Lead Information Packet

Module 2: Motion
3rd Grade

This document is not intended to give you all of the information you need to lead the module. It is only intended to be a reference during the module. You can find the complete instructions at http://www.chem.ucsb.edu/scitrek/module as well as the student notebook and picture packet used during the module.

Important Things to Remember During the Module

1. You are responsible for keeping track of time in the classroom and making sure that ALL activities run smoothly. There will be a time card in the lead box with suggested times to start/stop each activity.
2. You are responsible for keeping volunteers and students on track.
3. Walk around during times volunteers are working with students and help struggling groups.

Types of Documents:

- **Student Notebook:** One given to every student and is filled out by the student. In these instructions, the examples are rectangular and filled out in black. The lead will use a student notebook to write in as an example for students. The notebook that the lead uses is referred to as the class notebook in these instructions.

- **Notepad:** One given to every group and is filled out by the volunteer. In these instructions, the examples are squarer and filled out in blue.

- **Picture Packet:** One per class that, if needed, the lead fills out. In these instructions, the examples are rectangular, labeled, and, if applicable, filled out in blue.

In these instructions, all other example documents are labeled.

Day 1: Question Assessment/Technique/Observations/Reproducibility Discussion/Variables

**Schedule:** You are responsible for **BOLD** sections

- **Introduction (SciTrek Lead)** – 2 minutes
- **Question Assessment (SciTrek Lead)** – 5 minutes
- **Technique (SciTrek Lead)** – 10 minutes
- **Observation Discussion (SciTrek Lead)** – 2 minutes
- **Observations (SciTrek Volunteers)** – 15 minutes
- **Reproducibility Discussion (SciTrek Lead)** – 8 minutes
- **Variable Discussion (SciTrek Lead)** – 2 minutes
- **Variables (SciTrek Volunteers)** – 13 minutes
- **Wrap-Up (SciTrek Lead)** – 3 minutes
Preparation:

1. Make sure volunteers are writing their name and group color on the board.
2. Make sure volunteers are passing out nametags.
3. Make sure volunteers are setting up for the initial observation.
4. Set up the document camera to use for the Technique Activity (page 2, student notebook) and class data (page 1, picture packet).

Notebook Page, Notepad Pages, and Picture Packet Page:
Introduction: (2 minutes – Full Class – SciTrek Lead)

- Allow volunteers to introduce themselves.
- Introduce the module.
Question Assessment: (5 minutes – Full Class – SciTrek Lead)

- Pass out assessments.
- Read each question and have students circle if the question is testable or not testable by science.
- Collect assessments.

Technique: (10 minutes – Full Class – SciTrek Lead)

- Have volunteers pass out notebooks.
- Have students fill out the front cover of their notebooks.
- Introduce the class question, “What variables affect ball motion?” and discuss why/how scientists would investigate the question.
- Show students how to read a timer and fill out question 1 (student notebook, page 2) as a class, and then have students fill out question 2 by themselves before reviewing.
- Have volunteers pass out timers.
- Tell students how to use a timer and then have them time you unsnapping and snapping your lab coat and jumping 3 times. Compare results to times a SciTrek volunteer gets.
  - For the jumping trial, make sure students know to listen for your feet hitting the ground.

Observation Discussion: (2 minutes – Full Class – SciTrek Lead)

- Review the definition of an observation (a description using your five senses).
- Have students move to their groups.
  - If a student does not have a nametag, identify the group with the least number of students in it and write the student’s name on one of the extra nametags that are in the lead box using that color of marker.

Observations: (15 minutes – Groups – SciTrek Volunteers)

- Walk around and help groups that are struggling.
- Make sure groups are moving along and only spending ~10 minutes on recording observations of the experimental set-up and then start to roll the ball down the two run materials.
- Write down groups’ median times on the class data sheet (page 1, picture packet).

