

# Angular Momentum : A practical approach

## ROTATION

- Introduce by a contextual approach, e.g. the bicycle, a roller, wheels etc.
- Revise Year 12 Circular Motion.
- Develop equations for  $\theta$ ,  $\omega$  and  $\alpha$ .
- Develop equations involving  $\theta$ ,  $\omega$  and  $\alpha$ . (equiv to kinematic equations)
- Define Torque( $\tau$ ), establish Torque  $\propto$  Angular accln ( $\alpha$ ) using a flywheel and smart pulley (or ticker-timer) or video analysis.

## RELATIONSHIP BETWEEN MOMENT OF INERTIA AND ANGULAR MOMENTUM

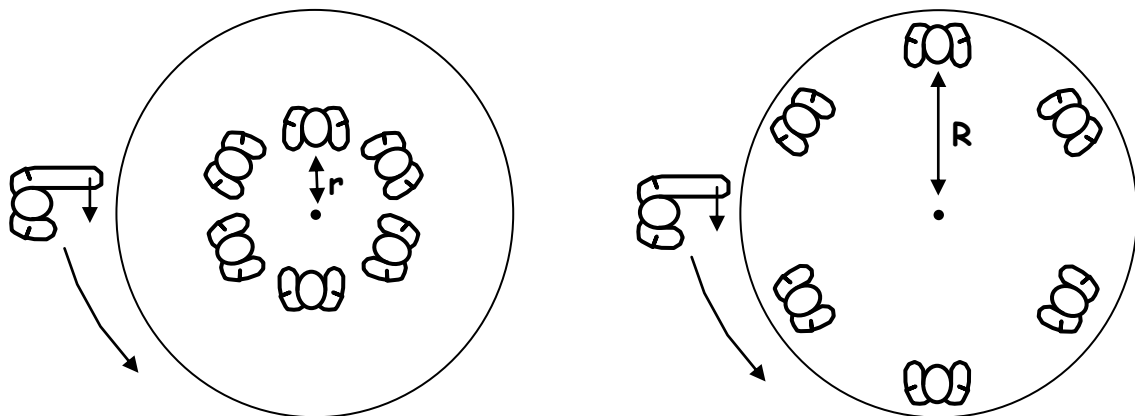
### PRACTICAL EXERCISE - The Merry-Go-Round

- What you need :
- one free-spinning merry-go-round
  - at least six students
  - a portable white board (or newsprint)
  - a digital still with MPEG facility or video camera for later analysis

### AIMS OF THE PRACTICAL

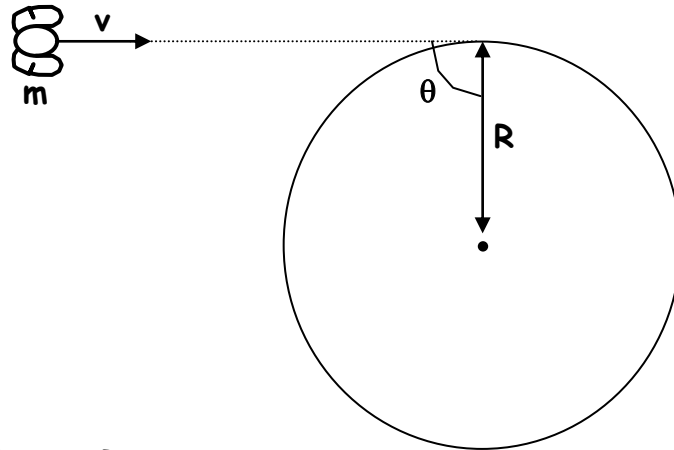
1. To show Linear Momentum can be converted to Rotational Momentum

#### Setting Part A



- Get each student to rotate the merry-go-round with two different mass distributions, this is to give them the 'feel' of the relationship between applied torque and angular acceleration.

### Part B

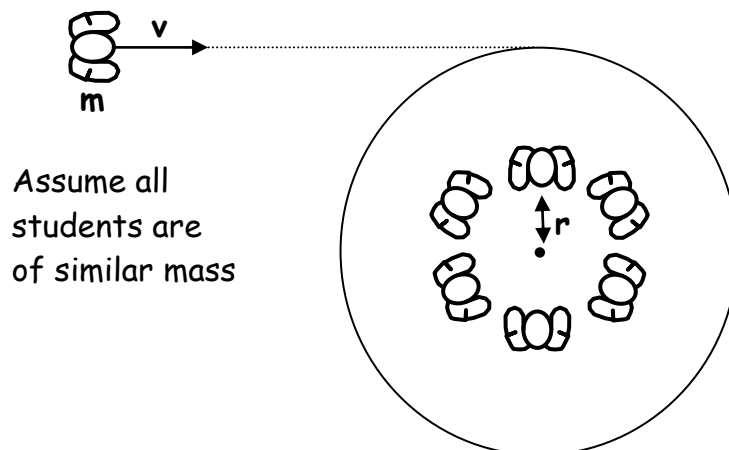


- Define  $p = mv$  and  $L = mvR$ .
- Try different speeds ( $v$ ) / same student / at  $90^\circ$  to  $R$
- Try different students ( $m$ ) / same speed / at  $90^\circ$  to  $R$
- Try angles up to  $90^\circ$  / same speed / same student
- Try different  $R$  values / same student / same speed
- Show
 

