

FOSS ® IDEAS AND INVENTIONS
TEACHER PREPARATION VIDEO TRANSCRIPT

<Larry Lowery Introduction to FOSS Program>

Lowery: Hello. Welcome to the Full Option Science System. This program was funded by the National Science Foundation. Its goal was to develop materials that would involve youngsters with both the processes and the content of science.

The program is developed with the Lawrence Hall of Science, with scientists, science educators and teachers working together as a team to develop the materials. The materials are tested in the hands of teachers and children in classrooms. It takes about two years to turn out a module.

Each module begins with firsthand experiences. This is done because it has been found that firsthand experiences are the best way for youngsters to learn about the concepts of science. As the module progresses, children are introduced to abstractions and reading materials. The sequence from firsthand experiences through reading materials is deliberate because it has been found that youngsters, when they have some experience before they read, learn and understand more from the reading. Authors of reading materials can then take youngsters to greater abstractions.

Trust the materials that you are getting acquainted with. They have been well-tested. We found that they work extremely well in the hands of all teachers and are effective for youngsters in learning about science.

<Larry Lowery Introduction to Ideas and Inventions>

>> This module introduces students to simple technologies, technologies that allow them to see the world with fresh eyes. Students begin this module by discovering what rubbings can reveal a hidden not easily seen aspect of the world around them. They continue with explorations of their own fingerprints. They next investigate the makeup of inks and pens through a technique called chromatography. And finally, they look at new ways of seeing reflections in mirrors.

Inventive use of each method or tool reveals a fresh view of something that seems ordinary and some knowledge about the world that normally goes unseen is revealed to the students in a surprising way.

Student: I can see it. I can see all the way around.

<Eileen Massey Introduction to Module>

Narrator/Eileen Massey: Hi. I'm Eileen Massey. And I'm here to help you get started with the FOSS Ideas and Invention kit. The FOSS Ideas and Invention module consists of four investigations that engage students in thought provoking activities and challenges them to use insight and creativity. Each investigation provides valuable science content while introducing techniques for revealing the unseen.

Most of the equipment you will need to teach this module comes in the kit. Everything you see here comes in this one box. There is enough permanent equipment in the kit for a class of 32 students and enough consumable equipment for at least two classes. You will need to check the inventory sheet in the Materials folio to see which materials are consumable and which are permanent.

From the FOSS Measurement Kit you'll need the basins and the hand lenses. Most of what you will need to provide will be for students to use while creating their own inventions, and most of these things you already have in your classroom. You will need to provide paper towel, masking tape, overhead transparency sheet, clay, scratch paper, newspaper, scissors, a collection of leaves, permanent black markers, some pennies, some chalk, colored pencils, about eight plastic baggies, aluminum foil, pencils, water based black markers, additional watercolor markers of assorted colors, crayons, scraps of cardboard and some water. During Investigation 2, if you have access to a slide projector, you will want to use that. But it is optional.

Before you begin teaching, it's important to read through the Teacher's Guide. First you will find the Overview folio which points out the national standards addressed in this module as well as information about how to make best use of the Teacher Guide. It also includes valuable background information specially written for teachers who have not had extensive science training.

Next you'll find the Materials folio. If you are the first teacher using a new kit, you'll want to turn to this section first. It describes first-time preparation. If the kit has been used, check the section called Preparing Your Kit for the Classroom. Both of these sections will give you helpful hints that will save you lots of prep time later.

The next four folios are the investigation folios. These are the heart of the program. Each takes one or two weeks to complete. The first page provides overview information. The At A Glance chart summarizes the investigations and helps you plan for assessment and extension activities.

Next you'll find background information specific to this investigation. There is a section called Teaching Children About, which gives you some insight into the research about how children think and learn. Then for each part of the investigation you find a Materials list, Getting Ready section, and step-by-step instructions for how to proceed through the investigation.

At the end of the folio, you'll find Interdisciplinary Extensions. You can do some of these extensions with the class or you might want to save them for students to use as projects at the end of the module. Next are the investigation duplication masters. Each master is labeled with a number so it will be easy to find when you need it.

Shortly before beginning this module, duplicate the Letter To Parents and send it home with the students. This letter tells parents about the module and suggests some activities that they can do at home with their children.

It's important to read the Assessment folio before you begin teaching. It describes a system for assessing students throughout the investigations and also gives you ideas for end-of-the-module testing or portfolio assembly. The folio contains scoring guides for each of the assessments suggested.

Next are the assessment duplication masters. Here you'll find all the masters for the assessment charts and end-of-the-module assessments.

As part of the kit, there are books of Science Stories for the students to read. The Science Stories folio gives you background information, recommends when to read the stories and suggests follow-up activities. In this module, different inventors are profiled for each investigation. You may want to read the Science Stories during a reading period rather than science time, especially if you only teach science a couple of times a week.

In the Resource folio you will find lists of trade books, videos, computer software and other resources that you can use to enrich the program. The final tab is the FOSS website folio. On the website you'll find simulations for each module in the program. The students can contact scientists and other FOSS students from across the country. You'll need to check the website to see the many features available there, including resources for teachers.

Now you're ready to begin.

<Investigation 1, Part 1>

Narrator: This investigation begins with students using a rubbing technique to discover patterns and textures that are not otherwise easily seen. For each part you'll want to set up a Materials Station. Here is what you'll need for this part: From the kit you'll need the bags of rubbing objects and white paper. From the measurement kit, the hand lenses. And you will need to supply pennies, crayons, pencils and colored pencils. Duplicate Student Sheet No. 2 called Rubbing Samples and make one copy of Assessment Chart for Investigation 1.

