FOSS ® BALANCE AND MOTION
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 Malone Introduction to Module>
Narrator/Larry Malone: Hi. I'm Larry Malone. And I'll be your guide as we take a brief look at the Balance and Motion module for Grades 1 and 2. Right at the start I would like to say that this video is not intended to be a substitute for the Teacher Guide. Rather what we would like you to do is open the box and take out the materials and familiarize you with them. And we would like you to see how they go together and take some brief glimpses of the students working in the classroom. Later you'll have the opportunity to look at the Teacher Guide and prepare yourself to teach the activities.

In this module students will be looking at some of the fundamental behaviors of solid materials. In the first activity they will grapple with ideas associated with dynamic equilibrium. We call that balance. In the second activity the students will be looking at things that go around, rotational motion. We call that spinning. And in the third activity the students will be dealing with linear motion and they will be rolling spheres.

Most of the materials needed to conduct the investigations come in these two boxes. In addition, there's a third box for this module, a cardboard carton containing the long runways used in Investigation 3. In the kit with the materials you'll find the all important Teacher Guide. Open your Teacher Guide to the Overview folio which contains many helpful suggestions for getting started. In it are the national standards that are addressed in this module, background information on balance and motion, ideas for organizing your classroom for the investigations,

suggestions for scheduling the activities and an overview matrix to help you plan the entire module and integrate it into the other areas of the curriculum. In the Materials folio, you'll find an inventory list for the kit, lists of any materials you'll need to provide for the investigations, directions for preparing the materials and information on ordering any replacements.

The next portfolios are the Investigation folios. These are the heart of the program. The first page gives overview information. The At A Glance chart summarizes the investigation and helps you plan for assessments and extension activities. Next you'll find background information specific to the investigation.

There is a section called Teaching Children About which gives you some insight into the research on how children think and learn. Each investigation has several parts. For each part you'll find a materials list, Getting Ready section and then step-by-step directions for conducting the activity with your students. The interdisciplinary section on the back of the folio has many ideas for extending the investigation into other areas of your curriculum.

In the next section are the duplication masters. Here you'll find all of the student sheets used in the investigations. There are also masters for math extensions and Home/School Connections for each investigation.

There are lots of ways to assess your students' learning as they progress through the investigations. Read through the module Assessment folio at the back of the Teacher Guide for more information about the formative assessments suggested at each session, end-of-the-module assessments and portfolio suggestions. After the Assessment folio you'll find duplication masters to help you with assessments.

On the anecdotal notes you can record your students' insights or the difficulties they run into. The assessment checklist is used when assessing specific skills or concepts the students have learned. In the kit, you'll find a class big book and eight student books, the Foss Science Stories for Balance and Motion. These are designed to be read periodically throughout the module after students have had hands-on experiences with the activities.

The Science Stories folio in the Teacher Guide provides background information and follow-up activities. Check out the resources folio located near the back of the Teacher Guide. This annotated list includes both fiction and non-fiction books for students, videos, software and teacher resources.

There are a few things to get ready that will be used throughout the module. Make copies of the anecdotal notes and assessment checklist sheets for assessing student understanding during the investigations. Many teachers write the students' names before making copies. Word Bank and content charts are used to help students remember the new vocabulary and concepts they learned as the module progresses. Students will add to these charts at the end of each session.

<Investigation 1, Part 1>

Narrator: In this activity, students balance lots of objects and systems. They will struggle with center of gravity, trying to establish stable positions, setups that waggle and wobble but return to their stable balanced position. It's through multiple experiences that the concepts emerge for the students very important structural strategy when working with early childhood students.

Here are the materials you'll need for the first part of the activity, Trick Crayfish. Eight and a half by 11 die cut sheets, clothes pins and large zip bags. There are four shapes on this die cut sheet. We only need one for this first part of the activity and that's the crayfish, which is right there in the center. So I can pull that out of the sheet and now I'm all set.

But while you're at it, you might as well take out the other three shapes. Here is the hand holding a pencil. Here is the arch. And here's the triangle. So you may as well bag up the other shapes and have them ready for Parts 2 and 3.

These shapes are made out of heavy paper. But they are permanent material. So urge the students to handle them with care and not to tear or fold them during the activity.

