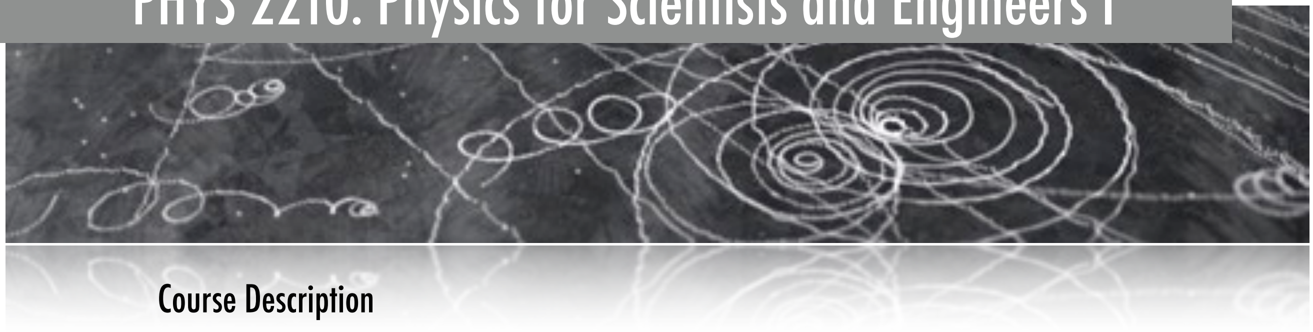
# PHYS 2210: Physics for Scientists and Engineers I



## Course Description

This is the first semester of a two-semester sequence in calculus-based physics, primarily for students in science, math, computer science, and pre-engineering. This semester covers topics in mechanics, including kinematics, Newton's laws, and the conservation laws of energy, linear momentum, and angular momentum. Also covered are topics in gravity, fluid mechanics, waves, and thermodynamics. Class meets five hours per week in lecture/discussion format. There is one 3-hour lab per week (PHYS 2219).

## Prerequisites

Math 1210 (co-requisite)

## General Information

| | |
|---|---|
| Class Times | LL 121, 9:30 AM Monday - Friday |
| Required Texts | Physics for Scientist and Engineers, 2nd Edition, Knight |
| Instructor | John Armstrong |
| Office Hours | SL 205, 11:30 AM - 12:30 PM, Mon and Weds, or by appointment |
| Email | jcarmstrong@weber.edu |
| Web | http://www.weber.edu/jcarmstrong |
| Phone | 801.626.6215 |

## Course Philosophy

This course has two main goals:

1. Survey the physical laws and phenomena that describe the nature of the Universe
2. Develop a method for studying the world that is based on experimental verification and problem solving

You will find that physics is embedded in everything we see and do, from driving our cars and cooking dinner to probing the fundamental nature of matter. But physics is more than a body of knowledge. It is a method for exploring and understanding the way the world works. When you are done with this course, you will possess a full range of valuable analytical problem solving skills. You will also learn that the Universe is comprehensible, not only by some scientist, but by **you**.

## Succeeding in Class

This course, and the materials in the course, are designed to help you learn physics. Like any complex mental activity, physics requires study and practice. Lucky for you, physics is also really fun! To succeed, you should take full advantage of the materials available. I recommend that you:

1. Prepare for class by reviewing the reading assignment. These are short reading assignments prior to each class to get you thinking about the discussion topics.

2. Actively engage through class participation. We will be practicing physics in class through demonstrations, simulations, and experiments. Read your text and come prepared to participate.
3. Practice what you have learned through the workbook exercises.
4. Re-read the reading assignment.
5. Hone your problem solving skills through homework problems.
6. Assess what you have learned through exams.

## Mastering Physics

All of our weekly assignments will be on Mastering Physics, due at 11:59 PM on Wednesday night, when the next homework is assigned. Late submissions will not be accepted (since I will be posting solutions on Thursday morning). All of the assignments in this class will be performed online, using the Mastering Physics Website: http://www.masteringphysics.com

This course will be using the Mastering Physics web resources supplied with your textbook. If you purchased a used textbook, you can purchase a subscription with a credit card on the web site. This is required for the course, as your Mastering Physics assignments will be recorded under your name in the online gradebook. The name of your course is ARMSTRONGPHYS2210F09. You will need this to register for our course on line.

## Exams

There will be five equally weighted exams during the course. These serve as a measure of your 'retained' knowledge and will help you (and me) keep tabs on your progress. If you must miss and exam due to a prior commitment, you must make arrangements **in advance**. Makeup exams will not be given except under the most extreme circumstances. All exams will be held in LL 121 on the dates indicated.

## Lab

Lab is a required component of this course, and you must be enrolled in a lab section. I will be doing my best to coordinate our schedule with the one in your lab, but be aware that some weeks we will cover topics after or before you cover them in lab.

