Instructor's Manual

Safety-Scale Laboratory Experiments for Chemistry for Today General, Organic, and Biochemistry

NINTH EDITION

Spencer L. Seager
University of South Dakota
Weber State University

Michal R. Slabaugh
University of South Dakota
Weber State University

Maren S. Hansen
West High School, Salt Lake City, UT

Prepared by

Spencer L. Seager
University of South Dakota
Weber State University

Michael R. Slabaugh
University of South Dakota
Weber State University

Maren S. Hansen
West High School, Salt Lake City, UT

CENGAGE Learning

Australia • Brazil • Mexico • Singapore • United Kingdom • United States

Table of Contents

INTRODUCTION

The authors of the laboratory manual have prepared this manual with the goal of making it as useful as possible for both the laboratory instructors and the stockroom personnel who are responsible for the preparation of reagents and equipment used in the experiments. With that goal in mind, we have divided this manual into two parts. Part I, *Conducting and Grading the Experiments*, contains answers to pre-lab questions, answers to the experiment questions, instructor tips, and comments on student results and grading. Part II, *Material Preparation and Disposal*, contains a listing of all materials needed for each experiment. This listing is divided into the categories of: chemicals (pure liquids or solids), reagents (solutions), miscellaneous supplies, and equipment needed from the stockroom (generally items that are too costly to be put into individual lockers). Complete directions are given for the preparation of all reagent solutions used in the experiments. Disposal containers described in each experiment are indicated with a label that matches those given to the students in the experiment. Suggestions are given for the appropriate disposal of materials put into the disposal containers by the students.

The separation of the manual into two parts allows it to be conveniently divided for use by the appropriate individuals. In our program, we put copies of the Material Preparation and Disposal part in loose leaf binders for use in the stockroom. Copies of the Conducting and Grading part are put into binders and distributed to all laboratory instructors.

In all projects of this type, some errors unavoidably get into the final product despite efforts by proofreaders, editors, and authors to prevent them. We welcome communication from both lab instructors and stockroom personnel who find any errors, or who have suggestions for improving either the lab manual or this instructor's manual. Our address is:

S.L. Seager or M.R. Slabaugh
Chemistry Department
Weber State University
2503 University Circle
Ogden, UT 84408-2503

PART I CONDUCTING AND GRADING THE EXPERIMENTS

This part of the manual contains instructor tips which are comments about each experiment based on the author's experiences in using the experiments in our program. In some cases, the tips take the form of suggestions or announcements an instructor might want to give to the lab students before they begin an experiment. Answers to pre-lab questions and the questions that follow each experiment are given to aid those who grade the experiments. In the case of the questions that follow each experiment, we also give an example of an acceptable explanation for each correct response. Where they are available, we also give comments on the results obtained by students who have done the experiment.

The grading approach we use involves collecting the pre-lab questions at the beginning of each lab session. These are graded on a 0-5 point basis; the scores are recorded, and the graded papers returned during the lab period. The completed data and report sheets are collected at the beginning of the lab session that immediately follows the session in which the data were collected. These are graded on a 0-15 or 0-20 point basis, and returned during the next lab session. We usually grade 2 or 3 of the lab questions. Two points are awarded for each question, with one point for a correct answer, and one point for an acceptable explanation. If an unknown is involved in the experiment, we usually make it worth about 5 (out of 20) points. In addition, we check data entries for correctness as well as calculations, etc.

EXPERIMENT 1: MEASUREMENTS AND SIGNIFICANT FIGURES

Instructor Tips

1. The time required for this experiment makes it possible for students to check into lockers, receive a short safety talk, and still have plenty of time to collect their data.

2. Sometimes we assign this experiment as a homework assignment. Everything the students need is readily available in their homes, and it makes it possible to do one more experiment in the regularly-scheduled lab sessions.

3. A slight bottleneck can develop because all students need the scissors at the beginning of the lab session. Extra pairs of scissors help, or you can have students cut out their rulers while they are waiting to check into lockers. Remind students to not cut out their rectangles.

4. Some students worry about which side of a rectangle represents the length, and which the width. For consistency we suggest you announce that the longer measurement always represents the length.

5. Students are able to use the cut-out rulers better if they are instructed to cut on the inside edge of the long line that is adjacent to the scale marks. This puts the scale marks directly against the lines to be measured in the rectangles.

6. Usually, time is available after data collection is completed. This can be used as a calculation/discussion session that is very beneficial in helping the students understand the concepts of measurement significance and significant figures.

Pre-Lab Review Answers

1. No specific safety alerts are given.

2. No specific disposal directions are given.

3. The 6.

4. 2.46 g has 3 sig. figures, 10.00 mL has 4, and 0.0109 cm has 3.