Part 1 starts with a challenge. "Boys and girls, we have a trick crayfish. And I know one trick that it can do. It can balance on my thumb or finger like this. Can you do the same?" And so getters come and get the crayfish and away they go and the students set to work trying to balance a crayfish on their finger or thumb.

Student: I can't do it.

Student: Look.

Narrator: After students have enjoyed some success, distribute two clothes pins to each student. Challenge them to find new ways to balance the crayfish with the assistance of the pins.

Student: It's in your fingernail, see.

Narrator: Part 1 ends when the students have all balanced their crayfish on its nose and discovered even more ways to balance the crayfish. Once students have had ample opportunity to find different ways to balance the crayfish shape, they are ready for new challenges that will be introduced in the next part.

<Investigation 1, Part 2>

Narrator: Here are the materials needed for Part 2, Triangle and Arch. Each student needs a triangle and an arch. These are cut out from the die cut sheet in Activity 1. Each student needs a popsicle stick and two clothes pins and for the class a roll of masking tape. You'll also want to make copies of the two duplication masters, letter home to parents and Stable Positions student record sheet.

Students use masking tape to attach a popsicle stick to the edge of the table like a little diving board. Through trial and error students will discover stable positions.

Student: That's what I did, Xavier.

Narrator: Cruise from group to group. When you find a balanced shape ask: Is it stable? Give it a gentle push. If it wobbles but doesn't fall, proclaim it to be a stable position and challenge the students to discover more stable positions by counter-weighting the objects in different ways. Part 2 may require a second session.

Introduce the student sheet with nine representations. The sheet can be used without materials to see if the ideas of balance and counterweight have been internalized. This is a good assessment. Then give the students materials and let them check their work and change their responses if they want to. Be sure to collect the stable position sheets at the end of the part and put them in the students' cumulative files.

<Investigation 1, Part 3>

Narrator: Part 3 is called The Pencil Trick. And it picks up right where Part 2 left off. Here are the materials that we'll need to conduct the activity: We've got the fourth of our cutouts from the original die cut sheet -- this is the hand and pencil -- the familiar popsicle sticks and the masking tape for making a little diving board, the clothes pins for counter-weighting the systems. And the new item you'll get from the kit is a piece of soft aluminum wire for each student and then each student will provide a pencil. And you need to secure a pair of pliers.

Some teachers feel that the wire poses a potential safety hazard in the classroom. So in order to alleviate that problem, we recommend you get a pair of pliers and roll the end over and crimp it so it's a nice blunt end.

The action for of Part 3 starts when you give the challenge for the students to take the picture of a hand holding a pencil and get it to balance on its point on the popsicle stick that, once again, they've taped to the edge of the tables. By now the students are pretty handy at counter-weighting using clothes pins and in no time at all all of the students will have the shape balanced effectively on the end of their popsicle stick.

At this point you give the more advanced challenge. Challenge the students to get their pencil, their real pencil, and balance it on its point on the end of their popsicle stick. While the students are reaching for their pencils, you distribute the soft aluminum wire. Caution the students no horseplay with the wire and remind them that their challenge is to get their pencil to balance, not to use their wire to tie their pencil onto the end of the popsicle stick.

Some students may land on a solution to the challenge quickly. But don't expect it. Let the students work at a solution. They will help each other and try, try, try. And the discoveries will be sweet. Students will be particularly enchanted by pencils that balance way over on their sides.

There are two basic strategies that students will use to accomplish a solution to the task. First is the single drop, which emulates the picture that they worked with of the hand holding the pencil. Some of the students will take this approach. Others will take the double drop approach where they've got two wires coming down counter-weighted on both sides. Another effective way. Occasionally you'll find students who'll try to balance one object on a balanced object. And great will be the excitement if they accomplish this task.

I would like to point out that even though it's not a main part of the activity, several of the extensions suggest the use of these notched popsicle sticks which are in the kit. You can use these as a mounting platform for lots of little projects that the students might make. Such as here is a stick that has been used as a mounting platform for a nice spring flower. And now with the proper counter-weighting, in this case just the weight of the wire, I can put this up on the clothes line that runs across most early childhood classrooms. And now I've got spring flowers that

wave in the breeze every time the windows open in the classroom.

Or students might be challenged to balance just about anything now that they have some understanding of counter-weighting a system so that the center of gravity is moved below the point of suspension. Here is a cup sitting on the clothes line running overhead. And it can waggle back and forth in a tantalizing fashion but not tip and fall.

