WAMC Lab Template

Math Concept(s): Quadratic Equations

Source / Text: CORD / Algebra 2 Learning In Context

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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):

Students will use paper balls to shoot free throws, stop watches to measure flight time, and worksheets to tabulate data. They will discuss the parabolic path their paper balls follow, and how their path creates a quadratic function that can be graphed. This lab will occur after Lesson 4.6 Solving Quadratic Equations That Have Complex Solutions.

Lab Plan

Lab Title: Toss a Free Throw

Prerequisite skills: Students must know the basic characteristics of a parabola, and use the characteristics to tabulate data in order to create a function of their path.

Lab objective: Use properties of quadratics to display real-life phenomena.

Standards: *(Note SPECIFIC relationship to Science, Technology, and/or Engineering)*

Mathematics K–12 Learning Standards:

- HSA-SSE.B.3 Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.
- HSA-CED.A.1 Create equations and inequalities in one variable and use them to solve problems.

Standards for Mathematical Practice:

- 1. Make sense of problems and persevere in solving them.
- 7. Look for and make use of structure.

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

- Writing: 9-10.8 Gather relevant information from multiple authoritative print and digital sources

Technology

- 1.b. Students build networks and customize their learning environments in ways that support the learning process.

Engineering

- HS-ETS1-4 Both physical models and computers can be used in various ways to aid in the engineering design process.

Leadership/21st Century Skills:

- 1.B.2 Be open and responsive to new and diverse perspectives; incorporate group input and feedback into the work
- 2.C.3 Synthesize and make connections between information and arguments

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

- Trash can(s)
- Meter sticks
- Paper
- Stop watches
- Graphing calculators
- Masking tape
- Worksheet
    - lab recording data sheet
    - roles for student pairs

Set-Up Required:

- Students will set up the scene
    - Including trash can placement, measuring where the masking tape line needs to go according to the trash can placement, and sit accordingly.

Lab Organization Strategies:

Leadership (Connect to 21st Century Skills selected):

- Students will work together to measure, tabulate, calculate and graph their results.

Cooperative Learning:

- Students will assist each other with calculations and compare results.

Expectations:

- Students will each conduct their own experiment to calculate data and tabulate results.

Timeline:

- This lab can be completed in one 46-minute class period. This includes time for set-up, clean-up, and data calculations.

Post Lab Follow-Up/Conclusions:

Discuss real world application of learning from lab

- Golf trajectory—how does the camera follow the golf ball?
- Baseball homerun analysis—how much factors in to the distance a homerun travels?

Career Applications

- Scientist, engineer, military, sports analyst

Optional or Extension Activities

- Trying the same activity with a basketball in the gym.

Toss a Free Throw – Lab Instructions

Materials Needed

- Trash can(s)
- Meter sticks
- Paper
- Stop watches
- Graphing calculators
- Masking tape
- Worksheet
    - lab recording data sheet
    - roles for student pairs

Lab Activity

Prep

Ask students to think about a free throw in basketball. What does the path of the ball look like? Let them know the name of the path is a parabola, and is in fact a quadratic that the unit has covered.

Students can practice throwing paper balls to see the shape.

They need room on the floor to set up the garbage can with 1.5 m space to tape their free throw line.

Teach

Students will work in pairs.

Student roles:

1. recorder and timer
2. free throw shooter

Students will both have to play each role. Each student needs to crumble a paper to shoot into the garbage can.

Let students know it might be helpful to video their partner for reference. Verify the recorder measures the initial height of the ball's release accurately.

Follow-up

Compare the data from all class members to make generalizations about the height and time it was in the air.

Have students use a graphing calculator relating height and time to find a curve of best fit.

You can have the students record hits and misses for further data analysis.

Toss a Free Throw – Lab Activity

Taken from: CORD / Algebra 2 Learning In Context: Chapter 4 Math Lab

When and object is thrown into the air along a path similar to a parabola, the maximum height it reaches is represented by the function $h(t) = rt^2 + vt + c$, where r is $\frac{1}{2}$ of the restraining force, v is the initial upward velocity, t is time in seconds, and c is the initial height. Students should work in pairs to complete this lab, which is a simulation of shooting basketball free throws.

Problem Statement

In this lab you will shoot a "free throw" and take measurements to determine the maximum height of the ball during the shot. Use a trash can that is between 75 cm and 100 cm tall as the basketball hoop and a paper ball as the basketball. When you shoot the free throw, you need to sit on the floor so that you are about the same height as the trash can. Find the maximum height your paper ball free throw reaches.

Equipment

- Trash can(s)
- Meter sticks
- Paper
- Stop watches
- Graphing calculators
- Masking tape

Procedure

1. Sit on the floor and act like you are going to shoot a free throw with a paper ball. Your partner needs to measure to get a value for c, the height at which you will release the shot. Trade roles so that you can measure your partner. Record the height in meters.
2. Use masking tape to create a line that is 1.5 meters from the trash can.
3. Sit on the free throw line and shoot a free throw. Your partner should use a stopwatch to measure the time it takes for the paper ball to leave your hand and hit the trash can or go into it.
4. Repeat Step 3 and time your partner's free throw.
5. Assuming the path the paper ball follows models a parabola, at what time during the flight would the paper have reached its maximum height? How do you find the value you use for t to find the maximum height of your free throw?
6. Use the formula to find the maximum height that your free throw shot reaches. For r, use -4.9 m/s, which represents $\frac{1}{2}$ of the restraining force, gravity. For v use 3.0 m/s. Round the calculated height to the nearest hundredth.
7. Sketch a graph of your free throw. The x-axis should show time (in seconds) and the y-axis should show height (in meters).