5. 1.0569 g has a represented uncertainty of + or - 0.0001 g.
   7.56 mL has a represented uncertainty of + or - 0.01 mL.
   1.815 cm has a represented uncertainty of + or - 0.001 cm.

6. 3.20 units.

7. 1.513 rounds to 1.51; 0.9866 rounds to 0.99; 0.0155 rounds to 0.016; 12.689 rounds to 13;

1.494 rounds to 1; 0.04020 rounds to 0.0402.

8. 0.521 x 2.1 = 1.0941, which rounds to 1.1 (2 sig. figs.).

   0.713 + 6.12 + 11.2 = 18.033, which rounds to 18.0 (one place to the right of the decimal).

   4.400/3.92 = 1.122449, which rounds to 1.12 (3 sig. figs.).

   5.472 - 4.001 + 0.0119 = 1.4829, which rounds to 1.483 (three places to the right of the decimal).

Answers to Experiment Questions

1. b: Ruler A value is estimated to 0.1 cm, which limits the calculated product to 2 sig. figs..

2. d: Lengths of sides are 10-13 cm. Ruler B measurements are estimated to 0.01 cm. Sum of values, when expressed to 0.01 cm gives 4 sig. figs..

3. c: The reading should be to one decimal place better than the smallest scale division.

4. b: Measuring device cannot be improved, and so limits the number of figures to right of decimal. A larger measured quantity increases the number of figures to the left of the decimal.

5. c: Ruler B measurements are estimated to 0.01 cm. Thus, by measuring exactly ten cm, the length is expressed as 10.00 cm which has four sig. figs.

Student Results

1. The average time required for our students to collect their data is 40 minutes. We often use some of the remaining lab time to go over the calculations.

2 Most students are able to collect the data properly. Some have problems with the calculations, usually because they don't understand the rules. This is especially true of the rules for adding and subtracting. Some also have problems with deciding when zeros are significant.

EXPERIMENT 2: THE USE OF CHEMICAL BALANCES

Instructor Tips

1. Remind students that they can begin with either of the balances. They don't have to do parts A and B in that order. This will help reduce waiting lines at the balances.

2. Remind students to record their unknown identification numbers on their experiment sheets.

3. Remind students to keep their unknowns for use in both parts A and B of the experiment.

4. Emphasize to students that they should not use any balances until they have been properly instructed.

5. Point out to students that example 2.1 in Part A, and example 2.2 in Part D are examples only, and should not be treated as experimental procedures.

Pre-Lab Review Answers

1. No specific safety alerts are given.

2. Part D, sodium chloride in sink.

3. Centigram: 2.62 g. Electronic (intermediate sens.): 2.621 g. Electronic (high sens.): 2.6211 g.

4. Average mass should be reported as 2.5368 g, using five significant figures to match the five in 10.147 g.

5. According to instructions given in the calculations and report section, the x value would be 4, and the y value (rounded to the nearest 0.1) would be 10.1.

6. In direct weighings, object is placed directly on balance and weighed. When weighing is done by difference, the object is weighed in a container. The container is weighed alone, and the mass of the object is obtained by subtracting the container mass from the mass of container-plus-object.

7. Weighing by difference is used when accurate masses are wanted, because the procedure eliminates errors in the balance such as an incorrect zero setting.

8. Accurate masses are usually recorded as data.

9. An approximate sample mass is determined by placing a container on the balance, and adjusting the weights to achieve balance. The weights are then adjusted to increase the mass

by the amount of sample wanted. Sample is then added until the balance just trips. Accurate masses are determined by the difference method described in question 4.

Answers to Experiment Questions

1. b: A centigram balance detects mass differences no smaller than 0.01 g, so accurate masses should be recorded to reflect that. No estimates should be made between the.01 marks.

2. c: Since direct weighings were done, either or both values could have balance errors included.

3. b: Since a balance reading represents ± .001 g, the two results of 28.774 g (direct) and 28.775 g (by difference) may be considered to be identical.

4. a: Weigh a group that is large enough to make the value to the left of the decimal 10 or greater. This increases the number of sig. figs in the total mass to five. When this is divided by a counting number to get the average, five sig. figs would be justified in the average mass.

5. This response will vary depending on the individual student results. The explanation will simply be a reference to the collected data.

6. b: After weighing the container, the mass reading is increased by an amount equal to the desired sample size. 0.71 g + 0.50 g = 1.21 g.

Student Results

1. The time required for our students to collect their data ranges from 1 hr, 30 minutes to 2 hr, 10 minutes. This time is influenced by the number of students in the lab and the number of balances made available. We often use surplus lab time to discuss the calculations.

2. Unknown masses: If the stockroom has done a good job of weighing the masses, the students usually get values done by difference that are correct to within ± 0.02 g(centigram balance) and ± 0.002 g (or 0.0002 g) for electronic balances.