## Grading Policy

Your grade will be compiled from homework, exams, and lab according to the following:

| | |
|---|---|
| Mastering Physics | 40% |
| Exams (5 exams @ 8% each) | 40% |
| Lab Reports (Average from lab) | 17% |
| Lab Final | 3% |

## Attendance Policy

While I will not be taking attendance in class, you are encouraged to attend regularly. This is going to be an awesome, exciting class, so why would you want to be anywhere else?

## Academic Integrity

Regarding academic integrity, I will enforce policies as laid down in Section IV:D of the Student Responsibilities outlined in the Student Code. Specifically, no cheating or other forms of academic dishonesty will be tolerated. The first instance of cheating will result in a zero on that assignment. The second instance will result in failing the class. You will be working in groups occasionally, however, so you will be required to distinguish the difference between collaboration and cheating. When in doubt, make sure to give credit where credit is due.

## Special Accommodations

Any students requiring accommodations or services due to a disability must contact Services for Students with Disabilities (SSD) in room 181 of the Student Service Center. SSD can also arrange to provide course materials (including this syllabus) in alternative formats if necessary.

Fall 2009

# PHYS 2210: Physics for Scientists and Engineers I

| Unit | Section | Date | Topics | Monday | Tuesday | Weds | Thursday | Friday |
|---|---|---|---|---|---|---|---|---|
| Particles and Energy | Newton's Laws | 8/24 | Concepts of Motion<br>1-D Kinematics | Introduction | 1.1-1.3 | 1.4-1.6 | 1.7-1.8 | 2.1-2.2 |
| | | 8/31 | 1-D Kinematics<br>Vectors | 2.3-2.5 | 2.6-2.7 | 3.1-3.2 | 3.3-3.4 | 4.1-4.2 |
| | | 9/7 | 2-D Kinematics | **Labor Day!** | 4.3-4.5 | 4.6-4.7 | **Review** | **Exam 1** |
| | | 9/14 | Force and Motion<br>Motion Along a Line | 5.1-5.4 | 5.5-5.7 | 6.1-6.2 | 6.3-6.4 | 6.5-6.6 |
| | | 9/21 | Newton's 3rd Law<br>Motion in a Plane | 7.1-7.2 | 7.3-7.4 | 7.5 | 8.1-8.3 | 8.4-8.5 |
| | Conservation Laws | 9/28 | Motion in a Plane<br>Impulse and Momentum | 8.6-8.7 | 9.1-9.3 | 9.4-9.6 | **Review** | **Exam 2** |
| | | 10/5 | Energy<br>Work | 10.1-10.2 | 10.3-10.5 | 10.6-10.7 | 11.1-11.3 | 11.4-11.6 |
| | | 10/12 | Work<br>Rotation of a Rigid Body | 11.7-11.9 | 12.1-12.2 | 12.3-12.4 | 12.5-12.6 | **Fall Break** |
| | Applications of Newton's Laws | 10/19 | Rotation of a Rigid Body<br>Gravity | 12.7-12.8 | 13.1-13.3 | 13.4-13.6 | **Review** | **Exam 3** |
| | | 10/26 | Oscillations<br>Fluids and Elasticity | 14.1-14.3 | 14.4-14.6 | 14.7-14.8 | 15.1-15.2 | 15.3-15.4 |
| | | 11/2 | Fluids and Elasticity<br>Macroscopic Description of Matter<br>First Law of Thermodynamics | 15.5-15.6 | 16.1-16.3 | 16.4-16.6 | 17.1-17.3 | 17.4-17.6 |
| Fields and Waves | Thermo-dynamics | 11/9 | First Law of Thermodynamics<br>The Micro/Macro Connection | 17.7-17.8 | 18.1-18.3 | 18.4-18.6 | **Review** | **Exam 4** |
| | | 11/16 | Heat Engines and Refrigerators | 19.1-19.2 | 19.3-19.4 | 19.5-19.6 | 21.1-20.2 | 20.3-20.5 |
| | Waves and Optics | 11/23 | Traveling Waves<br>Superposition | 20.6-20.7 | 21.1-21.4 | 21.5-21.8 | **Thanksgiving Holiday** | |
| | | 11/30 | Wave Optics | 22.1-22.2 | 22.3-22.4 | 22.5-22.6 | **Review** | **Review** |
| | | 12/7 | **FINALS WEEK** | | | | | |

**Schedule subject to change**

Name____________________________________

# Exam I

Physics 2210 Fall 2009
Armstrong

This is Exam I for PHYS 2210. There are five equally weighted questions. You may use a calculator, your 3x5 prepared card, **but no other materials are allowed**. Please write your answers on the sheets provided. Have fun!

1. A ball released from rest rolls down a ramp across a horizontal floor.

   (a) Draw and label a diagram representing situation.

   (b) Draw a motion diagram of the situation. Indicate the direction and relative magnitude of the velocity and acceleration. If the acceleration is zero, say so.

