Dropping an egg in a selfmade Harness attached to a bungee from the height of four meters and the analysis of what different types of energy are present at different stages of the drop

In this Advanced Physics class, we've been talking about energy and the conservation of energy for a while now. But the concept of energy conservation was, for me personally, always kind of hard to understand. Our teacher Mister Brian Gehring gave us the option of deciding between two very different kind of labs. We as a group decided to go for the egg-bungee lab, because it sounded more fun and like a little engineering challenge too. We didn't really know how to approach this physics lab in the first place, so our whole class had a brainstorm session where we went over all the things we learned about energy in the previous classes. We figured the theoretical process of the egg-dropping out. After we found out, what we had to do, what we had to calculate and solver for, in order to find out how much the bungee was going to stretch, so that we could find the adequate length of the string, so that our egg wasn't going to hit the ground, we started our experiment.

Purpose

The purpose of this lab, was to make us understand how exactly the concept of energy worked in real-life situations. In class, we've mainly focused on three different types of energy: Gravitational Potential Energy, Kinetic Energy and Spring Potential Energy. This lab was designed to help us understand the distribution of energy over the various stages of the drop and what energy was present at what stage. It would help us apply our knowledge in real-life scenarios, that involve energy (basically every situation imaginable involves energy), and to understand easy motions such as a simple jump and how energy acted during that movement.

Thought Process and Analysis

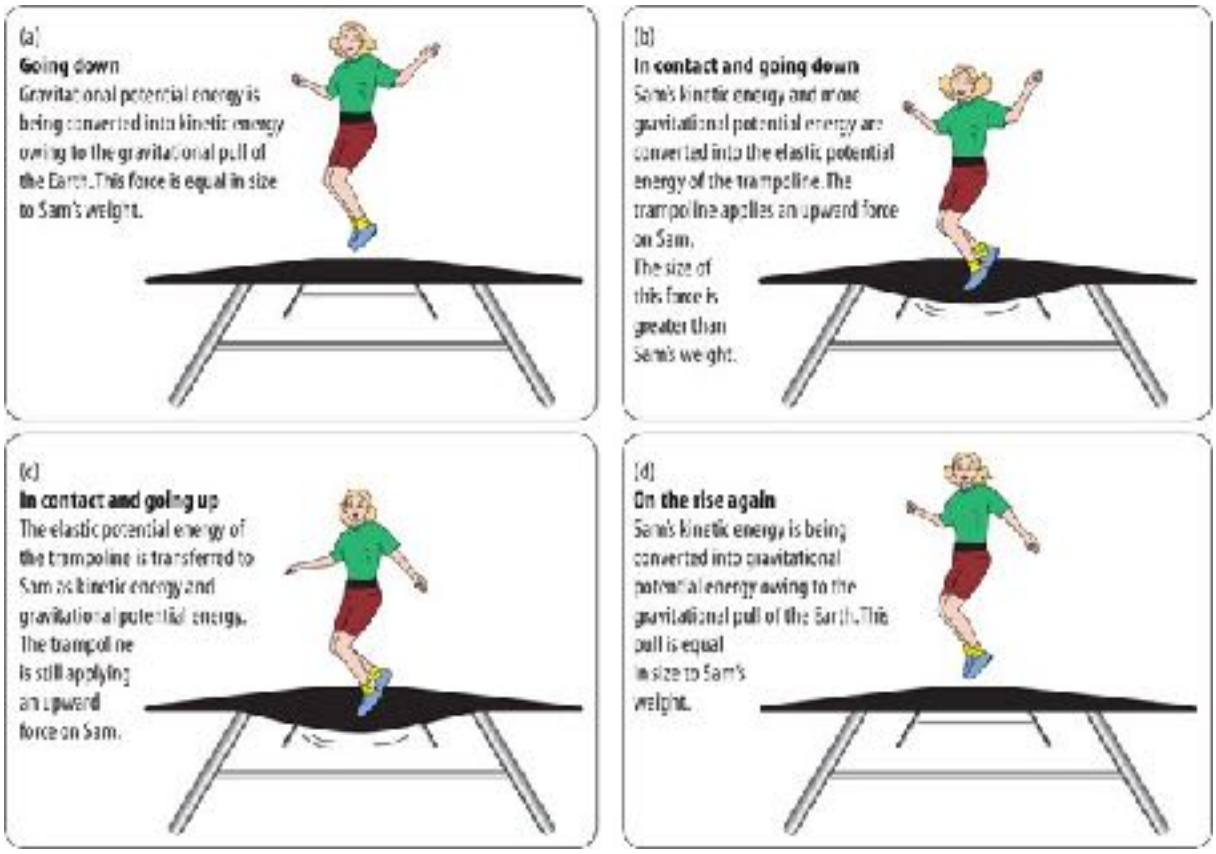
Before the start of this lab, we've had a couple lectures on energy and its conservation in our Advanced Physics course. We were given all the necessary tools, we needed to figure out this lab. Our professor Brian Gehring brought one of the most important physics concepts that "Energy is ALWAYS conserved" (Brian Gehring, March 21st, 2018) back to our attention. The understanding and knowledge of this concept is very essential to this lab and many other things in life. We first learned about the conservation of energy in our first lesson on energy on March 21st of 2018. We also talked and learned about it on the following trampoline problem we did as a homework assignment. The trampoline problem also addressed the three types of energy we mainly talked about (Gravitational Potential Energy, Kinetic Energy, Spring Potential Energy), and how they were distributed in this scenario.

