Flywheel

- **What is the aim of the experiment?**

  To determine the mass of flywheel.

- **What is flywheel?**

  A flywheel is a mechanical device which stores energy in the form of rotational momentum. Torque can be applied to a flywheel to cause it to spin, increasing its rotational momentum.

- **What is the principle used?**

  The angular acceleration of a flywheel depends on the couple acting on it. By applying a known couple the angular acceleration and hence moment of inertia is calculated.

- **Define angular displacement.**

  When a rigid body rotates about an axis, the angle through which any point on the body rotates is angular displacement.
  Denoted by θ.
  Units: deg, rad, revolutions.

  If a point P on the rigid body makes an angle θ at an instant of time t then $\theta(t)$ is the angular displacement at time t. See figure (1).

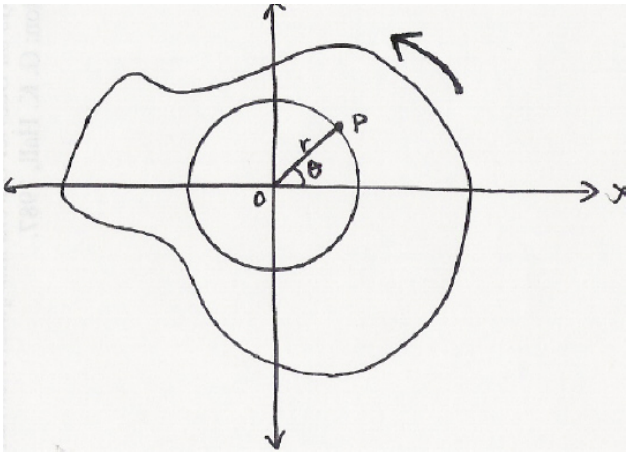

Figure 1: Angular displacement of point P.

- **Define angular velocity.**

  The rate of change of angular displacement with time is called angular velocity.
  Denoted by ω.
  SI unit: rad s^{-1}.

  If $\theta(t_1)$ is the angular displacement of a point at time t_1 and $\theta(t_2)$ is the angular displacement of the same point at time t_2, then angular velocity is

$$\omega = \frac{\theta(t_2) - \theta(t_1)}{t_2 - t_1}.$$

  When $t_2 - t_1 = \Delta t$ is infinitesimally small, we have instantaneous angular velocity

$$\omega = \frac{\mathrm{d}\theta(t)}{\mathrm{d}t}.$$

- **Define angular acceleration.**

  The rate of change of angular velocity with time is called angular acceleration.
  Denoted by α.
  SI unit: rad s^{-2}.

  If $\omega(t_1)$ is the angular velocity of a point at time t_1 and $\omega(t_2)$ is the angular velocity of the same point at time t_2, then angular acceleration is

  $$\alpha = \frac{\omega(t_2) - \omega(t_1)}{t_2 - t_1}.$$

  When $t_2 - t_1 = \Delta t$ is infinitesimally small, we have instantaneous angular acceleration

  $$\alpha = \frac{\mathrm{d}\omega(t)}{\mathrm{d}t} = \frac{\mathrm{d}^2\theta(t)}{\mathrm{d}t^2}.$$

- **Define moment of inertia.**

  Quantitatively, it is the product of mass of a particle and square of its distance from the axis of rotation, summed over all particles of the rigid body.
  If m_i is the mass of i^{th} particle and r_i is the distance of it from the axis of rotation then moment of inertia of the body about that axis is

  $$I = \sum_i m_i r_i^2.$$

  SI unit: kgm^2.

- **What is the moment of inertia of a circular disc about an axis perpendicular to its plane?**

  $$I = \frac{MR^2}{2},$$

  where M is its mass,
  R is its radius.

- **Does moment of inertia change when the axis of rotation is changed?**

  If mass distribution of the rigid body changes when axis of rotation is changed, then moment of inertia changes.

- **Does moment of inertia depend on mass of the rigid body?**

  Yes.

- **How is angular acceleration caused to the flywheel?**

  To cause angular acceleration, we need to apply torque. Torque is applied by attaching load to the flywheel via a thread. As the load is pulled downwards due to gravity, the flywheel accelerates.

- **How is the angular acceleration of flywheel calculated?**

  $$\alpha = \frac{4\pi n}{t^2},$$

  where n is the number of rotations completed by the flywheel,
  t is the time taken to complete n rotations.