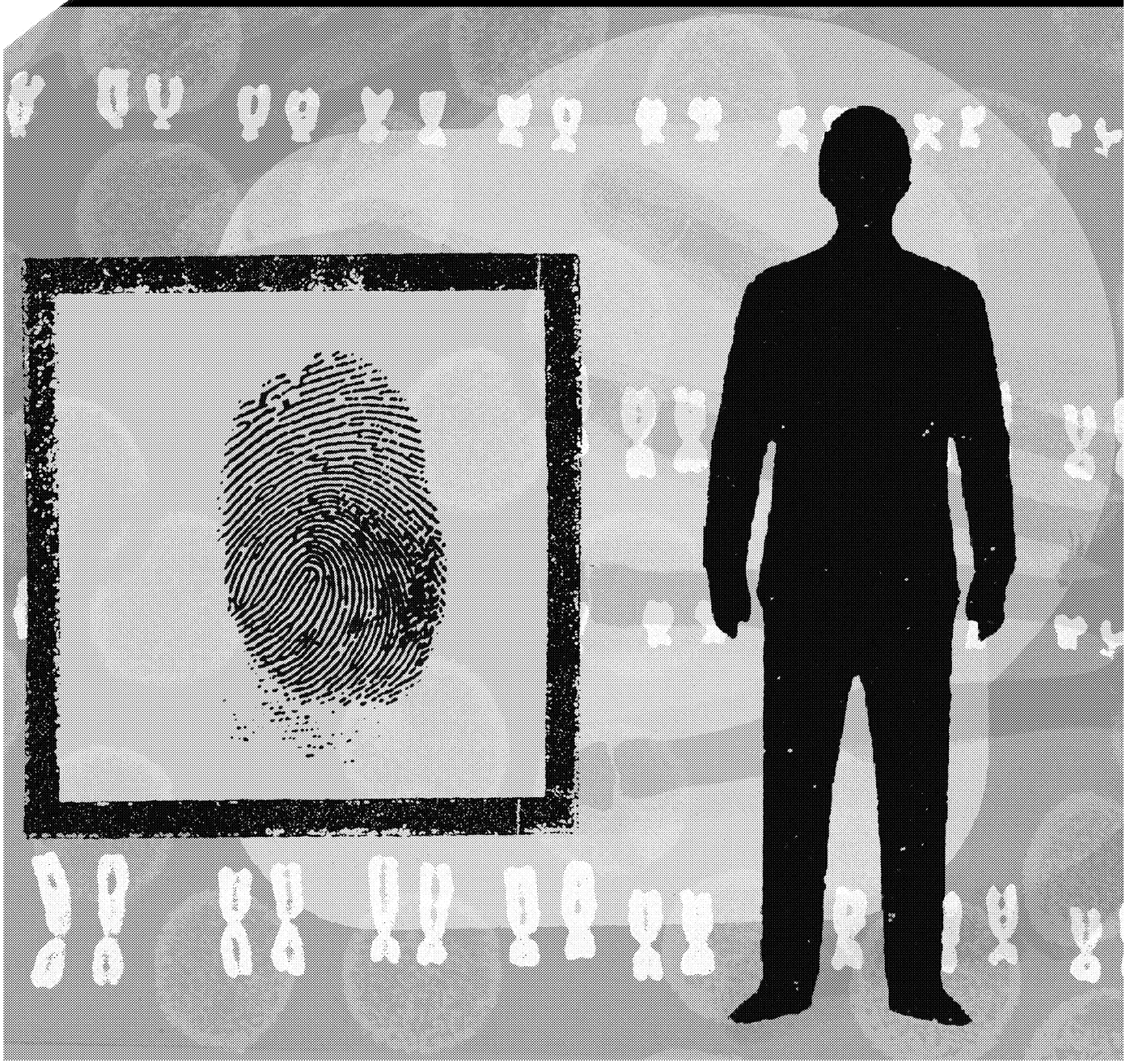
J. WESTON
WALCH
PUBLISHER
Portland, Maine

