**NAME: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**PROPERTIES OF WATER LAB**

**Part A. Drops on a Penny**

Materials: pennies, water, alcohol, eyedropper

Using the pennies and dropper provided – each team member should perform and compete at this activity. Compete with each other for “who can place the most drops of water on the penny WITHOUT spilling off the penny” and who can place the most drops of alcohol on the penny without spilling off the penny.” Record each team member’s results in a data table.

Record the average number of drops of water and the average number of drops of alcohol added to the penny. Answer the analysis questions below.

TITLE:

|  |  |  |
| --- | --- | --- |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |

1. State the property of water being examined in this experiment.
2. Explain why there is a difference between the number of alcohol and water drops.
3. Describe the importance of this property in the real world.

**Part B: Lipids in Water**

Introduction: One of the most important characteristics of fats and lipids, in general, is their insolubility in water due to their non-polar (having no charge) nature. Lipids are made of long chains of hydrocarbons with relatively little oxygen atoms. As a result, they tend to be non-polar and therefore do not dissolve in polar substances such as water. (“Like dissolves like.”) Polar substances can be dissolved in polar substances and non-polar substances can be dissolved in non-polar substances.

In human digestion, lipids are, in part, broken down by bile, which is produced by the liver and aids in the digestion of fats in the small intestine. Bile is not an enzyme, but it does help the enzymes do their job. Bile helps create minute, microscopic fat globules (a process called emulsification). Emulsification is important because it allows lipases (important digestive enzymes that break down fats) to attack and break down the smaller fat globules. Larger fat globs would mean that the lipases could not access the fats (lipids) on the interior of the lipid globs.

In this activity, you will use soap to mimic the action of bile. Soap is unique in that a soap molecule has a polar (charged) end and a non-polar (non-charged) end. The non-polar end grabs onto grease, oil, or fat, while the polar end grabs onto a polar substance such as water molecules. In this way, it is able to separate lipid molecules.

Materials: test tube, water, vegetable Oil, Dish Soap

Procedure:

1. Obtain a clean test tube (no soap or oil).

2. Fill the test tube 1/3 full with water and 1/3 full with vegetable oil

3. Make a labeled drawing of your observation after doing this.

4. Add about 1cm of soap to the test tubes.

5. Cover the openings of the test tube with hands/fingers and shake them vigorously.

6. Draw a picture of the test tube after adding the soap.

7. Answer the analysis questions.

Analysis questions:

1. Which is less dense, oil or water? Justify your response.

2. How are the test tubes different after shaking with the detergent?

3. Explain chemically why water and vegetable oil do not mix.

4. Detergents acts as an emulsification agent. Explain what this means and how detergents dissolve lipids

 like vegetable oil.

5. What kinds of food would bile help digest?

6. If bile is not an enzyme, then how does it help digest food? Is this process physical or chemical

 digestion? Justify your answer.

**Part C: Molecular Motion**

Introduction:

This activity relates molecular motion to polarity of molecules. Milk consists of polar (sugars and salts) and nonpolar (lipids) components. Detergents are surfactants and have a sort of split personality with polar and nonpolar regions in their molecules.

Problem: How does polarity relate to molecular motion? Hypothesis: Molecules of same and different polarities will repel and attract each other resulting in observable motions.

Materials: Whole Milk, Set of 4 food dyes, Dish-washing detergent or shampoo (a small dab into small beaker), toothpick or Q-tip, plate. Small beaker

Procedure:

1. Pour enough milk into the plate to cover the entire surface about 1/4 inch deep.
2. Add one drop of each different color food dye to each quadrant of milk in the pie plate, careful not to mix.
3. With single toothpick, add a small amount of detergent into the center of the pie plate containing milk. Hold the toothpick still and wait to see what happens.
4. Answer the analysis questions.

Analysis questions:

 1. Explain your observations. Please address the following in your explanation:

* --  a rationale for the food coloring floating initially in organized blobs on the surface of the milk
* --  changes in the surface tension of the water in the milk
* --  changes in the intermolecular forces involving the proteins in the milk
* --  the structure of the molecules making up the detergent

………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………

 2. Homes having hard water (which often contains more dissolved calcium) require more detergent

 to efficiently wash clothing. Explain this observation based on your knowledge of the chemical

 structure of detergents.

………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………

**Part D. Paper Chromatography**

Paper chromatography is a modern method used separate mixtures. Paper chromatography uses paper as the stationary phase and a liquid solvent as the mobile phase.

You will use paper chromatography to test food colorings to see if the color results from a single dye or mixture of dyes.

The technique relies on the idea that the solvent and the paper both have an attraction for the components in a mixture. The solvent creeps along the surface of the paper. If a material is placed on one spot on the paper and is soluble in the liquid solvent, the material will be dissolved when the solvent moves over it. The material will move along with the solvent. Each compound in a mixture will have its own characteristic balance of attractions to solvent and to paper, so all will not move at the same speed. Eventually this difference in speed will separate the compounds.

In paper chromatography when the conditions are kept constant, a particular compound always travels a fixed percentage of the distance traveled by the solvent front. The ratio of the distance the compound travels to the distance the solvent travels is called the Rf value. The symbol Rf stands for "retardation factor" or "ratio-to-front". It is expressed as a decimal fraction. When the conditions are duplicated, the same average relative positions will turn up for the solvent and solute; thus the Rf value is a constant for a given compound. The Rf value is a physical property for that compound. The Rf value is useful in identifying compounds, but other properties should be used in combination with the Rf value to confirm compound identification. Since it is difficult for different laboratories to exactly duplicate conditions for a chromatography experiment, Rf values are more useful for comparisons within one lab than for comparisons of data from different labs.



