An Introduction to Forensic Science

Missing money MYSTERY

INSTRUCTOR'S GUIDE

Community LEARNING

Missing Money Mystery

An Introduction to Forensic Science

Please direct any comments regarding this publication to info@commlearning.com.

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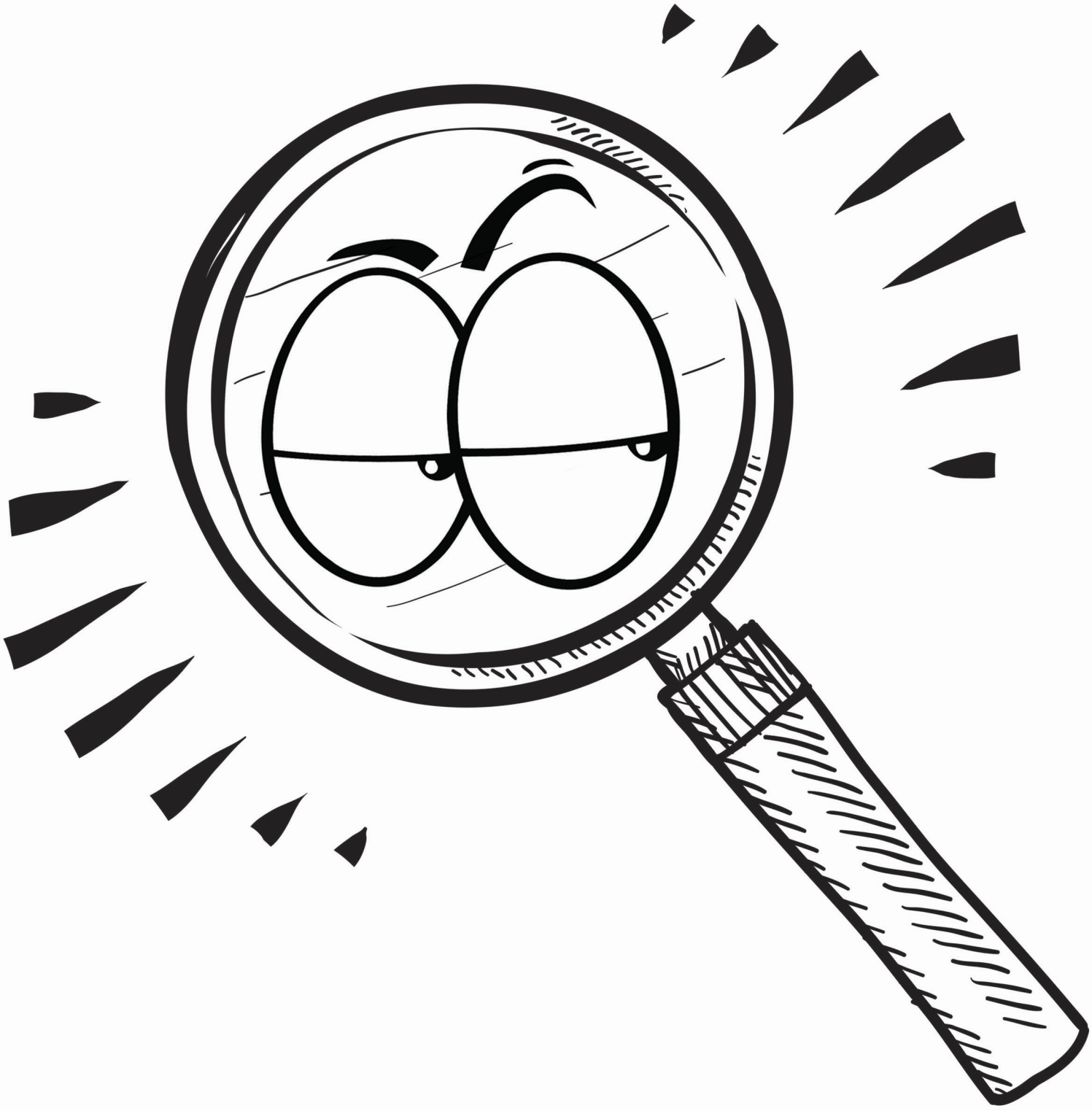


Preface

Welcome!

Missing Money Mystery: An Introduction to Forensic Science is a 12-lesson course for elementary students. It is designed to ignite curiosity and stimulate authentic learning by creating real life contexts ranging from lab analyses to print making to criminal investigation. *Missing Money Mystery* has been used enthusiastically in all 50 states, stimulating young minds and engaging young hands for many years. In fact, thematic integration—over an extended period of hands-on engagement—forms the driving concept behind all Community Learning's courses. The lessons and activities that comprise *Missing Money Mystery* are aligned to the practices, cross-cutting concepts, and disciplinary core ideas that are the foundation of the Next Generation Science Standards (NGSS). In addition, the activities included in this unit align to the Common Core State Standards in Mathematics and English Language Arts and Literacy. For more information on the standards please see the Standards Matrix included in the appendix.

Who Can Teach *Missing Money Mystery* and Where?

Instructors are supported by easy-to-manage materials and step-by-step plans. No specialized knowledge is required to launch the course, making this entertaining forensic science mystery ideal for classrooms, after-school programs, intersession programs, museum groups, summer camps, youth groups, and clubs . . . anywhere young people are gathered.

Hands-on Enrichment in Science and Critical Thinking

The call for hands-on activities that build critical thinking skills, confidence, competence, and science literacy can be heard on the national, state, and local levels. To be sure, educators and officials in both the public and private sectors point to the critical role ongoing, quality after-school programs play, especially programs with a focus on science, math, and reading—the same skills now tightly linked to the economic productivity of our society.

Missing Money Mystery exposes students to this and more. The course sets up scenarios that invite students to solve problems creatively, think critically, work cooperatively in teams, and use evidence, models, tools, and scientific techniques effectively.

> *"The students were engaged and enjoyed the experiments. The story keeps the activities meaningful and provided an interested way to connect standards. The teacher's manual was easy to follow and materials in the kits made it very convenient for set up. Overall, this is a great thing to do in afterschool and during the summer!"*
>
> - Genesis Center, Florida

Bringing the Mystery to Life

Missing Money Mystery is based on the premise that a crime occurred in Mr. Mugg's fourth grade classroom at Markwell Elementary. A canister holding the money for an upcoming geocaching field trip disappeared sometime after dismissal on a Monday afternoon. Mr. Mugg makes this discovery the following morning. He knows his students have been looking forward to this special trip which will introduce them to the natural world through a real life treasure hunt, and he decides to undertake the investigation himself—with the help of your (the course instructor's) students.

