Checklist for Today

• Things due Monday
  - Chapters 12 & 13 in WebCT

• Things that are due Tuesday
  - Read Chapters 14-16

• Things that were due yesterday
  - Chapter 14 problems
  - Read Lab hand out on webpage

• Things due next Monday
  - Chapter 14 in WebCT

• Next Tuesday
  - Exam 3, Chapters 10-13
  - Mini-practice exam and bonus points available
The Schedule

This week (4/7)
- Mon: Chapter 12 & 13 material due in WebCT
- Tues: Reading: Chap 14-16
- Wed: Recitation on Chap 14, Lab
- Today: Chap 15, Part 1

Next Week (4/14)
- Monday: Chapter 14 due in WebCT
- Tues: Exam 3 (Chaps 10-13)
- Wed: Recitation on Chap 15, Lab
- Thurs: Lecture on Chap 15, Part 2

Week after that (4/21)
- Monday: Chapter 15 & 16 due in WebCT
- Tues: Reading for Chapter 18
- Tues: Lecture on Chapter 18
- Wed: Recitation on Chapter 18, Lab
- Thurs: Last lecture, Chapter 18

Week after that (4/28)
- No lectures or recitations

Week after that (5/5)
- Final: Monday May 5th, 1PM-3PM in this room
Overview

- Chapters 12-16 are about Rotational Motion
- While we’ll do Exam 3 on Chapters 10-13, we’ll do the lectures on 12-16 in six combined lectures
- Give extra time after the lectures to Study for the exam
- The book does the math, I’ll focus on the understanding and making the issues more intuitive
Rotational Motion

Chapters 12 through 16 in six combined lectures

• This is the 5th of the 6 lectures
• Concentrate on the relationship between linear and angular variables

Today: Finish up topics
Next time: Hard problems
Angular Quantities

- Position $\rightarrow$ Angle $\theta$
- Velocity $\rightarrow$ Angular Velocity $\omega$
- Acceleration $\rightarrow$ Angular Acceleration $\alpha$

Moving forward:
- Force $\rightarrow$ Torque $\tau$
- Mass
- Momentum
- Energy
Analogue of Mass

The analogue of Mass is called **Moment of Inertia**

Example: A ball of mass $m$ moving in a circle of radius $R$ around a point has a moment of inertia

$$F=ma \Rightarrow \tau=I\alpha$$
Calculate Moment of Inertia

Calculate the moment of inertia for a ball of mass \( m \) relative to the center of the circle \( R \).
Moment of Inertia

- To find the mass of an object, just add up all the little pieces of mass

- To find the moment of inertia around a point, just add up all the little moments

\[ I = \sum mr^2 \quad \text{or} \quad I = \int r^2 dm \]
Torque and Moment of Inertia

- **Force vs. Torque**
  \[ F = ma \Rightarrow \tau = I \alpha \]

- **Mass vs. Moment of Inertia**
  \[ m \Rightarrow I = \sum mr^2 \quad \text{or} \quad I = \int r^2 \, dm \]
Pulley and Bucket

A heavy pulley, with radius $R$, and known moment of inertia $I$ starts at rest. We attach it to a bucket with mass $m$. The friction torque is $\tau_{\text{fric}}$.

Find the angular acceleration $\alpha$. 
Angular Quantities

- Position $\rightarrow$ Angle $\theta$
- Velocity $\rightarrow$ Angular Velocity $\omega$
- Acceleration $\rightarrow$ Angular Acceleration $\alpha$
- Force $\rightarrow$ Torque $\tau$
- Mass $\rightarrow$ Moment of Inertia $I$

Today we'll finish:
- Momentum
- Energy
Momentum

Momentum vs. Angular Momentum:

\[ \vec{p} = m \vec{v} \rightarrow \vec{L} = \vec{I} \vec{\omega} \]

Newton's Laws:

\[ \vec{F} = \frac{d\vec{p}}{dt} \rightarrow \vec{\tau} = \frac{d\vec{L}}{dt} \]
Angular Momentum

First way to define the Angular Momentum $\mathbf{L}$:

$$\mathbf{\dot{L}} = I \mathbf{\dot{\omega}}$$

$$\sum \mathbf{\dot{\tau}} = I \mathbf{\dot{\alpha}} = I \frac{d\mathbf{\omega}}{dt} = \frac{d(I\mathbf{\omega})}{dt} = \frac{d(\mathbf{\dot{L}})}{dt} = \frac{d\mathbf{\dot{L}}}{dt}$$

$$\sum \mathbf{\dot{\tau}} = I \mathbf{\dot{\alpha}} = \frac{d\mathbf{\dot{L}}}{dt}$$
Angular Momentum Definition

Another definition:

\[ \vec{L} = \vec{r} \times \vec{p} \]
Next Time

Exam 3

• Get caught up on your homework!!!

• Mini-practice exam 3 is now available

Thursday:

- Finish up angular “Stuff”