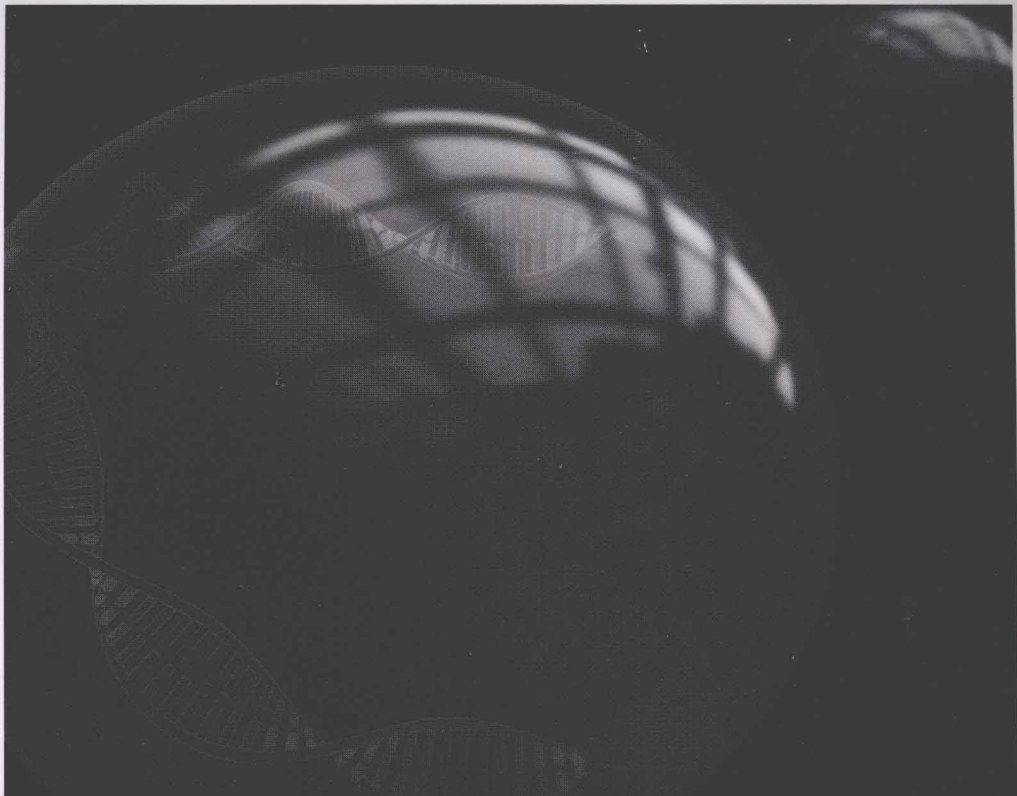
Lab Manual for



tenth edition

Richard Saferstein

criminalistics

An Introduction to Forensic Science

Meloan • James
Brettell • Saferstein

Lab Manual for Criminalistics

An Introduction to **Forensic Science**

Tenth Edition

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Prentice Hall

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10 9 8 7 6 5 4 3

Prentice Hall
is an imprint of

PEARSON

www.pearsonhighered.com

ISBN-10: 0-13-509944-7
ISBN-13: 978-0-13-509944-5

Preface

NEW TO THIS EDITION

- A glossary has been placed in Appendix 1 to provide students with a quick reference for definition of terms.
- The Metric System experiment has been placed in Appendix 2 for students who need to familiarize themselves with these units and also for instructors who would like to include this experiment in their syllabus.
- A new experiment utilizing microcrystalline testing of drugs has been added to the Manual (Experiment 18).

PREFACE TO THE FIRST EDITION

When lawyers present their cases before the courts, they often engage in debate. Another word for debate, when applied to the judicial process, is forensics (L. *forensis*, market or forum). Over the years, the increasing application of scientific principles to difficult court cases has given rise to the general field of *forensic science*, or science as applied to law. Forensic science includes all areas of scientific endeavor, such as medicine, psychiatry, psychology, geology, physics, chemistry, and biology. The particular area of forensic science that describes the services normally provided by crime laboratories is known as *criminalistics*.

