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 scitrek.chem.ucsb.edu/module as well as the 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 **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:

Notebook:
: One given to every student and is filled out by the student. The lead will use a notebook to write in as an example for students. The notebook 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 narrower and taller than the notebook pages.

Picture Packet:
: One per class that, if needed, the lead fills out. In these instructions, the examples are the same size as the notebook pages but are labeled.

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 names and group color on the whiteboard.
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 for the technique activity (notebook, page 2) and class data (picture packet, page 1).
5. Pass out the question assessments.

Introduction: *(2 minutes – Full Class – SciTrek Lead)*

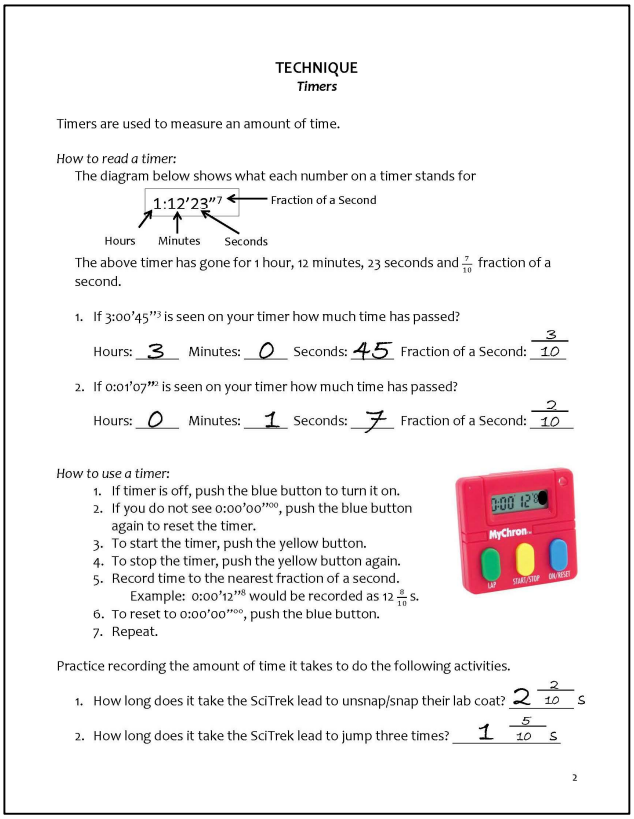
- Allow volunteers to introduce themselves.
- Introduce the module.

Question Assessment: *(5 minutes – Full Class – SciTrek Lead)*

- Read each question aloud and have students circle whether 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 covers of their notebooks.
- Introduce the class question, "What variables affect ball motion?"
- Show students how to read a timer and fill out question *1* (notebook, page 2) as a class, then have students fill out question *2* by themselves before reviewing.
- Have volunteers pass out timers.
- Show students how to use a timer and have them time you unsnapping and snapping your lab coat and jumping three 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.



TECHNIQUE
Timers

Timers are used to measure an amount of time.

How to read a timer:
The diagram below shows what each number on a timer stands for

1:12'23"7 ← Fraction of a Second
Hours Minutes Seconds

The above timer has gone for 1 hour, 12 minutes, 23 seconds and $\frac{7}{10}$ fraction of a second.

1. If 3:00'45"3 is seen on your timer how much time has passed?
   Hours: 3 Minutes: 0 Seconds: 45 Fraction of a Second: $\frac{3}{10}$
2. If 0:01'07"2 is seen on your timer how much time has passed?
   Hours: 0 Minutes: 1 Seconds: 7 Fraction of a Second: $\frac{2}{10}$

How to use a timer:
1. If timer is off, push the blue button to turn it on.
2. If you do not see 0:00'00"00, push the blue button again to reset the timer.
3. To start the timer, push the yellow button.
4. To stop the timer, push the yellow button again.
5. Record time to the nearest fraction of a second.
   Example: 0:00'12"8 would be recorded as 12 $\frac{8}{10}$ s.
6. To reset to 0:00'00"00, push the blue button.
7. Repeat.

Practice recording the amount of time it takes to do the following activities.

1. How long does it take the SciTrek lead to unsnap/snap their lab coat? 2 $\frac{2}{10}$ s
2. How long does it take the SciTrek lead to jump three times? 1 $\frac{5}{10}$ s

2

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

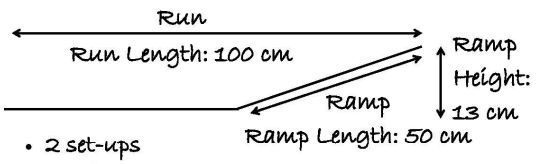
- Review the definition of an observation (a description using your five senses).
- Have students move to their groups.
    - If a student does not have a nametag, identify the group color with the least number of students in it and write the student's name on one of the extra nametags in the lead box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

Observations: *(15 minutes – Groups – SciTrek Volunteers)*

- Walk around and help groups who are struggling.
- Make sure groups are moving along and only spending ~10 minutes on recording observations of the experimental set-up, then roll the ball down the two run materials.
- Write down groups' median times on the *Class Data Sheet* (picture packet, page 1).

OBSERVATIONS

Experimental Set-Up:



- 2 set-ups
  - 1 shag carpet
  - 1 outdoor carpet

- Plastic ball (green)
- Ball Circumference: 27 cm
- Ball Mass: 200 g

1

OBSERVATIONS

Shag Carpet Run:

- Ball released from top of the ramp
- Time to hit the board: $1\frac{5}{10}$ s, $1\frac{6}{10}$ s, $1\frac{7}{10}$ s
- Ball made a sound when it hit the board

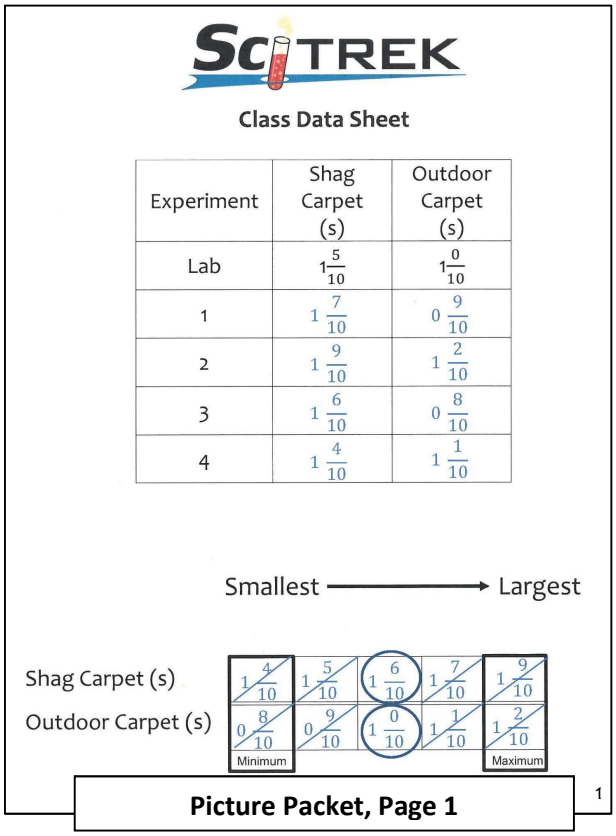
Outdoor Carpet Run:

- Ball released from top of the ramp
- Time to hit the board: $1\frac{1}{10}$ s, $1\frac{0}{10}$ s, $1\frac{2}{10}$ s
- Ball made a louder sound when it hit the board

2

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

- Have groups share what they did and 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 (picture packet, page 1) 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).



Class Data Sheet

Experiment	Shag Carpet (s)	Outdoor Carpet (s)
Lab	$1\frac{5}{10}$	$1\frac{0}{10}$
1	$1\frac{7}{10}$	$0\frac{9}{10}$
2	$1\frac{9}{10}$	$1\frac{2}{10}$
3	$1\frac{6}{10}$	$0\frac{8}{10}$
4	$1\frac{4}{10}$	$1\frac{1}{10}$

Smallest ⟶ Largest

Shag Carpet (s): $1\frac{4}{10}$, $1\frac{5}{10}$, $1\frac{6}{10}$, $1\frac{7}{10}$, $1\frac{9}{10}$

Outdoor Carpet (s): $0\frac{8}{10}$, $0\frac{9}{10}$, $1\frac{0}{10}$, $1\frac{1}{10}$, $1\frac{2}{10}$

Minimum Maximum

Picture Packet, Page 1

1

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 how and why they believe this variable might affect ball motion.

