

PRESENTS

CSI: LIVE

TEACHERS' RESOURCE MANUAL

Hands-On Experiments and
Classroom Demonstrations

Volume 1.0

Id. Does Not Apply
e Age: 2-5
Applicable





Teachers' Resource Manual

Mad Science CSI: LIVE!

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History and Mission of Mad Science®

Established in Montreal, Canada, in 1985, the Mad Science Group performs live, interactive, and exciting science programs to students in 22 countries through a network of more than 200 franchises. Mad Science presentations are designed specifically to be fun, entertaining, and educational. The CSI: LIVE! performance you attended with your group demonstrates Mad Science's commitment to both science education and sparking imaginative learning. Visit our website at www.madscience.org to discover how you can expand the experience and invite Mad Science into your community center, or home.

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Welcome to the CSI: LIVE! Teachers' Resource Manual

This manual provides demonstrations and activities related to Mad Science CSI: LIVE! They are performed in the classroom to extend the experience for students in fourth grade and up. This manual also fulfills specific standards to meet the needs of educators, outlined in the following section, as well as to make the inquiry-based learning process easier. Included is a collection of science activities, multi-curricular extension ideas, vocabulary and background information to ensure that the concepts in the activities are clear.

This guide is also practical for scout leaders, camp directors, after-school program animators, and parents to conduct hands-on science activities consistent with the concepts presented in CSI: LIVE! The activities, designed for one to twenty-five students, further illustrate the science concepts related to crime scene investigation.

The experiments follow a number of physics, chemistry, and even entomology principles. The activities demonstrate concepts related to forensic science. The organization of the main concepts, materials needed, tips, safety precautions, detailed steps, and explanations simplify conducting the experiments. Extension activities in other subjects and field trip suggestions are also included to expand the general multi-disciplinary nature of both science and particularly forensic science. Finally, there is a brief review of the main scientific concepts referred to in crime scene investigation, related vocabulary, and books to consult if more information is required.

The worksheets and answer keys section provides a generic experiment page to photocopy and distribute for students' use. It encourages students to note all the observations of any conducted science experiments—this will reinforce the scientific method's important elements. You may want to review these elements with the class before beginning any activities. The scientific method's definitions on the following page are suitable for students to help clarify the ideas and processes involved in conducting a scientific experiment.

Definitions of the Scientific Method

HYPOTHESIZE

A hypothesis is guessing what will happen when you do an experiment.

RECORD MATERIALS AND PROCEDURES

Write down or draw the materials you use and steps you follow.

OBSERVE

You should record whatever you see happening during an experiment. You can both write and draw what you see happening. This will help you assess what occurred during the experiment and can help if you ever want to do the experiment again. While recording your observations, try to observe using your sense of smell, taste, touch, sight, and hearing to gather the most from your senses as possible. Remember to never smell, taste, or touch anything that you do not recognize or your teacher does not approve.

DRAW CONCLUSIONS

Conclusions are your ideas about why the experiment worked—or did not work—the way it did.

CSI: LIVE! Teachers' Resource Manual Meets American National Science Education Standards

The National Research Council in the United States developed the National Science Education Standards, in collaboration with many other bodies, as well as a number of teachers, school administrators, parents, curriculum developers, college faculties, scientists, engineers, and government officials. They outline what students need to know, understand, and apply to be scientifically literate.

SCIENCE AS INQUIRY

- Ability to ask questions and perform experiments.

PHYSICAL SCIENCE

- Ability to identify properties of objects and materials.

LIFE SCIENCE

- Ability to identify characteristics of organisms.

SCIENCE & TECHNOLOGY

- Ability to distinguish between natural objects and those made by humans.

HISTORY & NATURE OF SCIENCE

- Understand science as a human endeavor.

Mad Science Teachers' Resource Manuals Meet American National Science Education Standards

	CSI: LIVE!	Don't Try This At Home	Don't Try This At Home II: Newton's Revenge	Funky Farmworks	Mad Mission to Mars: 2025	Movie Magic	Taking The World By Storm
Science As Inquiry							
Abilities necessary to do scientific inquiry	x	x	x	x	x	x	x
Understanding about scientific inquiry	x	x	x	x	x	x	x
Physical Science							
Properties of objects and materials	x			x		x	
Position and motion of objects	x	x	x		x	x	
Life Science							
Characteristics of organisms	x			x	x		
Life cycles of organisms				x			
Organisms and environments	x			x			
Earth and Space Science							
Properties of earth materials	x			x	x		
Objects in the sky					x		x
Changes in earth and sky					x		x
Science and Technology							
Ability to distinguish between natural objects and objects made by humans					x		x
Ability of technological design	x	x	x		x	x	x
Understanding about science and technology	x	x	x	x	x	x	
Science in Personal and Social Perspectives							
Personal health				x			
Characteristics and changes in populations							
Types of resources				x	x		
Changes in environments				x	x		x
Science and technology in local challenges							
History and Nature of Science							
Science as a human endeavor	x	x	x	x	x	x	x

The Production of CSI: LIVE! & Manual Meet Canadian Common Framework of Science Learning Outcomes

GENERAL LEARNING OUTCOMES

- Students investigate objects and events in their immediate environment and use scientific vocabulary when communicating their understanding and results
- Describe and demonstrate how to use materials and tools to answer science questions and solve practical problems
- Demonstrate that science and technology use specific processes to investigate the natural and constructed world or to seek solutions for practical problems

SKILLS

- Students observe, explore and record the results of materials and events that occur in their lives
- Teamwork: sharing and communicating ideas about explorations
- Use appropriate methods to interpret investigative findings

KNOWLEDGE

- Describe and compare characteristics and properties of living things, objects, and materials

SPECIFIC LEARNING OUTCOMES

- Ask questions that lead to exploration and investigation
- Identify problems that require solving
- Make predictions based on an observed pattern
- Select and use materials to carry out explorations
- Students identify materials and suggest a plan for their use

PERFORMING & RECORDING

- Students observe, explore, and record the results of materials and events in their immediate environment
- Follow a simple, one-step-at-a-time, instructional procedure
- Manipulate materials purposefully
- Use appropriate tools to manipulate and observe materials, and build simple models
- Observe using one, or a combination of the senses
- Use written language, pictures, and charts to make and record observations and measurements

ANALYZING & INTERPRETING

- Express observations to describe the characteristics of studied materials and objects
- Propose a theory to an initial question or problem, and observe or research to draw simple conclusions

COMMUNICATION & TEAMWORK

- Students work together to share and communicate ideas about their explorations

The Science of CSI: LIVE!

The word “forensics” comes from the Latin word “forensis,” which means before the forum. In Roman times, a defendant and plaintiff would stand before a forum, which is a group of citizens, to tell their sides of the story. The forum would determine the verdict, deciding which person had the best forensic’s skills. Nowadays, forensics is associated with the term forensic science, which is using scientific evidence to help solve crimes. Findings and conclusions from forensics science are evidence in courts of law.

Forensic science involves studying evidence to determine proof. Studying evidence includes other fields such as anthropology, medicine, odontology, biology, chemistry, psychiatry, document research, engineering, and toxicology. Some forensic science careers include Medical Examiner, Forensic Photographer, Criminalist, and Latent Print Technician. These people collect, preserve, package, transport, and document physical evidence left at the crime scene.

CSI: Crime Scene Investigation television series incorporates real-life investigation methods and stories adapted for prime time television. In order to make the drama series as realistic and accurate as possible, the writers of the show consult with forensic experts working in the field. The television show’s cutting-edge technology highlights the tools available in modern forensic science. The growing interest in forensics in today’s culture can be attributed to the success of the highly rated TV show and proves the point—CSI makes science cool.

Activities and Demonstrations

This manual has four main forensic themes that make up the class activities. There are three activities for each theme, with some challenging extension activities for advanced classes. All activities are appropriate for fourth grade and up. Each activity is rated with one of the following difficulty levels: basic (grades 4-6), moderate (grades 5-7), and advanced (grades 6-8). You will find worksheets, puzzles, and answer keys for each theme towards the end of the manual.

THEME 1: FORENSIC CHEMISTRY

Students learn about the chemical reactions that scientists use to identify substances from the crime scene.

THEME 2: SCENE OF THE CRIME

Students explore activities based on evidence collection.

THEME 3: IDENTIFICATION

Students examine physical and biological body marks and learn how scientists use such information to identify people.

THEME 4: EVIDENCE

Students engage in experiments using scientific techniques to analyze trace evidence.

Experiment: Swab Test

TIME

30 min

TOPIC

Forensic chemistry

SUMMARY

Students will create chemical reactions to locate an object's chemical substances.

DIFFICULTY LEVEL

Basic

SAFETY

- Wear goggles and gloves to prepare chemical recipes.
- Have children wear goggles and gloves to work with chemicals.
- Phenolphthalein contains alcohol, stains, and is flammable. Do not distribute more than two table-spoons in the bottom of each cup. Rinse any surfaces in contact with phenolphthalein with water; wash exposed skin in contact with soap and water.
- Either dispose used phenolphthalein (0.5% solution) at a local chemical depot, or flush used quantity down a sink with a large quantity of water (if local rules permit this).

TIPS

- You can purchase phenolphthalein solution from a science supply store. If you have phenolphthalein powder, follow the recipe to make a 0.5% solution.

MATERIALS

- White absorbent paper towels
- Cotton swab box
- 2 cups (to mix solutions)
- 3 teaspoons (for sugar, salt, and baking soda solutions in class)
- 1 small cup for each group
- 14g (1tbsp) sugar
- 14g (1tbsp) salt
- 14g (1tbsp) baking soda
- 0.75L (3 cups) water
- 0.5g (1/4 tsp) phenolphthalein
- 50mL (2fl. oz.) ethanol
- 50mL (2fl.oz.) distilled or spring water
- 5mL (1 tsp) ammonia
- 10mL (2 tsp) vinegar
- 4 bottles (for solutions)

RECIPES

Phenolphthalein 0.5% indicator solution

(preparation 5 min)

- 1 Mix 50mL (2fl.oz.) ethanol (95% solution) with 50mL (2fl.oz.) distilled or spring water.
- 2 Add 0.5g (1/4tsp) phenolphthalein and stir.
- 3 Store in a bottle away from light. (keeps about 1 year)
- 4 Add one drop phenolphthalein to 5mL (1tsp) ammonia to test: The liquid should turn pink.
- 5 Add 10mL (2tsp) of vinegar: The liquid should turn colorless.

Saturated solutions

(sugar, salt, and baking soda) (preparation 15-20 min)

- 1 Warm 250mL (1 cup) of water.
- 2 Stir in 14g (1tbsp) sugar at a time until dissolved.
- 3 Transfer to a bottle and allow to cool. Keeps about 1 week (may grow mold after 1week).

Experiment: Swab Test

- Repeat steps 1 to 3 with salt and baking soda.

PROCEDURE

- Before class begins, add a spoonful of each saturated solution to separate spots on each paper towel—at the same spots on five paper towels. Allow 5 to 10 minutes for the spots to dry before class begins.
- Divide the class into five groups. Hand each group a prepared paper towel.
- Inform the students they are going to search for a chemical that turns pink when it reacts with phenolphthalein. Tell them the paper towels are identical. Challenge the groups to a race to find the spot with the chemical.
- Pour the phenolphthalein in small cups and hand one to each group. Hand each student one cotton swab.
- Instruct the students to dip their cotton swab in the phenolphthalein solution.
- Instruct the groups to start, one-member-at-a-time, swiping different areas of their paper towel to cover as much area as possible. Observant students will swipe the visible, dry tiny crystals.

EXPLANATION

Phenolphthalein (pronounced fee-nole-FAIL-leen) is a pH indicator that turns pink with an alkaline or basic chemical. Sugar and salt are not alkaline. Baking soda is alkaline. Touching the phenolphthalein to the dried baking soda crystals dissolves the baking soda. The baking soda reacts with the phenolphthalein, which turns pink. Forensic scientists use phenolphthalein and other chemicals in a test called the Kastle-Meyer Test to find bloodstains. Blood turns pink when it reacts with phenolphthalein and other chemicals.

Experiment: Proofing Powders

TIME

60 min

TOPIC

Forensic chemistry

SUMMARY

Students will test chemicals with solutions to identify a substance.

DIFFICULTY LEVEL

Basic

SAFETY

- Wear goggles and gloves to prepare chemical recipes.
- Have children wear gloves and goggles to work with chemicals.
- Phenolphthalein contains alcohol, stains, and is flammable. Do not distribute more than two tablespoons in the bottom of each cup. Rinse any surfaces in contact with phenolphthalein with water; wash exposed skin in contact with soap and water.
- Dispose used Benedict's solution at a local chemical depot.
- Either dispose used phenolphthalein (0.5% solution) at a local chemical depot, or flush used quantity down a sink with a large quantity of water (if local rules permit this).