The one statement that perhaps most clearly epitomizes the pursuits of the criminalist is that made by Edmund Locard, who said, "Every contact leaves a trace." Many years ago such a statement was merely a dream, but modern technology now permits many contacts to be detected, and the future holds the promise of more to come. Even Locard would be amazed by the fact that it is now possible to take fingerprints from the throat of a strangled person, determine a smoker's blood type from the remains of a cigarette butt, and, through the use of holography, to measure the size of an invisible shoeprint left on a carpet. Certainly every contact leaves a trace; it is up to us to detect it. The following experiments show how a number of contacts are detected. We hope that students will find them interesting and gain a better appreciation of what a criminalist does, and that the experiments might also capture students' imaginations so that in the future they may well discover how to detect a new contact.

It must be clearly understood that this set of experiments is intended as an introduction to the analyses performed in a forensic laboratory. They are an attempt to acquaint nonscience students with the investigation of physical evidence through the use of scientific procedures. They are written at an introductory level, using terms that can be understood by nonscience students. The experiments are actual procedures, modified to fit the background of students.

Advanced-level experiments are also included for science-oriented students. These experiments are designed to familiarize these students with basic criminalistic techniques, such as the application of electrophoresis, the typing of bloodstains, and the determination of the index of the refraction of glass specimens using of the Becke line technique.

The specific objectives of this set of laboratory experiments are as follows:

1. To provide a first set of laboratory experiments for criminal justice and general science students who have had little or no previous science laboratory experience.
2. To show beginning students in criminal justice and general science the significance of physical evidence at the scene of a crime.
3. To demonstrate what happens to physical evidence when it is sent to the laboratory so that students will know what is needed, how much is needed, and how to prepare it.
4. To educate students in basic laboratory practices so that they can ask and/or answer questions more intelligently in a court of law.
5. And probably most important, to educate students so that they will not unintentionally destroy physical evidence at a crime scene, and will in fact try to preserve it for the trained forensic scientist.

We emphasize that these experiments, while being actual laboratory analyses, are designed to provide students with an overview of what can be done, not to make them polished forensic scientists.

The views expressed in this manual are those of the authors.

PREFACE TO THIS EDITION

A few changes have been made for this edition. A glossary has been placed in Appendix 1 to provide students with a quick reference for definition of terms. The Metric System Experiment has been placed in Appendix 2 for students who need to familiarize themselves with these units and also for instructors who would like to include this experiment in their syllabus. The Density of Glass Fragments experiment has been deleted, as have the KromeKote Paper section in Experiment 9 and the Breathalyzer section in Experiment 23. A new Experiment 18 on microcrystalline testing of drugs has been added.

A student once made the following comment: "I have learned a lot in this class, but since I'm not going to be a police officer, I have no idea how I might use it." The answer was, "In your lifetime you might be the first person at the scene of a crime. Now that you know what constitutes physical evidence and how important it is to obtain it in its original state, you can keep the crowd of onlookers away from it until the police arrive. This can be an invaluable service."

We continue to include selected references from the literature but have eliminated most of the old references prior to 1995. Every now and then a student wants to know more, and the teachers need to know more to make their lectures and discussions more accurate. We limit our suggestions to selections from two main forensic journals most likely to be in libraries: the *Journal of Forensic Science* (American), and *Science and Justice* (British, until 1995 titled *Journal of the Forensic Science Society*) The web page address for the *Journal of Forensic Science* is **http://www.aafs.org**.

Instructors should remember that is an introductory course; therefore, the students taking it have had very little science background.

Acknowledgments

We wish to thank the following people and organizations for providing technical information for the writing of these laboratory experiments for this and the previous editions:

- Mr. James Rhodes, Supervisor of the Laboratory of the Minnesota Bureau of Criminal Apprehension
- Mr. Leslie Loch, Crime Investigator based in St. Cloud, Minnesota
- Captain Richard Witschen, St. Cloud Police Department, St. Cloud, Minnesota
- Corporal Mike Lofgren, Minnesota Highway Patrol, expert on automobile lamp glass fragmentation and speed determination
- Mr. Ronald Jones and Mr. Robert Olsen, the Kansas Bureau of Investigation Criminalistics Laboratory at Topeka, Kansas
- Lt. Patrick B. Glynn, Wichita, Kansas Criminalistics Laboratory
- Lt. Al Riniker, Riley Co. Kansas Police Department
- Chief Kenneth Dickinson, Waite Park Police Department, Waite Park, Minnesota
- Dr. Jeffrey Payne, 3M Co., Minneapolis, Minnesota
- Laura Anne Roselli, Biotechnology Department, Burlington County College, Mt. Laurel, New Jersey
- Miss Nikki James, for the final exams
- Annina Carter, Adirondack Community College, for reviewing the manual

The *Journal of Forensic Science and Science and Justice* were consulted at great length to determine updated criminalistics procedures, particularly those at a level that could be understood by nonscience majors.

