PHY 113 A General Physics I
9-9:50 AM MWF Olin 101

Plan for Lecture 37:

Review – Part II

1. **General advice about how to study**
2. **Systematic review of PHY 113 topics**
3. **Review of past exam questions**

23	11/05/2012	Fluid mechanics	14.1-14.4	14.8, 14.24	11/07/2012
24	11/07/2012	Fluid mechanics	14.5-14.7	14.39, 14.51	11/09/2012
25	11/09/2012	Temperature	19.1-19.5	19.1, 19.20	11/12/2012
26	11/12/2012	Heat	20.1-20.4	20.3, 20.14, 20.24	11/14/2012
27	11/14/2012	First law of thermodynamics	20.5-20.7	20.26, 20.35	11/16/2012
28	11/16/2012	Ideal gases	21.1-21.5	21.10, 21.19	11/19/2012
29	11/19/2012	Engines	22.1-22.8	22.3, 22.62	11/26/2012
	11/21/2012	*Thanksgiving Holiday*			
	11/23/2012	*Thanksgiving Holiday*			
	11/26/2012	Review	14,19-22		
	11/28/2012	Exam	14,19-22		
30	11/30/2012	Wave motion	16.1-16.6	16.5, 16.22	12/03/2012
31	12/03/2012	Sound & standing waves	17.1-18.8	17.35, 18.35	12/05/2012
	12/05/2012	Review	1-22		
	12/07/2012	Review	1-22		
	12/13/2012	Final Exam -- 9 AM			

Comments on final exam for PHY 113

Date: Thursday, Dec. 13, 2012 at 9 AM
Place: Olin 101
Format: Similar to previous exams; covering material in Lectures 1-37, Chapters 1-22 (no time pressure)
Focus: Basic physics concepts; problem-solving techniques
Bring:

1. Clear head
2. Calculator
3. Pencils, pens
4. Up to 4 equation sheets

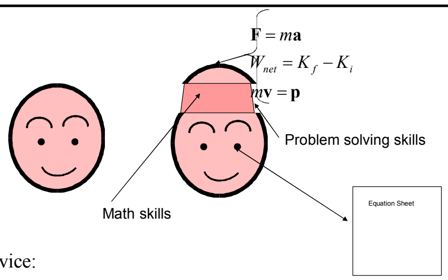
General advice for preparing for exam

- **Prepare equation sheet, including basic equations* from each chapter**
- **Work example problems from class notes, textbook examples, webassign, other sources using your equation sheet**
- **During your review, you may develop new questions. Make an effort to get answers by consulting with your instructor, physics TA, etc.**

***Note: One of the challenges is to distinguish the basic equations/concepts from particular examples**

Problem solving steps

1. Visualize problem – labeling variables
2. Determine which basic physical principle(s) apply
3. Write down the appropriate equations using the variables defined in step 1.
4. Check whether you have the correct amount of information to solve the problem (same number of knowns and unknowns).
5. Solve the equations.
6. Check whether your answer makes sense (units, order of magnitude, etc.).



Advice:

1. Keep basic concepts and equations at the top of your head.
2. Practice problem solving and math skills
3. Develop an equation sheet that you can consult.

What to include on equation sheet -- from Exam 1

Given information on exam	Suitable for equation sheet
Universal constants (such as g=9.8m/s^2)	Trigonometric relations
Particular constants (such as μ_s, μ_k)	Simple derivative and integral relationships
Unit conversion factors if needed	General relationships of position, velocity, acceleration
	Particular formulas for trajectory motion
	Expression for centripetal acceleration
	Expressions for model friction forces

What to include on equation sheet -- from Exam 2

Given information on exam	Suitable for equation sheet
Universal constants (such as g=9.8m/s^2)	Trigonometric relations and definition of dot product
Particular constants (such as μ_s, μ_k)	Simple derivative and integral relationships
Unit conversion factors if needed	Definition of work, potential energy, kinetic energy
	Work-kinetic energy theorem
	Relationship between force, potential energy, and work for conservative systems
	Relationship of impulse and momentum; conservation of momentum
	Elastic and inelastic collisions
	Center of mass

