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Subject: Regent Chem

Regents Physics Lab. Name: ……………………………………

0x08 graphic

Title: Conservation of cross bow energy

0x08 graphic

Pre-Lab Discussion

Energy comes in many forms, some of which you have already studied in your physics class. Behind this diversity is the unifying concept of the conservation of energy, which states that energy cannot be created or destroyed. Energy is, however, conserved and can be converted from one form to another and transferred from one object to another. In this lab, we will be using a “crossbow” and arrow to study energy transformations.

Purpose

To demonstrate that energy can change forms as it flows through a system, but is neither created nor destroyed.

Materials

PVC pipe cross bow Dowel arrow

Spring balance

Safety

Do not fire arrows at other students

Do not remove the rubber caps from the tips of the arrows

Procedure 1.

Elastic potential energy (PE_{el})

a. Record the number of your bow ………………. And arrow…………………

b. Draw the bow-string **straight** back with the spring balance and record the tension on the balance at 4.0cm intervals. Convert these distances to meters and record in table 1 (below) against the corresponding forces.

Stretch of bowstring (m)	Force (N)

c. On a separate sheet of graph paper plot the force required to stretch the bow string (Y axis) against the distance drawn (X axis).

d. Calculate the area under the graph and enter here with units:**……………………..**

e. What does this area represent?

f. Calculate the slope of the graph and enter here: **……………………..**

g. What does this value represent?

Procedure 2.

Gravitational Potential Energy (PE_g)

a. Find the mass of your arrow and record here in kilograms: **…………………**

b. Take your cross bows to an area where there is a high brick or block wall. Measure the height of one block then fire the arrow up the wall as high as it will go. Be sure that the arrow does not hit the wall on its way up. Count the number of blocks to the arrow's highest point and using their measurement calculate the arrow's height in meters. Repeat this five times and average the heights.

Trial	Height (m)
1	
2	
3	
4	
5	
Avg.	

c. Calculate the potential energy due to gravity stored in the average arrow shot at the top of its flight. (PE_g = mgh)

Pe_g = …………………………

d. How does the maximum gravitational potential energy of the arrow compare to the maximum elastic potential energy of the bowstring?

Fill in below, the sequence of energy transformations demonstrated in this laboratory:

Energy

added

to bow

Calculations

1. Use the equation below to calculate what percentage of the potential energy stored in the bow string was converted to potential energy against gravity of the arrow at the top of its trajectory.

% energy converted = (PEg/PEs) x 100%

2. Why was your answer in the previous question much less than 100%?

3. Where did the rest of the energy go? Give two possibilities.

4. If all of the energy stored in the bow string had been converted to gravitational potential energy, what height would the arrow have reached?

5. If all the energy stored in the bowstring had been transferred to the arrow, how fast would it have been moving when it left the bow?

6. Why did the table have you record the elongations in `meters' rather than in `centimeters'? (Hint: how does it make your later calculations of energy easier?)

7. Looking at your graph for force vs. elongation, does your spring follow Hooke's Law (Fs = kx)? Explain your answer.

8. In the graph below, elastic potential energy (PEs) is plotted versus spring elongation for springs A and B. Which stores more energy when pulled back 2.0 cm? _____ How do you know?

9. Speculate the effect that each of the following might have on the height reached by the arrow at the top of its flight.

a. Using a heavier arrow.

b. Pulling the bowstring back only halfway.

c. Using an arrow that produces less drag.

d. Using a bow that exerts more force.

10. Consider what you have learnt from the activities and calculations in this lab, and describe how this information can be applied to real life situations.