

## Investigation of the terminal speed of a falling object

### Introduction

When objects fall through the air, they accelerate until they reach a maximum speed - known as the terminal speed. You are going to investigate how the terminal speed of a falling object depends upon its mass. You are going to use paper cake cases. These are quite light and have a relatively large area. They reach their terminal speed after falling a very short distance.

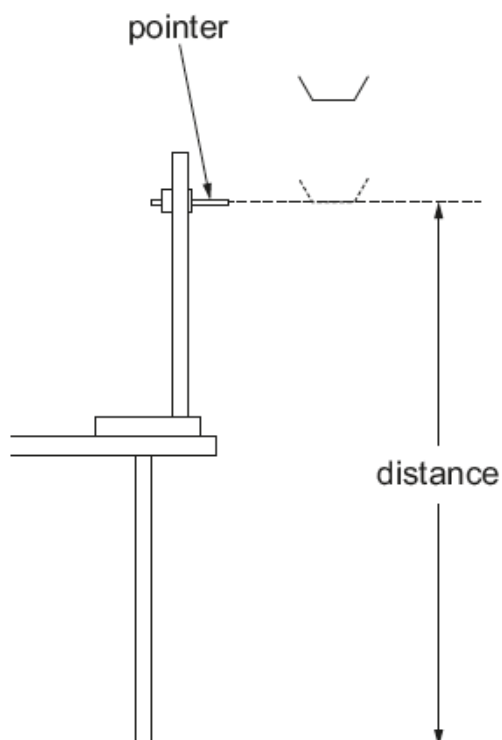
### Apparatus

6 × paper cake cases  
stopwatch  
2 × metre rulers  $\pm 1$  mm  
clamp stand, boss and clamp  
pointer (e.g. pencil)

#### Access to:

electronic balance  $\pm 0.1$  g

### Diagram of Apparatus



## Method

1. Set up a pointer in the clamp stand and adjust its height to a convenient level above the floor, e.g. 150 cm. Record this height accurately.
2. Take a single cake case and record its mass.
3. Drop the cake case from a height well above (e.g. about 20 cm) the pointer and record the time it takes to fall from the level of the pointer to the floor.
4. Repeat step 3 another four times.
5. Repeat steps 2 to 4 with 2, 3, 4, 5 and 6 cake cases in a stack.

## Analysis

1. Calculate the terminal speed of each stack of cake cases using:

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

2. Plot the number of cake cases against the terminal speed.

## Risk Assessment

Hazard	Risk	Control measure
Pointer at eye level is sharp	Could walk into pointer and injure eye	Wear safety goggles
	Stand could topple and pointer could injure eye	Clamp the stand to the bench

## Teacher / Technician notes

Cake cases are readily available from local shops / supermarkets.

Students will need to use the equation:

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

to calculate the terminal speed of each stack of cake cases. We assume that the cake cases have reached their terminal speed by the time they pass the pointer.

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

Number of cake cases	Mass of cake cases (g)	Time taken for paper cake case to fall (s)						Terminal speed (m/s)
		Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Mean	
1								
2								
3								
4								
5								
6								

Students could discuss the repeatability and reproducibility of the results obtained, evaluate the method used and suggest improvements. They could also discuss whether the cake cases have actually reached their terminal speed as they pass the pointer and how this may be investigated.

### 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.

#### 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.