Practice the rubbing technique before you begin the session. Place a penny on a flat, hard surface and cover it with a sheet of paper. Holding the pencil on its side, rub lightly to get an image. Remember to hold the penny in place. Then try the same thing but this time rub harder and compare the images. You might want to also try it with colored pencil or with a crayon to see which technique works the best for you.

You will need to provide fresh leaves for this investigation. They should be picked no more than a day before the activity so they don't get too dry. Try to get six to nine different types of leaves for each group with at least one displaying each of the venation patterns you see on the posters. You may ask students to bring some in, as well.

You'll find it easier to distribute the leaves if you put a collection of leaves in a zip bag for each group. Try to encourage the students when using the hand lens to bring the hand lens up to the eye and then bring the object up until it's in focus. If they work in that manner, they'll be able to see the details more easily.

Prepare the Word Bank and Content/Inquiry charts using large sheets of paper or a flip chart. Make a Project Folder for the class. As students think of ideas for projects during the investigations, ask them to write them down and put them in the folder to choose from at the end of the module.

This session begins with the teacher suggesting a way to make the texture of an object easier to

see.

Teacher: Now, here is a penny. You know what it looks like. I'm going to put this paper right over it. I'm going to feel it. And then I'm going to rub the paper with this pencil.

Narrator: The teacher demonstrates the rubbing technique for each group. After the getters bring the materials to their groups, the students begin to make their first rubbings. The students make several rubbings with their pencils and different colored crayons.

Student: You can see the head.

Teacher: Look at that. Let's see. Can you put that down so I can see it clearer? Very nice. And look at the blue came out very nicely.

Narrator: When the students have completed a few rubbings of the penny, the teacher introduces the word texture.

Teacher: It produces for you on this paper something that we call texture. I want everybody to take your hand right now. And I want you to go like this to the fabric on the top of your shirt and feel it. Close your eyes. Does that feel -- what's that feel like to you? Fabric. Something you're probably very used to. But that's got something that they call texture. And you can get the same picture pictorially if you rub an object under a piece of paper with a pencil or with a crayon.

What do you think worked better for you, the pencil or the crayon?

Student: The pencil. Because the color crayon, it's more difficult to see.

Teacher: It's more difficult to see? So the texture came out better for you with the pencil.

Narrator: The teacher asks the students what features of the penny they can see by rubbing. Did the crayon or the pencil work better. What technique did you use to make your rubbing? How does the rubbing style make a difference in the pattern you make? What happened if the coin moved while you were making the rubbing?

Teacher: John, how did you hold your pencil?

Student: Like this.

Teacher: To the side?

Student: To the side.

Teacher: A piece of denim. Feel your jeans.

Narrator: The teacher introduces the bag of textured objects from the kit and the Rubbing Samples sheet for the next part.

Teacher: Wallpaper.

Narrator: The teacher has the Materials Station ready with the bags of materials available. Each group member gets to select several objects and chooses a pencil or crayon for each rubbing. As the teacher moves from group to group, she discovers some children are making interesting rubbings from combinations of objects.

Student: When you put these two together, you can see the jean part. But you also can see the part with the cardboard.

Teacher: Can you do that on one of these circles?

Student: Right there.

Teacher: And it came out with something different than if you had done them separately.

I saw that a lot of you used different colors with the crayons. And that there were different impressions that came up, right? Different textures. What did you think was the most interesting square that you did the rubbing on?

Danae?

Student: I figured the screen that was like with the rectangles on it. Because when you rubbed on it, it left like a texture bumpy.

Teacher: It left it right on the paper, right?

Student: Yes.

Teacher: How about you, Ashley?

Student: Yes. Because when I did the -- when I did the screen, the lightly threaded one, it left like a --

Teacher: Bubble?

Student: Yeah, texture of -- it was hard -- it was like -- it felt more stranger than the tightly threaded one. Because it feels like you were touching the screen itself.

Narrator: After discussing the students' observations, the class builds the Word Bank.

Teacher: What's a word that you heard today that is new to you?

Student: Texture.

Teacher: Texture. Okay. Let's write that word down in our Word Bank. Texture. Bruce, what does that word mean to you?

Student: Feeling.

Teacher: Feeling.
John?

Student: Rubbing stuff.

Teacher: Rubbing stuff, texture. Rubbing stuff. Is that a new word to you? Rubbing?
Rubbing.

Does anybody have one more word they would like to put up on the Word Bank?

Shilona?

Student: Technique.

Teacher: Technique. Very good word.
Shilona, tell me what we mean by technique.

Student: Um, when you do something.

Teacher: When you do something. And how you do something is the technique.

Narrator: After discussing the words in the Word Bank, the teacher asks the students about the new things they learned and she records their ideas on the Content/Inquiry chart. The important thing for students to take away from this part is that rubbings enhance textures or patterns that are not readily visible.

Be sure to check the Science Stories folio so that you'll know the best time to have your students read the stories on rubbings.

<Investigation 1, Part 2>

Narrator: In this part, students apply what they've learned about rubbings to learn more about leaf structures. Here is what you'll need for this part: From the kit you'll need the sets of rubbing materials in the zip bags, the posters showing the venation patterns and white paper.

From the measurement kit you'll need the hand lenses. You'll need to supply pennies, crayons, pencils and a set of leaves for each group. Have the Assessment Chart for Investigation 1 available.

Begin this session by asking students if they think they can learn something new about leaves by making rubbings.

Teacher: Are there enough leaves? You want to get a couple leaves from each one of the groups.

Anyone else? Did anyone else see anything when you do rubbings on your leaves?

