Science Activity Book

Forensic Investigations:

Using Science to Solve Crimes

MIDDLE GRADES

Analysis Labs For:

Handwriting • Body Language • Fingerprints

DNA • Mammal Tracks • Soil pH

Chromatography • Forensic Dentistry

Patent, Plastic, and Latent Prints

State, National & Provincial CORRELATED Standards

SUPPORTS NSE STANDARDS

BY SCHYRLET CAMERON

Table of Contents

Introduction

Forensic Investigations: Using Science to Solve Crimes engages students in authentic science learning. Students explore the world of forensic science as they discover "whodunit" in each of the crime cases presented in this book. Students become crime scene investigators, examining clues, analyzing evidence, and interpreting data to identify the prime suspect.

Each "made-up" case is representative of a real-life middle-school situation. Student detectives gain an understanding of the difference between evidence and inference as they solve each case. There isn't one "correct" answer. This allows students to work like real forensic scientists: observing, experimenting, and discussing theories. The cases are purposefully designed to allow students to formulate different plausible solutions based on their interpretation of the evidence.

Forensic Investigations can be used to supplement current science curriculum, provide ideas for science fair projects, or energize your summer school program. Cases involve concepts and processes from different branches of science: inquiry science, earth science, life science, and physical science. The investigations in the book challenge students to actively combine science knowledge with reasoning and thinking skills. The activities provide students with many opportunities to practice the skills associated with the scientific method: observing, classifying, comparing, measuring, predicting, interpreting data, and drawing conclusions.

Each case contains the following sections:

- **Teacher Information** pages contain useful crime scene information, activities, and directions for the investigation. Suggested resources have been provided for further research or reference.
- A **Skill-Building Activity** introduces students to a specific skill that they will use to investigate the crime in each case.
- **Student Investigation** pages introduce the crime and guide students through the investigation and identification of the prime suspect.
- An **Analysis Lab** for each case provides students with the opportunity to apply the skills they have learned to analyze the evidence and come to a conclusion about "whodunit."

Forensic Investigations supports the No Child Left Behind Act. The investigations in this book promote student knowledge and understanding of science concepts. The inquiry-based activities are designed to strengthen scientific literacy skills and are correlated to the National Science Education Standards (NSES).
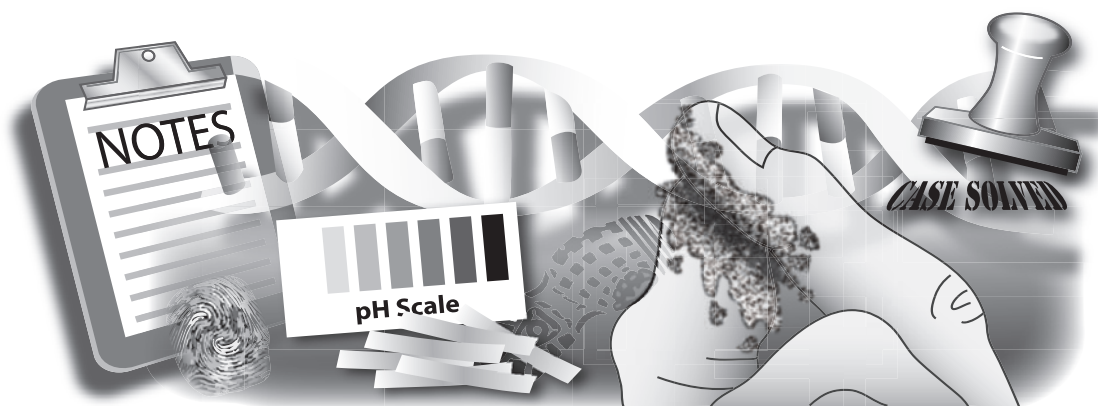
Using Science to Solve Crimes

Steps in Crime Investigation

A crime is like a giant jigsaw puzzle waiting to be solved. The police use science to put the pieces together to form a picture of what occurred at a crime scene. Many people are involved in gathering clues and searching for answers to solve the crime puzzle. One of the most important criminal investigative tools used by the police is the scientific method.

> **Scientific Method**
> Identify the Problem
> Collect Information
> Construct a Hypothesis
> Conduct Experiments
> Analyze Data
> Draw Conclusions

Step 1 Identify the Problem

Police officers are the first to arrive at the crime scene and identify the problem: a crime has been committed. They immediately secure the area by stretching yellow tape around the perimeter of the crime scene. The detectives and crime scene investigators arrive, put on plastic gloves, and walk through the crime scene together. They discuss various scenarios, identify items that might be evidence, and try to piece together what happened.