Reproducibility Discussion: (8 minutes – Full Class – SciTrek Lead)

- Have groups share what they did/learned.
  - Balls were rolled down outdoor carpet and shag carpet runs. The ball hit the board first on the outdoor carpet run.
- Show students the class data sheet (page 1, picture packet) and have them brainstorm why groups got different times.
- Discuss the importance of repeating measurements.
- Introduce median (the middle number) and have students find the median of the collected data.
- Have students tell you how what they learned relates to the class question (the smoother the surface the less time the ball takes to hit the board).

Variable Discussion: (2 minutes – Full Class – SciTrek Lead)

- Review the definition of a variable (something in an experiment that can be changed).
- Explore one possible changing variable with the class and have students share why/how this variable might affect ball motion.
**Variables**: (13 minutes – Groups – SciTrek Volunteers)

- Walk around and help groups that are struggling.
- Make sure volunteers are having their group come up with possible variables as well as how/why these variables might affect ball motion.

**Wrap-Up**: (3 minutes – Full Class – SciTrek Lead)

- Have each group share one variable with the class and how/why they think it will affect ball motion.
- Tell students what they will do next session.

**Day 2: Question Activity/Questions/Materials Page/Experimental Set-Up**

**Schedule**: You are responsible for **BOLD sections**

- **Introduction (SciTrek Lead)** – 2 minutes
- **Question Activity (SciTrek Lead)** – 20 minutes
- **Question Discussion (SciTrek Lead)** – 3 minutes
- **Testable Questions (SciTrek Volunteers)** – 8 minutes
- **Question Discussion (SciTrek Lead)** – 3 minutes
- **Non-Testable Questions (SciTrek Volunteers)** – 4 minutes
- **Question/Experimental Set-Up Discussion (SciTrek Lead)** – 3 minutes
- **Question (SciTrek Volunteers)** – 4 minutes
- **Materials Page (SciTrek Volunteers)** – 5 minutes
- **Experimental Set-Up (SciTrek Volunteers)** – 5 minutes
- **Wrap-Up (SciTrek Lead)** – 3 minutes

**Preparation:**

1. Make sure volunteers are setting out notebooks.
2. Set up the document camera to use for the Question Activity (page 3, student notebook).
Notebook Pages, Notepad Pages, and Materials Page:

**SCIENTIFIC PRACTICES**

Testable Questions

Circle TESTABLE if the question can be tested by science. Circle NOT TESTABLE if the question cannot be tested by science.

1. How much does an astronaut's suit weigh? **Testable**
   - Not Testable: Measure
2. Do dogs like astronaut ice cream? **Not Testable**
   - Not Testable: Not well defined
3. Is Venus prettier than Saturn? **Testable**
   - Not Testable: Not well defined
4. How many moons orbit around Jupiter? **Testable**
   - Not Testable: Count
5. Which planet, other than Earth, is the most habitable? **Testable**
   - Not Testable: Can't acquire data
   - Not Testable: Can't acquire data
7. How many telescopes are there in the United States? **Testable**
   - Not Testable: Count
8. Is the space shuttle big? **Testable**
   - Not Testable: Not well defined
9. Is studying the solar system valuable? **Testable**
   - Not Testable: Not well defined
10. What color light do stars give off? **Testable**
    - Not Testable: Observe

Circles are your initial thoughts and boxes are the correct answers.

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**SCIENTIFIC QUESTIONS**

If we change the ball mass, what will happen to the time it takes to hit the board?

- If the ball circumference is changed, how long will it take the ball to hit the board?
- How long will it take the ball to hit the board if I change the ramp height?

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**NON-SCIENTIFIC QUESTIONS**

- Does the ball like rolling down the ramp?
- Will Batman's car go down the ramp fast?
- Is the ramp big?
- What kind of ball is better, a big one or a small one?
Experimental Considerations:
1. You will only have access to the materials on the materials page.
2. You will cut your strips.
3. For each trial, you must measure the time the ball travels (time from ball release to ball hitting the board).

Changing Variable (Independent Variable): ball mass

Discuss with your group how you think your changing variable will affect ball motion.

**QUESTION**

Question our group will investigate:

- If we change the ball mass, what will happen to the time the ball takes to hit the board?