To launch his investigation, Mr. Mugg uses the classroom computer to learn about forensic science and the necessary activities, tools, and tests he needs to solve the crime. He shares this information with your students through a series of email letters. He then locates and gathers the clues and packages and sends them in a box to your classroom. Inside this

box are all the materials needed by your students to conduct the investigation, including photographs, scientific equipment and "evidence."

Each lesson introduces new intriguing evidence, forensic techniques, and insight toward solving the *Missing Money Mystery*. To limit the suspect possibilities, Mr. Mugg has narrowed the suspects to four—all current students of his. Two are boys and two are identical twin girls. Together, your students work toward the most plausible scenarios and celebrate their findings in the concluding lesson with certificates honoring their work as forensic investigators.

"The Missing Money Mystery was very easy to follow. The children had such a great time at it, we even allowed our group to re-enact the entire crime. This mystery was fantastic!"

- Jacqueline Jones-Ford, Director/Detective, Hempstead NY P.A.L.

Making the Most of Each Lesson

With all the necessary materials provided in convenient, lightweight carryalls, and the setups, processes, and procedures explained in detail, instructors will find *Missing Money Mystery* easy and fun to teach. Each lesson provides an activity that teaches a new but related aspect of scientific reasoning and a particular scientific process. None of the labs require special handling or complicated setups.

After familiarizing themselves with the lesson, vocabulary, and intended outcome of the activity, instructors set up their classroom so that it is easy for students to work in groups. Clear guidance is provided in each lesson on how to set up the demonstration area with all the relevant materials at hand.

Any necessary safety precautions specific to individual lessons are also provided. The instructor should be sure to know where emergency help and supplies are located.

Each lesson activity that the students accomplish becomes part of their "Case Notes" and contributes, ultimately, to solving the mystery. Because of this, instructors need to review the corresponding pages in the Student Activity Book in order to guide students in completing their part of the activity.

Course Kit Components

Each course kit contains an Instructor Guide, Resource CD, and all of the materials and tools necessary to teach the course to a class of 30 students. Start by reviewing this guide, the preparation chart, and tutorials on the Teacher Resource CD.

Instructor's Guide

Every step is taken to provide an easy-to-follow format and fun-to-read instructions for each lesson. In addition to a brief listing of objectives, materials, and setup procedures, useful icons point the instructor to a number of key elements:

Notes for the Instructor

Brief instructor notes introduce the subject matter and challenges presented in the particular lesson. They often contain real-life, age-appropriate examples from crime in history or popular culture.

Notes for the Students

These notes "set the stage" for each lesson by presenting brief material to read, listen to, and discuss.

Vocabulary

New and relevant terms are defined here. Note, too, the comprehensive "Glossary" at the rear of the Instructor's Guide and Student Books.

Activity Description

Here, step-by-step procedures are provided for both the instructor's demonstration and the students' immersion in the activity.

Wrap-up

Discussion-provoking questions are designed to summarize learning and help students take their inquiry further.

Clean-up

Clear instruction on preserving and storing materials is provided to ensure kit longevity and cost effectiveness.

Other Directions, Discussions and Destinations

To extend lessons and deepen understanding across disciplinary and cultural divides, relevant links to multimedia, web resources, and books are provided here.

Student Books

Designed for students to record their discoveries class after class, the Student Books acquire a narrative quality that keeps the young "Crime Scene Investigators" engaged in scientific investigation over time. The books serve as companions to the Instructor's Guide and contain reports, charts, places to attach samples, and areas to record observations, as well as a full glossary of terms used in the course.

The complete *Missing Money Mystery: An Introduction to Forensic Science* student book is provided in PDF on your Resource CD, with an unlimited license for reproduction for your school or organization's use.

Companion Resources

When you adopt *Missing Money Mystery: A Study in Forensic Science*, your instructors will have access to a number of companion resources. A Resource CD offers tips, lesson extensions, and other great ideas for the classroom. Word search and crossword puzzles help reinforce newly learned and used vocabulary. Links to forensic videos and other multimedia resources provide authentic lesson extensions. Immediate support is always available by phone, email, or webinar from the experts at Community Learning.

About Community Learning

Community Learning is a socially responsible company focused on impacting positive youth development through STEAM education. We create curriculum designed to expose students to careers and inspire their development into lifelong learners. Our products are developed in collaboration with subject area experts, providing complete support for program administrators desiring rich, engaging educational programs for their students.

If you have any questions, suggestions, or feedback, please visit our website or email us at info@commlearning.com.

Preparation Overview

	Lesson 1 Figuring Out Forensics: Organization and Observation	Lesson 2 Securing the Scene: Collecting Evidence	Lesson 3 Powder Power: Solutions or Suspensions	Lesson 4 Natural or Not: Fiber Identification
Print/Copy	Student Book pages iii-3	Student Book pages 4-6	Student Book pages 7-15	Student Book pages 16-19
Organize Kit Supplies	• Black marker • Plastic coins • Plastic cups • Paper bags • Textured objects • Pencils • Rulers • Hand lenses	• Crime scene tape • Measuring tape • Masking tape • Black marker • Graph paper • Sand • Membership card • Wipes • Lotion • Pencils • Rulers	• Black markers • Masking tape • Portion cups • Wipes • Container • Vinegar • Funnel • Dropper bottles • Wooden splints • Plastic cups • Dark construction paper • Tablespoon • White powders (baking soda, Plaster of Paris, powdered sugar, salt) • Light colored construction paper • Pencils • Hand lenses • Foam plates • Scissors	• Black fabrics (nylon, acetate, cotton, wool) • Aluminum tray • Container • Votive candles • Tweezers • Metal tongs • Wide tape • Black marker • Light colored construction paper • Scissors • Pencils • Hand lenses
Prepare	• Organize bags of textured objects • Count coins into cups	• Organize the mock crime scene in your room • Create a mock crime scene sketch - make copies for each student • Attach crime scene tape across doorway	• Organize powders into portion cups and place on labeled construction paper • Fill and label dropper bottles with water and vinegar • Set up demonstration area	• Cut and prepare fabric samples on labeled construction paper • Tear pieces of tape and set on edges of student desks or tables • Fill the container with water as a safety precaution • Set up pyrolysis demonstration
Acquire Additional Supplies			• Water	• Matches

