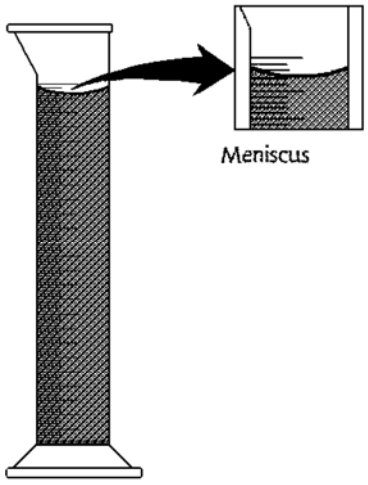


Figure 1 *To find the volume of liquid in a graduated cylinder, read the scale at the bottom of the curved part of the liquid (meniscus).*

The metric prefix *milli-*
represents 1/1000th
(0.001) of the unit
indicated. Thus one milliliter
(1 mL) is one thousandth of
a liter, or 0.001 L.

A.2 FOUL WATER

Laboratory Activity

Introduction

Your objective is to purify a sample of "foul water," producing as much "clean water" as possible. CAUTION: *Do not test the purity of the water samples by drinking or tasting them.* You will use three water-purification procedures: (1) oil-water separation, (2) sand filtration, and (3) charcoal adsorption and filtration. In **filtration**, solid particles are sepa-rated from a liquid by passing the mixture through a material that retains the solid particles. The liquid collected after filtration is called the **filtrate.**

If you have not already done so, carefully read "Safety in the Laboratory," pages iv–v, before beginning the laboratory procedure.

Procedure

1. In your laboratory notebook, prepare a data table similar to the one shown here. Be sure to provide more space to write your entries.
2. Using a beaker, obtain approximately 100 mL (milliliters) of foul water from your teacher. Measure its volume precisely with a graduated cylinder. See Figure 1. Record the actual volume of the water sample in your data table.

   Examine the properties of your sample: color, clarity, odor, and presence of oily or solid regions. Record your observations in the "Before treatment" row of your data table.
3. **Settling step:** While you are examining the foul water, try not to disturb the mixture. Let the solids settle to the bottom of the beaker. Try to avoid pouring these into the funnel in the next step of the lab.

Oil-Water Separation

As you probably know, if oil and water are mixed and left undisturbed, the oil and water do not noticeably dissolve in each other. Instead, two layers form. Which layer floats on top of the other? Make careful observations in the following procedure to check your answer.

4. Place a funnel in a clay triangle supported by a ring and ring stand. See Figure 2. Attach a rubber tube to the funnel tip as shown.
5. Close the rubber tube by tightly pinching it with your fingers (or by using a metal pinch clamp). Gently swirl the foul-water sample for several seconds. Then immediately pour about half the sample into the funnel. Let it stand for a few seconds until the liquid layers separate. (Gentle tapping may encourage oil droplets to break free.)
6. Carefully open the tube, slowly releasing the lower liquid layer into an empty 150-mL beaker. Just as the lower layer has drained out, quickly close the rubber tube.
7. Drain the remaining layer into another 150-mL beaker.
8. Repeat Steps 5 through 7 for the other half of your sample, adding each liquid to the correct beaker. Which beaker contains the oily layer? How do you know?
9. Dispose of the oily layer as instructed by your teacher. Observe the properties of the remaining layer and measure its volume. Record your results. Save this water sample for the next procedure.
10. Wash the funnel with soap and water.

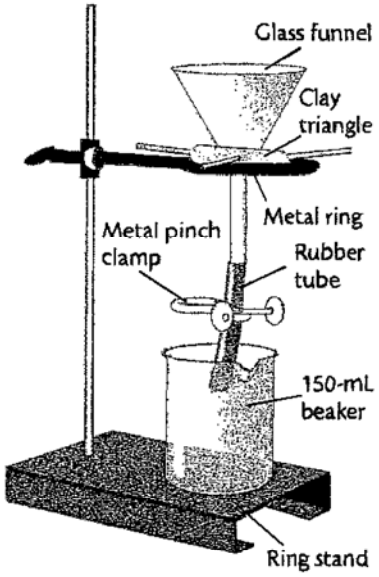


Figure 2 *Funnel in clay triangle.*

Sand Filtration

A sand filter traps and removes solid impurities—at least those particles too large to fit between sand grains—from a liquid.