TIPS

- Purchase Benedict's solution from a science supply store, pharmacy, or follow the recipe on the next page to make your own Benedict's solution.
- See previous activity for the phenolphthalein recipe.

MATERIALS

- 17g (1tbsp) sodium citrate
- 10g (2tsp) sodium carbonate
- 100mL (31/2fl.oz.) warm water (for Benedict's recipe)
- 1.7g (1/3 tsp) copper sulfate
- Benedict's solution
- 2 measuring cups for Benedict's solution
- Phenolphthalein 0.5% solution
- 125mL (1/2 cup) vinegar
- 125mL (1/2 cup) water (for baking soda recipe)
- 100g (1/2 cup) sugar
- 100g (1/2 cup) salt
- 100g (1/2 cup) citric acid
- 100g (1/2 cup) baking soda
- Bottle with cap for baking soda solution
- 25 pipettes
- 20 craft sticks (for children to handle powdered chemicals)
- 5 Proofing Powders worksheets (see worksheets at the back)
- 4 tablespoons (for powdered chemicals before class)
- 20 aluminum muffin cups
- 100 paper muffin cups
- 25 small cups
- Marker
- 25 pencils

HOW TO PIPETTE

- 1 Fill a cup with water and place it on a table.
- 2 Squeeze the pipette bulb between index finger and thumb.
- 3 Keep the bulb squeezed, and dip the pipette tip into the water.
- 4 Release the pressure on the bulb to draw water up into the pipette.
- 5 Position the tip of the pipette just above the mouth of another cup.
- 6 Squeeze the bulb gently to squirt drops out of the pipette.
- 7 Squeeze the bulb quickly to squirt water out of the pipette.

Experiment: Proofing Powders

RECIPES

Benedict's solution

(preparation 20 min)

- 1 Add 17g (1tbsp) sodium citrate and 10g (2tsp) sodium carbonate to 80mL (2 1/2fl.oz.) warm water in a measuring cup.
- 2 Once dissolved, increase water to 85mL (3fl. oz.).
- 3 Add 10mL (2tsp) water in a separate measuring cup, and dissolve 1.7g (1/3tsp) copper sulfate.
- 4 Slowly pour the step 3 solution into the step 2 solution, constantly stirring.
- 5 Increase water to 100mL (3 1/2fl.oz.).

Baking soda solution

(preparation 5 min)

- 1 Mix 20g (4tsp) baking soda in 125mL (4fl.oz.) water in a bottle.
- 2 Shake to dissolve, shake before use.

PROCEDURE

- 1 Before class begins, label and fill respectively every four aluminum cups with one of the following ingredients: sugar, salt, citric acid, and baking soda. Label, and fill respectively five small cups halfway (for each group) with the following ingredients: Benedict's solution, vinegar, water, baking soda solution, and phenolphthalein.

- 2 Divide the class into five groups. Give four different aluminum cups to each group: sugar, salt, citric acid and baking soda. Give twenty paper muffin cups, five pipettes, and four craft sticks to each group.
- 3 Give each group the Proofing Powders worksheet. Tell the students they will test four chemicals with five solutions and record the reactions.
- 4 Instruct the students to label a paper muffin cup with a test solution and chemical (i.e. Benedict's solution/sugar).
- 5 Use a craft stick to transfer a tipful of the chemical into the labeled paper muffin cup. Instruct the students to use the pipette to place a drop of a test solution with the chemical in the paper muffin cup, and record observations on their worksheet. Have the students repeat the test with each chemical and solution.

EXPLANATION

The answer key to the experiment is below. Four chemical changes can happen in a chemical reaction. The temperature or color changes, and bubbles or precipitate forms. A substance's chemical change reaction reveals clues about its characteristics. Scientists perform a series of tests on unknown substances to determine their chemical make-up. Scientists perform these tests with common substances in order to create a list of results to compare to unidentifiable substances.

Worksheet Answer Key

CHEMICAL	TEST SOLUTION				
	Benedict's Solution	Vinegar	Water	Baking Soda Solution	Phenolphthalein Indicator
Sugar	turns orange	dissolves	dissolves	dissolves	dissolves
Salt	stays blue	dissolves	dissolves	dissolves	dissolves
Citric Acid	stays blue	dissolves	dissolves	bubbles	dissolves
Baking Soda	stays blue	bubbles	dissolves	dissolves	turns pink

Extension Experiment: Powder Puzzle

TIME

10 min

TOPIC

Forensic chemistry

SUMMARY

Students will use the results from the previous experiment to identify an unknown substance.

DIFFICULTY LEVEL

Moderate

SAFETY

- Wear goggles and gloves to prepare chemical recipes.
- Have children wear gloves and goggles to work with chemicals.
- Phenolphthalein contains alcohol, stains, and is flammable. Do not distribute more than two tablespoons in the bottom of each cup. Rinse any surfaces in contact with phenolphthalein with water; wash exposed skin in contact with soap and water.
- Dispose used Benedict's solution at a local chemical depot.
- Either dispose used phenolphthalein (0.5% solution) at a local chemical depot, or flush used quantity down a sink with a large quantity of water (if local rules permit this).

TIPS

- Assign one chemical to each group member.
- See previous activities for the phenolphthalein and Benedict recipes.

MATERIALS

- Vinegar
- Water
- Baking soda solution
- Benedict's solution (see recipe on pg 13)
- Phenolphthalein 0.5% solution (see recipe on pg 10)
- Sugar
- Baking soda
- 7 tablespoons
- 25 pipettes
- 5 craft sticks
- 5 completed worksheets (from Proofing Powders activity)
- 25 aluminum muffin cups
- 30 paper muffin cups
- Marker

PROCEDURE

- 1 Before class begins, label and respectively fill each aluminium muffin cup with two spoonfuls of one of the following ingredients: Benedict's solution, vinegar, water, baking soda solution, and phenolphthalein solution. Label five paper muffin cups "unknown mix," and place one spoon of sugar and baking soda in each cup.

Extension Experiment: Powder Puzzle

- 2 Divide the class into five groups. Give each group one “unknown mix” cup. Give each group five paper muffin cups, five pipettes, and one craft stick.
- 3 The groups will use their completed Proofing Powders worksheet. Tell the students they will test the “unknown mix” of two substances and record the reactions to determine the identities of the two powders. Inform the students that the mixture can be any combination of two powders that they already tested: baking soda, citric acid, salt, or sugar.
- 4 Instruct the students to label an empty paper muffin cup with the name of one of the test solutions: Benedict’s solution, vinegar, water, baking soda solution, and phenolphthalein. Have the students use a craft stick to transfer a tipful of the “unknown mix” respectively to each labeled paper muffin cup.
- 5 Instruct the students to use the pipette to place a drop of the corresponding test solution on the chemical in the paper muffin cup, and record results on their worksheets. Have the students repeat the test with each solution.
- 6 Instruct the students to compare the test results with the results recorded on their Proofing Powders worksheet to determine which two substances are in their unknown mix. For instance, we can assume that one of the two powders in the unknown mix is sugar if the solution turned orange when tested with Benedict’s solution. The Proofing Powders worksheet shows this is the reaction of Benedict’s solution with sugar.

EXPLANATION

This extension activity challenges students to identify two powders from an unknown mixture. The powders can be any combination of the four substances from the previous activity. The students have already completed a chart that shows the individual reactions of each chemical with the five test solutions. Comparing reactions of an unknown substance with the reactions of known chemicals help pinpoint clues to identify it. In this case, the Benedict’s solution turns orange, identifying sugar. Phenolphthalein identifies baking soda because the reaction turns pink. Vinegar also identifies baking soda because the reaction creates bubbles. Since the unknown mixture is a combination of baking soda and sugar, it turns orange with Benedict’s solution, pink with phenolphthalein, and bubbles with vinegar. Scientists use a more advanced technology than these tests to determine chemical composition of unknown substances. They use a HPLC (high-pressure liquid chromatography) apparatus that separates the chemicals into their basic molecular structure for analysis.

Experiment: Blood Tests

TIME

20 min

TOPIC

Forensic chemistry

SUMMARY

Students will mix blood types to see how they react.

DIFFICULTY LEVEL

Moderate

SAFETY

- Wear goggles and gloves to prepare chemical recipes.
- Have children wear gloves and goggles to work with chemicals.

TIPS

- Assign a blood type to each group member. Assign a record keeper from each group.
- Health food stores or online science stores have calcium chloride and sodium alginate (kelp powder).

MATERIALS

- 20 test tubes
- 80 paper muffin cups
- 20 pipettes
- Marker
- 5 Blood Test worksheets (see worksheets at the back)
- 2.5g (1/2 tsp) sodium alginate
- 28g (2 tbsp) calcium chloride
- 500mL (17fl. oz.) Warm water
- 28g (2 tbsp) sugar
- Red food coloring
- 4 craft sticks
- 4 large paper cups (for solutions)

RECIPE (preparation 15 min)

Sodium alginate solution

- 1 Label a cup A, and mix 2.5g (1/2tsp) sodium alginate with 125mL (4fl.oz.) warm water.
- 2 Add two drops of red food coloring and mix well with a craft stick.

Calcium chloride solution

- 1 Label a cup B, and mix 28g (2tbsp) calcium chloride with 125mL (4fl.oz.) warm water.
- 2 Add two drops of red food coloring and mix well with a craft stick.

Sugar solution

- 1 Label a cup AB, and mix 28g (2tbsp) sugar with 125mL (4fl.oz.) warm water.
- 2 Add two drops of red food coloring and mix well with a craft stick.

Water solution

- 1 Label a cup O, Mix 125mL (4fl.oz.) warm water and two drops red food coloring.
- 2 Mix well with a craft stick.

Experiment: Blood Tests

PROCEDURE

- 1 Before class begins, make sure to prepare the recipes.
- 2 Label five test tubes A, five test tubes B, five test tubes AB and five test tubes O. Fill each 1/3 with its respective solution.
- 3 Divide the class into five groups. Give each group each test tube solution: A, B, AB and O. Give each group sixteen paper muffin cups, four pipettes, and one Blood Test worksheet.
- 4 Tell the students the test tubes are four simulated blood types and that they will mix different blood types to test the effects.
- 5 Instruct the groups to label a paper muffin cup with one blood type and use the pipette to transfer a few drops respectively.
- 6 Instruct the students to use the pipette to mix another blood type to the paper cup and record their observations on the Blood Test worksheet. Have the students repeat the test with each blood type.

EXPLANATION

The answer key is below. Blood cell surfaces carry identifiable substances called antigens. These antigens produce antibodies that fight infections from the body. Blood cell surfaces can have either antigen A, B, AB, or O. Antigen A blood cells are A type blood cells, B are B type, AB are AB type, and O are O type blood cells. These antigens determine the reaction of mixed blood types. Mixed blood types either clump or repel each other (no visible reaction). Mixing A and B type blood cells cause clumping. Inherited blood types can determine familial links.

The four main groups A, B, AB and O frequencies vary in populations throughout the world. In the UK, although not in every case, donors with similar ethnic backgrounds usually carry the rare blood types. For example, 10% of people with an Anglo-Saxon background are B group, compared to 25% of people with an Asian background. See the ABO distribution map in the worksheets section for more details.

Worksheet Answer Key

BLOOD TYPE	A	B	AB	O
A	no reaction	coagulation	no reaction	no reaction
B	coagulation	no reaction	no reaction	no reaction
AB	no reaction	no reaction	no reaction	no reaction
O	no reaction	no reaction	no reaction	no reaction

Experiment: Print Casting

TIME

30 min, 1hr waiting time, 24 hrs to dry

TOPIC

Scene of the crime

SUMMARY

Students create a three-dimensional plaster cast.

DIFFICULTY LEVEL

Basic

SAFETY

- Do not pour plaster down the sink!

TIPS

- The sand may be too fine if you have trouble making a foot impression. Try using a light dusting of talcum powder or hair spray to stabilize the impression before pouring the cast. If you use hairspray, just spray in the air and let the cloud settle on the sand.
- If the shoeboxes are large enough, have both students make a casting in the same box.

