

MASSACHUSETTS INSTITUTE OF TECHNOLOGY
Department of Physics

Physics 8.01

Spring 2005

PROBLEM SET 9

Saturday, April 2, 2005

Due Date: Thursday, April 7, 2005, 3:00 p.m.

Revised Version, 4/3/05, 9:30 pm: Shortened!!

Reading Assignment: Young and Freedman, Sections 10.1–10.6 (i.e., leaving 10.7 for next week); Busza, Cartwright, and Guth: pp. 312–320 of Chapter 9. While the *Study Guide* reading is the same as it was in the original version of this problem set, this week you will be expected to apply these concepts only to situations where all the motion takes place in a plane.

Topics for the week: Rotation of Rigid Bodies in Two Dimensions, Continued. Rotation about a moving axis (including rolling), work and power in rotational motion, angular momentum, decomposition of motion into motion of center of mass and rotation about the center of mass, and the conservation of angular momentum. You will be expected to understand the vector definitions of angular velocity, torque, and angular momentum, but the applications this week will be limited to two-dimensional motion. Gyroscopes are postponed until next week.

Instructions:

If a problem is marked **DO**, you should write a solution to hand in to be graded. The graders will read your answers to one or two questions on each problem set, and they will check whether the other problems have at least been handed in.

The quiz on this material, to be given at 10:05 am on Friday, April 8, will include at least one problem that is at most a slight modification of one of the problems (**DO** or **STUDY**) on this problem set.

Your written solutions are due by 3:00 pm in room 4-339B on Thursday, April 7. Please indicate the number, instructor, and time of your recitation section, and be sure to submit your paper to the correct bin. Solutions will be made available on the 8.01 website shortly afterward, so that you will be able to use them in studying for the quiz.

Angular Momentum in Two Dimensions

- 1) **DO:** SG:8D.2 (H) Rotation of a ruler about an off-center hole. Include also the extension of the problem in 8E.4, when the same ruler is allowed to swing from a horizontal rod. Skip the last part of the question, however, where it asks about pendulums and simple harmonic motion.
- 2) **DO:** Y&F:10.39 More things that you can do when your frictionless table has a hole in it
- 3) **STUDY:** SG:10.1 (S) A ball of putty hitting a pivoted stick. Assume that the pivot is completely frictionless.

— Problem Set continues on next page —

Rotation about a Moving Axis: Rolling

- 4) **STUDY:** SG:8E.8 (S) Rolling without slipping
- 5) **DO:** SG:9D.6 (H) Spinning wheels on an aircraft as it lands
- 6) **DO:** Y&F:10.24 Marble rolling in a bowl, with and without slipping
- 7) **STUDY:** SG:10.11 (S) Pulling a yo-yo along the floor by its string
- 8) **DO:** Y&F:10.98 The center of percussion of a baseball bat

Energy, Power, and Rotations

- 9) **DO:** Y&F:10.27 A child's work in pushing a merry-go-round
- 10) **DO:** Y&F:10.55 Energy and power for a wheel undergoing uniform angular acceleration

— End of Problem Set —

Problems to Hold Over:

The following problems are being held over for next week. They will be part of Problem Set 10, so you can start on them whenever you choose. They are not to be handed in this Thursday (April 7), and they will not be included on Quiz 9 (Friday, April 8).

Rotation, Angular Momentum, and Torque in Three Dimensions

- 11) **STUDY:** SG:9C.2 (S) Verifying that torque is the rate of change of angular momentum
- 12) **STUDY:** SG:9D.1 (S) A skewed rod on a turntable
- 13) **DO:** SG:9D.9 Rotating meteroid

Gyroscopes

- 14) **STUDY:** SG:9D.4 Motion of a gyroscope
- 15) **DO:** Y&F:10.48 Precession of a gyroscope and the force on its pivot