PROTOCOL: CLASSIFYING EMULSIONS

Here we are focusing on classifying different types of emulsions and exploring each one's physical characteristics. Through this activity we will learn how the ratio of each component of the emulsion - water, oil, and surfactant, which in this case is soy lecithin, affect the stability of the emulsion, as well as its appearance and texture.

We will prepare four sample tubes containing distinct emulsions with ratios chosen from the **phase diagram**. However, depending on your interest, feel free to **choose additional points** from the phase diagram to characterize. There are a few notes to consider before getting started:

1. Make sure your work surface, equipment, and containers are clean.
2. Organize your materials -- it is best to have everything ready.
3. Read through the protocol before starting so you know what to expect.

List of Materials and Equipment

Ingredients	**Equipment**
• Oil • Water • Soy Lecithin (or any surfactant of your choice) • Food coloring	• Tubes with blue cap • Scale • Weighboat • A stick to scrape off residue • Mortar and pestle • Vortex • Rubber band • Labels and pens • Notebook for record keeping

Sample Ratios

SAMPLE A			
Raw Ingredient	*Percent*	*Mass*	*Volume*
Oil	70%	7g	≈7.5ml
Water	20%	2g	2ml
Soy Lecithin	10%	1g	
Total	***100%***	***10g***	

SAMPLE B			
Raw Ingredient	*Percent*	*Mass*	*Volume*
Oil	20%	2g	≈2.5ml
Water	70%	7g	7ml
Soy Lecithin	10%	1g	
Total	***100%***	***10g***	

SAMPLE C			
Raw Ingredient	*Percent*	*Mass*	*Volume*
Oil	45%	4.5g	≈5ml
Water	45%	4.5g	4.5ml
Soy Lecithin	10%	1g	
Total	***100%***	***10g***	

SAMPLE D (Optional)			
Raw Ingredient	*Percent*	*Mass*	*Volume*
Oil	20%	2g	≈2ml
Water	60%	6g	6ml
Soy Lecithin	20%	2g	
Total	***100%***	***10g***	

Experiment Protocol (To make a single sample)

1. Prepare a tube with blue cap.
2. Weigh out water according to the ratios above and pour into tube.
3. Weigh out soy lecithin* according to the ratios above and pour into tube.
   Note: if soy lecithin is chunky use mortar and pestle to grind it thoroughly, but not smudging it onto the mortar, before putting it in.
4. Invert tube 2-3 times and vortex tube for three minutes at level 8.
   Note: If there are still undissolved soy lecithin particles, vortex a bit more, and use probing stick to manually break particles.
5. Weigh out oil according to the ratios above and pour into tube. (Volume can also be used, but weight may be more accurate for viscous solutions like oil.)
6. Put one drop of food coloring in the tube.
7. Vortex tube for five minutes until the color is uniformly distributed.
8. Record the following characteristics immediately after vortex, 30 minutes after the vortex, and two hours after the vortex:
   a. Emulsion state (can you see chunks of undissolved soy lecithin, or is the liquid uniformly emulsified?)
   b. Volume (read off of the tube)
   c. Color (see below)
   d. Texture (by eye)
   e. Viscosity (see below)
   f. Record other observations or add your own metrics for characterizing your emulsions

Color Test

This activity will help identify the type of emulsion the samples represent by revealing the dispersed and continuous phases of the emulsion.

List of Materials and Equipment

Materials	Equipment
• Samples	• Microscopy glass plates • pipette • Oil Red O • Red Food Coloring • (Optional) Microscope

Test Protocol

1. On **two** glass microscopty plates, transfer 2-3 drops of your sample using a pipette.
2. On one plate, dispense one drop of Oil Red O and on the other dispense one drop of red food coloring.
3. Mix the sample and coloring well on each plate.
4. Describe the color dispersion within the sample.
5. (Optional) Put the plate under the microscope and observe the micelles. Which part of the sample is dyed and which part isn't? --- can you tell the dispersed phase and continuous phase?

Viscosity Test

There are various ways to measure viscosity and you can always get creative as long as you can find a way to correlate your method with the stickiness of the emulsion. Here we used an acrylic pipette stand for a slanted surface; however any flat, smooth surface at an angle could work. In addition to the slope method, viscosity can be measured by a falling ball viscometer, viscosity cup, capillary viscometer, and so forth.

List of Materials and Equipment

Materials	Equipment
• Samples	• Triangular slope • Consistometer Paper • Pipette • Pen

Test Set-Up

1. Set up a triangular slope with the slanted side being the glass plate stand, etc.
2. If the surface is transparent, Print out the consistometer paper, or draw lines on a piece of paper by a 1cm increment. Paste consistometer paper on the back of the surface. If the surface is opaque, use a marker to draw lines on the surface using a marker that will not interact with your emulsion, or paste the consistometer paper next to the area where solutions will be placed.

Test Protocol

1. Using a pipette, get some amounts of each sample.
2. While tilting the pipette stand so the incline part becomes parallel to the floor, drop appx. three droplets of each sample (the size of the dot) on top of the purple dots corresponding to the letter of the sample.
3. Angle the surface to begin the experiment while simultaneously starting the timer for 30 seconds, and mark/record how far each sample goes at the end of the 30 seconds.
4. Take the multiplicative inverse (1/distance) of the distance traveled to approximate viscosity.
5. Record the viscosity category according to the standards below (in units of cm^{-1}).
   - **<0.2** : Low Viscosity
   - **0.2-.0.5**: Medium Viscosity
   - **>0.5**: High Viscosity

Analysis & Reflection

1. After collecting data on several emulsion concentrations over a few timepoints, analyze your data by comparing all of your data. Which metrics best show differences in emulsification between samples? Which metrics are most meaningful? Which metrics are easiest to compare/graph/etc.?
2. Graph your points on the Emulsion Phase Diagram sheet ... What can you say about the concentrations of stable emulsions from your data so far? Which concentrations would you try next and why?
3. What would you change about this experiment to get more information about your emulsions? What else would you like to be able to learn about emulsions?