Variables: *(13 minutes – Groups – SciTrek Volunteers)*

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

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

- Have each group share one variable with the class, as well as how and why they think this variable will (or will not) affect ball motion.
- Go over what students will do next session.

VARIABLES

Variable	How will changing this variable affect ball motion?
Ball Mass	Heavier balls will hit the board first because their weight will push them along. 3 Agree, 2 Disagree
Ramp Height	Taller ramps will cause the ball to hit the board first because they give the ball more energy All agree
Ball Circumference	Balls with bigger circumferences will hit the board first because larger objects can reach farther. 4 Agree, 1 Disagree
Ramp Length	Longer ramp length cause the ball to hit the board in more time because the ball has to travel a longer distance. All agree
Ball Material	Balls made out of rougher materials will take more time to hit the board because they will stick to the carpet more. All agree

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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 passing out notebooks.
2. Set up the document camera for the question activity (notebook, page 3).

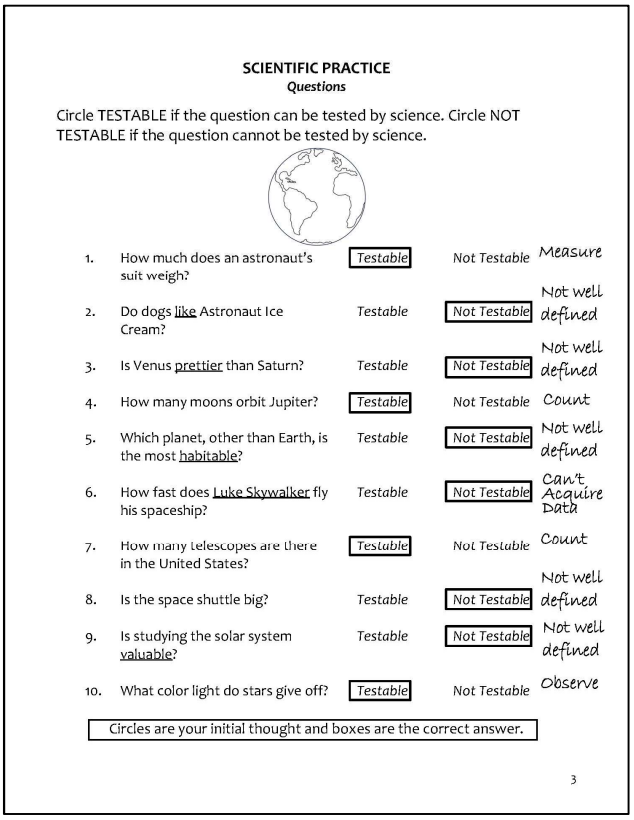
Introduction: *(2 minutes – Full Class – SciTrek Lead)*

- Review the class question, as well as what students did and learned last session.

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 (notebook, page 3).

- 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.



SCIENTIFIC PRACTICE
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?	Testable	Not Testable	Not well defined
3.	Is Venus prettier than Saturn?	Testable	Not Testable	Not well defined
4.	How many moons orbit Jupiter?	Testable	Not Testable	Count
5.	Which planet, other than Earth, is the most habitable?	Testable	Not Testable	Not well defined
6.	How fast does Luke Skywalker fly his spaceship?	Testable	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 thought and boxes are the correct answer.

3

        - *1:* How much does an astronaut's suit weigh?
            Testable
            Data: Measure the weight of an astronaut's suit.
        - *2:* Do dogs <u>like</u> Astronaut Ice Cream?
            Not Testable
            Revised: Which food do dogs eat first, Astronaut Ice Cream or steak?
        - *3:* Is Venus <u>prettier</u> than Saturn?
            Not Testable
            Revised: Which planet has more rings, Venus or Saturn?
        - *4:* How many moons orbit Jupiter?
            Testable
            Data: Count the number of moons that orbit Jupiter.
        - *5:* Which planet, other than Earth, is the most <u>habitable</u>?
            Not Testable
            Revised: What is the hottest temperature recorded on Venus in 2012?
        - *6:* How fast does <u>Luke Skywalker</u> fly his spaceship?
            Not Testable
            Revised: What is the average speed of a space shuttle?
        - *7:* How many telescopes are there in the United States?
            Testable
            Data: Count the number of telescopes in the United States.
        - *8:* Is the space shuttle big?
            Not Testable
            The word "big" is not well defined <u>in this context</u>.
            Revised: Which is taller, the space shuttle or a person? or What is the size of the space shuttle?
        - *9:* Is studying the solar system <u>valuable</u>?
            Not Testable
            Revised: Does studying the solar system increase the number of planets people can name?
        - 10: What color light do stars give off?
            Testable
            Data: Observe stars and determine the color light they give off.

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

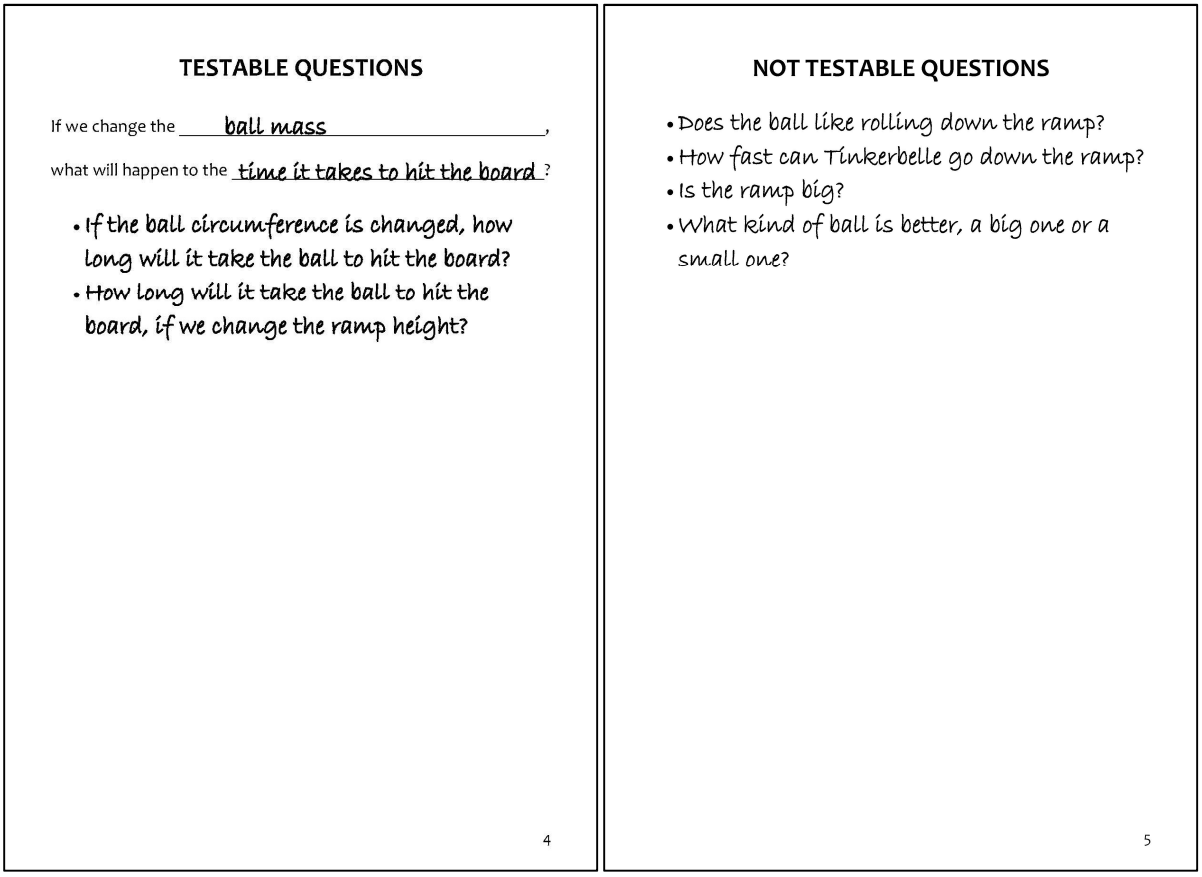
- Show the students the question frame on one of the group notepads and explain how it is used.
  - If we change the ___variable___, what will happen to the _____what you are measuring/observing_____?