So that's really the end of Part 3 and some of the extensions for Part 3. But as you can see, there's really no end to Part 3. It can go on forever.

<Investigation 1, Part 4>

Narrator: The fourth part of the activity, balance, is called Mobiles. And here are the materials each student will need in order to make his or her own mobile: One index card, several paper clips, one soda straw and additionally you have to cut a bunch of straws in half so each student has a half straw as well and three rubber bands. In addition, each group will need access to a pair of scissors and one or two push pins and a scrap of cardboard for poking holes in a critical time in the development of the mobiles.

If you would like to store all the materials needed by a group in a bag, large zip bags are provided for that purpose. And finally, you should look at the duplication masters for Mobile 1 Poster and Mobile 2 Poster and decide which you would like to duplicate for use by your students. You'll see that Mobile 2 is a little more complicated.

Start Part 4 by telling the students that there's a kind of art sculpture called a mobile and proceed to demonstrate for them one way to make one. We're going to use the materials here for the Mobile 2, which is the more complicated of the two. I'm going to start with the soda straw. And I'm going to put the paper clip right on here.

And you'll see that the paper clips fit nicely onto the soda straw holding on snugly but still I can slide them around. That's going to become very important as the students make the final balancing of their mobile. I'm going to put three of them on here. And after I've done this, I'm going to open up the outer two just a little bit to make them into like little hooks. And then what I can do is hang a rubber band on each of those hooks like that and like that.

Now I'm going to put a paper clip on the short piece. And I'm going to hang it right from one of these rubber bands here. So now you can see the second bar is starting to take form here. Now by putting another paper clip on each end of the short bar and making that into a bit of a hook, I'm ready to put the pictures onto my mobile.

Let's see how it's shaping up here. And this third one in the middle here is where I'm going to balance. And I can put a rubber band on there, too, just to suspend the whole rig. Let's see how we're doing. So far not very well balanced. But we'll deal with that later.

Now I'm going to take my three by five card and I'm going to cut it into three panels. And these panels can receive abstract art or parts of a drawing of an animal or a landscape or anything like that later on. I'm going to punch a hole using the push pin and the cardboard for backing right near the top of each of these little panels. And then each panel can be hung from one of these locations here.

I'm going to put one here on one end of the short bar and one right here on the other end of the short bar. Now, you can see that things are falling apart a little bit. But that's okay. I can reassemble here. And if the students do pinch these paper clips back into their original shape a little bit, that will prevent them from falling apart.

Okay. It's starting to take on the shape of a mobile here. The balance is looking better. And using the last paper clip and the last panel of my art, I can attach the last piece on over here.

Now, there is my mobile. In order to get the final balance, I can start sliding things around to adjust how things hang. And pretty soon, it comes into focus as a primitive but quite effective mobile. And at this point, some students may apprehend the idea that "Hey, I can increase the size of this by instead of putting a panel here, I could put another bar. And over here, as well." So the size and complexity of a mobile is limited only by the time and resources available.

We also recommend that in the classroom if you have the opportunity, you build maybe some small mobiles out of thread, toothpicks, that kind of thing and some large mobiles. Maybe start with a broom handle and put some sporting gear on there and get it all balanced. So the idea, the concept, of mobile transcends any one set of materials.

Another nice thing to do is bring in a commercial mobile of some kind and have that in the classroom. Whichever design the students build, it would be a nice idea to again hang up all of your mobiles up on your clothes line in your classroom so they can all be on display for a period of time.

That brings us to the conclusion of Activity 1, Balance. And as you can see, we've had the opportunity to investigate a number of systems that bring the students in contact with balance, stable position, center of gravity, all in a very intuitive and playful way.

Here are the concepts that students have been introduced to in Investigation 1. Objects can be balanced in many ways. A stable position is one that is steady: The object is not falling over. Counterweights can help balance an object. A mobile is a system of balanced beams and objects.

Now that the students have had experience with these concepts, you can introduce the Foss Science Stories. Students get a lot more out of reading material when the subject matter is familiar.

<Investigation 2, Part 1>

Narrator: Activity 2 is called Spinners. Can I make it go around? Can I make it go fast, slow? Can I make it stop? Can I make it do tricks? These are all questions that the students will be inquiring after as they investigate rotational or spinning motion.

