Class Question:
What variables affect ball motion?

Scientist (Your Name): ____________________________

Teacher’s Name: ________________________________

SciTrek Volunteer’s Name: ________________________
VOCABULARY

**Science:** The study of the material world using human reason. The scientific method is the way humans reason and apply logic to data to help gain knowledge of the world.

- **Observation:** A description using your five senses. This could include contents, mass, size, color, temperature, smell, texture ...
- **Opinion:** Something you believe or feel. Not a fact or observation.
- **Inference:** A guess based on past experiences.
- **Testable Question:** A question for which an experiment can be designed to answer.
- **Non-Testable Question:** A question for which an experiment cannot be designed to answer. For example, questions involving opinions, things that cannot be measured, or words that are not well defined.
- **Experimental Set-Up:** The materials, changing variable, and controls that are needed for an experiment.
- **Experiment:** A test or trials to discover something unknown.
- **Procedure:** A set of steps to conduct an experiment.
- **Controls:** The variables that are not changed in an experiment.
- **Changing Variable (Independent Variable):** The variable that is purposely changed in an experiment.
- **Results/Data (Dependent Variable):** The measurements/observations of the experiment, which are influenced/determined by the changing variable.
- **Prediction:** What you expect to happen based off of previous measurements/observations.
- **Scientific Practices:** A series of activities that scientists participate in to both understand the world around them and to communicate their results with others. (The specific practice worked on in this module is identifying testable questions.)
- **Technique:** A method for a specific task.
- **Reproducibility:** The ability to duplicate data from one trial to the next.
- **Median:** The middle number of a given set of numbers listed in increasing order.
- **Maximum:** The largest value in a given set of numbers.
- **Minimum:** The smallest value in a given set of numbers.
- **Circumference:** The distance around a sphere.
- **Motion:** When something is moving or changing position.
- **Speed:** How far something moves in a certain amount of time.
- **Gram (g):** A unit of mass (weight).
- **Centimeters (cm):** A unit of length.
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.

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: _______ Minutes: _______ Seconds: _______ Fraction of a Second: _______

2. If 0:01’07”2 is seen on your timer how much time has passed?
   Hours: _______ Minutes: _______ Seconds: _______ Fraction of a Second: _______

*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 then 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.
   Ex: 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. How long does it take the SciTrek leader to jump three times? ________________
SCIENTIFIC PRACTICIES

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

2. Do dogs like Astronaut Ice Cream?  
   Testable  Not Testable

3. Is Venus prettier than Saturn?  
   Testable  Not Testable

4. How many moons orbit around Jupiter?  
   Testable  Not Testable

5. Which planet, other than Earth, is the most habitable?  
   Testable  Not Testable

6. How fast does Luke Skywalker fly his spaceship?  
   Testable  Not Testable

7. How many telescopes are there in the United States?  
   Testable  Not Testable

8. Is the space shuttle big?  
   Testable  Not Testable

9. Is studying the solar system valuable?  
   Testable  Not Testable

10. What color light do stars give off?  
    Testable  Not Testable

Circles are your initial thought and boxes are the correct answer.
**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).

Changing Variable (Independent Variable): ________________________________

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

**QUESTION**

Question our group will investigate:

- If we change the ____________________________ insert changing variable (independent variable)
  what will happen to the ____________________________ insert what you are measuring (dependent variable)
  ____________________________? 

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

Determine the values of your changing variable (ex: ramp height) from the materials page and write the values (ex: 15 g) for your 4 trials under each set-up.

Trial A  Trial B  Trial C  Trial D

Changing Variable

_________________________ : ________  ________  ________  ________  ________

Controls (variables you will hold constant): Determine the variables that you will hold constant and indicate the specific value you will use in all your trials (control/value, example ball material/plastic).

Ball Material / Plastic

_________________________ / _____________________

_________________________ / _____________________

_________________________ / _____________________

Predictions

I predict that when the ___________________________ is ___________________________ the changing variable value of changing variable ball will hit the board in the least amount of time.

I predict that when the ___________________________ is ___________________________ the changing variable value of changing variable ball will hit the board in the most amount of time.
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.

<table>
<thead>
<tr>
<th>Ball Material:</th>
<th>Time Ball Travels (s): (In Increasing Order)</th>
<th>Median:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Styrofoam Ball</td>
<td>$5\frac{6}{10}$, $7\frac{0}{10}$, $6\frac{7}{10}$</td>
<td>$6\frac{7}{10}$</td>
</tr>
<tr>
<td>Metal Ball</td>
<td>$2\frac{3}{10}$, $1\frac{2}{10}$, $2\frac{7}{10}$, $1\frac{4}{10}$, $1\frac{9}{10}$</td>
<td></td>
</tr>
<tr>
<td>Wooden Ball</td>
<td>$2\frac{7}{10}$, $2\frac{6}{10}$, $2\frac{9}{10}$</td>
<td></td>
</tr>
<tr>
<td>Plastic Ball</td>
<td>$4\frac{1}{10}$, $3\frac{9}{10}$, $4\frac{2}{10}$, $4\frac{1}{10}$, $4$</td>
<td></td>
</tr>
<tr>
<td>Velcro Ball</td>
<td>$21\frac{4}{10}$, $21\frac{7}{10}$, $21\frac{9}{10}$, $20\frac{6}{10}$, $22\frac{3}{10}$</td>
<td></td>
</tr>
</tbody>
</table>
PROCEDURE

