Review: Exam II

Physics 3210
Spring Semester 2019

Details

- When: Thursday March 20th, 2:00-4:00 PM.
- Where: JFB B-1… here!
- Allowed materials:
  - Equation sheet
  - Pen/pencil(s)
  - Hand held calculator. Not the one on your cellphone.
  - Straightedge to make neat diagrams

More Details

- Coverage: Cumulative, but focusing on material since 1st exam, starting with **momentum**.
- Types of problems: Short answer and workout.
- Study recommendations:
  - Homework
  - Old exams
  - Discussion exercises
  - In-class examples
  - *Alles leben ist problemlösen…*

Exam II Topics

- Center-of-Mass
- Momentum Conservation
- Rocket Motion
- Work-Energy Theorem
- Conservative forces, Energy Conservation
- Lagrangian Mechanics
- Coupled Oscillations
- Rotational Dynamics
- ~~Angular Momentum Vector (Chapter 8)~~

Linear Kinematics			Rotational Kinematics
Displacement	x	θ	Angular displacement
Velocity	$v \equiv \dfrac{dx}{dt}$	$\omega \equiv \dfrac{d\theta}{dt}$	Angular velocity
Acceleration	$a \equiv \dfrac{dv}{dt}$	$\alpha \equiv \dfrac{d\omega}{dt}$	Angular acceleration