In the first activity the students will investigate tops. In the second activity they investigate a traditional toy that we call zoomers. And in the third activity the students work with systems that spin as they are dropped through the air.

The first activity is called simply Tops. So let's look at the materials that we'll need. Each student gets two large disks, two small disks and a small straw. This small straw is referred to as

a slim straw in the Teacher Guide. It's only used in conjunction with the disks. These straws are white. The ones in your kit may be a different color.

Later in this part of the activity the students will need a paper clip and access to some tape. You need to provide scissors so that the students can cut out their designs and colored pens so that they can color their designs.

In addition, you'll want to make copies of the Spinning Designs duplication master. Each copy can be cut in half so that each student gets three designs to work with. You'll need to familiarize yourself with the disk because there's an important idea that you'll have to convey to the students.

When these disks are molded, small circular mold marks result. You'll need to be able to locate these because this is the side of the disk that the students should insert the straws. The straws fit very snugly in the holes and that's important so that they will be able to make tops.

So be sure you can locate the side that has the mold mark. The other side is perfectly flat. No mold marks. The side with the mold marks is the one you want to direct the students to insert the straws. This has been carefully designed so that the straws fit very snugly. So if you find it necessary to replace the straws for any reason, do so from the original supplier. Because otherwise, they may not fit properly and you'll be disappointed.

Call the students to the rug to start this part. Ask them if they know what a top is, if they've seen one before, if they've played with them. Give them the challenge to make a top and see if they can get them to spin. Ask the getter to come get the materials described earlier and get the students building their tops. The activity may begin slowly but before too long, the students will start having success and the excitement will mount.

Student: Wow! It works!

Narrator: There will be many ways to spin the tops and there will be many designs.

Student: Tomiko!

Teacher: You create one of these and everything else goes back.

Narrator: This activity may spill over onto the floor. And this is fine because students often need a lot of room when the tops really get spinning.

Student: Mine was partnered; mine was partnered.

Narrator: I have to share one thing with you. I always thought I knew how to spin one of these tops. I thought you just took it in your hand between your index finger and your thumb and gave it a little spin and away it went. Well, in first grade those little thumbs and index fingers aren't quite strong enough or coordinated enough to get a satisfactory spin. They spin the tops between their palms. And that's a way to really get one of these tops humming. So this is something you might be prepared to share with your students.

Probably in a separate session the students can work with designs on tops to look what happens

at rotating designs. Here are the three designs that the students can use to start with. Students use scissors to cut out the designs, perhaps a pencil to poke a hole in the middle and slide the design down on the shaft of their top. And then with a bit of tape on the underside, secure it in place. Now they can rotate the design and see what the design looks like when it's spinning.

Now, many of the designs that they will create will be most interesting when they are rotated very slowly. So be prepared to show the students how to use a paper clip as a handle to support the top. Now they can rotate it very slowly indeed. And in the case of this design, they can see that the dots which may have looked quite random to begin with actually are in a pattern of spirals so that when they rotate the pattern, it will look like they are collapsing into the center or spinning out from the center, depending on the direction of rotation.

This second design is a classic. It's a visually active design that when rotated at different speeds and in different directions, different colors, artificial colors, emerge. So they may be able to see blues, yellows, oranges, browns out of this black and white design.

And this is the one that may be of the greatest interest to the students because this is the one they can use to create their own designs and see what happens to them when they spin them.
The tops that the students make with the disks and the straws is just part of the activity beginnings. Actually if you want to keep it going, there are ample opportunities. There are a number of extensions suggested at the end of the folio.

In the kit you'll find a pencil compass. And this can be used as a point of departure for making some homemade tops. Students can do this at home or they can make some disks and carry those home as an additional project by simply scribing a circle on cardboard and then using large scissors. This is not an easy task for first and second graders so I recommend that you get some adults to help with this.

You can cut out disks. If you then punch a hole through a disk, you can insert perhaps a felt tip pen. And now you've got a writing top. If I spin this on a piece of paper, it will make a mark wherever it goes. A starter supply of die cut disks is in the kit. In this case it's not too interesting. But at least I find out a little bit more about the behavior of this particular rotating object when it's at work.

In addition, I can, using the same kind of a system, putting a piece of paper on a disk. And now when I spin this, after putting drops of paint on, the paint will stream off in characteristic patterns.