2. Using the information from question 1:

   (a) Draw and label a position vs. time graph (along the direction of motion)

   (b) Draw and label a velocity vs. time diagram

   (c) Draw and label an acceleration vs. time diagram

3. Three forces are exerted on an object placed on a tilted floor. Forces are vectors. The three forces are directed as shown in the figure. Assuming the forces have magnitudes $F_1 = 3$ N, $F_2 = 5$ N and $F_3 = 10$ N, where N is a Newton, the standard unit of force. What is the component of the net force $\overrightarrow{F}_{net} = \overrightarrow{F_1} + \overrightarrow{F_2} + \overrightarrow{F_3}$ parallel to the tilted floor?

4. In a new game I am inventing called “Hockey Golf”, a player launches a small puck horizontally from a height 2 meters above the floor. The goal of the game is to land the puck exactly in a hole in the floor, located 20 meters away. How fast does the puck need to be launched in order to land in the hole? Remember: Model, Visualize, Solve, Assess. The acceleration due to gravity is $9.8\ \frac{m}{s^2}$.

5. I was riding my bike to school yesterday and got cut off by a car. Thankfully, I have very quick reflexes: I slammed on my brakes, came to a complete stop, and then accelerated forward again to my previous speed, all while keeping my feet clipped into the pedals. For my front wheel, including when I was braking and accelerating

   (a) Draw and label an angular position ($\theta$) vs. time graph

   (b) Draw and label an angular velocity ($\omega$) vs. time graph

Name______________________________

# Exam II

Physics 2210 Fall 2009
Armstrong

This is Exam II for PHYS 2210. There are five equally weighted questions. You may use a calculator, a paper or electronic dictionary (foreign or english), your 3x5 prepared card, **but no other materials are allowed**. Please write your answers on the sheets provided. Have fun!

1. Concept grab bag. Briefly answer the following questions:

   (a) In outer space, an astronaut is working with two pieces of equipment that are outwardly identical. However, one of the objects has a slightly larger mass than the other. Since objects are weightless in space, how can the astronaut distinguish between the two objects?

   (b) You are in a elevator which starts accelerating upward. Explain what happens to your apparent weight, and why.

   (c) Explain, from a force standpoint, why you need to reduce your normal driving speed around curves when it rains.

2. Future space stations will create an artificial gravity by rotating. Consider a cylindrical space station of 400 m diameter rotating about its axis. Astronauts walk on the inside surface of the space station. What rotation period will provide "normal" gravity? Draw an interaction diagram and a force diagram to show the effect on the person inside the station.

3. A 65 $kg$ ice skater pushes off his partner and accelerates backwards at 1.3 $m/s^2$. If the partner accelerates in the opposite direction at 2.0 $m/s^2$, what is the mass of the other skater? Assume that frictional forces are negligible.

4. A 200 g hockey puck is launched up a metal ramp that is inclined at a 30 angle. The coefficients of static and kinetic friction between the hockey puck and the metal ramp are $\mu_s = 0.4$ and $\mu_k = 0.3$, respectively. The puck's initial speed is 60 m/s. What vertical height does the puck reach above its starting point?

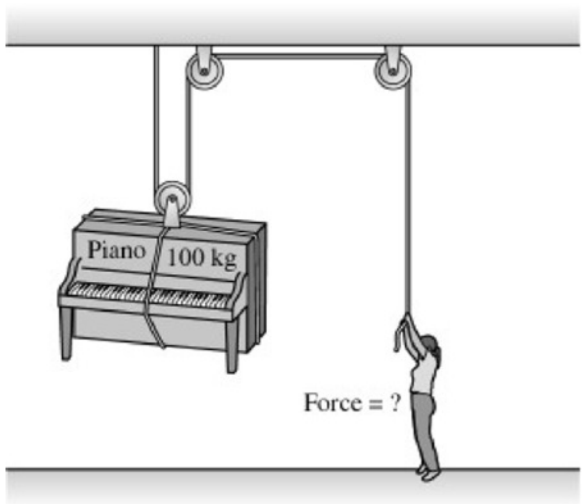



Figure 1: Question 5

5. A piano mover raises a 100 $kg$ piano at a constant rate using a frictionless pulley system, as shown below. With roughly what force is the mover pulling down on the rope? Draw an interaction diagram and a force diagram.

Name________________________________

**Exam III**

Physics 2210 Fall 2009
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This is Exam III for PHYS 2210. There are five equally weighted questions. You may use a calculator, a paper or electronic dictionary (foreign or english), your 3x5 prepared card, **but no other materials are allowed**. Please write your answers on the sheets provided. Have fun!

1. Conceptual grabbag:

   (a) A child swings a ball of mass $m$ on a rope in a uniform, vertical circle of radius $r$ at a constant speed $v$. How much work is done by the centripetal force on the ball during one complete revolution?