Knowledge

Gravitational Potential Energy

Gravitational potential energy is the energy stored in an object as the result of its vertical position or height. The energy is stored as the result of the gravitational attraction of the Earth for the object. The Gravitational Potential Energy is dependent on two variables: the mass of an object and the height of which the object is raised.

The gravitational potential energy can be calculated using the formula **m*g*h**.
m = the mass of the object you're calculating potential energy for (kg)
g = the gravitational constant 9.8 (m/s^2)
h = the height the object is being raised to (m)



In Sam's case:
m = Sam's weight
g = gravitational constant
h = height of jump on trampoline

<u>Kinetic Energy</u>

Kinetic energy is the energy of motion of a body observable as the movement of an object, particle, or set of particles. It ranges from 0 to a positive value. Any object in motion is using kinetic energy.

Kinetic energy can be calculated using the formula **½ *m*v²**.
m = mass of object (kg)
v = velocity of object (m/s)

In Sam's case:
m = mass of Sam
v = Velocity of Sam going down

<u>Spring Potential Energy</u>

Elastic potential energy is the energy stored in elastic materials as the result of their stretching or compressing. Elastic potential energy can be stored in rubber bands, bungee cords, trampolines, springs, an arrow drawn into a bow, etc. The amount of elastic potential energy stored in such a device is related to the amount of stretch of the device - the more stretch, the more stored energy.

The Spring Potential Energy can be calculated using the formula **½ K△x²**.

K = Spring constant (N/m)
△x² = stretch of spring (m)

But to find the Spring Potential Energy you need to find the Spring Constant first. The spring constant is the force needed to stretch or press a spring, divided by the distance that the spring gets longer or shorter

The spring constant can be found using the formula **F/△x** (N/m).

F = force put on spring (N)
△x = displacement of the spring from its equilibrium position (m)

In Sam's case:
F = force Sam exerts on trampoline just standing on it
△X = how much trampoline stretches when Sam's standing on the trampoline
K = F/△x
△x^2 = stretch of trampoline when Sam's jumping

Energy Conservation

The total energy of an isolated system remains constant irrespective of whatever internal changes may take place with energy disappearing in one form reappearing in another. The sentence "That was a waste of energy" is technically never true.

Experiment

With all the background information we were given and the materials we were allowed to use (egg, Dixie cup, tape, cotton balls, newspaper, string, rubber bands etc.), we started constructing and calculating. Our goal in this experiment on one side was to understand the concept of energy and its conservation, but on the other side we were trying to find how long our string was supposed to be, when we take the stretch of the bungee in consideration. Ultimately, we didn't want our egg to break or hit the floor but get as close to the ground as possible.

Procedure and Calculations

We took an egg and built a beautiful little harness for it. Our final construction weighed about. 0.0648 kg. From there we were able to calculate for our Gravitational Potential Energy and because of that we knew that this will be our energy present at all stages of the drop. We could solve for velocity, which we didn't need in that situation, by setting the formula for Kinetic Energy equal to the Gravitational Potential Energy value we calculated. We looked for the Spring constant by taking our rubber band bungee, measuring the length of it, putting weights on it and seeing how much it stretches from its equilibrium. Then you calculate the K by taking the mass of your egg in kilograms times the gravity over the distance it stretched in meters. From there we solved for the stretch, again by setting the formula for Spring Potential Energy equal to the Gravitational Potential Energy value we calculated, and the we solved for the stretch. From there we calculated that our string had to be 3m and 2cm. Then we gave our construction to our teacher Brian Gehring who was standing on top of a 4m ladder, where he dropped the egg from.

Results and Outcome

Sadly, our egg hit the ground. This was not necessarily because of a calculation error, but because we didn't realize that the spring constant wasn't exactly linear. We solved for our Spring Constant with weights that were too low, and if we had tried a higher mass, we would have seen how the spring constant goes down. Because of that, we didn't think that the bungee was going to stretch as much as it did in the end and therefore cut a piece of string that was way too long. Additional to that, we were a little bit under time pressure.
Overall this lab really helped me understand, that energy was neither destroyed nor created, but simply changes into different types and is conserved.