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

- Walk around and help groups who 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.



TESTABLE 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 we change the ramp height?

4

NOT TESTABLE QUESTIONS

- Does the ball like rolling down the ramp?
- How fast can Tinkerbelle go down the ramp?
- Is the ramp big?
- What kind of ball is better, a big one or a small one?

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

- Walk around and help groups who 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.

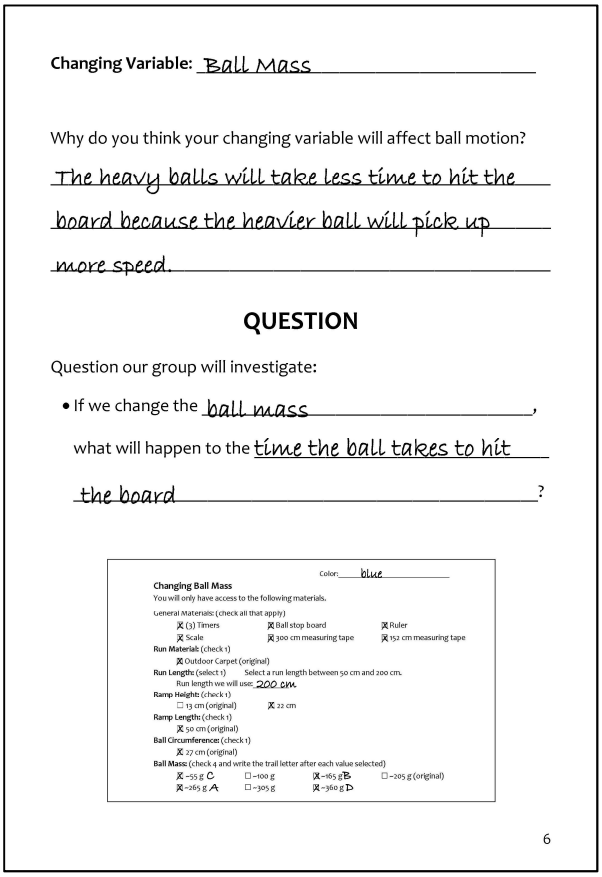
- Go over the options for variables that students can change: ball mass (show balls with different masses), ball circumference (show balls with different circumferences), ramp length (show ramps with different lengths), ramp height (show how the ramps can be at different heights), and run length.
- Go 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 who are struggling.
- Encourage groups to pick different changing variables.
- Make sure, for the second part of the question (what you are measuring/observing), students are specific (they should write, "the time it takes for the ball to hit the board" not just, "the time").

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

- Walk around and help groups who are struggling.
- Make sure groups fill out the materials page correctly and completely, and then tape it onto the notepad.



Changing Variable: Ball Mass

Why do you think your changing variable will affect ball motion?

The heavy balls will take less time to hit the board because the heavier ball will pick up more speed.

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?

Color: blue

Changing Ball Mass

You will only have access to the following materials.

General Materials: (check all that apply)

☒ (3) Timers ☒ Ball stop board ☒ Ruler
☒ Scale ☒ 300 cm measuring tape ☒ 152 cm measuring tape

Run Material: (check 1)
☒ Outdoor Carpet (original)

Run Length: (select 1) Select a run length between 50 cm and 200 cm.
Run length we will use: 200 cm

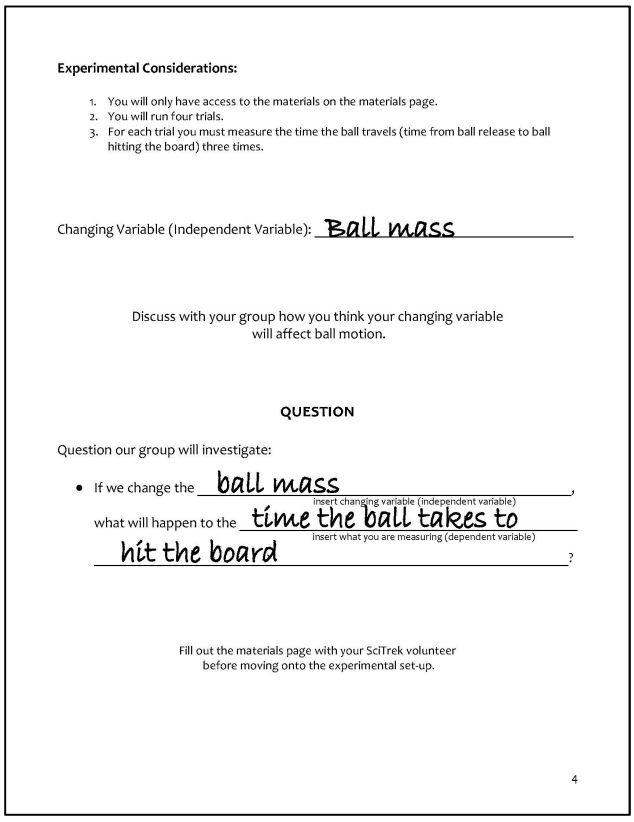
Ramp Height: (check 1)
☐ 13 cm (original) ☒ 22 cm

Ramp Length: (check 1)
☒ 50 cm (original)

Ball Circumference: (check 1)
☒ 27 cm (original)

Ball Mass: (check 4 and write the trail letter after each value selected)
☒ ~55 g C ☐ ~100 g ☒ ~165 g B ☐ ~205 g (original)
☒ ~265 g A ☐ ~305 g ☒ ~360 g D

6



Experimental Considerations:

1. You will only have access to the materials on the materials page.
2. You will run four trials.
3. For each trial you must measure the time the ball travels (time from ball release to ball hitting the board) three times.

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:

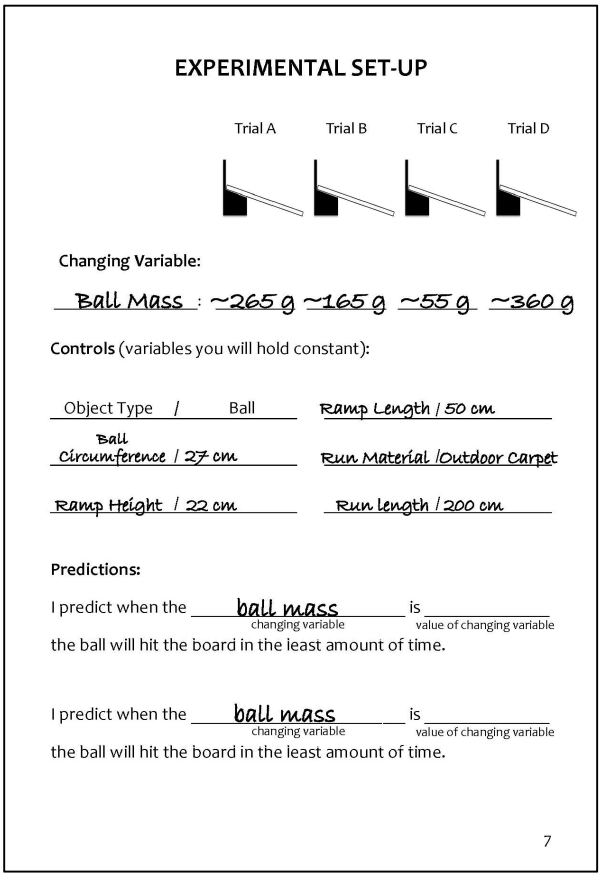
- If we change the ball mass (insert changing variable (independent variable)), what will happen to the time the ball takes to hit the board (insert what you are measuring (dependent variable))?

