

Physics 141

Problem Set 5

Due Monday, Nov. 3 (hand in in class).

Monday, Oct. 27, 2008
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General: Organization, Web page, Labs, Syllabus: See the (yellow) P141 'Poop Sheet'.
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Quiz: There will be the usual quiz in the Tuesday discussion session time. Problems may cover friction, solving systems by parsing with Free-Body Diagrams, and simple collisions.
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Reading (not trivial- allow at least a whole evening, and you may have to read it twice):

Schey, Chapter 1. Also the section on 'The Del Notation' in Chapter 2, pp44-45. Finally, Chapter 3, from p. 63 to 'Path Independence' on p. 71.

K&K: Chapter 4, Sections 4.1-4.7 inclusive (but do NOT read Examples 4.2 4.4 and 4.10).
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Study Groups You are strongly encouraged to discuss the problems in a study group to save time. However, the work you hand in has to be your own- you must **NEVER** copy anybody else's work! (grounds for severing your connection).
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Problem Solving: Please always work in symbols and only plug numbers in at the end where and if required. In general you should start by drawing a careful picture, with labelled axes..
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Problem 1: Conservation of \mathbf{E} and \vec{p}

Consider a muon (think heavy electron) traveling at velocity $\beta = 0.995$ ($\gamma = 10$). Suppose the muon decays to an electron and a photon such that in the muon rest frame the electron and photon directions are perpendicular to the direction of the muon motion. Take the muon mass to be 100 MeV, and ignore the electron mass (0.5 MeV). (Disclaimer: no muon has never been observed to decay this way, and the present upper limit is less than 1 in 10^{11} muon decays. Why it's forbidden we don't know (extra credit if you solve this).)

1. Draw a picture with labeled axes;
2. Find the electron and photon momenta in the muon rest frame;
3. Transform the electron and photon momenta to the 'lab' frame.

Problem 2: Kinematics of Constant Acceleration

Consider a circus roustabout shot from a cannon at an angle of 45^{deg} . If she goes a horizontal distance L how high did she go?

Problem 3: Line Integrals Schey, Problem III-4 Part a)

Problem 4: Work and Energy

A rectangular box of mass 100 kg sits on a loading dock. How much work does it take to tip the box up on one edge (not the corner) so that the diagonal of a side face is vertical? The dimensions of the box are 2m high, and 1m wide in both horizontal dimensions.

Problem 5: Momentum Conservation: A Collision

A hockey puck sliding down ice at 50 m/sec strikes a second identical hockey puck at rest. The first puck exits the collision at an angle of 30^{deg} to its initial direction. a) Set up the equations for the final velocities. b) Find the angle that the second puck exits the collision.

Problem 6: Momentum Conservation: Another Collision, and C of M (F. Merritt)

A tennis ball is hit horizontally at the back of a truck moving directly away along the direction of the ball. The truck is going 40 mph; the ball is traveling at 80 mph. Find the velocity of the ball after it bounces off the back of the truck. (you might want to transform to the truck's frame).

Problem 7: Newton's Laws and Friction (from K&K- hard)

On a sailboat the tension of a sheet (rope) which transmits the force of a sail is taken up by a winch, which consists of a cylindrical capstan around which the line is wrapped several turns. A member of the crew (called a 'tailer') puts a tension on the end of the line exiting the winch. Show that the force with which the tailer has to pull on the 'tail' of the line (T_T) is related to the pull of the sail (T_S) by:

$$T_T = T_S e^{-\mu\theta} \tag{1}$$

where μ is the coefficient of friction of the line on the capstan, and θ is the total angular extent of the line around the capstan (e.g. one turn is 2π , 2 turns is 4π , etc.).

Problem 8: Force as $d\vec{p}/dt$ (also hard).

A chain of length l m is dangled (held) over a table such that the lower end just touches the table. The upper end is then released. Calculate the force on the table as the chain falls on it.

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