**Title:** Solubility of Gas – A Daily Experience

**Subject**: Chemistry

**Grade Level**: $10^{th}$ – $12^{th}$

**Rational or Purpose**: This lesson brings an "everyday" life experience to students' knowledge on solubility of gas in water. Students should be able to conclude that rising ocean temperatures will lower the amount of oxygen in the sea. Students should be able to predict the outcome of the reduction of oxygen in the Earth's oceans.

**Materials**:
Carbonated soft drinks
Beakers
Hot plate

**Lesson Duration**: 45-60 minutes

**TEKS Objectives**:
§112.45. Chemistry.
(c) Knowledge and skills.
(4) Science concepts. The student knows the characteristics of matter. The student is expected to:
(A) differentiate between physical and chemical properties of matter;
(B) analyze examples of solids, liquids, and gases to determine their compressibility, structure, motion of particles, shape, and volume.
(5) Science concepts. The student knows that energy transformations occur during physical or chemical changes in matter. The student is expected to:
(A) identify changes in matter, determine the nature of the change, and examine the forms of energy involved;
(12) Science concepts. The student knows the factors that influence the solubility of solutes in a solvent. The student is expected to:
(A) demonstrate and explain effects of temperature and the nature of solid solutes on the solubility of solids;
(B) develop general rules for solubility through investigations with aqueous solutions.

**Background Information**:
Students may have experienced the great taste of carbonated soft drinks after the beverages have been first frozen in the freezer. On the other hand, when a soft drink is left open and sits at room temperature for a while, it no longer tastes very good; it tastes "flat." This is due to the escape of carbon dioxide within the liquid.

**Activity:**
Teacher will lead a discussion about cold carbonated drinks at room temperature. Students are encouraged to give detail, qualitative descriptions of their observation and experiences with soft drinks.

Explain how carbon dioxide is dissolved into the soda. Teachers can lead students to conclude the condition favoring solubility of gas.

Contrast between solubility of table salt and gas at room temperature (or higher temperature). Atmospheric gases tend to stay in gas phase at room temperature. Unless great compression and/or lower temperature is applied, gases will escape from liquid in normal condition.

*Regular lab precautions should be carried out in the activity.*

**Procedure:**
Following the sequence of activities according to the questions asked on the provided worksheets. Notes are included under every question on the teacher-edition worksheet.

Name: _____ Date: _____

Class Section: _____

Pour a can of cold carbonated soft drinks (provided by the teacher) into a beaker. Describe your observation of the changes happening within the beaker.

*Students should be able to describe bubbles coming out from the soda.*
*Sizzling sound can be heard.*

*Note: Teacher may go further to describe the soda can before opening it. If possible, lead students to realize that there is a pressure buildup inside the can. Comparison between squeezing a plastic bottle and an unopened soda can should convince students about the pressure buildup.*

How is temperature changing?

*Since the soda is place at room temperature, the temperature of the soda is increasing.*

What has been removed from the soda since it has been sitting in the beaker?

*Gas bubbles (carbon dioxide) are being removed from the soda.*

Is it a physical or chemical change? Explain.

*It is a physical change because nothing is added into the solution to cause a reaction.*

*Note: Students may insist that the appearance of bubbles is a chemical change. Teachers may refer to the boiling of water to convince students that this is a physical change. At boiling point, substances change from a liquid phase to a gas phase.*

Place the beaker on a hot plate. Does heating promote or slow-down something from happening? Write down your observation.

*Heating promotes the appearance of gas bubbles.*

In another clean beaker, half-fill it with water. Prepare a saturated table salt solution.
What does "saturated solution" mean?

*Saturated solution means that the solution can no longer hold anymore solute.*

If you add one extra spoonful of table salt into the saturated solution, what will happen?

*Since the solution is saturated already, the salt will remain at the bottom of the beaker.*

Without adding any more water, is there a way to dissolve the extra table salt?

*Students may have an experience of using hot water to dissolve any soluble compound faster.*

Contrast the dissolution of gas and table salt. What causes the difference?

*A gases' boiling point is low (much lower than room temperature). Therefore, the gas in the soda is actually boiling. However, certain conditions may force the gas to remain in a liquid state or dissolve in liquid.*

*For table salt, sodium chloride is packed together, forming little cubes that we can see. Table salt dissolves in water because the "packing force" is no longer there. This is due to the attraction force between water molecules and the ions in table salt.*

*Note: Teacher should draw particle arrangements for gas, liquid, and solid states. Students may find easier to understand that compression is required to change a gas to a liquid or a liquid to a solid.*

What do you think is the rate of gas escaping from a liquid if it stays cold?

*If heating promotes gas to escape, keeping the liquid cold should slow down the escape of gas.*

Oceanic organisms depend on the oxygen dissolved in the sea water.
How may global warming affect their lives?

*Warming Ocean → Less oxygen → Organisms compete for oxygen → Species death/extinction → Food Chain disturbed*

*Note: Teachers are encouraged to lead a discussion with students for this question. This may lead students to higher-order thinking. Teachers should encourage students to prepare explanations when they try to answer questions. This promotes their logical thinking ability.*

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Class Section: _____

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How is temperature changing?

What has been removed from the soda since it has been sitting in the beaker?

Is it a physical or chemical change? Explain.

Place the beaker on a hot plate. Does heating promote or slowdown something from happening? Write down your observation.

In another clean beaker, half-fill it with water. Prepare a saturated table salt solution.
What does “saturated solution” mean?

If you add one extra spoonful of table salt into the saturated solution, what will happen?

Without adding any more water, is there a way to dissolve the extra table salt?

Contrast the dissolution of gas and table salt. What causes the difference?

What do you think is the rate of gas escaping from a liquid if it stays cold?

Oceanic organisms depend on the oxygen dissolved in the sea water.
How may global warming affect their lives?