STUDY GUIDE 4: Equilibrium, Angular Kinematics, and Dynamics

Objectives

25. Define torque. Solve problems involving objects in static equilibrium.

26. Define angular displacement, angular velocity and angular acceleration. Given the graph or the functional form of one of the quantities versus time, determine the graphs of the other two. Describe in words and equations the motion from an analysis of one or more of the graphs.

27. Define moment of inertia, and solve problems involving rotational motion of rigid bodies subject to a net torque.

28. Calculate the angular momentum, relative to a specified axis, of a point mass traveling in a straight line.

29. Calculate the angular momentum of a rigid body whose angular velocity is specified.

30. Solve problems using the law of conservation of angular momentum.

Suggested Study Procedure for Chapter 11.

Study Sec. 10.1 first; then **Study** Secs. 11.1 and 11.3.
Study Example 10.1, and then Examples 11.2 through 11.4.
Answer Discussion Questions 2, 9, 11, 12 in Chapt. 11.
Do Exercises 10.1, 10.3, and then Exercises 11.5, 11.13, 11.15, 11.19.
Do Problems 49, 59, 65, 67, 73 in Chapt. 11.

A. So far we've ignored ONE LITTLE DETAIL about motion: that objects can ROTATE as well as TRANSLATE. We'll TURN to that little detail in this last section of the course. Perhaps you will be happy to hear that we don't really need any new theory for this. We just need to recast all of the old familiar ideas into angular terms. That's one of the things we'll be illustrating and emphasizing a lot in lecture and conference meetings.

B. We think that it is preferable to consider STATIC EQUILIBRIUM first before letting objects experience angular acceleration, so we're going to deviate just a bit from the order of topics in the text, first by studying Sec. 10.1 (for the definition of torque), and then by skipping to Secs. 11.1 and 11.3 (for the application of torque to static equilibrium situations). Note that the Problem-Solving Strategy on p. 349 applies to ALL of the work covered in Sec. 11.3. About all that changes from one problem to the next is the geometry of the situation! This is what takes some practice.

Suggested Study Procedure for Chapter 9.

Study Secs. 9.1 through 9.5.
Study the first nine examples in Chapt. 9, Examples 1 through 9.
Answer Discussion Questions 3, 4, 6, 7, 10.
Do Exercises 1, 7, 9, 13, 19, 23, 25, 39, 47.
Do Problems 83, 85, 87, 89.

A. As you study Secs. 9.1 through 9.4, keep in mind that ALL of the equations for rotational motion with constant angular acceleration are identical in form to those of one dimensional motion with constant linear acceleration. Table 9.1 is intended to help you learn the new set of angular symbols and to see how they are interrelated in constant acceleration situations.

B. MOMENT OF INERTIA plays a role in rotational motion similar to that of MASS in translational motion. We will emphasize the use of moment of inertia in rotational motion rather than the calculation of moment of inertia

for different bodies. On the other hand, we will expect you to be familiar with the expressions for the moment of inertia for our standard objects: the hoop, the uniform disk, the stick pivoted about one end, and the point particle at distance R from the rotation axis.

Suggested Study Procedure for Chapter 10.

Skim Sec. 10.1; **Study** Secs. 10.2, 10.4, 10.5, and 10.6.
Study Examples 2 and 3, and Examples 8-12.
Answer Discussion Questions 2, 3, 8, 10, 20, 21, 22.
Do Exercises 8, 13, 17, 27, 29, 40, 42, 43, 45.
Do Problems 64, 85, 87.

A. Study Sec. 10.2 with particular care. This section shows how to apply Newton's laws to problems involving rotation. Notice that the Free-Body Diagram is still an indispensable part of our problem-solving strategy!

B. Prior to this time we have ignored or neglected the effects of pulleys in problems other than their role in changing the direction of a force. Examples 10.2 and 10.3 show how a real pulley (with mass!) can affect a system.

C. ANGULAR MOMENTUM deserves more time than we can assign to it! Not only is it important in understanding all sorts of everyday situations but also in the study of phenomena from the sub-atomic way up through the astronomical. For now, however, we have to content ourselves with Secs. 10.5 and 10.6, and Examples 10.10 through 10.12, paying particular attention to the definition of angular momentum of a point particle (Eqn. 10.27), the definition of angular momentum of a rigid body (Eqn. 10.28), and the principle of ANGULAR MOMENTUM CONSERVATION (as shown in Examples 10.10 through 10.12). If you can stay focused, this should be enough coverage to help you understand the inner workings of many everyday angular motion situations that may have previously puzzled you.

LABORATORY WORK FOR STUDY GUIDE 4

Experiment #8 will give you practice in working with and doing calculations involving torque.
Experiment #9 will give you practice in relating rotational to linear motion, and vice versa.

Again, reading the instructions before going to the lab is helpful. See
http://www.wpi.edu/Academics/Depts/Physics/Courses/ph1110a13/ph1110a13Labs/.

HOMEWORK ASSIGNMENTS FOR STUDY GUIDE 4.

Reading Questions #13 – due in by **6AM Friday, Oct. 07. -** based on Sects. 9.1- 9.3

Homework Assignment #13 – due by **Noon** on **Tuesday, Oct. 08.**

Reading Questions #14 – due in by **6AM Friday, Oct. 09. -** based on Sects. 9.4, 9.5

Homework Assignment #14 – due by **Noon** on **Thursday, Oct. 10.**

Reading Questions #15 – due in by **6AM Friday, Oct. 11. -** based on Sects. 10.2, 10.4

Homework Assignment #15 – due by **Noon** on **Saturday, Oct. 12.**

Reading Questions #16 – due in by **6AM Friday, Oct. 14. -** based on Sects. 10.5, 10.6

Homework Assignment #16 – due by **Noon** on **Tuesday, Oct.15.**