PACT - Day 1

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BASIC INFORMATION

Date(s) Taught	3/12/2012
Content Area	Science
Grade/Level	Grade 9
Topic(s)	• Kinetic Energy • Elastic Potential Energy • Energy Transfer
Agenda	**9:14–9:20** Review lab procedure with class. Set clear expectations of what needs to be accomplished. **9:21–9:26** Distribute equipment to students. Students wheel out computer carts, plug them in, and turn them on. Students attach the motion sensor to the computers, start Logger Pro 3 software, and begin the friction compensation process by adjusting the slope of their dynamics track. **9:27– 10:12** Students collect and analyze data. **10:12 – 10:15** Students return materials, clean up classroom, and shut down computers. **10:15 – 10:16** Students are reminded to students to complete the combined analysis for homework along with worksheet #2.

STANDARDS AND OBJECTIVES

California Content & ELD Standards

Display: ○ Collapse All ◉ Expand All

- **CA- California K-12 Academic Content Standards**
  - **Subject:** Science
    - **Grade:** Grades Nine Through TwelveStandards that all students are expected to achieve in the course of their studies are unmarked. Standards that all students should have the opportunity to learn are marked with an asterisk (*).
      - **Area:** Physics
        - **Sub-Strand:** Conservation of Energy and Momentum
          - **Concept 2:** The laws of conservation of energy and momentum provide a way to predict and describe the movement of objects. As a basis for understanding this concept:

            Standard a.: Students know how to calculate kinetic energy by using the formula E =(1/2)mv^2 .

            Standard c: Students know how to solve problems involving conservation of energy in simple systems, such as falling objects.

Standard h: Students know how to solve problems involving conservation of energy in simple systems with various sources of potential energy, such as capacitors and springs.

Area: Investigation and Experimentation

Sub-Strand 1: Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other four strands, students should develop their own questions and perform investigations. Students will:

Standard a: Select and use appropriate tools and technology (such as computer-linked probes, spreadsheets, and graphing calculators) to perform tests, collect data, analyze relationships, and display data.

Standard b: Identify and communicate sources of unavoidable experimental error.

Standard c: Identify possible reasons for inconsistent results, such as sources of error or uncontrolled conditions.

Standard d: Formulate explanations by using logic and evidence.

Standard f: Distinguish between hypothesis and theory as scientific terms.

Standard g: Recognize the usefulness and limitations of models and theories as scientific representations of reality.

Standard j: Recognize the issues of statistical variability and the need for controlled tests.

Standard k: Recognize the cumulative nature of scientific evidence.

Standard l: Analyze situations and solve problems that require combining and applying concepts from more than one area of science.

Standard n: Know that when an observation does not agree with an accepted scientific theory, the observation is sometimes mistaken or fraudulent (e.g., the Piltdown Man fossil or unidentified flying objects) and that the theory is sometimes wrong (e.g., the Ptolemaic model of the movement of the Sun, Moon, and planets).

Learning Objective(s) for Content

- Students will discover that the kinetic energy of an object is proportional to its velocity squared. Students will make this discovery after they linearizing the graph of the velocity versus kinetic energy of data collected in this lab. All students will be able to adequately explain this relationship in the lab report according to the criteria set out in the rubric.
- Students will discover that the velocity of an objected squared is proportional to the inverse of its mass if kinetic energy is kept constant. Students will make this discovery after they linearizing the graph of the velocity versus mass of data collected in this lab. All students will be able to adequately explain this relationship in the lab report according to the criteria set out in the rubric.
- Students will discover that the kinetic energy of an object is proportional to mass. Students will make this discovery after they combine the two proportionalities listed above. All students will be able to adequately explain this relationship in the lab report according to the criteria set out in the rubric.

- Students will combine these to proportionalities to produce a quantitative model for kinetic energy of the form kinetic energy = kmv^2, where k is a constant. Students will calculate the value of this constant with less than a 15% error compared to the accepted value of 0.5.
- Students will be able to correctly calculate the kinetic energy of an object given its mass and velocity using the equation kinetic energy = 0.5 mv^2 with 100% accuracy on homework assignments and the unit quiz.
- Students will be able to solve problems involving the conversion of elastic potential energy to kinetic energy by using the energy flow diagram approach with 100% accuracy on the lab report, homework, and unit quiz.
- Students will be able to write a lab report with in one week of completing this activity that scores at least 18 out of 25 based of a rubric. This lab report will show their understanding of error analysis, proper equipment usage, interpretation of graphs, logical explanations, the scientific method, scientific terms, creating and using models, analyzing situations, problem solving, and statistical variability.

