Prelab Homework

Prelab homework outline:
1. Study, annotate, and become familiar with the concepts and practical understanding of the behavior of solutions, colloids, and suspensions described in this handout and in the unit 8 handout.
2. Outline/summarize potential lab hazards.
3. Outline/summarize lab procedures.

Prelab concept review - Here is part of what you must know/recall in preparation for this lab activity (also study/annotate the 1st section of the Unit 8 handout):

Solutions, colloids, and suspensions are mixtures in which one substance appears to be more or less uniformly dispersed throughout another substance. The size of the dispersed particles influences the properties of a mixture and determines whether the mixture is a solution, colloid or suspension. Are the particles large enough that they will settle upon standing or be trapped by a filter? Are the particles small enough that they will pass through a semipermeable membrane? Students will gain an understanding of the properties of mixtures using this four-part lab learning activity.

Solutions, colloids, and suspensions differ from one another in the size of the particles that are dispersed throughout a continuous phase. They are defined and distinguished from one another primarily in terms of their properties. Colloids, for example, may be defined as mixtures in which the dispersed particles are small enough to pass through a filter but too large to pass through a semipermeable membrane. Although colloids, like solutions, may appear uniform throughout, only solutions are considered truly homogeneous mixtures. The particles in a colloid are large enough that they will reflect or scatter light in all directions. In a true solution the dispersed particles are too small to scatter visible light. Suspensions are defined as mixtures in which the particles are large enough that they will settle upon standing (due to the effect of gravity) and will not pass through a filter. The following table summarizes the properties of solutions, colloids, and suspensions. Notice that the particle size for each type of mixture is a range and not an absolute or fixed value. There is thus a continuum of properties for solutions, colloids, and suspensions.

Concepts/terms
- Solution
- Colloid
- Suspension
- Mixture

Chemicals and apparatus
- Ammonium hydroxide solution, 6 M, NH₄OH, 1 mL
- Copper(II) sulfate solution, 0.1 M, CUS?4”’ 100 mL
- Colloidal starch, 0.5%, 130 mL
- Hydrochloric acid solution, 1 M, HCl, 25 mL
- Iodine-Potassium iodide test solution for starch, 12 mL
- Sodium thiosulfate solution, 2.0 M, N~S2O₃ 40 mL
- Starch, 1 g
- Beakers, 600-mL, 2
- Distilled water, 400 mL

Dialysis tubing, 25-mm, 4-6*
Dialysis tubing clamps, 2*
Erlenmeyer flasks, 125-mL, 6
Filter funnels, 3
Filter paper, 3
Flashlight
Funnel support clamp and ring stand
Tubes, or medicine droppers, 3
Stoppers to fit Erlenmeyer flasks, 3

Safety Warnings
Due to the length of the procedures in this lab, students will not be required to look up hazards for themselves. Instead they may write the following:

- Ammonium hydroxide (NH₄OH) solution is a corrosive liquid and is extremely irritating to the eyes and respiratory tract. It is toxic by ingestion and inhalation. Work with ammonium hydroxide in the hood or in a well-ventilated lab only.
- Hydrochloric acid (HCl(aq)) is moderately toxic by ingestion and inhalation and is corrosive to eyes and skin.
- Copper(II) sulfate (CuSO₄(aq)) solution is a body tissue irritant and is slightly toxic by ingestion.
- Sodium thiosulfate (Na₂S₂O₃(aq)) solution is a body tissue irritant.
- Iodine-potassium iodide (I₂(aq)) / KI(aq) solution is a skin and eye irritant.

Wear chemical splash goggles, chemical-resistant gloves, and a chemical-resistant apron.
Preparation
1. The starch suspension is made by mixing 1 g of soluble starch with 100 mL of distilled or deionized water at room temperature.
2. Obtain 100 mL of copper(II) sulfate solution, colloidal starch, and starch suspension in three separate 125-mL Erlenmeyer flasks. Label each flask.

Disposal of chemical waste
- Any remaining copper sulfate solution and starch solution may be disposed of down the drain with plenty of excess water according.
- Excess iodine-potassium iodide solution must be collected in a container marked by your lab instructor for this chemical solution. WARNING! Do NOT put other chemical solutions in the container for Excess Iodine-Potassium Iodide Soln. The collected solution will be reduced with 50% sodium thiosulfate solution before being flushed down the drain.
- The sulfur produced in the light scattering test MUST be placed in the filtration apparatus marked for this purpose to separate the sulfur for disposal in a landfill.

Note: Dialysis tubing is a semipermeable membrane made of cellulose. Small molecules pass through the membrane, while larger molecules do not. The tubing must be soaked in water before use-rinse the tubing with distilled or deionized water and allow it to soak for 5-10 minutes in distilled or deionized water prior to use. Once wet, the tubing should not be allowed to dry out again. Store the tubing in the container provided for this purpose once you have completed your experimentation.

