**Catapults: Launching into Physics**

**Stem Grant Grade Band Team: 6-8A**

**July 25, 2011** Jo Brinks

Sarah Dahlen

Deb Ferries

Amy Langner

Brian McGuire

Kristin Nelson

**Project Overview**

**Purpose**

In this project, students will identify the relationship of speed, force, and trajectory to the distance a spherical object will travel when launched by a catapult. Students will also determine which variables can be altered to reach a predetermined distance and calculate the ideal force and angle to launch an object a certain distance by designing and using a catapult.

**Key Terms**

**Math:** Area, pi, radius, diameter, circumference, sphere, angles, sides, similar, congruent, 2-dimensional, 3-dimensional, translate, rotate, reflect

**Science:** Mass, weight, force,gravity, net force, , balanced/unbalanced forces, friction, input, output, machines, work, inertia, Newton’s Laws of Motion, position, time, speed, velocity, acceleration, point of reference

**Learning Objectives:**

**Students will be able to:**

1. calculate the area of two dimensional figures.
2. explain the relationship between area, radius and circumference.
3. apply their understanding of factors affecting projectile motion and levers.
4. construct a catapult.
5. hypothesize which catapult design will be the most efficient.
6. compare the launch angle, mass, force, and distance traveled of a sphere.
7. demonstrate how to format and input data into Excel.
8. analyze the data to make predictions and draw conclusions.
9. assess which catapult worked the most efficiently and accurately.
10. demonstrate how changes in force effects movement.

**WMAS Math (Common Core)**

**7.G.3.** Describe the two-dimensional figures that result from slicing three-dimensional figures, as in plane sections of right rectangular prisms and right rectangular pyramids.

**7.G.4.** Know the formulas for the area and circumference of a circle and use them to solve problems; give an informal derivation of the relationship between the circumference and area of a circle.

**7.G.6.** Solve real-world and mathematical problems involving area, volume and surface area of two- and three-dimensional objects composed of triangles, quadrilaterals, polygons, cubes, and right prisms.

**8.G.2.** Understand that a two-dimensional figure is congruent to another if the second can be obtained from the first by a sequence of rotations, reflections, and translations; given two congruent figures, describe a sequence that exhibits the congruence between them.

**8.G.3.** Describe the effect of dilations, translations, rotations, and reflections on two-dimensional figures using coordinates.

**WMAS Science**

**D.8.5** While conducting investigations, explain the motion of objects by describing the forces acting on them

**D.8.6** While conducting investigations, explain the motion of objects using concepts of speed, velocity, acceleration, friction, momentum, and changes over time, among others, and apply these concepts and explanations to real-life situations outside the classroom

**Information and Technology Literacy**

**A.8.3**. Use a computer and productivity software to organize and create information

* explain the use of basic word processing functions (e.g., menu, tool bars, dialog boxes, radio buttons, spell checker, thesaurus, page layout, headers and footers, word count, tabs)
* use the spell checker and thesaurus functions of a word processing program
* move textual and graphics data from one document to another
* use graphics software to import pictures, images, and charts into documents
* use a graphical organizer program to construct outlines or webs that organize ideas and information
* compose a class report using advanced text formatting and layout styles (e.g., single and double spacing, different size and style of fonts, indents, headers and footers, pagination, table of contents, bibliography)
* classify collected data and construct a simple database by defining fields, entering and sorting data, and producing a report
* construct a simple spreadsheet, enter data, and interpret the information
* plot and use different types of charts and graphs (e.g., line, bar, stacked, scatter diagram, area, pie charts, pictogram) from a spreadsheet program
* incorporate database and spreadsheet information (e.g., charts, graphs, lists) in word-processed documents

**B.8.5.** Record and organize information

* use note-taking strategies including summarizing and paraphrasing
* record concise notes in a prescribed manner, including bibliographic information
* cite the source of specific quotations or visuals using footnotes, endnotes, or internal citation formats
* organize and compare information using graphic organizers, storyboarding, and other relational techniques
* organize information in a systematic manner appropriate to question, audience, and intended format of presentation
* record sources of information in a standardized bibliographic format

**Career Cluster**

Manufacturing, Production Process Development

Quality Assurance

**Materials**

Computer with Internet access

Pictures of catapults

Cardboard shoebox

Graph paper/poster paper

Balance Scale

Spring Scale

Calculator

Compass

Protractor

Metric Tape Measure

Push pins

String

Rubber bands

Popsicle sticks

Masking tape

Plastic spoon

Rulers

Scissors

Pencils

Balls of various size and density (ie. ping pong, golf, rubber)

Mouse trap

**Scenario**

In today’s manufacturing world machines are becoming more efficient and more accurate. More products are being made with less people yet with higher expectations of quality all while maintaining lower percentage of error. The reason for these higher expectations and changes in the types of jobs that exist in manufacturing is because of improved machines. Considering today’s competitive market, businesses are looking for creative thinkers and problem solvers to work within specified parameters. They also want their employees to be positive team players. The students will be working in groups to develop the most efficient complex machine (catapult) while maintaining accuracy of its launch.

**Teaching Methods**

Demonstration

Questioning

Gizmo Simulations

Cooperative Learning

Problem based learning

Project based learning

**Lesson Design**

**Lesson 1**: Golf Range Gizmo, http://explorelearning.com, Grades 6-8 Physical Science, Motion & Force

**Lesson 2**: "Brain"storming the Castle

**Lesson 3**: Launching Our Ideas

**Lesson 4**: Analyzing Data

**Faculty Resources**

"How to Build a Catapult", http://www.stormthecastle.com/catapult/how-to-build-a-catapult.htm

"The Art of the Catapult"

Punkin Chunkin: Catapult video, http://www.science.discovery.com

Motion, Forces, Energy and Electricity, http://www.discoveryeducation.com

Catapults, http://www.knightforhire.com

Circle Tool, http://illuminations.nctm.org

**Assessment**

Pre-test

Post-test

Projects

Lab notebooks

**Extension Options**

**Pocket Tanks** -A computerized game comprised of two tanks on a battlefield where you select an angle and power, and fire over 30 distinct weapons at your opponent. Each player gets 10 shots and games are won based on points for good aiming.

**Angry Birds** - A challenging physics-based castle demolition computerized game. There are 120 levels which require logic, skill, and brute force to crush the enemy.

**Trigonometry** to determine projectile height

**STEM Careers**

Mechanical Engineer, Structural Engineer, Design Engineer, Quality Control Technician, Inspector, Team Leader, Purchasing Agent, Tester, Process Improvement Technician, Safety Engineer, Environmental Engineer, and Calibration Technician.