A method by which a scientist solves a problem is called a scientific method. This method usually includes observation, experimentation, interpretation and hypothesis formation. Scientific method often has been compared to the procedure a detective uses in solving a crime or problem. The following investigation creates a scientific problem for you and asks you to solve it. You will follow a scientific method in attempting to solve the problem.

In this investigation, you will:
   a. use a scientific approach to solve whether or not flasks A & B contain similar or different liquids
   b. make careful observations
   c. record accurate experimental results
   d. use your data (recorded results) as a basis for deciding if the two liquids are similar or different

Materials:
- 2 Erlenmeyer flasks containing liquids
- Clock or watch w/ a second hand
- 2 stoppers to fit flasks
- Beaker

Safety Precautions
- You must wear goggles
- Some of the materials may be toxic

Procedure
Part A. Observation
- Accurate observations are a necessary part of any scientific method.
1. Examine the 2 flasks. DO NOT remove the stoppers and DO NOT shake the contents.
2. Make sure that the flasks have been labeled A & B
3. Record in Table 4-1 two or three similarities or differences between the 2 flasks.

<table>
<thead>
<tr>
<th>Similarities</th>
<th>Differences</th>
</tr>
</thead>
<tbody>
<tr>
<td>They are both liquids and are translucent.</td>
<td>Liquid A is clear, and liquid B is yellowish.</td>
</tr>
<tr>
<td>Don’t have interments to determine.</td>
<td>Liquid A is 75 mL and liquid B is over 125 mL.</td>
</tr>
</tbody>
</table>

Table 4-1. First Observations

Answer the following questions:
1. a) Do you think both flasks contain the same liquid? We do not think the flasks contain the same liquid.
b) Explain your reasoning. They did not contain the same liquid, because one of them were yellow and one of them were clear.

2. Is your answer to question 1 based on experimentation or guessing? The answer to question one was based on guessing.

3. Would scientists guess at answers to questions or would they experiment first? Scientist would guess first for their hypothesis. Then they would experiment their hypothesis.

Write a HYPOTHESIS: (If…then…) If both liquids have the same characteristics within the lab, then they might be the same type of liquid.

4. Are both flasks exactly alike in amounts of liquid? No, flask A has less liquid.

5. What gas may be in flask A that is NOT in flask B? The gas oxygen was in flask A, and not in flask B.

6. Is there any direct evidence for your answer to question 5? Yes, because flask B was full, so no oxygen was in the flask. Although, in flask A there was space, which had room for oxygen.

Part B. Experimentation

- In determining if the two liquids are the same or not, a scientist would carry out some experiments. Experimentation is another part of the scientific method.

Experiment 1. **What happens if you shake the liquids?**

- Give each flask one hard shake using an up-and-down motion of your hand. Make sure your thumb covers the stopper as you shake. Use Figure 4-1 as a guide.

- Observe each flask carefully
- Record your observations in Table 4-2. Again, look for similarities and differences.

<table>
<thead>
<tr>
<th>Table 4-2. Results of Experiment 1</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Similarities</strong></td>
</tr>
<tr>
<td>Qualitative Observations</td>
</tr>
<tr>
<td>Quantitative Observations</td>
</tr>
</tbody>
</table>

7. After shaking the flasks, do you think they contain different liquids? Yes, because flask A turned blue, and Flask B didn’t do anything.

8. What was present in flask A that may have been responsible for the change in the liquid? The gas oxygen was in flask A, that could of caused the chemical to react and change colors.
Experiment 2. **What happens if you remove some of the liquid in flask B so it appears like flask A?**
- Remove the stopper from flask B and pour out half of the contents into a beaker or other suitable container. Make sure that the amount of liquid in flask B is equal to the amount of liquid in flask A. Replace the stopper. Give both flasks one hard shake using an up-and-down motion of your hand. Hold stopper in place while shaking.
- Observe each flask carefully
- Record any similarities or differences observed in Table 4-3.