Clifton Meloan
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Contents

EXPERIMENT

1

Practice in Making Laboratory Measurements

This is an introductory laboratory exercise intended to prepare you for Experiment 2, which deals with the analysis of glass fragments. You will become more familiar with measurements using the metric system and learn to use a laboratory balance. In this exercise you will determine the density of several objects by various methods. Do the parts of this exercise slowly and carefully so that you fully understand what is required and what the results indicate.

Density is a physical property of matter that is specific to the sample being measured and which may be used as a means of identification or comparison, whichever is required. The equation for density is:

$$\text{Density} = \frac{\text{Mass of Object}}{\text{Volume of Object}} \text{ expressed as either } \frac{g}{cm^3} \text{ or } \frac{lb}{ft^3} \qquad (1\text{-}1)$$

The utility of this type of determination may be made clearer to you by the following example. Suppose that a man has a body volume of 3 cubic feet and weighs 198 lb. What is his density? The calculation would be done by application of equation 1-1.

$$\text{Density} = \frac{\text{Weight}}{\text{Volume}}$$

$$= \frac{198\text{lb}}{3\text{ft}^3} = 66\text{lb/ft}^3$$

Water weighs 62.4 lb/ft^3. Therefore, if the man jumps into a lake or swimming pool, he will sink unless he knows how to swim or to keep himself afloat by holding air in his lungs. In other words, an object placed in a fluid sinks if its density is greater than that of the surrounding fluid and floats if its density is less than that of the surrounding fluid.

THE TRIPLE-BEAM BALANCE

The triple-beam balance is the least sensitive balance commonly found in the chemistry laboratory. Figure 1–1 shows one such type of balance. It consists of a single pan on the left side of the beam. The right side of the beam is divided into three arms, each of which holds a rider. The two arms containing the larger riders are notched. With the pan empty, the point should come to rest at the midpoint of the scale at the extreme right. The object to be weighed is placed on the pan. The heaviest rider (10g in this case) is moved to successive notches until the pointer drops to the bottom of scale. The rider is then moved back one notch. The same procedure is then followed for the 1.0-g rider. The 0.01-g rider is carefully moved along the arm until the pointer is midway on the scale. The weight of the object is then the total of the values on each of the arms.

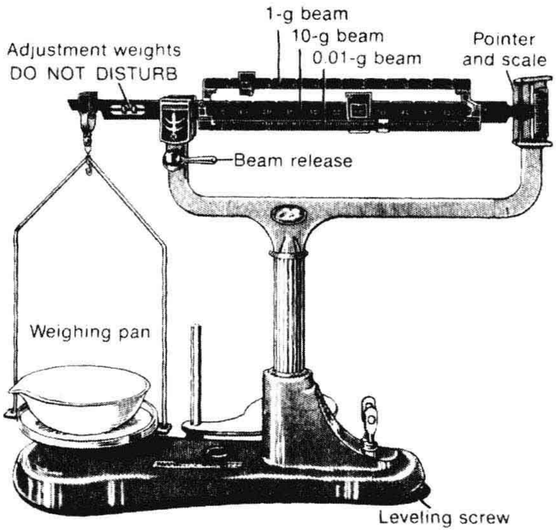

FIGURE 1–1 A triple-beam balance.

EQUIPMENT

1 Balance, triple beam (capable of an accuracy to ±0.01 g, with a support arm for immersion measurements)
1 Beaker, 250 mL
Cylindrical solids (wooden rods)
1 pr Goggles, safety
1 Graduated cylinder (1000 mL is best)
Irregular metal objects
1 Meter stick or metric ruler
Rectangular metal solids
1 pr Scissors
String, 60–90 cm long

METHOD

PART A: DENSITY OF RECTANGULAR SOLIDS

In this part of the exercise you will determine the density of an object by applying the relationship

$$\text{Density} = \frac{\text{Mass of Object (g)}}{\text{Volume of Object (cm}^3\text{)}}$$

See Table 1–1 for the densities of various common materials.

