Physics 121, Midterm Exam #3
Tuesday April 22, 2008
8.00 am – 9.30 am

Do not turn the pages of the exam until you are instructed to do so.

You are responsible for reading the following rules carefully before beginning.

Exam rules: You may use *only* a writing instrument while taking this test. You may *not* consult any calculators, computers, books, nor each other.

Answer the multiple-choice questions (problems 1 – 10) by marking your answer on the scantron form. For each multiple-choice question (problems 1 – 10), select only one answer. Questions with more than one answer selected will be considered incorrect. Problems 11, 12, and 13 must be answered in the blue exam booklets and need to be well motivated and expressed in terms of the variables used in the problem. **Answer questions 11 and 12 in booklet # 1 and question 13 in booklet # 2.** You will receive partial credit where appropriate, but only when we can read your solution. **Answers that are not motivated will not receive any credit, even if correct.**

At the end of the exam, you need to hand in your exam, the blue exam booklets, and your scantron form. **All items must be clearly labeled with your name, your student ID number, and your workshop day/time. If any of these items is missing, we will not grade your exam, and you will receive a score of 0 points.**

Name: _____

ID number: _____

Workshop Day/Time: _____

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Problem 1 (2.5 points)

Under what conditions does the equation $\sum \vec{\tau} = d\vec{L}/dt$ apply for a system of particles?

1. Under all conditions.

2. Only if the system consists of a single particle.

3. Only if the center of mass of the system is at rest.

4. If the quantities are calculated in an inertial reference frame or about the center of mass.

Problem 2 (2.5 points)

An object is spinning freely about a fixed axis when a small piece of its surface is ejected. The remainder will continue to spin with its initial angular velocity if the ejected piece leaves the surface with a velocity

1. that is directly away from the axis of rotation.

2. that is zero.

3. that is equal to the velocity of the center of mass of the initial object.

4. that is equal to its velocity on the surface of the object at the moment it is ejected.

Problem 3 (2.5 points)

What happens to the precession rate of a spinning top as the angular velocity of the top about its axis decreases?

1. The precession rate remains constant.

2. The precession rate decreases.

3. The precession rate increases.

4. It depends on the angle of tilt of the top.

Problem 4 (2.5 points)

The typical behavior of a solid that has reached its proportional limit is that the strain for a given increase in stress is

1. Greater than before the proportional limit is reached

2. Less than before the proportional limit is reached

3. The same as before the proportional limit is reached

4. Unlimited, as this the point at which the material fractures

Problem 5 (2.5 points)

A pencil standing vertically on its tip is an example of

1. Non-equilibrium

2. Stable equilibrium

3. Unstable equilibrium

4. Neutral equilibrium

Problem 6 (2.5 points)

What statement is necessarily true for a system that has no net torque and no net force acting on it?

1. The system is in static equilibrium.

2. The system is in stable static equilibrium.

3. The system is not in equilibrium.

4. The system is not undergoing translational or angular acceleration.

Problem 7 (2.5 points)

The acceleration of gravity at the surface of the moon is approximately one-sixth the acceleration of gravity at the surface of the earth. A pendulum at the surface of the earth has length L. On the surface of the moon, a pendulum with the same period will have a length

1. $6L$
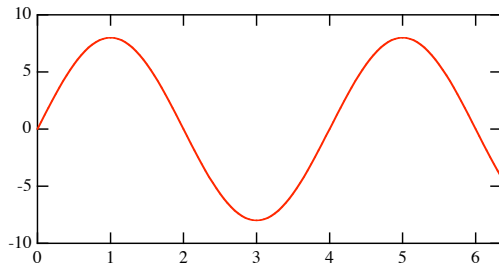
2. $L/6$

3. $36L$

4. $L/\sqrt{6}$

Problem 8 (2.5 points)

The amplitude of a damped harmonic oscillator decreases to half its initial amplitude in time t. How much longer does it take for the amplitude to reduce to one-fourth of its original amplitude?
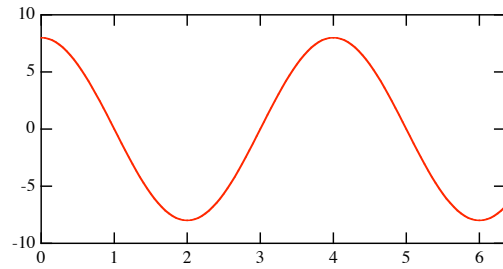
1. $t/2$

