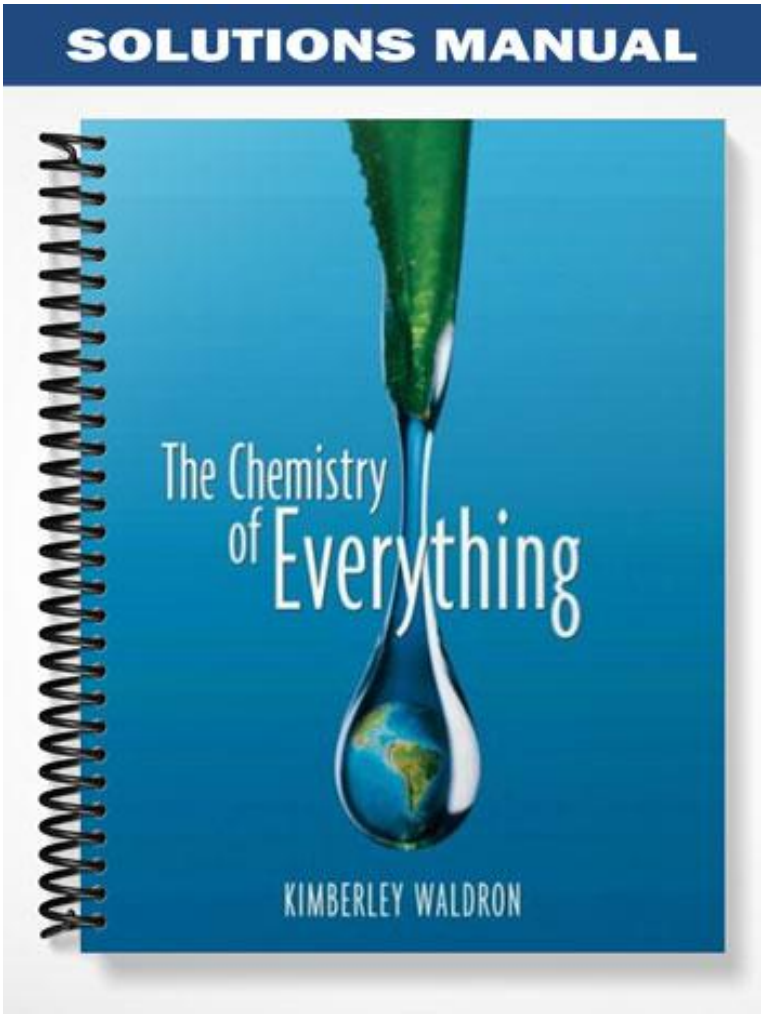
SOLUTIONS MANUAL



Instructor's Guide

for the lab manual

by Lawrence McGahey

to accompany Kim Waldron's text,

The Chemistry of Everything

Table of Contents

1 Safety First

Objective
To focus students' attention on laboratory safety

Equipment and Supplies Needed for 1 Student *or* 1 Group of Partners
None

Chemicals Needed for 10 Students or 10 Groups of Partners
None

Comments on the Exercise
This exercise is used at the first lab session to accompany orientation to lab procedures, locker check-in, or to accompany a brief first lab.
The exercise was developed to encourage students to pay more attention to safety issues by participating in a written exercise and discussion rather than simply listening to a lecture. As a rule, we do not collect or grade the exercise—students retain the materials in the lab manual for reference. However, it is a good plan to require students to secure the lab instructor's signature on the exercise before leaving class.

Answers to Pre-Lab Questions
Offer a brief rationale or explanation for each of the basic safety rules.

Rule 1: Familiarize yourself with the lab procedure *before* coming to class.
Answer: The lab work will go quicker and with less chance of mishap because you will know when it is important to be exact and cautious or not.

Rule 2: Wear long pants, shoes with socks, and a lab apron or coat.
Answer: These techniques reduce the chance of direct skin contact with chemical spills.

Rule 3: Wear eye protection when you or those near you are working with chemicals, glassware, or equipment. Goggles or safety glasses should have a shield that blocks materials from entering the eyes at the side of your head.
Answer: Proper eye protection reduces the potential of injury from splashed chemicals, shards of flying glass when a vessel is dropped, or absent-minded insertion of fingers in eyes. Standard glasses do not protect the eyes from objects approaching the eyes from the side of the head, nor do they retard accidental insertion of fingers in the eyes.

Rule 4: Keep your fingers out of your eyes, ears, nose, and mouth when you are working with chemicals. Wash your hands frequently. If the chemicals used are caustic or prone to causing stains, wear gloves.
Answer: The intent is to minimize skin contact with chemicals and reduce the chance of accidental ingestion or absorption.