Learning Objective(s) for Academic Language

- After completing the data collection and analysis, students will write a lab report that follows standard practices and conventions of scientific writing. Students will be achieve at least 18 out of 25 points as scored by a rubric.
- Students will create several graphs based on data collected in this lab. All students will appropriately plot, format, and label the graphs in the lab report.
- Student will interpret these graphs and provide clear written explanations of their significance in the lab report. Every student in the class will discuss the meaning of the slope, intercept, and final equation of the each of the graphs. This will be evaluated using the rubric.

Prerequisite Knowledge and Skills

Students already can:

- Collect data using motion detectors and Logger Pro 3
- Find the elastic potential energy stored in a spring with a known k value and stretch.
- use a ruler
- Linearize graphs
- Use combined analysis to relate three variables and solve for a constant.
- Work collaboratively with their lab groups

Students aready understand:

- Newton's Laws of Motion
- 1^{st} law of thermodynamics
- Hooke's law

LEARNING ACTIVITIES, ASSESSMENT, AND RESOURCES

Sequence of Activities

- Students will set up the dynamics track and motion detector
- They will adjust the slope of the track to compensate for friction. When friction is compensated for, the dynamics cart

will keep a constant velocity if given a slight push down the track. In other words, its acceleration must be 0 m/s^2. This occurs when the frictional force is equal in magnitude and opposite in direction to the component of the carts weight that is parallel to the track. In other words, the sum of these two forces is equal to 0 N when friction is properly compensated for.

- Students will conduct two separate investigations.
  - 1. The first investigation will be to determine the relationship between the velocity of the cart and its kinetic energy if its mass is kept constant.
    - Students will attach a spring with a known spring coefficient to cart on the dynamic track and a fixed point at the end of the track.
    - Students will then stretch the spring and measure the stretch.
    - Students will calculate the amount of elastic potential energy stored in the spring by using the spring constant and the model for stored elastic potential energy created in the previous lab.
    - Students will release the cart. They will assume that all of the elastic potential energy is converted into kinetic energy because the slope of the ramp compensates for friction.
    - Students will measure the maximum speed of the cart using the motion detector.
    - Students will repeat this process but vary the amount of kinetic energy they give the cart each time by changing how much the spring is stretched.
    - Students will conduct at least six trials in which they vary the kinetic energy, keep the mass constant, and record the maximum velocity. Students will record the data they collect and write it in their collect data and write it in their bound composition lab notebooks.
    - Students will plot their data on the computer using Logger Pro 3
    - Students will see that the graph is velocity versus kinetic energy is not linear.
    - Students will create a linear graph by squaring the velocity values and graphing them versus the kinetic energy.
    - From this graph, students will see that the square of an objects velocity is proportional to its kinetic energy.
  - 2. The second investigation will be to determine the relationship between velocity and mass if kinetic

energy is kept constant.

- Students will attach a spring with a known spring coefficient to cart on the dynamic track and a fixed point at the end of the track.
- Students will stretch the spring a known distance. This spring stretch will remain constant for all of the trials in this investigation.
- Student will change the mass of the cart in at least six different trial while keeping the kinetic energy of the cart constant.
- Students will measure the maximum speed of the cart using the motion detector.
- Students will record the data they collect and write it in their collect data and write it in their bound composition lab notebooks.
- Students will plot their data on the computer using Logger Pro 3.
- Students will see that the graph of velocity versus mass is not linear. They will linearize this graph by squaring the velocity and taking the inverse of the mass
- From this graph, students will conclude that the square of an objects velocity is proportional to its kinetic energy when its kinetic energy is constant.

- Students will neatly put away all materials and shut down the computers.
- If students have extra time, they can combine these proportionalities and solve for the constant to come up with a general model of kinetic energy that relates all three variables.

Teacher Activites

- The teacher will monitor student safety and make sure the equipment is properly used.
- The teacher will take role.
- The teacher will use formative assessment to identify and address mistakes as they occur.
- The teacher will answer questions.
- The teacher will help identify sources of error.
- The teacher will ensure that all members of lab groups are working effectively.
- The teacher will monitor the time and help students pace themselves so they can finish the lab before the end of the period

Student Groups

- Students will work with their normal lab groups.

- Three students are assigned per group.

Activity Prompts

- Students will follow the procedure that was collaborative developed in class the previous week.

Expected student work products

- Students are expected to complete all data collection and analysis within one class period.
- Students are expected to write a comprehensive lab report that develops an accurate model for kinetic energy.