For constant acceleration

$$x = x_o + v_o t + \frac{1}{2}at^2$$

$$v = v_o + at$$

$$v^2 - v_o^2 = 2a(x - x_o)$$

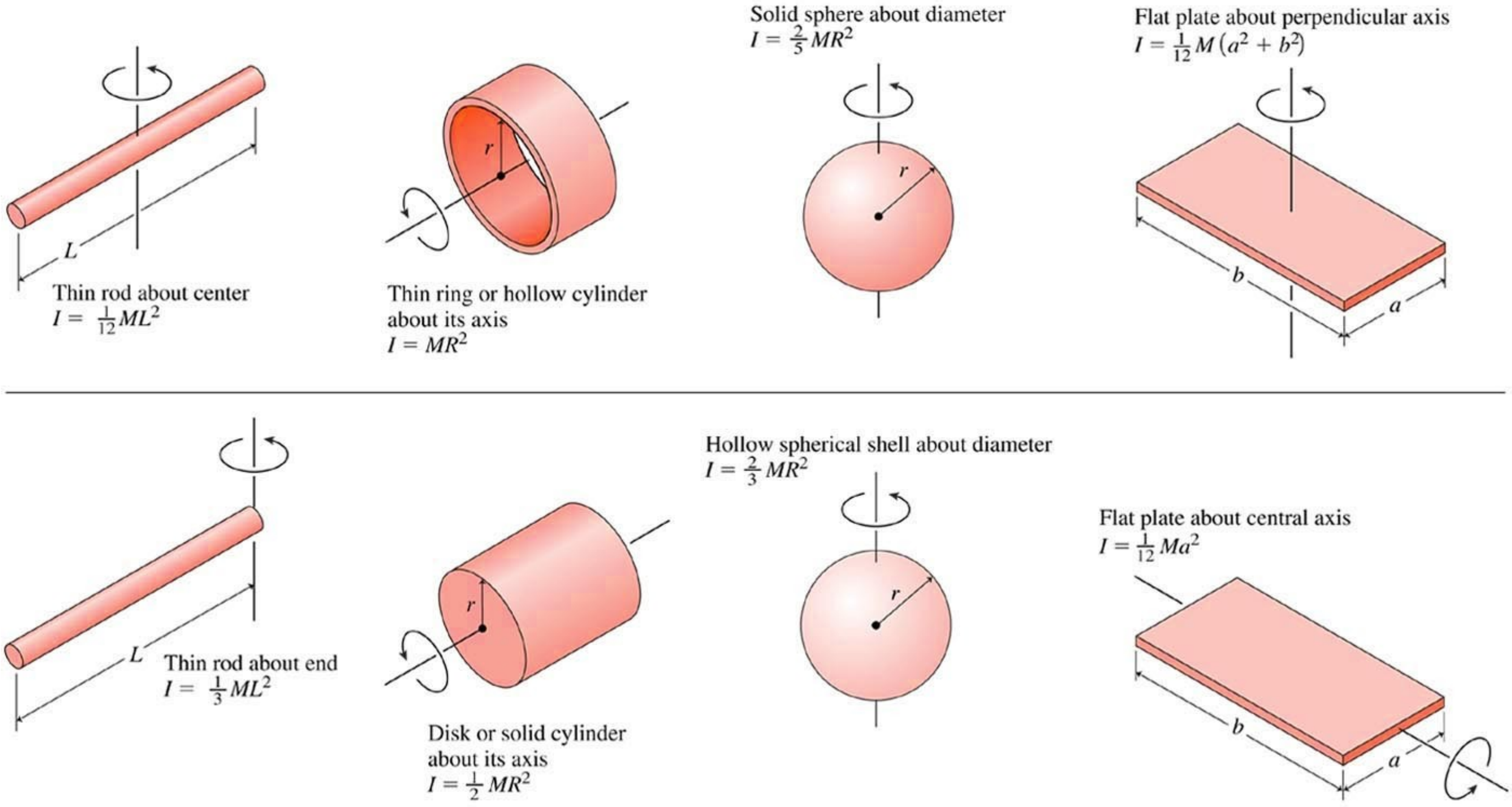
For constant angular acceleration

$$\theta = \theta_o + \omega_o t + \frac{1}{2}\alpha t^2$$

$$\omega = \omega_o + \alpha t$$

$$\omega^2 - \omega_o^2 = 2\alpha(\theta - \theta_o)$$

Linear Motion		Rotational Motion
$x = x_o + v_o t + \frac{1}{2} a t^2$	$\longleftrightarrow$	$\theta = \theta_o + \omega_o t + \frac{1}{2} \alpha t^2$
$v = v_o + at$	$\longleftrightarrow$	$\omega = \omega_o + \alpha t$
m	$\longleftrightarrow$	I
$\frac{1}{2} m v^2$	$\longleftrightarrow$	$\frac{1}{2} I \omega^2$
$\vec{F} = m\vec{a}$	$\longleftrightarrow$	$\vec{\tau} = I\vec{\alpha}$

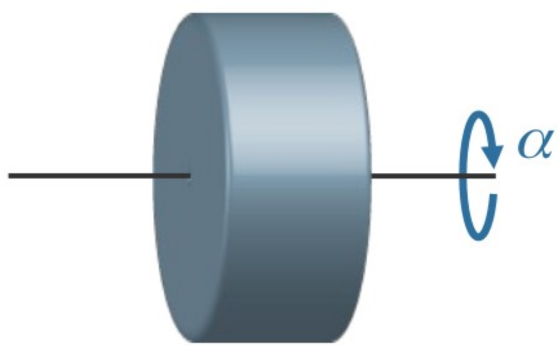


You will be given *I* for basic shapes.

Practice Exercises

A wheel which is initially at rest starts to turn with a constant angular acceleration. After 4 seconds it has made 4 complete revolutions.

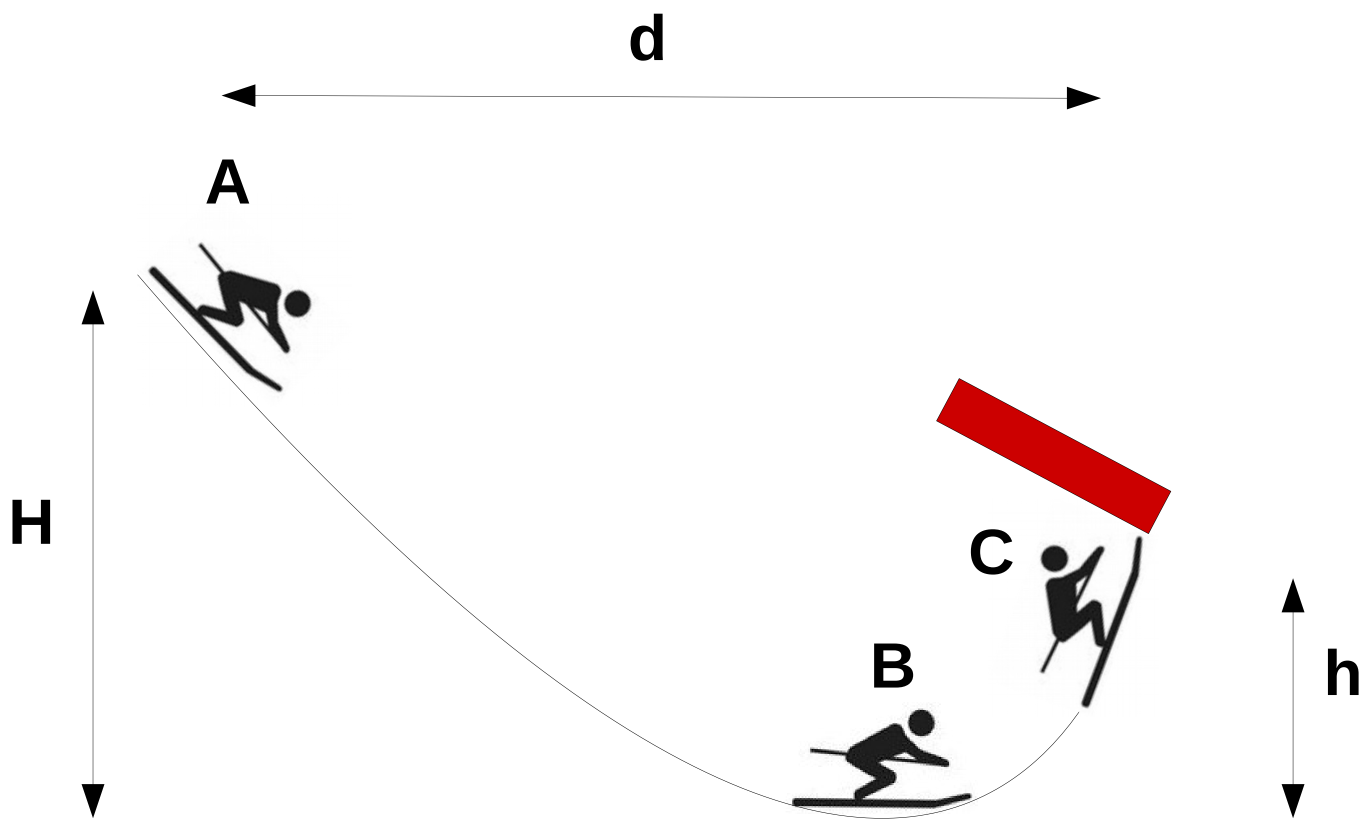
How many revolutions has it made after 8 seconds?



