Gold Seal Lesson:

Copernicus Education Gateway

Author(s): ***Michael Lucky Voiselle***			***Lesson Title:*** ***GRAPHING MOTION***			
Grade Span			***ICLE Application Model***			
K-4	***5-8***	***9-12*** ***XX***	***A***	***B***	***C*** ***XX***	***D***

Instructional Focus:

Measurement
Students use a variety of tools and techniques of measurement in a problem-solving situation. Students communicate the reasoning used in solving these problems.

Algebraic Concepts and Relationships
Students use algebraic methods to investigate, model, and interpret patterns and functions involving numbers, shapes, data, and graphs in a problem-solving situation. Students evaluate and communicate the reasoning used in solving these problems.

Unifying Concepts and Processes
Students recognize patterns and processes, making connections in terms of systems and subsystems that explain the interrelationships of the natural and designed world.

Science as Inquiry
Students demonstrate knowledge and skills necessary to perform scientific inquiry.

Performance Task

Your task is to develop an understanding of Newton's Second Law of Motion involving acceleration by following directions, recording data, graphing the acquired data, and answering questions.
Obtain anything you can use as a track to allow a steel ball bearing to roll down (a piece of cove molding, a square shaped aluminum trough, or a v-shaped piece of cardboard). Follow directions carefully. You will need to develop a well-organized data table to record information gained from the experiments. You will need to record all observations, comments, problems, and solutions to problems in your science journal. This will be a valuable reference for your conclusion summary.

Experiment 1

1. Cut your track to a 1meter length. Mark your track at 10centimeter intervals the full length.
2. Set your track up so that one end is 5centimeters higher than the other end.
3. Put your ball at the 50cm mark. Let go without a push and time the interval as it travels to the 10cm mark. Record these distances and times in your neatly organized data table. Repeat placing the ball at the 60cm mark and time to the 20cm mark. Repeat from 70cm to 30cm, 80cm to 40cm and 90cm to 50cm. Note the distance traveled is constant at 40centimeters.
4. Repeat each timing 3 times and average the results to increase accuracy. Why does repeating and averaging give more accurate results?
5. Are there significant differences in the times required for the ball to move through equal distances on the track? Why or why not?

Experiment 2

1. Place your ball at the 10cm mark, release it without a push, and record the time for the ball to move to the zero point. Record your results in another neatly organized data table.
2. Repeat 3 times and average the timings
3. Place the ball at the 20cm mark and time to the zero point.
4. Repeat 3 times and average the timings.
5. Repeat this process by placing the ball at 30cm, 40cm, 50cm, 60cm, 70cm, 80cm, and 90cm.
6. Plot a graph showing distance (controlled variable) versus time (responding variable). Keep in mind what variable is on the x axis and what is on the y axis.
7. What type of relationship does your graph reflect?

8. Does the ball accelerate down the ramp? Cite evidence for your answer.
9. What happens to the velocity of the ball as it goes down the ramp?
10. What is the difference between velocity and acceleration?

Experiment 3

Repeat experiment 2 using a larger steel ball. Construct a graph and compare it to your first graph. What is the effect of a heavier mass on acceleration and velocity?

Experiment 4

Repeat experiment 2 using a smaller steel ball. Construct a graph and compare it to your first graph. What is the effect of a smaller mass on acceleration and velocity?

Experiment 5

Investigate more carefully the distances traveled by the rolling balls in the 2^{nd}, 3^{rd}, and 4^{th} experiments.

1. Make another data table keeping the distances the same but square the time. This mean distances versus time x time.
2. Plot a graph of distance versus time squared
3. What type of graph does this represent?
4. Is the distance traveled proportional to time squared?
5. What does this mean?

You are to prepare a conclusion summary. The summary should reflect answers to all questions, thoughts, and ideas generated from the graphs. Your summary needs to reflect an understanding of the difference between acceleration and velocity, be well written, and free from spelling and grammatical errors.

ICLE Essential Skills

Apply in writing the rules and conventions of grammar, usage, punctuation, paragraphing and spelling. (ela1)
Follow written directions carefully and accurately. (ela6)
Present information in well-organized fashion that will be clear to the target audience. (ela11)
Know the components and properties of the ***rectangular coordinate system***, (i.e., x - y axis, origin, quadrants, abscissa (x-coordinate) and ordinate (y-coordinate), and the general representation of a point (x,y)). (m23)
Know and apply the principles of scientific inquiry. *(Implicit in this statement are the processes of prediction, estimation, developing hypotheses, drawing conclusions, evaluation, and following ethical principles and professional procedures.) (Not Ranked s*114)
Make observations using senses and instruments. Inferences and interpretations are arrived at based on observations. Classify observable properties and organize observations in a meaningful and logical way. (s5)
Exhibit good data management skills by collecting, organizing, and graphing data. (s19)
Understand and apply kinematics (i.e., the mathematical methods of describing motion without regard to the forces that produce it, such as velocity, acceleration and deceleration, and displacement). (s77)

Scoring Guide:

RATE THE CRITERIA: 3=Excellent, 2=Satisfactory, 1=Unsatisfactory, 0=Does not attempt or does not understand

CRITERIA	SCORE
Group work and experimental procedures	_____
Experiment 1 answers reflected in the summary	_____
Experiment 2 data table and graph neatly done and labeled correctly	_____
Experiment 2 answers reflected in the summary	_____
Experiment 3 data tables and graphs neatly done and labeled correctly	_____
Experiment 3 answers reflected in the summary	_____
Experiment 4 data tables and graphs neatly done and labeled correctly	_____
Experiment 4 answers reflected in the summary	_____
Experiment 5 data tables and graphs neatly done and labeled correctly	_____
Experiment 5 answers reflected in the summary	_____
Summary write-up well written and free from spelling and grammatical errors	_____
Student demonstrated an understanding of acceleration and velocity	_____

Keywords

English Language Arts	Mathematics	Science
Reading	**Algebra** **Computation** **Graphs** **Variables** **Coordinates**	**Earth Science**
Writing **Grammar** **Spelling** **Expository**	**Geometry**	**Life Science**
Communications	**Statistics** **Data Collection** **Data Organization** **Data Display**	**Chemistry**
Literature	**Calculus**	**Physics** **Acceleration** **Motion** **Velocity** **Gravity** **Scientific Process**
Other	**Trigonometry**	**Other**
	Other	