MATERIALS

- A shoebox, cup of water, large paper cup, craft stick, and two paintbrushes for every two students
- 1 large bag of sand
- Plaster of Paris
- Newspaper
- Paper towels

PROCEDURE

- 1 Before class begins, fill several shoeboxes (1 per 2 students), $\frac{3}{4}$ full with sand.
- 2 Divide the class into groups of two. Hand out the prepared shoeboxes and one cup of water to each group. Have the students use their fingers to sprinkle water over the sand until slightly damp and then smooth out the surface.
- 3 Instruct the students to place the box on newspaper, on the floor. Have one student from each group place their bare foot in the damp box of sand. Instruct the student to force their weight on that foot, and then remove it carefully. Wipe the foot off on a paper towel.
- 4 Following the plaster of Paris instructions, add plaster and water in the large paper cups. Hand one cup to each group and instruct them to use the craft stick to stir the mixture until smooth.
- 5 Instruct the students to pour the plaster slowly over the footprint until it is full. Allow it to dry for one hour.
- 6 Remove the cast from the box and let it dry on newspaper overnight.
- 7 Using a dry paintbrush, have the students brush off any sand stuck on their cast. Challenge the students to hypothesize about the foot based on its cast.

Experiment: Print Casting

EXPLANATION

Fingers, hands, feet, shoes, tires, tools, and even cars make prints. A print found at a crime scene is important evidence, which can help link a suspect to an offense. While criminals usually either wear gloves or wipe surfaces they touch to avoid leaving fingerprints, they often forget to cover up their shoe prints. Sometimes, forensic scientists are fortunate enough to find three-dimensional prints in a soft surface like soil, snow, or sand. In this case, a scientist can pour plaster in the print to make a cast. This creates a three-dimensional model to analyze or compare directly to the footwear of a suspect.

Demonstration:

Lifting a Shoeprint

TIME

30 min

TOPIC

Scene of the crime

SUMMARY

Use tape to lift a two-dimensional shoeprint.

DIFFICULTY LEVEL

Basic

SAFETY

- Beware of food allergies with students.

TIPS

- Choose a student with running shoes for the experiment (newer shoes work better).

MATERIALS

- Poster board with one shiny side (Bristol board)
- Sheet of white paper
- Cooking spray (PAM)
- Cocoa (Nestlé)
- Clear, wide packing tape
- Scissors
- Tablespoon

PROCEDURE

- 1 Put the poster down on the floor (shiny side up), and have the students gather around it.
- 2 Spray the bottom of a student's shoe with cooking spray.
- 3 Have the student step down directly and apply weight steadily onto the poster board.
- 4 Instruct the student to lift their foot up without smudging the shoeprint.
- 5 Use a spoon to sprinkle cocoa generously over the footprint.
- 6 Shift the paper around to ensure evenly coating the footprint with the cocoa. Shake the excess powder into the garbage.
- 7 Cut a piece of packing tape that is a bit longer than the footprint (avoid getting your fingerprints on the tape).
- 8 Place the tape over the footprint, and press down gently and evenly.
- 9 Lift the tape off the poster board; the cocoa print should stick to the tape.
- 10 Put a sheet of white paper on the floor, and carefully stick the tape pressing down firmly and evenly onto the paper. You now have the student's footprint.

Demonstration: Lifting a Shoeprint

EXTENSION

- 1 Divide the students, and provide the materials for each group to recreate the experiment on their own.

EXPLANATION

Footprints, tire tracks, and other types of evidence (fingerprints, hairs, fibers, etc.) can help investigators piece together what happened at the crime scene. A footprint is the impression a person leaves after they walk. Photographs, drawings, castings, or lifts collect footprints and tire tracks. Lifts involve pressing a clear sticky paper on a flat print. The tire impression, if properly collected, can prove a suspect's vehicle was at a crime scene. A footprint left at the crime scene can give us clues about the suspect's shoe type, height, stride length, and sex.

Experiment: Fingerprinting

TIME

30 min

TOPIC

Scene of the crime

SUMMARY

Students will mix glue and paint to create fingerprints, and then analyze them to determine type.

DIFFICULTY LEVEL

Basic

SAFETY

- None

TIPS

- If the fingerprint does not appear clearly on the plastic cup, it may be that you have too much glue/paint mixture on your finger. Try again using less glue.

MATERIALS

- White glue (school glue works best)
- Blue paint
- 5 small cups
- 1 craft stick
- Paper towels
- A disposable clear plastic cup, thin marker or pen, three envelope labels, and magnifying glass (optional) per student
- 25 child-safe scissors

PROCEDURE

- 1 Before the students arrive, use a craft stick to mix $\frac{1}{4}$ cup glue with a few squirts of blue paint. Prepare five cups.
- 2 Divide the class into five groups. Give each student a disposable plastic cup, marker, two paper towels, and three labels.
- 3 Have the students cut their labels in halves, stick one-half on the bottom of the cup (on the outside), and evenly stick the others—making sure to spread them out on the outside of their cups—near the rim.
- 4 Have the students choose which hand they will use to fingerprint, and write either “left” or “right” respectively on the label on the bottom of the cup.
- 5 Have the students write thumb, index, middle, ring, and pinky on the labels around the rim, leaving room for a fingerprint.
- 6 Instruct the students to dip their thumb into the prepared mixture, and then wipe some off with the paper towel.
- 7 Have the students press and remove their thumb under its label. They should see their fingerprint.
- 8 Repeat steps 6 and 7 for the other four fingers.
- 9 Have the students use magnifying glasses to compare the patterns on their fingers with the three most common classification patterns shown on the following page.

EXTENSION

- 1 Have students use the fingerprint cups to store pencils on their desks.

Experiment: Fingerprinting

EXPLANATION

Each person's fingers and toes (even identical twins) have a unique friction ridge pattern. Ridge pattern impressions are fingerprints. Our fingerprints leave the patterned mark that the glands in our hands and feet secrete (oil and sweat), which is on virtually everything we touch. Police agencies dust for fingerprints at the crime scene and try to match them to suspects in their huge international databases.

There are three main types of fingerprints: arch, whorl and loop patterns. A ridge characterizes a loop pattern when it enters from one side, rises, curves, and then exits from the same side it entered. A ridge characterizes an arch pattern when it enters from one side, rises, curves, and then exits from the opposite side it entered. Circular ridges characterize a whorl pattern.

Three main types of fingerprint patterns

ARCH



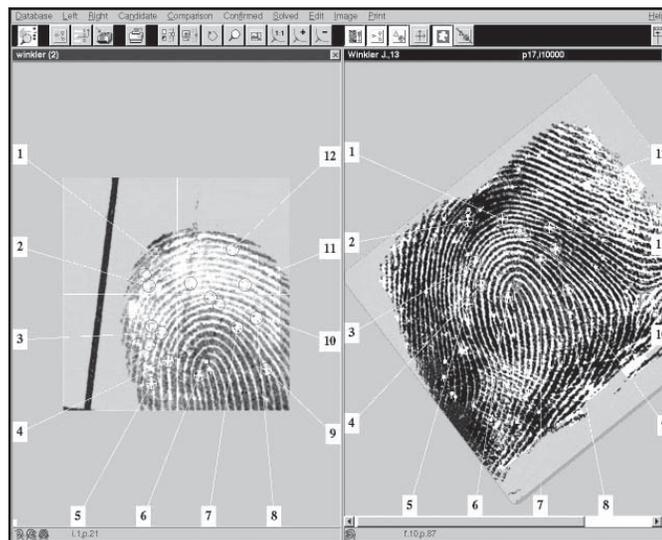
LOOP



WHORL



Typical Automated Fingerprint Identification System AFIS analysis



Reprinted from SPEX Forensics, Justification for getting your own APIS AFIS, 2004.

Experiment: DNA Extraction

TIME

25 min

TOPIC

Identification

SUMMARY

Students will extract DNA from cheek cells.

DIFFICULTY LEVEL

Advanced

SAFETY

- Wear goggles and gloves to prepare chemical recipes.
- Have children wear goggles and gloves to work with chemicals.

TIPS

- Have a stopwatch or clock with a minute hand handy. Have a waste container nearby for cups and liquid waste.
- Place a beaker filled with rubbing alcohol at each group's working space to keep the inoculating loops or crochet hooks sterile for reuse.
- Use clear sports drink to see the precipitated DNA clearly.

MATERIALS

- Lysis solution
- Bottle for Lysis solution
- 5 test tube racks
- 5 250mL beakers (for alcohol)
- 5 400mL beakers (for ice)
- A cup, pipette, and resealable bag per student

- A graduated plastic test tube with screw cap per student (purchase at an online or local science supply store)
- 1 microcentrifuge tube per student (purchase at an online or local science supply store)
- 1 inoculating loop or crochet hook per student (purchase at an online or local science supply store)
- 1.5g (1/3tsp) table salt
- 10mL (2tsp) liquid soap (e.g. Woolite)
- 90mL (3fl.oz.) water
- Ethanol 95% (or 70% isopropyl alcohol)
- Clear sports drink (e.g. Gatorade)
- Ice
- Marker

RECIPE

Lysis solution

(Preparation time 5 min)

- 1 Mix 1.5g (1/3tsp) table salt with 10mL (2tsp) liquid soap and 90mL (3fl.oz.) water in a labeled bottle.

HOW TO PIPETTE

- 1 Fill a cup with water and place it on a table.
- 2 Squeeze the pipette bulb between index finger and thumb.
- 3 Keep the bulb squeezed, and dip the pipette tip into the water.
- 4 Release the pressure on the bulb to draw water up into the pipette.
- 5 Position the tip of the pipette just above the mouth of another cup.
- 6 Squeeze the bulb gently to squirt drops out of the pipette.
- 7 Squeeze the bulb quickly to squirt water out of the pipette.

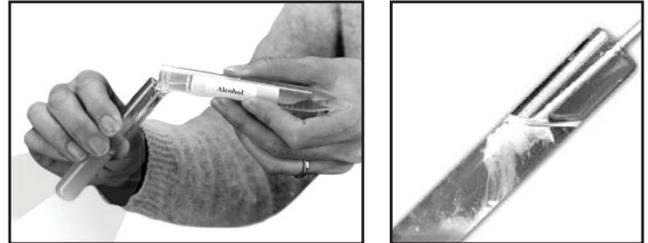
Experiment: DNA Extraction

PROCEDURE

- 1 For each student: Before class begins, fill the small bags with 2-3mL (1/2tsp) lysis solution. Fill each cup with 5mL (1tsp) sports drink. Fill the microcentrifuge tubes with 1mL (about 1/2 full) ethanol. For each group: Fill the 250mL beaker 1/2 full of ethanol. Fill the 400mL beaker 1/3 full of ice. Place the beaker with ethanol inside the beaker of ice.
- 2 Divide the class into five groups. Hand each group one test tube rack. Hand each student one graduated test tube with screw cap. Instruct the students to use the marker to label their test tubes with their initials.
- 3 Give each student a small cup of the sports drink. Instruct the students to take a sip, swish the drink for one minute (timed on your stopwatch), and scrape their cheeks with their teeth gently and continuously to help release the cheek cells.
- 4 Tell the students to spit the drink (with the collected cheek cells) back into the small cup. Have the students pour the cup's contents into their labeled test tube and discard the cup. Instruct the students to place their test tubes in the rack.
- 5 Tilt a test tube at an angle to add a bag of lysis solution to demonstrate to the students to do the same with their test tubes.
- 6 Instruct the students to cap and gently invert their test tubes 5-8 times to mix the solution, place the tubes in their rack, and let stand for two minutes (timed on your stopwatch).
- 7 Hand each student a pipette and each group one beaker of ethanol on ice. Instruct the students to hold their test tube at an angle and to use the pipettes to add the cold alcohol down the inside wall of the test tube until the total volume reaches the 12mL line (there should be two distinct layers). DO NOT shake the tubes to mix the two layers together!
- 8 Instruct the students to place their test tubes in the racks to stand for 15 minutes. Encourage the students to watch as translucent DNA strands begin to clump where the alcohol layer

meets the cheek cell solution.

- 9 After 15 minutes, hand each student one microcentrifuge tube and one inoculating loop. Instruct the students to scoop out their DNA from the test tube and transfer it into the microcentrifuge tube.



Reprinted from University of Utah, Genetic Science Learning Center, DNA Extraction, 2008.

EXPLANATION

DNA is in all body cells except blood cells (the DNA-containing nuclei of blood cells squeeze out of the cell when they mature). Lysing, or breaking open the cells and precipitating the DNA from the nucleus, extracts DNA. The lysis solution contains soap that breaks apart the cell membranes, and salt that increases the osmotic pressure to help break the membranes. The Gatorade or sports drink helps maintain the electrolytes and pH environment the DNA needs. The cold alcohol causes the DNA to precipitate, or extract from the solution. Each individual has a specific DNA sequence. In forensic science, scientists use DNA to help identify suspects and victims.