   (b) A block of ice flows downstream and it breaks into a number of pieces. How is the motion of the center of mass going to be affected?

   (c) If an astronaut were exactly halfway between the Earth and the Moon, the net gravitational force exerted on the astronaut by these two objects would be

      i. directed towards Earth.
      ii. zero.
      iii. directed towards the Moon.

   (d) A ball can be rolled down one of four different ramps, as shown below. The final elevation loss of each of the ramps is the same. Neglecting friction, for which ramp will the speed of the ball be the highest at the bottom?

2. You hear on a news report than an oddly shaped helium balloon, filled with enough helium to provide 3000 $N$ of lift, is floating at a constant altitude of 2500 $m$. You rush outside to see the balloon, and you notice something fall off! From your observations, you notice the balloon accelerates upward at 0.25 $m/s^2$. Another eye witness claims to have seen a small child fall out of the balloon!

   (a) Using your observations, calculate the mass of the object that you saw fall from the balloon.

   (b) Do you need to notify the authorities regarding the fate of the child?

3. Assume the drag on the falling object from problem 2 provides a force of 50 N. Using work and energy, determine the final velocity of the falling object.

4. A disk with a mass of 5 $kg$ and a 0.1 $m$ radius is free to rotate about a horizontal axis. A 5 $kg$ mass and a 10 $kg$ mass are attached by a massless string, which is hung over the disk. If the string does not slip, what is the angular velocity of the disk after 2 seconds.

5. The weight of spaceman Speff, solely due to the gravitational pull of planet X at its surface, is 400 $N$. If he moves to a distance of 20,000 $km$ above the planet's surface, his weight changes to 25 $N$. What is the mass of planet X, if Speff's mass is 75 $kg$?

Name____________________________________

# Exam IV

Physics 2210 — Fall 2009
Armstrong

This is Exam IV for PHYS 2210. There are five equally weighted questions. You may use a calculator, a paper or electronic dictionary (foreign or english), your 3x5 prepared card, **but no other materials are allowed**. Please write your answers on the sheets provided. Have fun!

1. A 100 g ball attached to a spring with a spring constant of $k = 2.5\ N/m$ oscillates horizontally on a frictionless table. The velocity is $20\ cm/s$ when $x = -5.0\ cm$. What is the amplitude of the oscillation?

2. A hurricane strength wind blows across a 10 m x 10 m flat roof at a speed of 60 m/s (about 130 mph). Assume the density of air is 1.2 $kg/m^3$.

   (a) What is the pressure difference between the house and air outside the roof?

   (b) How much force, and in what direction, is exerted on the roof?

3. A research group in San Francisco (at sea level with temperature of 20 degrees C) inflates a spherical latex weather balloon with helium until it is 3 meters in diameter. What is the net upward force of the balloon? Assume the density of air is 1.2 $kg/m^3$, that the latex balloon has a mass of 3 kg, and that the helium molecules each have a mass of $6.64 \times 10^{-27}$ kg.

4. A 10 kg bowling ball at 0 degrees C is dropped into a bathtub containing a mixture of water and ice. A short time later, after a new equilibrium is reached, there is 5 g less ice. From what height was the ball dropped? Assume the latent heat of fusion for water is $3.33 \times 10^5$ J/K and that no water or ice splashes out.

5. Consider a container of gas that undergoes two processes:

   (a) The gas is heated at a constant volume until the pressure is doubled. Draw a pressure vs. volume (P-V) diagram for this process.

   (b) The gas container expands at a constant pressure until the volume is doubled, and then is compressed to the original volume as the pressure doubles. Draw a P-V diagram for this process.

   (c) What process, a or b, does more work?

Name________________________________________

# Exam V

Physics 2210 Fall 2009
Armstrong

This is Exam V for PHYS 2210. There are five equally weighted questions. You may use a calculator, a paper or electronic dictionary (foreign or english), your 3x5 prepared card, **but no other materials are allowed**. Please write your answers on the sheets provided. Have fun!

Some useful constants:

$$k_B = 1.38 \times 10^{-23} \frac{J}{K}$$
$$R = 8.31 \frac{J}{mol\ K}$$
$$u = 1.66 \times 10^{-27} kg$$

1. (a) Neon is held in a tank at a temperature of 25C. The pressure inside a tank is 45 MPa. How far does a neon atom move between collisions on average? Neon's atomic mass number is approximately 20. Assume the radius of neon is $5 \times 10^{-9}$ meters.

   (b) What is the rms velocity of the gas?

2. A Carnot engine operating between a reservoir of liquid mercury at its melting point and a colder reservoir extracts 10.0 J of heat from the mercury and does 8.0 J of work during each cycle. Draw a heat transfer diagram for this situation, labeling $T_C$, $T_H$, $Q_C$, $Q_H$ and $W_{out}$. What is the temperature of the colder reservoir? Mercury melts at 233 K.

