***WHAT DOES IT MATTER?***

**A discussion of mixtures, solutions and states of matter**

**Background:**

 All food, and everything else, is made up of what scientists call **matter.** Matter is anything that has weight and takes up space. The physical properties of matter would include color, odor or its physical state. Matter has three physical states or **phases**: **gas, liquid** and **solid**.

In describing chemical properties, matter is made of pure substances called **elements** (atoms) which are combined into **compounds** (groups of elements bonded together to form molecules).

 **Solutions** are **homogenous** mixtures of elements or compounds. Solutions are made up of **solutes** that dissolve in a **solvent**. As they dissolve, solute particles **diffuse** into the solvent particles.

 What does this matter? Because how matter reacts, how particles join or not join together, and which physical phases are rearranged, creates **food**.

 For example: Koolaid is a diffusion of solutes of color, sugar and flavor particles in a solvent of water. Koolaid is a solution in a liquid phase. Using carbon dioxide—a gas—as an additional solute changes Koolaid into soda pop. Changing the temperature changes the phase and produces a Koolaid solution in a solid phase: Otter pops.

**Vocabulary:**

*Compound—a pure substance made of two or more elements that can only be broken down into*

 *a simpler substance by chemical methods.*

*Diffuse—to have something spread out and mingle with something else without needing to stir*

 *it. For example: dry Koolaid sprinkled into a cup of water will naturally diffuse into the*

 *water.*

*Element—an atom, the smallest particle of matter than keeps its identity.*

*Gas—One of the three physical phases of matter. It has no definite shape or form, but gas*

 *molecules will spread until they are evenly distributed within whatever space is given to*

 *them. Air is made up of gas molecules. Steam rising from a pan of boiling water is*

*water changing into a gas phase.*

*Homogenous—Being exactly the same throughout the mixture or group. It would not make a*

 *difference where a sample was taken because it is the same everywhere.*

*Liquid—One of the three physical phases of matter. Liquids have volume, but no shape. Liquids*

 *will take the shape of their container. Water is a liquid.*

*Matter—Anything, even something microscopic, that has weight and takes up space.*

*Phase—The physical state in which matter can exist. There are three basic states or phases: Gas, Liquid and Solid.*

*Solid—One of the three physical phases of matter. Solids have a definite shape and volume. Table sugar and carrots are solids.*

*Solute—The particle that dissolves and distributes itself through a solvent in a solution.*

*Solution—A homogenous (all the same) mixture in which one substance is dissolved into another substance.*

*Solvent—The particles of a solution that bond together and cause another substance to dissolve when added to them. Typically a solvent is liquid. In foods, water is a major*

 *solvent.*

**This lesson addresses the following USOE Core Standards:**

**Organization of Science Core Element #7**

Science Language Students Should Use

**Intended Learning Outcomes for High School Science:**

 #1b—Use comparisons to help understand observations and phenomena.

 #2b—Raise questions about objects, events and processes that can be answered through scientific investigation.

 #3c---Apply principles and concepts of science to explain various phenomena.

 #4b—Use precise scientific language in oral and written communication.

 #5a—Cite examples of how science affects human life.

 #6g—Understand that various disciplines of science are interrelated and share common rules of evidence to explain phenomena in the natural world.

**Foods & Nutrition 1**

Standard 2, Objective 3: Integration of mathematic concepts through equivalents, recipe adjustments and **conversions**.

**Chemistry**

Standard 3, Objective 2b: Compare the physical properties of a compound to the elements that form it.

Standard 6, Objective 1a: Use the terms solute and solvent in describing a solution

Standard 6, Objective 1b: Measure change in boiling and/or freezing point of a solvent when a solute is added (*If teacher uses Discussion Point #1 as a lab activity rather than a discussion).*

**Materials:**

Koolaid packet (presweetened or not doesn't matter)

Glass of water

Glass of made up Koolaid

Bottle of soda pop preferably of the same flavor as the Koolaid

Otter pop—for the demonstration have one the same color as the Koolaid

Otter pops for the class to eat

**Instructions** *(with teacher notes)***:**

 *This is meant as an introductory lesson to help the students realize that there is science behind everything we eat. This also introduces them to some basic food science language.*

 *As you go through the background, demonstrate the concepts using the Koolaid and water (diffusion), the soda pop and the otter pops (physical phases).*

**Discussion points/questions:**

1. The amount and type of solute in a solution affects the freezing and boiling points of the solution. With 50 grams of sugar added to 100 mL of water, the freezing point goes down to 27o F. Six grams of salt in 100 mL of water puts the freezing point at 25o F. Why would an ice cream manufacturer care about this little nugget of information?

 *An ice cream manufacturer needs to know at what temperature the ice cream will freeze. If an ice cream also has fruit added to it, the freezing point will go even lower. In other words, all of the solutes must be added up and the freezing point calculated if the manufacturer wants a frozen product. A manufacturer uses chemical refrigerants to lower the freezing point to get the ice cream to freeze. In a home freezer the ice around the canister has salt added to it to lower the freezing point of the water and therefore allow the ice cream in the canister to get cold enough to freeze.*

2. Although freezing point is not affected by altitude, the boiling point drops 1.8o Fahrenheit (1o Celsius) for every 960 feet above sea level. If Utah County is 4500 feet above sea level, what is their boiling point for water? [Hint: The equation is (elevation divided by 960) multiplied by 1.8o F. Sea level boiling point is 212o F, so subtract your answer from 212o to get the boiling point for Utah County.]

 *The equation is (elevation divided by 960) times 1.8o= degrees Fahrenheit lowered*

 *For Provo, the answer is 212oF – 8.4oF = 203.6o F is the boiling point of water.*

3. Why would a food company care about the boiling point in their area?

*Food companies need to know how hot their mixtures will be getting and how fast it gets there. For safety reasons they must know how long the mixture has to stay at a particular temperature to kill pathogens that might be in their product. Also, the solutes in the mixtures will affect the boiling point, so everything (altitude, all the solutes) has to be added together. Candy making is particularly susceptible to temperature, so a candy maker has a vital interest in the boiling point.*

 *Temperatures and length of time at that temperature in order to kill pathogens is the basis for home canning and commercial canning operations. If a pathogen (botulism toxin) can only be killed by keeping the product at 250o F for 20 minutes, and the boiling point is 212o F, then the cannery needs to find another method to get the cans hotter than boiling point. The answer to that is pressure. This is why low acid foods must be pressure canned rather than using a waterbath method.*

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