PHYSICS 191 **CLASS 25** **Fall 2009**

5 November 09

ASSIGNMENT: Text, Chapters 9, 10 (We will not do Section 7 in Ch. 10.)

CONCEPTS:

1. parallel axis theorem (Ch. 9)
2. Gravitational potential energy of a rigid body equals the gravitational potential energy of the center of mass (Ch. 9, p. 301).
3. rotational inertia (or moment of inertia): The inertia of a rotating object depends not only on the mass, but on how that mass is distributed with respect to the axis of rotation
4. Torque and its relation to rotational inertia and angular acceleration. The rotational form of Newton II is Torque = $I\alpha$
5. Work-Energy Theorem as applied to rotational motion

TURN IN: Chapter 9, Exercises 9.45, 9.57; Problem 9.93; Chapter 10, Exercises 10.3 (see below for extra part), 10.16 (parts (a) and (b) only; see below); Problem 10.58; and the **Question** on the other side of the sheet; Extra Credit Problem 10.64

For Exercise 9.45: Think of the 500 J as the work done by the engine, and apply the work-energy theorem.

For Exercise 10.3: Add a second part: Assume the mass of the metal plate is 5 kg, and find the angular acceleration. (answer: 92.6 rad/sec^2)

For Exercise 10.16: For convenience, let the mass on the horizontal surface be M_2 and the descending mass be M_1. Begin by making a **careful** force diagram showing all forces acting on M_1, M_2, and the pulley.

(a) Explain carefully why the tensions T_1 and T_2 pulling in opposite senses on the pulley cannot be equal if the pulley has a finite rotational inertia.

(b) Show that the acceleration of the descending mass M_1 is given by

$$a = \frac{M_1 g}{M_1 + M_2 + \frac{I}{R^2}}$$

where I and R are respectively the moment of inertia and the radius of the pulley. Substitute numbers **only** after you have derived this result.

Hint: This problem is similar to Example 5.8 in Chapter 5, where we tacitly assumed that the pulley has a negligible moment of inertia. The analysis is also similar to that for the Atwood machine.

OVER

NOTES AND ANNOUNCEMENTS

1. There are three important sections in Chapter 10:
   - Torque and angular acceleration (Newton II for rotational motion); initially we consider rotational motion about a *fixed* axis.
   - Rotational motion about a moving axis
   - Angular momentum and conservation of angular momentum

2. The laboratory meets Tuesday, Wednesday, and Thursday of next week, 10–12 November, Days 4, 5, and 6. We will do Experiment 9, Rotational Dynamics (Part I only). This experiment should help with the ideas of torque and moment of inertia.
3. I am tentatively scheduling our next exam for Thursday 19 November. The exam will cover Chapters 9 and 10. I think this schedule will allow us to set aside Tuesday 17 November for review. But next week will be busy—don't get behind!

Question: The figure given below shows a meter stick, half wood and half steel. The version on the left is pivoted at the wood end at *O*. A force *F* is applied to the steel end at *a*, as shown. In the version on the right, the stick is reversed and pivoted at the steel end at *O* , and the same force applied to the wood end at *a*, as shown. Is the resulting angular acceleration of the meter stick on the left greater than, less than, or the same as that of the one on the right? Explain your answer **carefully**.