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Analysis of The Properties and Quick of Wave Creation on A Simple Ripple Tank Using Frequency Sensors

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Abstracts

Practicum is one of the effective methods for students in learning Natural Sciences (IPA), especially Physics subjects. The purpose of the practicum is to make it easier for students to understand concepts and help explain physics concepts that cannot be observed directly by the eye. The 2013 curriculum demands physics learning to integrate various concepts, so that students have a thorough understanding of a phenomenon. This study aims to determine the effect of spring strain and tube length on the speed of propagation and wavelength. Ripple tank experiments that currently exist, only calculate variations in fluid height, gap size, vibrator frequency, and so on. The method used in this research is experimental, for the components used consist of a set of simple ripple tank tools and frequency sensors. The analytical technique used in this research is descriptive quantitative. The highest and lowest frequencies produced from the small tube were 20 Hz (l=70 cm; = 0.04 cm) and 1 Hz (l=5 cm; = 4.30 cm). The highest and lowest frequencies obtained from the large tube were 52 Hz (l=70 cm; = 0.05 cm) and 3 Hz (l=5 cm; = 4.95 cm). The highest and lowest wave propagation velocities produced by the small tube are 4.3 cm/s (l=5 cm) and 0.89 cm/s (l=70 cm). The highest and lowest wave propagation velocities produced by the large tube are 9.87 cm/s (l=5 cm) and 2.69 (l=70 cm). Based on the results of the study, it was shown that the greater the spring strain, the higher the frequency, the wavelength and the speed of wave propagation.

Keywords: frequency, wave, ripple tank, practicum, physics

1. Introduction

Learning Natural Sciences (IPA), especially Physics subjects, is not enough to be taught orally. This is because the characteristics of the Physics subject require students to produce a product, not only that for the learning process of students it is also the main goal of the learning that has been carried out. In this case, the product includes factual, conceptual, and procedural knowledge. Then for Physics subjects, students are required to have good scientific performance. Thus, we need a learning where students can practice directly. The practicum method is seen as an opportunity for students to be directly involved in the learning process [1][5][6].

Physics learning tends to only emphasize the formulation of mathematical formulas, and it makes students feel lazy and not active in these learning activities. In addition, students assume that physics lessons are full of formulas and they must memorize them in order to be able to follow the learning process well. Physics learning based on the 2013 curriculum must produce an integrated or integrated learning process. It is intended that students have a thorough understanding of a phenomenon.

To make it easier for students to understand the concept as a whole, a practicum must be carried out. When students do practicum, of course they need a tool. The tool must be easy to use, made of safe materials, and capable of producing accurate data. This study aims to create a practical tool that is able to integrate physics concepts, especially to explain the concept of waves. The concept of waves is one of the most important unifying threads and crosses the entire structure of science [2].

A wave is a condition in which disturbance or disturbance occurs at the equilibrium point. This disturbance can travel and propagate from the intermediate medium so that vibrations occur. In addition, a wave is a disturbance that propagates in a medium, where the medium is a collection of interacting objects. In the study of wave propagation, energy is propagating, while the intermediate substance does not propagate [3].

Based on the energy, waves are divided into two, namely mechanical waves and electromagnetic waves. Mechanical wave is a disturbance that travels through several mediums, one example is water waves. Water waves are one of the most easily observed mechanical waves. The properties of water waves are easy to observe using a ripple tank. In addition, the ripple tank is a tool used to investigate the motion of waves on the surface of the water, and is used to observe the pattern of water waves.

The pattern generated from the ripple tank experiment can be seen by placing white paper under it, but in this study the wave pattern on the surface of the water can be observed by recording the practicum in video form. Thus, the crest and bottom of the wave on the surface of the water will be seen in the form of dark and light lines/patterns [4].

The shape of the waves generated by the surface of the water in the form of circles. Starting from a small circle, then the small circle propagates away from the center of the circle and forms wider circles. The distance between two adjacent wavefronts is equal to one wavelength (λ) and the time it takes to travel one wavelength is called one period (T).

In general, the ripple tank experiment only varies the height of the water in the tank and the frequency that comes from the vibrator. We want to know another thing, namely how the wavelength and the speed of wave propagation are if in this study the distance of the spring strain and the length of the tube that acts as the air column are varied.

Based on the above background, the researcher wants to conduct a study by making a ripple tank using simple materials. This study aims to determine the effect of the spring strain distance and the length of the air column on the wavelength and the speed of wave propagation.