topSHELF
FORENSICS



Barbara Deslich
John Funkhouser

Contents

PREFACE

Introduction . . . . . *vi*

National Science Standards for High School . . . . . *vii*

Safety and Ethical Issues . . . . . *viii*

Parent/Teacher/Student Guide . . . . . *ix*

FORENSICS BACKGROUND

What Is Forensic Science? 1

The Legal System 2

TYPES OF EVIDENCE

Evidence 4

Forensic Activity: Robbery 11

Probability and Statistics 12

HAIR EVIDENCE

Hair as Forensic Evidence 15

The Morphology of Human Hair 17

Student Lab: Microscopic Examination of Human Hair 19

Student Lab: Comparison of Animal and Human Hair 25

Forensic Activity: Dognapping 27

FIBER EVIDENCE

Fibers as Forensic Evidence 31

Student Lab: Microscopic Examination of Fibers 33

Polymers 36

Student Lab: Burning Tests 37

Student Lab: Thermal Decomposition 39

Student Lab: Chemical Tests 41

Density and Refractive Index of Fibers 43

Student Lab: Examination of Fiber Cross Sections 45

Student Lab: Observing Fluorescence in Fibers 47

Student Lab: Dyeing Different Fabrics 48

Student Lab: Chromatography of Dyes 50
Forensic Activity: Attempted Abduction 53

BLOOD EVIDENCE

Blood as Forensic Evidence 56
Student Lab: Detection of Blood 60
Student Lab: Testing Human or Animal Blood 62
Forensic Activity: Assault 63
Blood Spatter Analysis 67
Student Lab: Blood Pattern Analysis 68

GLASS EVIDENCE

Glass as Forensic Evidence 69
Student Lab: Examination of Glass Pieces 71
Student Lab: Measuring the Density of a Glass Fragment 73
Refractive Index 75
Student Lab: Determining Refractive Index 76
Student Lab: Refractive Index of Glass Fragments 78
Forensic Activity: Burglary 80
Fracture Patterns 83
Student Lab: Analysis of Glass Fracture Patterns 86

SOIL EVIDENCE

Soil as Forensic Evidence 87
Student Lab: Examination of Soil 89
Student Lab: Physical Properties of Soil 90
Student Lab: Texture of Soil 92
Student Lab: Density Profile 93
Student Lab: Chemical Properties of Soil 94
Forensic Activity: Theft 96

APPENDIX I

Teaching Notes and Answer Key 99
Rubrics: Assessing Laboratory Reports 121
Rubrics: Assessing Crime Reports 122
Rubrics: Assessing Essays 123

APPENDIX II

Resources 124

Scientific Supply Companies 128

APPENDIX III

Time Line of Forensic Science 129

APPENDIX IV

Overheads, Labels, and Forms 131

Sine Table 135

GLOSSARY 137

INDEX 141

Introduction

The unprecedented interest in forensic science among students and teachers shows that it can be employed as an effective mechanism for teaching science to today's students. The advantages of this approach are:

- Forensic science is multidisciplinary. It embodies concepts in many areas, including chemistry, zoology, anatomy, genetics, physics, medicine, math and statistics, sociology, psychology, communications, and law. There is a great emphasis today on the wisdom of teaching science in a multidisciplinary fashion, and forensic science is among the best examples of this.
- Forensic science is a tool that uses the methods of science to help solve crimes by determining who committed them and how. It is also used to help with noncriminal activities, such as structural failures and mass disasters.
- Forensic science appeals to the detective in people. It can be fun to learn and use.

This text offers program materials for an introductory course in forensic science. Its primary focus is on the practice of forensic science and the analysis of physical evidence found at crime scenes. The fundamental objective is to teach the basic processes and principles of scientific thinking to enable them to be applied to problem solving in science and across all disciplines.

The Scientific Method

1. observation
2. inductive reasoning
3. hypothesis
4. deductive reasoning
5. theory

Forensic science presents itself as a natural vehicle for students to practice science as inquiry. For every piece of physical evidence brought in for analysis, the student must apply the scientific method. The five steps of the scientific method are observation; collection and classification of data and looking for relationships; forming a hypothesis; testing the hypothesis; and developing a conclusion or opinion. Students must then be prepared to defend their conclusions based on their own empirical evidence.

The ultimate goal of this book is for students to gain confidence in their ability to make sense of complex problems that involve numerical data, evidence, logical reasoning, and uncertainty.