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

4

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

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



EXPERIMENTAL SET-UP

Trial A Trial B Trial C Trial D

Changing Variable:

Ball Mass : ~265 g ~165 g ~55 g ~360 g

Controls (variables you will hold constant):

Object Type / Ball — Ramp Length / 50 cm

Ball Circumference / 27 cm — Run Material /Outdoor Carpet

Ramp Height / 22 cm — Run length / 200 cm

Predictions:

I predict when the ball mass (changing variable) is _____ (value of changing variable) the ball will hit the board in the least amount of time.

I predict when the ball mass (changing variable) is _____ (value of changing variable) the ball will hit the board in the least amount of time.

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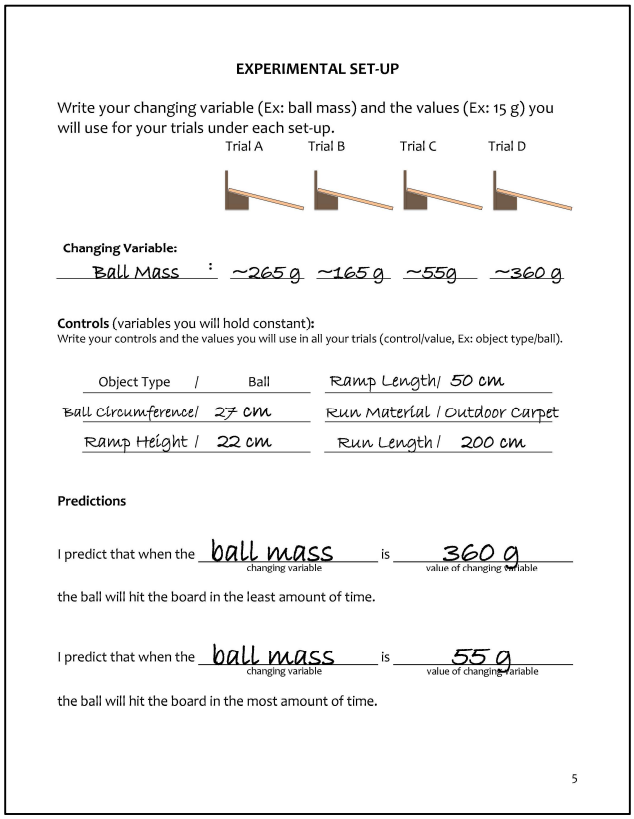

EXPERIMENTAL SET-UP

Write your changing variable (Ex: ball mass) and the values (Ex: 15 g) you will use for your trials under each set-up.

Trial A Trial B Trial C Trial D

Changing Variable:

Ball Mass : ~265 g ~165 g ~55g ~360 g

Controls (variables you will hold constant)**:**
Write your controls and the values you will use in all your trials (control/value, Ex: object type/ball).

Object Type / Ball — Ramp Length/ 50 cm

Ball Circumference/ 27 cm — Run Material / Outdoor Carpet

Ramp Height / 22 cm — Run Length / 200 cm

Predictions

I predict that when the ball mass (changing variable) is 360 g (value of changing variable) the ball will hit the board in the least amount of time.

I predict that when the ball mass (changing variable) is 55 g (value of changing variable) the ball will hit the board in the most amount of time.

5

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

- Have one student from each group share the question that they will investigate.
- Go over what students 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 passing 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 for the technique activity (notebook, page 6).

***Introduction*:** *(3 minutes – Full Class – SciTrek Lead)*

- Review the class question, as well as what students did and learned last session.

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.
- Find the median of the first two data sets as a class (notebook, page 6) and then let students find the other three on their own.

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

- Walk around and help groups who are struggling.
- Make sure procedures are concise, but still include all values of the controls and changing variable, as well as the data that 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.

TECHNIQUE
Median

When running multiple trials in an experiment it is necessary to find one number to represent all of the data. The middle number, also known as the median number, is sometimes used to represent all the data. To find the median, first place all of the numbers from each trial in increasing order, second circle the middle number.

Ball Material:	Time Ball Travels (s): (In Increasing Order)	Median (s):
Styrofoam Ball	$5\frac{6}{10}$, 7, $6\frac{7}{10}$	$6\frac{7}{10}$
Metal Ball	$2\frac{3}{10}$, $1\frac{2}{10}$, $2\frac{7}{10}$, $1\frac{4}{10}$, $1\frac{9}{10}$	$1\frac{9}{10}$
Wooden Ball	$2\frac{7}{10}$, $2\frac{6}{10}$, $2\frac{9}{10}$	$2\frac{7}{10}$
Plastic Ball	$4\frac{1}{10}$, $3\frac{9}{10}$, $4\frac{2}{10}$, $4\frac{1}{10}$, 4	$4\frac{1}{10}$
Velcro Ball	$21\frac{4}{10}$, $21\frac{7}{10}$, $21\frac{9}{10}$, $20\frac{6}{10}$, $22\frac{3}{10}$	$21\frac{7}{10}$

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PROCEDURE

1. Roll out outdoor carpet.
2. Set up ramp that is 50 cm long and 22 cm high.
3. Get balls that have a circumference of 27 cm and masses of A) 265 g, B) 165 g, C) 55 g, and D) 360 g.
4. Roll balls 200 cm and time.
5. Repeat 2 more times.
6. Find median time for each trial.

8

PROCEDURE

1. Roll out outdoor carpet.
2. Set up ramp that is 50 cm long and 22 cm high.
3. Get balls that have a circumference of 27 cm and masses of A)265 g, B) 165 g, C) 55 g, and D)360 g.
4. Roll balls 200 cm, and time.
5. Repeat 2 more times
6. Find median time for each trial.

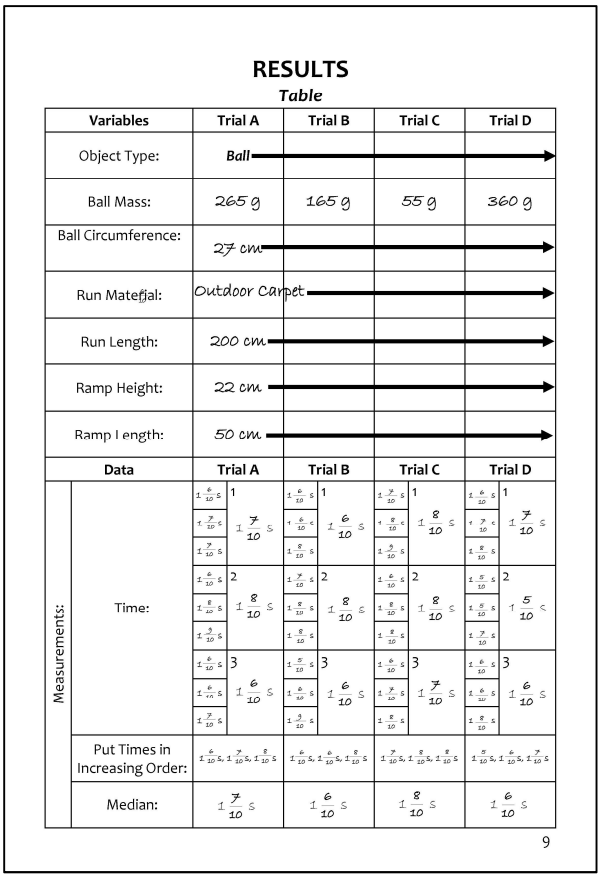
7

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

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

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

- Walk around and help groups who are struggling.
- Students should leave their notebooks at their desks during the experiment.
- All measurements will be recorded in the notepad.
    - Make sure times for each trial are entered into the notepad from smallest to largest.
- Groups should be finding the median and recording it on the 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.