2. $t/4$

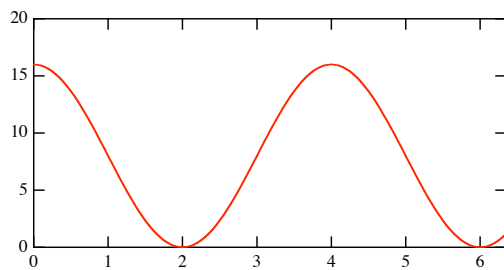3. $t \ln 2$

4. t

Problem 9 (2.5 points)

Which of the following graphs could represent the kinetic energy of simple harmonic motion as function of time?
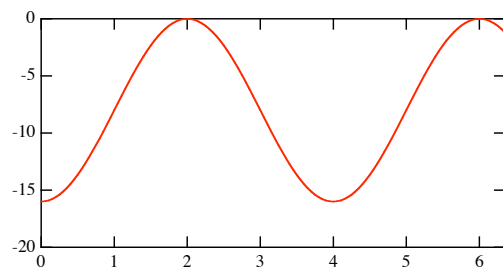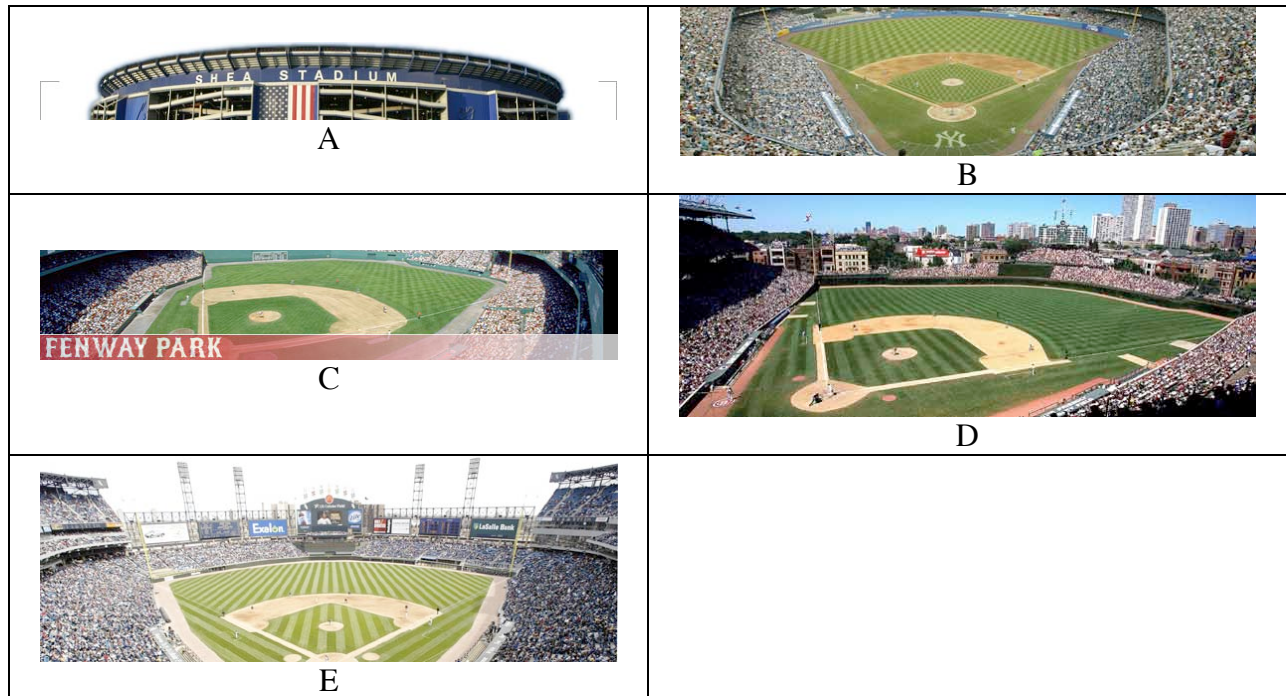
A

B

C

D

1. A

2. B

3. C

4. D

Problem 10 (2.5 points)

A	B
C	D
E	

Match the pictures of the ball parks shown above to the team names listed below.

