Investigation: Falling Objects

Introduction

Falling is something that we observe all the time in everyday life, and have been learning about during our earlier classes.

We know that a force called gravity is involved. We know from experience that when things fall down they get faster and faster. But is this the case all the time?

What happens when you drop your mobile phone? What differences do you observe if you drop it onto the table, or the floor, or over a railing – which of these will cause the most damage?

In this experiment, we will analyse the motion of objects falling straight down in a straight line. This is called vertical motion in one dimension, also given the fancy name of ‘rectilinear motion’. We will be looking at their final speed when they hit the ground. We will also look at something called the average speed. Things to think about: how heavy the objects are, their masses and the height they are dropped from. Do you expect heavy objects to accelerate faster than light objects? Why/why not?

1. Questioning and predicting

So let us think about the aim of this investigation.

1. As something falls, how does its displacement changes with time?
2. What is the final velocity of the falling object?
3. How does the velocity change as the object travels?
4. What is the value of acceleration due to gravity close to Earth’s surface?

HYPOTHESIS

As an object falls, its velocity will (increase/decrease).

Heavy objects will accelerate (faster/slower/at the same rate) as light objects.

2. Planning investigation

This investigation has been planned for you.

We will use two objects with different masses. These masses could be any shape, but if you want to ‘model’ your mobile phone, you might create an object about the same shape, size and mass of your mobile phone. Or some groups might try standard laboratory masses of 100g and 200g.

1. Place a meter ruler against the wall. This will give you a scale for measuring the displacement of the object.
2. Hold the first object at a height of 1 m above the floor.
3. Use a smartphone or digital camera to record a video of the object falling from the time when it is released.
4. The frame rate (in frames per second) of the recording is a fixed value which you can get from the camera settings. Find this value. Convert his to the time per frame. (For example, if the video is recorded at 30 fps, each frame lasts for 1/30th of a second.)
5. Look at the video frame by frame. What is the positon of your object against the ruler for each frame?
6. Record the object’s position at each frame in the table on the next page. If there are a large number of frames, you may wish to take data every five or ten frames.

3. Conducting investigation

For each object, you should take a video that clearly shows the ball falling and the scale of the ruler until the object hits the floor. Choose suitable time intervals and record its downward displacement.

Light object

|  |  |  |
| --- | --- | --- |
| Time (s) | Displacement (m) | Any other comments on motion of object and taking the video |
|  |  |  |

Heavy object

|  |  |
| --- | --- |
| Time (s) | Displacement (m) |
|  |  |

**Did you make any changes to the method? Did you have design problems to solve? Did you have some ‘smart’ ways of doing the investigation?**

4. Processing and analysing

Plot the displacement of the ball versus time on graph paper or using a spreadsheet program.

What shape are the displacement-time graphs?

To calculate the average speed of the objects, we simply need to know the distance travelled and the amount of time it took. In the case of this experiment, the distance is always one metre.

Finding the instantaneous speed requires us to know how quickly the distance is changing at a certain time. We can do this by looking at how the distance changes between the time intervals in part 3. We can also interpolate between our data points by reading from our graph.

Plot velocity-time graphs from the data you have derived.

What shape do you expect the velocity-time plots to be?

When the data form a linear trend, we can draw a line of best fit to find the overall trend. Remember that acceleration is the change in speed versus the change in time.

Hence calculate the acceleration of the object from your velocity-time graph.

Describe the acceleration of the objects.

5. Problem solving

This is the section where we think about the results and what they mean.

When we drop an object, the force of gravity acts on it. The force on an object due to gravity is known as its weight, and can be calculated from the formula:

W = mg

The mass of the object is m and the local acceleration due to gravity is g, which is a constant.

The weight of an object depends on its mass. Does its acceleration depend on its mass?

\_\_\_\_\_\_\_\_\_\_\_\_

What other factors might influence the acceleration of an object?

\_\_\_\_\_\_\_\_\_\_\_\_

For large, light objects, the effects of wind resistance may become noticeable. What type of objects will be **least** affected by wind resistance?

An object with a constant acceleration will increase in speed by the same amount each second. Hence the velocity will increase linearly with time. (The displacement will increase with the square of the time.)

6. Conclusions

As something falls, its velocity increases \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

The final velocity depends on \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

Objects with larger masses have \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ acceleration compared to objects with smaller masses.