Basic Experiments for General, Organic, and Biochemistry 2 Ed.

Instructor's Manual

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Experiment 1

This may be a student's first experience in the laboratory. Therefore, the instructor should demonstrate all the techniques used in this laboratory. Show how a Bunsen burner is lit, with a match or a gas striker, and how the flame is adjusted by control of the gas valve and air vents.

This is a relatively simple laboratory for students to work. Most of the common equipment used in the laboratory are introduced here. For many this might be the first time some of the glassware will be encountered. For the instructor, patience is in order since the lack of familiarity of the student with the laboratory ware often creates problems. Take the graduated cylinder, for example. Since it is tall, it is easily knocked over, and although laboratory glassware is reasonably durable, it will shatter and could cause severe cuts. Remind students not to pick up broken glass with the fingers but to use the dustpan and brush. Broken glass should be discarded in a waste container specifically for glass.

While there is little danger in this laboratory of eye damage, nevertheless, it is essential that the rules of the laboratory be followed: **safety glasses are to be worn at all times in the laboratory.**

The thermometers in this laboratory are made of glass and must be handled properly. A thermometer is not a stirring rod and must not be used as such. If a student wants to bring the fluid level in the thermometer down, remind him/her to use cold water from the tap. The laboratory thermometer is not a clinical thermometer and does not require that it be shaken down! Waving the thermometer usually results in it hitting a bench top and breaking. Some of these thermometers contain mercury; the breakage of a thermometer with resultant spillage of mercury must be cleaned up quickly. Mercury is toxic, especially as a vapor. The instructor should be notified immediately for proper clean up. No mercury should be left freely about anywhere. Mercury can be collected with commercial collectors or by a home made suction apparatus. Connect a side-arm suction filter flask to a water aspirator. The flask is fitted with a one-hole rubber stopper with a small section of glass tubing inserted into the hole. Rubber tubing connects the glass tube to a Pasteur pipet. When the water is turned on, the spheres of mercury will be sucked into the pipet and then into the suction flask. The recovered mercury can be stored under water.

Balances should be handled with care; electronic top-loading balances are sensitive and lose calibration easily. Demonstrate proper use of the balance. Emphasize that no chemical should be weighed directly on the pan; use either weighing paper or a suitable container. Also hot objects should not be put on the pan. Proper care requires that all weights be returned to zero.

The difference between precision and accuracy can be easily demonstrated. Use two balances, one that has been zeroed and calibrated, a second not zeroed and uncalibrated. Repeated weighings of the same object of known weight on the two balances will show high precision (high reproducibility in the clustering of the weights) for each of the two balances but not the same accuracy (agreement with the known weight).

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Experiment 1

PRE-LAB QUESTIONS

A. Safety concerns.

1. Why do you use a weighing container or weighing paper to hold a chemical when using a balance?

   Weighing containers and paper protection the balance pan from chemical action.

2. What precautions need to be followed when using a mercury thermometer?

   Do not use as a stirring rod; do not touch the sides or bottom of a glass container. If it gets broken, beware of touching and breathing the mercury; clean up at once.

B. Basic principles.

1. Why do scientists use the metric system of measurements instead of the English system?

   The system uses the base 10 for the measurements, so conversions need be multiplied or divided by the factor of 10.

2. Solve the following problems and record the answers to the proper number of significant figures:

   a. 50.2 x 30.12 = *1510*

   b. 9.03 ÷ 2.5 = *3.6*

   c. 5.03 + 6.059 + 1.003 = *12.09*

   d. 7.02 - 6.1 = *0.9*

3. Name the type of balance you would use for the following determinations:

   1. A mass of approximately 110 g *a platform triple beam balance*.

   2. An accurate mass of 110.000 g *a top-loading balance*.

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Experiment 1

REPORT SHEET

Length

1. Length *10 15/16* in. *27.7* cm

   Width *8 4/16* in. *20.9* cm

2. Length *277* mm *0.277* m

   Width *209* mm *0.209* m

3. Area *90 4/16* in^2 *579* cm^2 *57900* mm^2

   (Show calculations)

(10 15/16 in.) x (8 4/16 in.) = 90 4/16 in.^{2} *[(175/16) x (132/16) = 23100/256]*

(27.7 cm) x (20.9 cm) = 578.93 cm^2 *= 579 cm*^{2}

(277 mm) x (209 mm = 57893 mm^2 *= 57900mm*^{2}

Volume

4. Erlenmeyer flask: volume in flask: 50 mL

   volume in graduated cylinder: *49.5* mL *0.0495* L

5. Beaker: volume in beaker: 40 mL

   volume in graduated cylinder: *42.0* mL *0.0420* L

6. Erlenmeyer flask

   Error in volume: volume in graduated cylinder – volume in flask = *0.5* mL

   $$\% \text{ Error} = \frac{\text{Error in volume}}{\text{Total volume}} \times 100 =$$ (Show your calculations) *1* %

