Experiment 5
Angular Momentum

SAFETY

Make sure that you have read the **General Safety Notes**, in the Introductory section of this book, 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

Rotating and falling objects constitute a potential hazard. Keep your hands away from the spokes of the rotating wheel.

Make sure that the retort stand is securely clamped to the bench.

Outline of Experiment

Whether you round a corner in a car or go on a carnival ride that spins, you will feel a force pushing you out of the circle you are travelling in. In this experiment you will be investigating this apparent force known as 'centrifugal force'. To do this you will be measuring the minimum velocity of a mass freely connected to a wheel. You can use the gravitational acceleration as 9.8 ms^{-2}. In section A, you will use the addition of vector quantities to measure the orbital velocity of a mass from a string. In section B you will find the minimal velocity of a mass to achieve "lift off" when in a circular path.

✓***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 compare and contrast methods and models to portray the best and most accurate representation of the data collected.
- To critically analyse and identify sources of error and uncertainty
- To explore the relationship between various aspects of circular motion through Newton's 2nd Law of Motion.

Introduction

Before beginning this lab please open up: http://hyperphysics.phy-astr.gsu.edu/hbase/corf.html#cent and read the sections on centrifugal force and centripetal force.

✓ **Pre-lab question 1**

Briefly explain the difference between centrifugal and centripetal forces. (hint: draw a diagram if needed)

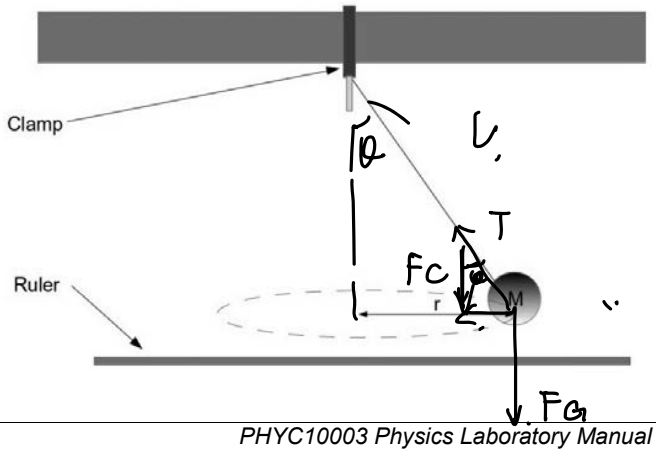
✓ **Pre-lab question 2**

Derive a formula to express the velocity of an orbiting object with gravity perpendicular to the orbital surface such as in Section A. (hint: draw a force-body diagram)

Section A: Measuring the Centrifugal Force Using Gravity

Experimental Set-up

In this experiment you will be measuring the velocity of an orbiting mass using two perpendicular "forces" in the form of gravity and centripetal. Don't take too long on this section.



✓ Set up a mass, M, on a string connected to a clamp hanging from the desk. Align the centre of a ruler

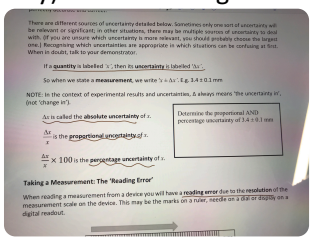
along the ground with the mass hanging vertically.

✓ Swing the mass around the in a circular fashion so that the mass orbits at constant r.

✓ Measure the value of r and determine the angle of the string.

✓ Using the equation, you derived previously, calculate the velocity of the orbiting mass.

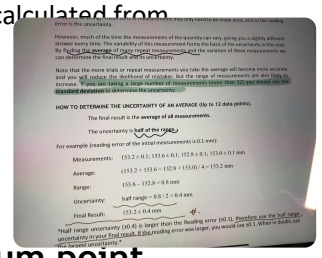
✓ Using a stop watch measure the period (and therefore velocity) of the orbiting mass and compare the value to that measured previously.



✓ Repeat this for various radii (4-5 should be enough)

Data

✓ Plot your results for radius versus velocity for both velocities in excel. (Velocity 1 calculated from the equation, Velocity 2 from the period.)



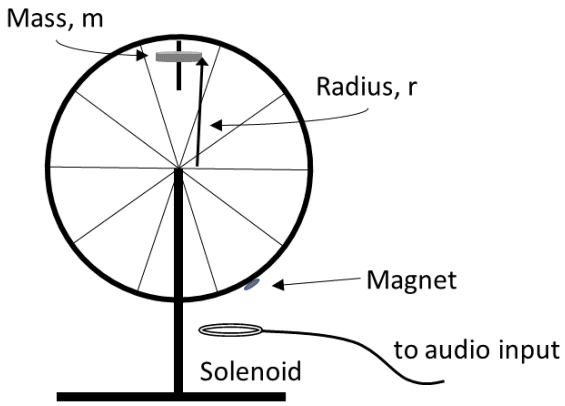
Analysis

✓ Comment on your results and consider any sources of error in your experiment.

Section B: Measuring the Centrifugal and Gravity equilibrium point

Experiment

The setup will be on your bench. Rotating the wheel will make the mass, m at radius, r sit with its centre of mass as far out as possible due to the centrifugal force.



✓ Open the program 'Scope' and make sure your coil is connected to the microphone input. A magnet on the wheel will induce a current in the coil.

✓ Rotate the wheel and measure the frequency using the oscilloscope. At a certain velocity the centrifugal force will equal the gravitational force, at this point the mass will start to drop as gravity is now the dominant force. You will be able to see (and hear) when your mass is reaching this point. The moment you start to hear the mass drop, stop the run and measure the period of the wheel.

✓ Determine the critical velocity at the equilibrium point between the gravitational force and centrifugal force.

✓ If you have time, adjust the position of the mass on your wheel to vary your radius. How would you expect you period to change with radius?

Analysis

✓ Derive a formula for the period such that the mass' centrifugal force equals its weight force.

✓ Use this formula to find yet another experimental value for the acceleration due to gravity, g. If you used multiple radii, you will be able to use a graphical method to determine g.

Conclusion

✓ Summarise your findings and how well they compare with the theory.