Conservation of Energy Lab

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Target Grade: 9-12 Physics or Physical Science

Time Required: 120 minutes

Standards:

PWC.PS3: Energy

- Investigate the definitions of force, work, power, kinetic energy, and potential energy.
- Analyze the characteristics of energy and conservation of energy including friction, gravitational potential energy, and kinetic energy.
- Demonstrate how or explain how energy is conserved in an isolated system even if transformations occur within the system.
- Calculate quantitative relationships associated with the conservation of energy.

Lesson Objectives:

Students will:

- Demonstrate understanding of the conditions that a system needs in order to have kinetic energy and/or potential energy.
- Demonstrate comprehension of conservation of energy in a system and how energy is transferred between states.
- Demonstrate both in writing and calculations the science and math of how energy is conserved in an isolated system.

Central Focus:

Students will use this lab activity to drop objects of different mass from the same height to calculate the objects' final velocity. They will determine if the mass of the object affects its velocity or not. While this may be a familiar lab activity, this lesson puts a spin on it by using drones to drop the objects. Topics addressed in this lab are the Law of Conservation of Energy, transfer of energy, and kinematics.

Background Information:

The Law of Conservation of Energy states that energy can neither be created of destroyed; rather it changes from one type of energy to another. In an ideal situation, the work done lifting a ball against Earth's gravitational field gives the ball potential energy (PE=mgh), and that potential energy can be converted into kinetic energy (KE=1/2mv2). In reality, we lose a little energy to heating up the air and the floor, so our conservation of energy formula (mgh=1/2mv2) has to be modified to include the lost energy. In this lab, student will answer the question of whether an object with greater mass will reach the ground with more velocity than an object with less mass. Note that velocity is not a measurement of energy, like potential and kinetic energy are. It is important to note that in a drop lab such as this one, the rate of acceleration is gravity, and the objects should be similarly sized and shaped as to eliminate error due to drag.

Materials

- Drone
- Hook
- Hacky-sack
- Softball
- Tennis ball
- String
- Meter stick
- Timer
- Student lab notebook
- Lab Handout (attached below)

Instruction

Day 1

- Opening (15 minutes) The students will view a PowerPoint presentation which will provide information about kinetic energy, potential energy and conservation energy. The presentation also shows the students the algebra needed to complete the lab through examples and exercises. Depending on what's appropriate, the teacher may lead the class through the presentation, students may work through it with a shoulder partner, or student may work through it independently. In all cases, the teacher should check with students when finished to ensure they understand the concepts and practice problems before continuing.
- Pre-lab (5 minutes) Students should receive the lab handout, read it, and have clear understanding of what they need to do in the lab. First, students should answer the following critical question: "Will an object reach the ground with more velocity than an

object with less mass"? Students will develop and write their hypothesis for the lab based on their prior knowledge and what they learned from the presentation at the beginning of class.

- Lab setup (10 minutes) Students will work in groups of 4 and discuss their hypothesis and the answer to the critical question. During this time, groups should also decide on the roles that they will take on for their lab group: Research Leader, Recorder, Experimenter 1, Experimenter 2. Research Leaders should go ahead and gather materials at this time.
- Lab activity (60 minutes) Students will follow the rest of the lab handout, collect data and complete the process.

Day 2

- Lab write up (20 minutes) Students will write the lab report in their lab notebook. They will follow the format previously established in class, including the use of complete sentences.
- Closing (10 minutes) Teacher will facilitate a class discussion in which each group reports their results and what was learned during the lab.

Differentiation

- ELL students will be given the material in both English and their native language and they will be paired up with groups that will help them. Their lab reports will have different items for them to do.
- SPED students will be given a different format (reduced) for their lab report.

Assessment

- The students' understanding of the theory and algebra will be assessed with examples and problems done in class during the opening part of the class.
- During the lab, the teacher will be asking question about the topic and evaluation students' understanding of the lab and what they are doing.
- There will be an exit ticket on at the end of both lab days to evaluate students understanding of the topic.
- The students will be evaluated on the completion of their lab report.

