Name

Date

Sciences 10

**Conservation of Energy**

**Introduction**

The law of conservation of energy states the energy can neither be created nor destroyed, but can only be transformed from one form to another. For instance, the kinetic energy of a golf ball in free fall doesn’t disappear when the ball stops falling, but rather it is converted to other forms of energy such as thermal energy, acoustic energy, or elastic energy. In this experiment, you will have the opportunity to observe energy transformations and to calculate the quantity of energy transformation occurring by utilizing an app called Phyphox. The built-in (In)elastic Collision experiment will allow you to drop a ball from a given height and obtain data from each bounce on the ball’s height, percent energy retention, and time spent in the air. The data can then be utilized to observe how much energy was transformed during the bouncing of the ball. By dropping different types of balls from different heights, one can then obtain a clearer picture of the variables involved in energy transformation.

**Objectives**

-Formulate hypotheses around the result of an object in free fall and the quantity of energy transformed upon each bounce.

-Measure the height of a bouncing ball utilizing digital technology.

-Analyze the recorded data to determine the amount of energy transformation.

**Materials**

* a smartphone or tablet with Phyphox installed
* a setting with minimal ambient noise
* a variety of different types of balls and different surfaces on which to drop the balls

**Hypothesis** – In terms of the amount and types of energy it possesses, explain what you think will occur as different types of balls are bounce off different surfaces.

**Procedure**

1. Obtain a device with Phyphox installed.
2. Familiarize yourself with the Phyphox app, in particular the use of the (In)elastic Collision experiment.
3. Set the “Threshold” and “Minimum Delay” parameters of the (In)elastic Collision experiment to the appropriate settings in order to reliably obtain recordings for your bouncing ball in your particular environment.
4. Perform one or two test runs in order to ensure data is reliably recorded.
5. Place the device on the surface onto which your ball will be dropped and, with the (In)elastic Collision experiment open, tap the “play” button.
6. Drop the ball allowing it to bounce until it comes to rest, then tap the “pause” button.
7. Record the heights, times, and percent energy retained obtained by the Phyphox app.
8. Perform the same drop twice more to obtain data for a total of three trials for each combination of ball and surface.
9. Perform steps #3 to #8 with at least one other type of ball and one other type of surface.

**Results and Observations**

Table 1 – Results obtained for the first combination of ball and surface

|  |  |  |  |
| --- | --- | --- | --- |
| Ball type – \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  Surface type – \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  Manually Measured Initial Height = \_\_\_\_\_\_\_\_ | | | |
| Bounce Number | Height (cm) | Time | Percent of Energy Retained |
| - | Trial 1 = \_\_\_\_\_\_\_\_  Trial 2 = \_\_\_\_\_\_\_\_  Trial 3 = \_\_\_\_\_\_\_\_ | Trial 1 = 0.00 s  Trial 2 = 0.00 s  Trial 3 = 0.00 s | Trial 1 = 100 %  Trial 2 = 100 %  Trial 3 = 100 % |
| 1 | Trial 1 = \_\_\_\_\_\_\_\_  Trial 2 = \_\_\_\_\_\_\_\_  Trial 3 = \_\_\_\_\_\_\_\_ | Trial 1 = \_\_\_\_\_\_\_\_  Trial 2 = \_\_\_\_\_\_\_\_  Trial 3 = \_\_\_\_\_\_\_\_ | Trial 1 = \_\_\_\_\_\_\_\_  Trial 2 = \_\_\_\_\_\_\_\_  Trial 3 = \_\_\_\_\_\_\_\_ |
| 2 | Trial 1 = \_\_\_\_\_\_\_\_  Trial 2 = \_\_\_\_\_\_\_\_  Trial 3 = \_\_\_\_\_\_\_\_ | Trial 1 = \_\_\_\_\_\_\_\_  Trial 2 = \_\_\_\_\_\_\_\_  Trial 3 = \_\_\_\_\_\_\_\_ | Trial 1 = \_\_\_\_\_\_\_\_  Trial 2 = \_\_\_\_\_\_\_\_  Trial 3 = \_\_\_\_\_\_\_\_ |
| 3 | Trial 1 = \_\_\_\_\_\_\_\_  Trial 2 = \_\_\_\_\_\_\_\_  Trial 3 = \_\_\_\_\_\_\_\_ | Trial 1 = \_\_\_\_\_\_\_\_  Trial 2 = \_\_\_\_\_\_\_\_  Trial 3 = \_\_\_\_\_\_\_\_ | Trial 1 = \_\_\_\_\_\_\_\_  Trial 2 = \_\_\_\_\_\_\_\_  Trial 3 = \_\_\_\_\_\_\_\_ |
| 4 | Trial 1 = \_\_\_\_\_\_\_\_  Trial 2 = \_\_\_\_\_\_\_\_  Trial 3 = \_\_\_\_\_\_\_\_ | Trial 1 = \_\_\_\_\_\_\_\_  Trial 2 = \_\_\_\_\_\_\_\_  Trial 3 = \_\_\_\_\_\_\_\_ | Trial 1 = \_\_\_\_\_\_\_\_  Trial 2 = \_\_\_\_\_\_\_\_  Trial 3 = \_\_\_\_\_\_\_\_ |