3. You and your surfing buddy are waiting to catch a wave a few hundred meters off the beach. The waves are conveniently sinusoidal, and you notice that when you're on the top of one wave, your friend is exactly halfway between you and the trough of the wave. 1.50 seconds later, she's at the top of the wave. You estimate the horizontal distance between you and your friend at 8.00 m. Calculate

   (a) the phase difference between you and your friend;

   (b) the frequency of the waves;

   (c) the speed of the waves.

4. A plucked guitar string produces a sound wave of frequency 440 Hz.

   (a) What is the wavelength of the sound wave (assume the speed of sound in air is 340 m/s)?

   (b) How much time elapses between the impacts of two adjacent compressions on your eardrum?

5. A rope with a total mass of 25.0 kg is tied to a tree on one side of a 125 meter wide ravine, and you're pulling on the other end of the rope with a force of 415 N. If you pluck the rope, how long will it take the pulse to travel across the ravine to the tree?

Student View | Summary View | Diagnostics View | Print View with Answers | ıment | Settings per Student

# Assignment 9

**Due: 11:59pm on Thursday, October 28, 2010**

[ Print ]

**Note: You will receive no credit for late submissions.** To learn more, read your instructor's Grading Policy

## Problem 11.32

**Description:** At midday, solar energy strikes the earth with an intensity of about 1 ( kW/m)^2. (a) What is the area of a solar collector that could collect 150 MJ of energy in 1 hr? This is roughly the energy content of 1 gallon of gasoline.

At midday, solar energy strikes the earth with an intensity of about 1 $\mathrm{kW/m^2}$.

### Part A

What is the area of a solar collector that could collect 150 $\mathrm{MJ}$ of energy in 1 $\mathrm{hr}$? This is roughly the energy content of 1 gallon of gasoline.

ANSWER: $A$ = $41.7$ $\mathrm{m^2}$

## Problem 11.41

**Description:** A m elevator accelerates upward at a for h, starting from rest. (a) How much work does gravity do on the elevator? (b) How much work does the tension in the elevator cable do on the elevator? (c) Use the work-kinetic energy theorem to find the...

A 1300 $\mathrm{kg}$ elevator accelerates upward at 1.00 $\mathrm{m/s^2}$ for 14.0 $\mathrm{m}$, starting from rest.

### Part A

How much work does gravity do on the elevator?

ANSWER: $-m \cdot 9.8h$ J

### Part B

How much work does the tension in the elevator cable do on the elevator?

ANSWER: $m\left(9.8+a\right)h$ J

Part C

Use the work-kinetic energy theorem to find the kinetic energy of the elevator as it reaches 14.0 $\mathrm{m}$.

ANSWER: $mah$ J

Part D

What is the speed of the elevator as it reaches 14.0 $\mathrm{m}$?

ANSWER: $\sqrt{\frac{(mah)\cdot 2}{m}}$ m/s

## Problem 11.42

**Description:** Bob can throw a 500 g rock with a speed of 30 m/s. He moves his hand forward 1.0 m while doing so. (a) How much work does Bob do on the rock? (b) How much force, assumed to be constant, does Bob apply to the rock? (c) What is Bob's maximum power...

Bob can throw a 500 g rock with a speed of $30\ \mathrm{m/s}$. He moves his hand forward 1.0 m while doing so.

Part A

How much work does Bob do on the rock?

ANSWER: $225$ J

Part B

How much force, assumed to be constant, does Bob apply to the rock?

ANSWER: $225$ N

Part C

What is Bob's maximum power output as he throws the rock?

ANSWER: $6.75$ kW

## Problem 11.44

**Description:** Sam, whose mass is 75 kg, straps on his skis and starts down a 50-m-high, 20 degree(s) frictionless slope. A strong headwind exerts a horizontal force of 200 N on him as he skies. (a) Find Sam's speed at the bottom using work and energy. (b) Find...

Sam, whose mass is 75 kg, straps on his skis and starts down a 50-m-high, $20^\circ$ frictionless slope. A strong headwind exerts a *horizontal* force of 200 N on him as he skies.

### Part A

Find Sam's speed at the bottom using work and energy.

ANSWER: $$\sqrt{\left(2\cdot 9.8\cdot 50+\frac{\frac{2}{75}\cdot 200\cdot 50}{\sin\left(\frac{20\pi}{180}\right)}\cos\left(\frac{160\pi}{180}\right)\right)}$$ m/s

### Part B

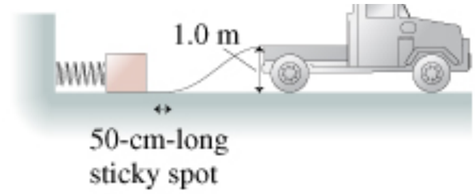
Find Sam's speed at the bottom using Newton's laws.

