

Name: _____

Physics Practical Work: Data Analysis for an Accelerating Trolley

Adapted from OUP A-Level Sciences support materials

Introduction

In this activity you will be given some data and be asked to make appropriate calculations and plot a suitable graph in order to identify relationships and patterns. You will also be asked to carry out an error analysis of the data, enabling you to identify systematic and random errors.

Learning objectives

After completing the worksheet you should be able to:

- tabulate and process measurement data, using equations
- plot and use appropriate graphs to establish relationships between variables
- use data from graphs, including the gradient and the intercept, and to relate these values to a linear equation
- make reasonable estimates of errors using the range of the data
- identify systematic errors.

Background information

A trolley is accelerated along a ramp. A falling mass provides the accelerating force as shown in Figure 1.

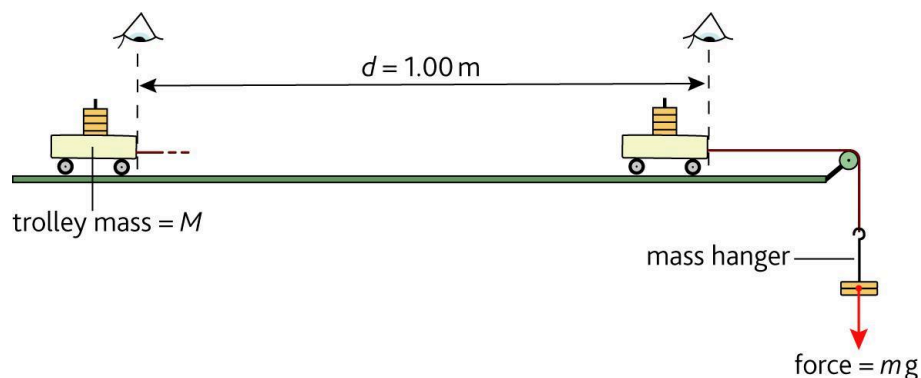


Figure 1 *Experimental set-up*

The time taken, t , for the trolley to travel a distance of 1.00 m from rest was measured three times for different values of the falling mass. The results are shown in Table 1.

Table 1

Falling mass $m / 10^{-3} \text{ kg}$	Time 1 / s	Time 2 / s	Time 3 / s
100	1.6	1.8	1.7
200	1.2	1.4	1.1
300	1.1	1.0	1.0
400	1.0	0.8	0.9
500	0.7	0.7	0.9

Task

The equation $(M + m) a = m g - F_0$ describes the relationship between the falling mass, m , and the acceleration of the trolley.

M is the mass of the trolley (1.00 kg).

m is the falling mass.

a is the acceleration of the trolley which can be calculated using

$$a = \frac{2d}{t^2}$$

$m g$ is the accelerating force.

F_0 is the frictional force opposing the motion of the trolley. It can be assumed for the purposes of this activity that the frictional force, F_0 , is constant.