Fill out the materials page with your Scitrek volunteer before moving onto the experimental set up.

**Materials Page**

<table>
<thead>
<tr>
<th>Color:</th>
<th>red</th>
</tr>
</thead>
</table>

**Changing Ball Mass**
You will only have access to the following materials:

**General Materials:**
- [X] Yarn
- [X] Ball stop board
- [X] Ruler
- [X] Scale

**Run Materials:**
- [X] Outdoor Center (original)

**Ramp Length:**
- Select a ramp length between 90 cm and 120 cm.
- Ramp length will be used: **90 cm**

**Knee Height:**
- [ ] 3 cm (original)
- [X] 6 cm

**Knee Length:**
- [X] 90 cm (original)

**Ball Circumference:**
- [X] 7 cm (original)

**Ball Mass:**
- [X] 55 g (original)
- [X] 15 g (original)
**Introduction:** (2 minutes – Full Class – SciTrek Lead)

- Review the class question, what they learned/did last session, and what they will do today.

**Question Activity:** (20 minutes – Full Class – SciTrek Lead)

- Ask students, “What types of questions can be tested by science?”
  - Questions that involve things that are measurable, observable, or countable.
  - On the board, write:
    - Testable Questions
      - Measurable
      - Observable
      - Countable
- Ask students, “What types of questions cannot be tested by science?” Then review categories.
  - Questions in which you **cannot acquire the data**.
  - Questions that contain words that are **not well defined** or are **opinions**.
    - Opinion questions contain opinion words such as prettier, nicest, better, etc.
    - Not well defined questions contain words such as affected, react, etc.
    - Not well defined questions can contain semi-measurable words such as big, wide, heavy, etc. Ex: Is the Golden Gate Bridge wide?
  - On the board, write:
    - Not Testable Questions
      - Can’t Acquire Data
      - Not Well Defined/Opinion
- Read the directions (page 3, student notebook).
For each question, read it, then give students ~15 seconds to circle if the question is testable or not testable by science. Then go over the question and have students box the correct answer. In addition:

- For testable questions, have students identify what data they would need to collect to answer the question and write measure, count, or observe by the question to indicate how you would collect data to answer the question.
- For questions not testable by science, have students identify why the question is not testable and, if applicable, underline the word that makes the question not testable and write not well defined or can’t acquire data by the question to indicate why it is not testable. Then, have students revise the question to be testable.

**Number 1:** How much does an astronaut’s suit weigh?
*Testable (Easy to Test-Measurement)*
Data: Measure the weight of an astronaut’s suit.

**Number 2:** Do dogs like Astronaut Ice Cream?
*Not Testable (Not Well Defined/Opinion-Contains the Word Like)*
Revised: Which food do dogs eat first, Astronaut Ice Cream or steak?

**Number 3:** Is Venus prettier than Saturn?
*Not Testable (Not Well Defined/Opinion-Opinion Comparison)*
Revised: Which planet has more rings, Venus or Saturn?

**Number 4:** How many moons orbit Jupiter?
*Testable (Easy to Test-Counting)*
Data: Count the number of moons that orbit Jupiter.

**Number 5:** Which planet, other than Earth, is the most habitable?
*Not Testable (Not Well Defined/Opinion-Contains an Not Well Defined/Opinion Word)*
Revised: What is the hottest temperature recorded on Venus in 2012?

**Number 6:** How fast does Luke Skywalker fly his spaceship?
*Not Testable (Can’t Acquire Data-Fictional Character)*
Revised: What is the average speed of a space shuttle?

**Number 7:** How many telescopes are there in the United States?
*Testable (Hard to Test)*
Data: Count the number of telescopes in the United States.

**Number 8:** Is the space shuttle big?
*Not Testable (Not Well Defined/Opinion-Semi Measurable)*
The word “big” is not well defined in this context.
Revised: Which is taller, the space shuttle or a person? or What is the size of the space shuttle?