Shilona?

Narrator: The teacher asks the students what they were able to see and record by making their rubbings. They mention the size, shape, edges and lines in the center part. The teacher takes this opportunity to introduce the word blade to describe the thin flat part of the leaf. The students

identify the veins and learn that the pattern that the veins make on the leaf is called the venation pattern. The teacher asks the students to group their rubbings by similarity of venation patterns.

Teacher: I want you to take a look at the leaf.

Narrator: The teacher uses the leaf posters to help organize the students' observations. One group of leaves has palmate venation. The veins on these leaves resemble the palm of the hand with fingers extending in five directions.

Teacher: Very good. Leslie held one up.

Narrator: Other leaves have parallel venations. The teacher points out that parallel leaves have veins that look like many straight lines all running in the same direction from the base to the tip. She asks the students to check their rubbings as well as the leaves. None of these leaves have the parallel pattern.

Owen?

Student: Could we find these leaves in Mexico?

Teacher: Could we find these leaves in Mexico? You know, I don't know. But I think that would be a good question to put in our Project Folder. What do you think? That's something we can research.

Student: Yes; uh-huh.

Teacher: Let's look at another one.

Narrator: A third group of leaves has pinnate venation.

Teacher: Does this look like a leaf that you worked with today?

Narrator: The pinnate leaves look something like a feather and have one main vein with many smaller veins branching off sideways all along the main vein.

Student: The lines connect on that one.

Teacher: The lines connect on this one.

Student: Up here.

Student: This is a pinnate.

Student: And right here, this is --

Student: That's a palmate.

Student: Yeah. Right here is the pinnate. These are two palmates.

Student: This would be a pinnate.

Student: Yeah.

Student: This one is -- this one is a palmate.

Student: On this one -- we have two palmates. One, two, three, four --

Teacher: I would like you to go home tonight -- for your homework assignment tonight, I would like you to look around either in your garden, in your house, in your kitchen, in your backyard, in your front yard. I would like you to take a look at different objects that you think that you could do a rubbing on. And I would like you to take a piece of paper and your pencil and I would like you to rub it.

And then I don't want you to put anything else on that piece of paper. I want you to bring it in. And I want to see if we can guess what it is. How many of you think -- don't say anything. But how many of you think you know of something that you could do a rubbing on and it could be a surprise? Good.

Narrator: In this part, students should learn the technique of making rubbings allows us to clearly see venation patterns of leaves and that leaves can be grouped based on venation. Veins transport materials within the leaf.

Before ending this session, introduce the Project Folder to your class. Explain at the end of the module they will be selecting ideas to learn more about. And this is a good time for them to begin adding their ideas and questions to this folder.

<Investigation 1, Part 3>

Narrator: In Part 3, students use their own ideas to make a rubbings invention. Here is what you'll need for this part: From the kit, sets of rubbing materials and paper. You'll need to provide crayons, colored pencils, clay and some students may want to work with leaves.

Duplicate the student sheet called Rubbing Invention Ideas and the student sheet called Response Sheet - Rubbings, which you can use for assessment. Have the Assessment Chart for Investigation 1 available.

This part of the investigation is a performance assessment so think about what criteria you want to use to assess your students' work. A day or two before beginning, ask students to make rubbings at home and bring them in.

Begin this part by having students share their rubbings. Brainstorm some ideas for inventions with your students. Make a detective game. Make a sorting game. Create an art project using rubbings. Use rubbings to find out something about shoes. Find out what kind of paper makes the best rubbings.

These students are inventing a game called Guess the Rubbing.

These students are inventing a game called Guess Whose Shoes These Are.

These students are planning a collage using their rubbing.

Teacher: That's your milk carton at the bottom?

Student: Uh-huh.

Teacher: And a radio vent?

Student: Uh-huh.

Teacher: Oh, good one.

Narrator: This is the first time you've asked students to come up with their own ideas and create inventions. They will probably need quite a bit of support and guidance. But as they work through the module, you'll get to see them work more independently. It's a good idea to plan time for show and tell when they've completed their inventions so that they get a chance to share them with the rest of the class.

Add words and concepts that students come up with to the charts. This brings us to the end of Investigation 1. Be sure to look through the Interdisciplinary Extensions for your students and have them do the math problem of the week before moving on.

<Investigation 2, Part 1>

Narrator: In this investigation, students are introduced to a second technique to help reveal hidden patterns: Carbon printing. In this part they use pencils and transparent tape to make carbon prints of their skin texture and then use the same technique to make fingerprints. Here is what you'll need for this part: From the kit you'll need the transparent tape, slide frames, sticky notes and the posters of fingerprint patterns.

From the measurement kit you'll need hand lenses. You will need to provide scratch paper, newspaper, pencils, paper towel for the students to clean their hands with afterwards and a slide projector if you have one available. Duplicate the student sheet called Finger Patterns and the teacher sheet called Fingerprint Replicas. Make one copy of the Assessment Chart for Investigation 2.

Make sure that you have sent the Letter To Parents home with students so that parents know that part of this activity involves students making their own fingerprints and then making fingerprints of family members at home.

You will need to prepare a chart for students to make a bar graph of their thumb prints. Use large chart paper and draw three columns labeling them W for whirl, A for arch and L for loop.

No. 2 pencils work best for carbon printing and although they are commonly referred to as lead pencils, they contain no lead at all, only carbon, and are not a health hazard. But if you choose, you can have your students use newsprint and have your students rub their finger across the print and there will be enough black residue for their fingerprint.

