Experiment 3
Friction

SAFETY

Make sure that you have read the **General Safety Notes**, in the Introductory section of this manual, before you begin.

Do not, **under any circumstances,** attempt to repair or dismantle any of the equipment. If you suspect equipment to be faulty, turn it off at the power point and talk to your demonstrator.

ADDITIONAL HAZARDS

In today's experiment, you will be moving a cart along the top ledge of your laboratory bench. It is important to move the cart **carefully** to prevent if falling over the edge.

Be aware that a loose rolling object is a potential hazard: it can damage equipment, or it can be stepped on or cause a person to trip.

Outline of Experiment

Friction is a force that we are constantly experiencing whether we are in motion or stationary. Today you will be investigating the properties of frictional forces between materials.

Before you begin you practical please read through the following information on friction and the different types of friction you may explore in the experiment: http://hyperphysics.phy-astr.gsu.edu/hbase/frict2.html

You will be using the datalogging system to determine the motion of a cart under a couple of different experiments, one of which you and your partner will design yourselves. You may find some ideas at the end of this lab or think of something on your own.

Appendix C will help you with the PASCO Capstone software so please familiarise yourself with the toolbars and functions available. You may wish to watch this video to find out how to use the software: https://youtu.be/5uuEQfQ8hnU

✓***Pre-lab exercises:*** *Read the laboratory exercise, complete the questions below, then submit the pre-lab task online (LMS or http://fyl.ph.unimelb.edu.au/prelabs) for this experiment. [Your marks for the pre-lab will be based on the answers to the online questions, which are taken from the pre-lab work in the manual]*

Learning Goals

- To use and interpret data logged from the PASCO carts.
- To critically argue the validity of all data and its meaning.
- To compare and relate the data from multiple graphs.
- To design and perform a secondary experiment which explores friction in a new context.
- To observe and quantify the amount of friction experienced when the cart is in motion.

✓ **Pre-lab question 1**

What is the difference between Static Friction and Kinetic Friction? Use a graph and/or equations if needed.

✓ **Pre-lab question 2**

How does Rolling Friction relate to static and/or kinetic friction?

✓ **Pre-lab question 3**

What is the general relationship between Friction and the mass of the object?

Section A: Friction with changing mass

In this experiment you will be using a pulley system to drop a mass connected to a PASCO Smart Cart which will move across a felt surface. You will be recording the position, velocity and acceleration of the cart with time as the cart moves along the felt surface with different amounts of mass. From the acceleration and a force diagram you will be able to determine the rolling friction coefficient of the cart.

This laboratory uses carts that carry a number of sensors to measure the position and force between the cart and an object in front of it. The information is then sent to the computer via Bluetooth. The carts do go into sleep mode when not being used. If your cart turns off, just press the On button again. The direction of the carts is shown on the top of the cart.

Note: Please be careful with the carts and ensure they do not fall off the benches.

Capturing motion using PASCO Capstone

- ✓ Start the PASCO Capstone software package.
- ✓ Select the first experiment type displaying a graph and table.
- ✓ From the **Hardware Setup** tab, select your cart number (check *your* cart number) and select which sensors you will need. See Appendix C for details on the menus and how to start a run.

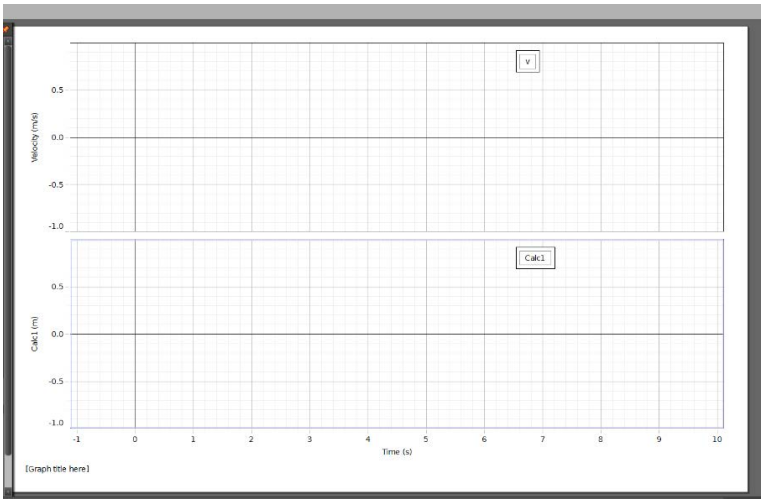


Figure 2: An empty graph

- ✓ In the graph page, click on the axes labels to choose which data you will plot. Add more graphs by selecting the Add new Graph button on the toolbar at the top of the graph (See Appendix C for information on Capstone Toolbars).

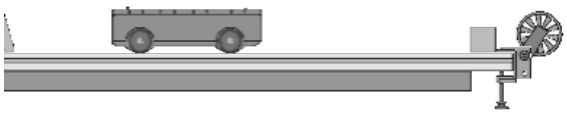
- ✓ Click the 'Record' button at the bottom of the screen to begin capturing data. You will be able to see the data appear on your graph.
- ✓ Move your cart backwards and forwards for a few seconds then click 'Stop'
- ✓ A position-time graph should now be displayed, showing the position of your cart as a function of time. Your cart will always start at a position of zero.

If no data is displayed, consult your demonstrator

- ✓ Repeat a few times until you are confident capturing data and have a feel for the movement of the cart.

Experimental Set-up

You will have the following set up in front of you;



- ✓ Before your first trial, predict the shape of the position/time, velocity/time and acceleration/time graphs. Discuss any assumptions you have made.
- ✓ Start with no extra mass on the cart.
- ✓ Start the cart in the middle of the track and once recording, gently push the cart backwards and then allow the cart to move towards the pulley before stopping the cart and stopping the recording.
- ✓ Comment on how well your predictions matched the data collected. What were the differences.
- ✓ Repeat this by adding one additional 250 g mass at a time. You may need to borrow some from another group.

Data

✓ Discuss the graphs you have recorded and how they relate to each other. What do you notice about the acceleration graph? Is this what you expected?

✓ Draw up a force diagram and determine the friction.

Section B: Experimental Design

Experiment

Design a *simple* experiment with the equipment provided that will explore another way friction plays a role with an object moving along a surface. There are some ideas below, or you may like to come up with your own.

- ✓ Repeat the above but with a varying incline.
- ✓ Turn the cart over to look at static or kinetic friction and determine their coefficient.
- ✓ Explore different surfaces.
- ✓ Change the mass over the pulley.

Make sure you record the method you employed for your experiment in your logbook, you may even plan this out the week before. Think about how you will define your variables, what assumptions you make and how you will ensure to minimise or eliminate uncertainties in your experiment. Please discuss your experiment with your demonstrator prior to collecting data.