**Number 9:** Is studying the solar system valuable?
*Not Testable (Not Well Defined/Opinion- Students Think the Answer is Yes)*
Revised: Does studying the solar system increase the number of planets people can name?

**Number 10:** What color light do stars give off?
*Testable (Easy to Test-Observation)*
Data: Observe stars and determine the color light they give off.

**Question Discussion:** (3 minutes – Full Class – SciTrek Lead)

- Show the students the question frame on one of the group notepads and explain how it is used.
  - If we change the ______ variable____, what will happen to the ______________________ ______?

**Testable Questions:** (8 minutes – Groups – SciTrek Volunteers)

- Walk around and help groups that are struggling.
**Question Discussion: (3 minutes – Full Class – SciTrek Lead)**

- Have one student from each group share one of their testable questions with the class.
- Have the other students identify if the question is testable or not, as well as the data that would need to be collected to answer the question.
- Review the categories of questions science cannot answer:
  - Category 1: Questions in which data cannot be acquired.
  - Category 2: Questions that contain words that are not well defined or contain opinions.

**Non-Testable Questions: (4 minutes – Groups – SciTrek Volunteers)**

- Walk around and help groups that are struggling.

**Question/Experimental Set-Up Discussion: (3 minutes – Full Class – SciTrek Lead)**

- Have one student from each group share a question that science cannot answer.
- Have the other students identify if the question is testable or not, as well as why the question is not testable.
- Go over the options for variables that students can change: ball mass (show balls with different masses), ball circumference (show balls with different circumferences), ramp length (show ramps with different lengths), ramp height (show them how the ramps can be at different heights), and run length.
- Go over experimental considerations with students:
  - You will only have access to the materials on the materials page.
  - You will run four trials.
  - For each trial, you must measure the time the ball travels (time from ball release to ball hitting the board) **three times**.

**Question: (4 minutes – Groups – SciTrek Volunteers)**

- Walk around and help groups that are struggling.
- Encourage groups to pick different changing variables.
- Make sure for the second part of the question (what you are measuring/observing) that students are specific (Ex: the time it take for the ball to hit the board instead of the time).

**Materials Page: (5 minutes – Groups – SciTrek Volunteers)**

- Walk around and help groups that are struggling.
- Make sure groups fill out the materials page correctly and completely.

**Experimental Set-Up: (5 minutes – Groups – SciTrek Volunteers)**

- Walk around and help groups that are struggling.
- Make sure all control blanks are filled out.

**Wrap-Up: (3 minutes – Full Class – SciTrek Lead)**

- Have one student from each group share the question that they will investigate.
- Tell students what they will do next session.
Day 3: Technique/Procedure/Results Table/Experiment

**Schedule:** You are responsible for BOLD sections

- **Introduction (SciTrek Lead)** – 3 minutes
- **Technique (SciTrek Lead)** – 7 minutes
- **Procedure (SciTrek Volunteers)** – 18 minutes
- **Results Table (SciTrek Volunteers)** – 5 minutes
- **Experiment (SciTrek Volunteers)** – 25 minutes
- **Wrap-Up (SciTrek Lead)** – 2 minutes

**Preparation:**

1. Make sure volunteers are setting out notebooks.
2. Make sure volunteers are setting out the materials that their group will use on an area on the floor.
3. Set up the document camera to use for the Technique Activity (page 6, student notebook).

**Notebook Pages and Notepad Pages:**

![TECHNIQUE

<table>
<thead>
<tr>
<th>Material</th>
<th>Time Ball Travels (s) (in increasing order)</th>
<th>Median (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Styrofoam Ball</td>
<td>5.2, 7.6, 6.0</td>
<td>6.7</td>
</tr>
<tr>
<td>Metal Ball</td>
<td>7.3, 10.2, 9.5</td>
<td>9.2</td>
</tr>
<tr>
<td>Wooden Ball</td>
<td>5.5, 6.5, 7.0</td>
<td>6.7</td>
</tr>
<tr>
<td>Plastic Ball</td>
<td>4.5, 5.0, 4.5</td>
<td>4.5</td>
</tr>
<tr>
<td>Velcro Ball</td>
<td>2.7, 3.0, 4.0, 5.0</td>
<td>3.0</td>
</tr>
</tbody>
</table>
**Introduction:** (3 minutes – Full Class – SciTrek Lead)