1. __________________________________________________________________________________________
   __________________________________________________________________________________________
   __________________________________________________________________________________________

2. __________________________________________________________________________________________
   __________________________________________________________________________________________
   __________________________________________________________________________________________
   __________________________________________________________________________________________
   __________________________________________________________________________________________

3. __________________________________________________________________________________________
   __________________________________________________________________________________________
   __________________________________________________________________________________________

4. __________________________________________________________________________________________
   __________________________________________________________________________________________
   __________________________________________________________________________________________

5. __________________________________________________________________________________________
   __________________________________________________________________________________________
   __________________________________________________________________________________________

6. __________________________________________________________________________________________
   __________________________________________________________________________________________
RESULTS

*Table*

Fill out the chart for each of your trials. For the variables that remains constant, write the value in trial A and then draw a line through each box to indicate that this variable is a control.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Trial A</th>
<th>Trial B</th>
<th>Trial C</th>
<th>Trial D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ball Material:</td>
<td><em>Plastic</em></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ball Mass:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ball Circumference:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Run Material:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Run Length:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ramp Height:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ramp Length:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Data</th>
<th>Trial A</th>
<th>Trial B</th>
<th>Trial C</th>
<th>Trial D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time:</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

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

*Final Measurements:*

<table>
<thead>
<tr>
<th>Put times 1-3 in order:</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Median:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
My experiment shows ____________________________________________

____________________________________________________________
I acted like a scientist when ________________________________________________________________________
__________________________________________________________________________________________
__________________________________________________________________________________________
__________________________________________________________________________________________

TIE TO STANDARDS

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

________________________ and ______________________

2. If all distances are equal, the ball that hits the board first, has a (larger / smaller) 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 T if the two balls tied.

<table>
<thead>
<tr>
<th>Set-Up 1</th>
<th>Set-Up 2</th>
<th>Prediction</th>
<th>Trials</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Set-Up 1 Diagram" /></td>
<td><img src="image2" alt="Set-Up 2 Diagram" /></td>
<td>Which set-up will cause the ball to hit the board first? (Circle One)</td>
<td></td>
</tr>
<tr>
<td>Ramp Height: 13 cm</td>
<td>Ramp Height: 22 cm</td>
<td>1</td>
<td>Trial 1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>Trial 2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tie</td>
<td>Trial 3</td>
</tr>
</tbody>
</table>

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

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

__________________________________________________________________________________________________
__________________________________________________________________________________________________

__________________________________________________________________________________________________
**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>Trials</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Ball Mass: ~265 g" /></td>
<td><img src="image2" alt="Ball Mass: ~360 g" /></td>
<td>Which set-up will cause the ball to hit the board first? (Circle One)</td>
<td>Tie</td>
</tr>
<tr>
<td>Trial 1</td>
<td>Trial 2</td>
<td>Trial 3</td>
<td></td>
</tr>
</tbody>
</table>

7. Does the ball mass affect the speed of the ball? **YES** **NO**

8. Explain how the ball mass affects the speed of the ball.

____________________________________________________________________________________________________________________________

9. Which ball do you think will hit the wooden run first when dropped from the same height?

Blue Ball (~265 g)  Purple Ball (~360 g)  The Balls will Tie

10. Which ball hit the ground first?_______________________________________________________

**Run Material**

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>Trials</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image3" alt="Run Material: Turf" /></td>
<td><img src="image4" alt="Run Material: Wood" /></td>
<td>Which set-up will cause the ball to hit the board first? (Circle One)</td>
<td>Tie</td>
</tr>
<tr>
<td>Trial 1</td>
<td>Trial 2</td>
<td>Trial 3</td>
<td></td>
</tr>
</tbody>
</table>
12. Does the run material affect the speed of the ball? YES NO

13. Explain how run material affects the speed of the ball.

__________________________________________________________________________
__________________________________________________________________________

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.

<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></td>
<td></td>
<td>Either</td>
</tr>
<tr>
<td>Ball Mass:</td>
<td></td>
<td>100 g</td>
<td>1,000 g</td>
</tr>
<tr>
<td>Run Material:</td>
<td>Sand</td>
<td>Plastic</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></td>
<td></td>
<td>Either</td>
</tr>
<tr>
<td>Ball Mass:</td>
<td>1 g</td>
<td>10 g</td>
<td>Either</td>
</tr>
<tr>
<td>Run Material:</td>
<td>Tar</td>
<td>Card board</td>
<td>Either</td>
</tr>
</tbody>
</table>
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: ____________________________________________________________?

3. Is drinking eight glasses of water a day a good idea?  
   Testable  Not Testable
   
   Revision: ____________________________________________________________?

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: ____________________________________________________________?

6. Do bees land on bright colored flowers?  
   Testable  Not Testable
   
   Revision: ____________________________________________________________?

7. Is ice cream more delicious than cookies?  
   Testable  Not Testable
   
   Revision: ____________________________________________________________?
SciTrek is an educational outreach program that is dedicated to allowing 2<sup>nd</sup>-8<sup>th</sup> grade students to experience the scientific process first hand. SciTrek partners with local schools to present student-centered inquiry-based modules that not only emphasize the process of science but also specific grade level content standards. Each module allows students to design, carryout, and present their experiments and findings.

For more information please feel free to visit us on the web at http://www.chem.ucsb.edu/scitrek/ or contact us by e-mail at scitrekadmin@chem.ucsb.edu.

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