ANSWER: $$\sqrt{\frac{\frac{2\left(75\text{-}9.8\sin\left(\frac{20\pi}{180}\right)-200\cos\left(\frac{20\pi}{180}\right)\right)}{75}\cdot 50}{\sin\left(\frac{20\pi}{180}\right)}}$$ m/s

## Problem 11.49

**Description:** A freight company uses a compressed spring to shoot m packages up a 1.00-m -high frictionless ramp into a truck, as the figure shows. The spring constant is k and the spring is compressed x. (a) What is the speed of the package when it reaches the ...

A freight company uses a compressed spring to shoot 2.00 $\mathrm{kg}$ packages up a 1.00-$\mathrm{m}$ -high frictionless ramp into a truck, as the figure shows. The spring constant is 368 $\mathrm{N/m}$ and the spring is compressed 34.0 $\mathrm{cm}$.




Part A

What is the speed of the package when it reaches the truck?

ANSWER:

$$v = \sqrt{\frac{\left(\frac{kx^2}{2} - m\cdot 9.8\cdot 1.0\right)\cdot 2}{m}} \quad \text{m/s}$$

Part B

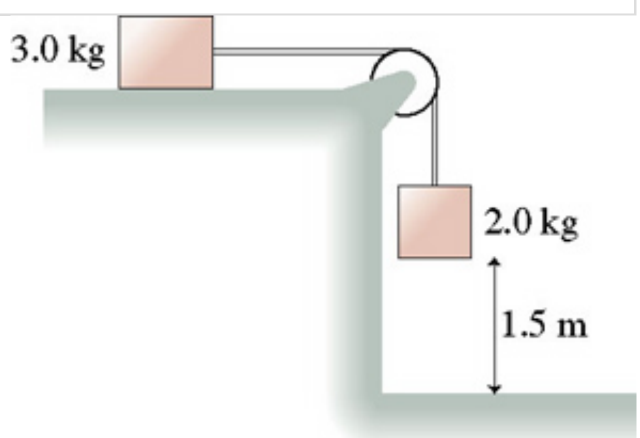
A careless worker spills his soda on the ramp. This creates a 50.0-cm-long sticky spot with a coefficient of kinetic friction 0.300. Will the next package make it into the truck?

ANSWER:

- Yes
- No

## Problem 11.50

**Description:** (a) Use work and energy to find the speed of the 2.0 kg block just before it hits the floor if the table is frictionless. (b) Use work and energy to find the speed of the 2.0 kg block just before it hits the floor if the coefficient of kinetic...



Part A

Use work and energy to find the speed of the 2.0 kg block just before it hits the floor if the table is frictionless.

ANSWER: $\sqrt{\frac{2 \cdot 2.0 \cdot 9.8 \cdot 1.5}{2.0+3.0}}$ m/s

Part B

Use work and energy to find the speed of the 2.0 kg block just before it hits the floor if the coefficient of kinetic friction of the 3.0 kg block is 0.15.

ANSWER: $\sqrt{\left(\frac{2}{2.0+3.0}\left(2.0 \cdot 9.8 \cdot 1.50-0.15 \cdot 3.0 \cdot 9.8 \cdot 1.50\right)\right)}$ m/s

## Problem 11.51

**Description:** An m crate is pulled l up a 30 degree(s) incline by a rope angled alpha above the incline. The tension in the rope is T and the crate's coefficient of kinetic friction on the incline is mu. (a) How much work is done by tension, by gravity, and by...

An 7.9 $\mathrm{kg}$ crate is pulled 5.0 $\mathrm{m}$ up a 30° incline by a rope angled 16° above the incline. The tension in the rope is 140 $\mathrm{N}$ and the crate's coefficient of kinetic friction on the incline is 0.23.

Part A

How much work is done by tension, by gravity, and by the normal force?

**Express your answers using two significant figures. Enter your answers numerically separated by commas.**

ANSWER: $W_T, W_g, W_n$ = $Tl\cos(\alpha)$, $m \cdot 9.8 l \cos\left(\frac{\pi}{2}+\frac{\pi}{6}\right)$, $0$ J

Part B

What is the increase in thermal energy of the crate and incline?

**Express your answer using two significant figures.**

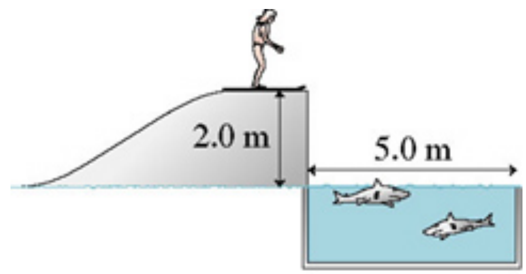
ANSWER:

$\Delta E_{th}$ = $\mu l\left(m\cdot 9.8\cos\left(\frac{\pi}{6}\right)-T\sin\left(\alpha\right)\right)$ J

## Problem 11.73

**Description:** You've taken a summer job at a water park. In one stunt, a water skier is going to glide up the 2.0-m-high frictionless ramp shown in the figure, then sail over a 5.0-m-wide tank filled with hungry sharks. You will be driving the boat that pulls her...

