

## Determination of the acceleration of a moving object

### Introduction

An object moving down an inclined ramp will accelerate. The velocity of the object as it leaves the ramp can be used to calculate the mean acceleration of the object using the formula:

$$\text{acceleration} = \frac{\text{change in velocity}}{\text{time}}$$

Since the object starts from rest at the top of the ramp this means that:

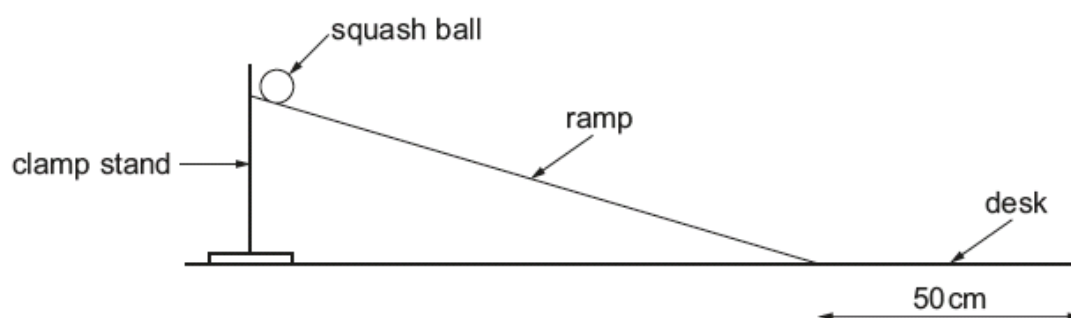
$$\text{acceleration} = \frac{\text{velocity at bottom of ramp}}{\text{time to reach bottom of ramp}}$$

The velocity at the bottom of the ramp can be calculated from the time the object takes to travel a certain distance along the bench.

### Apparatus

ramp  
squash ball  
metre ruler  $\pm 1$  mm  
stopwatch  
clamp stand, clamp and boss

### Diagram of Apparatus



## Method

1. Set the height of the ramp to 10cm above the desk.
2. Measure a distance of 50cm from the end of the ramp and mark this point.
3. Release the squash ball from the top of the ramp starting the stopwatch as you do.
4. When the squash ball reaches the bottom of the ramp press the lap button on the stopwatch.
5. Stop the stopwatch when the squash ball reaches the 50cm mark.
6. Record the time taken for the ball to travel down the ramp (lap time) and the total time.
7. Repeat steps 1-6 increasing the height in 5cm intervals each time up to 25cm.
8. Repeat the experiment twice more.

## Analysis

1. Calculate the time taken for the ball to travel 50cm along the bench;  
this is the total time – the lap time.
2. Calculate the velocity at the bottom of the ramp using the formula

$$\text{velocity} = \frac{0.5}{\text{mean time taken to travel 50 cm along the bench}}$$

3. Calculate the acceleration using the formula

$$\text{acceleration} = \frac{\text{velocity at bottom of ramp}}{\text{mean time to reach bottom of ramp}}$$

4. Plot a graph of ramp height against acceleration.

## Risk Assessment

Hazard	Risk	Control measure
There is <b>no significant risk</b> in carrying out this experiment.		

## Teacher / Technician notes

Self-adhesive trunking which is widely available in DIY stores can be stuck onto metre rules to make effective ramps which work well with squash balls.

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

Height (cm)	Time to reach bottom of ramp (s)			Mean time to reach bottom of ramp (s)	Time to travel 50 cm along bench (s)			Mean time to travel 50 cm (s)	Velocity (m/s)	Acceleration ( $\text{m/s}^2$ )
	Trial 1	Trial 2	Trial 3		Trial 1	Trial 2	Trial 3			

This investigation is good for developing evaluation skills and students could be encouraged to judge the repeatability and reproducibility of their results. Data could be compared against doing the same experiment with data loggers and sources of error considered.

## Working scientifically skills covered

### 1. Development of scientific thinking

Use a variety of models such as representational, spatial, descriptive, computational and mathematical to solve problems, make predictions and to develop scientific explanations and understanding of familiar and unfamiliar facts.

### 2. Experimental skills and strategies

Evaluate methods and suggest possible improvements and further investigations.

### 3. Analysis and Evaluation

Carry out and representing mathematical analysis.

Represent distributions of results and make estimations of uncertainty.

Evaluate data in terms of accuracy, precision, repeatability and reproducibility and identifying potential sources of random and systematic error.

### 4. Scientific vocabulary, quantities, units, symbols and nomenclature

Recognise the importance of scientific quantities and understand how they are determined.