- Review the class question, what they learned/did last session, and what they will do today.
**Technique:** (7 minutes – Full Class – SciTrek Lead)

- Review why scientists perform multiple trials and what number they will use to represent all the trials (median).
- Review how to find the median.
- Have students find the median of each data set (page 6, student notebook). Find the median of the first two data sets as a class and then let students find the other three on their own.

**Procedure:** (18 minutes – Groups – SciTrek Volunteers)

- Walk around and help groups that are struggling.
- Make sure procedures are concise, but still include all values of the controls, changing variable, and what data will be collected.
- Volunteers should be writing one step of the procedure and having students copy that step before moving on to the next step.

**Results Table:** (5 minutes – Groups – SciTrek Volunteers)

- Walk around and help groups that are struggling.
- Make sure control values are written in the trial A box with an arrow through the rest of the trials’ boxes and that changing variable values are written in each trial’s box.

**Experiment:** (25 minutes – Groups – SciTrek Volunteers)

- Walk around and help groups that are struggling.
- Students should leave their notebooks at their desks during the experiment.
- All measurements will be recorded in the group notepad.
  - Make sure times for each trial are entered into the group notepad from smallest to largest.
- Groups should be finding the median and recording it on the group notepad for each trial before moving onto the next trial.
- Students will move back to their desks and copy only the median number from each trial into their notebooks.

**Wrap-Up:** (2 minutes – Full Class – SciTrek Lead)

- Tell students what they will do next session.

**Day 4: Graph/Results Summary/Poster Making**

**Schedule:** You are responsible for BOLD sections

- Introduction (SciTrek Lead) – 2 minutes
- Graph (SciTrek Volunteers) – 10 minutes
- Results Summary (SciTrek Volunteers) – 10 minutes
- Poster Making (SciTrek Volunteers) – 33 minutes
- Wrap-Up (SciTrek Lead) – 5 minutes
Preparation:

1. Make sure volunteers are setting out notebooks.
2. Find a place to leave student posters.

Notebook Page, Notepad Page, Poster, and Highlighted/Numbered Notebook Pages:

A larger version of this poster is in your lead box.

Example Highlighted Notebook Pages
**Introduction:** (2 minutes – Full Class – SciTrek Lead)

- Review the class question, and what they learned/did last session, and what they will do today.

**Graph:** (10 minutes – Groups – SciTrek Volunteers)

- Walk around and help groups that are struggling.
- Make sure students are graphing their trial on the individual graph piece with the value of the changing variable written underneath (Ex: 165 g), not the trial letter (Ex: trial B).
- Make sure volunteers are having students arrange the individual graph pieces in increasing order by time and then taping them onto the group notepad.
- Make sure students are labeling their axis and writing the numerical value of the time on top of each column.

**Results Summary:** (10 minutes – Groups – SciTrek Volunteers)

- Walk around and help groups that are struggling.
- Make sure groups are generating a claim (ideally the claim will allow them to make a prediction about future experiments) and use at least two specific data points to support it.
  - Groups will be using measurements as their data, so make sure they are including numerical values in their data statement.
  - Do not reference trial letters in the results summary.
- Volunteers struggle with results summaries, therefore, check each group’s results summary.
- Make sure students fill out the sentence frame on page 10, “I acted like a scientist when.”