Safety and Ethical Issues

The *Top Shelf Science* series contains several laboratory experiments. Special care must be taken to ensure student safety when these experiments are performed. Experiments involving living organisms should be done carefully, and the health of the living specimen should be kept in mind. Here are some guidelines for general safety issues in a laboratory setting:

- Wear proper safety equipment at all times. This includes an apron, a smock, or a lab coat; safety goggles; and gloves. Do not wear open-toed shoes, such as sandals, during lab experiments.
- Do not eat or drink anything in the lab.
- Be sure to turn off heat sources when not in use.
- Perform any chemical experiments involving gas emissions within a chemical fume hood or in a well-ventilated room.
- Before disposing of chemical ingredients, be certain that they are neutralized; then dispose of them in proper containers.
- Establish a location for the disposal of sharp objects, such as broken glass or nails.
- Use extreme caution when heating solutions.
- Animals, plants, and other life forms deserve respect. Treat living specimens with care and, when possible, release them or replant them outdoors.
- Use care when using electrical appliances of any sort. Know how to recognize a short circuit or a blown fuse.
- Keep fire extinguishers on hand and properly charged, and know how to use them. Be sure that you have an ABC-rated extinguisher, as well as a Halon™ extinguisher for electrical fires.
- Follow all local, state, and federal safety procedures.
- Have evacuation plans clearly posted, planned, and actually tested.
- Label all containers and use original containers. Dispose of chemicals that are outdated.
- Be especially aware of the need to dispose of hazardous materials safely. Some chemistry experiments create by-products that are harmful to the environment.
- Take appropriate precautions when working with electricity. Make sure hands are dry and clean, and never touch live wires, even if connected only to a battery. Never test a battery by mouth.
- When using lasers, never look directly into the beam, and make sure students are conversant with the dangers of laser light.

Safety precautions unique to a given laboratory will be provided within the lab write-up itself. These safety precautions are provided as a guide only. They may be incomplete. Use common sense when working with any chemicals, electricity, or living organisms.

Parent/Teacher/Student Guide

Dear Parents, Teachers, and Students,

Thank you for choosing the *Top Shelf Science* series to help you better understand some of the difficult ideas in high-school science. We are confident that our books will help students who have a greater knowledge of the subject matter being studied; they can also be used to provide a lab-based program for students learning at home.

Each volume of the *Top Shelf Science* series is designed for a particular course of study. Within each volume, concepts build sequentially, and it is recommended that students begin with the first section and move forward.

Each book has sections that are thematically designed. The laboratory exercises associated with each section are specific to a deeper understanding of the overlying concept. In Appendix I, you will find a list of materials that are necessary to conduct each lab and Forensic Activity. Occasionally the list of materials appears with the lab or activity. A list of science equipment dealers is also provided.

In Appendix I, you will also find answers to the activities in each unit, as well as a suggested grading rubric for essays and lab reports. Share these rubrics with students so that they can correct areas that need to be corrected before the next assignment. In keeping with the national science standards, we have also included a time line of the history of each discipline. Each volume also contains an index and a glossary.

Whether you are using our product as the basis for a home school experience, a new and fresh way of supporting textbook material, or as preparation for a college placement test, we are confident that *Top Shelf Science* can meet your needs.

Thank you!

The authors and editors of *Top Shelf Science*

BACKGROUND

What Is Forensic Science?

Forensic science is the study and application of science to legal matters. "Forensic" is derived from the Latin *forensis,* meaning a public forum where, in Roman times, senators and others debated and held judicial proceedings. Forensic science and **criminalistics** can be used interchangeably and cover a multitude of disciplines. The first seven subjects in the list below are those most commonly applied in crime laboratories.

"Forensic" is derived from the Latin *forensis,* meaning a public forum where, in Roman times, senators and others debated and held judicial proceedings.

chemistry	anthropology
biology	psychiatry
firearms	**odontology**
document examination	engineering
photography	computer technology
toxicology and drug analysis	geology
fingerprints	environmental science
polygraphy	**entomology**
pathology	physics

A forensic scientist primarily studies the different types of evidence recovered from a crime scene. The forensic scientist must be prepared to testify as an expert witness at a trial or hearing. As such, he or she presents data, evaluates evidence, and renders an impartial opinion to the court. A forensic scientist will also perform scientific research and train others in the area of forensic science.

BACKGROUND

Evidence

What Is Evidence?