Extension Experiment: DNA Fingerprinting

TIME

20 min

TOPIC

Identification

SUMMARY

Students will examine DNA fingerprints from gel electrophoresis and compare the results.

DIFFICULTY LEVEL

Advanced

SAFETY

- None

TIPS

- None

MATERIALS

- DNA Fingerprinting worksheets for the students (see worksheets at the back)
- Rulers per student
- Four different colored pencils per student

PROCEDURE

- 1 Hand each student a worksheet. Inform them they are looking at DNA fingerprint results.
- 2 Explain that DNA fingerprints are as unique as human fingerprints. The DNA prints on the worksheet belong to birds. There are four bird nestlings, one mother bird, and three adult male birds (one is the father of the nestlings).
- 3 Explain that children inherit DNA from their parents, so what they see in a nestling's DNA print corresponds to either one or both parents' DNA prints.
- 4 Challenge the students to follow the instructions on the worksheet to determine which male bird is the father.

EXPLANATION

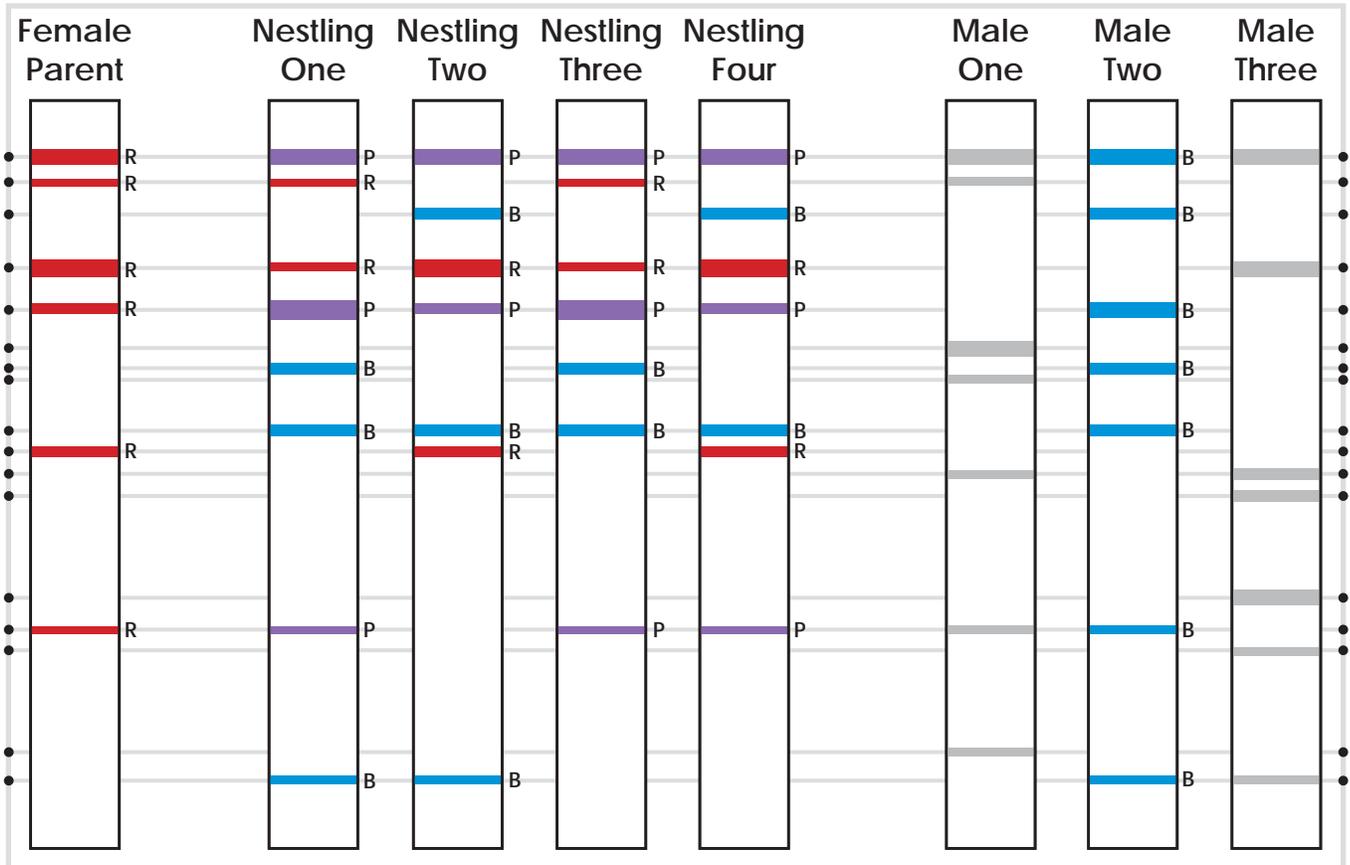
The answer key is on the next page. Analyzing DNA is sorting extracted DNA fragments by size. The process involves extracting DNA, cutting it up into fragments, and filtering through a gel that looks like a flat slab of jelly. The smaller fragments filter through the gel faster than the larger fragments so the entire batch of DNA fragments end up separating along the gel. These fragments are bands. The bands are exposed to a DNA marker (genetic code segments that light up with a chemical reaction), and then analyzed. A DNA marker marks a DNA fragment to be captured on film or digital camera. A visible marked band pattern across the gel is a DNA fingerprint or profile. Individuals inherit genetic codes from their parents. This means that DNA from a child will correlate with the DNA from the parents. Analyzing DNA fingerprints for paternity claims requires that all of the bands in the child's profile must be visible in either the mother or father's DNA profile.

Extension Experiment: DNA Fingerprinting

Worksheet Answer Key

The father of the nestlings is male #2. In nestling profiles, blue bands are inherited from the male parent. Red bands are inherited from the female parent. Purple bands come from both parents.

Parent Two



R = red
 B = blue
 P = purple

Experiment: Body Mapping

TIME

50 min

TOPIC

Identification

SUMMARY

Students identify “lifetime marks” – marks that remain on a body for a lifetime such as broken bones, surgical scars and tattoos

DIFFICULTY LEVEL

Basic

SAFETY

- None

TIPS

- None

MATERIALS

- Body mapping worksheets per student (created by the teacher)
- 8 measuring tapes
- Pencils for students

PROCEDURE

- 1 Create a worksheet before class begins. List the following measurements:
 - Body height
 - Trunk height
 - Head width
 - Head length
 - Right ear length
 - Right ear width
 - Left foot length
 - Left pinky finger length
 - Left forearm length
 - Left middle finger length
 - Outstretched reach of both arms
 - Scar length and locations
 - Broken bone locations
 - Birthmarks
 - Tattoos
 - Other body marks
- 2 Divide the class into groups of three. Hand each group a measuring tape. Hand each student a worksheet.
- 3 Instruct the students to perform the measurements requested on their worksheet. Have each group decide how to measure the body parts and how to present this information. For instance, stand with your heels against the wall to measure the body height, head length from the bottom of the chin to the top of the head, and ear width across the middle of the ear.
- 4 Have each group present their method and information to the class.

Experiment: Body Mapping

EXPLANATION

Many scientists have tried to identify a person based on their physical characteristics. One of the more famous methods is anthropometry or Bertillonage, developed and named after Alphonse Bertillon. This method, which is no longer used, consisted of cataloguing an offender's body measurements. Bertillonage was widely used until a flaw was uncovered—two people at the same prison had identical measurements. Fingerprinting replaced the Bertillonage identification.

Experiment: Indentations

TIME

45 min, one 1 hour waiting

TOPIC

Identification

SUMMARY

Students will cast their own teeth impressions.

DIFFICULTY LEVEL

Basic

SAFETY

- Do not ingest the dental alginate or modeling clay.
- Do not force a child to keep the mold in their mouth.

TIPS

- Purchase dental alginate from a medical supply store or art supply store. You can substitute dental alginate with non-toxic, air-drying, modeling clay (like Crayola Magic).
- Mold just the top set of teeth for younger students.

MATERIALS

- Dental alginate
- Water
- 25 small paper cups (e.g. Dixie cups) or dental trays for students (purchase dental trays from local medical supply stores) (for alginate)
- 25 plastic cups
- 25 child-safe scissors
- 3 unflavored gelatin packages (can be purchased at the grocery store in the baking section)
- Sauce pan
- Food coloring
- Wooden spoon
- 5 buckets
- Bowl

RECIPE

Dental alginate

(Preparation time during class 10 min)

(Working time 3 min)

- 1 Mix equal amounts of cold water with dental alginate. You have 3 minutes to work with the alginate after you add the water.
- 2 Mix until completely wet. The mixture may appear lumpy—this is okay.

Gelatin cast material

(Preparation time 5 min) (Waiting time 30 min)

- 1 Refer to the gelatin package for instructions, and add a few drops of food coloring.
- 2 Allow to cool about 30 min before using.

Experiment: Indentations

PROCEDURE

- 1 Before class begins, fill each plastic cup half-full with water.
- 2 Divide the class into five groups. Give each group a bucket. Give each student an empty paper cup and scissors. Instruct the students to cut the cups into two equal halves.
- 3 Hand each student a cup of water. Instruct the students to rinse their mouths with water and spit into the bucket.
- 4 Mix the dental alginate. Instruct the students to hold one half cup at an angle to contain the dental alginate, and fill it to the brim. The alginate should touch the entire edge of the bottom of the cup (see image).
- 5 Instruct the students to bite down into the alginate in the bottom of the cup and hold for 2 minutes before removing the mold from their upper teeth. The mold may feel stuck to the teeth, but it is just suction. (While the students are biting their molds, mix more dental alginate and pour them into the second cup halves.)
- 6 Instruct the students to place the molds on their desks.
- 7 Instruct the students to turn the cups upside-down to bite into them with their lower teeth. Have the students keep this position for about 2 minutes until the alginate sets, and then instruct the students to remove their teeth slowly. Allow these molds to set about 2 minutes.
- 8 Fill the students' cups with water if needed, and instruct them to rinse their mouths.
- 9 Pour the cooled gelatin mixture into the tooth molds and let set for 1 hour.
- 10 Gently break off dental alginate pieces to remove the gelatin teeth. The gelatin will be hard like plastic in 2-3 days.



Tilt cup up to hold the dental alginate.

EXPLANATION

Indentations or tooth markings are supporting evidence of a person's presence at the crime scene. Odontology is the science of collecting and analyzing evidence from teeth and teeth marks. Bite marks on the victim, perpetrator, object, or even a lost tooth found at the crime scene is collected evidence.

Experiment: Chromatography

TIME

30 min

TOPIC

Evidence

SUMMARY

Students will use chromatography to determine which pen the teacher uses to sign permission slips.

DIFFICULTY LEVEL

Basic

SAFETY

- None

TIPS

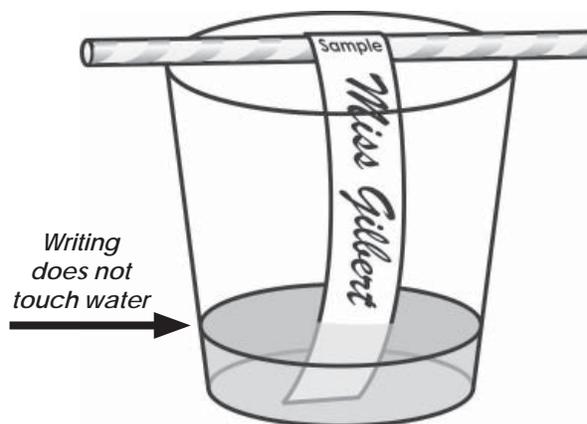
- None

MATERIALS

- A small cup, pencil, and straw per group
- 15 filter paper strips (or coffee filter strips)
- Masking tape
- Water
- 2 different black fine-point markers per group (washable, water-based)

PROCEDURE

- 1 Before class begins: Find five, black, identical, fine-point tip markers and five, black, different fine-point tip markers. Cut pieces of masking tape and use the pencil to label the five identical markers as A and the other markers B. Use marker A to sign your name (e.g. Miss Gilbert) on paper strips 1in. (2-3cm) from one end. At the other end, in pencil, write the word "sample." Make five strips.
- 2 Explain the scientific method called chromatography (see explanation). Divide the class into five groups.
- 3 Tell the class that you used a particular marker to sign your name. Hand out the sample strips to each group. Hold up the two markers and tell the class that you used one of the markers to sign your name, and the other marker is an imitation. Challenge the students to determine which black marker you used to sign permission slips (or sign letters to parents).
- 4 Add water to cover just the bottom of the small cups. Instruct the students to tape the "sample" end of the strip to the straw to form a T shape. Rest the straw horizontally on the rim of the cup so that the end of the strip immerses in the water but the signature is not touching the water.