**Poster Making:** (33 minutes – Groups – SciTrek Volunteers)

- Help volunteers glue poster pieces onto the posters. When gluing, make sure you or the volunteers (not the students) are gluing the poster in the exact order that is shown on the diagram and that the poster has a landscape orientation.
- Make sure the student in each group who is presenting the results graph has the appropriate sentence frame sticker in their notebook and the volunteer has gone over how to present the four sentences with the student several times.
  - If a group’s changing variable is run length, make sure the sentence frame sticker has been corrected accordingly.
• Each student should have the part(s) that they are presenting highlighted and numbered in their notebook: 1) scientists’ names, 2) question, 3) experimental set-up, 4) procedure, 5) results graph, and 6) results summary (see pictures above).
  o Remind the volunteers that if a student is presenting multiple parts, they should have multiple sections highlighted and numbered in their notebook.
• Volunteers often forget to highlight student notebooks, so make sure this is done before Day 5.

Wrap-Up: (5 minutes – Full Class – SciTrek Lead)

• Ask students the following questions:
  o How did you act like a scientist during this project?
  o What did you do that scientists do?

Day 5: Poster Presentations

Schedule: You are responsible for BOLD sections

  Introduction (SciTrek Lead) – 2 minutes
  Practice Posters (SciTrek Volunteers) – 15 minutes
  Poster Presentations (SciTrek Volunteers/SciTrek Lead) – 41 minutes
  Wrap-Up (SciTrek Lead) – 2 minutes

Preparation:

1. Assign volunteers a new group to practice posters with.
2. Make sure volunteers are setting out notebooks.
3. Set up the document camera to use for the Notes on Presentations (page 2, picture packet).
4. Organize posters so experiments featuring the same changing variable are presented back to back and posters are presented from easiest to understand to hardest to understand (suggested order: run length, ramp length, ramp height, ball circumference, ball mass).
**Introduction: (2 minutes – Full Class – SciTrek Lead)**

- Review the class question, what they learned/did last session, and what they will do today.
- Tell students that today they will work with a new volunteer.

**Practice Posters: (15 minutes – Groups – SciTrek Volunteers)**

- **DO NOT GIVE STUDENTS MORE THAN 15 MINUTES TO PRACTICE OR YOU WILL RUN OUT OF TIME FOR PRESENTATIONS.**
- Have volunteers rotate groups so that each group can explain their experiment and practice their poster with a new volunteer.
- Make sure volunteers are having students explain their experiment and asking them questions that make them generate predictions based on their data.
- Make sure students are reading from their notebook and practicing the poster in the following order: 1) scientists’ names, 2) question, 3) experimental set-up, 4) procedure, 5) results graph, and 6) results summary. They will NOT read the “I acted like a scientist when” or results table from their poster.
Poster Presentations: (41 minutes – Full Class – SciTrek Volunteers/SciTrek Lead)

- Have students present their posters.
- While posters are being presented, record each group’s changing variable values and their data on page 2 of the picture packet.
  - After groups read their question, stop the presentation and have the class identify the changing variable. Then record it in the picture packet.
  - When groups read their results graph, record the values of the changing variable and their measurements.
- After each presentation, ask students:
  - What questions do you have for this group?
- Once students have asked their questions (make sure each student answers a question; you should ask at least one question per presentation) ask students:
  - What was the group’s changing variable?
  - What pattern do you see in the (insert changing variable)?
  - What pattern do you see in the time?
  - Can someone put what we learned into a sentence?
- Record what they learned under the summary on page 2 of the picture packet.
- After all presentations are over, have students tell you the variable values that they would select to have a ball hit a board in the least amount of time.

Wrap-Up: (2 minutes – Full Class – SciTrek Lead)

- Tell the students that the volunteers that have been working with them are undergraduate and graduate students that volunteer their time so that they can do experiments. Have the students say thank you to the volunteers. This is the last day with their SciTrek volunteers, therefore, they should say goodbye to them.
- Tell students to remove the paper part of their nametag from the plastic holder and that they can keep the paper nametag but need to give the plastic holder back to their volunteer.

