Name:________________________

Test 1
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1) (25 points) A 60kg rider on the super slide at the state fair has the following trajectory measured in meters: $\vec{\mathbf{x}}(t) = (3t)\hat{\mathbf{x}} + (24 - (29/5)t + (11/25)t^2 - t^3/100)\hat{\mathbf{y}}$.
   a) What is the rider's position at the start (i.e., t=0)?
   b) What is the rider's position at the end, 24 seconds later?
   c) What is the rider's total displacement?
   d) What is the rider's average velocity?
   e) What is the velocity vector as a function of time?
   f) What is the speed at t=12s?
   g) What is the acceleration vector as a function of time?
   h) Is the acceleration constant?
   i) Is there a time during the 24s ride when the acceleration is zero? If so, what time?
   j) What is the force on the rider?
   k) Is there a time during the 24s ride when the force is zero? If so, what time?
   l) We will later learn that the power is the dot product of the force and the velocity. What are the units of power and what is the value of the power at t=1s?

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2) (25 points) The vertical thrust (force) from the engine on a 2kg model rocket is $\vec{\mathbf{F}}(t) = 214(\text{N/s})t\hat{\mathbf{y}}$. The rocket starts (t=0) from rest on the ground at $\vec{\mathbf{x}} = \vec{\mathbf{0}}$. The thrust is applied only for first 2s. (hint: Assume that gravity is constant.)
   a) What is the net force on the rocket during the first 2s?
   b) How high does the rocket travel during the first 2s?
   c) What is the velocity after 2s?
   d) What is the net force on the rocket after 2s when the engine is off?
   e) What is the maximum height that the rocket reaches?
   f) Estimate the diameter of the earth. What is the ratio of the rockets maximum height to the diameter of the earth?
   g) (Extra Credit: 3 points) How long is the rocket in the air from take off to landing?

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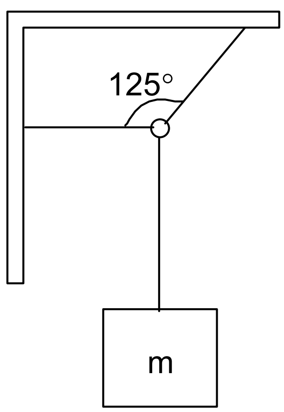
3) (25 points) You hang a mass m using massless rope as shown.
   a) If m=10kg what is the tension in each of the three ropes?
   b) If each rope is rated to hold a 500N weight, what is the largest m that the arrangement can hold without breaking?
   c) If you slowly increase the mass until it is larger than that calculated in part b, which rope will break first?



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4) (25 points) You place a 214g book on the hood of your freshly waxed car. The hood has a constant slope of 21 degrees. The static coefficient of friction μ_s is 0.2 and a kinetic coefficient of friction μ_k is 0.1 between the book and the car hood.
   a) Will the book slide off of the car?
   b) Would a 10kg rock placed on top of the book keep it from sliding off?
   c) Would placing a rough piece of paper between the book and the hood to increase the static coefficient of friction to 0.5 keep it from sliding off?
   d) If you place the book 1.4m from the edge, how long will it take for the book to slide off of the car?