WAMC Lab Template

Math Concept(s): Length of Rubber Band's effect on Distance
Source / Text: Holt
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Attach the following documents:

- Lab Instructions
- Student Handout(s)
- Rubric and/or Assessment Tool

Short Description (Be sure to include where in your instruction this lab takes place):

Lab Plan

Lab Title: Catapult Experiments – Hookes Law

Prerequisite skills: Basics of graphing, operational catapult built from previous, determining equation of a line from a graph skill.

Lab objective: The objective of this lab is derive Hookes law from experimenting with the student built catapults.

Standards: *(Note SPECIFIC relationship to Science, Technology, and/or Engineering)*
Mathematics K–12 Learning Standards:

- **High School: Functions - Interpreting Functions (F-IF)**
  - Understand the concept of a function and use function notation (F-IF.1, F-IF.2).
- **High School: Functions - Building Functions (F-BF)**
  - Build a function that models a relationship between two quantities (F-BF.1).
- **High School: Functions - Linear, Quadratic, and Exponential Models (F-LE)**
  - Construct and compare linear, quadratic, and exponential models and solve problems (F-LE.1, F-LE.3, F-LE.4).
- **High School: Algebra - Creating Equations (A-CED)**
  - Create equations that describe numbers or relationships (A-CED.1, A-CED.2).
- **High School: Statistics & Probability - Interpreting Categorical & Quantitative Data (S-ID)**
  - Summarize, represent, and interpret data on a single count or measurement variable (S-ID.1, S-ID.2, S-ID.3).

Standards for Mathematical Practice:

- 4. Model with mathematics
- 6. Attend to Precision

K-12 Learning Standards-ELA (Reading, Writing, Speaking & Listening):

- Speaking and Listening. Comprehension and Collaboration
- 2.Work with peers to set rules for collegial discussions and decision making
- 3.Propel conversations by posing and responding to questions that relate to the current information

K-12 Science Standards

- HS—PS3 Energy

Technology

5b Students collect data or identify relevant data sets, use digital tools to analyze them and represent data in various ways to facilitate problem solving and decision making.

Engineering

- HS-PS2 Motion and Stability

Leadership/21st Century Skills:

21st Century Interdisciplinary themes (Check those that apply to the above activity.)

☐ Global Awareness ☐ Financial/Economic/Business/Entrepreneurial Literacy ☐ Civic Literacy
☐ Health/Safety Literacy ☐ Environmental Literacy

21st Century Skills (Check those that students will demonstrate in the above activity.)

LEARNING AND INNOVATION
Creativity and Innovation
☒ Think Creatively
☐ Work Creatively with Others
☒ Implement Innovations
Critical Thinking and Problem Solving
☒ Reason Effectively
☐ Use Systems Thinking
☒ Make Judgments and Decisions
☒ Solve Problems
Communication and Collaboration
☐ Communicate Clearly
☐ Collaborate with Others

INFORMATION, MEDIA & TECHNOLOGY SKILLS
Information Literacy
☐ Access and Evaluate Information
☐ Use and manage Information
Media Literacy
☐ Analyze Media
☐ Create Media Products
Information, Communications and Technology (ICT Literacy)
☐ Apply Technology Effectively

LIFE & CAREER SKILLS
Flexibility and Adaptability
☒ Adapt to Change
☒ Be Flexible
Initiative and Self-Direction
☒ Manage Goals and Time
☐ Work Independently
☐ Be Self-Directed Learners
Social and Cross-Cultural
☒ Interact Effectively with Others
☐ Work Effectively in Diverse Teams

Productivity and Accountability
☐ Manage Projects
☒ Produce Results
Leadership and Responsibility
☐ Guide and Lead Others
☐ Be Responsible to Others

Teacher Preparation: (What materials and set-up are required for this lab?)

Materials

- Catapults from previous lessons. Measuring tape. Graphing paper and pencil

Set-Up Required:

- Open area in class or hall with which to lay out the tape measure for the students to collect the distance data.

Lab Organization Strategies:

Leadership (Connect to 21st Century Skills selected):

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Cooperative Learning: Students will work together on the data collection and will be competing in a sense through the activity. Students will be allowed to work and share their learning and help.

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Expectations: It is expected that students gain an understanding of how the length of rubber band correlates with the distance the projectile is thrown. They are expected to represent his data graphically properly and accurately. Students will apply math in order to derive the relationship between band stretch and force applied to projectile.

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Timeline:

- This is a part of multiple explorations using the catapult. This class is 55 minutes but will extend into the following day for data analyses if needed by the students.