Step 2 Collect Information

Investigators look carefully at everything inside the perimeter of the crime scene. The smallest detail may help them piece together exactly what happened. Investigators carry crime scene kits containing everything they need to gather items from a crime scene: evidence bags to collect hairs and fibers; cotton swabs to save fluid samples; plastic tubes to store sand, dirt, or powder; and tweezers, pliers, scissors, and files to collect evidence when it cannot easily be picked up. Investigators record what the crime scene and evidence looks like by taking photographs and making sketches. The evidence is taken back to the forensic lab for closer examination and testing.

- **Physical evidence** is any items found at the crime scene or on victims such as DNA, fingerprints, footprints, or tire prints.
- **Trace evidence** is a very small amount of a material found at the crime scene or on victims such as hair, glass fragments, soil, or paint.

Step 3 Construct a Hypothesis

Detectives gather information about the crime by interviewing witnesses and victims. Using their research and the evidence found at the crime scene, detectives form a hypothesis: What crime took place? How was the crime committed? Who might be guilty of committing the crime?

Using Science to Solve Crimes (cont.)

Step 4 | Conduct Experiments

Forensic scientists use various types of scientific equipment, including electronic microscopes, infrared photography, ultraviolet light, and X-ray machines, to examine physical and trace evidence found during a criminal investigation. Evidence is weighed, measured, and compared to reference files and computer databases.

Step 5 | Analyze Data

Forensic scientists analyze data collected from the examination of the crime scene. They prepare reports that explain the results and describe the methods and techniques used to conduct the analysis.

The knowledge and experience of many different types of scientists may be needed to solve a crime.

- **Anthropologist:** examines and evaluates bones found at the crime scene to determine the identity of the victim and the way in which the person died
- **Biologist:** analyzes body fluids such as blood or saliva that have been left at the crime scene
- **Chemist:** analyzes substances found at the crime scene to determine if they contain chemicals (drugs or poisons)
- **Odontologist:** examines and evaluates dental evidence found at the crime scene to determine the identity of the victim or the offender
- **Entomologist:** examines insects at a crime scene to determine the time and location of the death of the victim
- **Geologist:** examines items such as soil, rock, sand, and minerals to determine where the crime was committed
- **Pathologist:** analyzes cells and tissues found at a crime scene and on a victim or suspect
- **Psychologist:** analyzes the behavior of people involved in the crime

Step 6 | Draw Conclusions

Forensic science holds the key to solving the crime scene puzzle. Scientific principles and procedures are used to examine the evidence, obtain data, interpret results, and draw conclusions. The forensic scientist provides the detective with the information needed to determine the innocence or guilt of those accused and to solve the crime.
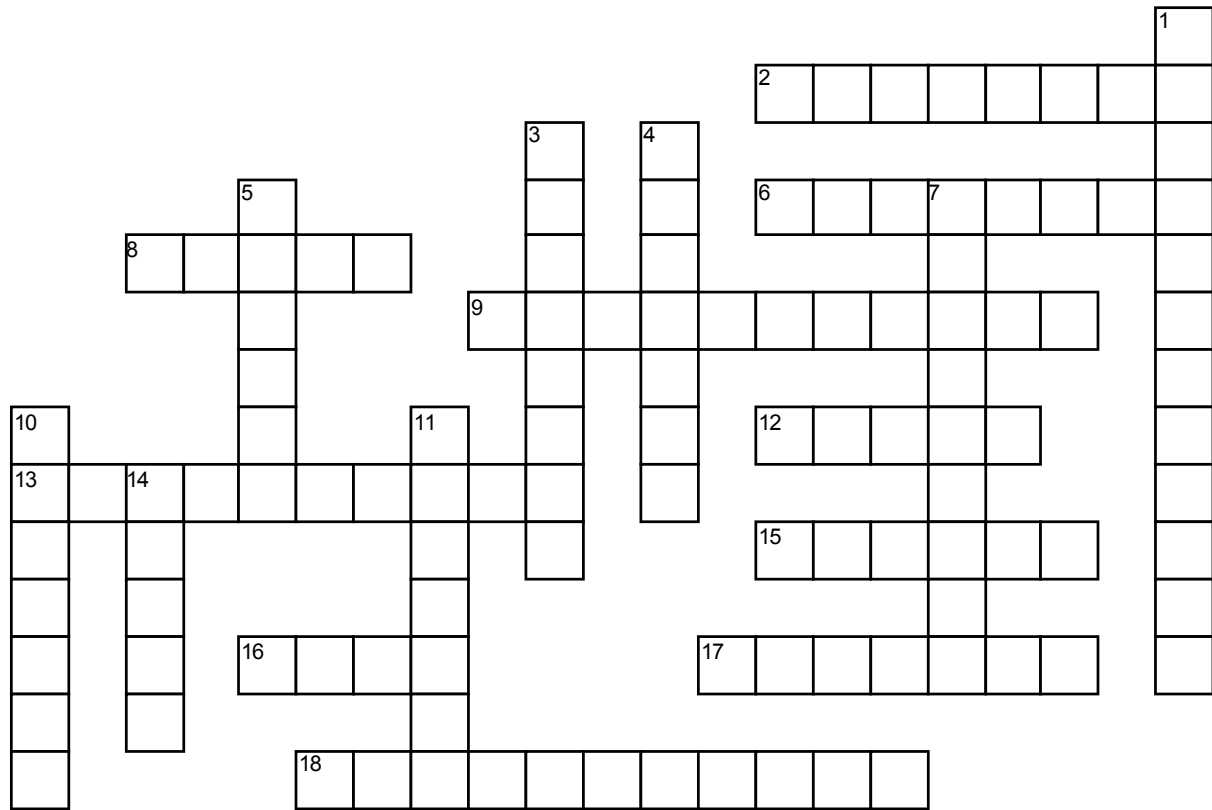
CSI Vocabulary