1. Obtain a rectangular solid from the sample supply.
2. Measure the three dimensions of the object with a ruler, using the centimeter as the unit of measurement, and record the values on the data sheet.
3. Determine the volume by applying the formula

   $$V = \text{length} \times \text{width} \times \text{height} \qquad (1\text{-}2)$$

   The volume will then be derived in units of cubic centimeters.
4. Determine the mass of the object by use of the laboratory balance.
5. Measure the mass of the object to the nearest 0.01 g, and record the mass on the data sheet for this exercise.
6. Determine the density of the object by applying the formula given at the beginning of this section, and record the value on the data sheet.

TABLE 1–1 Densities of Various Common Materials (g/cm^3)

Material	Density	Material	Density
Cork	0.22–0.26	Glass, flint	2.9–5.9
Bone	1.7–2.0	Iron	7.86
Glass, window	2.47–2.56	Brass, yellow	8.44–8.70
Flint	2.63	Lead	11.34
Aluminum	2.70	Gold	19.3

PART B: DENSITIES OF CYLINDRICAL SOLIDS

1. Obtain a cylindrical solid from the sample supply, measure its mass in the same manner as done previously, and record the value. Since this object is not of the same shape as the rectangular solid, you will have to determine its volume using a different mathematical relationship. The formula to be used in this case is

$$\text{Volume} = \pi r^2 h \qquad (1\text{-}3)$$

where $\pi = 3.14$
r = radius
h = height or length of the object

The height and radius of a cylinder are shown in Figure 1–2.

2. Measure the diameter in cm, and divide by 2 to obtain the radius.
3. Measure the height or length of the object in centimeters.
4. Record these values, and determine the volume of the object.
5. Enter this value on the data sheet.
6. Determine the value for the density of the object using the relationship

$$D = \frac{M}{V}$$

and record this value.

PART C: DENSITIES OF IRREGULARLY SHAPED SOLIDS

1. Obtain an irregularly shaped solid from the sample supply. Since it would be very difficult to obtain the volume of this object by measurement, we will approach this determination in a different manner.
2. Measure the mass of the object by using the balance as you did in Part A.

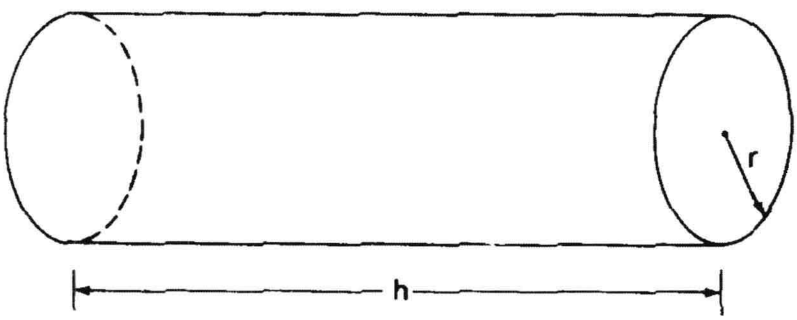

FIGURE 1–2 Diagram of a cylinder showing the measurements needed.

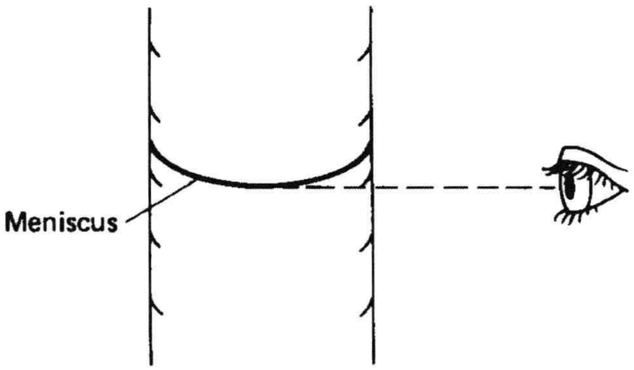

FIGURE 1–3 Illustrating a meniscus and proper eye level.