Preparation Overview

	Lesson 5 Tracking the Tires: Tread Patterns	Lesson 6 Digging for Dirt: Soil Samples	Lesson 7 Cast a Clue: Shoe Print Evidence	Lesson 8 Crack the Code: Cryptograms
Print/Copy	Student Book pages 20-24	Student Book pages 25-27	Student Book pages 28-33	Student Book pages 34-39
Organize Kit Supplies	• Wipes • Masking tape • Rulers • Reclosable bags • Modeling clay • Pencils • Tire sample • Hand lenses • Foam plates • Photos of tread evidence and cast of tread evidence • 8 oz. plastic dish • Plaster of Paris tub • Portion cups • Plastic spoon • Cup of water	• Soil samples (sandy soil, clay, loam) • Wipes • Black marker • Portion cups • Container • Dropper bottles • Foam plates • Tablespoon • Pencils • Hand lenses • Wooden splints	• Scrub brushes • Shoe shine sponges • Paint brushes • Dusting powder • Photos of crime scene shoe print • Portion cups • Wipes • Hand lenses • Pencils	• Index cards • Black marker • Masking tape • Photos of coded note • Pencils
Prepare	• Separate modeling clay into bags for each group of students • Make a mold/cast at least 1 hour before class begins • Set up demonstration area to make a second mold/cast	• Label portion cups and scoop soil samples • Fill dropper bottles with water • Set up foam plates with soil samples for each group	• Fill portion cups with dusting powder • Set up shoe printing stations	• Write letters and numbers on index cards for deciphering cryptogram
Acquire Additional Supplies	• Cooking spray • Paper towels • Water • Scissors	• Paper Towels • Water	• Paper Towels • Blank Copy Paper	

Preparation Overview

	Lesson 9 **Lifting Lips: Lip Prints**	Lesson 10 **Proof in Profiling: DNA Identification**	Lesson 11 **Suspicious Statements: Means, Motive, Opportunity**	Lesson 12 **Case Closed: Analyzing Evidence**
Print/Copy	Student Book pages 40-45	Student Book pages 46-48	Student Book pages 49-50	Student Book pages 51-53 Certificates of Completion
Organize Kit Supplies	• Portion cups • Wooden splints • Powder (cornstarch) • Lipstick • Petroleum jelly • Wide tape • Index cards • Black marker • Wipes • Photos of lip print on Envelopes • Pencils • Mirrors • Feathers • Rulers • Hand lenses • Crayons • Rolls of tape • Tissues	• DNA strands handouts • Envelopes • Scissors • Rolls of tape • Pencils • Photos of blood drops from crime scene	• Pencils	• Pencils
Prepare	• Scoop lipstick and petroleum jelly into portion cups for each student • Fill portion cups with powder • Label index cards with lip print patterns	• Set up DNA cutting demonstration	• Organize groups of students	• Print out and fill in the Certificates of Completion
Acquire Additional Supplies				

Introduction

Instructor's note: To build intrigue and set the scene, read this introduction to students prior to beginning the first lesson.

Missing Money Mystery

Mr. Mugg is stumped. He is a fourth grade science teacher at Markwell Elementary School and an old friend of mine. On Tuesday, he arrived early to his classroom as usual, but there was nothing usual about his day after that. He found a chair overturned by the window, white powder scattered across the classroom floor, and, strangest of all, the canister which always stood at the front edge of his desk was missing. The canister holding the money donated by the Markwell PTA (Parent Teachers Association) for an upcoming field trip had vanished!

Poor Mr. Mugg. He thought immediately of his students. They had been looking forward to the special trip they had been planning since the fall. Each year, Mr. Mugg takes his class on a real-world treasure hunt called geocaching. Geocaching is an outdoor game that uses a GPS device to pinpoint the location of anything anywhere on the planet. Most "smart phones" have a GPS (Global Positioning System). On Mr. Mugg's geocaching trips, students find small boxes, just like the missing canister, hidden in unlikely places. In fact, he had just been showing the canister to his class to explain more about geocaching. Last year, his class found a geocaching box hidden behind a waterfall, and another in a hole in a tree near a nest that had three tiny blue eggs it. A third box lay under a rock at the edge of a pond covered with lily pads the size of dinner plates. Each treasure box has trinkets inside it, one for each student. Sometimes the trinket is a charm that illustrates the natural wonder. Other times it's a postcard of a bird or another creature that lives nearby. My friend Mr. Mugg loves to teach his students about geography and the natural world. In fact, he keeps a small garden just outside his classroom window. Yesterday morning, when he discovered the crime, he walked carefully around the overturned chair to have a peek out the window. Another surprise: the garden had been disturbed. At that point, my friend decided he must act quickly but carefully.

He was determined to solve this mystery of the missing money, but he knew he had to overcome two things: First, he needed to inform himself about forensics—the science that focuses on solving crimes. Second, he needed to enlist helpers—others who live far away from the scene of the crime and don't know any of the suspects. While Mr. Mugg doesn't know a lot about forensics, he does know that the best people to solve a crime are those who are removed both emotionally and physically. Mr. Mugg is too close to his students to be truly objective. This is why he asked me if my class would be interested in conducting this forensic investigation for him. He assigned me to be his Crime Scene Investigator and you, if you are willing to accept the assignment, to be my forensic scientists!

Today, I received a big box from Mr. Mugg in the mail. It contains photographs and drawings of the evidence he found, as well as all the supplies we need to make careful observations and tests toward solving the crime. My friend Mr. Mugg has spent the last few days learning about crime investigation from the best crime investigators there are: the FBI. The Federal Bureau of Investigation is the US agency charged with solving the toughest crimes in the country and around the world. Mr. Mugg will share his new knowledge with us as we work through identifying all the evidence we can.

Are you ready to help solve this mystery? Mr. Mugg's students have been so excited about the geocaching trip. Let's not disappoint them!