Problem 2 *Center of Mass: Run the Plank*

In frozen Minnesota the Winter Sports Carnival includes some unusual events. Since it is dangerous to run on ice, each runner runs on a heavy (240 kg) and long (40 m) wooden plank, which itself rests on the smooth and horizontal ice. One of the competitors is a 60-kg woman who runs the length of the plank in 4.4 seconds, quite an impressive time. Her performance is viewed by a crowd huddled on the ice. The performance that they see is less impressive.

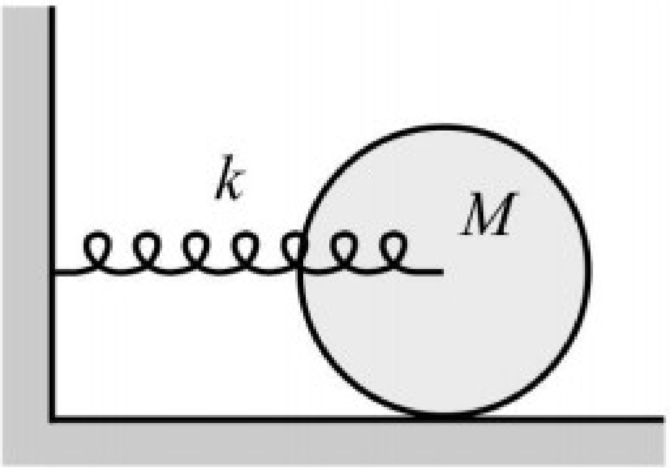
With what speed does the crowd see the woman moving?



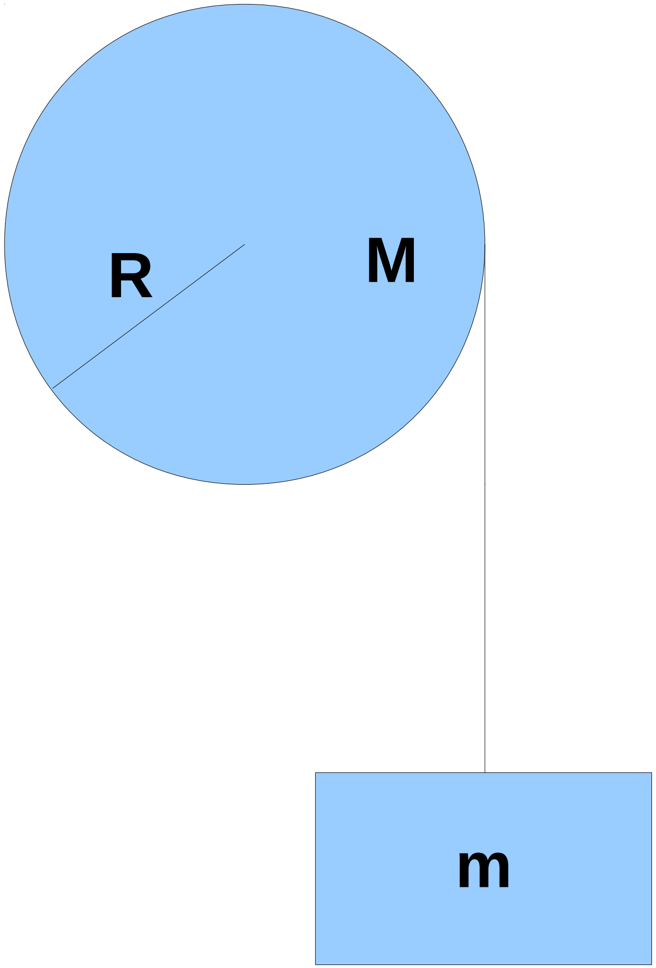
A skier starts from rest at A, slides without friction down the slope to B, then up a ramp to C where she crashes into a brick wall and comes to rest again.