Day 6: Question Assessment/Draw a Scientist/Tie to Standards/Content Assessment

Schedule: You are responsible for BOLD sections

- Question Assessment (SciTrek Lead) – 10 minutes
- Draw a Scientist (SciTrek Lead) – 5 minutes
- Tie to Standards (SciTrek Lead) – 35 minutes
- Content Assessment (SciTrek Lead) – 10 minutes

Preparation:

1. If the teacher is not leading the Tie to Standards Activity do the following:
   a. Ask the teacher if they completed the SciTrek final survey. If not, give them the QR code and ask them to go to the website (at a later time) and fill out the evaluation of the program.
   b. Give the teacher an extra student notebook and have them fill it out with their students during the Tie to Standards Activity.
   c. Collect the teacher’s lab coat and put it in the lead box.
2. If you are a teacher and have not completed the SciTrek final survey, get the QR code from the lead box and use it to fill out the evaluation of the program at a later time.
3. Pass out notebooks and Question Assessment.
4. Set up the document camera to use for the Tie to Standards Activity (pages 10-12, student notebook).
5. Assemble the Tie to Standards Activity set up (seen in picture below as well as on page 3 of the picture packet):
   a. Roll out the 5 ft × 2 ft carpet onto a table in the front of the class (if it is not possible to do this on a table then it can be done on the floor).
   b. Set up two 50 cm × 30 cm outdoor carpet covered ramps on the two different wood ramp holders (heights 13 cm tall and 22 cm tall).
   c. Align the ramps so the bottom of the ramps are sitting on the 50 cm mark on the carpet.
   d. Set the ball stop board at the 150 cm mark (Set-Up 1).
   e. Have the rest of the Tie to Standards materials close (purple ball, 2 light blue balls, additional 13 cm tall wood ramp holder, board with Astroturf, wood board 100 cm, and Astroturf).

6. Put your lab coat in the lead box at the end of the day.
I acted like a scientist when I measured how long it took the ball to hit the board.

TIE TO STANDARDS

1. What two measurements do you need to get the speed of an object? 
   time and distance

2. If all distances are equal, the ball that hits the board first has a faster speed.

Ramp Height

3. Fill out the following chart. Predict which set-up will cause the ball to hit the board first and circle your answer in the prediction column. For each of the trials write the set-up that hit the board first, or tie if the two balls tied.

<table>
<thead>
<tr>
<th>Set-Up 1</th>
<th>Set-Up 2</th>
<th>Prediction</th>
<th>Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ramp Height: 15 cm</td>
<td>Ramp Height: 30 cm</td>
<td>Tie</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tie</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4. Does the ramp height affect the speed of the ball? 
   NO

5. Explain how ramp height affects the speed of the ball.
   The taller the ramp, the faster the ball hits the board.

Ball Mass

6. Fill out the following table with the same directions as question 3.

<table>
<thead>
<tr>
<th>Set-Up 3</th>
<th>Set-Up 4</th>
<th>Prediction</th>
<th>Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ball Mass: 255 g</td>
<td>Ball Mass: 360 g</td>
<td>Tie</td>
<td>Tie</td>
</tr>
<tr>
<td>Tie</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

7. Does the ball mass affect the speed of the ball? 
   YES

8. Explain how the ball mass affects the speed of the ball.
   Ball mass does not affect the speed of the ball.

Run Material

9. Which ball do you think will hit the wooden run first when dropped from the same height?
   Blue Ball (-255 g) Purple Ball (-360 g) The Balls Will Tie

10. Which ball hit the ground first? 
    - The balls tied

In Motion Predictable

11. Fill out the following table with the same directions as question 3.

<table>
<thead>
<tr>
<th>Set-Up 5</th>
<th>Set-Up 6</th>
<th>Prediction</th>
<th>Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Run Material: Turf</td>
<td>Run Material: Wood</td>
<td>Tie</td>
<td>Tie</td>
</tr>
<tr>
<td>Tie</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

12. Does the run material affect the speed of the ball? 
   NO

13. Explain how run material affects the speed of the ball.
   The smoother the run material, the faster the ball.

14. Circle the values below that would cause a ball to travel at the fastest speed, if the variable does not affect the speed of the ball, then circle either. Assume a ramp length of 50 cm and a run length of 150 cm.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Option 1</th>
<th>Option 2</th>
<th>Option 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ramp Height:</td>
<td>100 g</td>
<td>1,000 g</td>
<td>Either</td>
</tr>
<tr>
<td>Ball Mass:</td>
<td>Sand Paper</td>
<td>Flash Paper</td>
<td>Either</td>
</tr>
</tbody>
</table>