Lesson 1

FIGURING OUT FORENSICS

ORGANIZATION AND OBSERVATION

Lesson 1

Figuring Out Forensics: Organization and Observation

OBJECTIVES

Students will:

- Use senses to record written observations
- Apply the properties of shape, texture, size, color, odor, and sound to record observations
- Use written information to identify objects
- Collect data through the use of measurement

MATERIALS

Instructor:

- black marker
- plastic coins
- 15 plastic cups
- 15 paper bags
- 15 textured objects

Students (per pair):

- 2 Student Book pages (on Resource CD)
- 2 pencils
- 1 ruler with inches and centimeters
- 1 cup of coins (5 in each)
- 1 magnifier
- 1 paper bag with 1 textured object inside
- 1 black marker

PREPARATION

1. Organize 15 bags of textured objects.
   - ➔ Number the bags one through fifteen.
   - ➔ Put 1 object into each of the bags.
   - ➔ Fold top over securely.
2. Put 5 coins into each of 15 cups. Try to have 2 similar coins in each cup. (similar colors, similar sizes etc).
3. Assemble student materials.
4. Group students in pairs.

Notes for the Instructor

In these opening activities, students are introduced to a crime that has taken place in Mr. Mugg's classroom and to the process of criminal investigation. Students work in pairs and groups to practice their observational skills on a variety of objects. They record their observations in the form of lists and data tables and refer to the properties of different coins—color, texture, shape, size, and image—to complete the tables. In addition to the use of their physical senses, the students measure using rulers and the appropriate abbreviations for specific units. It is crucial that students observe and record the details of evidence accurately. These skills are evaluated over the course of the students' work as they attempt to identify specific objects based on their peers' data.

While "science" is defined as the study of the natural and physical worlds through observation and experimentation, "forensic science" is science applied to evidence. This evidence and other information discovered through the activities of forensics can be used in court. In fact, "forensic" derives from *forensis*, Latin for "forum," meaning a public meeting place for discussion. In Ancient Rome, if a citizen was accused of a criminal act, his or her case had to be presented in public. Both the accused and the accuser were required to deliver speeches presenting their sides of the story. The final decision in the case rested on the party who presented their information most convincingly.

Different kinds of scientists can be part of forensic study. **Forensic anthropologists** are responsible for the recovery and identification of skeletal remains. Conducting DNA testing of body fluids for the purpose of identifying an individual is one job of a **forensic biologist**. Soil, mineral, and petroleum evidence are handled by **forensic geologists**. **Forensic odontologists** study teeth—their development, structure, and diseases. **Forensic pathologists**, often appearing on television shows, study diseases and changes in the body to determine the cause of death. Analyzing the effects of drugs and poisons on a body is the responsibility of **forensic toxicologists**.

One of the first instances of using forensic science in a legal case took place in Harwick, England in 1016.

A maid had been assaulted and drowned. Footprints and an impression made by corduroy fabric were found near the scene; the impression showed that a patch had been sewn on the fabric. Wheat particles were also found in the area. Based on the distinctive shape of the patch revealed in the impression and the wheat particles, a man who worked in a local wheat field was convicted of the crime.

Crime scene investigators learn to make keen and accurate observations using all of their physical senses as well as specialized tools and equipment. They then tackle the process of recording the observations accurately and completely. These records may take the form of notes or drawings, such as a crime scene map. Qualitative information, such as eye and hair color, is included. Information related to numbers of any kind, such as the height and weight of a suspect and the number of suspects involved, is referred to as quantitative data.

The crime scene investigator plays an important role in the legal process and often testifies during trials. If evidence or information is incomplete or mishandled, the guilty person could be set free.

The more facts and details the investigator can supply, the more likely the correct suspect will be convicted. In these opening activities, your budding crime scene analysts will have an opportunity to exercise the observations skills critical to a successful investigation.

The activities in this lesson address Next Generation Science Standards practices of Asking Questions and Defining Problems and Planning and Carrying Out Investigations. In addition, they address Common Core State Standards CCSS.ELA-Literacy. CCRA. SL.1 and CCSS.Math.Content.3.MD.B.4. See the Standards Matrix included in the appendix for more detailed information.

Notes for the Students

Read to your students the following note from Mr. Mugg, found in the box of supplies he has sent. Students can follow along in their books.

Dear Students,

I want to begin by thanking you very much for your willingness to help me solve the mystery of the missing geocaching trip money. Not only are you great problem solvers and observers, according to your instructor, but you're far away from where the crime took place. This makes you the perfect candidates to help get to the bottom of this crime. Inside this box I sent, you will find various clues and tools: bags of evidence, photographs, supplies for forensic testing, and notes that contain both factual scientific information as well as my own personal commentary on what I am learning about the crime that took place in my classroom at Markwell Elementary.

Quickly, before my students arrive, I'd like to share what I learned from the website of the Federal Bureau of Investigation, or the FBI, the government agency that helps protect our country against crime.

First, I learned that forensic science is made up of lots of different kinds of science. It draws on all the science it can to solve crimes: chemistry, biology, geology and other fields. All sorts of **forensic scientists**—from those who specialize in parts of the earth to those who specialize in parts of the human body—help during an investigation. They work together as a team, and the information they present must be the result of careful **observations**. Forensic scientists are trained to use special tools AND their own five senses to make these observations, which can used in a court during a criminal trial.

Second, I learned that forensic scientists must make careful observations of the **properties** of evidence. Properties might be size, color, shape, texture, or how something smells or tastes. All of this information, or **data**, must be written down in some way. Charts, lists, drawings and graphs are some ways to record data. Eventually, this data could be presented in court, so it needs to be accurate and detailed.

Let's start by practicing the observational skills you're going to use to be the best forensics investigators you can be. You'll work in teams and record your observations carefully, just as real forensic scientists do. You're sure to like this first game I planned for you!

Mr. Mugg

Vocabulary

Data: information, often in written form.

Forensic scientist: any type of scientist who can supply information that can be used in court or in a legal manner. For example, forensic anthropologists recover and study skeletons so the skeletons can be identified.

Observation: to study something using your five senses (sight, hearing, taste, touch and smell).

Properties: descriptive characteristics such as color, texture, shape and size.

Activity 1: What's in the Bag?