2. Experiments Procedure

This research was conducted from May 26, 2019 to June 13, 2019 at the Workshop Laboratory of the Faculty of Mathematics and Natural Sciences (FMIPA) Semarang State University, Central Java. The method used in this study is an experimental method with repeated measurements. This ripple tank experiment uses quantitative and qualitative descriptive techniques. Quantitative descriptive using the equation v = . f to calculate the magnitude of the speed of propagation of water waves. Then to determine the magnitude of the wavelength produced by water waves using the Tracker-5.0.3 application. While the qualitative descriptive technique is used to analyze the wave pattern.

Based on the preliminary study, it is necessary to make a practical tool, especially on wave material using various tools and materials that are affordable, safe, and easy to make. In addition, these tools are made of simple materials found in everyday life. During the manufacturing process, the tools and materials used underwent several changes. After the material is shaped and cut, sanded (smoothed the surface) so that it is not sharp and injures.

The image of the tool that has been successfully made can be seen in Figure 1.

Figure 1. Product of the Ripple Tank Practical Tool

The tool set consists of various components, including: (1) tool frame (made of wood and thin aluminum), (2) support rods (made of wood), (3) paralon, (4) spring/slinki (kids toy).), (5) table tennis ball, (6) air column (made of paralon with a lid from rubber used motorcycle tires), (7) valve (made of wire), (8) plastic straw, (9) pool of water (made of from a plastic case measuring 30 cm x 20 cm), (10) couplers, (11) screwdriver (supplied), (12) light source, and (13) frequency/vibration sensor.

For more details, the components of the tool can be seen in Figure 2.

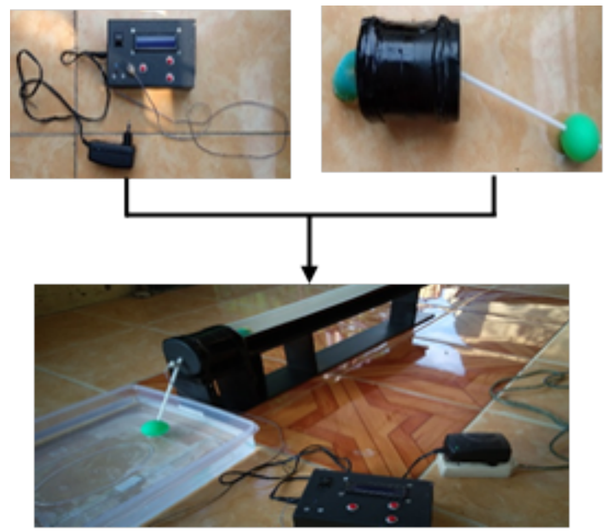

Figure 2. Parts of Practicum Tools

The working principle of the practicum tool is that a plastic container filled with water will cause wave symptoms when vibrated by a slinky with a different length of tube (air column). Then to see the symptoms of the resulting wave, then provide sufficient lighting. When the slinky is pulled with a certain deviation and then released, it can be seen the wave pattern, the number of ripples formed, and the magnitude of the frequency.

In general, practical activities that can

The activities carried out by students include: (1) Students give deviations to the slinky and move the slinky back and forth, then (2) pay attention to the magnitude of the frequency indicated by the frequency/vibrating sensor, and (3) pay attention to the ripples of water in the water pool. In this study, variations were added for practical activities, including students being able to replace the slinky deviation and using two air columns with different lengths. To facilitate practical activities, the teacher must first make a Student Worksheet (LKS).

3. Result and Discussion

Based on the research that has been done, it can be seen that there is an effect of tube length and spring deviation on the wavelength and the speed of wave propagation. This study used three tubes with different lengths. For the results of observations on a small tube that has a tube length of 10 cm, it can be seen in the table below.

Table 1. Effect of Deviation (x) on Wavelength (λ) and Wave Speed (v) in Small Tubes (p = 10 cm)

No.	*x* (cm)	f (Hz)	Number of Water Ripples	*λ* (cm)	*v* (cm/s)
1.	10	2	3	2,10	4,20
2.	20	5	6	0,78	3,92
3.	30	8	8	0,46	3,70
4.	40	11	11	0,27	3,00
5.	50	13	14	0,16	2,04
6.	60	17	16	0,10	1,70
7.	70	20	18	0,04	0,89

Furthermore, the results of observations on a medium tube which has a length of 15 cm can be seen in the table 2.