Experiment: Chromatography

- 5 Instruct the students to observe the filter paper as it slowly absorbs water. Leave the paper in the water until the traveling water line is at least 2-3 cm (1in.) above the ink signature.
- 6 Remove the filter paper from the straw. Tape the paper to the edge of a desk to dry. Tell the students the result of the filter paper is a chromatogram.
- 7 Hand out two blank filter paper strips and two markers labeled A and B to each group. Ask the groups to use a pencil to label the filter strips A and B at the top.
- 8 Have the groups make chromatograms using marker A, then marker B.
- 9 After the chromatograms have dried, have the students compare the colorful black-ink dye patterns and determine which chromatogram (marker A or B) matches your sample signature.

EXPLANATION

Different colors actually make up ordinary, black ink. Chromatography can separate the dyes that make up black ink. Knowing how much of the dyes make up the black ink allows you to identify the pen used to write a note. When the water carries the ink up the filter paper, the different dyes that comprise the ink form a color pattern. A chromatogram is the filter paper with the color pattern.

Police use chromatography to help them solve crimes. If the police have a suspect and find a note at a crime scene, they can test the ink from the note and suspect's pen. The test results determine whether the two inks match. These tests become evidence.

Experiment: Locard's Principle

TIME

40 min

TOPIC

Evidence

SUMMARY

Students will experiment with various items to demonstrate forensic scientist, Edmond Locard's principle: Two items that come in contact leave interacting evidence.

DIFFICULTY LEVEL

Basic

SAFETY

- Beware of food allergies with students.

TIPS

- None

MATERIALS

- 5 modeling clay colors (non-drying e.g. Play-Doh)
- 4 oranges
- 5 pads of paper, ballpoint pens, and pencils
- 2 plates
- 1 pair of scissors (for instructor)
- 5 cups
- Bowl
- Lipstick
- Cotton swabs
- Paper towel
- 1 Lip Sample worksheet per group (see worksheets at the back)

PROCEDURE

- 1 Before class begins, prepare four working centers. Roll a piece of each color of modeling clay in a ball, and place them on a plate at the first center. Put the oranges in a bowl. Place the bowl and a plate at the second center. Place pens, pencils, and paper at the third center. Photocopy the lip sample worksheet so that there is one sample for each group. Place the lipstick, plastic cups, cotton swabs and lip sample worksheet at the fourth center.
- 2 Divide the class into four groups, and explain what to do at each center: allow for 5-7 minutes per center.

Center 1:

Have one group member leave and the others choose two balls from the plate to squish together. Separate the two colored balls and place them back on the plate. Have the group member return to try to identify the two colors that were in contact. (Have them look for specs of one colored clay on another.) Re-mold the two balls to erase the evidence for the next group.

Center 2:

Have one group member leave and the others choose one child to peel an orange. Have the child place the peel and orange on the empty plate, and then invite the other group member to return and try to identify who peeled the orange.

Center 3:

Have each group member write "Top Secret" on the pad of paper with a ballpoint pen. Have the students flip over to the second sheet and rub the pencil over the imprint on the blank page.

Experiment: Locard's Principle

Center 4:

Have each group member write their name in one square on the Lip Sample worksheet and then use a cotton swab to apply lipstick to their lips. Have them press their lips on the worksheet under their name. Have a group member leave, and the others choose one child to reapply the lipstick to make a print on the plastic cup. Have wet paper towels handy to wipe off lipstick. Invite the other group member to return and try to figure out whose lip print is on the cup.

- 3 After each group has worked at all four centers, discuss the Locard principle below.

EXPLANATION

Dr. Edmond Locard believed that “every contact leaves a trace,” and relied on this principle when he began his forensic laboratory—one of the first in the world—in Lyons, France, in 1910. Locard described the principle of trace evidence. In other words, a transfer of material will occur when any two materials are exposed to each another, leaving evidence behind. Even the most careful criminal will often leave behind traces at a crime scene. Forensic scientists gather this traceable evidence to enable the police to catch the criminals. Locard proved his principle when investigating the case of Emile Gourbin, a man accused of strangling his mistress. Gourbin had an alibi, but Locard scraped beneath the man’s fingernails and found skin flakes coated with the dead woman’s face powder. Gourbin subsequently confessed.

Experiment:

Exploring Entomology

TIME

20 min

TOPIC

Evidence

SUMMARY

Students will act as flies to learn that decaying matter attract flies.

DIFFICULTY LEVEL

Moderate

SAFETY

- Beware of food allergies with students.

TIPS

- None

MATERIALS

- 3 plastic plates
- Caramels (wrapped candy; at least 50 pieces)
- Pickles (or sour snack food)
- Popcorn (or salty snack food)
- 1 Lifecycle card per student (see worksheets at the back)
- 1 Lifecycle pictures worksheet per student (see worksheets at the back)

PROCEDURE

- 1 Before class begins, photocopy and cut out the Lifecycle cards. Prepare a plate of caramels, pickles, and popcorn at the front of the class. Place the plates visibly in three different classroom locations. (E.g., near a window, lamp, sink etc.)
- 2 Have the students quickly gather around one or all three plates of food if they haven't already done so after entering the classroom.
- 3 After a few minutes, instruct the children to return to their seats and solicit ideas about the purpose of the food.
- 4 Explain to the students that they acted like flies attracted to dead meat or flesh. Specific food types attract different students just as bodies in specific areas attract certain bugs.
- 5 Hand out a random life cycle card to each student. The card that they choose will determine if they are an egg, larva, pupa, or adult fly.
- 6 Explain the first bugs attracted to a body are flies. Choose three "flies" to pick a caramel.
- 7 Explain that the flies lay eggs before they leave. Have five "eggs" pick a caramel.
- 8 Explain that the eggs hatch into larvae. Have five "larvae" pick a caramel.
- 9 Explain that the larvae grow into pupae. Have five "pupae" pick a caramel.
- 10 Explain that the pupae grow into adult flies. Have another five "flies" pick a caramel. Repeat the cycle once more. Inform the students they acted out a blowfly's lifecycle as it feeds and multiplies on a corpse.
- 11 Provide the students with the life cycle pictures and arrows. Instruct the students to cut and paste the pictures and arrows onto a paper in the correct order.

Experiment: Exploring Entomology

EXPLANATION

When a person or animal dies, certain bugs come feed on the flesh and lay eggs in the body's openings. Entomologists study insects on and in decaying matter to help determine the time of death. The corpse first attracts common blowflies since they have a keen sense of smell; they lay thousands of eggs. The eggs hatch into larvae in twelve to seventy-two hours depending on the fly species, temperature, and weather. Fly larvae are commonly known as maggots. Maggots go through three phases as they develop into pupae and then adult flies. It can take fourteen hours to twenty-five days for a blowfly to mature from egg to adult. Dead bodies attract many different insects such as beetles, wasps, spiders, mites, and ants. Bodies attract certain bugs depending on specific places such as the city, country and even underwater. Similarly, the food in the different classroom locations attracted certain students.

CSI: Crime Scene Information

- Real-life crime science investigators do not perform all the activities portrayed in the CSI: Crime Scene Investigation television series. Real crime scene investigators collect all the evidence at a scene such as fingerprints, bullets, etc., but they do not interview witnesses or suspects or solve crimes.
- The femur bone, upper leg, estimates an individual's height.
- A crime scene investigator may take several hundred or even thousands of photographs at a crime scene to document a record of the observed scene!
- Markings on a tire cast can tell forensic scientists the tire brand and may even tell the car type.
- Numerous law enforcement agencies including the FBI have computerized programs designed to match unknown shoe impressions with the brand and manufacturer.
- First responders and crime scene investigators often wear special treads or plastic booties to prevent their footprints from mixing up with those already present at the crime scene.
- Fingerprints collect on objects because tiny fingertip ducts secrete an oily substance that sticks to everything we touch.
- Hair is the most frequently analyzed trace evidence.
- Investigators use vacuums with special filters to collect small evidence pieces at large crime scenes.
- In 1784, John Toms was convicted of a serious crime because a paper scrap found in his pocket matched the newspaper used to pack gunpowder into his pistol!
- In 1843, detective Allan Pinkerton invented the mugshot, an arrested person's picture.
- Bright, cherry-red skin is a symptom of carbon monoxide poisoning.
- Cyber Action Teams, or CATs, are small groups of highly trained FBI agents, analysts, and computer forensics experts who combat cyber fraud around the world.
- John Dillinger is an infamous criminal who tried to burn off his fingerprints with acid, only to have them grow back a few years later.
- The *titan arum* is a rare plant whose smelly foliage attracts beetles and other bugs that ordinarily burrow in dead animals to lay their eggs.

Additional Extension Ideas

MATH

- Triangulate a fictional crime scene—Measure the distance between two fixed points at a crime scene. Measure the distance between objects from the two fixed points.
- Measuring strides—Select someone to dip their feet in tempera paint and walk along the length of butcher paper placed on the floor. Allow the prints to dry. Have the same person clean their feet, dip them in a different colored paint, and run across the butcher paper. Compare running and walking strides.

LANGUAGE ARTS

- Memory game—Select students to memorize the position of all the objects at the front of the classroom and then leave the classroom. Remaining students change the position of some objects. Selected students return and try to identify what changed.
- Eyewitnesses—Have someone enter your classroom and make a scene (e.g., a person searching for lost equipment). Wait 30 minutes, and then have the students write an account of what they witnessed. Compare the details of the students' descriptions.
- Forensic story—Write a narrative based on a picture of a crime scene (e.g., what do you think happened?).

ART

- Crime composites—Have the students draw what they think they saw after you flash an image at the front of the class.
- Forensic artists—Have student pairs reconstruct their partner's face with modeling clay.
- Top-down scenes—Create a crime scene with dollhouse furniture and figurines. Instruct the

students to draw a birds-eye view diagram of the crime scene.

- Side-view scenes—Make a diorama to reconstruct a crime scene from a story.

SOCIAL STUDIES

- Fingerprinting—Research fingerprinting and the Automated Fingerprint Identification System (AFIS) history.
- Justice system—Research and create a flowchart outlining what happens once authorities catch a suspect.
- History—Research what tools and methods detectives used in the past century.
- The CSI Effect—Juries expect evidence as depicted in CSI shows. Research and explore the changes to evidence produced in court cases due to the effect of watching CSI and other crime/law television shows.
- Careers—Interview a detective or police officer about the aptitudes required for their line of work.

TECHNOLOGY

- Research what technological tools forensic scientists use in the lab and at a crime scene.
- Search the Internet for up-to-date forensic games.
- Visit websites:
 - < <http://www.fbi.gov/fbikids.htm> > FBI (Federal Bureau of Investigation) page for kids
 - < <http://www.csitheexperience.com> > Guide for the CSI museum exhibit

FIELD TRIP IDEAS

- Seek out guest speakers—Check with local universities, police stations, and government labs that welcome your class for a visit.

CSI Dictionary

CSI SCIENCE	DESCRIPTION
Ballistics	The study of guns and bullets in relation to crimes.
Blood Spatter	The blood of violently killed people usually tends to spatter. How that occurs can determine the angle of impact, the item used, etc.
Botanist	A botanist studies plant growth at a crime scene and can analyze plant spores.
Dactyloscopy	The dactyloscopist compares fingerprints, foot, and hand prints.
Forensic Anthropology	Authorities often face badly decomposed corpses, unidentified remains, or skeletons. Forensic anthropologists may work with forensic odontologists, pathologists, and homicide investigators to determine the age, sex, and stature of human remains.
Forensic Art	A forensic artist sketches the offender, uses computer enhancement to identify someone, or uses two- and three-dimensional facial reconstruction on decomposed remains.
Forensic Entomology	Forensic Entomology is the use of insects and other arthropods found at decomposing remains to aid investigations.
Forensic Medicine/Science	Forensic medicine is the science of medical and paramedical specialties' (e.g., dental, chemical, psychological, biological, and mechanical techniques) applications to determine the cause(s) of an individual's death, injury or disease.
Forensic Odontology	Forensic Odontology is the science of dentistry and Para-dental knowledge applications to help solve criminal and civil matters. Odontologists can examine teeth impressions, bite marks, and dental formation for identification.
Forensic Photography	Forensic Photography is utilizing photographic techniques to capture crime scenes in photographs.
Forensic Psychology/Psychiatry	Forensic Psychology/Psychiatry applies its science to legal cases, which covers trauma, serial killers, stalking, false memories, etc.
Forensic Serology	A serologist analyzes any bodily fluids found at the crime scene or on a victim.
Forensic Toxicology	Forensic Chemistry and Toxicology generally involves detecting and identifying poisons or toxins that exhibit adverse physiological effects.
Geology	A geologist analyzes soil content to provide information about where a body might have been.
Geographical Profiler	A geographical profiler uses computer models to help establish where a serial offender may reside.