   (0.5/50) x 100 = 1%

   Beaker

   Error in volume: volume in graduated cylinder – volume in beaker = *2.0* mL

$$\% \text{ Error} = \frac{\text{Error in volume}}{\text{Total volume}} \times 100 =$$ (Show your calculations) *5.0* %

(2.0/40) x 100 = 5.0%

Mass

Object	Balance					
	Platform		Centogram®		Top-Loading	
	g	mg	g	mg	g	mg
Quarter	*5.8*	*5800*	*5.61*	*5.610*	*5.613*	*5613*
Test tube	*8.1*	*8100*	*7.92*	*7920*	*7.872*	*7872*
125-mL Erlenmeyer	*77.1*	*77100*	*76.95*	*76950*	*76.948*	*76948*

Temperature

	°C	°F	K
Room Temperature	*22.5*	*72.5*	*295.7*
Ice Water	*0.5*	*32.9*	*273.7*
Boiling Water	*99.5*	*211.1*	*372.7*

How well do your thermometer readings agree with the accepted values for the freezing point and boiling point of water? Express any discrepancy as a deviation in degrees.

Deviation in Freezing Point (°C) *+0.5°C*

Deviation in Boiling Point (°C) *-0.5°C*

POST-LAB QUESTIONS

1. From your results, which balance gave the most accurate weight measurement?

   A top-loading balance.

2. A student attempted to obtain the mass of a warm beaker on a triple beam balance. What problems might the student encounter in trying to obtain the mass of the beaker?

The hot object might mar the pan. Buoyancy effects will cause incorrect mass readings.

3. Two students each obtained the mass of a 125-mL Erlenmeyer flask that had a true mass of 70.621 g. Each student recorded three mass readings for the flask and took an average. Below are the results.

	Student A	**Student B**
	70.519	70.596
	69.873	70.673
	70.934	70.643
Average	70.442	70.637

a. Which set of results is more accurate? *Student B*.

b. Which set of results is more precise? *Student B*.

c. What can be said of the results from Student A and Student B?

The measurements of Student B are precise and accurate. Student A has neither precise nor accurate measurements.

4. A 250 mg sample was placed in a beaker with a mass of 15.645 g. What is the combined mass of the beaker and sample in grams?

15.645 + 0.250 = 15.895

5. Using your value for the mass of a quarter, how many (to the nearest whole number) would it take to make up one pound of quarters?

1 quarter has a mass of 5.61 g; the factor you need is 1 quarter/5.61 g.

1 lb. = 454 g

(454 g) x (1 quarter/5.61 g) = 81 quarters

6. Temperatures in the Southwest often reach 110°F in the summer. What is this temperature in °C? Show your work.

5/9(110 - 32) = 43°C

7. Mount Everest in the Himalayan Range is the highest peak in the world at 8850 m. What is this in (1) km and (2) mi.? Show your work.

(8850 m) x (1 km/1000m) = 8.850 km

(8.850 km) x (1 mi./1.61 km) = 5.28 mi.

8. A trip from Boston to Washington, D. C. is 450 mi. What is the distance in km? Show your work.

(450 mi.) x (1.61 km/1 mi.) = 725 km

9. Measurements for a new born were 24 in. and 9.98 lbs. What are the baby's measurements in cm and in kg? Show your work.

(24 in.) x (2.54 cm/1 in.) = 61 cm

(9.98 lbs.) x (454 g/1 lb.) x (1 kg/1000 g) = 4.53 kg

10. A container of corn oil reads "2 gal." on the label. How many quarts and how many liters are in the container? Show your work.

(2 gal.) x (4 qts./1 gal.) = 4 qts.

(2 gal.) x (4 qts./1 gal.) x (0.96 L/1 qt.) = 7.7 L

Experiment 2

This laboratory provides a bit of fun for the student; the student will use the equipment in the locker to solve a puzzle. Each will be given unknowns of various kinds and asked to find out the identities by taking suitable measurements. Thus, using precision, accuracy, and significant figures in their measurements, each unknown can be identified. (Eureka!)

In the use of the balances, again remind students not to weigh directly on the pan, but to use a container or weighing paper. In the case of the unknown metal, provide suitable containers for their recovery. For the other unknowns, waste containers should be provided. Nothing should be discarded into the sink.

Reading the volume in a graduated cylinder requires lining up of the eye with the meniscus. Demonstrate the proper technique for doing this. It may be the student's first encounter with the Spectroline pipet filler. It would be best to go through the way it works, particularly in the suction phase of its use. If the tip of the pipet is not immersed far enough into the liquid to be pipetted, the force of the suction might cause the liquid to be drawn up into the Spectroline pipet filler's body; these liquids will cause the inside to deteriorate. In addition, the liquids in the pipet filler will contaminate the next liquid to be pipetted, and so this situation should be avoided.