3. Obtain a graduated cylinder from the equipment supply and fill it with water to one of the graduations. The volume of water is read by noting the position of the bottom of the curve (meniscus) of the liquid level, as shown in Figure 1–3.
4. Record this value.
5. Tie a piece of string around the object. Gently lower the irregular object into the graduated cylinder so that it is entirely immersed (submerged) below the water level. Note that the water level has risen in the graduated cylinder. (This method would not be used for an object that would absorb water or dissolve in it.)
6. Read the level of the meniscus and record it.
7. Subtract the first value from the second value for the water level, and you have the volume of the object by a method known as **water displacement**. Record this value also.

   You may now find the density of the object by applying the following reasoning. The volume of the object has been indirectly determined and is expressed in milliliters of water, its equivalent volume. A relationship exists in the metric system between units of volume of liquids and units of volume of solids. This relationship is

   $$1 \text{ mL} = 1 \text{ cm}^3 \qquad (1\text{-}4)$$

   Thus, all that is necessary to express the volume in cubic centimeters is the volume in milliliters.
8. Determine the density by applying the equation in step B-6. Record this value.
9. Repeat the steps in Part C using the rectangular or cylindrical solid sample, and record the values for the mass, volume, and density of this object.

PART D: CLEANUP, CALCULATIONS, AND QUESTIONS

Dry all glassware, return all materials to the place from which you obtained them, and clean up your work area. Complete the data sheet, answer the questions, and hand your completed papers to your laboratory instructor.

EXPERIMENT 1 **Name** ____________________________

DATA SHEET **Date** ____________________________

PRACTICE IN MAKING LABORATORY MEASUREMENTS

Part A: Density of Rectangular Solids

Calculations:

Mass

Volume

Density

Part B: Density of Cylindrical Solids

Calculations:

Mass

Volume

Density

Part C: Density of Irregularly Shaped Solids

1. Irregular solid

Calculations:

Mass

Volume of water with solid immersed

Volume of water initially

Volume of solid

Density

2. Rectangular or cylindrical solid

Calculations:

Mass

Volume of water with solid immersed

Volume of water initially

Volume of solid

Density

Questions

1. Compare the density of a single solid object by various methods. Which methods do you think give the most accurate values? Why?

2 Could you have used the method in Part C for determining the volume of any wooden solid object? What would you have to change in the apparatus to permit the value for the volume to be more accurately obtained?

EXPERIMENT 2

Density of Glass by Flotation and Density Gradient Columns

The objective of glass comparison is to associate one glass fragment with another while minimizing or eliminating the possible existence of other sources. Glass will have its greatest evidential value when it can be individualized to one source. Such a determination, however, can only be made when the suspect and crime-scene fragments are assembled and physically pieced together (a physical match). The possibility that two pieces of glass originating from different sources will fit exactly together is so unlikely as to exclude all other sources from practical consideration. If this effort fails, the forensic examiner will compare the glasses to determine whether they do or do not have the same densities and refractive indices. This experiment will allow you to become familiar with laboratory techniques employed for comparing the densities of glass. The purpose of such an analysis is to establish the possibility or impossibility of any glass fragments having a common origin.

The simplest comparative-density technique is known as **flotation** (not floatation). It is based on the observation that a solid particle will float in a liquid medium of greater density, sink in a liquid of lower density, or remain suspended in a liquid of equal density. A second comparative-density technique is the **density gradient** method. A standard density gradient tube is made up of layers of two liquids mixed in varying proportions so that each layer has a different density value. When completed, a density gradient tube will usually have 6 to 10 original layers, in which the bottom layer has the heaviest density and the top layer the lightest density. After standing for 24 hours these layers will diffuse into one continuous gradient. A solid particle added to the tube will sink until its density is the same as the surrounding liquid and then remain suspended at that level. Furthermore, if absolute density values are desired, the gradient tube can be calibrated by adding to it solids of known densities. Densities for glass and similar materials are listed in Table 2–1.

CRIME SCENE

During a mugging, the attacker drops his glasses and one lens breaks. He picks up the pieces and flees. The victim, however, observes this incident and when the police officer arrives, describes it to him. The officer, upon careful searching, finds a few very small pieces of glass. These have been given to you. Once the suspect is apprehended, you try to match the glass fragments.