<table>
<thead>
<tr>
<th>Property</th>
<th>Solution</th>
<th>Colloid</th>
<th>Suspension</th>
</tr>
</thead>
<tbody>
<tr>
<td>Particle Size</td>
<td>0.1-1 nm (atoms, ions, and small molecules)</td>
<td>1-200 nm (large protein molecules)</td>
<td>&gt;200 nm (aggregates of large molecules)</td>
</tr>
<tr>
<td>Light Scattering</td>
<td>None</td>
<td>Tyndall effect</td>
<td>Tyndall effect</td>
</tr>
<tr>
<td>Settling Behavior</td>
<td>Stable, does not separate.</td>
<td>Stable, does not separate.</td>
<td>Particles separate on standing.</td>
</tr>
<tr>
<td>Filtration</td>
<td>Particles pass through filter.</td>
<td>Particles pass through filter.</td>
<td>Particles do not pass through filter.</td>
</tr>
<tr>
<td>Dialysis</td>
<td>Particles pass through membrane.</td>
<td>Particles do not pass through membrane.</td>
<td>Particles do not pass through membrane.</td>
</tr>
</tbody>
</table>

Lab Procedure:

Note: Step 1 may be done for you or you may have to do it yourself:
1. Obtain 100 mL of copper(II) sulfate solution, colloidal starch, and starch suspension in three separate 125-mL Erlenmeyer flasks. Label each flask.
   Observe all your mixtures before you start experimentation.

Part A. Are the particles large enough to settle upon standing?
2. Stopper the Erlenmeyer flasks and shake each mixture vigorously for 15 seconds. Allow the mixtures to stand for a few minutes and record observations. Analyze this result in your lab notebook (be sure to label this as Analysis): Write can be determined from these observations?
   If separation starts to occur after the mixture has been allowed to sit undisturbed for a few minutes, then the mixture is probably a suspension. If separation does not occur, then the mixture is probably a colloid or solution.

Part B. Are the particles small enough to pass through a filter?

Note: Step 3 may be done for you or you may have to do it yourself:
3. Set up three filter funnels with qualitative filter paper and place the funnels in a funnel support clamp.
4. Briefly shake each mixture from step 2 and pour half of each mixture through a separate funnel. Collect the filtrates in clean, 125-mL Erlenmeyer flasks or large test tubes.
5. Observe and record whether any solid remains behind on the filter paper in each case. Analyze this result in your lab notebook (be sure to label this as Analysis): Write can be determined from these observations?
   Colloidal and solution particles are typically small enough to pass through the pores in filter paper, but suspension particles are usually not.

6. Add 10 drops of 6 M ammonium hydroxide testing solution to the original copper sulfate solution and to the filtrate. Did the composition of the solution change? Record observations. Analyze this result in your lab notebook (be sure to label this as Analysis): Write can be determined from these observations?

7. Add 10 drops of iodine testing solution to the original colloidal starch and to the filtrate. Did the composition of the mixture change? Record observations. Analyze this result in your lab notebook (be sure to label this as Analysis): Write can be determined from these observations?

8. Add 1 drop of iodine testing solution to the original starch suspension and to the filtrate. Did the composition of the suspension change? Record observations. Analyze this result in your lab notebook (be sure to label this as Analysis): Write can be determined from these observations?
   In the presence of starch, iodine turns dark blue.

Part C. Are the particles small enough to pass through a semipermeable membrane?

9. Obtain a six-inch piece of pre-soaked dialysis tubing and clamp one end with a tubing clamp.
   Note: See the earlier note about this tubing for directions for soaking the dialysis tubing and keeping it wet.

10. Pour about 30 mL of colloidal starch mixture into the dialysis tubing. Clamp the other end of the tubing so that the tube is securely sealed and will not leak.

I 1. Add about 300 mL of distilled or deionized water, followed by 10 mL of iodine test solution, to a 600-mL beaker.

12. Place the dialysis tubing in the beaker. Observe the solutions in the beaker and in the dialysis tubing. Record observations. Analyze this result in your lab notebook (be sure to label this as Analysis): Write can be determined from these observations?
   Recall: In the presence of starch, iodine turns dark blue.
   Solution particles are small enough to pass through a semipermeable membrane, but colloidal and suspension particles are not.

Part D. Are the particles large enough to scatter light?

13. Obtain 40 mL of 2.0 M sodium thiosulfate solution in a large, 600-mL beaker. Add distilled water to the 400-mL mark of the beaker. Stir.

14. Shine a flashlight through the solution in the beaker. Record observations. Analyze this result in your lab notebook (be sure to label this as Analysis): Write can be determined from these observations?
   If the beam of light passes through a solution, it can be projected on a screen or wall. The path of light in the solution itself is not visible when viewed through the side of the beaker. A colloid will typically cause the mixture to glow when a focused beam of light is shined through it.

15. Add about 25 mL of I M hydrochloric acid to the sodium thiosulfate solution and shine a flashlight through the resulting mixture.

16. Observe any changes in the path of the beam of light. Record observations. Analyze this result in your lab notebook (be sure to label this as Analysis): Write can be determined from these observations?

Part E. Can the particles be separated using centrifugation?

13. Place small samples of your mixtures in a centrifuge tube. Place the samples in a balanced manner in the centrifuge and centrifuge for 2 minutes. Do not remove samples until the centrifuge has come to a full stop. Record observations. Analyze this result in your lab notebook (be sure to label this as Analysis): Write can be determined from these observations?