You've taken a summer job at a water park. In one stunt, a water skier is going to glide up the 2.0-m-high frictionless ramp shown in the figure, then sail over a 5.0-m-wide tank filled with hungry sharks. You will be driving the boat that pulls her to the ramp. She'll drop the tow rope at the base of the ramp just as you veer away.




Part A

What minimum speed must you have as you reach the ramp in order for her to live to do this again tomorrow?

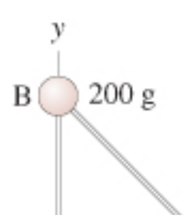
ANSWER:

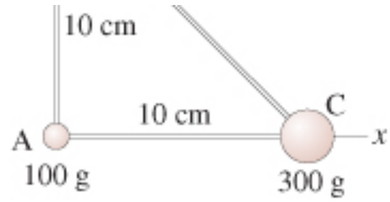
$\sqrt{\left(\frac{5.0^2\cdot 9.8}{2\cdot 2.0}+2\cdot 9.8\cdot 2.0\right)}$ m/s

## Problem 12.6

**Description:** The three masses shown in the figure are connected by massless, rigid rods. (a) What are the coordinates of the center of mass? (b) ...

The three masses shown in the figure are connected by massless, rigid rods.






Part A

What are the coordinates of the center of mass?

**Express your answer using two significant figures.**

ANSWER: $x$ = 5.0 cm

Part B

**Express your answer using two significant figures.**

ANSWER: $y$ = 3.3 cm

## Problem 12.9

**Description:** (a) What is the rotational kinetic energy of the earth? Assume the earth is a uniform sphere. Data for the earth can be found inside the back cover of the book.

Part A

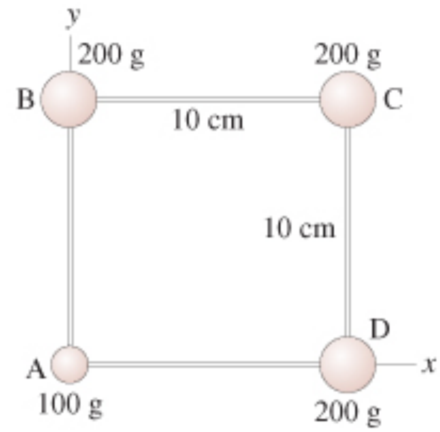
What is the rotational kinetic energy of the earth? Assume the earth is a uniform sphere. Data for the earth can be found inside the back cover of the book.

ANSWER: $K_{rot}$ = $2.57 \cdot 10^{29}$ J

## Problem 12.14

**Description:** The four masses shown in the figure are connected by massless, rigid rods. (a) Find the coordinates of the center of mass. Find the x-coordinate. (b) Find the y-coordinate. (c) Find the moment of inertia about an axis that passes through mass A and ...

The four masses shown in the figure are connected by massless, rigid rods.




Part A

Find the coordinates of the center of mass. Find the $x$-coordinate.

**Express your answer using two significant figures.**

ANSWER: $x_{\mathrm{cm}}$ = 5.7 cm

Part B

Find the $y$-coordinate.

**Express your answer using two significant figures.**

ANSWER: $y_{\mathrm{cm}}$ = 5.7 cm

Part C

Find the moment of inertia about an axis that passes through mass A and is perpendicular to the page.

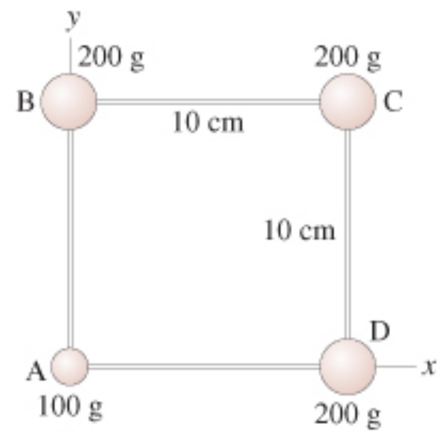
**Express your answer using two significant figures.**

ANSWER: $I$ = 0.0080 $\mathrm{kg \cdot m^2}$

## Problem 12.15

**Description:** The four masses shown in the figure are connected by massless, rigid rods. (a) Find the coordinates of the center of mass. Find the x-coordinate. (b) Find the y-coordinate. (c) Find the moment of inertia about a diagonal axis that passes through...

The four masses shown in the figure are connected by massless, rigid rods.




Part A

Find the coordinates of the center of mass. Find the $x$-coordinate.

**Express your answer using two significant figures.**

ANSWER: $x_{cm}$ = 5.7 cm

Part B

Find the $y$-coordinate.