11. Using a straightened paper clip, poke small holes in the bottom of a disposable cup. See Figure 3.
12. Add pre-moistened gravel and sand layers to the cup as shown in Figure 4. (The bottom layer of gravel prevents the sand from

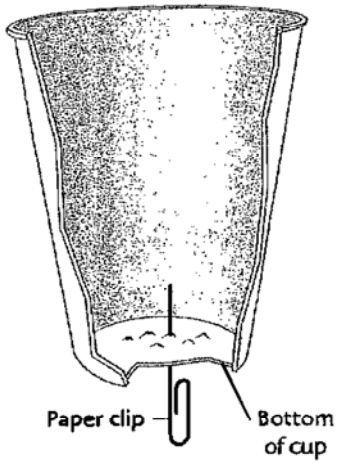


Figure 3 *Preparing a disposable cup.*

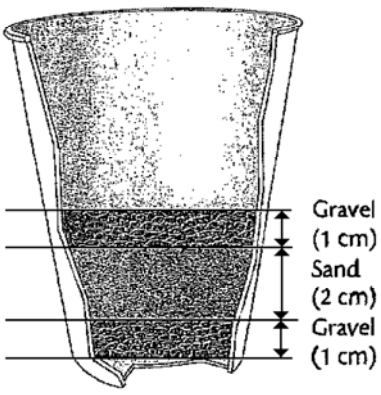


Figure 4 *Sand filtration.*

washing through the holes. The top layer of gravel keeps the sand from churning up when the water sample is poured into the cup.)

13. Gently pour the sample to be filtered into the cup. Catch the filtrate (filtered water) in a beaker as it drains through.
14. Dispose of the used sand and gravel according to your teacher's instructions. Do not pour any sand or gravel into the sink!
15. Observe the properties of the filtered water sample and measure its volume. Record your results. Save the filtered water sample for the next procedure.

Charcoal Adsorption and Filtration

Charcoal **adsorbs**, which means attracts and holds on its surface, many substances that could give water a bad taste, an odor, or a cloudy appearance. The pump system in a fish aquarium often includes a charcoal filter for this same purpose.

16. Fold a piece of filter paper as shown in Figure 5.
17. Place the folded filter paper in a funnel. Hold the filter paper in position and wet it slightly so that it rests firmly against the base and sides of the funnel cone.
18. Place the funnel in a clay triangle supported by a ring. See Figure 2, page 9. Lower the ring so that the funnel stem extends 2 to 3 cm (centimeters) inside a 150-mL beaker.
19. Place one teaspoon of charcoal in a 125- or 250-mL Erlenmeyer flask.
20. Pour the water sample into the flask. Swirl the flask vigorously for several seconds. Then gently pour the liquid through the filter paper. Keep the liquid level below the top of the filter paper—liquid should not flow through the space between the filter paper and the funnel. (Can you explain why?)

There are about 2.5 cm (centimeters) in an inch. You can think metric" and make a good estimation of the length of a centimeter by realizing that a cassette audio cartridge or a piece of chalk has a thickness of about 1 cm