Table 2. Effect of Deviation (x) on Wavelength (λ) and Wave Speed (v) on Medium Tubes (p = 15 cm)

No.	*x* (cm)	f (Hz)	Number of Water Ripples	*λ* (cm)	*v* (cm/s)
1.	10	3	3	2,41	7,23
2.	20	6	6	0,85	5,12
3.	30	8	8	0,50	4,98
4.	40	10	10	0,31	4,37
5.	50	13	13	0,19	3,39
6.	60	17	17	0,11	2,58
7.	70	21	21	0,05	1,39

Then the results of observations on a large tube that has a length of 20 cm can be seen in the table 3.

Based on the results of observations and data analysis, it can be seen that the larger the deviation (x) of the slinky, the more ripples are produced. This is because when the slinki is pulled with a maximum deviation, the impact of the slinki on the air column cover becomes stronger. When the impact of the slinki on the lid is getting stronger, the vibrations in the tube are getting bigger. This is also followed by the greater the frequency value indicated by the sensor. The vibration sensor used in this study has the advantage that the practicum data is directly stored in the device. This makes it easier for students to make observations. The tube is connected to a slinki, then one of the lids is given a hole to insert a plastic straw that has been connected to a table tennis ball.

Table 3. Effect of Deviation (x) on Wavelength (λ) and Wave Speed (v) on Medium Tubes (p = 20 cm)

No.	*x* (cm)	f (Hz)	Number of Water Ripples	*Λ* (cm)	*v* (cm/s)
1.	10	5	3	1,63	8,15
2.	20	8	6	0,83	6,63
3.	30	12	8	0,50	6,03
4.	40	16	11	0,29	4,57
5.	50	22	14	0,19	4,09
6.	60	30	16	0,12	3,55
7.	70	52	18	0,05	2,69

The plastic straw used in this study acts as a connecting channel to propagate vibrations from the air column, besides that it functions to create ripples on the surface of the water. The number of wave ripples shown by the surface of the water can affect the wavelength of the surface of the water.

The more ripples the wave produces, the smaller the wavelength, because the distance from the center of the wave to the last ripple is divided by the total ripple produced. The purpose of this study was to determine the value of the wave propagation speed (v) influenced by the size of the wavelength and the resulting frequency. To calculate the speed of the wave using the equation:

$$v = \lambda f \quad (1)$$

Explanation of the above equation:
v = speed of wave propagation (cm/s)
λ = wavelength (cm)
f = frequency (Hz)

The effect of tube length and slinky deviation on the speed of water surface waves can be seen in Figure 3. Figure 3 shows the wave propagation speed data influenced by the length of the tube and the distance of the slinky deviation. Wave propagation speed data can be obtained through calculations using the equation below:

$$v = \lambda f \quad (2)$$

The fastest wave propagation comes from a tube that has a length of 20 cm. In addition, it is also influenced by the distance of the slinky deviation, based on the picture above, it can be seen that the speed of propagation is greatest when given a deviation of 10 cm. The longer the tube, the greater the vibrations produced because the air column used to propagate the wave becomes wider. Thus, the speed of wave propagation is strongly influenced by the size of the frequency and wavelength of the resulting wave.

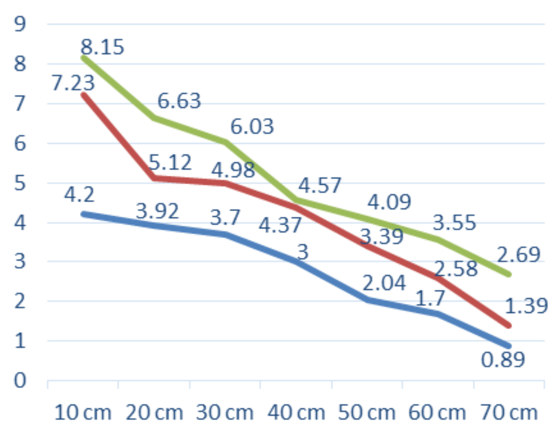

Figure 3. Effect of Slinky Deviation and Tube Length on Wave Velocity

4. Conclusion

Based on the experiments that have been carried out, it can be concluded that the ripple tank practicum tool can be used as a support in the Physics learning process, especially when explaining the concept of waves. This study aims to determine the effect of tube length (air column) and slinky deviation on frequency, wavelength and speed of wave propagation.

In this study, three tubes with different lengths were used. From the experimental results and data analysis on the three tubes with different lengths, it can be concluded that the greater the slinky deviation distance (x), the greater the frequency (f) produced, and the smaller the wave propagation speed (v). This is because when the slinki is pulled to the maximum deviation and released, there will be a collision between the slinki and the tube cap so that the impact force is stronger. As the impact force gets stronger, more vibrations are generated in the tube (air column).

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