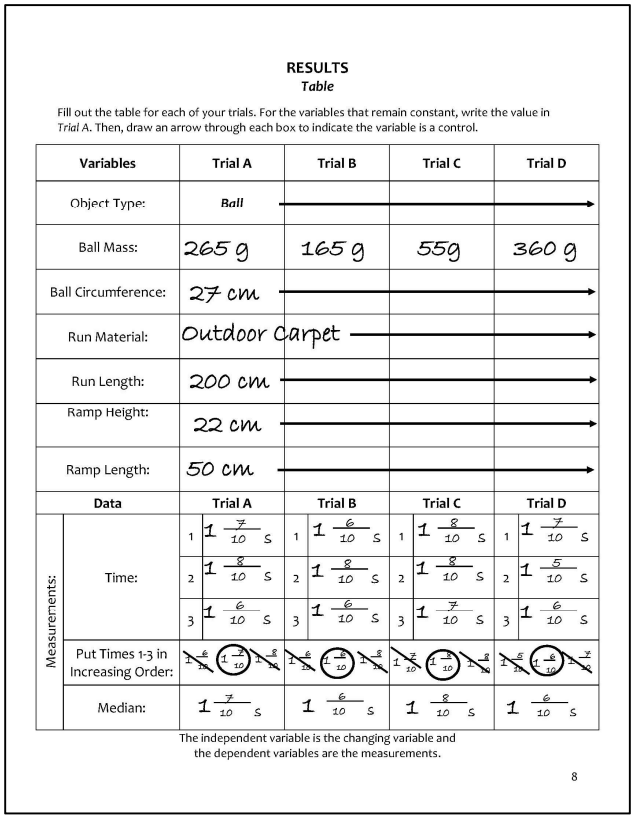
RESULTS

Table

Variables	Trial A	Trial B	Trial C	Trial D
Object Type:	*Ball* →			
Ball Mass:	265 g	165 g	55 g	360 g
Ball Circumference:	27 cm →			
Run Material:	Outdoor Carpet →			
Run Length:	200 cm →			
Ramp Height:	22 cm →			
Ramp Length:	50 cm →			

Data		Trial A	Trial B	Trial C	Trial D
Measurements:	Time:	1: $1\frac{6}{10}$ s, $1\frac{7}{10}$ s, $1\frac{7}{10}$ s 2: $1\frac{6}{10}$ s, $1\frac{8}{10}$ s, $1\frac{9}{10}$ s 3: $1\frac{6}{10}$ s, $1\frac{6}{10}$ s, $1\frac{7}{10}$ s	1: $1\frac{6}{10}$ s, $1\frac{6}{10}$ s, $1\frac{8}{10}$ s 2: $1\frac{7}{10}$ s, $1\frac{8}{10}$ s, $1\frac{8}{10}$ s 3: $1\frac{5}{10}$ s, $1\frac{6}{10}$ s, $1\frac{9}{10}$ s	1: $1\frac{7}{10}$ s, $1\frac{8}{10}$ s, $1\frac{8}{10}$ s 2: $1\frac{6}{10}$ s, $1\frac{8}{10}$ s, $1\frac{8}{10}$ s 3: $1\frac{6}{10}$ s, $1\frac{7}{10}$ s, $1\frac{8}{10}$ s	1: $1\frac{6}{10}$ s, $1\frac{7}{10}$ s, $1\frac{8}{10}$ s 2: $1\frac{5}{10}$ s, $1\frac{5}{10}$ s, $1\frac{7}{10}$ s 3: $1\frac{6}{10}$ s, $1\frac{6}{10}$ s, $1\frac{8}{10}$ s
	Put Times in Increasing Order:	$1\frac{6}{10}$ s, $1\frac{7}{10}$ s, $1\frac{8}{10}$ s	$1\frac{6}{10}$ s, $1\frac{6}{10}$ s, $1\frac{8}{10}$ s	$1\frac{7}{10}$ s, $1\frac{8}{10}$ s, $1\frac{8}{10}$ s	$1\frac{5}{10}$ s, $1\frac{6}{10}$ s, $1\frac{7}{10}$ s
	Median:	$1\frac{7}{10}$ s	$1\frac{6}{10}$ s	$1\frac{8}{10}$ s	$1\frac{6}{10}$ s

9



RESULTS

Table

Fill out the table for each of your trials. For the variables that remain constant, write the value in *Trial A*. Then, draw an arrow through each box to indicate the variable is a control.

Variables	Trial A	Trial B	Trial C	Trial D
Object Type:	*Ball* →			
Ball Mass:	265 g	165 g	55g	360 g
Ball Circumference:	27 cm →			
Run Material:	Outdoor Carpet →			
Run Length:	200 cm →			
Ramp Height:	22 cm →			
Ramp Length:	50 cm →			

Data		Trial A	Trial B	Trial C	Trial D
Measurements:	Time:	1: $1\frac{7}{10}$ s 2: $1\frac{8}{10}$ s 3: $1\frac{6}{10}$ s	1: $1\frac{6}{10}$ s 2: $1\frac{8}{10}$ s 3: $1\frac{6}{10}$ s	1: $1\frac{8}{10}$ s 2: $1\frac{8}{10}$ s 3: $1\frac{7}{10}$ s	1: $1\frac{7}{10}$ s 2: $1\frac{5}{10}$ s 3: $1\frac{6}{10}$ s
	Put Times 1-3 in Increasing Order:	1: ~~$1\frac{6}{10}$~~, $1\frac{7}{10}$, ~~$1\frac{8}{10}$~~ 2: ~~$1\frac{6}{10}$~~, $1\frac{8}{10}$, ~~$1\frac{8}{10}$~~ 3: ~~$1\frac{6}{10}$~~, $1\frac{7}{10}$, ~~$1\frac{8}{10}$~~	1: ~~$1\frac{6}{10}$~~, $1\frac{6}{10}$, ~~$1\frac{8}{10}$~~ 2: ~~$1\frac{7}{10}$~~, $1\frac{8}{10}$, ~~$1\frac{8}{10}$~~ 3: ~~$1\frac{6}{10}$~~, $1\frac{6}{10}$, ~~$1\frac{8}{10}$~~	1: ~~$1\frac{7}{10}$~~, $1\frac{8}{10}$, ~~$1\frac{8}{10}$~~ 2: ~~$1\frac{5}{10}$~~, $1\frac{5}{10}$, ~~$1\frac{7}{10}$~~ 3: ~~$1\frac{6}{10}$~~, $1\frac{7}{10}$, ~~$1\frac{8}{10}$~~	1: ~~$1\frac{6}{10}$~~, $1\frac{6}{10}$, ~~$1\frac{7}{10}$~~ 2: ~~$1\frac{5}{10}$~~, $1\frac{5}{10}$, ~~$1\frac{7}{10}$~~ 3: ~~$1\frac{6}{10}$~~, $1\frac{6}{10}$, ~~$1\frac{8}{10}$~~
	Median:	$1\frac{7}{10}$ s	$1\frac{6}{10}$ s	$1\frac{8}{10}$ s	$1\frac{6}{10}$ s

The independent variable is the changing variable and the dependent variables are the measurements.

8

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

- Go over what students 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:

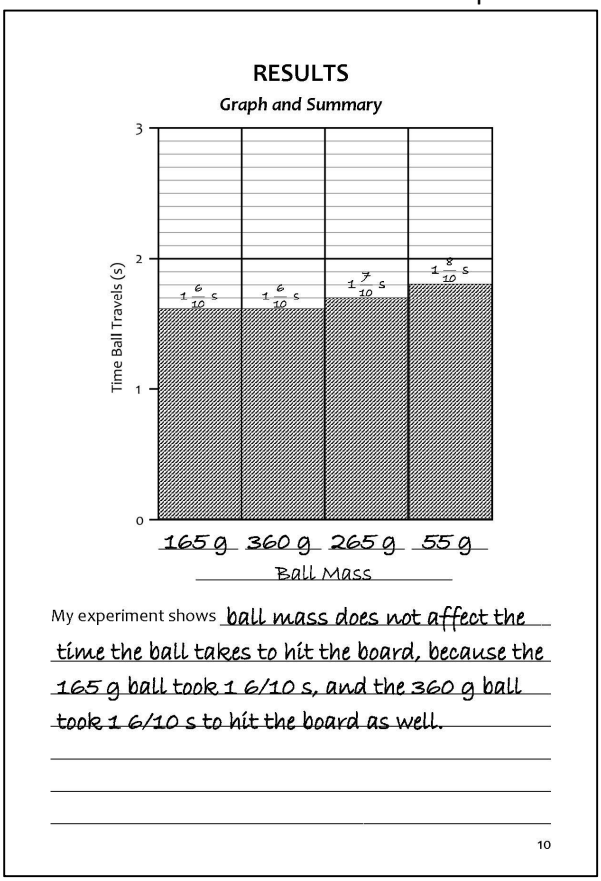
1. Make sure volunteers are setting out notebooks.
2. Find a place to leave student posters.

