

PHYSICS 221

NAME:

Final Exam (100 points)

May 9, 2007

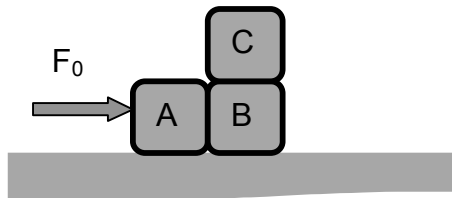
This is a closed book, closed notes 110 minute exam. You are allowed **two** 3 1/2" x 5" card of formulae.

Your Score	Your Grade
	/100

Multiple Choice
/25
Section

Short Answer Section (25 points)

Write the answer **and circle it**. Or circle the letter corresponding to the best answer. The grade will be based on the answer alone, so it is not necessary to show any work.



1 Three blocks of equal mass are pushed to the right across a frictionless table by a hand exerting force F_0 on the left-most block. Write down **all horizontal** contact forces (i.e. normal forces or friction forces) **between blocks** in **increasing** order of their **magnitude** (i.e. from smallest to largest). Include an equals sign (=) between any two that are equal.

/5

2. A potato chip falls out of a window 5.0 m above the ground. It begins from rest and hits the ground at its terminal speed of 2.0 m/sec. Among the following energies circle the one with the **greatest magnitude**. Circle more than one **if there is a tie** for the greatest magnitude.

/4

- A. The work done by gravity on the potato chip.
- B. The kinetic energy of the potato chip just before it hits the ground.
- C. Work done by the aerodynamic drag force on the potato chip.

3. A pipe of length L is open at both ends. The air in it oscillates at a fundamental frequency f_1 . Then a solid tube is inserted to block $1/3$ of the pipe. This creates a pipe of length $2L/3$ with one open end and one closed end. The air in this resonates at a fundamental frequency f_2 . How do these frequencies compare?

/4

- a. $f_1 = f_2$
- b. $f_1 > f_2$
- c. $f_1 < f_2$

4. Steve ($M=80.0$ kg) and his little daughter Alexia ($M=20.0$ kg) sit at opposite ends of a 2.0 m light wooden bench, resting on a frozen pond. At what point can you push the bench so that it will not rotate as it accelerates across the ice? Give the distance from Steve.

/4

5. A hollow sphere (i.e. a shell) and a solid sphere each have the same mass and the same radii. They are each spun to the same angular momentum. Which has greater kinetic energy?

/4

6. A bumble bee emits sound at a frequency of $f_b=400$ Hz. A soprano sings a pitch of $f_s=1000$ Hz. From an equal distance the soprano sounds **much louder** than the bee. Circle any and all true statements (you might circle more than one).

/4

- A. The sound waves from the soprano have **longer** wavelength than the bumble bee's waves.
- B. The sound waves from the soprano have **shorter** wavelength than the bumble bee's waves.
- C. The sound waves from the soprano travel **faster** than the bumble bee's waves.
- D. The sound waves from the soprano travel **slower** than the bumble bee's waves.
- E. The soprano **gets paid more** than the bumble bee.

Open Response Questions (75 points total)

Open Response

/75

Section

Notice: In this part of the exam, it is very important that you show how you obtained your answer. A complete answer will include a diagram, if appropriate. Circle your answer. Use the back if necessary.

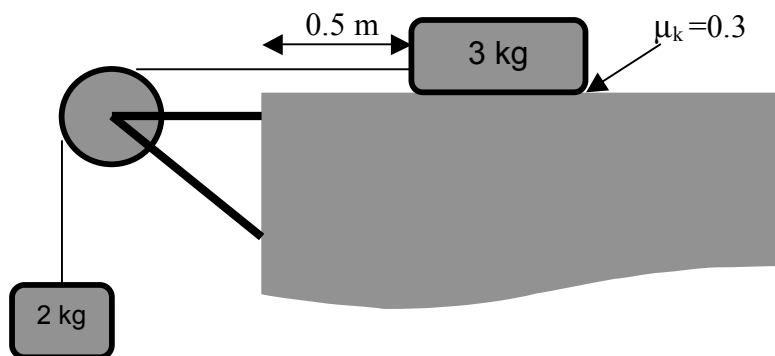
1. (10 pts) A 100 g bob hangs from the end of a massless string of unknown length. It swings in a horizontal circle whose radius is 30.0 cm, completing a rotation in 1.5 s.
 - a. Draw a free body diagram for the bob when it is at the extreme right.
 - b. What is the tension on the string?

/10

/15

2. (15 pts.) A thin, uniform 80 cm-long beam has mass 500 g by itself. It has a small 500 g lead weight fixed to its midpoint. It is pivoted at one end by a frictionless pivot. The beam and weight system is released from rest when the beam is **horizontal**.

- a. Find the moment of inertia of the system about the pivot.
- b. Find the angular acceleration of the beam **at the instant it is released**
- c. Find the magnitude and direction of the force **exerted by the beam on the pivot**, at the same instant.



3. (20 pts) A 2.0 kg mass hangs from a massless string, draped over a massless pulley. The other end of the string is attached to a 3.0 kg mass which slides across the table with a coefficient of friction $\mu_k = 0.30$. The sliding mass is released from rest when it is 0.50 m from the edge of the table.

/20

- Draw free body diagrams for both masses
- Find the acceleration of the sliding mass.
- How fast is the sliding mass traveling when it reaches the edge of the table?
- How much work did the friction do on that block?

4. (18 pts) A mass of 2.0 kg hangs at rest at the end of a 0.75 m string (assumed massless). It is then struck by a 20 g pellet. The pellet hits the mass going horizontally initially at a speed of 35 m/s, and bounces off, also horizontally, at 15 m/s.

- a. Find the speed of the mass immediately after it is hit.
- b. To what height does the mass swing?
- c. How long after it is hit does the mass take to reach its maximum height, (assume the mass swings only to very small angles.)

/18

5. (12 pts) A cylindrical bucket of water, 50.0 cm in **diameter**, has a hole in its side, 10.0 cm from the floor. The hole is 2.0 mm in **diameter**, and a stream of water is leaving it horizontally at a speed of 2.5 m/s.

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- a. Assume each bit of water is a point mass undergoing free-fall after leaving the hole. How far from the bucket does it travel before hitting the floor?
- b. The bucket is open so the water at the surface is at atmospheric pressure, $P=10^5 \text{ N/m}^2$. What is the level of the water in the bucket? (i.e. how high it is from the floor?)