**Express your answer using two significant figures.**

ANSWER: $y_{cm}$ = 5.7 cm

Part C

Find the moment of inertia about a diagonal axis that passes through masses B and D.

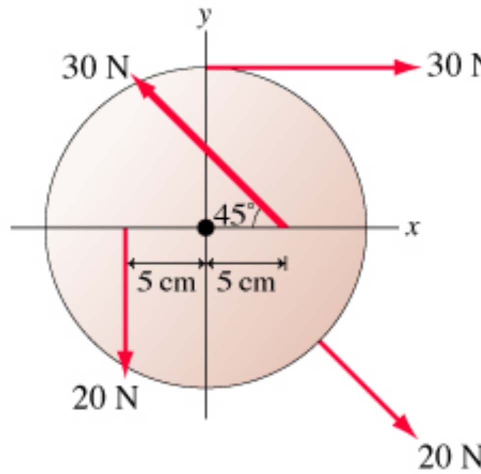
**Express your answer using two significant figures.**

ANSWER: $I$ = 0.0015 $kg \cdot m^2$

## Problem 12.22

**Description:** The 20-cm-diameter disk in the figure can rotate on an axle through its center. (a) What is the net torque about the axle?

The 20-cm-diameter disk in the figure can rotate on an axle through its center.




Part A

What is the net torque about the axle?

ANSWER: $-0.937$ Nm

## Problem 12.62

**Description:** (a) A 3.0-m-long rigid beam with a mass of 100 kg is supported at each end. An 80 kg student stands 2.0 m from support 1. How much upward force does support 1 exert on the beam?

Part A

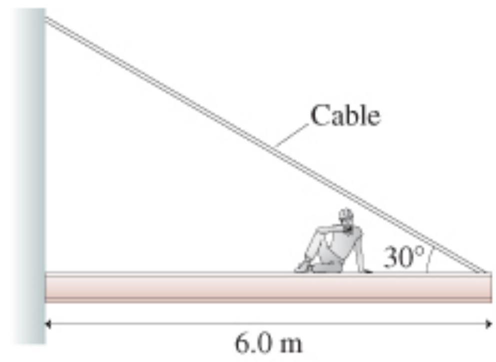
A 3.0-m-long rigid beam with a mass of 100 kg is supported at each end. An 80 kg student stands 2.0 m from support 1. How much upward force does support 1 exert on the beam?

ANSWER: $751$ N

## Problem 12.63

**Description:** An 80 kg construction worker sits down 2.0 m from the end of a 1450 kg steel beam to eat his lunch. The cable supporting the beam is rated at 15000 N. (a) Should the worker be worried?

An 80 $\mathrm{kg}$ construction worker sits down 2.0 $\mathrm{m}$ from the end of a 1450 $\mathrm{kg}$ steel beam to eat his lunch. The cable supporting the beam is rated at 15000 N.




Part A

Should the worker be worried?

ANSWER:

- (•) **Yes**
- ( ) **No**

## Problem 12.69

**Description:** Flywheels are large, massive wheels used to store energy. They can be spun up slowly, then the wheel's energy can be released quickly to accomplish a task that demands high power. An industrial flywheel has a d diameter and a mass of m. Its maximum...

Flywheels are large, massive wheels used to store energy. They can be spun up slowly, then the wheel's energy can be released quickly to accomplish a task that demands high power. An industrial flywheel has a 1.5 m diameter and a mass of 240 kg. Its maximum angular velocity is 1400 rpm.

Part A

A motor spins up the flywheel with a constant torque of 60 $N \cdot m$. How long does it take the flywheel to reach top speed?

**Express your answer using two significant figures.**

ANSWER:

$t = \frac{\omega}{\frac{\tau}{\frac{\frac{1}{2}md^2}{4}}}$ s

Part B

How much energy is stored in the flywheel?

**Express your answer using two significant figures.**

ANSWER:

$E$ = $\frac{\frac{\frac{1}{2}\cdot 1}{2}md^2}{4}\omega^2$ J

Part C

The flywheel is disconnected from the motor and connected to a machine to which it will deliver energy. Half the energy stored in the flywheel is delivered in 2.5 $\mathrm{s}$. What is the average power delivered to the machine?

**Express your answer using two significant figures.**

ANSWER:

$P$ = $\frac{\frac{\frac{\frac{1}{2}\cdot 1}{2}md^2}{4}\omega^2}{2}}{t}$ W

Part D

How much torque does the flywheel exert on the machine?

**Express your answer using two significant figures.**

ANSWER:

$\tau$ = $\frac{\frac{\frac{1}{2}md^2}{4}\left(\omega - \frac{\omega}{\sqrt{2}}\right)}{t}$ $\mathrm{N \cdot m}$

**Score Summary:**

Your score on this assignment is 0%.
You received 0 out of a possible total of 160 points.