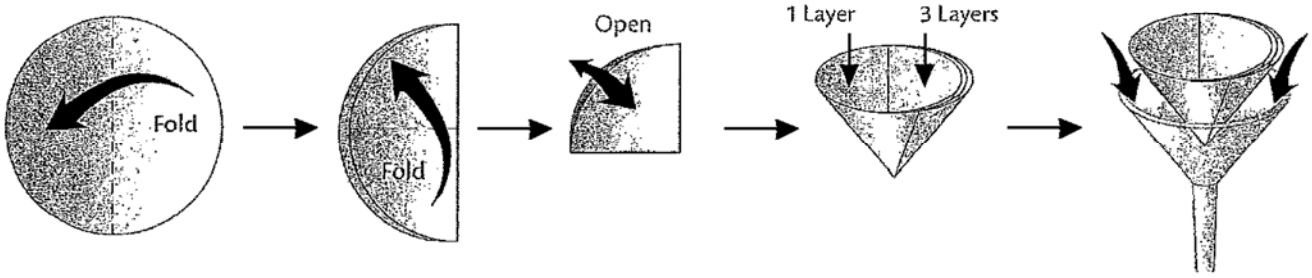


Figure 5 *Folding filter paper.*

21. If the filtrate is darkened by small charcoal particles, refilter the liquid through a clean piece of moistened filter paper.
22. When you are satisfied with the appearance and odor of your charcoal-filtered water sample, pour it into a graduated cylinder. Record the final volume and properties of the purified sample.
23. Follow your teacher's suggestions about saving your purified sample. Place used charcoal in the container provided by your teacher.
24. Wash your hands thoroughly before leaving the laboratory.
25. Clean all your glassware with Alconox(soapy H_2O) and leave on drying racks or return it to the back bench where you got it. Wash off your table.

Foul Water Lab

Pre-Lab Activity: Please read the Introduction and Procedure to the Foul Water Lab in the previous pages and find a way to illustrate *what* needs to be done and *how* these separations will be done in the space provided below. *No details on quantity needed.* You may draw, color, do a flow chart, make a cartoon, or simply summarize. Be creative! The goal of this is for you to know the big picture of what this lab is about. This also will provide me a way to get to know your hidden talents and perhaps insights on how you learn best.

Foul Water Lab

Data and Observations

	Volume (mL)	Color	Clarity	Odor	Presence of Oil	Presence of Solids	Tyndall effect	Conductivity
Before Treatment								
After Oil-Water Separation								
After Sand Filtration								
After Charcoal Adsorption & Filtration								

Foul Water Lab Questions

1. What percent of your original foul water sample did you recover as "purified" water? Show your work.

$$\% \text{ recovered} = \frac{\text{volume of purified water}}{\text{starting volume of water}} \times 100$$

2. Purity:
   a. Is your "purified" water pure? (Would you drink your water?) How do you know?

   b. Compare your sample to samples from other lab groups.

3. We tested the electrical conductivity of the purified water samples. This test detects the presence of dissolved, electrically charged particles in the water. Compare your results to the tests on distilled and tap water. What does this suggest about the purity of your sample?

4. Tyndall Effect:
   a. Did your purified water show the Tyndall effect?

   b. What does this tell you about the purity of your sample?

5. Distillation:
   a. Another technique for purifying water is distillation. How can you tell that distillation is able to separate out dissolved salt?

   b. Explain how distillation can remove salt from the water.

   c. Why did the techniques that you used in the lab fail to remove salt from the water?

6. Municipal water treatment plants do not use distillation to purify water. Why?

7. After each stage of the purification process, classify your sample as suspension, colloid, or a solution. Give evidence to support your answer.

After stage…	Classification	Evidence
Oil separation		
Sand/Gravel		
Charcoal/Filtration		