What to include on equation sheet – from Exam 3

Given information on exam	Suitable for equation sheet
Universal or common constants (such as g, G, M_E, M_S, R_E…)	Basic equations from material from earlier Chapters: Newton's laws, energy, momentum, center of mass
Particular constants (such as *k,m,l*…)	Simple derivative and integral relationships, including trigonometric functions
Unit conversion factors such as Hz and rad/s	Definition of moment of inertia, torque, angular momentum, rotational kinetic energy
	Newton's law for rotational motion; combination of rotational and center of mass motion
	Equations describing simple harmonic motion and driven harmonic motion
	Newton's universal gravitation force law and corresponding gravitational potential energy
	Gravitational stable circular orbits

What to include on equation sheet – from Exam 4

Given information on exam paper	Suitable for equation sheet
Universal or common constants (such as g, R, ..)	Basic physics equations from earlier Chapters: Newton's laws, energy, momentum,…
Particular constants (density of fluid, heat capacity of fluid, latent heat for phase change …)	Relationship between pressure and force; fluid density; pressure within fluids; buoyant force; Bernoulli's equation
Unit conversion factors such atm to Pa, Cal to J, ^oC to K, …	Concept of temperature and its measurement scales; ideal gas law
	Definition of thermodynamic heat and work; first law of thermodynamics
	Molecular model of ideal gas law; internal energy of ideal gas
	Thermodynamic cycles and their efficiency

What to include on equation sheet – from Wave Motion

Given information on exam paper	Suitable for equation sheet
Particular constants (speed of wave …)	The wave equation and forms of its solution
	Traveling wave ←→ standing wave
	Standing wave frequencies on a string; standing wave frequencies in a pipe
	Relationship between standing wavelength on a string and the corresponding wavelength of sound
	The Doppler effect

iclicker question:

How have you found the equation sheet in past exams?

A. Not really helpful; did not use it during the exam
B. Very helpful during exam
C. A bad idea altogether

iclicker question:

For those of you who find the equation sheet helpful, how do you expect to prepare your sheets for the final exam

A. I will just bring the 4 sheets I have used in the past and add a few equations from wave motion
B. I will prepare new sheets

Review materials
- Past lecture notes
- Past exams
- Webassign
- Your textbook

Links to past reviews:
- Exam 1 review
- Exam 2 review
- Exam 3 review
- Exam 4 review

iclicker exercise:
How do you use the posted lecture notes?
A. I have never used them outside of class
B. They are not even helpful in class
C. They are only helpful in class
D. I find them somewhat useful outside of class

Review questions from Exam 4:

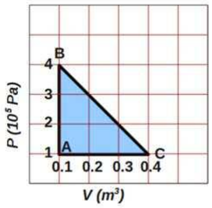
3. In this problem, we will assume that we have $n = 2$ moles of an ideal gas confined within a thermally insulated container having a volume of 0.1 m^3. The gas has an initial temperature of T_i=600° K. We will also assume that the internal energy of the gas is well modeled by the equation

$$E_{int}(T) = \frac{1}{\gamma - 1} nRT,$$

where in this case, the constant is given by $\gamma = 1.5$.

(a) What is the initial $E_{int}(T_i)$ of the gas?
(b) What is the change in the internal energy (ΔE_{int}) after heat in the amount of $Q = 6000$ J is added to the system in the constant volume and insulated container?
(c) What is the subsequent temperature of the gas within the container?

Review questions from Exam 4:



4.

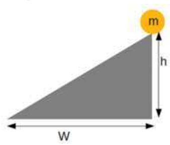
The graph above shows a $P - V$ diagram of a thermodynamic cycle on an ideal gas for $A \rightarrow B \rightarrow C \rightarrow A$. We will again assume that the internal energy of the ideal gas is well modeled by the equation

$$E_{int}(T) = \frac{1}{\gamma - 1} nRT,$$

where in this case, the constant is given by $\gamma = 1.5$.

(a) What is the net work done on the system each cycle?
(b) What is the net heat added to the system each cycle?
(c) What is the change in the internal energy of the system each cycle?

Review questions from Exam 3:



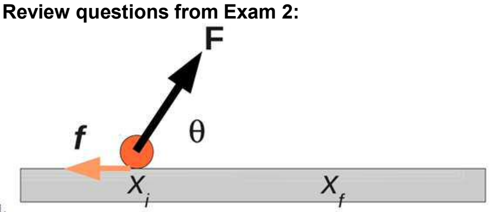
1.