<table>
<thead>
<tr>
<th>Qualitative Observations</th>
<th>Both liquids produced bubbles.</th>
<th>Liquid A turned blue, and Liquid B turned green.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quantitative Observations</td>
<td>Each liquid went back to their original volume.</td>
<td></td>
</tr>
</tbody>
</table>

9. Do both flasks now appear to contain the same liquid? No, because Flask B turned green, and Flask A turned blue.

10. What may have been added to flask B that was not present before? (see #5) The gas oxygen was able to get into Flask B once we poured some of the liquid out.

Experiment 3. **What happens if you shake the flasks more than once?**
- Shake each flask hard once with an up-and-down motion.
- Note the exact time in seconds after shaking that it takes for each liquid to return to its original condition. Record the time in Table 4-4.
- Shake each flask hard twice with an up-and-down motion.
- Again record in Table 4-4 the time it takes for the liquids to return to their original conditions.
- Shake both flasks hard 3 times with an up-and-down motion.
- Record in Table 4-4 the time it takes for them to return to their original conditions.

<table>
<thead>
<tr>
<th>Time in Seconds to Return to Original Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Shake</td>
</tr>
<tr>
<td>Flask A</td>
</tr>
</tbody>
</table>
11. After 1 shake, are the two liquids generally “behaving” in a similar way? That is, is the time needed for flasks A & B to return to their original condition about the same? Flask A turned a darker color and took longer to go back to its original form.

12. After 2 and 3 shakes, are flasks A & B generally “behaving” in a way similar to each other? Flask A is still a darker color, but near the end they started taking almost the same amount of time to go back to their original form.

13. Look at your data in Table 4-4.
   a. Does Flask A show an increase or decrease in time needed to return to its original condition as the number of shakes increases from 1 to 3? The more you shake Flask A, the longer it takes to go back to its original form.
   b. Does flask B show a similar change? Yes, Flask B started taking longer with each shake also.

Post-Lab Questions
1. On the basis of your first observations in part A, could you decide if both flasks contained the same liquid? We didn’t have direct evidence to determine if they were the same liquids or not.

2. After performing Experiment 1, could you decide if both flasks contained the same liquid? No, we could not, because one could not react with no oxygen.

3. Which experiment or experiments may have helped you to decide that the liquids were similar or different? In experiment 2 and 3 when the flask both contained the same amount of liquids and shakes.
   a. Explain. The reason why, if because when Flask B had the whole flask full, you could not tell how it would react to oxygen like Flask A was.

4. Besides the liquid itself, what else seems to be needed in order for the liquid to change color? The presents of oxygen was needed to change the liquids color.

Questions 5-7 should help you to form a hypothesis. In a hypothesis, all facts are joined in an attempt to explain what has been observed.

5. Explain why flask B did not change color when shaken in experiment 1. Flask B didn’t contain any oxygen in the flask because it was full.

6. Why must the liquids in the half-filled flasks be shaken in order to produce a color change? When the liquid is sitting still, the oxygen isn’t mixing with the molecules of the liquid to change any characteristics.

7. Why did more shaking increase the amount of time needed for the liquids in flasks A & B to change back to their original color? When you shake the flask more, the molecules and oxygen are combining more and more. Causing it to take longer to change separate and change back.
8. Could you have solved question 1 in Part A by guessing? Not with the tools we were accessible to.

9. Why is experimenting a better method of problem solving than guessing? When you guess, you are just coming up with an idea. When you are experimenting, you can do different things to the liquid, getting information about it. Causing you to have answers and proof to you guesses and hypothesis.

10. What is meant by the phrase “solving a problem by using the scientific method”? It means you have to go through the steps and guidelines of a practiced formula that scientist use to help solve everyday problems and experiments.

Conclusion: Write a paragraph (5-9 complete sentences) describing what you can conclude from your observations during this lab. Be sure to include whether your data rejected or failed to reject your hypothesis. Please discuss possible errors in experimental design or in the experiment itself, too.

In our hypothesis, we stated that we thought they were the same type of liquid based on the observation we made. Although during our experiment the characteristics of the liquids reacted different. Yes, both liquids changed colors once we poured some of the liquid B out, but liquid B turned a darker color. Also, they took different times to go back to their original form. Therefore, they might be close to the same liquid, but they are not the same exact liquid.