NILE UNIVERSITY OF NIGERIA

Faculty of Natural and Applied Sciences

Department of Computer Science

Physics Unit

PHY 107: Experimental Physics I (Mechanics)

Experiment 4: CENTRIFUGAL FORCE

Student Name:

Student ID:

Department:

Date of the Experiment:

Group:

Purpose: To determine centrifugal force as a function as function of the angular velocity for different masses.

Equipment needed:

- Centrifugal force apparatus (1)
- Car for measuring and experiments (1)
- Holding pin (1)
- Laboratory motor, 220 V AC (1)
- Gearing 30/1, for Laboratory motor, 220 V AC (1)
- Bearing unit (1)
- Driving belt (1)
- Support rod w. hole, 100 mm (1)
- Barrel base (1)
- Power supply 5 V DC/2.4 A (1)
- Spring balance holder (1)
- Support rod -PASS-, square, l= 250 mm (1)
- Boss head (2)
- Bench clamp (2)
- Fish line, l= 100 m (1)
- Spring balance, transparent, 2 N (1)
- Slotted weight, 10 g, black (4)
- Slotted weight, 50 g, black (2)
- Light barrier with Counter (1)

Theoretical background:

In the reference system which rotates with the angular velocity, the equation of motion of a mass point (mass m, position vector $\vec{r}$) reads:

$$\omega = 2\pi/T \tag{1}$$

$$m\frac{dv}{dt} = -\nabla U + mr \times \frac{d\omega}{dt} + 2mv \times \omega + m\omega \times (r \times \omega) - F \tag{2}$$

The external force field U (gravitational field) is compensated by the track, the angular velocity ω is constant, and the car is at rest in the rotating reference system (U= 0; v = const. = 0; ω = const.).

From (2), there only remain the centrifugal force and the compensating force F, which is read on a spring balance:

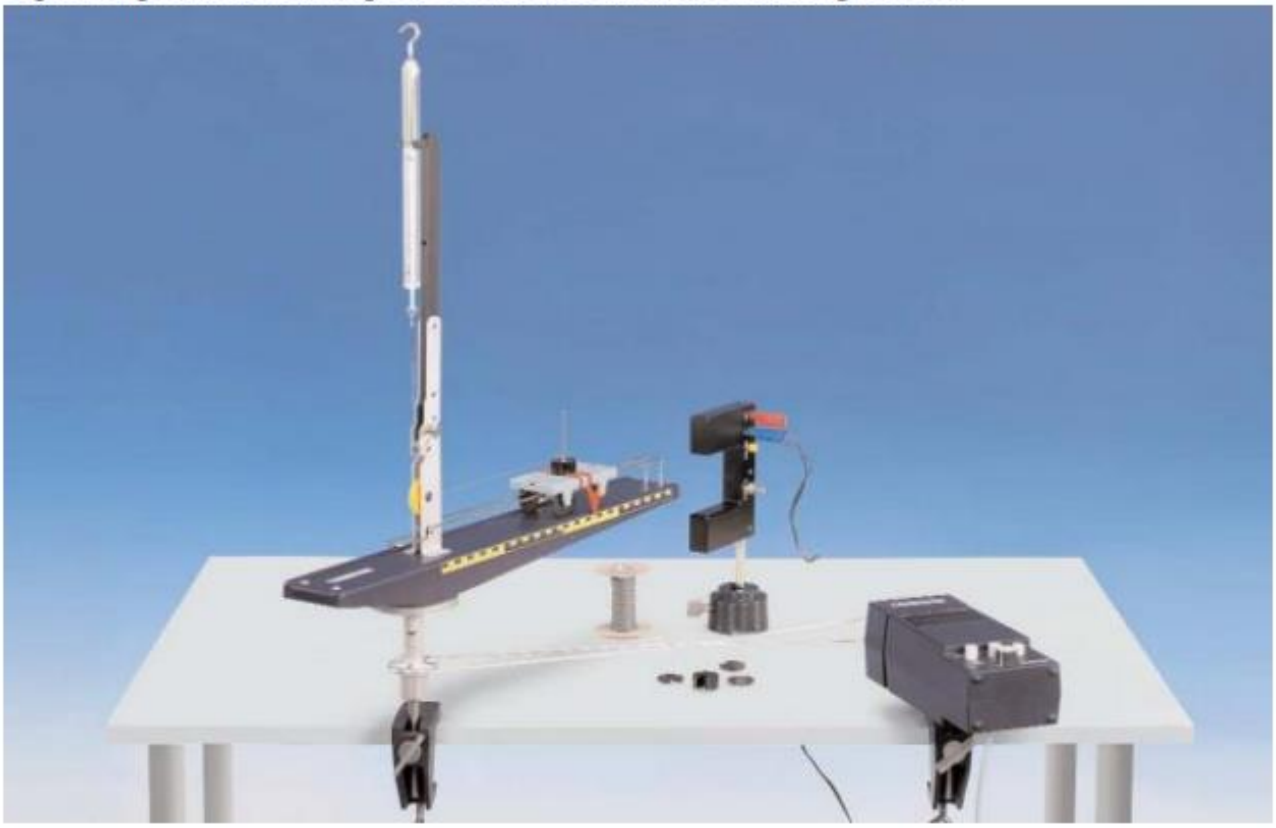
$$F = m\omega \times (r \times \omega)$$

Since $r \perp \omega$, it follows that

$$|F| = m\omega^2 \cdot r \tag{3}$$

Set-up and procedure:

Fig. 1: Experimental set-up for the measurement of centrifugal force.



The experimental set-up is as shown in Fig. 1. The red pointer supplied should be fitted on the central rod of the car. It indicates the distance (axis of rotation to centre of gravity of car). At the outermost end of the centrifugal apparatus, a mask is glued between the guide rods and serves for the start-stop triggering of the light barrier. When measuring the duration of a complete cycle switch to mode. Ensure that the car does not touch the light barrier at maximum radius. With increasing angular velocity, the radius increases, since the force measurement involves movement. This should be compensated by moving the spring balance up and downwards.

Measuring the centrifugal force as function of the angular velocity for different masses

Set up the centrifugal force apparatus for the body of varying mass m with the radius r =17 cm.

Record the period T for a complete revolution from the light barrier. To increase

accuracy measure and record the period three time and get the average.

Read and record the centrifugal force using the spring balance

Determine the deflection of the pointer, ω and ω^2

Repeat the procedure for $m = 20, 40, 60, 80, 100, 120$ and $140g$ respectively.

Use Hooke’s law to determine the deflection of the pointer:

$$F_s = -kx$$

where, k = 20 N/m is the spring constant.

Data sheet: (40 Points)

Mass (g)	Period T_1(sec)	Period T_2(sec)	Period T_{AV}(sec)	Centrifugal force (N)	Deflection of the pointer (cm)	Angular velocity ω (rad/s)	ω^2 (rad^2/s^2)
140							
120							
100							
80							
60							
40							
20							

Instructor Signature and Date____

Graph(s) (20 Points)

- Plot a graph of the centrifugal force against the mass.
- Plot a graph of centrifugal force against the square of the angular velocity.

Title: **Scale:**

Title: **Scale:**

Precautions:

State the precautions taken to ensure accurate result.

Question

1. Evaluate the slope of your graphs
2. Find the y-intercept of your Line of best fit
3. From your graph find the value of F when $m = 50g$
4. Using your understanding of centrifugal force from the experiment, explain the role of centrifugal force in a circular motion in relation to centripetal force.