If you have a set of Tinker Toys, students can use these to demonstrate their understanding of how to make tops. The sticks, the various hubs and so forth can be assembled. And then using the techniques that the students have mastered previously, they can spin tops. They might be able to assemble a square top.

I don't know. Do you think this will spin? Let's see. Sure enough. In fact, this is suggested in the folio as an assessment of the students' understanding of how to build tops, how to manipulate the variables to get them to spin a long time, to spin fast and so forth.

In addition, there's a vast array of commercial tops out there. And if you're so disposed, you

might want to start collecting a few to bring to class. Ask the students to bring in any that they may have at home because the variety is just breathtaking. Like for instance, I have just a few here that I've collected over the last couple of years. And this I will guarantee is just a small sampling of what you might encounter.

Here is one that's called a penny top. It's just a flat disk with a penny pushed through it. The penny provides both a grip to spin it and a surface on which it can rotate. It's got one design on this side and a separate one on this side. So let's see how this one looks.

Here is one with a shaft with a spring attached and a handle so when I pull that, I can really get that one humming. And this is a commercial drawing top. Let's just see what happens when this one is put into action. A drawing tops are included in the kit.

Research tells us that students learn a lot more about objects in motion if those objects leave a path or a tracing behind that they can study and refer to later. This is a good example of a kind of a moving object that leaves a tracing that the students can ponder later. You notice it makes smaller and smaller circles. And then it starts to make larger circles again. And then it kicks out with a tail. And on that note, we bring the first part, Tops, to a close.

<Investigation 2, Part 2>
Narrator: Part 2 is called Zoomers. These are the materials that you will need: A ball of string, which you will have to cut into the length of about 45 inches for each student, a large disk. And you'll have to supply a jump rope or piece of cord if you want to demonstrate to the students how to tie knots. For each group of students make a copy of the duplication master called Zoomer. It shows how to assemble a zoomer and how to tie a knot.

Here is a trick for preparing the 100 centimeter strings that each student will need in the kit: You will find a bunch of sheets of cardboard like this. Get two of them. Overlap them just the right amount so that you have 50 centimeters or about 22 inches of length from one end to the other. Use some clothes pins to secure them in that position and then wrap the string around the cardboard one time for each student.
One, two, three, et cetera.

After you've wrapped it enough times for each student, then use scissors to cut the whole bundle at once. Now all of the strings are measured. And then one more trick, when you distribute the strings, hold the whole bundle in two hands and offer them to the students so that they can pull them out one or two at a time. By holding both ends of the bundle, you'll keep them from tangling up and forming a big macramé.

Start Part 2 by calling the students to the rug. If you have determined that the students need a little coaching with their knot tying, bring a cord or jump rope with you. Show the students how to bring the two ends of the string or cord together, how to make a loop and then how to bring the two ends up through the loop and pull it tight. This simple overhand knot should be sufficiently strong for the students to make successful zoomers.

Then tell the students that tops aren't the only things that spin. That you know how to build a zoomer that will spin, too. Demonstrate how to build a zoomer. Send the students off to their groups. Let the getters get the materials and start zooming.

Student: Whoa!

Student: Whoa!

Narrator: It may be some time before the students get the hang -- get the rhythm of how to get the zoomer zooming. The students will help each other. Pretty soon you'll see one, two, three spins getting it. And then pretty soon most of the students will get it.

You can assist some students to feel the rhythm of the zoomer by coming behind them and holding their hands to help them get into the rhythm of the zoomer. As more and more students get the rhythm and start zooming, caution them to keep their hair out of the zoomer and remind them not to zoom their neighbors or harass them in any way.

By the end of the activity, everybody in the classroom will be contentedly working their zoomers. And everybody will feel very satisfied with their accomplishment. There are a number of extensions suggested at the end of the activity folio so if you would like to have more experience with zoomers, refer to that. A starter supply of die cut round and square disks is in the kit for the extensions.

<Investigation 2, Part 3>

Narrator: Part 3 is called Twirlers. Students make two different kinds of twirlers that rotate as they fall through the air. Here are the materials that they will need: Each student needs one jumbo soda straw and a paper clip. And each group needs access to a pair of scissors and tape. In addition, you will have to make copies of the two student sheets used in this part, Twirly Bird and Twirler Wings.

Each copy of the Twirly Bird master makes four copies of the Twirly Bird. So it will serve four students. Each copy of the Twirler Wings makes two copies of two wings. So each sheet will serve two students.