15. Circle the values below that would cause a ball to travel at the slowest speed. If the variable does not affect the speed of the ball, then circle either. Assume a ramp length of 50 cm and a run length of 150 cm.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Option 1</th>
<th>Option 2</th>
<th>Option 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ramp Height:</td>
<td>1 g</td>
<td>10 g</td>
<td>Either</td>
</tr>
<tr>
<td>Ball Mass:</td>
<td>Cardboard</td>
<td>Flash Paper</td>
<td>Either</td>
</tr>
</tbody>
</table>
Question Assessment: (10 minutes – Full Class – SciTrek Lead)

- Pass out assessments.
- Read each question and have students circle if the question is testable or not testable by science.
- Have students turn the page over and answer the Attitudes Towards Science Questions.
- Collect assessments.

Draw a Scientist: (5 minutes – Full Class – SciTrek Lead)

- Pass out the Draw a Scientist page.
- Give students exactly 4 minutes to draw a picture of a scientist.
- If the students drew a specific person, have them write who they drew on the line at the bottom of the page. Have them leave it blank if it is just a general person/picture.
- Collect assessments.

Tie to Standards: (35 minutes – Full Class – SciTrek Lead)

- Tell the class that their experiments have taught you a lot about ball motion and today we will review some of the variables that affect ball motion.

Speed vs. Time (4 minutes)

- Have students fill in the measurements that are needed to get speed, question 1.
- Have students circle the relative speed of the ball that hits the board first, question 2.

Effects of Ramp Height (8 minutes)

- Show students the two different ramp heights and have them predict which ramp height will cause the ball to hit the board first.
- Roll the balls down both ramps at the same time and record which ball hits the board first. Repeat this process three times.
- Have students fill out questions 4 and 5.
  - IMPORTANT: While students are writing, remove the 22 cm ramp holder and one of the 50 cm ramps. Place a second 13 cm ramp holder under the 50 cm ramp that is left (Set-Up 2).
- Discuss what happens if the ramp height gives an angle that is above 45°.
  - The time it takes the ball to hit the board will go up because although the ball will have more energy, the energy will be directed more downwards instead of towards the ball stop board.

Effects of Ball Mass (10 minutes)

- Show students the two balls with different masses (~265 g (light blue ball) and ~360 g (purple ball)) and have them predict which ball will hit the board first.
- Roll the balls down both the ramps at the same time and record which ball hits the board first. Repeat this process three times.
- Have students fill out questions 7 and 8.
- IMPORTANT: While students are writing, place the Astroturf over the outdoor carpet on half of the set-up and place the 100 cm ramp wood side up on the other half of the set-up. Then replace the ramp on the Astroturf base with an Astroturf ramp. For the wooden ramp, turn the outdoor carpet ramp over (Set-Up 3).
• Have students predict which ball (light blue or purple) will hit the board first when dropped, question 9.
• Drop both balls on the wooden ramp so that they can hear that both balls hit the wood at the same time.
• Have students fill out which ball hit the ground first, question 10.

Effect of Run Material (8 minutes)

• Show students the two different run materials and have them predict which run material will cause the ball to hit the board first.
• Roll the balls down both ramps at the same time and record which ball hits the board first. Repeat this process three times.
• Have students fill out questions 12 and 13.
• Discuss with students what friction is.

Motion Predictability (5 minutes)

• Ask students if ball motion is predictable.
• Have students select values that would cause the ball to travel at the greatest speed, question 14(a).
• Have students select values that would cause the ball to travel at the slowest speed, question 14(b).
• Review how all variables affect ball motion.

Content Assessment: (10 minutes – Full Class – SciTrek Lead)

• Pass out Content Assessments.
• Read each question to students.
• Collect Content Assessments.

Extra Practice Solutions: