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Energy Box Simulator

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Abstract

This research is focused on making the trainer kit in the form of a device for measuring and calculating energy with an interactive practicum mode that is fun for students as part of the Thermodynamics course. This device will be equipped with a timer for measuring time, electrical mass measurement and a length calculator for measuring kinetic energy and potential energy using data on mass, velocity and height of an object. The data obtained from the measurement results will then be compared with the results of calculations on an application-based simulator in the visual basic .exe program.

Keywords: Energy box simulator, energy, kinetic energy, potential energy, thermodynamics, visual basic.

1. INTRODUCTION

Thermodynamics is one of the fields of science that discusses energy and its various uses [1]. Thermodynamics comes from the Greek with therme as heat and dynamics as force. Although the beginning of the science of thermodynamics is not known, however, the beginning of the 19th century is considered to be the time when the equipment for this science has begun [2]. The first law of thermodynamics states that energy can neither be created nor destroyed. He can only change form, from one form of energy to another [1, 2].

Thermodynamics in general is the process of observing and calculating energy. There are various types of energy ranging from mechanical, electrical to chemical. The total energy change in the system itself from a thermodynamic point of view is a translation of the sum of kinetic energy, potential energy and internal energy [1, 2]. Several energy simulators are available for free in the market such as PhET Interactive Simulator [3]. However, this simulator only focuses on visual-based applications, without being equipped with the supporting tools needed, especially for vocational school students who get more practice than theory.

This research will focus on making Energy Box Simulator in the form of a tool to measure and calculate energy with a fun mode for students. This kit will be equipped with a timer for measuring time, electrical mass measurement and a length calculator for the development of measurement of kinetic energy, potential energy and measurement of mechanical work. The data obtained from the measurement results will then be compared with the results of calculations on the simulator.

Energy does many things for humans. Energy drives diesel cars, motorcycles, and airplanes in the air. Energy makes boiled water boil and makes our syrup cool in the refrigerator. Energy also turns on lights in parks and roadsides [4].

Energy is the thing that changes, does, moves, and works. Energy is defined as the ability to produce change or do work. Energy can produce several important components in the form of light, heat, sound movement and growth in living things [4].

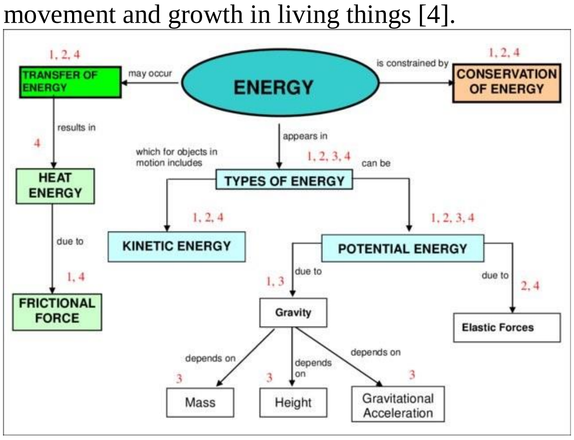

Figure 1: Map Energy Concept [5]

Potential energy is a form of energy from a system caused by the position of objects or systems [6]. The

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unit of potential energy in SI Units is symbolized as J in honor of the scientist James Prescott Joule.

The term "potential energy" was coined by William Rankine [7], although it has a connection with the concept of potential of the Greek philosopher Aristotle.

Potential energy is a series of energy in the body, where it only depends on the position of the object in a vacuum. Therefore, potential energy makes the set of forces has a vector. This vector is defined at each point. This point is used as the formation of the force field. If the work of this force from the initial path to the final path is determined only by two positions and does not depend on the path it takes, there is a "potential" which we called as potential energy. [6, 7].

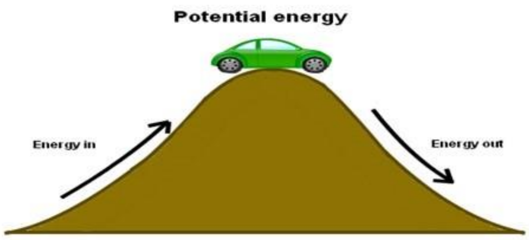

Figure 2: Potential Energy Illustration [8]

On the other hand, kinetic energy is the energy possessed by an object based on its motion. Every time an object moves, the object will have kinetic energy [9].

An athlete who is getting ready for free fall, but still in a stationary position, will have potential energy but no kinetic energy. This is because the object has not moved. If the athlete slides and begins to descend towards the ground, the athlete will gain kinetic energy. The value of kinetic energy obtained depends on its mass and velocity [9].

In other words, an athlete who has a greater mass and plunges to the earth will have more kinetic energy when compared to a cat parachuting in the same position. [9].

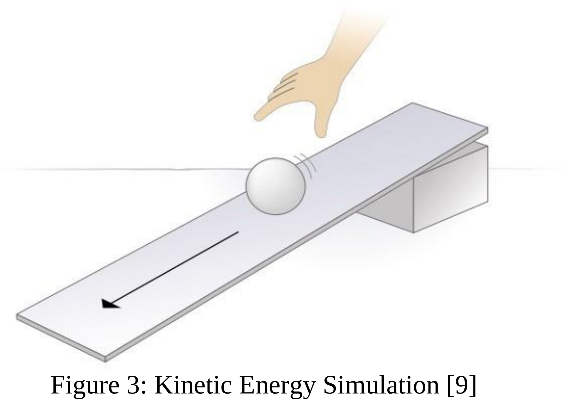

Figure 3: Kinetic Energy Simulation [9]

2. METODOLOGY

The design of this system is made to provide an overview of the work that will be carried out for the construction of Energy Box Simulator. In general, the box will be designed first, followed by mechanical work. After that, the electrical circuit will be carried out by adding a timer and mass measurement system. Software is then developed based on the measurement results obtained.

The software implementation of this final project follows the flow of the block diagram. In the initial conditions when the trainer kit is used, first the object mass data is taken in grams using a load cell, then the time when the object moves is calculated using a timer in milliseconds. Time measurement is done by pressing the green push button to start and stop the time and the red push button to restart the time measurement. The mass and timer input data will be processed by the Arduino microcontroller and displayed on the LCD. Calculations are carried out using a calculator program in the form of a 4x4 keypad. The calculated data will be displayed on the LCD again.

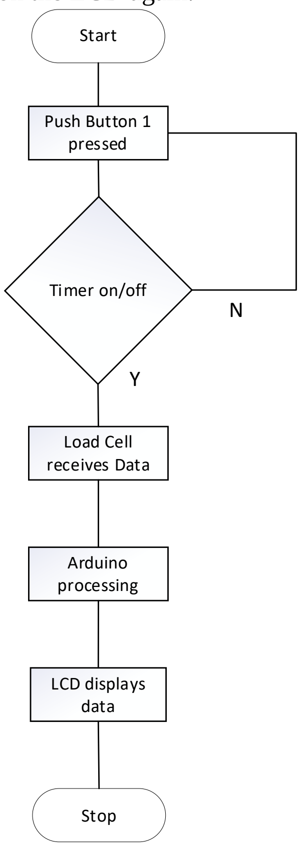

Figure 4: Software Implementation Block Diagram

3. RESULT AND ANALYSIS

The designed Energy Box Simulator has been able to take measurements to determine the value of the amount of energy obtained. Measurements were carried out four times at different distances. The energy measured is in the form of kinetic energy with mass and distance as input, while potential energy has mass and height as input. The measurement results can be seen in the following table.

Table 1: Measurement Result

Length of track (cm)	Height (cm)	Mass (gr)	$(V)^2$ (mm/ms)	Energy (mJ)	
				E_k	E_P
10	10	5	$(3)^2$	22.5	500
20	20	5	$(7)^2$	122.5	1000
30	30	5	$(4)^2$	40	1500
40	40	5	$(6)^2$	90	2000

Based on the data in the table, it is found that at a path length of 10 cm with a mass of 5 grams, the kinetic energy produced is 22.5 mJ while the potential energy is 500 mJ. Kinetic energy is obtained after an object experiences motion, while potential energy is obtained when an object is at rest. With the addition of the path, the kinetic energy changes in line with the change in the squared velocity that occurs. The potential energy will increase towards the maximum number. This is because potential energy depends only on two variables, namely mass and height. The greater the height, the greater the potential energy produced. While the gravitational force can be said to be a constant if all experiments are carried out on the surface of the earth. This corresponds to the following equation:

$$E_k = \frac{1}{2} \times m \times v^2 \text{ [4]}$$

Whereas:

m = mass (kg)

v = velocity (m/s)

E_k = kinetic energy (J)

And

$$E_p = m \times g \times h \text{ [6]}$$

Whereas:

m = mass (kg)

g = gravity (m/s^2)

h = ketinggian (m)

E_p = potential energy (J)

The results of measurements using the trainer kit have a time difference for each track length or distance traversed. The resulting value proves that the greater the distance traversed, the greater the time required.

Figure 5: Mass Display on Energy Box Simulator

The figure above shows the mass measurements that are stored in data processing for further use as a source for calculating kinetic and potential energy. There is a load cell-based mass scale that is used to measure the mass of the object to be used. Various variants for mass simulation can be used with a maximum mass of 100 grams.

This data will then be compared with the energy calculator that has been made. This energy calculator uses a visual basic program with a simple screen display related to the variables of mass, altitude and speed whose numbers can be changed as needed. The following figure shows the results of the energy calculator calculations for the quantities of kinetic energy and potential energy.

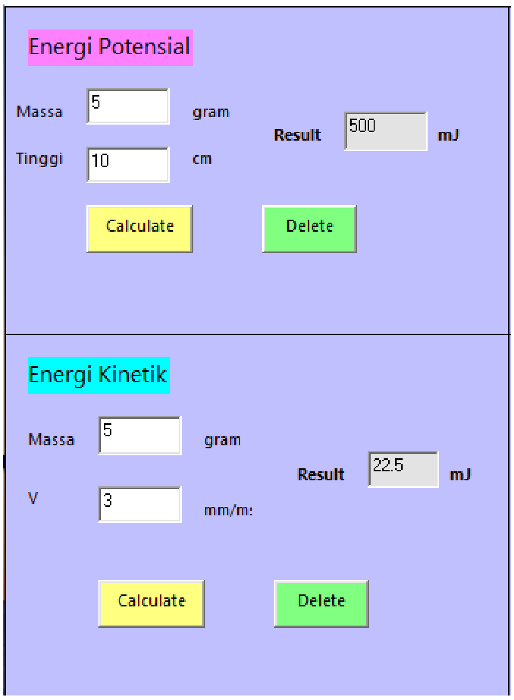

Figure 6: Energy Calculator Display

Based on the results of the measurements and calculations above, it is known that at a length of track of 10 cm with an object mass of 5 grams and a speed of 3 mm/m, the results obtained are 500 mJ of potential energy and 22.5 mJ of kinetic energy.

4. CONCLUSIONS

This energy box simulator is expected to be one of the interactive and educative learning modes, especially in the field of thermodynamics in relation to kinetic energy and potential energy.

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