Part 3 starts with a challenge. Each student is given a soda straw and challenged to see if they can get it to spin by dropping it. Well, after a few minutes, the students will become disgruntled because it doesn't work very well. So that's when you have to propose adding wings to the straw.

Show the students how to use scissors to slit the end of the straw and then you're going to have to distribute the wings that they can add in their own way. Now I'm going to show you what the students might come up with. But this is not a demonstration that you show the students. They should discover how to use the wings in conjunction with their soda straw.

Let's take a look at the sheet. Twirler Wings is the first sheet that the students will use. Cut the sheet in half right in the middle because each sheet serves two students. So each student will get the two wings.

First thing they will do, cut off the bottom, the words. Don't need that. And cut the two wings apart along the central line. The rule is: Cut on solid lines; fold on dashed lines. After they cut the wings apart, then they are going to remove this gray area right here from this wing. The result is that they will end up with a pair of wings that look like this.

Now, they can use these wings in any way they would like, folding them here, folding them there, attaching them to the straw, using the slit to find out if they can get their straw to twirl. Let's see how our wings work.

Here is the wing that doesn't have the cutout. And after much experimentation, the students may discover that the most effective way to use it is to fold it in half and insert the fold into the slit in the straw.

Then fold the wings down. If you have to, perhaps put a little crease along the dashed lines at the end of the wings. And they are ready to fly. Let's see how it works. Not bad.

The other wing that the students will have been working with is this one, the one that has the sections cut out. Again, this one is folded in the middle for its most effective use, inserted into the slit in the straw and, once again, the wings brought out to the sides. So let's try this one, see how it goes. Even more satisfactory.

But I think it's time for a fly-off just to make certain. Here I've got both wing configurations, everything equal. And let's see how they go. I'll let you be the judge of who was the winner.

After the students have finished flying their straws, then you can introduce another flying device, this one the Twirly Bird. There's a little construction involved here, too, so let's see how the students might put that together. To prepare the Twirly Birds for distribution, you'll have to first cut the sheet into four strips along these solid lines so that each student gets one Twirly Bird. When the students get their Twirly Bird, then their task is to cut on the solid lines and fold on the dashed lines to make their Twirly Bird.

They'll find it advantageous to put a paper clip on the tip end of the Twirly Bird, in this instance to get it to fly properly. And the wings will be most effective if they are folded one one way and one the other. But once again, this is not a demonstration. This is what the students will discover through their investigations. So let's see how this one flies.

And, Twirly Birds is the grand finale of this second activity called Spinners. Here are the concepts that students have been introduced to in Investigation 2: Objects and systems that turn on a central axis exhibit rotational motion. The amount and position of mass affect how an object rotates. There are different ways to initiate rotational motion. The motion of an object can be changed by pushing or pulling.

<Investigation 3, Part 1>

Narrator: Activity 3 is called Rollers. In this activity, students investigate linear motion, things going from here to there. In the first activity they will work with wheel and axle systems using the familiar disks and slim straws. In the second activity they will work with cups. They will roll cups down an inclined plain. And the cup is actually a wheel and axle system with a large wheel and a small wheel.

In the third part the students will work with marbles. They will roll spheres. And to contain them, they will roll them in marble runways. So let's get started.

Let's look at Part 1 called Wheels. The materials the students will need are these: Each student gets two large disks, two small disks and a slim straw. And for each pair of students we have one cardboard sheet and four clothes pins. With the clothes pin and cardboard sheet they will assemble an incline plain. Be prepared to demonstrate how to assemble a ramp so the students will be able to do it efficiently.

It's done like this: The students just take the four clothes pins and attach two of them to one end of the cardboard like this. And then the other two are connected to the first two clothes pins for legs. That gives you a nice incline plain, a nice ramp.

Now, students will think that if a slope -- if this slope is good, then one twice as steep will be even better. But that's not necessarily the case. Because as the ramp gets steeper, things tend to skid rather than roll down the ramp. So encourage them to maintain the ramp in this configuration.

This part starts at the rug. Review spinning with the students. And after the spinning has been reviewed, introduce the disk once again. Ask the students if they can get the disks to behave like a wheel. That's the introduction.

Send the students off to their desks to start assembling their ramps. And while they are assembling the ramps, come around and distribute two wheels to each student. Students will have some success rolling disks. But the experience will not be completely satisfactory until you visit each student and distribute a straw.