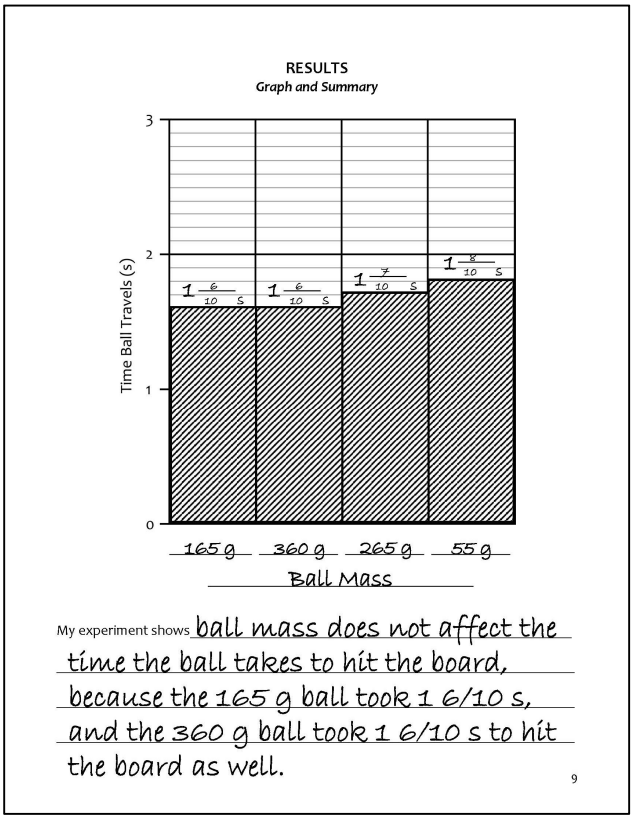
***Introduction:** (2 minutes – Full Class – SciTrek Lead)*

- Review the class question, as well as what students did and learned last session.

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

- Walk around and help groups who 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, then tape the pieces together and attach them to the notepad.
- Make sure students are coping the graph into their notebook including labeling their x-axis and writing the numerical value of the time on top of each column.





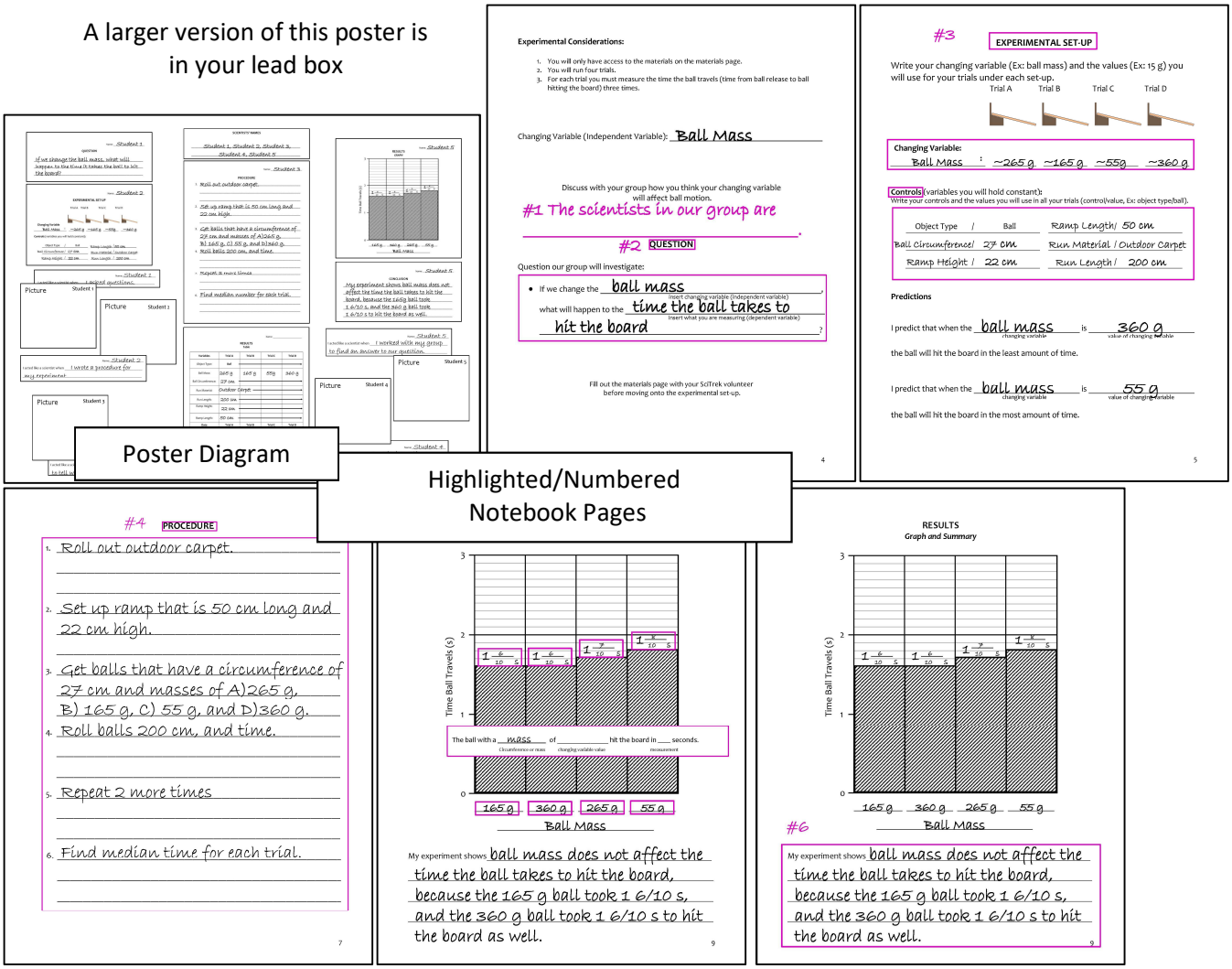
Results Summary: *(10 minutes – Groups – SciTrek Volunteers)*

- Walk around and help groups who 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; make sure they are including numerical values in their data statement.
    - Do not let groups reference trial letters in their results summary.
- Volunteers struggle with results summaries, so you should check each group's results summary.
- Make sure students fill out the sentence frame, *I acted like a scientist when* (notebook, page 10).

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 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 a 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) 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 below).
    - Remind volunteers if a student is presenting multiple parts, they should have multiple sections highlighted and numbered in their notebook and the sections should be paperclipped together.
- Volunteers often forget to highlight notebooks, so make sure this gets done before Day 5.

A larger version of this poster is in your lead box



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

- Ask students the following questions:
  - How did you act like a scientist during this project?
  - 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. Make sure volunteers are setting out notebooks.
2. Assign volunteers a new group to work with.
3. Set up the document camera for the *Notes on Presentations* (picture packet, page 2).

4. Organize posters so experiments featuring the same changing variable will be presented back-to-back and posters are presented from simplest to understand to most difficult to understand (**suggested order: run length, ramp length, ramp height, ball circumference, ball mass**).