It's a good idea to practice making carbon prints before you begin. You'll see a demonstration by the teacher in the classroom in just a moment. The students create a bar graph on the chart to show the distribution of thumb print types in the class. The results look something like this. Most classes find the majority of students have the loop pattern.

There are several ways you can chart their thumb prints. You can make copies of the fingerprint replicas onto full sheet labels and cut them out. Then let students choose the replica that matches the pattern on their thumb, peel off the back and stick it on the chart. Or you can make copies of the fingerprint replicas onto plain paper, cut them apart and then have students tape the replicas onto the chart. Or you can have students make another print. Only this time putting the tape on a small sticky that can be attached to the chart.

Begin this lesson by asking the students to rub the palm of their hand and report how it feels. Most students will say their hands feel smooth. The teacher tells the students that even though their hands feel smooth, they have texture. High and low places on a surface give it texture. He points out the texture of some things in the room and continues to explain that the palm of their hands have only slight differences between the highs and lows, so often they don't see them. He continues to explain that there are special techniques to help them see them.

Teacher: How we're going to do that -- and then we're all going to get a chance to get fingerprints made of each one of you, of all of your fingers and a little bit on your hands, too. And you're going to have a piece of scratch paper. And what you're going to do is you're going to rub your pencil on the scratch paper for quite a long time in a nice big spot so that the lead or - this isn't really lead, the metal lead. This is really carbon.

And it leaves little tiny pieces of carbon. Just like when you write with your pencil, it leaves some behind. We're going to leave a whole bunch behind. And then what we're going to do is put your hand in it first. You're going to get some carbon on your hand, which you can hardly see on my hand right now. But it's there.

Then we're going to get some scotch tape. We'll put the tape on your hand. Then when we take the tape off and put it on a piece of paper, you'll be able to see exactly what the marks on your hand -- all the different lines and texture of your hand are because it's going to pull the carbon from -- off from the pencil lead right onto the tape. And you'll be able to see it because it's on the tape.

Narrator: The Materials Station is all ready for the getters.

Teacher: There you go. Maybe too wide of a spot, Gavin. Maybe do it in here and do it harder so they -- you want it to be really dark.

Narrator: The students make a practice print first. Many students look for a dark black mark on their hands. At first they don't trust that the tape will get a print from what looks like a clean hand.

Now they really see the results. The students are preparing to print all five fingers.

Teacher: Take your scotch tape long ways, same as the length of your finger, and put the tape over your finger that way. Not across your finger but long ways. Then when you take it off, you'll put it on the corresponding finger on your sheet. Okay? Long ways on your fingers.

And don't get too much carbon. All you have to do is push your finger down for a second or two and then lift it back up. Then when you put the scotch tape on your finger, it should come right up. And put it on the corresponding finger on your finger pattern sheet.

Narrator: Once students have all five prints, be sure to give them time to study, compare and discuss them with their partners.

Student: Is any of yours like that one?

Student: Huh-uh, not at all.

Student: Yours --

Student: That one is like that one.

Teacher: What did they look like when you looked at them?
Raven?

Student: Some of them looked like whirlpools. My thumb did. It looked like a whirlpool kind of.

Teacher: Okay. That's a good description.

Student: It looked like a wave kind of.

Teacher: Okay. Waves. That's a good description, too.

Narrator: The teacher introduces the three main fingerprint patterns. The loop, the arch --

Teacher: This is the kind that I have on some of my fingers.

Narrator: -- and the whirl.

Teacher: And some of you might have a whirl. Some might have an arch. Some might have loops. Some might have combinations of all three. Everybody is a little bit different. What I would like you to do is using the hand lens, see if you can find out what kind of pattern yours would be classified under.

Student: I have little loops. I have three loops. One whirl and one arch.

Student: This one is an arch.

Student: This one is an arch and a loop.

Narrator: The students can make slides of their fingerprints by taking the transparent tape with their print and attaching it to a slide frame like that. If you do have the ability to project your students' fingerprints, they will be able to see so much more. Here you can even see the portion in the skin. Once the students have identified the types of prints on their own hands, they share the results.

Student: Three loops and two arches.

Student: I have pretty much an even share. Two loops, two whirls and one arch.

Student: Cool.

Teacher: Okay. So you should have been able to find out whether you have an arch or a whirl or a loop type of fingerprint or if you had a combination of all three or just a couple of them.

How many people had all arches, raise your hand? How many people had all loops? We have one. Steven.

How many people had all whirls? Okay. How many -- obviously everybody had a combination of all three. How many people had mostly arches? How many had mostly loops? Okay. Great. And how many people had mostly whirls? So it looks like we have a pretty loopy class here.

Narrator: In this part, students should learn that carbon printing technique reveals the textured patterns of our fingerprints. Fingerprints can be organized based on three different patterns. And there are no two fingerprints that are exactly the same.

Check the folio for the FOSS Science Stories so that you can plan to have your children read them at the most appropriate times.

<Investigation 2, Part 2>

Narrator: In this part, students use what they've learned about carbon printing to solve a mystery. Here is what you'll need for this part: From the kit you'll need transparent tape and index cards. From the measurement kit you'll need the hand lenses.

You'll need to provide pencils, scratch paper and paper towels. Duplicate the student sheet called Solving A Mystery and have the Assessment Chart for Investigation 2 available.

Begin this session by explaining to students that each person's fingerprints are unique and can be used to identify that person.

Teacher: Okay. So first someone has been bringing presents to the teacher. Last week somebody got me a candy bar. This week I got an apple. Who could it be?

Pretend you're the detectives. The apple had a nice fingerprint on it. The mystery solver's lab lifted the print from the apple and stuck it on a card like that. They labeled the card "Mystery Person." Your job is to compare the four students who were seen in your room and which one of them was bringing presents to me.