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Experiment 2

PRE-LAB QUESTIONS

A. Safety concerns

1. Why do you not discard your solid or liquid samples into the sink? Where should you discard these samples?

The samples may pollute the environment; also, they may stop-up the drain if they do not dissolve. Samples should be disposed of in appropriately labeled waste containers.

2. Should you use your mouth when you pipet a liquid? Explain.

Never use your mouth to pipet a liquid. The liquid may be poisonous if swallowed or can cause burns if any got into the mouth.

3. Why is it necessary to lubricate the end of the pipet before inserting into the pipet filler?

In order not to force, lubrication allows the glass to enter the opening without binding. Forcing may break the glass.

B. Basic principles

1. Identify the following characteristics as either an *intensive* property or an *extensive* property.

a. Melting point *Intensive*.

b. Color *Intensive*.

c. Volume *Extensive*.

d. Mass *Extensive*.

e. Density *Intensive*.

2. Cork stoppers float on water. Could you use the water displacement to determine the density of the cork stopper? Explain.

The displacement method depends on the object being completely submerged. Since the cork floats, not all of it is covered with water, so not all of the object would be accounted for, and the method would not work.

3. Exactly 50.0 mL of liquid has a mass of 40.30 g. What is its density? Show your work.

40.30 g/50.0 mL = 0.806 g/mL

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Experiment 2

REPORT SHEET

Report all measurements and calculations to the correct number of significant figures.

A. Density of a regular-shaped object	**Trial 1**		**Trial 2**	
Unknown code number *1 (wood block)*				
1. Length	*20.8*	cm	*20.8*	cm
Width	*5.3*	cm	*5.3*	cm
Height	*4.4*	cm	*4.4*	cm
2. Volume (L x W x H)	*485*	cm^3	*485*	cm^3
3. Mass	*287.57*	g	*287.57*	g
4. Density: (3)/(2)	*0.593*	g/cm^3	*0.593*	g/cm^3
Average density of block	*0.593*	g/cm^3		

B. Density of an irregular-shaped object	**Trial 1**		**Trial 2**	
Unknown code number *2 (Al shot)*				
5. Mass of metal sample	*5.232*	g	*6.702*	g
6. Initial volume of water	*14.90*	mL	*16.80*	mL
7. Final volume of water	*16.80*	mL	*19.30*	mL
8. Volume of metal: (7) - (6)	*1.90*	mL	*2.50*	mL
9. Density of metal: (5)/(8)	*2.75*	g/mL	*2.68*	g/mL
Average density of metal	*2.72*	g/mL		

10. Identity of unknown metal *Aluminum*

C. Density of water

	Trial 1	Trial 2
11. Temperature of water	*22.0* °C	*22.0* °C
12. Mass of 50-mL beaker	*26.264* g	*26.257* g
Volume of water	10.00 mL	10.00 mL
13. Mass of beaker and water	*36.143* g	*36.176* g
14. Mass of water: (13) - (12)	*9.879* g	*9.919* g
15. Density of water: (14)/ 10.00 mL	*0.9879* g/mL	*0.9919* g/mL

16. Average density of water *0.9899* g/mL

Density found in literature *0.998* g/mL

D. Density of unknown liquid

Unknown code number *3 (Ethanol)*

	Trial 1	Trial 2
17. Temperature of unknown liquid	*22.0* °C	*22.0* °C
18. Mass of 50-mL beaker	*26.810* g	*26.810* g
19. Mass of beaker and liquid	*34.671* g	*34.842* g
20. Mass of liquid: (19) - (18)	*7.861* g	*7.882* g
Volume of liquid	10.00 mL	10.00 mL
21. Density of liquid: (20)/10.00 mL	*0.7861* g/mL	*0.7882* g/mL

Average density of unknown liquid *0.7872* g/mL

22. Identity of unknown liquid *Ethanol*

POST-LAB QUESTIONS

1. When a student drew liquid into the volumetric pipet, air bubbles were trapped in the volumetric pipet. Would this give a density less than expected or greater than expected? Why?

The air bubbles occupy space, so it would appear that the metal pieces had a bigger volume than there actually was. Since the mass did not change, only the volume (which appears larger) "changed;" Thus, the density would be less than expected.

2. A student has a regular wooden block to work with for a density determination. Unknown to the student is that the block has a hollow center. How will this affect the student's determination of the density?

The density would be less than it should be. The volume displaced assumes a completely solid object. The mass of the hollow solid is less than the mass of a completely solid block of the same volume.

3. Ethanol has a density of 0.791 g/cm^3 at 20°C. How many milliliters (mL) are needed to have 30.0 g of liquid? Show your work.

$d = m/V$

$0.791\ g/cm^3 = 30.0\ g/V$

$V = 30.0\ g/0.791\ g/cm^3 = 37.9\ cm^3 = 37.9\ mL$