Questions for a Class Discussion

- What is the hypothesized shape of the graphs?
- What are the hypothesized intercepts of the graphs?
- In which direction is the friction on the cart compensated for?
- How many trials should be conducted?
- What range of masses should be used in the second investigation?
- What are the sources of error?

Special facilities or Equipment

- This lab will not require special facilities. It will be conducted in the normal classroom.
- The equipment required for this lesson can be seen in the materials section of this lesson plan.

Extended tasks for early finishers

- Students who finish early can begin to work on the lab report.

Differentiated Instruction	The teacher will provide differentiated instruction to groups and individual students throughout the class period. The teacher will use formative assessment to identify groups and individuals that need additional instruction. The instructor will respond to individual students and use his background knowledge of students to provide relevant and individualized instruction that best meets the needs of students.
Monitoring and Assessing Learning	The teacher will circulate throughout the class the entire period to monitor the progress and learning of students. Formative assessment will be used to assess student learning. The teacher will ask students verbal questions to gauge their understanding of concepts and the procedure. In addition, the teacher will inspect student data and look for errors. Student learning will formally be assessed by the rubric shown below.
Rubrics (if applicable)	Appearance 1. Typed, neatly presented

2. Appropriate order

Overall Objective

1. Overall objective clearly stated indicating why you are doing the investigation

Purpose

1. A statement of which variables you are going to investigate the relationship
between.

Diagram

1. Diagram showing how you set up your experiment.
2. Labels indicating parts of the apparatus or where you made measurements.
3. Energy Flow Diagram including friction compensation.

Procedure

1. Description of your procedure
2. Procedure is a numbered list of instructions

Dara Table

1. Measurements organized into a neat, labeled table
2. Other information (like fixed values) are also listed

Evaluation of Data Set –Interpretation of Graphs

1. Clear explanations of each step of the data evaluation
2. Table of Calculated Values (could be in your data table)
3. Graphs (including any linearized graphs)
a. Appropriate format (graph paper or computer print out)
b. Labels, units, etc.
c. Quality of results
4. Interpretation of graphs
a. Written interpretation of general trends
b. Meaning of intercept
d. Equation

Combined Analysis

1. Clear explanations of proportionality argument
2. Combined proportionality
3. Calculation of proportionality constant
a. Slope and fixed measurements
b. “k” value
c. average “k”
4. Error Analysis
a. % error from expected constant
b. Explanation of possible sources of error
5. Final Equation

Conclusion

1. Restatement of and answer to purpose
2. Written description (English sentences) of general relationship
3. Restatement of final equation
4. Meaning of final equations (general trends relating all 3 variables)

Post Lab

1. Notes on Post Lab
2. Relation to other energy quantities.
3. Domain of Model

Resources and Materials

- Springs
- PASCO dynamic carts
- Masses
- Electronic balance
- Computers
- Loger Pro 3 software
- Ruller
- Vernier lab pro interfaces
- Vernier motion detectors
- Aluminum collision tracks
- PASCO Dynamics Track
- Ring stand clamps
- Ring stand rods
- Track rod clam
- Mass hangers

REFLECTION

Reflection

Directions for learning tasks

I made the goal of the lab clear, but I did not make the individual steps to achieving that goal very explicit.

The procedure for this lab was created the previous week as a collaborative class discussion. With teacher guidance, students determined the variables of interest and then created a step by step method to find the relationship between them. Students copied the steps into their lab notebooks as I wrote them on the board.

Inquiry Skills

I purposely did not give students a clear "recipe" to follow because I wanted to teach inquiry and the scientific method. For most students in the class class, this was successful. However, I had to provide additional assistance to several groups who were unclear of how they could achieve the goal of this lab.

In retrospect, it may have been useful to provide students with a final list of the procedure that we agreed upon as a class. This would have allowed class time to be used more efficiently and reduced confusion.

Time management

Overall, time was used efficiently by students. Tasks were made very clear and students were give a timeline that they needed to follow. However, the learning task was very involved and ideally more time should have been devoted to it. About half of the class had to come back during lunch to finish their data collection.

Several students did not remember which spring they calculated the spring constant from in the previous lab. This set these groups of students back by about 20 minutes because they had find this again. I did not make clear enough that I expected students to write down the number of the spring that they used in the previous lab. This would have saved several students a significant amount of time.

Summary

Overall, the day was successful. Based on my formative assessment throughout the period, students understood the purpose of the lab and collected "good data."