Name _____

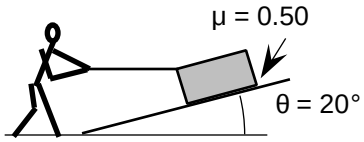
PLEASE READ THIS FIRST: Work the problems on separate sheets of paper and staple this sheet to the front. Read each problem carefully. Show your work and/or give explanations for *all* answers. Make sure that all numerical answers are given with a reasonable number of sig figs and that you have included appropriate units. Check your answers for physical *reasonableness* whenever possible. I do give partial credit, but *only* if I can follow your work, so try to be clear about what you are doing.

1. [10 pts] A hiker walks 10 miles straight north, then turns and walks 20 miles in a direction 30° to the east of south. How far and in what direction does she have to walk to return to her starting place? (Make sure that your answer makes *sense* by drawing a reasonably accurate diagram showing the entire walk.)

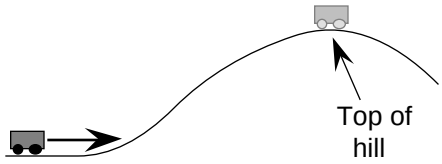
2. [10 pts] An 1800 kg car entering the freeway accelerates uniformly from rest to 100 km/hr in a distance of 0.20 km. What is its acceleration in $m/s^2$?

   [5 pts Extra Credit] What average output power does the engine develop to do this?

3. [20 pts] A freight handler is pulling a box down a 20° incline with a horizontally-oriented rope as shown in the figure at right. The incline has a kinetic coefficient of friction of 0.50 and the handler pulls with a force equal to 10% of the weight of the box. Is the box speeding up or slowing down? (Full credit only for answers that include a determination of the acceleration. Lots of credit simply for a complete and correctly drawn free body diagram and for the corresponding component equations of Newton's second law.)




4. A roller coaster car moving at 20 m/s encounters a hill whose top is 15.0 m higher than its current position and is in the form of a circular arc with an 8.0 m radius.

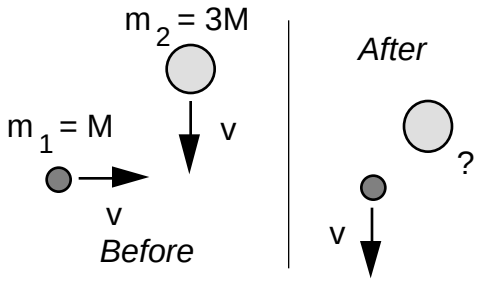



   a) [10 pts] How fast will it be traveling at the top of the hill? (Assume that friction is negligible.)

   b) [10 pts] If the mass of the car and its occupants is 2500 kg, what force (magnitude *and* direction) will the track have to exert on the car at the top of the hill?

(over for problems 5 and 6)

5. Two particles, one with a mass three times that of the other, collide. Just before the collision, they move at right angles to each other with the same speeds. As shown, the collision deflects the lighter particle by 90° clockwise from its original direction of motion without changing its speed.



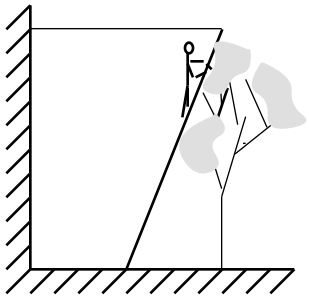

   a) [14 pts] Find the velocity—magnitude *and* direction—of the heavier particle after the collision. (Express the magnitude in terms of v.)

   b) [2 pts] Through what angle was the heavier particle deflected from its original direction of motion?

   c) [4 pts] Was this an elastic collision?

   d) [5 pts Extra Credit] *If* the collision had been *perfectly inelastic*, what percentage of the original kinetic energy would have been lost?

6. To trim a tall but fragile tree, an 80 kg man attaches the top of a 30 kg ladder to his house by a line and leans the ladder 20° off vertical toward the tree with the line extended horizontally. He climbs 3/4 of the way up the ladder to work on the tree. The ladder receives negligible support from the tree.



   a) [12 pts] What is the tension in the line? (Hint: All you need is torques about the lower end of the ladder. Draw a good free body diagram of the ladder.)

   b) [8 pts] What is the minimum required static coefficient of friction between the ladder and the ground? (Hint: You will need to find the normal and frictional forces on the ladder.)

   c) [5 pts Extra Credit] In specific terms of torques and/or forces, why would leaning toward the tree without going any higher on the ladder increase the danger that the line might break or the ladder might slip?