Physics 218
Lecture 19
Dr. David Toback
Checklist for Today

• Things due Last Thursday:
  - Read Chapters 12 & 13

• Things that were due Monday:
  - Chapter 10 & 11 HW on WebCT

• Things that are due tomorrow for Recitation
  - Chapter 12&13 problems
  - Read Lab hand out on webpage

• Things due next Monday
  - Chapter 12 & 13 in WebCT
The Schedule

This Week (3/31)
• Mon: Chapter 10 & 11 due material in WebCT
• Tues: Second lecture on Chaps 12 & 13
• Wed: Recitation on Chapters 12 & 13, Lab
• Reading for Thurs: Chapters 14-16
• Thurs: Lecture: Chap 14

Next week (4/7)
• Mon: Chapter 12 & 13 material due in WebCT
• Tues: Second Lecture on Chap 14
• Wed: Recitation on Chap 14, Lab
• Thurs Lecture: Chap 15, Part 1

Week after that (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
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
Overview: Rotational Motion

- Take our results from "linear" physics and do the same for "angular" physics
- Analogue of
  - Position
  - Velocity
  - Acceleration
  - Force
  - Mass
  - Momentum
  - Energy

Start here!

Chapters 1-3
Rotation and Translation

Objects can both translate and rotate at the same time. They do both around their center of mass.
Rolling without Slipping

- In reality, car tires both rotate and translate
- They are a good example of something which rolls (translates, moves forward, rotates) without slipping

- Is there friction? What kind?
Derivation

The trick is to pick think of the wheel as sitting still and the ground moving past it with speed $V$.

Velocity of ground (in bike frame) = $-\omega R$

$\rightarrow$ Velocity of bike (in ground frame) = $\omega R$
A bicycle with initial linear velocity \( V_0 \) (at \( t_0=0 \)) decelerates uniformly (without slipping) to rest over a distance \( d \). For a wheel of radius \( R \):

a) What is the angular velocity at \( t_0=0 \)?
b) Total revolutions before it stops?
c) Total angular distance traversed by the wheel?
d) The angular acceleration?
e) The total time until it stops?
Uniform Circular Motion

• Fancy words for moving in a circle with constant \textit{speed}
• We see this around us all the time
  - Moon around the earth
  - Earth around the sun
  - Merry-go-rounds
• Constant $\omega$ and \textit{Constant R}
Uniform Circular Motion - Velocity

- Velocity vector $= |V|$ tangent to the circle

- *Is this ball accelerating?*
  - Yes! why?
Centripetal Acceleration

- "Center Seeking"
- Acceleration vector = $\frac{V^2}{R}$ towards the center
- Acceleration is perpendicular to the velocity

$\vec{a} = \frac{V^2}{R} (-\hat{r})$

$\hat{r}$ direction
Circular Motion: Get the speed!

Speed = distance/time

Distance in 1 revolution divided by the time it takes to go around once

Speed = \( \frac{2\pi r}{T} \)

Note: The time to go around once is known as the Period, or \( T \)
The Trick To Solving Problems

\[ \sum \vec{F} = m \vec{a} \]

\[ = m \left( \frac{v^2}{R} \right) (-\hat{r}) \]
You are a driver on the NASCAR circuit. Your car has mass $m$ and is traveling with a speed $V$ around a curve with Radius $R$. What angle, $\theta$, should the road be banked so that no friction is required?
Skidding on a Curve

A car of mass $m$ rounds a curve on a flat road of radius $R$ at a speed $V$. What coefficient of friction is required so there is no skidding? Kinetic or static friction?
A small ball of mass $m$ is suspended by a cord of length $L$ and revolves in a circle with a radius given by \[ r = L \sin \theta. \]

1. What is the velocity of the ball?
2. Calculate the period of the ball
Exam 2

- Class average for the 2\textsuperscript{nd} exam (including the 5 points) was 65% 
  \hspace{1cm} Average for first two exams is a 69%

- Note for students who didn't take the mini-practice exam:
  \hspace{1cm} Exam 2 Average=51%!!! High score=75
  \hspace{1cm} Two exam average = 60%, almost 20 points below those who took it

- Planning on only a small curve for now, will decide after the 3\textsuperscript{rd} exam
Should you Q-drop?

• Many have asked “should I q-drop?”
  - Talk to your advisor and read my FAQ!
  - Generic advice: Drop if you can’t keep up with the homework by yourself
Next Time

• Wednesday Recitation: Recitation on Chapters 12 & 13
• Wednesday Lab: Elastic Collisions
• Thursday: Lecture on Chapter 14
• Monday: Chapters 12 & 13 due in WebCT