Narrator: First each group member will tape two fingerprints to an index card and write their name on the card.

Student: Who wants to be the person?

Student: Jasmine, pick a number between 1 and 10.

Student: And 10?

Teacher: We're just about done.

Student: 6.

Student: The answer was 3 so Jasmine got closer. You get to be the mystery person. We'll disguise the handwriting so they don't know it's you.

Narrator: Each group secretly chooses who will be the mystery person. Then the mystery person makes another carbon print using one of the fingers they used on the first index card, tapes it to the mystery index card and labels it "Mystery Person."

When everyone is ready, the groups exchange cards and each group uses their hand lenses to try to solve the mystery.

Student: I can look in the middle of each of them, of the index finger and this. And I can see kind of a match. Because down at the bottom -- that's kind of down at the bottom, too. Take a look at it. Look at it.

Student: Let me see.

Student: See. See that?

Student: Okay. Now look at the index fingers of Leslie's.

Student: Let me see.

Student: It has to be someone. It can't be Shaquere's.

Student: It's kind of different.

Student: I think it's Leslie.

Student: Okay. Let's see.

Student: It's Leslie.

Student: It has to be Leslie.

Student: It's Leslie.

Student: Okay. What's the other piece?

Student: It's Leslie's.

Student: It's Leslie's. It has to be.

Student: It's Leslie's, yeah.

Teacher: Did everybody have a chance to figure out who the mystery person was.

Class: Yes.

Teacher: I'm going to go around and ask the reporter to tell who they think the mystery person is. And then I want the group that got their cards to confirm or deny whether that was the person that it really was.

So Nicole, who do you think the mystery person is?

Student: Martina.

Teacher: Martina, was it you?

Student: No. It was Joshua.

Narrator: Okay. Joshua. Do you guys have the same fingerprints?

Student: No.

Teacher: Well, you fooled them. Okay.
Martina?

Student: We thought Julian.

Teacher: Julian. And are they correct, Julian? That looks like a guilty face if I've ever seen one. Gotcha. Your life as a criminal is over.

Narrator: The students record their experience on their student sheet.

In this part, students come to understand that fingerprints can be used to identify a person. Be sure to remind students to add questions and ideas to the Project Folder before moving on.

<Investigation 2, Part 3>

Narrator: In this part, students create their own inventions using the carbon printing technique. Here is what you'll need for this part: From the kit you'll need transparent tape, the slide frames and the bags of textured materials.

You'll need to provide colored pencils, chalk, leaves, newspaper, No. 2 pencils, two sizes of

scratch paper, paper towels and a slide projector, if you have one available. Duplicate the student sheet called Carbon Printing Invention Ideas and Response Sheet - Carbon Printing, which you can use for assessment. Have the Assessment Chart for Investigation 2 available.

Begin this session by asking students to think about what kinds of inventions they can come up with using carbon printing. Some ideas that might be interesting to students: Toe prints, making an art project, comparing animal paw prints or comparing carbon printing to a rubbing technique to see the differences.

This will become Guess the Body Part.

Student: I got it. I got my belly. Oh, there's fingerprints on my belly.

Student: There; there. I did it.

Student: I don't see it from my elbow. Do you see it?

Student: There's my toe print. Now where is my sock?

Narrator: The important thing to look for in this part is that students are using carbon printing to solve new problems. This brings us to the end of Investigation 2. Be sure to look through the Interdisciplinary Extensions for your students and have them do the math problem of the week.

<Investigation 3, Part 1>

Narrator: In this part, students are introduced to chromatography, another technique to help them see things that are not readily visible like pigments and watercolor inks. Here is what you'll need from this part: From the kit you'll need transparent tape, colored markers, paper clips, one half liter container, rubber bands and coffee filters.

From the measurement kit you'll need the basins and the hand lenses. You'll need to provide newspaper and paper towel. Duplicate Student Sheet No. 10 called Chromatography. Make one copy of the Assessment Chart for Investigation 3.

You'll need to cut coffee filters into strips for this activity. Take about 50 coffee filters, about 15 at a time or so. And you'll need to square them by removing the edges. You can use a paper cutter or if you're more comfortable using a pair of scissors, that will do, as well.

After you've removed the edges, cut the squares into strips about two and a half centimeters wide. Separate the strips and place them in a plastic bag to save for the activity.

You may want to cover an area with newspaper for the students to use when they make their marks on the filters. This will prevent the ink from getting on the tabletop.

Begin this session by telling the students a story. "Once upon a time a scientist was writing a letter to a friend. He had to leave the room for a moment and a gust of wind blew his letter so that a corner fell into his cup of tea. When he returned, the letter was unreadable. He didn't know it at the time, but he had made an important discovery." And we're going to find out what that was.

Teacher: And you are going to put the rubber bands over the basin with -- trying very hard not to snap it so it doesn't pop. Because what can happen if it pops? It can hurt, huh? It can shoot across the room and hit someone. So we're going to do this very slowly, very cautiously, and we're going to put four of these across the basin. You can do two from this side. It might be easier. And then you can go over to the other side of the basin and put two more on.

Narrator: After the teacher demonstrates the setup, the getters get the supplies for their groups. Each student in the group slides a rubber band on the basin. As each group finishes placing their rubber bands on the basin, the getter brings the basin to the Materials Station and uses the half liter container to add about a half liter of water to the basin.

Next the starter comes to the Materials Station and makes a purple line on one filter strip. The pens remain at the Materials Station. The strips tend to stick together so you may want to tell the students that this part works better with just one strip.