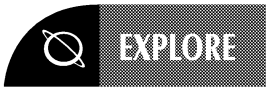
In law, evidence can be divided into two general types: direct evidence and physical evidence

In the law, evidence can be divided into two general types: direct and physical. **Direct evidence** is evidence in the form of a statement made under oath, such as a witness pointing to a person in court saying, "That's the guy who robbed the grocery store." This is also known as **testimonial evidence. Physical evidence** is any object or material that is relevant in a crime. It can be most any tangible thing, as large as an EP-3E spy plane, as small as a hair, as fleeting as an odor, or as obvious as a demolished federal building.

Edmond Locard (1877–1966), a French forensic scientist, espoused that there was always an exchange or transfer of material when two objects came into contact. The methods of detection may not be sufficiently sensitive, timely, or technologically advanced to ascertain its impact; nevertheless, a transfer takes place. This tenet is known as **Locard's principle.**

TABLE 1 Types of Common Physical Evidence

drugs and toxic substances	fibers
paints	soil, glass
gunshot residues	blood
firearms and ammunition	body fluids
impressions (shoe prints, bite marks, etc.)	fingerprints
petroleum products	hair
alcohols (especially ethanol)	tissues
rubber material	pollen
resins, plastics	wood material
explosives residues	feathers
serial numbers	bones
documents	



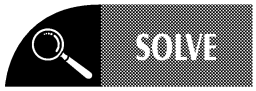
Exploration Activities

Characterizing Your Shoes

1. What are some class characteristics of the shoes you are wearing today? Note shoe type, color, size, brand, and style name (if known).

2. How can you individualize your shoes using characteristics that will link them to you and no one else—regardless of whether someone else has the same type, color, size, and brand? Look for identifying characteristics, such as scuff marks and wear patterns. Use a sketch if needed.

3. How would you visualize or record the tread of your shoes where individual wear patterns, cuts, and marks are most likely to be found?



Forensic Activity: Robbery

A large appliance store was robbed, but no forced entry was apparent. A tab from a beverage can was found by one of the outside doors, causing investigators to assume that it may have been used to wedge the door for later access. The next day, the driver of a vehicle was pulled over for a minor traffic violation. In the car was a number of empty soft-drink cans, all with their tabs removed.

1. Can the tab found at the crime scene be associated with the tabless empties in the suspect's car? How would you go about trying to individualize the tab to the can?

2. How strong a case can you, the forensic investigator, establish?

Student Lab: Examination of Soil

How Can Soil Be Useful as Forensic Evidence?

If all soil were the same, it would be like matching white cotton fibers to a common source. In this lab, we will see if all soil is the same.

Materials

- Wet soil sample
- Dry soil sample (dried overnight by your teacher)
- Notebook paper
- Stereomicroscope
- Petri dishes

Procedure

1. Dump the sample of wet soil on a clean sheet of white notebook paper. Note its features.
2. Rub a little of the soil into the paper with a wet finger. Note the color before and after it has dried. Place the sample back in the container.
3. Place a portion of your dried soil sample in a clear plastic or glass petri dish. Examine it under a stereomicroscope with transmitted as well as reflected light. Pay special attention to any synthetic artifacts as described in the FBI definition of soil. Observe any once-living organisms.
4. Compare the description of your soil sample, wet and dry, to the descriptions made by classmates.

Conclusions

1. Describe what you observed about the soil sample in step 1 of the Procedure section. Was it wet, damp, cohesive, rocky, smelly?
2. What did you observe about the soil in step 2?
3. Describe your observations of the dry soil sample in step 3. Were there any synthetic artifacts? Once-living organisms?
4. How did your descriptions of your soil samples compare to your classmates' descriptions? Were the soil samples different? How so?