accomplice: a person connected with committing a crime

alibi: an account of where a suspect was or who they were with at the time of a crime

break-in: the illegal entrance into a premise with criminal intent

clue: a fact or an object that helps to solve a crime

crime: an act committed in violation of the law

criminal mischief: to damage, deface, or destroy someone's property

crime scene: the location where a crime has been committed

deduce: to infer by logical reasoning

detective: a person who investigates crimes and gathers information

evidence: an item used as proof in a crime

forensic science: the study of evidence in order to solve crimes and convict criminals

hunch: a feeling not based on known facts

investigation: the procedure of collecting evidence by law enforcement officers to solve a crime

investigator: a person who collects evidence to solve a crime

larceny: a minor theft

misdemeanor: a minor crime for which the punishment includes a fine and/or a maximum of one year of jail time

motive: the reason a person does something or acts in a certain way

offender: a person accused of a crime

perpetrator: a person who has allegedly committed a crime

petty larceny: to take something valued at less than $250.00

robbery: to take anything of value from a person by force, threat of force, or violence

suspect: a person thought to have committed a crime

trace evidence: anything found at a crime scene or on a victim in small but measurable amounts

victim: a person who is harmed or suffers some loss

witness: a person who saw or can give a firsthand account of a crime

Name: _____ Date: _____

CSI Crossword Puzzle

Use the clues below to complete the crossword puzzle.

ACROSS

2. the illegal entrance into a premises with criminal intent (hyphenated word)
6. an item used as proof in a crime
8. an account of where a suspect was or who they were with at the time of a crime
9. a person who has allegedly committed a crime
12. a feeling not based on known facts
13. a person connected with committing a crime
15. the reason a person does something or acts in a certain way
16. a fact or an object that helps to solve a crime
17. to take anything of value from a person by force, threat of force, or violence
18. a minor crime

DOWN

1. a person who collects evidence to solve a crime
3. a person accused of a crime
4. a person thought to have committed a crime
5. a person who is harmed or suffers some loss
7. a person who investigates crimes and gathers information
10. a minor theft
11. a person who saw or can give a firsthand account of a crime
14. an act committed in violation of the law

Science Vocabulary

classify: to use a system to group information into categories

conclusion: a summary of the results of the experimentation and a statement of how the results relate to the hypothesis

data: a group of measurements, facts, or statistics

data analysis: to organize and examine collected data using narratives, charts, graphs, or tables

experiment: the steps used to test a hypothesis

examine: to look closely at somebody or something

hypothesis: an idea about the solution to a problem that can be tested or investigated

identify: to name or recognize a person, place, or thing

laboratory: a place used for conducting scientific experiments

measure: a system of assigning numbers to an observation

observation: to use the senses to gather information about an object or event

predict: a forecast of future events based on previous observations and experiments

research: the method of collecting information and data about a topic being studied

