MASSACHUSETTS INSTITUTE OF TECHNOLOGY
Department of Physics

Physics 8.01L   Fall 2005

Problem Set 2: Equilibrium and Kinematics

Due Friday, September 23 at the start of class at 10am.

Please write your name, recitation number, and tutor name on the top right corner of the first page of your homework solutions. Please place your solutions in the Problem Set Solution hand-in bin at the entrance of the classroom.

Reading:
Young & Freedman Chapter 2 (Sections 2.1 – 2.5)
Young & Freedman Chapter 3
Young & Freedman Chapter 4 (Sections 4.5 – 4.6)
Young & Freedman Chapter 5 (Section 5.1)

This problem set will give you a chance to practice some (possibly rusty) math skills (including trigonometry and geometry) and also begin to work on basic kinematics.

Problem 1 How big is the Moon?
By viewing a full moon, you will find that the moon's diameter subtends an angle of about 0.5 degrees. (This means that two lines drawn from your eye to opposite edges of the moon have an angle of 0.5 degrees between them). The distance from the surface of the earth to the center of the moon is about 59 earth radii.
  a) Find the radius of the moon in terms of earth radii.
  b) How far from your eye would you need to hold a dime to just barely cover the Moon? (Does the width of your thumb cover the moon if you hold your arm out straight? The moon is next full on Sep. 18, but a partial moon is enough to judge the diameter.)

Problem 2 Geometry and Angles
  a) For each of the three figures below, clearly indicate all angles which are equal in size to the one marked α. The small boxes indicate right angles.

  b) What is the cosine of all numbered angles in terms of cos(α) or sin(α)?
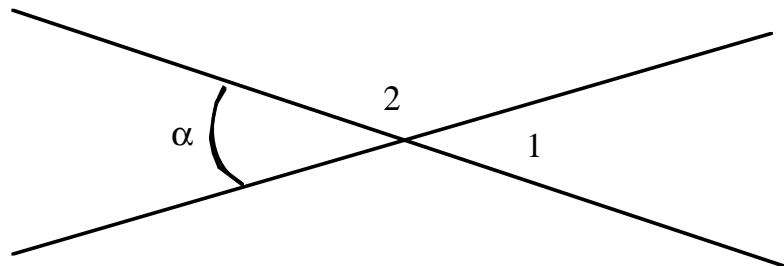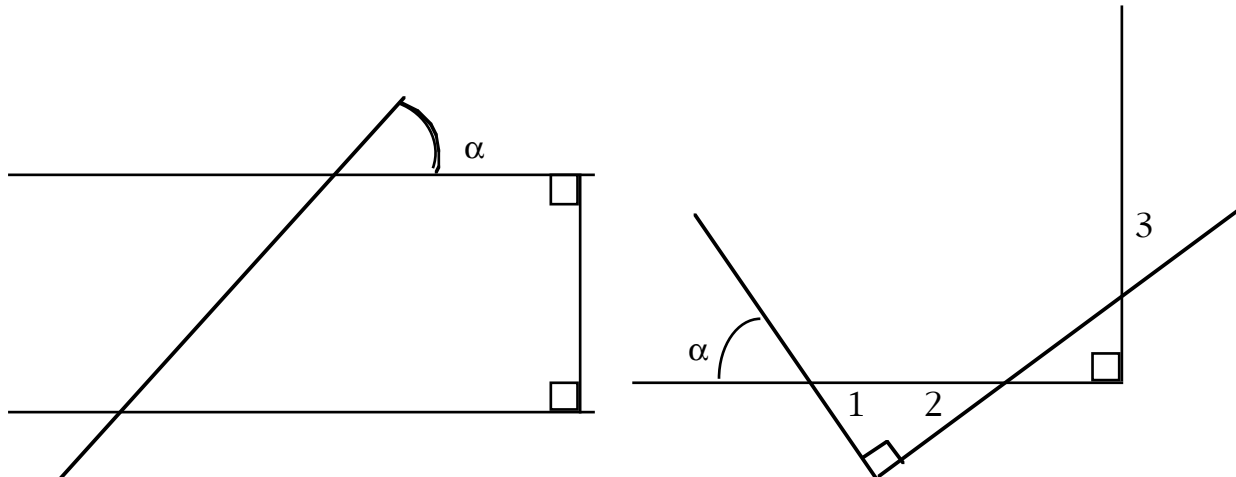
Problem 3 Hanging Lamp
Young & Freedman Problem 5.8 (Page 194)

Problem 4 Two Blocks
Young & Freedman Problem 5.13 (Page 194)

Problem 5 Safe Landing
Young & Freedman Problem 5.78 (Page 200)

Problem 6 Wow, that's fast!
A lesson in unit conversion and ship, plane, (and pilot!) requirements. In order to take off from an air-craft carrier, a plane is attached to a catapult which accelerates it from 0 to 160 mph (miles per hour) in 2.0 seconds. Assume that this acceleration is a constant value.
 a) Calculate the acceleration in meters per second squared and compare to the value of the gravitational acceleration near the Earth's surface (9.8 m/s^2)
 b) How long (in meters) must the deck of the aircraft carrier be?

Problem 7 Falling-apart Elevator
An elevator ascends with an upward acceleration of 1.75 m/s^2. At the instant its upward speed is 2.0 m/s, a loose bolt drops from the ceiling of the elevator 3.5 m from the floor. Calculate the time of flight of the bolt from the ceiling to the floor. Assume that the elevator continues its upward acceleration. (Use a frame of reference fixed with respect to the elevator shaft.)

Problem 8 Watch Out!
Young & Freedman Problem 2.66 (Page 75)

Problem 9 Was this in the movie?
Young & Freedman Problem 2.87 (Page 76)

Problem 10 Throwing Vegetables
A nasty teenager is dropping tomatoes from a bridge onto cars on the road below.
The height of the bridge (the point from which the tomatoes are dropped) is 10 m
above the ground. The teen first sees cars when they come around a corner which is
50 m away. All cars drive at exactly the speed limit of 40 kilometers per hour. You
may use g=10 m/s^2 to solve these problems.

a) How long after a car comes around the curve does she need to wait before
dropping a tomato to hit the hood of the car at a height of 1.0 m above the
ground?

b) After some time, the teen gets bored with just dropping the tomatoes. As a
challenge, she decides to throw the tomatoes straight up with some initial
velocity, v_0, rather than just dropping them. Assume she throws the tomatoes
1.5 s after she sees the cars. What value of v_0 is needed for the tomatoes to hit
the cars at the same height above the road?

c) Eventually, the teen gets bored with this new game and she decides to throw
the tomatoes straight down at an initial velocity of 15 m/s. Now, how long does
she need to wait after seeing the cars to hit them at the same height?

Problem 11 Cliff Diving
Young & Freedman Problem 3.12 (Page 110)