Sine Table *(continued)*

Angle	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
45°	.7071	.7283	.8096	.7108	.7120	.7133	.7145	.7157	.7169	.7181
46	.7193	.7206	.7218	.7230	.7242	.7254	.7266	.7278	.7290	.7302
47	.7314	.7325	.7337	.7349	.7361	.7373	.7385	.7396	.7408	.7420
48	.7431	.7443	.7455	.7466	.7478	.7490	.7501	.7513	.7524	.7536
49	.7547	.7559	.7570	.7581	.7593	.7604	.7615	.7627	.7638	.7649
50°	.7660	.7672	.7683	.7694	.7705	.7716	.7727	.7738	.7749	.7760
51	.7771	.7782	.7793	.7804	.7815	.7826	.7837	.7848	.7859	.7869
52	.7880	.7891	.7902	.7912	.7921	.7934	.7944	.7955	.7965	.7976
53	.7986	.7997	.8007	.8018	.8028	.8039	.8059	.8059	.8070	.8080
54	.8090	.8100	.8111	.8121	.8131	.8141	.8151	.8161	.8171	.8181
55	.8192	.8202	.8211	.8221	.8231	.8241	.8251	.8261	.8371	.8281
56	.8290	.8300	.8310	.8320	.8329	.8339	.8348	.8358	.8368	.8377
57	.8387	.8396	.8406	.8415	.8425	.8434	.8443	.8453	.8462	.8471
58	.8480	.8490	.8499	.8508	.8517	.8526	.8536	.8545	.8554	.8563
59	.8572	.8581	.8590	.8599	.8607	.8616	.8625	.8634	.8643	.8652
60°	.8660	.8669	.8678	.8686	.8695	.8704	.8712	.8721	.8729	.8738
61	.8746	.8755	.8763	.8771	.8780	.8788	.8796	.8805	.8813	.8821
62	.8829	.8838	.8846	.8854	.8862	.8870	.8878	.8886	.8894	.8902
63	.8910	.8918	.8926	.8934	.8942	.8949	.8957	.8965	.8973	.8980
64	.8988	.8996	.9003	.9011	.9018	.9026	.9033	.9041	.9048	.9056
65	.9063	.9070	.9078	.9085	.9092	.9100	.9107	.9114	.9121	.9128
66	.9135	.9143	.9150	.9157	.9164	.9171	.9178	.9184	.9191	.9198
67	.9205	.9212	.9219	.9225	.9232	.9239	.9245	.9252	.9259	.9265
68	.9272	.9278	.9285	.9291	.9298	.9304	.9311	.9317	.9323	.9330
69	.9336	.9342	.9348	.9354	.9361	.9367	.9373	.9379	.9385	.9391
70°	.9397	.9403	.9409	.9415	.9421	.9426	.9432	.9438	.9444	.9449
71	.9455	.9461	.9466	.9472	.9478	.9483	.9489	.9494	.9500	.9505
72	.9511	.9516	.9521	.9527	.9532	.9537	.9542	.9548	.9553	.9558
73	.9563	.9568	.9573	.9578	.9583	.9588	.9593	.9598	.9603	.9608
74	.9613	.9617	.9622	.9627	.9632	.9636	.9641	.9646	.9650	.9655
75	.9659	.9664	.9668	.9673	.9677	.9681	.9686	.9690	.9694	.9699
76	.9703	.9707	.9711	.9715	.9720	.9724	.9728	.9732	.9736	.9740
77	.9744	.9748	.9751	.9755	.9759	.9763	.9767	.9770	.9774	.9778
78	.9781	.9785	.9789	.9792	.9796	.9799	.9803	.9806	.9810	.9813
79	.9816	.9820	.9821	.9826	.9829	.9833	.9836	.9839	.9842	.9845
80°	.9848	.9851	.9854	.9857	.9860	.9863	.9866	.9869	.9871	.9874
81	.9877	.9880	.9882	.9885	.9888	.9890	.9893	.9895	.9898	.9900
82	.9903	.9905	.9907	.9910	.9912	.9914	.9917	.9919	.9921	.9923
83	.9925	.9928	.9930	.9932	.9934	.9936	.9938	.9940	.9942	.9943
84	.9945	.9947	.9949	.9951	.9952	.9954	.9956	.9957	.9959	.9960
85	.9962	.9963	.9965	.9966	.9968	.9969	.9970	.9972	.9973	.9974
86	.9976	.9977	.9978	.9979	.9980	.9981	.9982	.9983	.9984	.9985
87	.9986	.9987	.9988	.9989	.9990	.9990	.9991	.9992	.9993	.9993
88	.9994	.9995	.9995	.9996	.9996	.9997	.9997	.9997	.9998	.9998
89	.9998	.9999	.9999	.9999	.9999	1.000	1.000	1.000	1.000	1.000