Materials: 4 different colors of food coloring, toothpick, ceramic plate, filter paper, ruler, plastic cup, tape, pencil

Procedure:

1. Make a start line with a pencil mark ½ inch from one end of each of the filter paper strips. This will be the bottom of your strips.

|  |  |
| --- | --- |
|  Top  |  Bottom |

|  |
| --- |
| http://www.800mainstreet.com/e3/Image7.gif |

1. Place around 2 drops of blue food color on a ceramic plate.
2. Cut off one end of a toothpick. Dip the fresh cut end into the food coloring.
3. Use the toothpick to place a dot of blue food color on the pencil mark start line and allow it to dry. The dot should be approximately 1 mm across.
4. Attach a piece of tape to the top end of the strip of paper. Tape the paper to the pencil and lower the paper into the plastic cup.
5. Check how far the paper projects into the plastic cup and mark the position of the bottom edge of paper on the outside of the cup. Remove the pencil and paper.
6. Add water to the container so the water level will touch the bottom of the strip of paper; the water level must be below the pencil mark start line on your strip of paper and at least ¼ in below the blue spot.
7. Lower the paper into the bottle so the water touches the bottom of the paper. The water MUST NOT touch the blue spot of food color.



1. Allow the water wick (climb) up the paper. Note where the water wets the paper; the top of the wet area is the “solvent front.” The water will climb the first few centimeters quickly. The food color will probably trail behind the water.
2. When the front edge of the water reaches ¾ of the way up the paper, remove the paper from the

 plastic cup. Use a pencil to mark the front edge of the solvent.

1. Allow the paper to dry.
2. Use the pencil to mark the “center of gravity” of the dye spot. The “center of gravity” of the dye spot is its “average” position on the paper.
3. Note if more than one color appears on the paper. If so, find the “center of gravity” for each dye.
4. Measure the distance between the start line and the mark for the upper edge of the solvent front. Record the distance.
5. Measure the distance between the start line and the “center of gravity” of the color. Record the distance.
6. Repeat for the additional food colors.
7. Complete the analysis questions and calculations below.

Conclusion and analysis:

1. Colors observed in chromatogram for each food color.

|  |  |  |
| --- | --- | --- |
| **Food Color** | **Colors observed in chromatogram for each dye** | **Mixture (yes / no)** |
| **Blue** |  |  |
| **Red** |  |  |
| **Yellow** |  |  |
| **Green** |  |  |

1. Data and calculations of Rf values. (Note: If a food color contains only 1 dye, enter the data for “fast dye” only. If a food color contains only 2 dyes, enter data for “fast dye” and “slow dye” only.

A. Data for the distance traveled by the solvent for each food coloring

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Blue food color solvent | Yellow food color solvent | Green food color solvent | Red food color solvent |
| Distance traveled by solvent front (mm) |  |  |  |  |

B. Data for the distance traveled by the “fast dye” in food coloring (greatest distance traveled)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Blue food color | Yellow food color | Green food color | Red food color |
| Color |  |  |  |  |
| Distance (mm) |  |  |  |  |
| Rf Value |  |  |  |  |

C. Data for the distance traveled by the “middle dye” in food coloring (greatest distance traveled)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Blue food color | Yellow food color | Green food color | Red food color |
| Color |  |  |  |  |
| Distance (mm) |  |  |  |  |
| Rf Value |  |  |  |  |

D. Data for the distance traveled by the “slow dye” in food coloring (greatest distance traveled)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Blue food color | Yellow food color | Green food color | Red food color |
| Color |  |  |  |  |
| Distance (mm) |  |  |  |  |
| Rf Value |  |  |  |  |

1. Do you think that other substances like vegetable dyes or inks could be tested using this chromatography method? Justify your answer.
2. Explain briefly what would have to be done if the dyes or inks would not dissolve in water? Could chromatography still be used to separate the mixture?
3. Would a pure substance show more than one color or SPOT in a chromatogram? Explain

 **PART E: Heat of Vaporization**

Water has a high heat of vaporization - the energy required to convert liquid water to a gas. Water's high heat of vaporization helps moderate the earth's climate.

Part 1

Evaporation rates of water vs ethanol - Let’s examine the relative heats of vaporization of water and ethanol as follows:

Procedure

1. Simultaneously stick one cotton swab into a beaker of water while doing the same with a second cotton

 swab in a beaker of ethanol

2. Gently draw thin lines of liquid (a few cm long) with each swab on your bench top and record how long

 it takes for each to evaporate.

Data and Analysis questions:

1. Time required for evaporation.

Water =

Ethanol =

1. Which substance had the higher heat of vaporization?
2. Based on your results explain why water is a much more effective coolant than alcohol for the

 body.

Part 2

Water has a high specific heat capacity. Specific heat is a measure of heat capacity, is the heat required to raise the temperature of 1 gram of water 1°C. Water, with its high heat capacity, therefore, changes temperature more slowly than other compounds.

1. Think about what happens when you boil water for pasta. Which becomes hot first, the pot or the water in the pot?

2. Explain why specific heat is an extremely important property of water.