Post Lab Follow-Up/Conclusions:

Discuss real world application of learning from lab

- Understanding the linear relationship of force and compression or stretching of rubber bands or springs via hookes law.

Career Applications

- Engineering, Automotive, mechanical engineering

Optional or Extension Activities

- Students can calculate the force exerted by the angle the rubber band given a fixed length of band but variable angle in order to examine vector forces? Students can manipulate the weight of the projectile and graph the curve to find the optimal projectile weight.

Hookes Law **Name:**

Instructions: Using your catapult from yesterday we will know determine the effect of changing the length of the rubber band on the distance of your throws. We will be trying to get good data on this today so be sure to be as exact possible with your measurements and procedures as possible! When doing your throws be as consistent and possible with your method. Have a spotter to measure the exact distance of the throw. Lay out the tape measure and have 2 group members down the line watching for the location the projectile first lands, not where it rolls to! Record the data below.

You will be trimming the rubber band to the length listed below and reattaching them at the exact same spot each time. Again, be as accurate as possible with the lengths and the taping methods. Consistency is key for this lab!

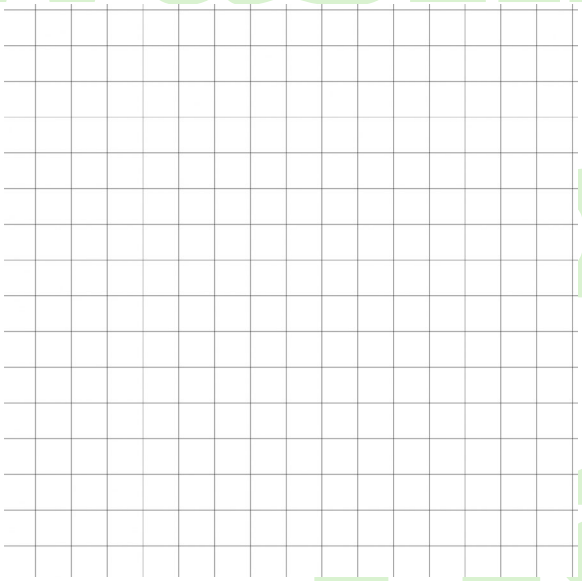
Round 1

With the Rubber Band at length 2 inches. Do 5 throws and calculate the average length below.

	2” Band Length	1.5” Band Length	1” band length
Throw 1			
Throw 2			
Throw 3			
Throw 4			
Throw 5			
Average Length			

Graph the Results

Be sure to label your axis and use proper charting methods from our previous lessons. On the graph below, mark the averages only of the 3 different averages from the table above.



Data Analyses Questions

1) Do the 3 dots plotted create a mostly straight line? If so, please draw a linear approximation through the 3 dots. I will model this for the class. Show me your work for me to sign off on before proceeding. Then determine the linear equation created by this line.

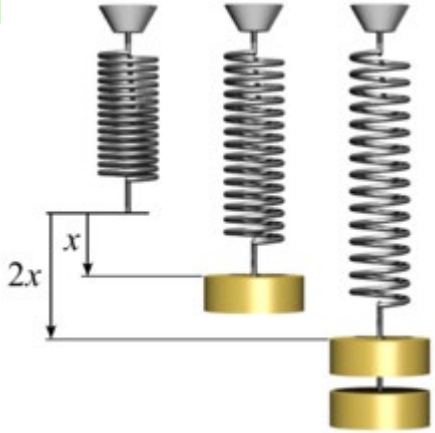
2) What is the slope of the line?

3) What relationship does the slope represent? Between which 2 variables?

4) Hypothesize: What does the linear relationship say about the force/resistance of the rubber band as you stretch it further. Put it in your own words. (3 sentences)

Exit ticket Name:

Hooke's law is an empirical law which states that the force (F) needed to extend or compress a spring by some distance (x) scales linearly with respect to that distance—that is, Fs = kx, where k is a constant factor characteristic of the spring/rubber band.



1) Today's experiment was designed to introduce the concept of hookes law. Did your experiment prove Hooke to be true? What about your chart indicated this?

2) If you added a 2nd rubber band next to the original, would the results change? Sketch on the graph above what you predict will be the outcome (draw the points and line and label your line 2nd "rubber band").

3) What are the limits of this law? Where would the line change from being a straight line and what could cause this change? (Sketch what you think this would look like on the graph and label and "limits").

4) What real world applications do you think this law is used? Think of mechanical things.

5) Which professions would use this law in their day to day work?