Gold Seal:

Copernicus Education Gateway

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

Instructional Focus:

Writing Students write for a variety of purposes and audiences with sophistication and complexity appropriate to the grade level.
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.
Science as Inquiry Students demonstrate knowledge and skills necessary to perform scientific inquiry.
Communication Students communicate and apply scientific concepts.

Performance Task

Your task is to determine how fast you can throw a baseball. When you throw a baseball, you exert an average force on the ball through some distance. Therefore, you do work on the ball, which becomes the ball's kinetic energy.

To determine the kinetic energy of the ball you will need to know both its horizontal velocity component (Vx) and its vertical velocity component (Vy) at the time of release. Once these are known, the kinetic energy (KE) can be determined. See accompanying diagram.

Once the ball is released, its horizontal velocity remains constant because the only force acting on the ball is gravity pulling downward, which has no horizontal component

You may form groups of 4. Have two group members using stopwatches determine the total time (t) the ball is in the air. Next, measure the distance it has traveled. Record all data in a neatly organized table. From this you can calculate the horizontal velocity because Vx is equal to distance divided by time. The ball's vertical velocity can be found from the fact that all objects near the earth's surface accelerate downward at 9.8 meters per second squared (g). The time for the ball to reach its peak height will be the time it takes for the ball's vertical velocity to change from Vy to zero. Thus, Vy is equal to g times t. See accompanying diagram. The time for the ball to reach the peak of its path will be half its total time in the air. Therefore, you can multiply half the balls' air-time by g to determine this vertical component.

Brainstorm with your group to determine a plan for answering the following questions. You may use any resources available to you to obtain any needed information including a physics textbook, encyclopedias, the Internet, and any living expert. Show all mathematical calculations and unit cancellations in a well organized manner.

1. What was the kinetic energy of the ball you threw?
2. How much work did you do on the ball? (Remember, the force and the distance that acted upon the ball)
3. What is the ball's momentum at the point of release? (Remember mass and velocity in the direction of movement)
4. Determine the time that the ball was in your hand from the action of throwing. (Remember, momentum is also impulse)
5. Using the accompanying diagram and any other resources available, determine how these velocity vectors were added.
6. Using the accompanying diagram and any other resources available, determine how and why the Pythagorean theorem was used.
7. Your group is to design and carry out an experiment to determine the kinetic energy of a batted baseball or a thrown football.

Prepare a well organized summary describing the experimental procedures, problems encountered, and how your group solved the problems. The summary should 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)
Use brainstorming, role playing, and standard problem solving strategies to define a problem and suggest solutions. (ela19)
Present information in well-organized fashion that will be clear to the target audience. (ela 11)
Understand ***basic algebraic properties*** (i.e., commutative: ab = ba; associative: ab(c) = a(bc); and distributive: a(b+c) = (ab)+(ac)). (m3)
Understand the ***use of variables*** in expressions such as 4x, x+2, and 2x-1, solve for the variable, and know how to represent expressions such as "twice the number" or "four more than the number" using variables. (m7)
Use the ***Pythagorean theorem*** to compute side lengths of right triangles. M20
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* s114)
Know the metric system and the units of metric measure and convert metric units to English units. S4
Understand and apply the concepts of potential energy (energy related to the position of an object) and kinetic energy (energy related to the motion of an object). (s52)
Understand and apply the concepts of work and power and how they relate to energy. An object experiences work when a force displaces the object; power is the time-rate of doing work. (s70)
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 CRITERIA: 3=Excellent, 2=Satisfactory, 1=Unsatisfactory, 0=Does not attempt or does not understand

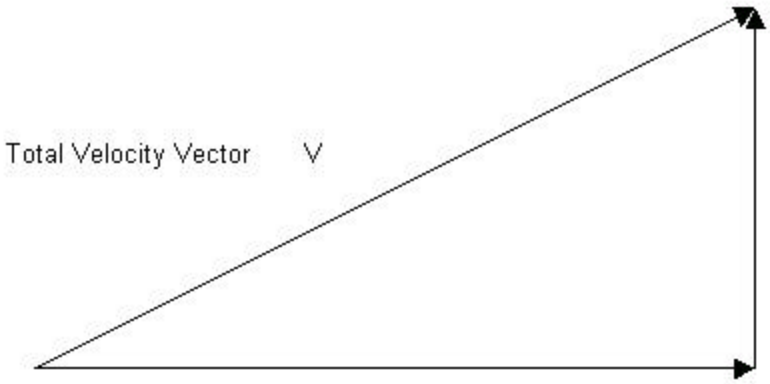
CRITERIA	**SCORE**
Group work and experimental procedure	_____
Data was recorded and organized in a neat tabular form	_____
Math calculations and unit cancellations were correct and organized well for:	
Question 1	_____
Question 2	_____
Question 3	_____
Question 4	_____
Answers to question 5 and 6 demonstrated research and well organized	_____
Question 7 designed experiment executed in a well organized manner	_____
Question 7 math calculations and unit cancellations correct and organized well	_____
Summary write-up was well written and free from spelling and grammatical errors	_____

Keywords

English Language Arts	Mathematics	Science
Reading	**Algebra** **Algebraic Operation** **Computation** **Equations** **Math in Daily Life Problem solving**	**Earth Science**
Writing **Spelling** **Grammar** **Expository**	**Geometry** **Pythagorean Theory Triangles**	**Life Science**
Communications	**Statistics**	**Chemistry**

Discussion		
Literature	**Calculus**	**Physics** **Energy** **Motion** **Mechanics, Scientific Process**
Other	**Trigonometry**	**Other**
	Other	

Baseball Kinetic Energy



V_X Component = $\frac{\text{distance traveled}}{\text{time in air}}$

V_Y Component = acceleration(a) = $\frac{\text{change in velocity}}{\text{time}}$

In this case a = g

$\Delta V = V_Y - 0$

Then plug letters in acceleration formula and solve for V_Y (Velocity Component)

From vector addition and Pythagorean Theorem, we can derive:

$V^2 = V_X^2 + V_Y^2$

Since KE = 1/2 mV^2

Derive the formulas you need for Kinetic Energy