1. Yankees

2. White Sox

3. Mets

4. Cubs

5. Red Sox
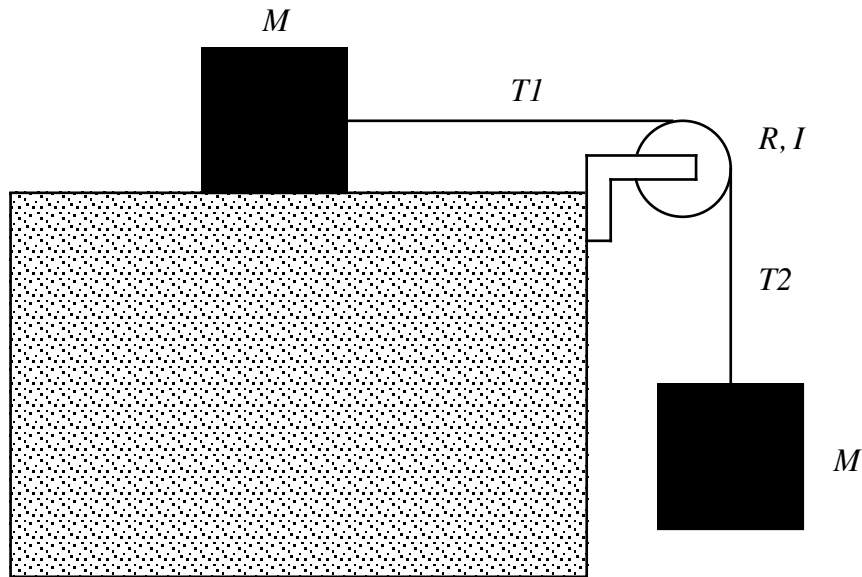
ABCDE =

1. 12345

2. 21453

3. 21534

4. 31542

5. 31254

6. 42351

Problem 11 (25 points)   **Answer in Exam Booklet 1**

Two identical blocks, each of mass M, are connected by a light string over a frictionless pulley of radius R and rotational inertia I (see Figure). The string does not slip on the pulley, and it is not known whether or not there is friction between the plane and the sliding block. When the system is released, it is found that the pulley turns through an angle θ in time t and the linear acceleration of the blocks is constant.
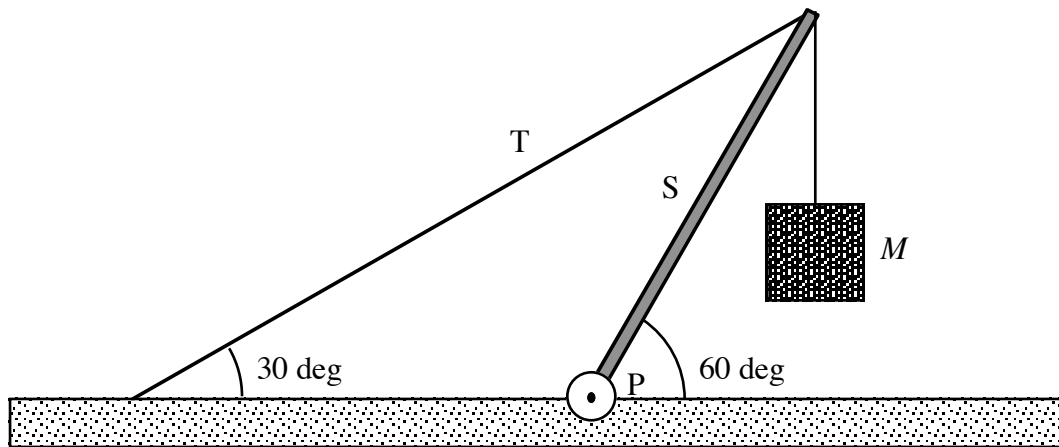

a) What is the angular acceleration α of the pulley?

b) What is the linear acceleration a of the two blocks?

c) What are the tensions T_1 and T_2 in the upper and lower sections of the strings?

Express all your answers in terms of M, R, I, θ, t, and g.

Problem 12 (25 points)   **Answer in Exam Booklet 1**

The system shown in the Figure below is in equilibrium. The mass of the block hanging from the end of the strut S is M, and the mass of the strut itself is m. The density of the strut S is homogeneous.
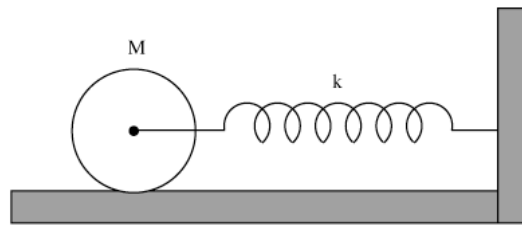

a) Find the tension T in the cable.

b) Find the horizontal and vertical force components exerted on the strut by the pivot P.

Express all your answers in terms of m, M, and g.

Problem 13 (25 points)   **Answer in Exam Booklet 2**

A solid cylinder of mass M is attached to a horizontal massless spring so that it can roll without slipping along a horizontal surface, as shown in the Figure below. The spring constant of the spring is k. The system is released from rest at a position in which the spring is stretched by a distance d.

a) What is the translational kinetic energy of the cylinder when it passes through the equilibrium position?

b) What is the rotational kinetic energy of the cylinder when it passes through the equilibrium position?

c) Under these conditions the center of mass of the cylinder executes a simple harmonic motion. What is the period of this motion?

Express all your answers in terms of M, k, and d.

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