15 minutes

1. Ask students to write their names where indicated on their book covers.
2. Read "Notes for the Students" aloud while students follow along in their books.
3. Review the properties listed on the chart in "Activity 1: What's in the Bag?"in their books. Ask students to name examples of descriptive words that might appear under each property. For example, "smooth" or "rough" might appear under "Texture." Discuss the importance of safety when observing. Tasting and smelling can be dangerous with unknown objects or substances. While these objects pose no danger, others could give off fumes that are poisonous.
4. Instruct each pair to take one paper bag from where they are arranged or stored. **They are not to open it!**
   - ➔ Pairs should spread out around the room, so they cannot be seen by any other pairs.
   - ➔ In each pair, one person is "the observer" and the other is "the recorder." The pair will then switch jobs so that each student will have a turn doing both.
   - ➔ "The observer" puts one hand in the bag, feels the object, and describes it to "the recorder," naming shape and texture properties. Encourage them to take a guess at what the object might be!
   - ➔ "The recorder" lists these observations in the chart provided in "Activity 1: What's in the Bag?"
   - ➔ Have the observer remove the object from the bag and continue making observations using sight, smell, and hearing properties. Invite the students to use magnifiers and rulers from the supply area. Remind students that smelling needs to be done carefully and gently—and no tasting!
5. Instruct student pairs to return the object to their bag and fold down the flap.
6. Have pairs switch paper bags and "observer"/ "recorder" roles, then follow the same process.
7. Instruct students to return objects to paper bags.
8. Ask several students to share what they discovered.

Activity 2: Describing Coins

15 minutes

1. Read the following from Mr. Mugg while students follow along in their books:

> I am sure that you are doing a fantastic job learning about making observations and recording data. The next activity involves describing coins. It might not be as easy as the previous activity, but now you will have a chance to put your observation and data skills to the test. Use the tools you need, including your senses and drawing skills, to help you with your observations.

2. Tell pairs they will use the chart in "Activity 2: Describing Coins!" and the supplies provided to make written observations of at least one coin.
   - ➔ Have each pair pick one coin from their cup and observe it carefully, using their magnifiers and rulers.
   - ➔ Both students should record the same information in the chart in "Activity 2: Describing Coins!"

- Coins should be returned to the cup after information is recorded.
- Pairs may make observations of additional coins in the chart provided in their books until other students are finished.

3. Instruct each pair to exchange their books and cups of coins with another pair.
   - Using each others' written data, students should try to identify the correct coin.
   - Once pairs believe they have identified the correct coin, they should check with the other pair.
4. Ask students to return each activity book to its owner.

Wrap-up

5–10 minutes

1. Ask: What do we know about observations? Responses will vary:
   - use your senses
   - senses are: sight, hearing, smell, and touch
   - observations can be recorded in a list or table
   - tasting may not be safe
   - sometimes it is hard to identify something just from written information
   - some properties are: color, texture, size, shape

Encourage students to add to what others have said. For example, if someone says that the five senses are used, then ask what the five senses are. Help students share anything they learned today. Encourage them to look through their books to refresh their memories.

2. Ask and answer any questions they may have.
3. Instruct students to record their observations, findings, or suspicions in the Case Notes section at the end of the Student Books.

Clean-up

5 minutes

1. Have students return all materials.
2. Check the floor for any stray books, materials or pencils. Return all materials to suitcase boxes.

Other Directions, Discussions and Destinations

The following activities and websites will enrich this lesson about observation and the five senses.

1. Using only your memory, try drawing a map of your bedroom. Take it home and check your work.
2. Pair up with a friend and observe each other for 30 seconds. Then go into separate rooms and list observations about your partner. Meet again and check to see how accurate you each were.
3. Check out The Kid's Page created by the FBI at **http://www.fbi.gov/fbikids.htm**. This page has information on the history of the FBI, safety, and various breeds of "working dogs," as well as games.
4. Visit Questacon, Australia's national science and technology center at **https://www.questacon.edu.au/discover/for-school-students**.

Lesson 1

Activity 1: What's in the Bag?

Directions:

1. In pairs, take a paper bag. **Do not open it!**
2. Spread out around the room, so you cannot be seen by any other pairs.
3. One person is the **observer** and the other is the **recorder**. Jobs will switch, so you will each have a turn doing both.
4. Observer puts one hand in the bag, feels the object and describes it to the recorder (in a low voice) using properties such as shape and texture. Taking a guess here at what the object is might be fun!
5. Recorder lists these observations below. **Make sure to record the bag number!**
6. Observer removes the object from the bag and continues with observations using sight, smell and hearing: no tasting and be careful smelling. Magnifiers and rulers are available for use.
7. Return item to paper bag.
8. Switch paper bags with another pair.
9. Switch observer/recorder roles with each other.
10. Repeat steps 4–7.

Properties	Bag # _____	Bag # _____	Bag # _____
Shape			
Texture			
Size			
Color			
Odor			
Sound			

Activity 2: Describing Coins!

I am sure that you are doing a fantastic job learning about observations and recording data. The next activity has to do with describing coins. It might not be as easy as the previous activity, but now you will have a chance to put your observation and data skills to the test. Remember, you may use a ruler and magnifier to help you with your observations.

Directions:

1. Pick a coin from the cup and observe it carefully. Feel free to use the magnifiers and rulers.
2. Record your observations below. Make sure to return the coin when you are done.