Introduction: *(2 minutes – Full Class – SciTrek Lead)*

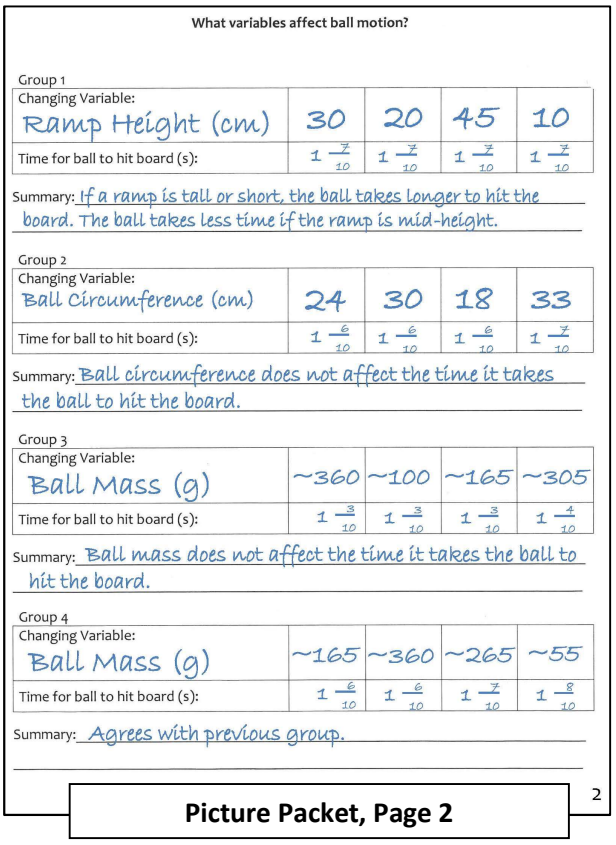
- Review the class question, as well as what students did and learned last session.
- Explain to students they will work with a new volunteer today.

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

- **Do not give students more than 15 minutes to review their experiment and practice their poster, or you will run out of time for presentations.**
- Have volunteers rotate groups so 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 have them generate predictions based on their data.
- Make sure students are reading from their notebooks and practicing the posters 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 tables, from their posters.

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 (picture packet, page 2).
    - After a group reads their question, stop the presentation and have the class identify the changing variable. Then, record it in the picture packet.
    - When a group reads 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 the whole class:
    - What was the group's changing variable?
    - What patterns do you see in the (insert changing variable)?
    - What patterns do you see in the time?
    - Can someone put what we learned into a sentence.
- Record what students learned under the *Summary* (picture packet, page 2).
- After all presentations are over, have students tell you the variable values they would select to have a ball hit a board in the least amount of time.



What variables affect ball motion?

Group 1

Changing Variable: Ramp Height (cm)	30	20	45	10
Time for ball to hit board (s):	$1\frac{7}{10}$	$1\frac{7}{10}$	$1\frac{7}{10}$	$1\frac{7}{10}$

Summary: If a ramp is tall or short, the ball takes longer to hit the board. The ball takes less time if the ramp is mid-height.

Group 2

Changing Variable: Ball Circumference (cm)	24	30	18	33
Time for ball to hit board (s):	$1\frac{6}{10}$	$1\frac{6}{10}$	$1\frac{6}{10}$	$1\frac{7}{10}$

Summary: Ball circumference does not affect the time it takes the ball to hit the board.

Group 3

Changing Variable: Ball Mass (g)	~360	~100	~165	~305
Time for ball to hit board (s):	$1\frac{3}{10}$	$1\frac{3}{10}$	$1\frac{3}{10}$	$1\frac{4}{10}$

Summary: Ball mass does not affect the time it takes the ball to hit the board.

Group 4

Changing Variable: Ball Mass (g)	~165	~360	~265	~55
Time for ball to hit board (s):	$1\frac{6}{10}$	$1\frac{6}{10}$	$1\frac{7}{10}$	$1\frac{8}{10}$

Summary: Agrees with previous group.

2

Picture Packet, Page 2

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

- Tell students, "The mentors who have been working with you are undergraduate and graduate students who volunteer their time so you can do experiments. This is the last day you might see your volunteers, so we should say thank you and goodbye."
- Have students remove the paper parts of their nametags (which they can keep) from the plastic holders, and return the plastic holders to their volunteers.

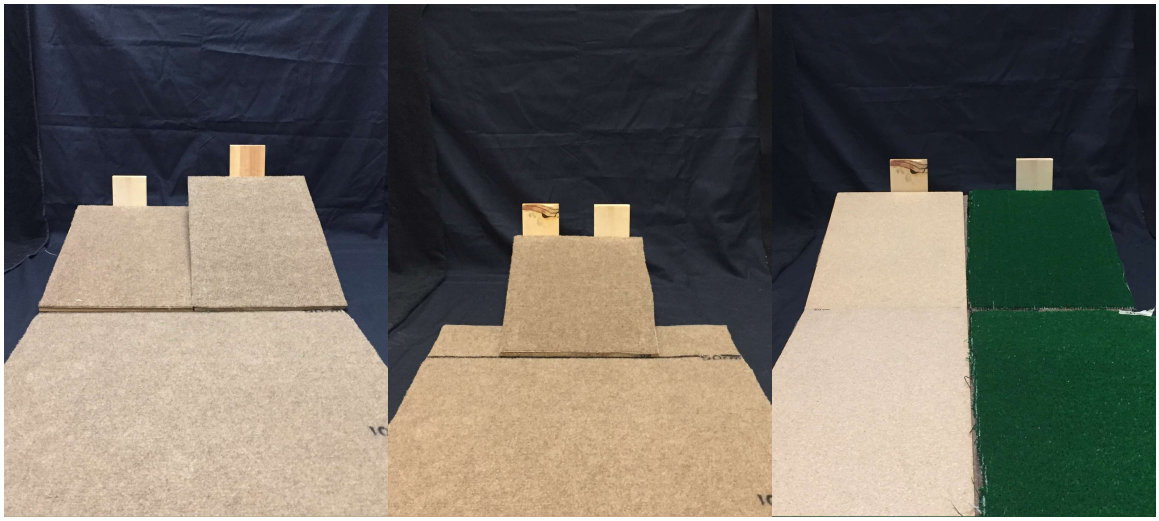
Day 6: Question Assessment/Draw a Scientist/Tie to Standards/Content Assessment

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 from the lead box, then, tell them to go to the website (at a later time) and fill out the evaluation of the program.
    b. Give the teacher an extra notebook and have them fill it out with their students, to follow along 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, take 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 the question assessments and notebooks to students.
4. Set up the document camera for the tie to standards activity (notebook, pages 10-12).
5. Assemble the tie to standards 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 bottoms 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).
        i. If the table is too small for a 150 cm run length, a shorter distance can be used. It is recommended that the distance is at least 75 cm.
    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.



Set-Up 1 Set-Up 2 Set-Up 3

Question Assessment: *(10 minutes – Full Class – SciTrek Lead)*

- Read each question and have students circle whether 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 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)*

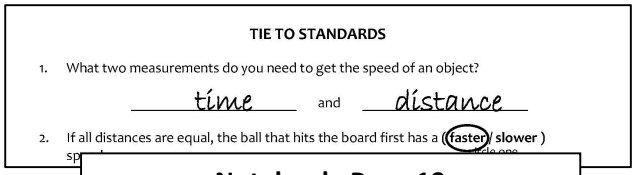
- Tell the class, "Your experiments have taught me a lot about ball motion, today we will review some of the variables which affect ball motion."

Speed vs. Time (4 minutes)

- Have students determine and then 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 two times.



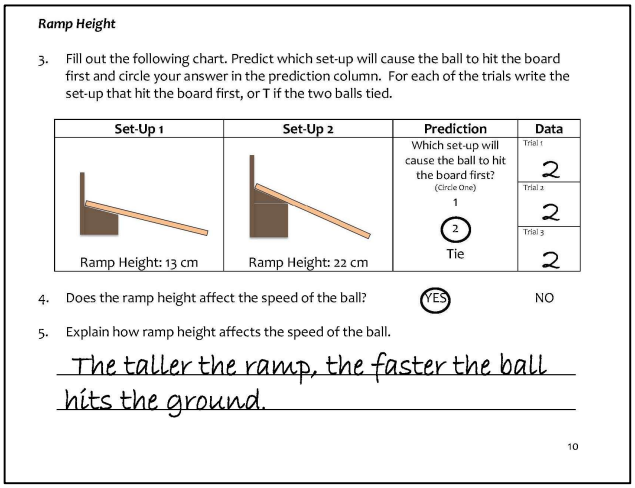
TIE TO STANDARDS

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 / slower)

Notebook, Page 10



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 T if the two balls tied.