science: the study of the natural world

scientific method: a series of steps scientists use to solve a problem

Name: _____ Date: _____

Science Word Search

Find and circle the words from the list below in the word search. Words may be printed horizontally, vertically, diagonally, forward, and backward.
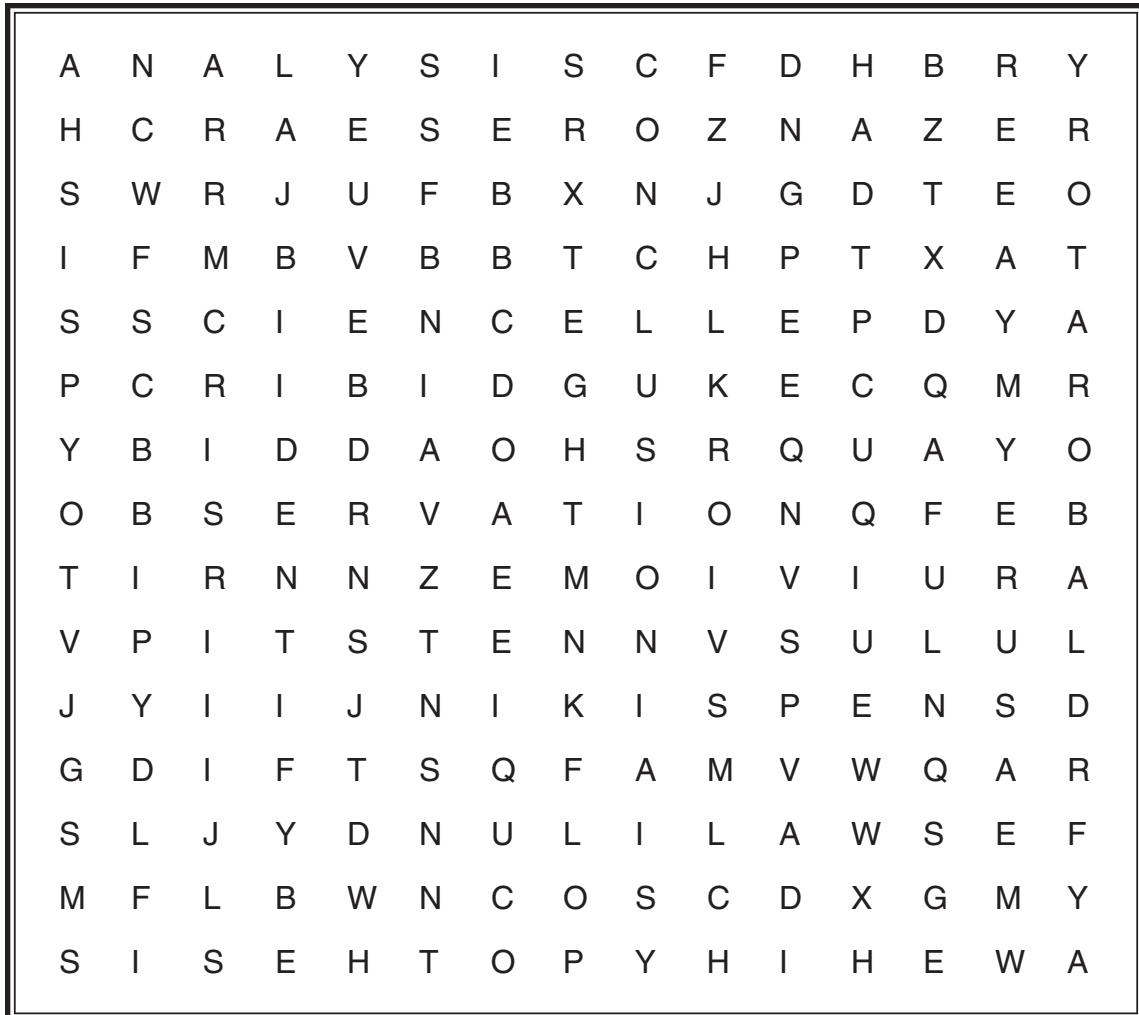
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A  N  A  L  Y  S  I  S  C  F  D  H  B  R  Y
H  C  R  A  E  S  E  R  O  Z  N  A  Z  E  R
S  W  R  J  U  F  B  X  N  J  G  D  T  E  O
I  F  M  B  V  B  B  T  C  H  P  T  X  A  T
S  S  C  I  E  N  C  E  L  L  E  P  D  Y  A
P  C  R  I  B  I  D  G  U  K  E  C  Q  M  R
Y  B  I  D  D  A  O  H  S  R  Q  U  A  Y  O
O  B  S  E  R  V  A  T  I  O  N  Q  F  E  B
T  I  R  N  N  Z  E  M  O  I  V  I  U  R  A
V  P  I  T  S  T  E  N  N  V  S  U  L  U  L
J  Y  I  I  J  N  I  K  I  S  P  E  N  S  D
G  D  I  F  T  S  Q  F  A  M  V  W  Q  A  R
S  L  J  Y  D  N  U  L  I  L  A  W  S  E  F
M  F  L  B  W  N  C  O  S  C  D  X  G  M  Y
S  I  S  E  H  T  O  P  Y  H  I  H  E  W  A
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ANALYSIS	CLASSIFY	CONCLUSION
DATA	EXAMINE	EXPERIMENT
HYPOTHESIS	IDENTIFY	LABORATORY
MEASURE	OBSERVATION	PREDICT
RESEARCH	SCIENCE	SCIENTIFIC

Case #1
Forgery

Teacher Information

Crime Location: A middle-school science classroom is the crime scene.

Crime: Someone forged a field trip permission slip.

Investigation: Students compare the similarities and differences in handwriting samples.

Time Required: The student investigation takes approximately one 50-minute session to complete.

Materials Needed
* magnifying glasses
* a set of the Student Investigation pages for each team member

Teacher Notes
1. <u>Skill-Building Activity:</u> Instruct students to write the following sentence on unlined paper: "Every person has a unique style of handwriting." Students can use the information found on the Handwriting Characteristics page to analyze their own handwriting.
2. <u>Crime Scenario:</u> Students read and discuss the Crime Scene, Suspect Information, and Investigation Directions found on the Forgery page.
3. <u>Investigation:</u> Divide the class into teams. Instruct each team to complete the Handwriting Lab page using the permission note and the suspect's handwriting found on the Handwriting Samples page.
4. <u>Solve the Crime:</u> Students use the evidence to identify the prime suspect. Teams present their conclusions. There isn't one "correct" answer. The cases are purposely designed to allow students to formulate different plausible solutions based on their interpretation of the evidence.

NSES Science as Inquiry: Content Standard A:
As a result of activities in grades 5–8, all students should develop abilities necessary to do scientific inquiry.

Resources
<www.fbi.gov/fbikids.htm>
("Kids Page." <u>Federal Bureau of Investigation.</u> U.S. Department of Justice.)

Lowe, Shelia R. *The Complete Idiot's Guide to Handwriting.* Alpha Books, 1999.

Handwriting Characteristics

How each person learns to hold a pencil, form letters, and space words results in every person developing a unique style of handwriting. For this reason, handwriting analysis is a tool used by forensic scientists to detect forged documents.

The police often collect handwriting samples, or exemplars, when they believe forgery is involved in a case. A forensic document examiner is a handwriting expert. An examiner usually looks at the writing characteristics called traits. Traits include letter formation, size, and slant. The expert compares the key points of each trait found in the suspicious document to the exemplars.

Handwriting Traits

Forensic scientists analyze the key points of each handwriting trait when examining written documents. Some examples of handwriting traits and key points are illustrated in the table below.

TRAITS	KEY POINTS		
Baseline	Up *crime scene*	Down *crime scene*	Straight *crime scene*
Slant of Letters	Right *handwriting*	Left *handwriting*	Straight *handwriting*
Letter Size	Large *letters*	Medium *letters*	Small *letters*
Word Spacing	Close Together *keypoints*	Wide apart *key points*	Normal *key points*
Letter Formation "i"	Dots "i"	Does Not Dot "i"	Stylized "i"
Letter formation "t"	Cross "t"	Does Not Cross "t"	Stylized "t"
Letter Formation "r"	Angle "r" to Point	Flat-topped	Stylized "r"
Letter formation "e"	Looped "e"	Not Looped "e"	Stylized "e"

Name: _____   Date: _____

Handwriting Lab
Skill-Building Activity

Purpose: identify the handwriting traits found in the different writing samples

Materials Needed: an assortment of ink pens

Procedure:
Step 1: Each team member selects a different writing pen. Using cursive writing, each member copies the sample sentence in the correct space provided on the table.
Step 2: Examine the handwriting samples with a magnifying glass. Use the information found on the Handwriting Characteristics page to identify the traits found in the different writing samples.