Student: Here. This is my straw.

Narrator: Now they will make wheel and axle systems. They will try big wheels, little wheels, big wheels in the middle and different sized wheels. The students may try off-center mounting of wheels to produce a wobbly rolling motion. They may discover if two wheels are attached by engaging the notches, the system will roll in a strange manner.

If additional straws are provided, students might make lawn mowers or some other inventive rolling system. Sometimes two pairs will bring their ramps nose to nose so that rollers will roll down one ramp and up the other. Of course, races are a certainty.

Student: Yea!

<Investigation 3, Part 2>

Narrator: Part 2 is called rolling cups. And here are the materials that the students will need: Each student will need a large cup, a small cup and a penny and access to tape. Each pair of students will reassemble the ramp. This is the same one they used in Part 1. They'll use it again in Part 2.

This part starts with a brief introduction at the rug. Students are introduced to cups as rolling objects, materials are distributed and the students start rolling. The students will find out that the cups roll in circles. Challenge them to park the car in the garage. They should discover how to roll both cups down the ramp, around and under the ramp, getting the cups to roll in from both the side and the back.

Student: I did it! Hey! Hey! I made it; I made it!

Narrator: Next challenge the students to work together to get their cups to roll straight. Make tape available to help them solve this problem. Provide pennies and ask the students to stick them in the two cup systems to make them roll in peculiar ways.

It's fun to conclude Part 2 with a Show And Tell at the end. Set up a ramp where all the students can gather round and let teams show the interesting systems that they've discovered. Some of the asymmetries and some of the funny weighted systems will be amazing to all of the students.

<Investigation 3, Part 3>
Narrator: Part 3 is called Rolling Spheres. You will probably want to conduct this part in at least two sessions. In the first session the students will become familiar with the marbles and how they roll and how to control them. And in the second session you'll want to conduct the grand finale, the long runway. So let's see what materials the students will need to conduct this part of the activity.

In this part students work in pairs. Each pair will need two cups with lids and two marbles. In addition, each pair will share one of these runways. Then when you get to Session 2, the long runway, you'll need lots of masking tape for the class.

The first action in this part is to put the marble inside the cup. Put the lid on and see if you can get the marble to roll inside the cup. When the students get the coordination just right, the marble will spin up to the top of the cup and the action can be quite hypnotic for a time. Students might try spinning the cup upside down or sideways. And in each case they will find that the marble heads for the wide end of the cup.

Student: Jupiter.

Narrator: Following the cup investigation, students use the foam runway to find out how they can control the direction which the unruly marbles roll. They practice making the marble go from one end to the other, over hills and in loops. Students learn some important principles. Marbles have to start high and finish low. And bank tracts keep the marble from flying out of the runway.

Finally, the students are ready for the long runway challenge. The idea is to tape all of the sections of runway together and make one continuous runway and put the marble in at one end and see it come out the other. The rules are you can't touch the runway while the marble is running. It has to be freestanding.

A very important aspect to the success of this endeavor is how you connect the runways. So let's look at one effective way to connect the runways. Bring the two sections up together tight against each other. Take a piece of masking tape and stick it right in the bottom of the trough. Stick it down securely.

Next, take another piece of masking tape, stick it onto the top edge here right at the connection. Stick the tape securely across the connection between the two sections and press the whole

business down securely. Now we have an effective pathway for the marble to go between two runway sections. The rest is up to the creativity of the students.

Student: We have to stand up on a chair.

Narrator: Roam among them dispensing tape in half meter lengths. Expect lots of false starts and fixes as the marble fails to complete its assigned mission.

Teacher: Now, class, tell me why it's doing that.

Narrator: Eventually the marble will make it through.

Class: Yea!

Narrator: Here are the concepts that students have been introduced to in Investigation 3: Wheels and spheres roll down a slope. Axles support wheels. Wheel and axle systems with wheels of different sizes roll toward the smaller wheel. The amount and location of an added weight can change the way a system rolls.

Well, that brings us to a conclusion with the module on Balance and Motion. At times the atmosphere may have a deceptive look and feel of play, but the students will be working hard to find out what makes things balance, spin and roll. And even greater than the content advantages that the students will gain will be the qualities of persistence and problem solving that will emerge as a result of this module. It will be a lasting experience for all of you.