Cadet Research Library

There are numerous books available on CSI. Below are some suggested resources for fourth grade and up students.

REFERENCE BOOKS

Title: When Objects Talk: Solving a Crime with Science
Author(s): Mark P. Friedlander and Terry M. Phillips

Publisher: Lerner Publications

ISBN: 0822506491

Description: This book combines facts and storytelling to illustrate the theories and practices of forensic science. This book is appropriate for students in 4th to 8th grade.

Title: The Bone Detectives: How Forensic Anthropologists Solve Crimes and Uncover Mysteries

Author(s): Donna M. Jackson

Publisher: Little, Brown & Company

ISBN: 0316829358

Description: This book explores the world of forensic anthropology and its applications in solving crimes. This book is appropriate for students in 4th to 8th grade.

Title: The Forensic Science of C.S.I.

Author(s): Katherine Ramsland

Publisher: Berkley Boulevard Books

ISBN: 0425183599

Description: The popularity of CSI: Crime Scene Investigation television series inspired the author to investigate crime-solving, dramatized techniques to examine the reality of these cutting-edge procedures. This book is appropriate for students in 4th to 8th grade.

Title: 24/7: Science Behind the Scenes: Forensic Files

Author(s): Various

Publisher: Franklin Watts

ISBN: Various

Description: Science as inquiry is the core of this dynamic, investigative, high-interest series for students in 8th to 12th grade. The series focuses on the science and technology used to solve real-life crimes and heart-stopping mysteries.

EXPERIMENT & ACTIVITY BOOKS

Title: Crime Scene Investigations: Real-Life Science Activities for the Elementary Grades

Author(s): Pam Walker, Elaine Wood

Publisher: Jossey-Bass

ISBN: 0130842508

Description: The book includes teacher background information and reproducible activity sheets that challenge students to observe carefully, organize and record data, think critically, and conduct simple tests to solve crimes. Themes range from theft and dog-napping to vandalism and water pollution. These experiments are appropriate for students in 3rd to 6th grade.

Title: Detective Science: 40 Crime-Solving, Case-Breaking, Crook-Catching Activities for Kids

Author(s): Jim Wiese

Publisher: Jossey-Bass

ISBN: 0471119806

Description: This book is an introduction to concepts such as forensics, voiceprints, DNA testing, and how detectives and forensic experts use science to do their jobs. Readers learn how to take and analyze fingerprints, identify blood, and detect counterfeit bills through a variety of easy experiments. This book is appropriate for students in 3rd to 6th grade.

Cadet Research Library

Title: Science Sleuths: 60 Forensic Activities to Develop Critical Thinking and Inquiry Skills

Author(s): Pam Walker, Elaine Wood

Publisher: John Wiley & Sons

ISBN: 0787974358

Description: The forensic science activities in this book help children understand, master, and apply science concepts. In addition, the activities rely heavily on science process, manipulative, laboratory, and interpersonal skills. The National Science Education Standards emphasizes these skills. This book is appropriate for students in 4th to 8th grade.

Title: Crime-Solving Science Projects: Forensic Science Experiments

Author(s): Kenneth G. Rainis

Publisher: Enslow Publishers

ISBN: 0766012891

Description: Crime-Solving Science provides readers with detailed experiments describing forensic crime-solving tactics. This book is appropriate for students in 4th to 8th grade.

FORENSIC FICTION

Title: Who Killed Olive Soufflé?

Author(s): Margaret Benoit

Publisher: Learning Triangle Press

ISBN: 0070062757

Description: Detective Angel Cardoni solves crimes using forensic science techniques. In this book, she investigates a French chef's mysterious murder while trapped by a snowstorm at a country lodge. This book is part of a series starring detective Angel Cardoni. This book is appropriate for students in 3rd to 6th grade.

Title: Framed

Author(s): Malcom Rose

Publisher: Kingfisher

ISBN: 075348292

Description: With help from his computerized sidekick, Malc, newly graduated forensic investigator Luke Harding, age 16, takes on his first case—a murder in school, followed by two more killings. This book is appropriate for students in 4th to 8th grade.

Title: The Christopher Killer: a forensic mystery

Author(s): Alane Ferguson

Publisher: Viking Children's Books

ISBN: 0670060089

Description: Aspiring forensic pathologist Cameryn Mahoney convinces her father, the county coroner, to hire her as his assistant. She has no idea that one of the first deaths she will investigate will be that of her friend, Rachel Geller. The teen must put aside her emotional response to the murder to evaluate the information clinically. This book is appropriate for students in 4th to 8th grade.

Title: The Crime Lab Case

Author(s): Carolyn Keene

Publisher: Aladdin Paperbacks

ISBN: 0743437446

Description: A mystery arises involving a high school teacher as the story's protagonist. Nancy Drew, a detective, volunteers at a forensic science camp. This book is appropriate for students in 4th to 8th grade.

Welcome to Mad Science's World

In March 1985, brothers Ariel and Ron Shlien, teenagers at the time, began launching rockets at birthday parties in their neighborhood. They quickly realized that their means of extra income was very appealing to educators, parents, after-school programs, and community centers. Fun, cool, hands-on science experiments were in demand. As a result, the first franchise opened in 1994, and the network has grown to include over 200 franchises worldwide.

The franchise system, which continues to expand, consists of a network of thousands of Mad Scientists who work with schools, camps, community centers, and scout groups to spark imaginative learning in millions of elementary school children. All of the programs are inquiry-based, age-appropriate, and tested by both children and scientists prior to their integration into programs.

Mad Science sparks the imagination and curiosity of children everywhere. Our array of programming fosters confidence in children as potential scientists and engineers.

WORKSHOPS

This is a hassle-free and convenient way to bring hands-on science programs directly into your class. All workshops meet state and provincial curricula requirements and offer teachers the flexibility to continue enriching their class with Pre and Post workshops. The workshops contain an assortment of topic-related experiments and additional activities. Children from Kindergarten to Grade 6 can learn more about the intriguing world of light, sound, magnets, chemistry, measurement, ecosystems, and so much more.

AFTER-SCHOOL PROGRAMS

Mad Science sparks imaginative learning even when school is out. We offer fun, hands-on science

classes that will keep your students entertained and engaged. After-school programs can run during lunchtime or after school, and range from four to eight weeks. Parents pay a low, all-inclusive fee at no cost to the school. Children create and take home specially designed and branded Mad Science products after each class—like model rockets, putty, periscopes, and more.

BIRTHDAY PARTIES

Mad Science birthday parties are exciting, high-energy, and interactive shows that make all children feel extra special on their birthday. Our entertaining Mad Scientist will come to your home, or party room, and perform exciting experiments both for and with the children. Mad Science introduces children to the exciting world of science with bubbling potions, laser lights, and slippery slime.

SPECIAL EVENTS

Thrill and captivate your school assemblies with an extraordinary Mad Science special event. In large groups, children will participate in conjuring up foggy, dry ice storms and ride a Mad Science Hovercraft. Mad Science can customize special events to suit group size, theme, or budget.

SUMMER & VACATION PROGRAMS

Our summer camp programming relates science to life. With interactive and unique activities, children learn to discover the world around them with fascinating experiments such as soil testing, the power of the sun to bake nachos, and engineering skills to build bridges and domes.

Welcome to Mad Science's World

PRESCHOOL WORKSHOPS

Mad Science preschool workshops are designed specifically to present experiments and activities to children ages three to five. Hands-on programs on color, sound, sight, dinosaurs, and much more makes science fun. Children also have the opportunity to make projects to take home. Finally, teachers can continue the learning process with Mad Science teacher resource manuals that accompany each class. The manuals contain an assortment of activities related to the program theme. Call 1-877-900-7300 toll-free, or visit our website at <http://www.mad-science.org> to invite Mad Science into your school, home, summer camp, or community center.

MAD SCIENCE PRODUCTIONS

Mad Science Productions is the live stage show division of the Mad Science Group specializing in large-scale, interactive theatrical productions. In addition to Movie Magic, Mad Science Productions has also produced Funky Farmworks, Don't Try This at Home, Don't Try This at Home II, Newton's Revenge, Mad Mission to Mars: 2025, and Taking the World by Storm—each with their own correlated Teachers' Resource Manual. Mad Science Productions brings their shows to theme and amusement parks, local and state fairs, children's festivals, and special events in major markets across North America.

CSI: LIVE! Experiment Log

Name

Hypothesis

Guess what might happen.

Materials

Be sure to include measurements!

Procedure

Make sure to write down all the steps.

Observations

Record what you noticed. You can draw a diagram on the back of this paper.

Conclusions

What happened and why?

Proofing Powders Worksheet

Name _____

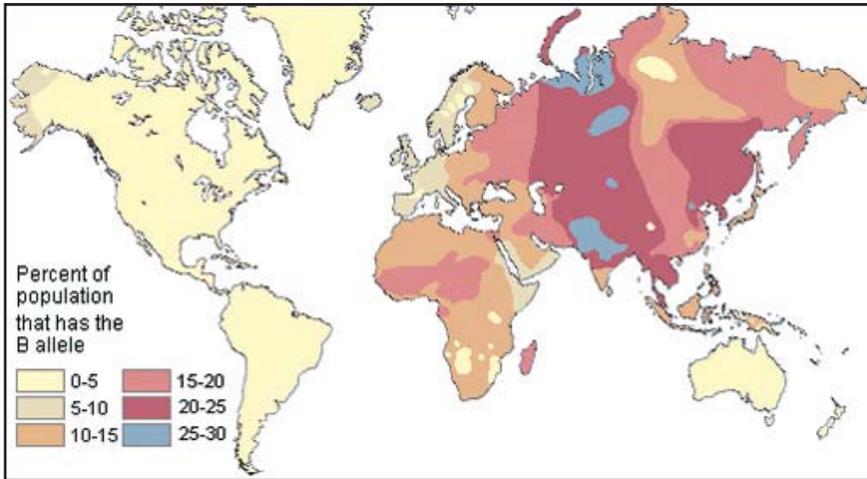
Directions

- 1 Label a paper cup with a test solution and chemical name.
- 2 Transfer some chemical from the aluminum cup to the labeled paper cup.
- 3 Use a pipette to add a drop of a test solution to the chemical.
- 4 Record the reaction's result in the appropriate box below.

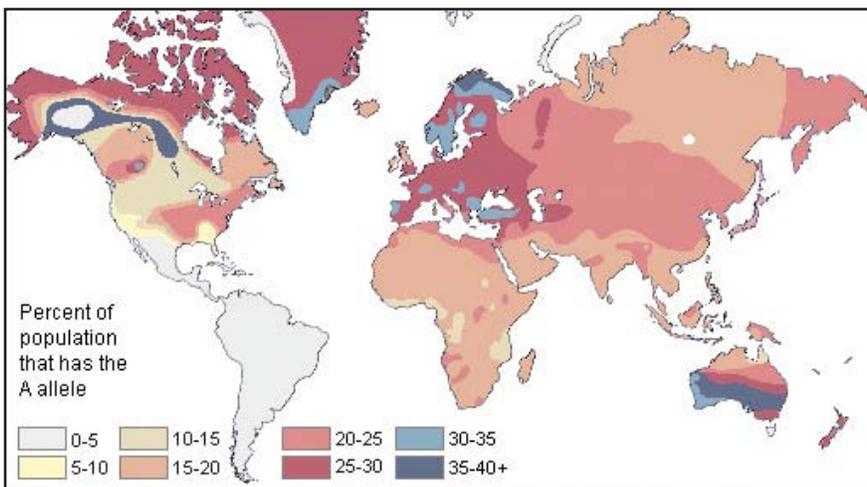
Results

CHEMICAL	TEST SOLUTION				
	Benedict's Solution	Vinegar	Water	Baking Soda Solution	Phenolphthalein Indicator
Sugar					
Salt					
Citric Acid					
Baking Soda					

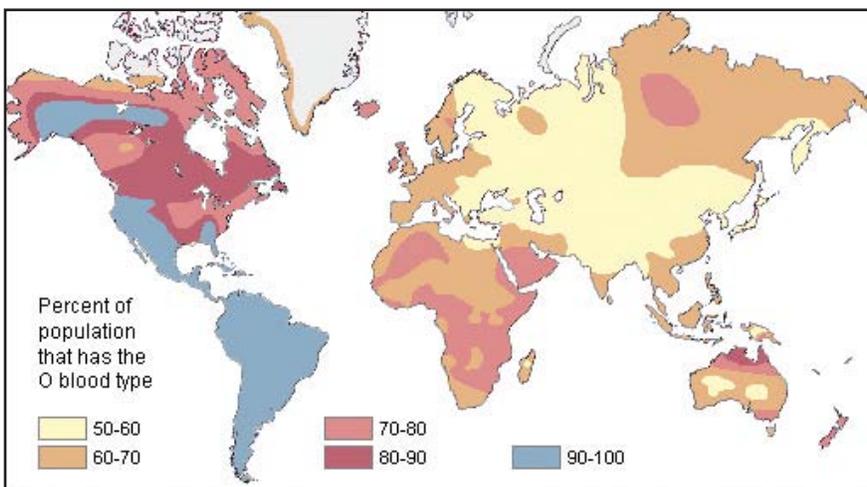
Distribution of ABO blood types in the world



1 Map showing native world populations' B type blood distribution.



2 Map showing native world populations' A type blood distribution.



3 Map showing native world populations' O type blood distribution.

Reprinted from Oxford University Press. From A.E. Mourant et al., *The Distribution of the Blood Groups and Other Polymorphisms* 2nd ed., 1976.

