

PHYSICS 221

NAME:

Midterm Exam #3 (100 points)

April 11, 2007

This is a closed book, closed notes 50 minute exam. You are allowed one 3 1/2" x 5" card of formulae.

Your Score	Your Grade
/100	

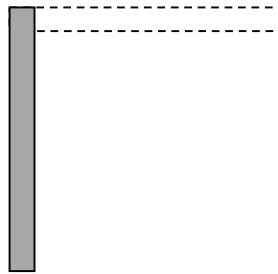
Multiple Choice
/28
Section

Short Answer Section (28 points)

Write the answer **and circle it**. Or circle the letter corresponding to the best answer. It is not necessary to show any work.

1. A uniform beam is supported at one end from a frictionless pivot. It swings from rest, at the horizontal, to a vertical position as shown. When it is vertical the force **exerted by the pivot** is

- A. Straight down
- B. Down and left.
- C. Down and right
- D. Straight up
- E. Up and left
- F. Up and right



/4

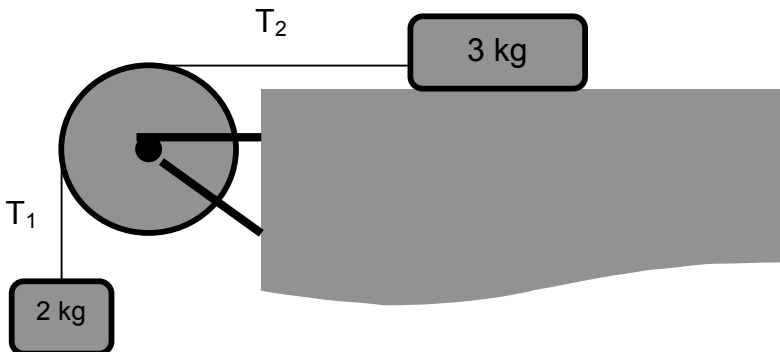
2. A force $\mathbf{F} = 2\text{N } \mathbf{i} - 1\text{N } \mathbf{j}$ acts at point $\mathbf{r}_f = 2\text{ m } \mathbf{j}$. Find the **torque about** the point $\mathbf{r}_o = 3\text{ m } \mathbf{i} - 1\text{ m } \mathbf{j}$

$\boldsymbol{\tau} =$

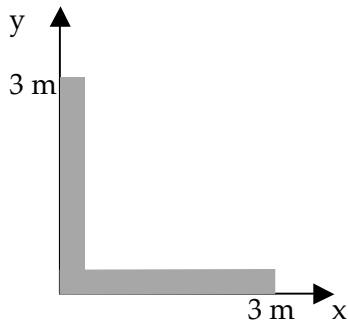
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3. Two blocks are connected by a string of negligible mass looped over a wheel of mass M as shown below. The string does not slip over the wheel. The heavier block slides across a frictionless table, while the lighter one is allowed to fall from rest. The wheel turns on a frictionless pivot supported from the table. How do the tensions on the two ends of string compare?

- a. $T_1 = T_2$
- b. $T_1 > T_2$
- c. $T_1 < T_2$



/4



4. A thin uniform 2 kg beam, 6 m long, is bent at the mid-point as shown above. What is the position of its center of mass.

/4

$\mathbf{r}_{cm} =$

.

5. For the bent beam above, what is the moment of inertia about an axis directed out of the page through the right-most tip ($\mathbf{r} = 3\text{m } \mathbf{i}$).

/4

$I =$

6. Three balls of the same mass are released from rest, to travel down an inclined plane. Two balls roll down the plane **without slipping**, and the third, made of frictionless material, slides down **without rolling**. The three balls are

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U: a **uniform**, solid ball which **rolls without slipping**

H: a **hollow** shell which **rolls without slipping**

F: a **uniform**, solid ball whose surface is frictionless. It slides along the plane **without rolling**

Rank the times take for the three balls to reach the bottom.

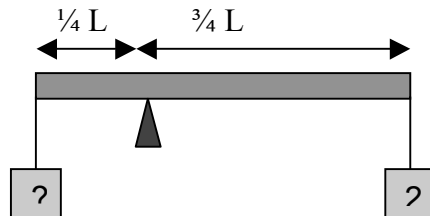
A: $t_U < t_H < t_F$

B: $t_H < t_U < t_F$

C: $t_H < t_U = t_F$

D: $t_H < t_F < t_U$

E: $t_F < t_H < t_U$



7. A uniform 2 kg beam is placed on a pivot at a point $\frac{1}{4}$ of its length from one end. An additional 2kg mass is hung from the long end. What mass should be hung from the short end to make the system balance?

/4

Open Response Questions (72 points total)

Open Response

/72

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.

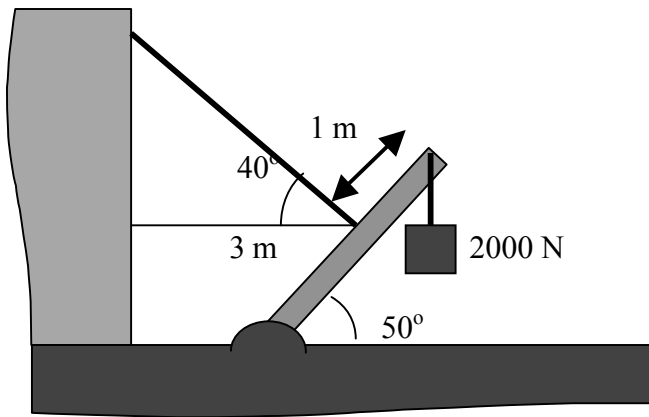
1. (18 pts) Jerry is sitting in a stationary sled on ice with $\mu_k = 0.3$; the mass of Jerry and the sled together is 80 kg. Bill, whose mass is 60 kg, jumps into the sled after building up a speed of 7.0 m/s. (His speed when he first lands in the sled).

- (a) How far do Jerry and Bill slide before coming to rest?
- (b) What is the **impulse** delivered by Bill?

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- 2. (18 pts.)** (a) Determine the acceleration of the center of mass of a uniform solid disk rolling down an incline making angle 30° with the horizontal.
- (b) What is the minimum coefficient of friction required to maintain pure rolling motion for the disk?

/18



3. (18 pts.) A 1 000-N uniform boom, 3.0 meters long, is supported by a cable attached 1.0 m from its end, as shown above. The boom is pivoted at the bottom, and a 2 000-N object hangs from its top.
- Find the tension in the cable
 - the components of the reaction force by the floor on the boom.

/18

/18

4. **(18 pts.)** A uniform sign of mass 2.0 kg hangs from a hinge along its top edge. Its vertical dimension is 75.0 cm down from that hinge. Some ne're-do-well shoots a 10.0 gm bullet through a point **50.0 cm from the top edge**. The bullet enters the stationary sign going 200 m/s, normal to the surface, and exits going 50.0 m/s. You may ignore the change in moment of inertia due to the hole made by the bullet.
- (a) What is the maximum angle made by the sign after it is shot?
- (b) How much energy is lost as the bullet rips through the sign?