This problem concerns notions of energy conservation as well as rotational motion. The figure shows an object with mass $m = 5kg$, radius $R = 0.04m$, and moment of inertia $I = 0.006$ kg·m^2, initially at rest on the top of an incline of height $h = 0.6$ m and width $W = 1.2$ m. The 2 questions involve 2 different conditions for the interaction of the object with respect to the surface of the incline. You can assume that the mass in the object is distributed so that the center of mass of the object coincides with center of the object.

(a) In the first case, consider what happens when the object slides down the incline without friction and without rotating.
   i. What is the initial energy (kinetic, potential, and total) of the system?
   ii. What is the final energy (kinetic, potential, and total) of the system when the object reaches in the end of the incline?
   iii. What is the final speed of the center of mass of the object?

(b) In the second case, consider what happens when the object rolls without slipping down the incline.
   i. What is the initial energy (kinetic, potential, and total) of the system?
   ii. What is the final energy (kinetic, potential, and total) of the system when the object reaches in the end of the incline?
   iii. What is the final speed of the center of mass of the object?
   iv. What is the final angular velocity of the object?

Review questions from Exam 2:

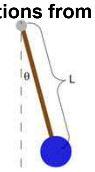


1.

The figure above shows an object of mass $m = 30kg$ which is being pulled along a horizontal surface by a pull force of $\mathbf{F} = 50N$ at an angle of $\theta = 70^o$ measured with respect to the horizontal, while a constant opposing friction force of $f = 3N$ is also acting on the object. Assume that that the object starts at position x_i at rest and the final position is given by $x_f = x_i + 4m$.

(a) What is the work done by the pull force $\mathbf{F}$ in moving the object from x_i to x_f?
(b) What is the total work done by the combination of the pull force $\mathbf{F}$ and the friction force f in moving the object from x_i to x_f?
(c) What is the final kinetic energy of the object when it reaches the position x_f?
(d) What is the final velocity of the object when it reaches the position x_f?

Review questions from Exam 3:



3.

The figure above shows a thin rod of length $L = 3$ m and of negligible mass. A mass m=5 kg is attached to the end of the rod. For the purpose of analyzing this problem, it is a good approximation to assume that the angular displacement θ measured in radians is small enough so that

$$\sin\theta \approx \theta.$$

(a) Initially, the rod-mass system is displaced from equilibrium by an angle $\theta(t = 0) = 0.26$ radians.

i. At $t = 0$, the rod-mass system is released from rest. Find the angular displacement $\theta(t)$ for $t > 0$. In expressing your answer, evaluate all of the parameters except for the variable time t.

ii. Find the maximum angular speed $\omega(t)$ of the rod-mass system.

iii. Find the maximum angular acceleration $\alpha(t)$ of the rod-mass system.

(b) Now the rod-mass system is connected to a motor which applies a harmonic driving torque of the form

$$\tau_{driving} = \tau_0 \sin(\Omega t),$$

where $\tau_0 = 1.5$ Nm and $\Omega = 2$ rad/s.

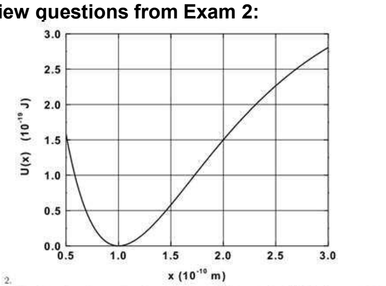
i. Show that a solution to the driving rod-mass system can be written in the form

$$\theta(t) = \Theta_0 \sin(\Omega t),$$

where Θ_0 is a constant (independent of time).

ii. Evaluate the magnitude of Θ_0 from the given information.

Review questions from Exam 2:



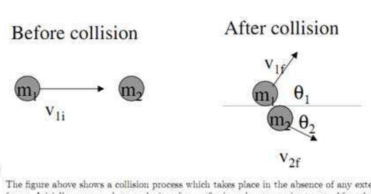
2.

The figure above shows a plot of potential energy U (in units of 10^{-19} Joules), associated with the conservative forces between two atoms in a molecule, as a function of their separation x in units of 10^{-10}m. For the purposes of this problem, we will focus on the motion and energy associated with the separation of the atoms, assumed to be confined to the x direction.

(a) What is the work by the interaction forces in the molecule as its separation changes from $x_i = 1 \times 10^{-10}$m to $x_f = 2 \times 10^{-10}$m?

(b) What is the kinetic energy of the molecule when its separation is $x_f = 2 \times 10^{-10}$m, if $K_i = 2 \times 10^{-19}$J at a separation of $x_i = 1 \times 10^{-10}$m?