Blood Tests worksheet

Name _____

Directions

- 1 Label a paper cup with a blood type.
- 2 Use a pipette to transfer a few drops of blood from the test tube to the labeled paper cup.
- 3 Use a pipette to add another blood type to the cup.
- 4 Record the reaction's result in the appropriate box below.

BLOOD TYPE	A	B	AB	O
A				
B				
AB				
O				

DNA Fingerprinting worksheet

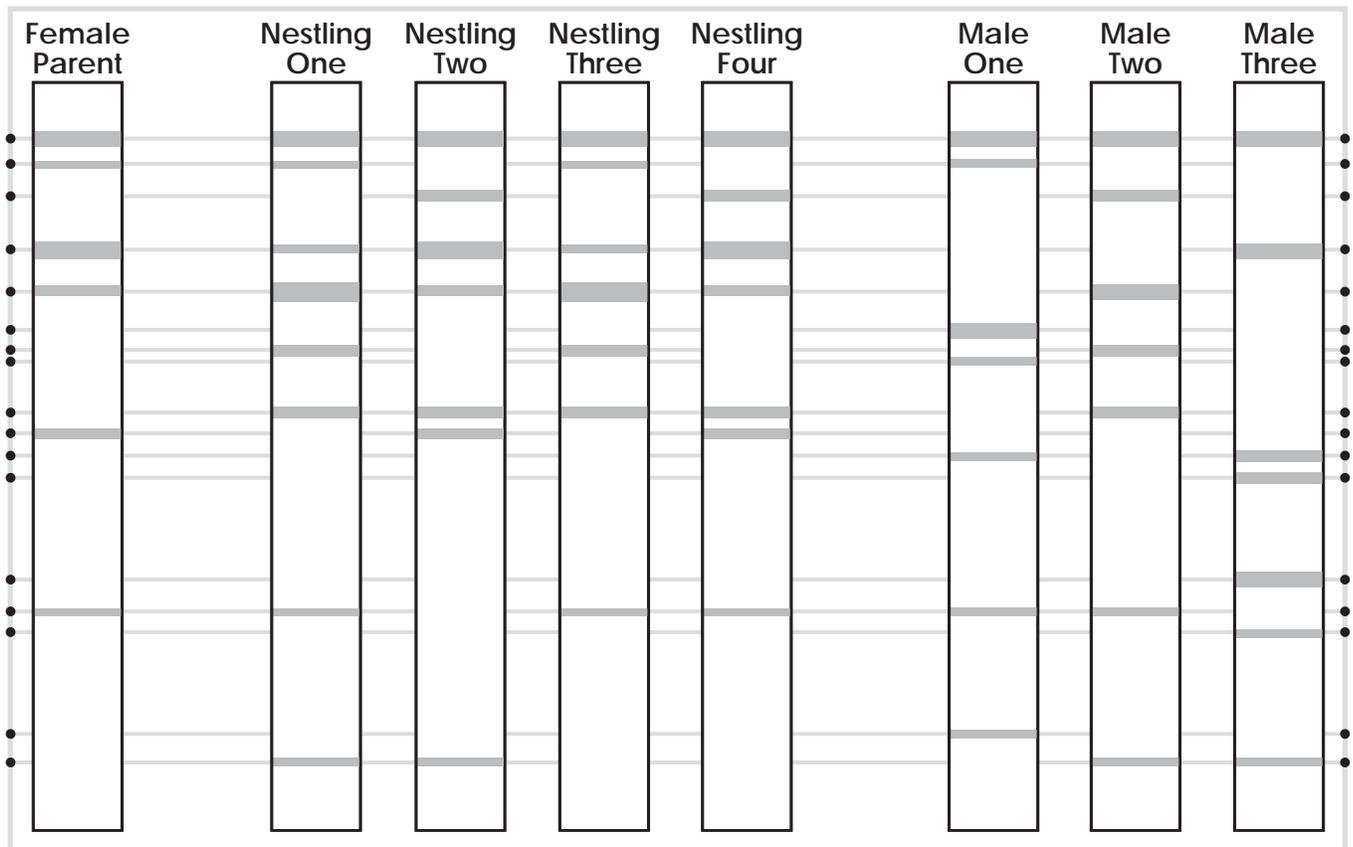
Name _____

Directions

- 1 Examine the DNA fingerprints to determine which male bird is the father.

Procedure

- 1 Color all of the known parent's grey bands red. In this case, we know who the female parent is, so color all the bands in her DNA print red.
- 2 Use a ruler to match the bands on the female parent's DNA print with that of the four nestlings. Color all of the bands from the nestlings that exactly match a band from the female parent red.
- 3 Look at the DNA prints of the three males. Assign each one of them a different color: blue, green, and yellow for instance.
- 4 Color all of the male's bands with his assigned color.
- 5 Look at the nestlings' remaining bands. These must be associated with the second parent. Use a ruler to compare these bands to those of the male adults. Find the male adult whose DNA print contains ALL of the remaining non-colored bands in the nestlings' DNA prints.
- 6 Color the identifying bands in the nestlings' prints the same color as the male parent's bands.



Lip Sample	NAME



Lip Sample worksheet

(photocopy)

NAME	Lip Sample



Blowfly Lifecycle worksheet

Directions

- 1 Cut out the nine squares below.
- 2 Glue your blowfly lifecycle name in the middle of a blank sheet of paper, and write your name in the given space.
- 3 Arrange the pictures and arrows in the order of a blowfly lifecycle around your name card.
- 4 Glue the squares onto the paper around your name.



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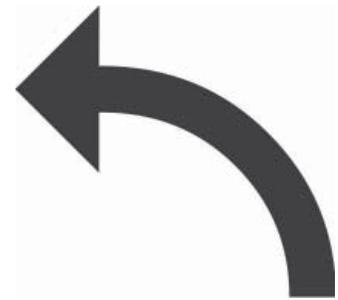


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BLOWFLY LIFECYCLE

Name

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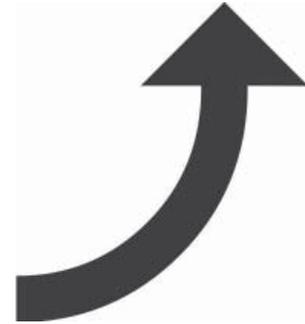
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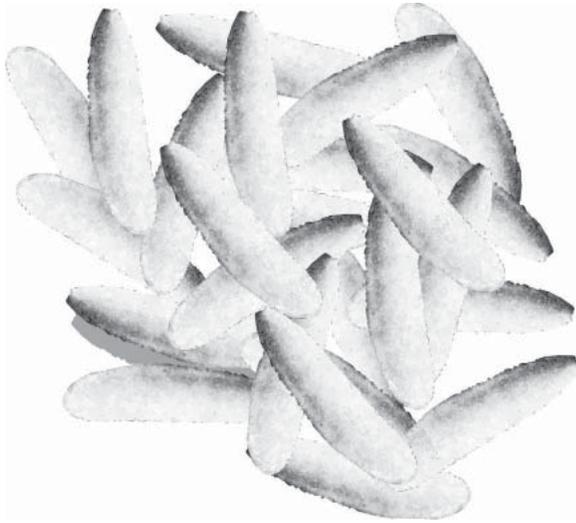


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Blowfly Lifecycle cards

Directions

- 1 Photocopy this sheet so that there is one square card for each student. Cut the photocopies into cards and use as outlined in the experiment.



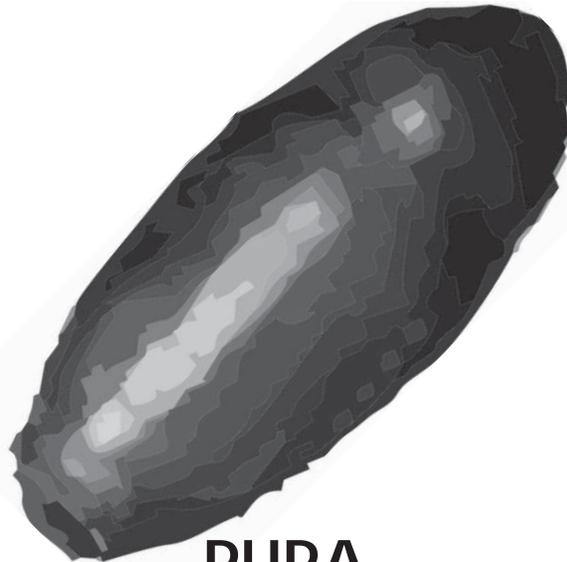
EGGS

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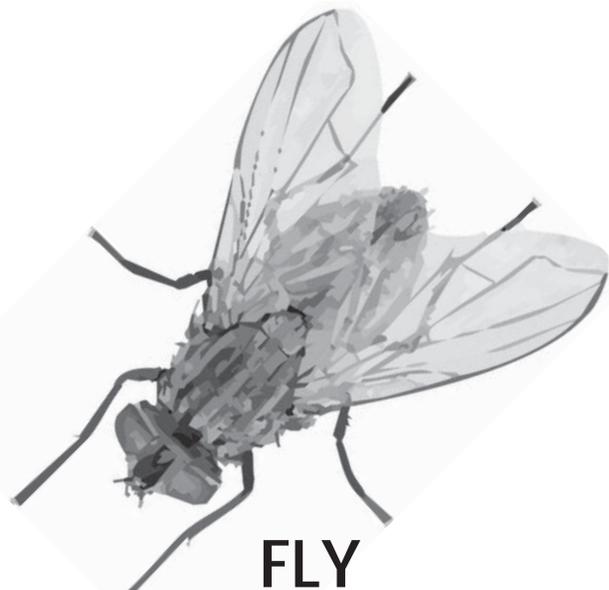
LARVA

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PUPA

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FLY

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Forensic Chemistry Logic Puzzle

Difficulty Level

- Advanced

A scientist receives five chemicals found at a crime scene and is asked to identify them. She examines the chemicals' shapes under a microscope. She then burns each chemical to test the flames' colors. The scientist identified the chemicals as potassium, lithium, sodium barium, and copper. Each chemical had a different shape (flakes, granules, crystals, powder, or lumps) and flame color (red, blue, yellow, green, purple). Use the facts and grid below to match the chemicals to their results.

Directions

- Read the facts on the following page one-at-a-time, and find and place an O in the box for matching results. Place an X in a box for results that do not match. There are three grids. There should be four X's and one O in each row and column of each grid.
- For instance, the first fact states that crystals burn with a yellow flame. Place an O in the box linking crystals and yellow. Place X's in the rest of the row to eliminate the other flame colors. Place X's in the rest of the column linking the color yellow to the crystals to eliminate the other chemical shapes.
- The second fact states that potassium does not burn blue, yellow, or green. Place X's in the boxes to eliminate blue, yellow, and green colors. If potassium does not burn yellow, it cannot be a crystal based on fact #2. Place an X in the box linking the chemical potassium to the chemical shape of crystals.

Tips

- If there are already four X's in a row or column, place an O in the fifth box.
- If there is an O in a box, place X's in the other boxes of that row and column.
- Use your logic to match up the results! E.g., if one grid links a chemical's name and shape, and the same shape links to a particular color in another grid, then mark an O in the third grid to link the chemical's name to that color.

Logic Puzzle Facts

- Crystals burn with a yellow flame.
- The flame for potassium (K) is not blue, yellow, or green.
- Sodium (Na) is not a flake, lump or powder shape.
- The flame for flakes is not blue, green, or purple.

If you completed the puzzle with facts 1-4, you're using intuition more than logic!