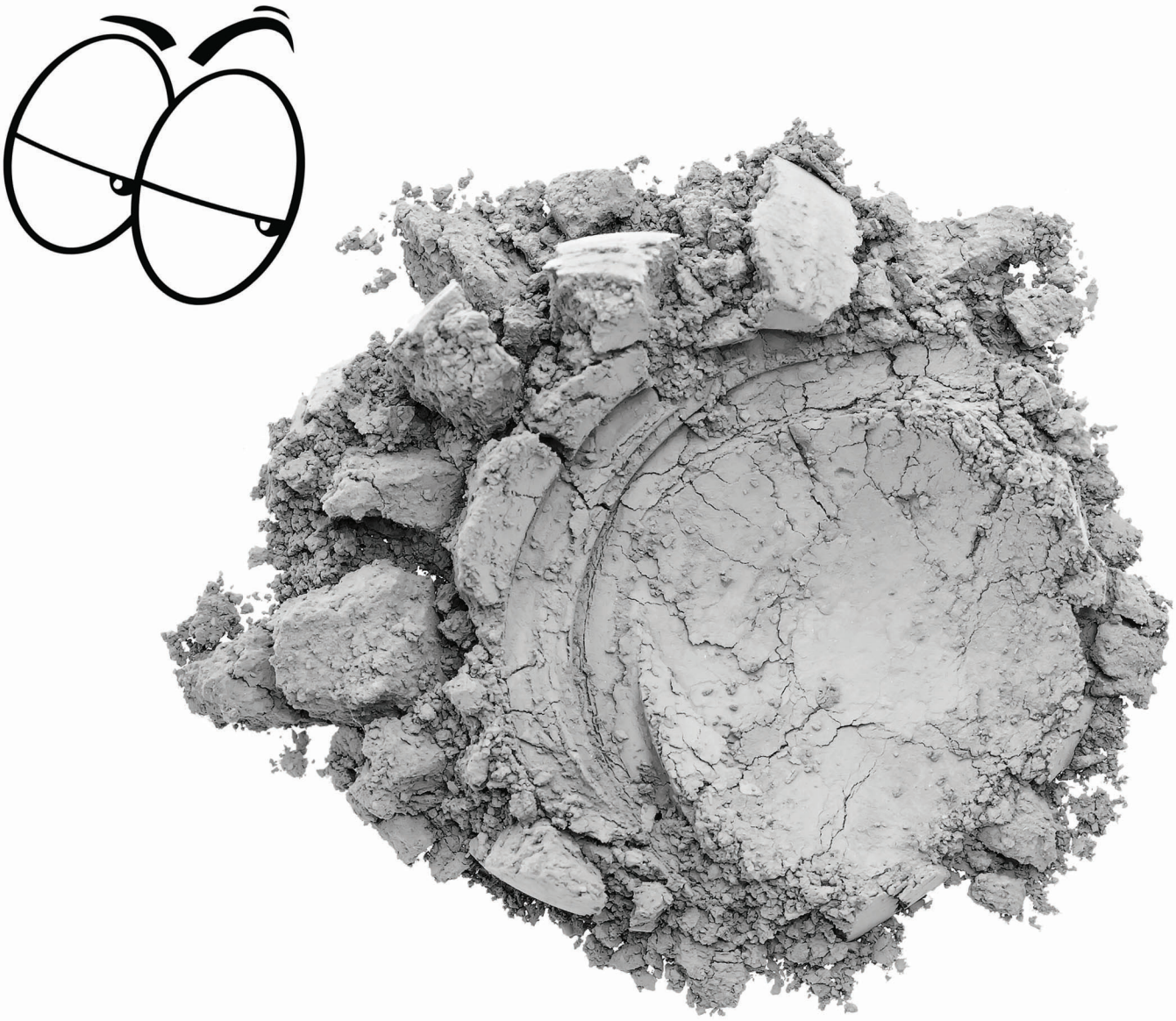
	Coin #1	Coin #2	Coin #3
Color Is it one color, many colors? Are the outer edges a different color than the top & bottom?			
Texture How does it feel? Smooth, bumpy? Do the outer edges feel different from the top & bottom?			
Shape Is it round? Does it have angles?			
Size Use the ruler!			
Image Use the magnifier! Look at the edges, top and bottom.			
Make a drawing of the coin			

Notes

Lesson 3

POWDER POWER

SOLUTIONS OR SUSPENSIONS



Lesson 3

Powder Power : Solutions or Suspensions

OBJECTIVES

Students will:

- Conduct a solubility test to determine if powders create solutions or suspensions
- Test and record observations of various powders and their reactions
- Identify crime scene evidence based on recorded data

MATERIALS

Instructor:

- black marker
- masking tape
- 50 portion cups
- wipes
- container for water
- vinegar
- funnel
- 20 dropper bottles
- wooden splint
- plastic cup
- 1 sheet of dark construction paper
- tablespoon
- powders: baking soda, Plaster of Paris, powdered sugar, salt
- 5 sheets of light-colored construction paper
- Student Book pages (on Resource CD)

Students (groups of three):

- 3 pencils
- 1 dropper bottle of vinegar
- 1 dropper bottle of water
- 5 plastic portion cups
- 3 hand lenses
- 1 sheet of dark construction paper
- 5 wooden splints
- wipes
- 1 foam plate
- 1 black marker
- 1 pair of scissors

PREPARATION

1. Write "baking soda" on one sheet of light-colored construction paper; write "Plaster of Paris" on another, "powdered sugar" on another, "salt" on another, and "evidence" on the last.
2. Organize powders:
   - ➛ Place 1 tablespoon of baking soda into 20 portion cups.
   - ➛ Place 10 cups on paper labeled baking soda.
   - ➛ Place 10 cups on paper labeled evidence.
   - ➛ **Rinse and dry tablespoon!**
   - ➛ Repeat for remaining 3 powders, but only make 10 cups each.
   - ➛ Place 1 tablespoon of Plaster of Paris in a cup for demonstration. (Never place in sink! Always throw in garbage.)
3. Organize dropper bottles:
   - ➛ Tear off 20 small pieces of masking tape.
   - ➛ Write "V" on 10 pieces of tape.
   - ➛ Place on 10 dropper bottles.
   - ➛ Write "W" on 10 pieces of tape.
   - ➛ Place on remaining 10 bottles.
   - ➛ Using the container, fill the 10 "W" bottles with water.
   - ➛ Using the funnel, fill the 10 "V" bottles with vinegar.
4. Organize student supplies.
5. For demonstrating the first set of experiments, set aside: 1 cup of Plaster of Paris, 1 bottle each of water and vinegar, wooden splint, and 1 sheet of dark construction paper.
6. Place trash can in a central location.

Notes for the Instructor

In this lesson, students play the role of **toxicologists** as they observe and conduct chemical tests on a variety of powders. The expertise of toxicologists regarding chemicals and their reactions is necessary to perform the many tests conducted during an investigation.

Toxicologists perform tests on body fluids and tissues, like organs, to determine if traces of drugs, alcohol, or poisons are in the body. Even hair and nails can contain traces of drugs. Although police officers may conduct very simple tests when there is an arrest, often the qualitative testing must happen at a more sophisticated level. If the police test indicates there is a significant likelihood that illegal drugs are present, then a blood or urine sample must be taken for further study.

Most of the testing that toxicologists conduct is related to driving-under-the-influence arrests. Special machines have been designed to conduct these tests. First, it must be determined that the sample does indeed contain drugs or alcohol. If drugs or alcohol are found, the exact amount present must be determined. The machines, similar to small robots, are able to vacuum up the sample, prepare them for testing, conduct the tests, and display the results on a computer!

In the following activities, students observe the properties of powders and crystals, record their observations, and then use them to determine the substance found at the crime scene.