When the tip of the paper just touches the water, students fold the paper over the rubber band and secure it with the paper clip. The students observe the strip for about three minutes.

Student: Nothing yet.

Student: The purple is spreading a little.

Student: It's spreading a little bit.

Student: Then purple and pink.

Student: The blue is lower and now it's bigger.

Student: The blue is a lot bigger.

Student: And there's more pink now.

Student: But I'm wondering how come the purple wasn't at the bottom inside of the blue.

Student: The purple was at the bottom.

Student: But it turned blue.

Student: Why didn't the purple stay at the bottom? Because that's where it was drawn at. And then the blue goes where the purple was and it goes purple, blue, pink.

Student: Purple, blue, pink.

Student: Purple, blue, pink.

Teacher: Can somebody tell me what happened?
Laura?

Student: The color that you got turned into different colors.

Teacher: What colors?

Student: Blue, purple and pink.

Teacher: Blue, purple and pink.

Ashley?

Very good.

Student: And first it was only one color. And then it turned into a lot of colors.

Teacher: Then it turned into a lot of colors, right.

Student: At the bottom it was purple. Now at the bottom it's turning blue.

Teacher: Now at the bottom it's blue. So the purple has actually changed to blue.

Student: It came up.

Narrator: The teacher introduces the words pigment and chromatography and tells the class that the finished product is called a chromatogram. The students come up to the station, select a color and mark the strip. All the pens stay at the Materials Station. The students decide which colors each student in the group will be responsible for getting so that all eight colors are sampled.

A simple line at the 2 centimeter mark is best. And they must use only one color on each strip of paper. Have students mark the color they are using on their student sheet and then make a mark on both ends of the strip. This way they have a permanent record of the color ink that they began with. The strips are hung from the rubber bands exactly the way the students hung the purple strip.

Teacher: What color did you start with this one?

Student: Black.

Teacher: Black. What color pigments do you see from that color black?

Student: Blue and brown.

Teacher: Brown. There you got it, Maleah.

Student: It's like brown and burgundy and pink.

Student: The blue is where the black was.

Student: That's interesting.

Student: I wonder how it got that color from black to blue.

Student: My blue is turning all blue.

Student: Mine is turning dark.

Student: Do you see mine is just going to turn yellow? It was green.

Narrator: The students remove the strips from the rubber bands and blot them dry with a paper towel before taping them to their sheets. When the groups have completed their chromatography student sheets, the teacher explains that chromatography is a technique that allows them to see things they normally cannot see. The students describe the colors of the pigments they couldn't see before.

In this part students learn that chromatography is a technique to separate pigments. Water carries the pigments through the fibers of the paper. Remember to check the Science Stories folio so that you can plan the best time for students to read the stories as you work through this investigation.

<Investigation 3, Part 2>

Narrator: In Part 2, students will use what they've learned about chromatography to identify a mystery pen. Here is what you'll need for this part: From the kit you'll need transparent tape, a half liter container, the strips that you cut from coffee filters, paper clips, rubber bands, two of the watercolor markers, black, and two transparency markers, black.

From the measurement kit you'll need the basins and the hand lenses. You'll need to provide newspaper, paper towel and four black watercolor pens, two of one brand, and two of another brand. Have Assessment Chart for Investigation 3 available.

To get ready, you will also need to make at least two chromatograms and display them on two wanted mystery pen posters like this one. You will use the overhead transparency pen provided in the kit to make the mystery pen chromatograms. Students will compare chromatograms they make to the one made with the mystery pen.

This station has been set up with the filter strips and one of each black marker. You will need to set up two stations just like this for this part.

This session begins with the teacher challenging the students to find the black pen that was used to make the mystery chromatogram. The getters go to the Materials Station and each use marker at the station to mark four strips of paper. The starter places them in the basin and they begin to look for the mystery marker.

Student: Like the brown is like the ground and the fire is coming up. And like you said, the blue is a mountain or a sky. And the black is like smoke.

Student: It's like a brownish reddish color.

Student: I think it's this one because look.

Teacher: This is it. Let's see which one.

Student: It's this one.

Teacher: Which one looks like this?

Student: This.

Teacher: That one. Okay.

Narrator: In this part students learn that we can use chromatography to identify inks. Remind your students to add their questions and ideas to the Project Folder.

<Investigation 3, Part 3>

Narrator: In this part, students invent ways to use chromatography. Here is what you'll need for this part: From the kit you'll need the match sticks without heads, rubber bands, half liter containers, plastic cups, food coloring, paper clips and large washers. From the measurement kit you'll need basins and additional containers.

You'll need to provide aluminum foil, an assortment of watercolor pens, facial tissues, scissors and several different brands of paper towel. Duplicate the student sheet called Chromatography Invention Ideas and the Response Sheet - Color Writing. Have the Assessment Chart for Investigation 3 available.

Food coloring can be used to make designer inks. But its use must be controlled closely. A mixing tray can be made by using a sheet of aluminum foil. You fold this foil in half, place it over a large washer and mold the foil around the washer so that the center part becomes an inkwell. Students can make several of these on one sheet of foil.

When they are ready to mix their colors, they simply take the food coloring and add a few drops into the well. Select a second color and add some. And they mix the new color with the match stick.

This part begins by having students observe what happens when they put drops of water on a coffee filter. They put one drop in the middle and they put one drop on the edge. The movement of the water through the paper is called wicking. This observation helps students plan their inventions.

These students have decided to use chromatography to make a rainbow.

Student: See this one is done with the label.

Student: You have to make a second one.

Narrator: These students will use their strips to make an art piece.