Rule 5: Do not eat or drink in the lab, and be sure to wash your hands after leaving lab before eating.
Answer: Again, this is to reduce the likelihood of ingesting a toxic material.

Rule 6: Learn the location of emergency exits and safety equipment such as the eye-wash fountain, safety shower, and fire extinguishers. Know how to use the equipment before an emergency occurs.

Answer: In an emergency, a person is more likely to be able to carry out a task with less conscious effort if s/he has performed it previously.

Rule 7: Perform only approved and supervised experiments.

Answer: Even "simple" experiments may have unanticipated, dangerous outcomes.

Rule 8: Replace broken or cracked glassware. Do not heat cracked glass.

Answer: Broken, cracked, and chipped glassware can slice through skin. Cracked glass vessels may shatter when heated.

Rule 9: Use a suction bulb to draw liquids up into a pipette. Do not draw liquids into tubes by mouth suction.

Answer: These practices prevent accidental ingestion of chemicals.

Rule 10: Keep flames (matches, lighters, burners, and alcohol lamps) away from open containers of flammable materials.

Answer: This reduces the chance of igniting a fire. Vapors also can creep over the edge of a container and onto a bench. A "flash-back" may occur when a heavier-than-air vapor trail is ignited.

Rule 11: Use highly volatile or smelly substances in a fume hood.

Answer: This practice reduces the spread of flammable vapors into the lab and decreases irritation of your mucous membranes (and complaints from coworkers).

Rule 12: Label containers of chemicals while you work so the contents can be identified quickly.

Answer: This simple procedure helps prevent mixing the wrong chemicals or accidentally discarding a product. The practice also makes proper disposal easier in case the container is accidentally left unattended after class.

Rule 13: If you spill a chemical, immediately ask the instructor for assistance in cleaning it up properly.

Answer: The same clean-up procedures cannot be used for all substances; in some cases, protective equipment must be worn. An immediate clean-up reduces the chances of exposing yourself and others to potentially harmful materials.

Rule 14: Dispose of chemical waste in the designated containers provided by the instructor.

Answer: Reactive materials must be kept separated, waste disposal costs often depend on the level of hazard the waste represents, and legal sanctions may be imposed for improper disposal. Environmental stewardship is everyone's responsibility.

Rule 15: Do not remove chemicals from the laboratory.

Answer: Even "harmless" chemicals may cause injury if misused. Being in the possession of a chemical may place you under suspicion of being a drug dealer or terrorist.

Rule 16: Be alert to what others around you are doing – anticipate unsafe combinations of activities.

Answer: You may need to take evasive action if those around you are not acting safely.

3 A Penny for Your Hypothesis

Companion Sections in Waldron: Chapters 1.5 and 1.6

Objectives

a) to introduce students to proper use of balances
b) to demonstrate application of the scientific method to a problem

Equipment and Supplies Needed for 1 Student or 1 Group of Partners

1 balance, preferably top-loading reading to 0.001 g
15-20 U.S. pennies from minted in 1970 or later
Weighing paper or plastic weighing boat
Optional: forceps to handle coins

Chemicals Needed for 10 Students or 10 Groups of Partners

none

Comments on the Exercise

This exercise is a variation on a well-known experiment (see Robert F. Mauldin in *Journal of Chemical Education* , Vol. 74, pages 952-955, August 1997) to introduce students to the scientific method. As presented here, students are asked to make some preliminary hypotheses about pennies based on their prior experience handling them. The mass of pennies of different mint date are then determined and recorded. The exercise leads students to test the earlier hypotheses and generate further ideas for experimentation.

Another useful reference is the U.S. Mint website at
http://www.usmint.gov/about_the_mint/fun_facts/index.cfm?flash=yes&action=fun_facts2
(accessed 24 August 2006).

Answers to Pre-Lab Questions

Pre-Lab Exercise B

Scientists sometimes formulate hypotheses *before* making formal observations by considering what is already known about the subject they plan to study. Clearly, you already have knowledge of U.S. coins, and some additional information has been provided in the reading above. Based on the information and experience you already have, list several hypotheses that you can form about the mass of pennies that might relate to the year they were minted, where they were minted, their age, and so on. It should be possible to refute or prove the hypothesis wrong on the basis of the year and weight data you will collect in lab.

Some possible hypotheses include:
H1: All pennies have the same mass.
H2: Only pennies made in the same year at the same mint have the same mass.
H3: Older pennies weigh less than newer pennies (because use wears away some copper).
H4: Older pennies weigh more than newer, shiny coins (because the patina or dirt adds mass).
H5: All pennies minted in the same year have the same mass.
H6: The observed weight of older pennies varies more than newer pennies.