CORD Applied Mathematics
Unit 16 – Solving Problems that involve Linear Equations
Developed by: Rachel Bishop – Lakewood Career Academy
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Created: June 2011

Short Description: *In this lab students will drop balls from different heights and measure how high they bounce. They will then create a graph of their data and find a best fit line. They will use the best fit line to make predictions.*

Bouncing Balls

Lesson Objectives	Students will collect data that can be represented by a linear function. Students will graph their data, find a best fit line, and use it to make predictions. Students will work effectively in teams.
Pre-requisite Skills	Students need to be able to measure using meter sticks Students need to be able to create a graph Students need to be able to find a best fit line (or guide them through this step)
New Vocabulary	Best fit line, Slope, y-intercept
Materials	Balls of different types (1 per group) Meter sticks (2 per group) Masking tape Graphing Calculators (optional but helpful)

Math Standards:

A1.1.B *Solve problems that can be represented by linear functions, equations, and inequalities.*

A1.4.B *Write and graph an equation for a line given the slope and the y-intercept, the slope and a point on the line, or two points on the line, and translate between forms of linear equations.*

A1.3.A *Determine whether a relationship is a function and identify the domain, range, roots, and independent and dependent variables.*

A1.3.B *Represent a function with a symbolic expression, as a graph, in a table, and using words, and make connections among these representations.*

Reading Standards:

2.1 *Demonstrate evidence of reading comprehension.*

2.1.5 *Apply comprehension-monitoring strategies for informational and technical materials, complex narratives, and expositions; synthesize ideas from selections to make predictions and inferences.*

2.1.6 *Apply comprehension-monitoring strategies for informational and technical materials, complex narratives, and expositions: monitor for meaning, create mental images, and generate and answer questions.*

3.1 *Read to learn new information.*

Writing Standards:

1.2 *Use style appropriate to the audience and purpose; use voice, word choice, and sentence fluency for intended style and audience*

2.2 *Write for different purposes, such as telling stories, presenting analytical responses to literature, persuading, conveying technical information, completing a team project, and explaining concepts and procedures.*

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Leadership & Workplace Skills:
Manage Time and Resources
Teamwork
Appropriate Language and Attitude
Work Ethic
Participation

Organization and Set-up:
1. Pose the question to students: *"If I dropped this ball off of the space needle how high would it bounce?"* (Space Needle is 184 meters tall. Some other tall structure can be easily substituted) Have students make predictions and record their predictions. Depending on how open ended you want the activity to be, you could ask them to design their own experiment to answer the question, or give them the directions.
2. Go over instructions and expectations with students and divide them into groups of three.
3. Students find a space on the wall and tape their meter sticks to the wall stacked vertically.
4. Students drop their balls and record bounce height. They should use at least 6 different drop heights and take three measurements for each. Suggested roles:
    a. One student drops ball.
    b. One student watches closely and notes bounce height
    c. One student records drop heights and bounce heights.
5. Students take the average of their three measurements for each height.
6. Students graph their data. This can be done by hand on graph paper or using a graphing calculator if you have them available.
7. Students find the best fit line. Once again, this can be done by hand drawing the line that best fits the points. Or if graphing calculators are used, the linear regression line can be found. If a paper pencil graph is used, student will need to find the equation of their best fit line in the form $y = mx + b$
    a. Choose two points on the line (x_1, y_1) and (x_2, y_2).
    b. Find slope: $m = \frac{x_2 - x_1}{y_2 - y_1}$
    c. Find y-intercept: $b = y_1 - mx_1$
8. Students use their equation to predict the bounce height when their ball is dropped off of the space needle. Be careful, depending on what unit was used, you will need to convert measurements.

Timeline:
10 minutes Introduce activity, divide students into groups
20 minutes Students take data and fill in data table.
20 minutes Student graph data and find best fit line (this can be done in small groups or demonstrated by the teacher to the whole class)
30 minutes Student use their best fit line to predict the bounce height of Space Needle
Students write up their lab

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Assessment of student learning
Student could be provided a blank lab sheet to fill in with a scoring guide. Or this could be left a bit more open ended and students could be challenged to create a poster that shows their experiment design and results.

This lab can be used as a formative assessment of student's skills in

- Identifying independent and dependent variables
- Setting up a graph
- Finding and equation of a line from two points
- Using the equation of a line to make predictions.

Summary of learning
As a closing activity:

- Students could share the results of their lab with the rest of the class on posters if desired
- Students could compare their answer about the bounce height when a ball is dropped off of the space needle to their initial prediction. Talk about the value of conducting an experiment to address this question.

Optional activities
Students could make a composite graph showing the data from all groups. This graph could be used to investigate how different balls of different sized and materials compare in their bounce height.

Career Applications
Calculating the bounce height of a ball could be important planning strategy in different sports. This is also relevant in computer programing. Programmers must decide how to make a ball act in a virtual world.

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Bouncing Balls

Group Members: _____ _____ _____

Problem Statement:
Your teacher will give you a ball. If you dropped this ball off of the Space Needle, how high would it bounce? Design an experiment that would allow you to answer this question. The space needle is 184 meters tall.

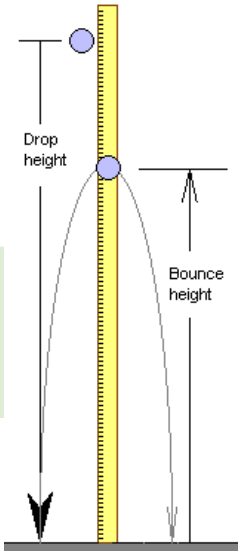
Supplies

- Ball
- Meter Sticks
- Masking Tape
- Graphing Calculator/Graph paper.

If there are other supplies that would help you see your teacher and he/she will try and find them for you.

Procedures

1. Design your experiment. What data will you collect?
2. Create a data table.
3. Take your data and fill in the table.
4. Graph your data.
5. Draw a best fit line and find the equation of the line.
6. Use your line to answer the question.
7. Write up your procedure, your data, and your results on a poster so that others may understand what you have done.
8. Present your experiment and your results to the class.



[**Teachers note:** (remove this before you print) This is a very open ended lab sheet for this lab activity. I think students benefit from designing the experiment themselves. If your students need it, a more guided lab procedure and data collection sheet could be designed for them. However time did not permit me to create on this week]