

MASSACHUSETTS INSTITUTE OF TECHNOLOGY
Department of Physics

Physics 8.01T

Fall Term 2004

In-Class Problems 7-10: Newton's Laws of Motion

Section _____ Table and Group Number _____

Names _____

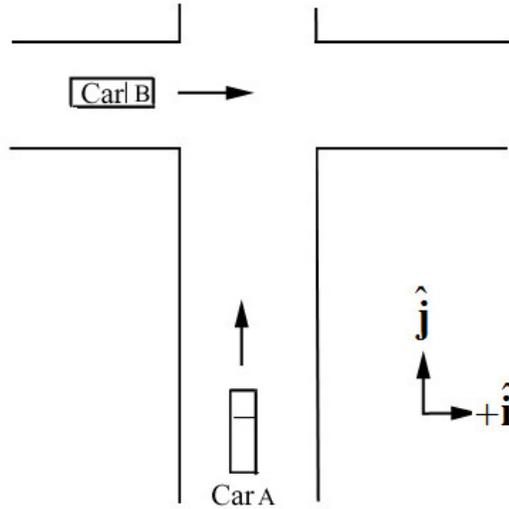
Hand in one solution per group.

We would like each group to apply the problem solving strategy with the four stages (see below) to answer the following two problems.

- I. Understand – get a conceptual grasp of the problem**
- II. Devise a Plan - set up a procedure to obtain the desired solution**
- III. Carry out your plan – solve the problem!**
- IV. Look Back – check your solution and method of solution**

In-Class Problem 7: Law of Addition of Velocities (Morning Session)

a) Suppose two cars, Car A, and Car B, are traveled along roads that are perpendicular to each other. An observer is at rest with respect to the ground. A second observer is in Car A. According to the observer on the ground, Car A is moving with a velocity $\vec{v}_A = v_A \hat{j}$, and Car B is moving with a magnitude of velocity $\vec{v}_B = v_B \hat{i}$.

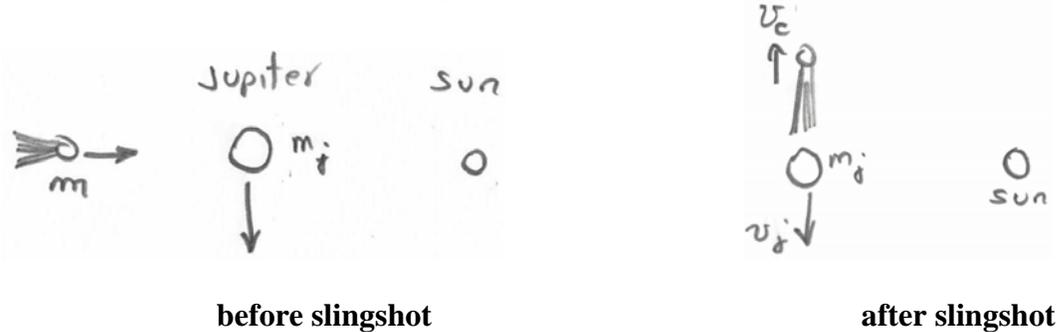


What is the velocity of Car B according to the observer in Car A? Express your answer as a vector, and in terms of the direction and magnitude of the velocity.

In-Class Problem 8: Gravitational slingshot

A comet of mass m is initially in the Oort Cloud which is a distance far enough away from the sun that you may approximate it as infinity. Due to random motions in the cloud, the comet picks up a negligibly small initial velocity but it now moves out of the cloud and heads directly towards the sun. Denote the mass of the sun by m_s . The planet Jupiter is directly in the way of the comet. Let m_j denote the mass of Jupiter. Assume Jupiter is in a nearly circular orbit around the sun with radius $r_{s,j}$ and has tangential velocity v_j , as measured in a reference frame at rest with the sun. When the comet reaches the orbit of Jupiter, the comet has a velocity, $v_c = \sqrt{2}v_j$ directed towards the sun. Jupiter's gravity changes the direction of the comet's path by 90° until the comet is moving opposite the direction of Jupiter's velocity. As seen by an observer moving with the planet Jupiter, the comet changes its direction but not the magnitude of its velocity v_c' .

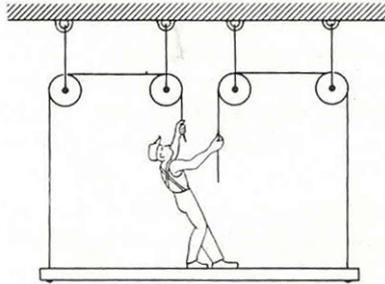
Reference frame at rest with respect to sun:



- As seen in a reference frame moving with the planet Jupiter, what is the magnitude of comet's velocity v_c' before the collision? Express your answer in terms of v_j .
- As seen in a reference frame at rest with the sun, what is the magnitude of the comet's final velocity after it's flyby of Jupiter? Did it speed up, stay the same speed, or slow down? Express your answer in terms of the initial velocity of the comet $v_c = \sqrt{2} v_j$

In-Class Problem 9: Painter on a Platform

A painter of mass m_1 stands on a platform of mass m_2 and pulls himself up by two ropes which hang over massless pulleys. He pulls each rope with a force F and accelerates upward with a uniform acceleration a . Find the acceleration a .



In-Class Problem 10: Glass on a tablecloth (Afternoon Session)

Consider a glass that is resting on top of a tablecloth. The glass has mass m_1 and the tablecloth has mass m_2 . Suppose the coefficient of static friction between the tablecloth and glass is given by μ_s , and the table is highly polished so it is nearly frictionless. What is the maximum force that the tablecloth can be pulled horizontally so that the glass and table cloth move together without slipping?