Table 2 – Results obtained for the second combination of ball and surface

|  |  |  |  |
| --- | --- | --- | --- |
| Ball type – \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  Surface type – \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  Manually Measured Initial Height = \_\_\_\_\_\_\_\_ | | | |
| Bounce Number | Height (cm) | Time | Percent of Energy Retained |
| - | Trial 1 = \_\_\_\_\_\_\_\_  Trial 2 = \_\_\_\_\_\_\_\_  Trial 3 = \_\_\_\_\_\_\_\_ | Trial 1 = 0.00 s  Trial 2 = 0.00 s  Trial 3 = 0.00 s | Trial 1 = 100 %  Trial 2 = 100 %  Trial 3 = 100 % |
| 1 | Trial 1 = \_\_\_\_\_\_\_\_  Trial 2 = \_\_\_\_\_\_\_\_  Trial 3 = \_\_\_\_\_\_\_\_ | Trial 1 = \_\_\_\_\_\_\_\_  Trial 2 = \_\_\_\_\_\_\_\_  Trial 3 = \_\_\_\_\_\_\_\_ | Trial 1 = \_\_\_\_\_\_\_\_  Trial 2 = \_\_\_\_\_\_\_\_  Trial 3 = \_\_\_\_\_\_\_\_ |
| 2 | Trial 1 = \_\_\_\_\_\_\_\_  Trial 2 = \_\_\_\_\_\_\_\_  Trial 3 = \_\_\_\_\_\_\_\_ | Trial 1 = \_\_\_\_\_\_\_\_  Trial 2 = \_\_\_\_\_\_\_\_  Trial 3 = \_\_\_\_\_\_\_\_ | Trial 1 = \_\_\_\_\_\_\_\_  Trial 2 = \_\_\_\_\_\_\_\_  Trial 3 = \_\_\_\_\_\_\_\_ |
| 3 | Trial 1 = \_\_\_\_\_\_\_\_  Trial 2 = \_\_\_\_\_\_\_\_  Trial 3 = \_\_\_\_\_\_\_\_ | Trial 1 = \_\_\_\_\_\_\_\_  Trial 2 = \_\_\_\_\_\_\_\_  Trial 3 = \_\_\_\_\_\_\_\_ | Trial 1 = \_\_\_\_\_\_\_\_  Trial 2 = \_\_\_\_\_\_\_\_  Trial 3 = \_\_\_\_\_\_\_\_ |
| 4 | Trial 1 = \_\_\_\_\_\_\_\_  Trial 2 = \_\_\_\_\_\_\_\_  Trial 3 = \_\_\_\_\_\_\_\_ | Trial 1 = \_\_\_\_\_\_\_\_  Trial 2 = \_\_\_\_\_\_\_\_  Trial 3 = \_\_\_\_\_\_\_\_ | Trial 1 = \_\_\_\_\_\_\_\_  Trial 2 = \_\_\_\_\_\_\_\_  Trial 3 = \_\_\_\_\_\_\_\_ |

