

Investigation of the speed of water waves

Introduction

The speed of waves on the surface of water, created when the water is moved out of position, depends only on the depth of the water and the gravitational field strength. To measure the speed of the waves the time they take to travel a certain distance is measured and the following equation is applied.

$$\text{speed} = \frac{\text{distance}}{\text{time}}$$

Apparatus

rectangular apparatus tray with straight sides
stopwatch
large beaker
large measuring cylinder

Diagram of Apparatus



Method

1. Measure the length of the tray and record the result.
2. Add water to the tray to give a depth of 0.5cm and record the volume used.
3. Lift the end of the tray up a few cm and gently replace on the desk.
4. Start the stopwatch when the wave produced hits the end of the tray.
5. Record how long it takes the waves to travel 3 lengths of the tray.
6. Repeat steps 3-5 four more times.
7. Repeat steps 2-6 increasing the depth each time by 0.5cm up to 3.0cm.

Analysis

1. Calculate the mean speed of the waves using:

$$\text{mean speed} = \frac{\text{distance}}{\text{mean time}}$$

2. Plot a graph of depth against speed.

Risk Assessment

Hazard	Risk	Control measure
Wet floors are slippery	If water splashes on the floor during the experiment people may slip and be injured	Do not overfill the trays. Place tray down gently when producing waves. Mop up any spillages

Teacher / Technician notes

Although straight sided trays are preferable, Gratnell trays work quite well in this experiment.

Pupils will need to be given the value for the volume of water required to fill the tray to a depth of 0.5 cm – in cm^3 this is numerically equal to half the surface area.

The data should give a smooth curve as the speed is proportional to $\sqrt{\text{depth}}$.

Students should plot a graph of depth against mean speed and be encouraged to plot a smooth curve of best fit (if they have measured carefully!) and to examine the quantitative relationship between the variables.

Students should be told that they need to use the length of tray $\times 3$ in calculating the mean speed for each depth.

It is interesting to investigate the factor by which the depth must change to double the speed of the waves this could provide good extension opportunities for the more able.

Students should design their own table, but a suggested table format is shown below.

		Time taken for waves to travel three lengths of the tray (s)						Mean speed (cm/s)
Depth of water (cm)	Length of tray (cm)	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Mean	

Working scientifically skills covered

2. Experimental skills and strategies

Carry out experiments appropriately having due regard to the correct manipulation of apparatus, the accuracy of measurements and health and safety considerations.

Make and record observations and measurements using a range of apparatus and methods.

Evaluate methods and suggest possible improvements and further investigations.

3. Analysis and Evaluation

Present observations and other data using appropriate methods.

Translate data from one form to another.

Carry out and representing mathematical analysis.