Student: A red one.

Narrator: The students may need more than one class period to finish their inventions. Remember to add new words to the Word Bank and add any questions or ideas that the students have to the Content/Inquiry chart.

<Investigation 4, Part 1>

Narrator: In this part, students use mirrors to help see things they can't normally see. Here is what you'll need for this part: From the kit you'll need the mirrors. You'll need to provide scrap paper and pencils. Duplicate Student Sheet No. 13 called Mirror Images and Student Sheet No. 14 called Mirror Puzzles. Make one copy of the Assessment Chart for Investigation 4.

If the kit is brand-new, you'll need to remove the plastic film from the front of each mirror. Practice using the mirror with the student sheet before you begin this lesson. You can use the mirror to make three circles into six. We can create a cowboy hat. And the mirror can be used to test letters in the alphabet for symmetry.

Begin this session by asking students where they find mirrors.

Student: Usually you can find mirrors in a house or in a bathroom.

Student: You can find them like at a circus in the house of mirrors.

Teacher: What kind of mirrors do you find there?

Student: Weird mirrors that make you look strange, all big and skinny and short and tall.

Teacher: What are some other things that you could use as a mirror if you didn't have a glass mirror like this?

Jessie?

Student: Well, sometimes if you like look at your chair or if it's really clean, you can see your reflection in it.

Student: You can see your reflection on people's cars.

Student: Like on your desk.

Teacher: On your desk? Well, I guess your desk is sort of shiny. I don't know if anybody else's is very shiny, though.

Student: Or like if you look in the lake or something, you can see your own reflection and it sort of ripples.

Teacher: Okay. Very good. What are some things that you can see with a mirror that you can't see without one?

Josh?

Student: Like around corners. When you hold up your mirror like this, you look at it and you can see around the corner.

Teacher: Okay.
Nicole?

Student: Your face.

Teacher: Very good. Your face.

Student: You can -- like if you're in a submarine, you can see up and out of the water. Like you can see what's above you.

Student: You can see your ears.

Teacher: You can see your ears. They are sort of part of your face I guess. Huh?

What we're going to do today is everyone is going to get a mirror. And --

Narrator: Each student will be able to start investigating with a mirror. The teacher must advise students to be very careful. The mirrors have pointed corners and can break. The getters go to the Materials Station and get a mirror for each group member.

Student: You'll have to see things in front of you.

Student: I can see you, Jodi. I can see Brandy and Jerome.

Teacher: Look at the mirrors. You can do things with the mirrors using those images.

Student: Hi, Jodi.

Student: Hi, Jessie.

Student: I can see around the corner.

Student: Go like this.

Student: Go like this.

Student: Corners.

Student: This one up. Wait.

Student: Here.

Student: See.

Teacher: Looking in the mirror you know what you see isn't real because you know you're here

and that person on -- in the mirror, that's not a real person.

Narrator: The teacher explains that what they are seeing is called a mirror image. He asks the students for examples of other kinds of images.

Teacher: RJ?

Student: Television.

Teacher: Leslie?

Student: A photograph.

Teacher: Very good.

Narrator: Other answers can include movies and drawings. Now the students investigate how mirrors can be used to change the appearance of objects and pictures.

Student: I made a heart here. Jerome, I made a heart.

Student: That's cool. That's a reflection. But it's really not it. It's just in the mirror.

Student: No, the reflection is backwards.

Student: Uh-huh.

Student: An L looks like a C.

Student: Wow, M is weird.

Narrator: The students need plenty of time to explore the student sheet with their mirrors.

Student: It's an arrow.

Student: That's cool.

Student: A pilgrim hat.

Student: A cowboy hat. I have a cowboy hat.

Teacher: If I folded it in half, exactly in half --

Narrator: The teacher uses this piece of paper to show a concrete example of symmetry.

Teacher: If I open it up, this line is right down the middle. Since both sides are exactly alike, that's called a line of symmetry. And symmetry means that it has equal sides or equal amounts on either side.

Narrator: Symmetry is a difficult concept for some students. Mirrors can serve as a tool to find lines of symmetry in objects. Some students will need additional explanations before they understand that a line of symmetry divides an object into two parts that are exactly the same.

Teacher: Joey?

Student: Can you go a diagonal way on it?

Teacher: Sure, you can go diagonal. But it has to be exactly a line of symmetry.

Narrator: After discussing the students' discoveries on the Mirror Image sheet, the teacher introduces the Mirror Puzzles sheet.

Teacher: You decode the secret words that are here. Then you'll go down to the next part, see if you can read the secret messages. And then finally, we'll come back to this. But this is going to be you trying to draw these shapes just using your mirror.

Student: Hike.

Student: Yeah, hike.

Student: Box.

Student: The sky is --

Student: Choke.

Student: If you can read this message, draw a star on this line.

Narrator: Tracing the oval by looking at its reflection is a difficult task. Check to be sure the paper is positioned so the students can't see the actual image but only the image reflected in the mirror. After the students successfully complete the oval, they begin the next image. Now the oval seems easy.

A fun and quick extension you might try is to have the students write their names so that the name can be read in the mirror reflection.

In this part, students learn that images can be produced by mirrors as light bounces off the mirror. Windows, water and other smooth surfaces can produce mirror images. Be sure to check the Science Stories folio so that you can plan the most appropriate time for your students to read the selections.

<Investigation 4, Part 2>

Narrator: In this part, students reflect an image from one mirror to another and then apply this idea to build a periscope. Here is what you'll need for this part: From the kit you'll need the cardboard for making periscopes, mirror clips and mirrors.