Table 3 – Results obtained for the third combination of ball and surface

|  |  |  |  |
| --- | --- | --- | --- |
| Ball type – \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  Surface type – \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  Manually Measured Initial Height = \_\_\_\_\_\_\_\_ | | | |
| Bounce Number | Height (cm) | Time | Percent of Energy Retained |
| - | Trial 1 = \_\_\_\_\_\_\_\_  Trial 2 = \_\_\_\_\_\_\_\_  Trial 3 = \_\_\_\_\_\_\_\_ | Trial 1 = 0.00 s  Trial 2 = 0.00 s  Trial 3 = 0.00 s | Trial 1 = 100 %  Trial 2 = 100 %  Trial 3 = 100 % |
| 1 | Trial 1 = \_\_\_\_\_\_\_\_  Trial 2 = \_\_\_\_\_\_\_\_  Trial 3 = \_\_\_\_\_\_\_\_ | Trial 1 = \_\_\_\_\_\_\_\_  Trial 2 = \_\_\_\_\_\_\_\_  Trial 3 = \_\_\_\_\_\_\_\_ | Trial 1 = \_\_\_\_\_\_\_\_  Trial 2 = \_\_\_\_\_\_\_\_  Trial 3 = \_\_\_\_\_\_\_\_ |
| 2 | Trial 1 = \_\_\_\_\_\_\_\_  Trial 2 = \_\_\_\_\_\_\_\_  Trial 3 = \_\_\_\_\_\_\_\_ | Trial 1 = \_\_\_\_\_\_\_\_  Trial 2 = \_\_\_\_\_\_\_\_  Trial 3 = \_\_\_\_\_\_\_\_ | Trial 1 = \_\_\_\_\_\_\_\_  Trial 2 = \_\_\_\_\_\_\_\_  Trial 3 = \_\_\_\_\_\_\_\_ |
| 3 | Trial 1 = \_\_\_\_\_\_\_\_  Trial 2 = \_\_\_\_\_\_\_\_  Trial 3 = \_\_\_\_\_\_\_\_ | Trial 1 = \_\_\_\_\_\_\_\_  Trial 2 = \_\_\_\_\_\_\_\_  Trial 3 = \_\_\_\_\_\_\_\_ | Trial 1 = \_\_\_\_\_\_\_\_  Trial 2 = \_\_\_\_\_\_\_\_  Trial 3 = \_\_\_\_\_\_\_\_ |
| 4 | Trial 1 = \_\_\_\_\_\_\_\_  Trial 2 = \_\_\_\_\_\_\_\_  Trial 3 = \_\_\_\_\_\_\_\_ | Trial 1 = \_\_\_\_\_\_\_\_  Trial 2 = \_\_\_\_\_\_\_\_  Trial 3 = \_\_\_\_\_\_\_\_ | Trial 1 = \_\_\_\_\_\_\_\_  Trial 2 = \_\_\_\_\_\_\_\_  Trial 3 = \_\_\_\_\_\_\_\_ |

**Analysis**

1. Just prior to releasing the ball, what forms of energy does the ball possess?
2. As the ball falls through the air, yet prior to reaching the surface, what types of energy transformations take place?
3. Once the ball bounces and begins travelling upwards again, what energy transformations are occurring?
4. a) How did the manually measured initial height compare with the initial height calculated by the app?

b) What does this difference indicate about the validity of the other measurements obtained by the app?

c) What might explain any discrepancy between the manually and digitally measured values?

1. For one of the trials of one of the combinations of ball and surface, draw a graph of the mechanical energy of the ball versus time as it bounces.
2. a) Describe differences between the percent energy retained by different types of balls.

b) Describe the impact of different surfaces on the percent energy retained in each experiment.

c) Describe an application in which knowing the amount of energy retained by a falling object would be important and why it would be important.

Conclusion

* Summarize the results of your hypothesis, the analysis of your data, and any sources of error.