$L \propto$	angle to $R$	}	$L = mvR$ if $\theta = 90^\circ$
$\propto$	Mass ( $m$ )		
$\propto$	incoming momentum ( $p$ )		
$\propto$	radius ( $r$ )		

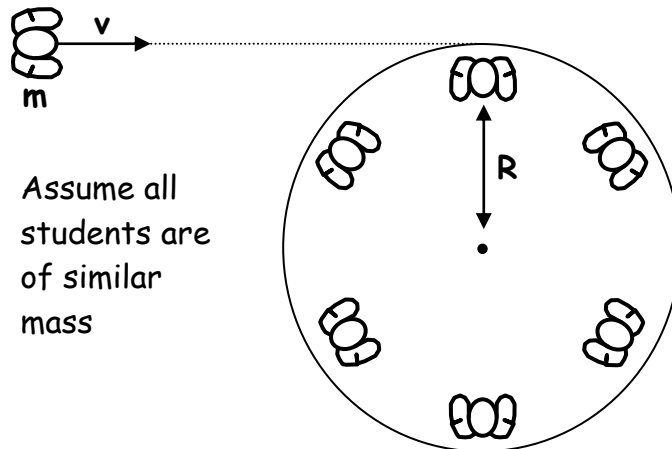
## 2. To investigate Mass Distribution and Angular Momentum

### Setting Part A



- Place six students near the centre / same incoming momentum / observe resulting angular speed of the merry-go-round.

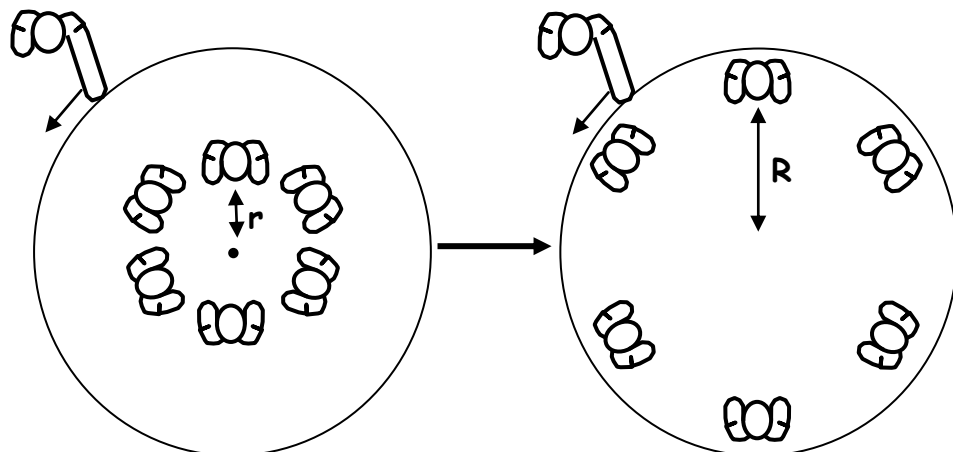
**Part B**



- Move the six students to the outside / same incoming momentum / observe resulting angular speed of the merry-go-round.
- Show angular velocity reduces even though the initial angular momentum was the same in each case - discuss 'idea' conservation of angular momentum.
- Define a new quantity :  $I$  - Angular momentum  
 $\propto$  mass  
 $\propto$  mass distribution

**3. To investigate Conservation of Angular Momentum**

**Setting**



- Start with six students at radius  $r$  / rotate to a high  $\omega$  / instruct students to move to radius  $R$  at the same time / observe  $\omega$ .

- Try to reverse moving students from radius  $R$  to  $r$  (make sure you start this exercise with a LOW  $\omega$  as the resulting increase in speed is spectacular)
- Show as  $R$  increases then  $\omega$  reduces and vice versa i.e.  $L_{\text{before}} = L_{\text{after}}$

### Follow-up in class :

1. Relate results from the Torque  $\propto$  angular acceleration experiment to the idea of rotational inertia (i.e. slope of the graph of  $\tau \propto \alpha$ )
2. Show a video of an ice skater doing a pirouette or a karate expert doing a kick turn manoeuvre.
3. Use rotating stool and masses to revise conservation of angular momentum. (see picture below)
4. Use a rotating stool and spinning bike wheel to do the same, i.e. orientation changes of the bike wheel.
5. Construct an efficient spinning top.

