Rotational motion

Physics 211
Syracuse University, Physics 211 Spring 2017
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Announcements

- Next homework is due tomorrow
- HW8 posted today or tomorrow morning, due next Tuesday

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- HW8 posted today or tomorrow morning, due next Tuesday
- Information about alternate group exam sent out today/tomorrow
- Alternate date/time for Exam 3: **Wednesday, 7:30 PM**
- Possible weekend/Monday review: TBA

Homework questions?

Sample question: an Atwood machine

(On the document camera)

Sample question: a pinball machine

(Also on the document camera!)

Angular momentum

Translational motion

- Moving objects have momentum
- $\vec{p} = m\vec{v}$
- Momentum conserved if there are no external forces

Rotational motion

- Spinning objects have angular momentum L
- $L = I\omega$
- Angular momentum conserved if no external torques

$\rightarrow L = I\omega =$ constant; analogue to conservation of momentum

Conservation of angular momentum

We saw that the conservation of momentum was valuable mostly in two sorts of situations:

- Collisions: two objects strike each other
- Explosions: one object separates into two

There is a third common case for conservation of angular momentum:

- Collisions: a child runs and jumps on a merry-go-round
- Explosions: throwing a ball off-center
- A spinning object changes its moment of inertia

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This last happens because moment of inertia depends on *how the mass is distributed*, not just how much there is!

Conservation of angular momentum

These problems are approached in exactly the same way as conservation of *linear* momentum problems: write down expressions for L_i and L_f and set them equal (if there are no external torques).

$$L = I\omega$$

$$\sum L_i = \sum L_f$$

Conservation of angular momentum

If I kept the mass of the Earth the same, but enlarged it so that it had twice the diameter, how long would a day be?

(Remember, the total angular momentum, $L = I\omega$, stays the same)

A: 6 hours

B: 12 hours

C: 24 hours

D: 48 hours

E: 96 hours

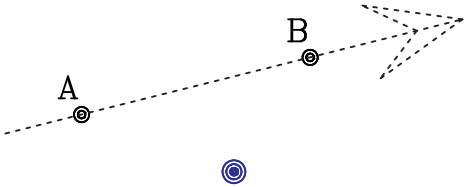
Angular momentum of a single object

A single object moving in a straight line also has angular momentum.

$$L = mv_{\perp}r = mvr_{\perp}$$

If we are to trust this relation, then the angular momentum of an object moving with constant $\vec{v}$ should be constant!

Is the angular momentum the same at points A and B?



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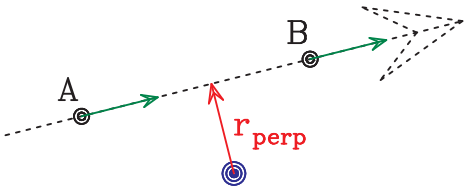
Is the angular momentum the same at points A and B?

Yes: $r_{\perp}$ (and v) are the same at both points.



Angular momentum demonstrations

Can a spinning person change their moment of inertia?

Angular momentum demonstrations

Can a spinning person change their moment of inertia?

Can a spinning person exchange angular momentum with a spinning object?