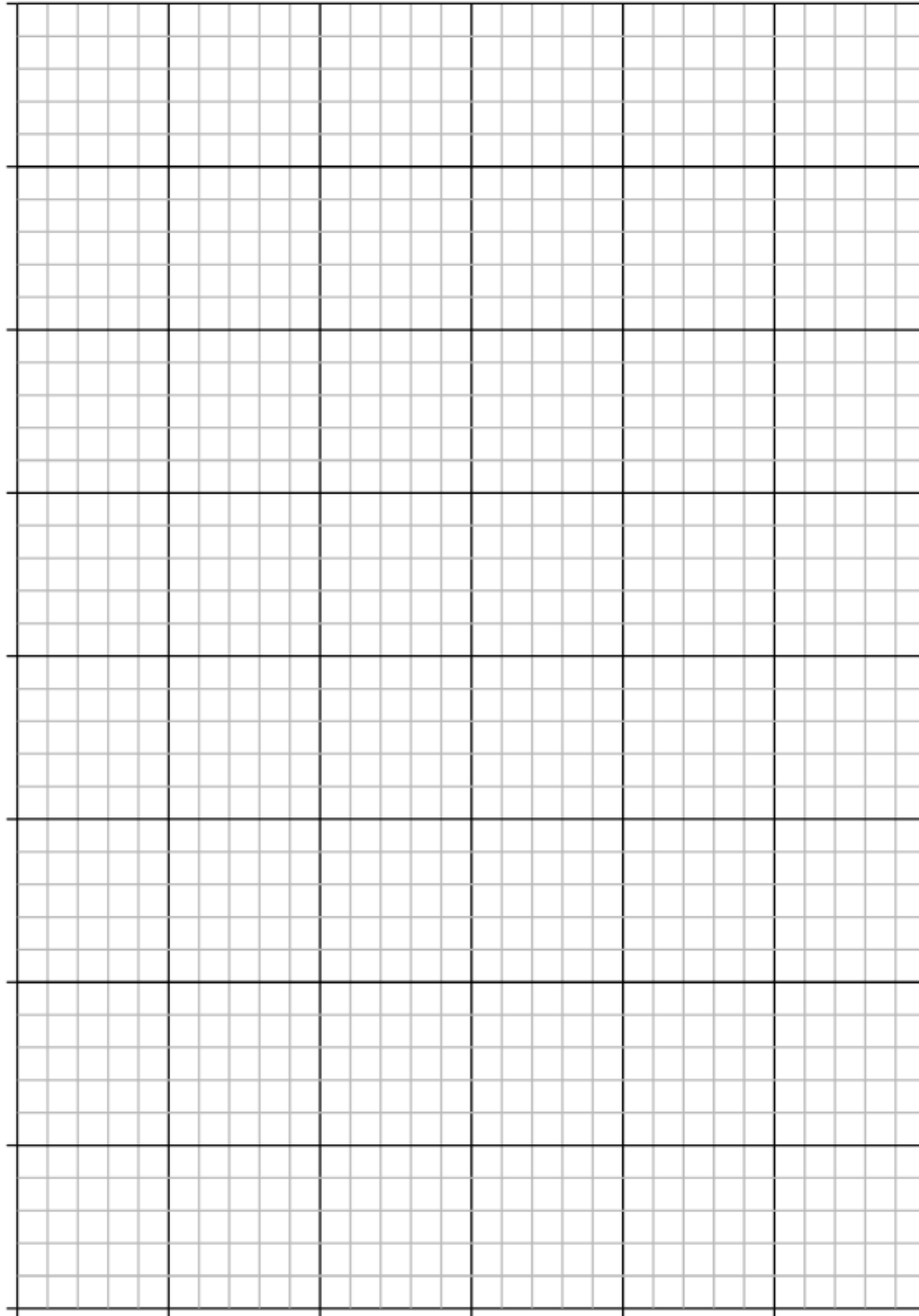
1 Using the experimental data, complete the table below and plot a graph of $(M + m)a$ (on the y -axis) against m (on the x -axis)

(4 marks)

$m / 10^{-3} \text{ kg}$	average t / s	a / ms^{-2}	$(M + m) a / \text{kg ms}^{-2}$
100			
200			
300			
400			
500			

2 From your graph measure the gradient and the intercept, and hence state values for the acceleration due to gravity and the frictional force.

(2 marks)



3 Using the range of values for t when $m = 100$ g, estimate a percentage uncertainty in the measurements of t when $m = 100$ g.

(4 marks)

4 A student observes a fellow classmate carrying out a similar experiment. Below is a list of some errors that the student observes their classmate making.

Identify whether each of the errors is a random error or a systematic error, and comment on the effect each error might have on the results.

a) The student did not observe the trolley at eye level at either end. She stood in the middle and took measurements, rather than moving along the side of the ramp as the trolley moved and observing the trolley at right angles.

(3 marks)

b) The student measured from the back of the trolley at the starting position and stopped the stopwatch as soon as the front of the trolley passed the finishing point.

(2 marks)

c) The student did not include the mass of the mass hanger when adding up the masses used to accelerate the trolley.

(2 marks)

d) The ramp was not horizontal but sloped downwards slightly to right.

(2 marks)