You need to provide transparent tape, clay and masking tape. Duplicate the student sheet called Response Sheet - Reflecting and have the Assessment Chart for Investigation 4 available.

Before you begin this part, practice attaching the plastic clips to the mirror to make it stand. Here are a couple of different ways that it can be done. You can attach the clips to the side like this and it will stand. Or you can attach the clips like this and it can stand.

You'll want to assemble a periscope before you begin this session. Take one of the cardboard periscope pieces and fold back the flaps at each slot. Fold it back really good. Then fold the tube along the scored sections, and you'll use two pieces of tape to seal it.

Slide the mirrors through the slots so that they face each other. When the tubes are new, it can be a tight fit and it may take a little jiggling before you're finally able to get the mirror through. And now your periscope is ready to use.

Student: Put your mirror in front of the book. Make it facing towards the book.

Narrator: The students begin by trying to arrange their mirrors using mirror clips so it is possible to see around a book. This is a challenging task.

Student: Put it up in front of it.

Student: Oh, I can! I can see the front now. Can you see the back?

Student: I can see the back.

Student: Can you see the back.

Student: Can you see yet?

Student: We need yours turned that way a little.

Student: But the cover is coming off on yours.

Student: I can't see all the way around.

Student: I can see all the way around.

Student: Does that mirror show something?

Student: See, I can see something else.

Narrator: These students figure out that it works best if they don't look in their own mirror.

Student: I can see it. I can see all the way around.

Student: I can, too.

Student: I see the pencil.

Student: I can see all the way around.

Narrator: Now that students have discovered how to use two mirrors to see images, they are ready to construct a periscope. Allow ample time. Your students will probably have to try installing the mirrors more than once before they get them to work.

Student: Cool.

Student: It keeps going like this.

Student: I can see. I can see outside.

Student: What do you see?

Student: I see the ground. I see the park.

Narrator: In this part, students discover that two or more mirrors can be used to reflect light and allow you to see the image of an object that is hidden from view. This is a good time to remind students to add their questions and ideas to the Project Folder.

<Investigation 4, Part 3>

Narrator: In Part 3, students use mirrors to make their own inventions. Here is what you'll need for this part: From the kit you'll need cup lids, mirrors and mirror clips.

You'll need to provide masking tape, cardboard scraps, a transparency sheet, pennies, clay and transparent tape.

Duplicate the student sheet called Multiple Images and have the Assessment Chart for Investigation 4 available.

Begin this part by discussing multiple images. The teacher distributes copies of the Multiple Images sheet, mirrors with clips and a penny to each pair of students.

Student: Cool. One, two, three --

Student: Here you don't got pennies. Oh, one, two, three, four, five, six --

Teacher: How many do you have in there?

Student: 10, 11, 12, 13.

Student: I have one, two, three, four, five --

Student: I counted 13.

Narrator: Now that students have investigated multiple images, they are ready to think about their own inventions ideas. Include rearview mirrors, a kaleidoscope, a flashlight that shines in two directions at once, mirrors to light a dark corner, mirrors in artwork, a drawing that needs a mirror to make sense. They can work alone or in groups.

Student: I think we should make a box with stars in it. We can make the flashlight and -- have a flashlight, shine it in and yellow paper on the back of the cardboard box. And then there will be stars all around it when you look inside it.

Student: We can have a couple of (inaudible) shining down and the reflection all over.

Student: Okay. Go. It's a kaleidoscope. Okay. Sit down.

Student: How do you make a kaleidoscope?

Student: You can get one of those cardboard things, too. Now, go.

Narrator: You and your students may go on a scavenger hunt for materials that they can use in their inventions. When they have an idea in place, the getter gets supplies and they begin.

Student: What color do you want on the outside of this?

Student: We can decorate it.

Student: Why don't you start softening that stuff up, softening the clay up?

Narrator: This level of involvement is typical of students when they are working on their own inventions. This is the beauty of the FOSS approach.

Student: That's a little big, don't you think?

Student: That's a little big.

Student: Okay. Now we have to cut up this paper in four pieces.

Student: Okay. Do you want to cut some?

Student: I'll put a piece of tape on my face.

Student: Try to put them itty bitty.

Narrator: The teacher circulates from group to group adding suggestions to help each group create a successful invention. When the students have completed their inventions, plan to have a show and tell session. Allow the inventors to show and demonstrate their inventions.

The most important thing for your students to remember is that mirrors can be positioned to create multiple images.

<Investigation 4, Part 4>

Narrator: The last part of this module gives students an opportunity to choose their own investigations. These projects allow students to follow their own interests and gives you insight into what they understand about ideas and inventions.

This is the time to bring out the Project Ideas Folder. As much as possible you want students to use their own ideas and investigate the questions that they have come up with during the module. The students have been doing many projects along the way. Some may choose to continue working on those and develop them further and others may choose to go in a different direction.

If you don't have enough ideas in the Project Folder for everyone to investigate, you can use the project ideas sheet to help students think about more investigations. The project plan sheet should be completed by each student or team of students doing a project. This sheet helps you control materials and keep tabs on what students are working on.

You should plan about two weeks for students to complete their projects. You might allow them time to work on their projects at school but also suggest that they do some of the work at home.

The Assessment folio has suggestions for scoring the students' work on the projects. Also in that folio you will find information and masters for two kinds of summative assessment: An end-of-module test given in a variety of formats and suggestions for assembling portfolios.

This is the end of the Ideas and Inventions module. Keep in mind that there are details in the Teacher's Guide that we have not been able to show you on video. And remember, the Ideas and Inventions module should be exciting for both you and your students.