Review questions from Exam 2:



3.

The figure above shows a collision process which takes place in the absence of any external forces. Initially mass m_1 has a velocity of $v_{1i} = 8$m/s and mass m_2 is at rest. After the collision, mass m_1 has a final velocity of $v_{1f} = 4$m/s, moving at an angle $\theta_1 = 60°$ with respect to its initial position and mass m_2 has a final velocity of $v_{2f} = 3$m/s, moving at an angle $\theta_2 = 30°$. It is known that mass $m_1 = 4$u (1 u $= 1.66 \times 10^{-27}$kg).

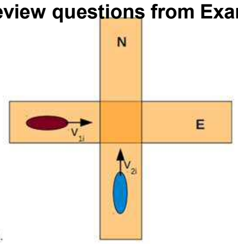
(a) Write down the equations that represent conservation of the two components of momentum in the plane of the collision.

(b) Solve one of the equations to find the mass m_2.

(c) Check whether the second equation is consistent with the same value of mass m_2.

(d) Is energy conserved in this collision?

Review questions from Exam 2:



4.

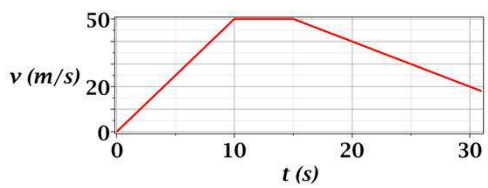
The diagram above shows two vehicles approaching an intersection. The vehicle labeled "1" has mass $m_1 = 1500kg$ and a velocity of $v_{1i} = 20m/s$ in the east (**E**) direction. The vehicle labeled "2" has a mass $m_2 = 2000kg$ and a velocity of $v_{2i} = 20m/s$ in the north (**N**) direction. The two vehicles collide in the middle of the intersection and stick together with the velocity of the combined system of $\mathbf{v_f}$ immediately after the collision. Assume that because of road conditions (small friction due to ice), it is a good approximation to assume that momentum is conserved immediately before and after the collision.

(a) What is the momentum of the two vehicle system before the collision?

(b) What is the momentum of the two vehicle system immediately after the collision?

(c) What is the velocity of the combined system of $\mathbf{v_f}$ (magnitude and direction) immediately after the collision?

Review questions from Exam 1:



1.

The figure above shows a plot of the one-dimensional velocity $v(t)$ versus time t of an object. Use this graph the determine the following:

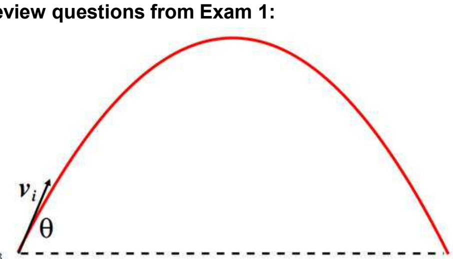
(a) What is the instantaneous acceleration at $t = 5$ s: $a(5s)$?

(b) What is the instantaneous acceleration at $t = 12$ s: $a(12s)$?

(c) What is the instantaneous acceleration at $t = 20$ s: $a(20s)$?

(d) What distance does the particle travel during the time $0 \le t \le 15s$: $[x(15s) - x(0s)]$?

Review questions from Exam 1:



3.

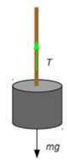
The figure above represents the $x-$ and $y-$ trajectory of a golf ball moving over a level field on the earth's surface (where the acceleration of gravity has the magnitude of $g = 9.8$ m/s^2). The initial velocity of the ball has the magnitude $|\mathbf{v}_i| = 30m/s$ and the initial angle above the horizontal is $\theta = 47°$.

(a) From the time that the ball leaves the ground, how long does it take the ball to reach it's heighest point?

(b) What is the heighest distance the ball reaches during the trajectory?

(c) What is the horizontal distance that the ball travels before it hits ground?

Review questions from Exam 1:



4.

The figure above shows an object having the weight of $mg = 1000N$ supported by a massless rope which has a tension T. The rope is attached to a crane.

(a) Suppose that crane accelerates the rope and object at a constant acceleration with magnitude 5 m/s^2 in the upward direction. What is the consequent tension T in the rope?

(b) Suppose that crane accelerates the rope and object at a constant acceleration with magnitude 5 m/s^2 in the downward direction. What is the consequent tension T in the rope?