a) What is the work done by gravity on the skier as she moves from A to C?
b) What is the skier's speed when she hits the wall?
c) What is the work done by the wall?
d) The normal force of the wall does work on the skier, but the normal force of the snow on the skis does not. Explain.

8. The axle of a solid cylinder of mass m and radius r is connected to a spring with spring constant k, as shown in the figure. If the cylinder rolls without slipping, what is the frequency of the oscillations?

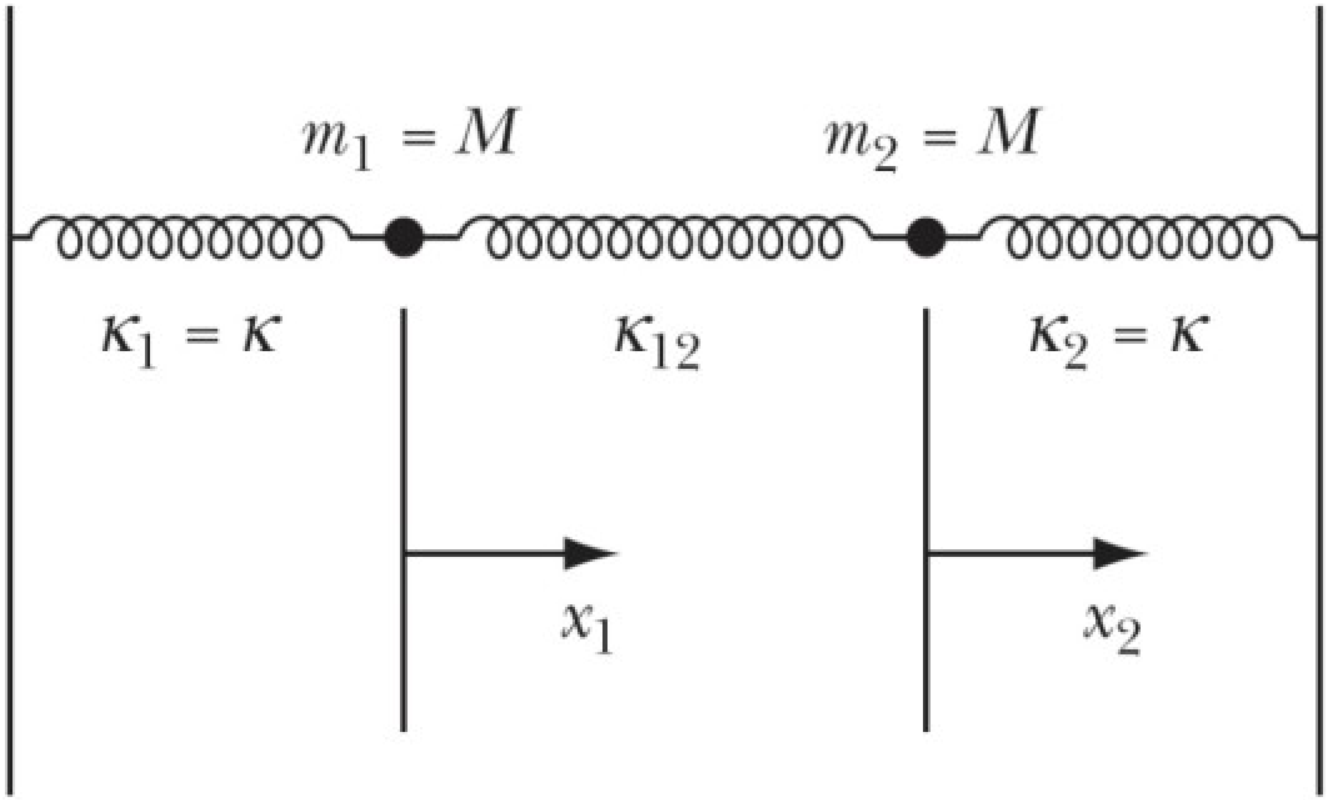


Solve this homework problem using the *Lagrangian Method*



A block of mass **m** hangs from a massless string, which is wound around a disk of radius **R** and mass **M**. The disk is free to rotate about its center.

If the string unwinds without slipping, what is the acceleration of the hanging block?



Write down *but do not solve* the equations of motion for x_1 and x_2.