The activities in this lesson address Next Generation Science Standards practices of Asking Questions and Defining Problems, Planning and Carrying Out Investigations, and Engaging in Argument from Evidence as well as disciplinary core idea PS1.A. In addition, they address Common Core State Standards CCSS.ELA-Literacy.CCRA.SL.1 and CCSS.ELA-Literacy.CCRA.SL.2. See the Standards Matrix included in the appendix for more detailed information.

Notes for the Students

Dear Forensic Scientists,

Today I am seeking your help in analyzing the white powder that was scattered on a small area of the floor behind the classroom door. This type of evidence is called **trace evidence** because it is such a small amount. From my science background, I knew that a **toxicologist** would be needed to identify the substance.

A toxicologist is a particular kind of **chemist** who specializes in testing substances that people come in contact with, including body fluids, such as saliva, and organs from the body, such as lungs, for drugs, alcohol, or poison. These test results could lead to valuable information in a case.

An entire group of people called toxicologists work for the FBI. Like chemists, they sometimes make important criminal discoveries by mixing things together and studying the **reaction**, or change. Think of it like making lemonade with a powdered mix. When you add the powder to the water, does the powder mix completely or float on top? When you stir the **solution**, does it dissolve completely and create a different liquid? Of course it does. You have just made lemonade.

On that Monday after school, I know that four of my students had club meetings. These students are:

#1_____(male);

#2_____(female);

#3_____(male);

#4_____(sister of #2).

Each of these students participated in a different club and had different activities that exposed them to different substances as part of these activities. I've included all the material they came in contact with for you to test.

I can't wait to find out your results, dear toxicologists, and if any match the evidence found at the scene of the crime!

Mr. Mugg

Vocabulary

Chemist: A person who examines what things are made of and how they change.

Crystal: A shape that is colorless and see-through. Might appear to have edges and points.

Opaque: Not allowing light to pass through.

Reaction: A change.

Solution: Made when a substance dissolves and the reaction forms a liquid.

Suspension: Made when a substance does not dissolve completely; liquid and powder remain separate. Oil and water, for example, create a suspension.

Toxicologist: Person who tests body fluids, such as saliva, or organs, such as lungs, for the presence of drugs, alcohol or poison.

Trace evidence: Small amounts of evidence, such as soil or glass, that could connect a suspect to the crime.

Translucent: Not completely clear, but clear enough to allow light to pass through.

Activity 1: Observing Properties of Powders and Crystals

15 minutes

1. Read "Notes for the Students" aloud while students follow along in their books.
2. Have 1 person from each group cut the dark paper into 6 smaller pieces. (Fold, then cut in half length-wise, then cut half sheets into thirds.)
3. Have students turn to "Activity 1: Data Table."
   - ➔ Review the headings for the columns and rows together. Don't focus too much on vocabulary at this time. You will discuss it as you do the first sample together, which is Plaster of Paris.
   - ➔ Remind students never to put Plaster of Paris in the sink, wet or dry.
   - ➔ Review vocabulary for columns prior to conducting that specific test.
   - ➔ Record the data for Plaster of Paris by following the directions below:

Directions:

1. One student per group should obtain a sample, beginning with Plaster of Paris. The sample should be placed on the foam plate to catch any spills.
2. Row #1: Senses
   - Using a wooden splint, scoop out small amount of powder and put on dark paper.
   - What color is it? How does it feel? Gritty, smooth, grainy?
3. Row #2: Hand Lens
   - Record if **translucent** or **opaque**.
   - Record if **crystal** or powder.
4. Row #3: Water Test
   - Using a wooden splint, transfer 1/2 of powder to an empty cup.
   - Add water from dropper bottle and stir.
   - Continue to add water and stir until powder dissolves. Powder may or may not dissolve.
   - Record if solution or suspension.
5. Row #4: Vinegar Test
   - Add vinegar from dropper bottle to the remaining half of the powder.
   - Record if reaction or no reaction.
6. Cleaning up
   - Put the cups, splints, and used wipes into the trash. Keep the plate.
   - Return to work station.
   - Wipe off foam plate!
7. Obtain next sample and repeat testing for 3 remaining powders. (Do not test powder labeled "evidence.")
   - Finish with cleaning up.

- ➔ Emphasize cleaning workspace before beginning to test a new powder.
- ➔ Students can complete tests for samples, except for "evidence," by following the directions.
- ➔ Circulate to check progress and clean any spills. Take wipes with you.

4. Review the observations from the table.
   - ➔ Discuss any differences in results. ***Mixed results could be the result of contamination. Contamination occurs when some powders are accidentally mixed with others. These test results are not accurate.***

Activity 2: Identify the Powder Evidence

10 minutes

1. Invite one person from each group to obtain the last sample: the "evidence" sample. They should perform all the tests and record their observations in the last column of the data table.
2. Ask students if they can determine what the evidence is. (Students should be able to determine this based on previous data and current testing.)
3. Instruct student to complete the chart entitled "Evidence Summary: Powder Evidence"
   - ➔ Write suspect names in the correct boxes.
   - ➔ Place an X in the box for each suspect who matches the evidence.
4. Ask:
   - ➔ What is the evidence? ***baking soda***
   - ➔ How do you know this? ***results match***
   - ➔ How can we use this information in our investigation?

Activity 3: Get to Know the Suspects

15 minutes

1. Instruct students to open their books to "Activity 3: Letters from the Suspects."
2. Read aloud the following email from Mr. Mugg.

> Dear Forensic Scientists,
>
> At the start of the school year, I always ask my students to write a letter to me about themselves—their interests, activities, hopes about fourth grade, and dreams about the future. I keep these letters because they help me get to know my students better, and they come in handy when I plan lessons and activities. Enclosed are the letters written by the four suspects in this mystery. I'm sharing them with you now because, as important evidence, they shed light on whether any of these students may have been involved in the missing money. Specifically, were any of these students exposed to the powder substance you identified today?
>
> Good luck! I look forward to learning about your discoveries!
>
> Mr. Mugg
>
> P.S. Please keep your copy of these letters. They contain a lot of information that is likely to prove useful as we move forward in our investigation.