8. What was removed at each stage of the purification process?

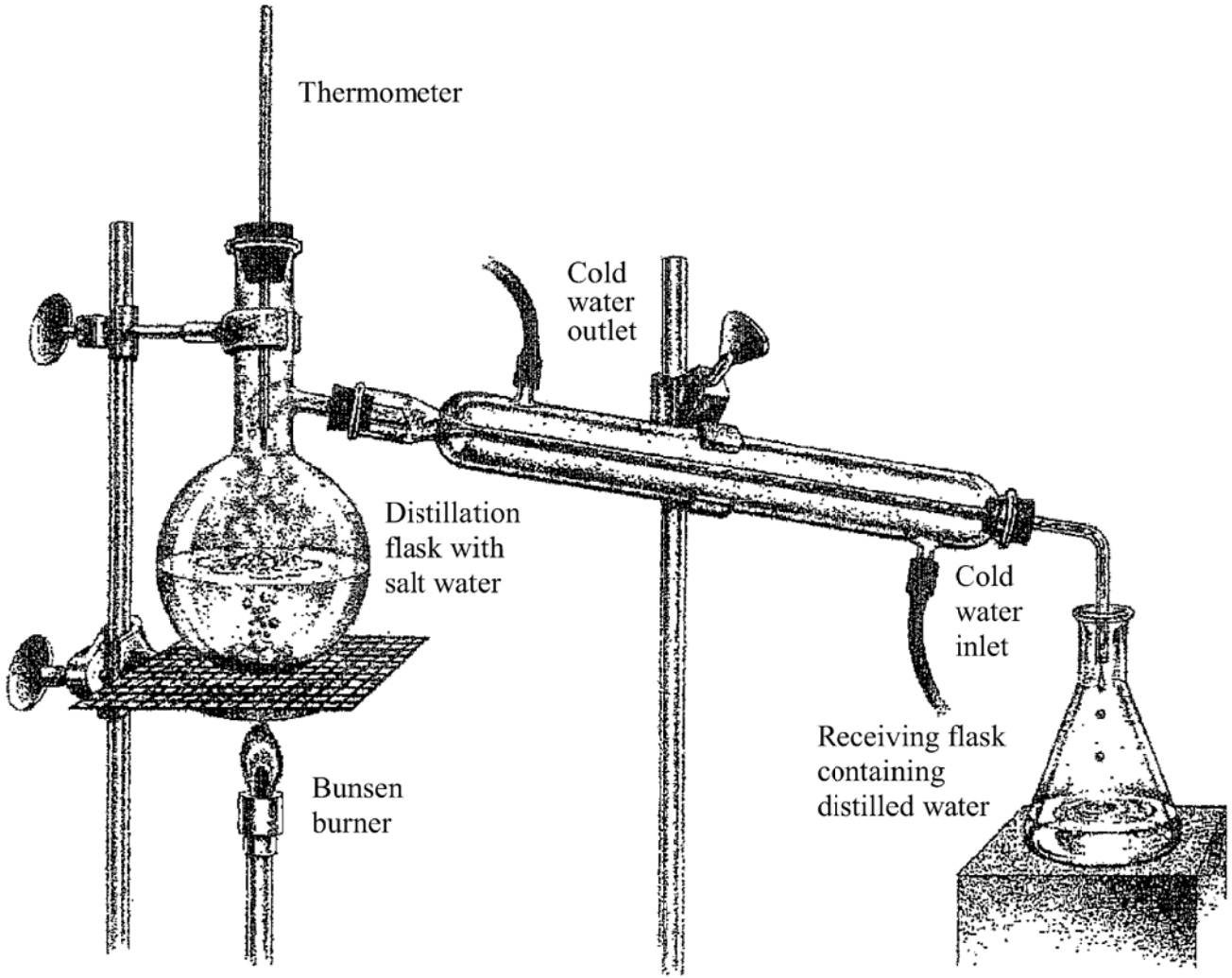
   a. Oil:

   b. Sand/Gravel:

   c. Charcoal/Filtration:

9. How would you improve the procedure so that you would either recover a higher percentage of water of equal quality or improve the quality of the water?

Distillation Set-Up



Distillation Set-Up Questions

1. a. List the phase changes or state of matter changes that occur during distillation.

   b. Label the distillation diagram with the phase changes.

2. List the phase change that is endothermic and explain why it is endothermic.

3. What are the water molecules doing as heat is being added to them? Draw pictures to show how the interaction of the water molecules may change.

4. a. What is the purpose of the cold water?

   b. What would happen if you didn't have cold water running and you distilled for a long time?

5. a. What are the water molecule doing as heat is being removed from them? (You may draw pictures to show this if you wish as in question 3.)

   b. Is this process endothermic or exothermic? Explain.

6. Can distillation be used to separate two liquids? Explain your thinking.

7. Foul water is very smelly. If you try to distill foul water straight from the bottle you get crystal clear water that doesn't conduct but it stinks! Why do you think this happens?