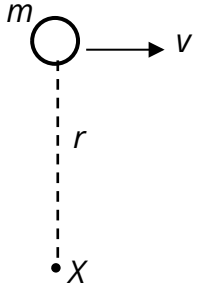
PENANG SANGAM HIGH SCHOOL
WEEK 18 LESSON NOTES
PHYSICS – Y13

STRAND: MECHANICS
SUB-STRAND: ROTATIONAL DYNAMICS
CONTENT LEARNING OUTCOME: To understand the concept of Angular Momentum and solve problems.

Angular Momentum (L)

The diagram shows a point mass m moving at a speed v at a perpendicular distance r from point X.



The angular momentum, L, of the mass about the axis through X is the product of the linear momentum, p, and the perpendicular distance, r.

ie. $L = pr$ but $p = mv$

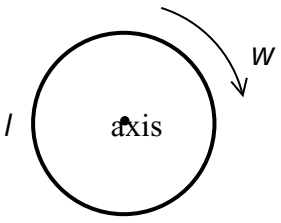
$$L = mvr$$

L = angular momentum (kgm^2/s) m = mass (kg) v = velocity (m/s) r = radius (m)

Eg 1
Calculate the angular momentum of a 2 kg mass moving in a circular path of radius 0.3 m at a constant speed of 5 m/s.

Eg 2
A point mass of 2 kg swings in a horizontal circle of radius 1 m at the end of a string of negligible mass. The mass completes 200 revolutions per minute. Find its angular momentum.

Angular Momentum of an object rotating about its own axis

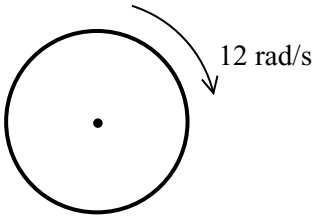


The angular momentum, L , of the object about its axis is given by:

$$L = Iw$$

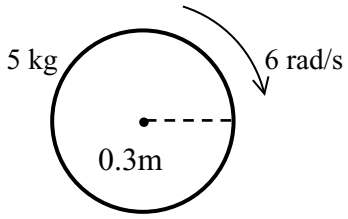
L = angular momentum (kgm^2/s) I = inertia (kgm^2/s) w = angular velocity (rad/

Eg 1
The diagram below shows a wheel of inertia 2.8 kgm^2 rotating about its axis at 12 rad/s.



Calculate the angular momentum of the wheel.

Eg 2
Calculate the angular momentum of a solid cylindrical wheel of mass 5 kg and radius 0.3 m rotating at 6 rad/s.



$I = mr^2$ ($\frac{1}{2}$)

Eg 3
Calculate the angular momentum of a solid sphere of mass 8 kg and radius 0.4 m rotating about its axis at 5 rev/s.

For the sphere, $I = mr^2$ ($\frac{2}{5}$) .

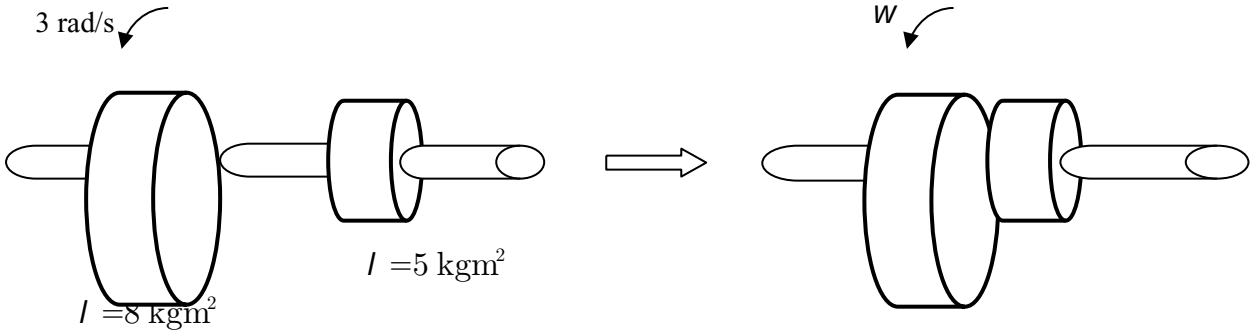
Conservation of Angular Momentum
The total angular momentum of a system is always conserved if no resultant torque is acting on the system.

If L_i = initial angular momentu and
L_f = final angular momentu

then $L_i = L_f$ -

Eg 1

A disc of moment of inertia 8 kgm^2 rotating at 3 rad/s is brought into contact with a stationary disc of inertia 5 kgm^2. The two discs stick together and rotate with a common velocity, ω.



Calculate the common angular velocity, ω.

Eg 2

A ballet dancer of inertia 50 kgm^2 rotating at 5 rad/s, folds her arms, decreasing her inertia to 36 kgm^2.

a) Calculate the final angular velocity of the dancer.

b) Calculate the increase in kinetic energy of the dancer.

Linear and equivalent Rotational quantities and formulas

Linear	Rotational
s	θ $(s = r\theta)$
v	ω $(v = r\omega)$
a	α $(a = r\alpha)$
F	τ
m	I
p	L
$v = u + at$	$\omega = \omega_0 + \alpha t$
$s = ut + \frac{1}{2}at^2$	$\theta = \omega_0 t + \frac{1}{2}\alpha t^2$
$v^2 = u^2 + 2as$	$\omega^2 = \omega_0^2 + 2\alpha\theta$
$F = ma$	$\tau = I\alpha$
$p = mv$	$L = I\omega$
$K = \frac{1}{2}mv^2$	$K = \frac{1}{2}I\omega^2$
$W = Fs$	$W = \tau\theta$
$F = \frac{\Delta p}{t}$	$\tau = \frac{\Delta L}{t}$