3. Direct them to write in the name of the suspect at the top of his or her letter.
4. In their pairs, students should take turns reading aloud the letter from each suspect.
5. Ask students:
   - ➔ How can we use this information in our investigation?
   - ➔ Which information seems the most relevant to our activities today?
   - ➔ Based on the information in these letters which students were most likely to come into contact with the evidence?
   - ➔ Do these names match those you identified with an "X" on the chart "Evidence Summary:

Powder Evidence"?

- ➔ What other observations, findings, or suspicions do you now have?

6. Instruct students to record their observations, findings, or suspicions in the Case Notes section of the Student Books.

Wrap-Up

10 minutes

Encourage discussion about this lesson as a whole.

Ask:

- ➔ How certain can you be that a student suspect left the powder evidence at the crime scene? ***Not very***
- ➔ Can you positively identify someone based on your findings in today's activities? ***No. Many people, teachers and students, come into contact with the powders investigated today. Such evidence is called "class evidence" because it cannot lead to a conviction of a crime, but it can provide additional information. (See Lesson 5 for more on "class evidence.")***
- ➔ What other interesting things did you learn from the student letters that might have a bearing on this case? ***Possible answers could be that letter writers mentioned wearing "black sweaters," writing "coded messages," curiosity about geocaching and the contents of the canister containing treasures.***
- ➔ What can you tell about the personalities of the writers of these letters?
- ➔ What can a personality tell you about a person's involvement in a crime?

Clean-up

5 minutes

1. Choose two people to circulate with garbage bags or cans to collect from each group. Foam plates should not be thrown out. They will be needed in future lessons.
2. Wipe down work spaces.
3. Check the floor for spills and clean.
4. Hands should be wiped.
5. Return materials to the suitcase box.

Other Directions, Discussions and Destinations

The following activities and websites will enrich what has been learned in this lesson about chemistry!

1. How does a chemical reaction happen? Check out this free science site by a reputable organization to find out: **http://www.chem4kids.com/files/react_intro.html**
2. PBS Kids leverages the full spectrum of media and technology to bring the world of science to young imaginations. Try playing these videos to get kids excited about and involved in chemistry: **https://www.pbslearningmedia.org/collection/zoom-chemistry/.**

Lesson 3

Activity 1: Data Table

Name:					
	Suspect #1	Suspect #2	Suspects #3 & #4	Suspects #3 & #4	Evidence
Sample:	**Plaster of Paris**	**Powdered Sugar**	**Baking Soda**	**Salt**	
Senses color texture					
Hand Lens **translucent**: allows light through **opaque**: can't see light through **crystal**: colorless & see-through powder					
Water Test **solution**: completely dissolves to form a liquid **suspension**: does not completely dissolve; stays separated					
Vinegar Test **reaction**: change occurs **no reaction**: nothing happens					

Circle the powder you believe matches the evidence:

Plaster of Paris **Powdered Sugar** **Baking Soda** **Salt**

Activity 2: Evidence Summary: Powder Evidence

Directions:

1. Write suspect names in the correct boxes.
2. Place an X in the box for each suspect who matches the evidence.

Name:				
	Suspect #1	**Suspect #2**	**Suspect #3**	**Suspect #4**
Evidence Matches			X	X

Lesson 3

Suspect #1

Name: _____

Dear Mr. Mugg,

I'm glad you want to learn more about me because I'm interesting! My best friend is Willard, a fifth grader, and my second best friend is Tammy, my Golden Retriever. We do everything together, including geocaching, so I'm really excited about our field trip.

I play basketball and like to ride my bike. I also make up games for my friends in the neighborhood, like treasure hunts and my own special version of capture the flag. I like solving puzzles, and making up puzzles too. I'm in the model building club at school.

School is O.K. If I had to choose a favorite subject, I guess it would be science or history. I like to build things, and I like to imagine what it would be like to live in the world a long, long time ago, when people had to grow their own food and hunt.

My dreams about the future are not very clear. Sometimes I think I would like to run my own bike shop. Other times I think I could be an explorer.

I hope we have a good year.

Lesson 3

Suspect #2

Name: _____

Dear Mr. Mugg,

You will get to know me really quickly, so I don't need to write much about myself. My friends say I talk a lot. They still like me, though, because I come up with the best ideas for things to do. We have a secret club and meet in a very cool treehouse. No one knows where it is or what we do because we send coded messages to each other. At school, I'm in the cooking club. Today we are making chocolate crackles with powdered sugar on top.

I either ride my bike or walk to school every day with my friends. Sometimes Alicia brings her puppy, Merry-go-Round, with us. (We call her "Mary" for short.) On cold days, Mary wears a little black sweater. She's the cutest!

My parents say I will be a lawyer or a CEO someday because "I like to tell people what to do." Especially my sister! That's not always true, but a CEO is the president of a big company. I would like that.

I can't wait to go on the field trip and find treasures. What kinds of treasures will we find, Mr. Mugg? Can you tell us?

Lesson 3

Suspect #3

Name: _____

Dear Mr. Mugg,

I really hope we have a good year because third grade was not so great for me.

I did not do well in math, and my parents made me go to tutoring. Actually, my parents make me do lots of things, like ride my bike to school, wear stupid black sweaters, and take cooking lessons. In fact, they made me join the cooking club at school. (It's actually kind of fun, but please don't tell my parents this.)

My favorite subject is recess (just kidding). I also like art and music, reading and doing crossword puzzles. My parents don't let me go many places, so I'm really looking forward to our geocaching field trip. Kids from your class last year talk about it all the time.

I like to dream about the future a lot. I plan to live in a big city and have lots of friends and do lots of fun stuff—like traveling to new places. My parents probably won't see me much.

My hopes for fourth grade are that I will not need a math tutor and I will make more friends.

Lesson 3

Suspect #4

Name: _____

Dear Mr. Mugg,

I have one sister, two best friends, and one goldfish named Sammy. My sister is bossy, so I spend most of my time with Abigail and Maris. We like to look at fashion magazines and design new outfits for ourselves. I'm making a jacket in my sewing club from a photograph I found in a magazine! I'm also in the cooking club because my parents made me and my sister go. It's O.K. I like to be busy.

Abigail and Maris and I are already planning what we'll wear on our class field trip. Do you think the weather will be warm or cold? I'm hoping we get to see the tiny blue eggs in the nest that your students saw last year.

My favorite subjects in school are math and art. I know these don't go together, but it's true that I feel at my best in both of these subjects.

I have many dreams for the future. Maybe I will be a famous clothing designer with my own label someday. That would be a dream come true!