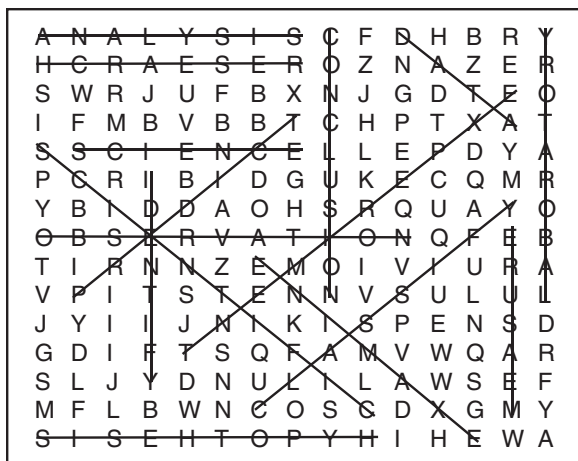| Every person has a unique style of handwriting. |
| --- |
| Team Member #1 |
| Team Member #2 |
| Team Member #3 |
| Team Member #4 |
| Team Member #5 |

Conclusion (Identify at least two traits of each handwriting sample.)

_____

_____

_____

Answer Keys

CSI Crossword Puzzle (page 5)

```
                              I
              B R E A K - I N V
        O   S         E
      V F   U   E V I D E N C E
  A L I B I F S       E       S
      C   F R P E R P E T R A T O R
      T   E E         E       I
  L   I   W C   H U N C H     G
  A C C O M P L I C E         A
  R R   I T   R     M O T I V E O
  C I   M N         I       V   R
  E M   C L U E     R O B B E R Y
  N E         S
  Y       M I S D E M E A N O R
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Science Word Search (page 7)

```
A N A L Y S I S C F D H B R Y
H C R A E S E R O Z N A Z E R
S W R J U F B X N J G D T E O
I F M B V B B T C H P T X A T
S S C I E N C E L L E P D Y A
P C R I B I D G U K E C Q M R
Y B I D D A O H S R Q U A Y O
O B S E R V A T I O N Q F E B
T I R N N Z E M O I V I U R A
V P I T S T E N N V S U L U L
J Y I I J N I K I S P E N S D
G D I F T S Q F A M V W Q A R
S L J Y D N U L T L A W S E F
M F L B W N C O S C D X G M Y
S I S E H T O P Y H I H E W A
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Case #1: Forgery
Handwriting Lab (page 10)
Conclusion: Every person has a unique style of handwriting. Traits will vary.
Handwriting Analysis Lab (page 13)
Whodunit? Four of the suspects' handwriting samples contain similar features found in the permission note: Kathy, Jordan, Amber, and Reilly. Amber and Reilly have the strongest motives for forging the notes.

Case #2: Deception
Truth or Deception Data Sheet (page 17)
Knowing how to interpret body language can help a detective determine if a suspect is being truthful.
Body Language Analysis Lab (page 20)
Whodunit? Jessica and Mrs. Evans both displayed signs of deception when questioned. Their statements revealed they both had a motive.

Case #3: Theft
Fingerprint Analysis Lab (page 27)
Whodunit? Both Mrs. Miller and Kaylee's fingerprints were found at the crime scene. Their statements revealed they both had a motive.

Case #4: Criminal Mischief
Mammal Track Analysis Lab (page 34)
Whodunit? Skunk, squirrel, opossum, and dog prints were found at the crime scene. Madison, Jordan, and Mrs. Martin own dogs. Mr. Scott also has access to dogs and wild animals. All four suspects gave statements that reveal they had a motive.

Case #5: Break-In
pH Analysis Lab (page 41)
Whodunit? Gage and Mikalya both had soil from the crime scene on their shoes. Each gave statements that reveal they had a motive. Each of their alibis placed them near the school during the time the break-in occurred.

Case #6: Burglary
DNA Analysis Lab (page 47)
Whodunit? Breanne and Brittany are twins and have the same DNA. Their DNA matches the crime scene DNA. Each gave statements that reveal they had a motive. Each of their alibis placed them near the school during the time the burglary occurred.

Case #7: Petty Larceny
Chromatography Data Sheet (page 50)
Forensic scientists can use one of the many types of chromatography to identify substances left behind at a crime.
Lipstick Chromatography Data Sheet (page 54)
Whodunit? Answers will depend on how the teacher sets up the lab.

Case #8: Arson
Bite Mark Analysis Lab (page 62)
Whodunit? Matthew's teeth marks most closely match the evidence.