Lab 6 Momentum and Energy

Objective

In this lab, students will review the concepts they have learned in class, such as kinetic energy, gravitational potential energy, momentum, impulse, force, and the relationships among them.

Supplies

- Two balls (any types, but better be a bouncy one and a less bouncy one)
- A ruler or a measuring tape

Theory

When a ball is dropped on the floor, the ball will bounce back to a certain height. The height will be less than the original height where the ball was released, due to the energy loss when the ball collides with the floor. By measuring the height before the ball is released and the height it reaches after bouncing back, one can calculate the amount of energy loss in this process. The speed of the ball right before and after colliding with the floor can also be calculated, so can the momentum, impulse and the force acting on the ball by the floor when they collide (interact).

If the initial gravitational potential energy of the ball, when it is about to be released, can be expressed and calculated using the following formula:

$$\Delta PE_1 = mg \cdot \Delta h_1$$

And the final gravitational potential energy of the ball, when it bounces back to the highest point, is expressed and calculated using the following formula:

$$\Delta PE_2 = mg \cdot \Delta h_2$$

Then the energy loss will be:

$$\Delta PE = \Delta PE_1 - \Delta PE_2$$

The speed of the ball at the moment it is about to collide with the floor can be calculated using the following formula if air resistance is ignored. Take the floor as the reference position, then:

$$v_1 = \sqrt{2gh_1}$$

And the corresponding momentum is:

$$p_1 = m\, v_1 = m\sqrt{2gh_1}$$

The speed of the ball right after it collides with the floor can be calculated using the following formula if air resistance is ignored:

$$v_2 = \sqrt{2gh_2}$$

And the corresponding momentum is:

$$p_2 = m\, v_2 = m\sqrt{2gh_2}$$

Then the impulse acting on the ball during the collision can be calculated using the following formula:

$$Impulse = p_2 - p_1 = m\,(\sqrt{2gh_2} - \sqrt{2gh_1}\,)$$

The force acting on the ball by the floor is:

$$F = \frac{Impulse}{\Delta t}$$

And Δt is the acting time between the floor and the ball when the collision happens.

Procedure

1. Drop the two balls one by one from the same height and observe if they will bounce back to the same height. If not, identify which ball (the bouncy one or the less bouncy one) bounces back to a relatively higher position? Record your result. If yes, try to use two balls that have a bigger difference in their bounciness and try again.
2. Mark a specific position h_1 (relative to the floor) and drop one ball (Ball 1) from that height and record the highest position the ball can reach after bouncing back and record it as h_2.
3. Use the formulas discussed in the "Theory" part to calculate PE_1, PE_2, ΔPE, v_1, p_1, v_2, p_2, and Impulse.
4. Considering that the collision time is super short, the best way to find the acting time is probably recording the collision and figure out the acting time Δt from the video.

5. Once Δt is figured out, use the last formula stated in the "Theory" part to calculate the force acting on the ball: F.
6. Repeat steps 2, 3, 4 and 5 using the other ball (Ball 2).

Data and Calculations

Table 1. Measurement results and reaction time

Trial	Ball 1	Ball 2
h_1 (m)		
h_2 (m)		
PE_1(J)		
PE_2(J)		
ΔPE(J)		
v_1(m/s)		
v_2(m/s)		
$P_1(kg\frac{m}{s})$		
$P_2(kg\frac{m}{s})$		
$Impulse{=}\Delta P = P_2 - P_1$ $(kg\frac{m}{s})$		
Δt *(s)*		
F (N)		

Questions

1. Does the ball bounce back to the same height where it is released after bouncing back from the floor?

   Write down the given value. _____

   If no, explain why there is energy loss? In other words, where did the energy go? Was the lost energy transferred to other objects or transformed to other form of energy? Name it and provide your answer here.

2. According to your experiment, which ball, the bouncy one or the less bouncy one, has a longer interacting (collision) time with the floor?

   _____

3. According to your experiment, which ball, the bouncy one or the less bouncy one experienced a bigger *Impulse* when colliding with the floor?

   _____

   How about the force, F?

   _____

First and last name:

_____ (required)

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