Set-Up 1	Set-Up 2	Prediction	Data
Ramp Height: 13 cm	Ramp Height: 22 cm	Which set-up will cause the ball to hit the board first? (Circle One) 1 (2) Tie	Trial 1: 2 Trial 2: 2 Trial 3: 2

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

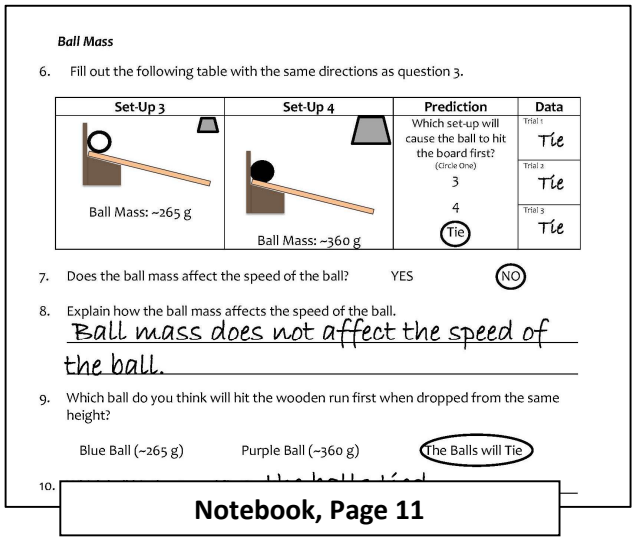
5. Explain how ramp height affects the speed of the ball.

The taller the ramp, the faster the ball hits the ground.

10

- 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).
- If a group experimented with ramp heights over 45˚, discuss how this is different than the experiment that was just done.
  - When the ramp height is over 45˚, the time it takes the ball to hit the board will go up because even though the ball has more energy, the energy will be directed downwards instead of towards the ball stop board.

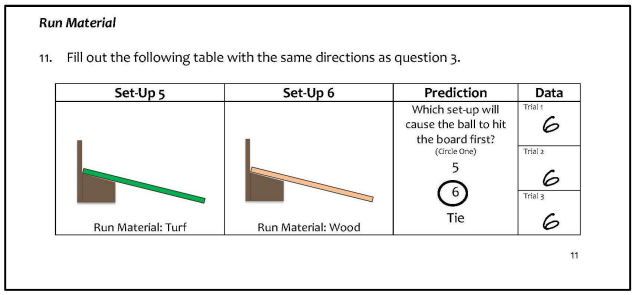
Effects of Ball Mass (10 minutes)



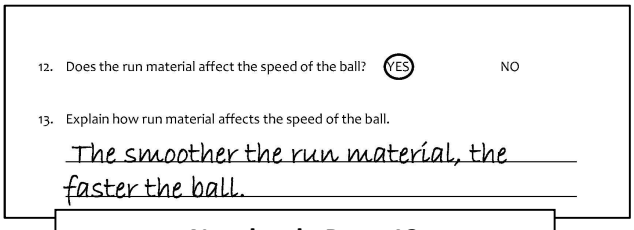
Notebook, Page 11

- 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 two 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*.
- If students are still struggling take two pieces of flat printing paper and have them tell you the relative masses of them (the same) and which will hit the ground first (hit at same time). Before you drop one crumple it up. Then discuss with student that the shape played a roll in the time but not the mass.

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 two times.
- Have students fill out questions *12* and *13*.
- Discuss the role of friction in ball motion with students.



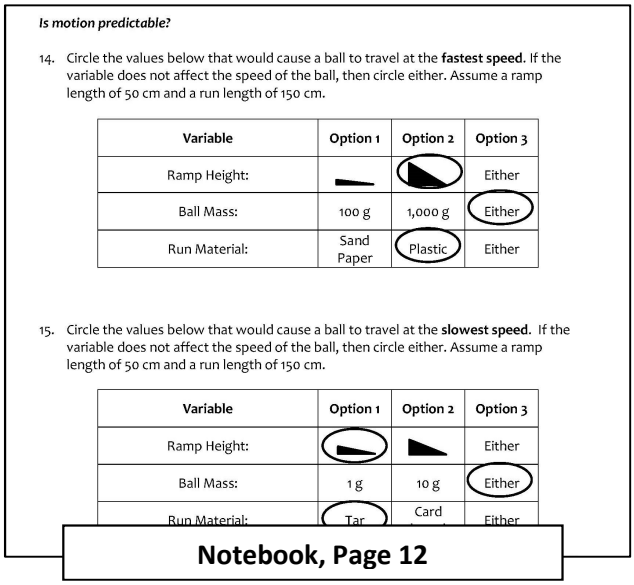
Notebook, Page 12

Motion Predictability (5 minutes)

- Ask students, "Is ball motion is predictable?"
- Have students select values that would cause the ball to travel at the greatest speed, question *14*.
- Have students select values that would cause the ball to travel at the slowest speed, question *15*.
- 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.



Is motion predictable?

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.

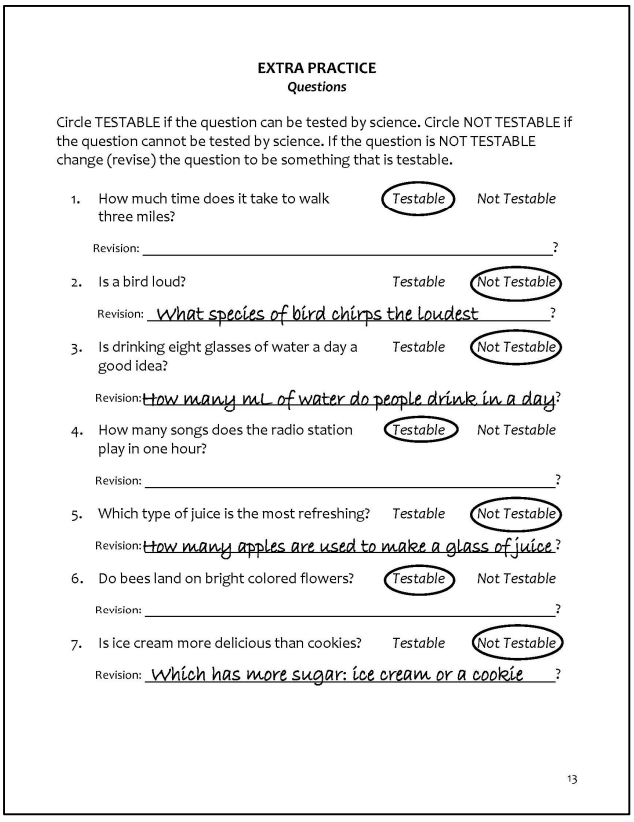
Variable	Option 1	Option 2	Option 3
Ramp Height:			Either
Ball Mass:	100 g	1,000 g	Either
Run Material:	Sand Paper	Plastic	Either

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.

Variable	Option 1	Option 2	Option 3
Ramp Height:			Either
Ball Mass:	1 g	10 g	Either
Run Material:	Tar	Card	Either

Notebook, Page 12

Extra Practice Solutions:



EXTRA PRACTICE
Questions

Circle TESTABLE if the question can be tested by science. Circle NOT TESTABLE if the question cannot be tested by science. If the question is NOT TESTABLE change (revise) the question to be something that is testable.

1. How much time does it take to walk three miles? *Testable* *Not Testable*
   Revision: _____?
2. Is a bird loud? *Testable* *Not Testable*
   Revision: What species of bird chirps the loudest?
3. Is drinking eight glasses of water a day a good idea? *Testable* *Not Testable*
   Revision: ~~How many~~ How many mL of water do people drink in a day?
4. How many songs does the radio station play in one hour? *Testable* *Not Testable*
   Revision: _____?
5. Which type of juice is the most refreshing? *Testable* *Not Testable*
   Revision: ~~How many~~ How many apples are used to make a glass of juice?
6. Do bees land on bright colored flowers? *Testable* *Not Testable*
   Revision: _____?
7. Is ice cream more delicious than cookies? *Testable* *Not Testable*
   Revision: Which has more sugar: ice cream or a cookie?

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