Conservation of Energy- lab handout

Objective

1. Apply the properties of kinetic and potential energy.
2. Identify and describe the transfer of potential energy to kinetic energy.
3. Understand the role of the mass in a conservation of energy situation.

Hypothesis- Answer the following question: **Will an object reach the ground with more velocity than an object with less mass?** Write your hypothesis based on your answer. Remember to use "if" and "then" statements.

Materials:

- Drone
- Hook
- Hacky-sack
- Softball
- Tennis ball
- String
- Meter stick
- Timer

Introduction:

"Energy can't be created nor destroy but it only transforms." This is the principle that we are going to use today to test if the mass of an object affects how fast the object hits the ground. You are going to use different type of masses and drop them from the same height and calculate their final velocity using conservation of energy and kinematics.

Theory:

Energy	Kinematics
KE= ½ mV_1^2	V_f= at
PE =mgh	a= acceleration due to gravity (9.8m/s^2)
Conservation of Energy PE = KE	

Group set-up:

You will work on groups of 4.

- **Research leader:** This student will collect the materials and return them. The research leader will also ensure that all students in the group follow their role.
- **Recorder:** This student will record the data and answer the questions. The recorder will also explain the data to the others.
- **Experimenter 1 and 2:** These students will perform the procedure of the lab (with the help of the research leader).

Part I – Collecting Data

- Tie the string to the hacky sack and attach it to the hook in a drone. The goal is that you can pull on the string and the hacky sack will drop from the drone. You will also use the string to measure the height where you drop the masses from. Remember that they have to be the same height for all the objects.
- Prepare the drone and fly it until it reaches the desired height
- Once the drone is hovering at the height you want to use, put some tension on the string so you can measure the height with the string.
- Drop the hacky sack and at the same time collect the time of drop. Record the time on the correct table.
- Repeat the process two more times with the hacky sack.
- Repeat the process with the other two objects and record the times on the correct table

Part II – Fill out the tables

- Complete the tables below with the information that you collected in **part I.** Note that you won't be able to fill out some parts of the tables until part III.
- Table 1 should have the time for the hacky sack.
- Table 2 should have the time for the softball.

- Table 3 should have the time for the tennis ball.
- Table 4 should have all information, including height.

Part III – Calculations and completing the tables

- Measure the mass the hacky sack, softball and tennis ball on the triple-bean balance in the classroom. Put this information on table 4.
- Calculate the average times from tables 1, 2 and 3 and put them in table 4.
- Calculate the final velocity using conservation of energy on the "energy" part of the table.
- Calculate final velocity using the kinematic equation on the 'kinematic" part of the table.
- **Show a sample calculation for each value determined.**

Table 1: Hacky sack	
Trial	time
1	
2	
3	
Ave. time	

Table 2: Softball	
Trial	time
1	
2	
3	
Ave. time	

Table 3: Tennis ball	
Trial	time
1	
2	
3	
Ave. time	

Table 4: finding final velocity					
		Energy		Kinematics	
	Mass	Height	Final velocity	Ave. Time	Final velocity
Hacky sack					
Softball					
Tennis ball					

Part IV – Wrap Up: Answer these in your notebook

- What did you notice while calculating the final velocity using the conservation energy?
- What is your data telling you when comparing the final velocities between the different masses?
- Which method did you find easier to use? Explain your reasoning.
- Why was mass not used for the kinematic portion of the calculations?

Your lab report should have the following items

Title of the experiment and date. These will go at the top of the first page of each lab.

Objective/purpose (look at the objective above and paraphrase) Give a brief statement of what you are attempting to do in the lab.

Data- Record all your data directly in your notebook. Organize your data in a neat and orderly form. This is where your tables should go.

Result- Include equations/formulas used. Your calculation should go in this section. Remember you only have to a sample calculation for each value determined.

Summary- This section should have a brief summary of the point/purpose of the lab. Include here your opinion of the lab, focusing on what you learned. Your percent error calculation should go in this section. Any questions that the lab asks you be answer here. Re-write the question if you have to.

Conclusion- The wrap-up of the research based on the data and information retained. Answer the following questions: Was your hypothesis supported? (not right or wrong)

What data or support do you have that shows if your hypothesis was supported or not?

What should the person do next based on this information?