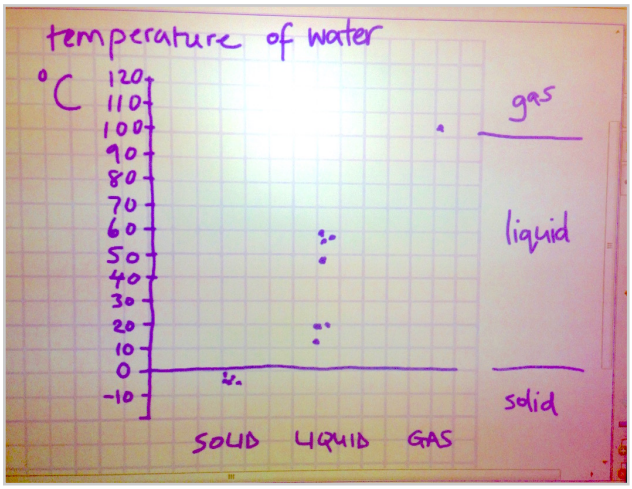
Set-up prior to experiment: Pre-boil a full kettle of water. At the beginning of the lesson, before activity (1), fill the cans with ice and pour the salt over them. Leave undisturbed on student table groups. Students will work in one large group (parts of this are a demonstration), then move to their table groups.

1. Distribute an ice cube to each student. Ask if it is a solid, liquid or gas, and why (fixed size, fixed shape). Remind them that the particles in the ice are packed together, as the students modelled in the previous activity.

2. As the ice cube melts in their hand, ask students what is happening to the ice cube, and why. Fill in the explanation if necessary: it is melting to a liquid because it is getting warm from hands and from the warm air in the classroom. The water molecules are gaining energy, moving apart, and flowing as a liquid.
3. Ask students how can we make the liquid water turn into a gas. [We can warm it up more.] Boil the kettle of water, showing students the gas bubbles forming in the liquid. The kettle gives the liquid water enough energy to make it evaporate to a gas. Bubbles of gaseous water rise and escape into the air.
4. Ask students how we can make gaseous water turn back into a liquid. [Cool it down.] Put a glass lid over the boiling kettle until droplets of water form on the glass. The gaseous water particles suspended in the air lose energy on the cool glass, so condense out as droplets of water.
5. Finally, how can we make liquid water turn back into a solid? [Cool it down even further.] Look at the outside of the cans of ice previously set up on desks. Students will discover ice on the bottom of the outside of the can. The ice and salt in the can made the outside of the can cold. Gaseous water in the air turned to a solid where it was cool enough. (Liquid water droplets form at the top of the outside of the can where it is not quite as cold.)

3. Measuring Temperature of Water

Methods and Instructions:
Set-up prior to experiment: Boil a kettle of water, then pour hot water into one styrofoam cup per table group. Mix with some cold water if it will be too hot when students use it.
Students will work in table groups.



1. Distribute thermometers. Review or introduce reading a thermometer by asking students to read the temperature of the air. Depending on the quality of the thermometers, and the location of heaters in the classroom, the temperature readings may vary by a few degrees.
2. Distribute styrofoam cups of warm water to each table group. Fill more styrofoam cups with ice, and distribute one to each table group. Ask students to put a thermometer in each cup, making sure that the bulb of the thermometer is submerged in the ice or water.
3. Ask students to wait until the thermometer reading has stabilized, then to note down the temperature readings they get. Graph the results on a class graph (see photo).
4. As a demonstration, measure the temperature of gaseous water, by using heat proof tongs to hold a thermometer above a kettle of boiling water. Add the temperature to the graph.
5. Look at the graph together, and explain that ice forms at 0°C and remains solid at any temperature below that. Liquid water is between 0°C (the melting point of water) and 100°C (the boiling point of water). Water in the gaseous state is 100°C or above.

4. **Popcorn and skits**

Purpose of Activity:

To use water changing state to make a snack, and to review what the particles are doing as matter changes state.

Methods and Instructions:
Set-up prior to experiment: Set up the popcorn apparatus ready for popping.
Students will work in groups.

1. Start making popcorn (either on a hot plate or in a microwave), and discuss what is happening to make it pop: each kernel has some water inside, and as it heats up the water evaporates to a gas. As the heat increases, the water vapour molecules move around more and more vigorously, exerting more and more pressure on the inside of the shell, until the pressure bursts the shell open.
2. Split students into groups and ask them to make a skit about what is happening to the particles inside a popcorn kernel as it is heated then pops. Encourage them to act out what the molecules inside the kernels are doing. Students watch each others' skits, then eat popcorn while watching a slow motion video of popcorn popping (ref.1).

References

<https://www.youtube.com/watch?v=NCSr18vtjeo> You tube video of popcorn popping slow motion. Accessed May 17, 2016.