- Powder burns with a green flame.
- The flame for copper (Cu) is not green, yellow, or purple.
- Lithium (Li) burns with a red flame.
- Copper is not a granule or a crystal shape.

If you completed the puzzle with facts 1-8, you have great logic abilities!

- The flame for granules is not red, green, or blue.
- Barium (Ba) and lithium (Li) are not crystal shapes.
- Potassium (K) is a granule shape.
- The lump shapes are not lithium or barium.

If you completed the puzzle with facts 1-12, congratulations for thinking logically!

- Potassium, barium, and copper are not flake shapes.
- The flame for barium is not blue or yellow.
- The flame for sodium is not blue.

If you completed the puzzle with facts 1-15, keep practicing your logic!

Logic Puzzle Grid

Name _____

The links from facts #1 and #2 are already marked in the grid.

		FLAME TEST RESULTS					SHAPE TEST RESULTS				
		Red	Blue	Yellow	Green	Purple	Flakes	Granules	Lumps	Crystal	Powder
CHEMICAL NAME	K		X	X	X					X	
	Li										
	Ba										
	Na										
	Cu										
SHAPE TEST RESULTS	Flakes			X							
	Granules			X							
	Lumps			X							
	Crystal	X	X	O	X	X					
	Powder			X							

Summary from the grid (write down the results as you find them):

CHEMICAL NAME	FLAME TEST COLOR	SHAPE TEST RESULT
Potassium (K)		
Lithium (Li)		
Barium (Ba)		
Sodium (Na)		
Copper (Cu)		

Scene of the Crime Crossword Puzzle

Name _____

Difficulty Level

- Moderate

Directions

- Read the clues and fill in the blank squares on the grid.

1		2						3											
		4											6						
5						8			7										
												10							
			9																
							12										17		
11			13																
							14												
15																			
	16																		

CROSSWORD ANSWER LIST	FBI	forensic	footprint	evidence
	hair	lifting	collect	cast
	witness	trace	vacuum	
	fingerprint	tire tracks	photographs	
	CSI	victim	fibers	



DOWN

- No two are alike, even in twins.
- A method used for collecting fingerprints.
- Frequently analyzed piece of trace evidence.
- The study of evidence discovered at a crime scene and used in a court of law is called _____ science.
- You should make a _____ of a three-dimensional print.
- We use this machine to clean our carpets, but a special one with filters is used at crime scenes to collect tiny bits of evidence.
- Federal Bureau of Investigation
- Crime Scene Investigators must _____ evidence.

ACROSS

- An impression left by a person's foot.
- Crime scene investigators collect this at the crime scene.
- A type of trace evidence that can come from clothing.
- Crime science investigators take _____ to record the crime scene.
- A paint chip is a type of _____ evidence.
- One who is harmed or killed by another.
- The impression that cars leave on the earth.
- A person who saw a crime occurring.
- Crime Scene Investigation

Identification Word Search

Name _____

Difficulty Level

- Advanced

Directions

- Find and circle the words from the list below.

ANALYSIS
EXTRACTION
INVESTIGATE
PROOF

BLOOD
FINGERPRINT
MOLECULE
PROTEIN

BODY
FOOTPRINT
PERSON
SCIENTIST

BONES
FORENSICS
POWDER
TEETH

DNA
IDENTIFY
PROFILE
TEST

T	D	H	V	L	M	H	F	F	Y	Y	A	Q	M	F	A	I	S	B	F
T	R	A	J	N	X	O	X	F	L	T	S	H	E	E	N	Y	C	H	N
K	Q	H	H	Z	R	F	L	W	L	Z	J	L	A	V	A	N	I	G	I
P	A	A	N	E	J	K	L	E	B	N	U	W	E	E	L	A	S	W	A
Q	Z	H	D	T	S	E	T	G	C	K	O	S	E	H	Y	V	N	W	J
D	M	U	H	H	R	C	J	V	Q	U	T	S	U	X	S	O	E	O	W
N	O	I	T	C	A	R	T	X	E	I	L	P	R	J	I	F	R	Q	V
D	H	E	O	N	R	X	B	E	G	Q	R	E	P	E	S	C	O	E	E
P	E	I	F	A	I	O	F	A	U	O	C	S	G	Q	P	Z	F	G	O
T	L	R	I	B	D	R	T	Y	F	N	I	E	T	O	R	P	K	J	R
A	W	W	N	Y	L	E	P	I	D	E	N	T	I	F	Y	R	I	A	P
Q	N	J	G	F	D	O	L	T	B	K	S	O	A	S	T	E	T	P	Y
Y	N	D	E	L	H	E	O	T	O	I	Q	M	F	A	R	D	Z	R	W
T	P	A	R	S	W	U	F	D	T	O	G	A	I	X	D	W	Q	O	W
J	E	P	P	Z	F	Y	O	N	T	J	F	I	Z	T	X	O	R	O	I
Q	K	V	R	K	G	K	E	P	Y	J	G	P	N	G	C	P	A	F	T
C	A	A	I	R	Y	I	U	Z	I	T	L	B	O	N	E	S	I	R	P
H	N	U	N	M	C	L	E	D	Y	X	M	H	G	R	B	W	T	S	U
P	H	B	T	S	Y	S	H	L	Y	P	P	C	Q	R	X	R	Q	Q	I
P	H	R	I	M	G	G	P	A	B	X	M	W	G	N	Q	A	K	M	R

Evidence Bug-doku puzzle

Name _____

Difficulty Level

- Basic

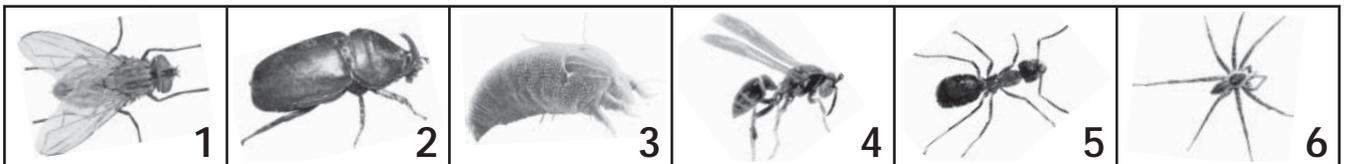
Sudoku tip

- Start with images 1 and 2

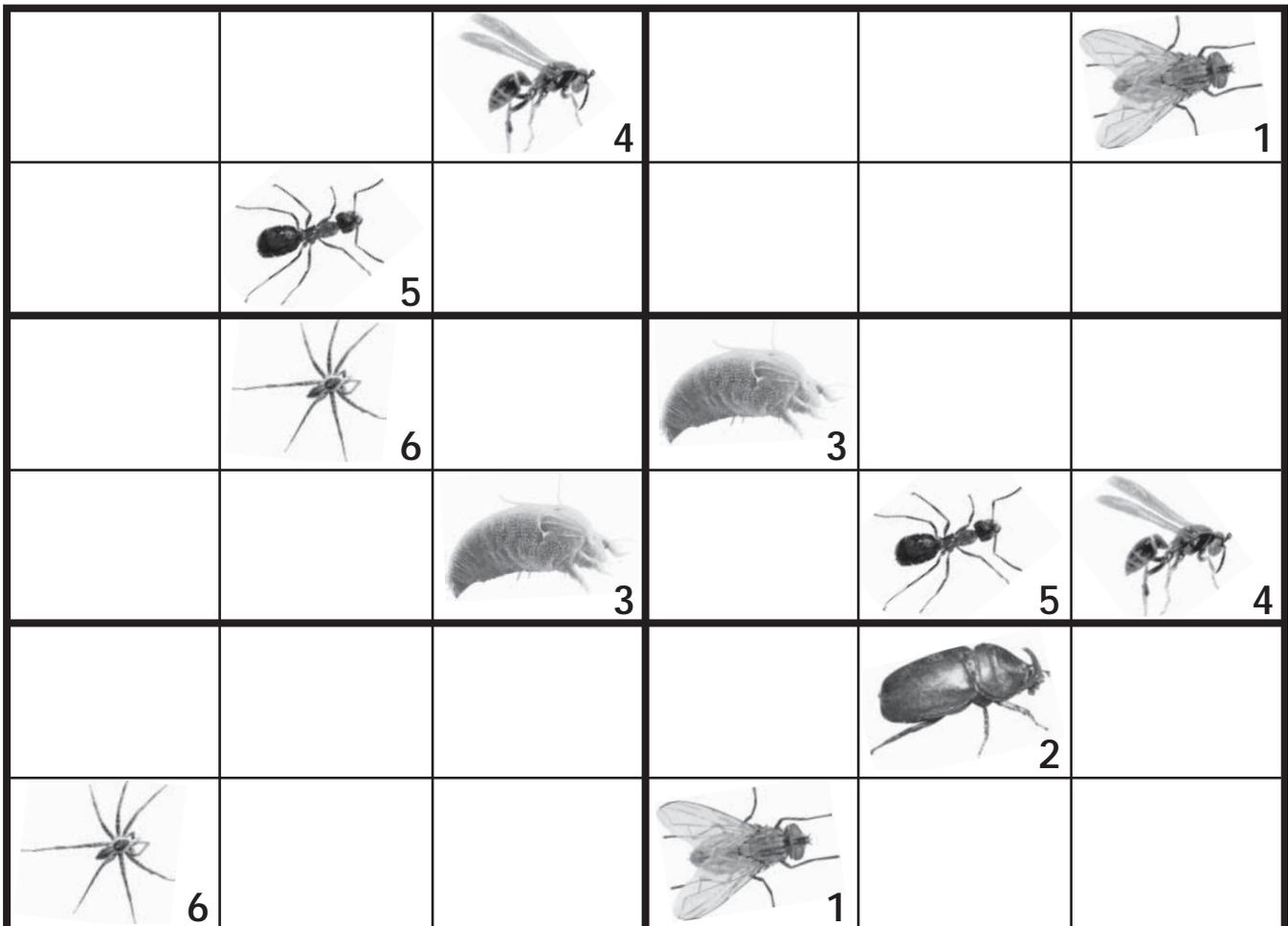
Directions

- 1 Fill in the grid so that every row, column, and box contains only one of the six bugs: flies, beetles, mites, wasps, ants, and spiders. Dead bodies left outside attract these bugs, which helps forensic entomologists investigate. There is only one solution for each puzzle.

The Images



The Puzzle



Worksheet Answer Keys

Logic Puzzle

		FLAME TEST RESULTS					SHAPE TEST RESULTS				
		Red	Blue	Yellow	Green	Purple	Flakes	Granules	Lumps	Crystal	Powder
CHEMICAL NAME	K	X	X	X	X	O	X	O	X	X	X
	Li	O	X	X	X	X	O	X	X	X	X
	Ba	X	X	X	O	X	X	X	X	X	O
	Na	X	X	O	X	X	X	X	X	O	X
	Cu	X	O	X	X	X	X	X	O	X	X
SHAPE TEST RESULTS	Flakes	O	X	X	X	X					
	Granules	X	X	X	X	O					
	Lumps	X	O	X	X	X					
	Crystal	X	X	O	X	X					
	Powder	X	X	X	O	X					

Crossword Puzzle

F		L					H							
I		I					A							
N		F	O	O	T	P	R	I	N	T			F	
G		T					R						O	
E	V	I	D	E	N	C	E		F	I	B	E	R	S
R		N				A							E	
P		G				S			V				N	
R			P	H	O	T	O	G	R	A	P	H	S	
I									C				I	
N						F			C				C	S
T	R	A	C	E		B			U					
			O		V	I	C	T	I	M				
			L											
			L											
T	I	R	E	T	R	A	C	K	S					
			C											
	W	I	T	N	E	S	S							

Worksheet Answer Keys

Word Search Puzzle

					M											A	I	S			
						O											N		C		
							L								V	A		I			
								E		N			E			L		S			
				T	S	E	T		C		O	S				Y		N			
				H						U	T	S				S		E			
N	O	I	T	C	A	R	T	X	E	I	L	P	R		I		R				
		E		N			B		G		R	E			E	S		O			
	E		F		I	O		A		O					P		F				
T			I	B	D	R	T		F	N	I	E	T	O	R	P					
A			N	Y	L	E	P	I	D	E	N	T	I	F	Y	R					
	N		G			O	L	T			S					E		P			
		D	E				O		O	I						D		R			
			R					D	T	O						W		O			
			P					N			F					O		O			
			R			E										P		F			
			I			I							B	O	N	E	S				
			N		C																
			T	S																	

Bug-doku Puzzle

3	2	4	5	6	1
1	5	6	2	4	3
4	6	5	3	1	2
2	1	3	6	5	4
5	3	1	4	2	6
6	4	2	1	3	5

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Note: Mad Science is not responsible for website content.

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