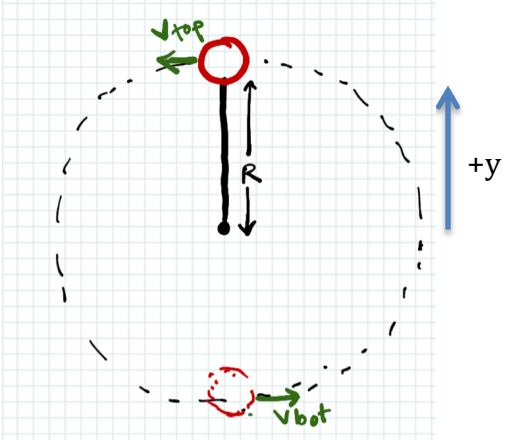
Name: _____

Midterm 2 Practice Exam

1. [25 pts] A yo-yo is being swung in a vertical circle, as shown in the diagram to the right, where acceleration due to gravity points downward. The radius of the circle is R = 0.5 m.



   a. [4 pts]At the top of the circle, the yo-yo is moving at a velocity of 4 m/s. Draw a free body diagram for the yo-yo at the top of the circle.

   b. [5pts] What is the tension in the string at the top of the circle?

   c. [4pts] At the bottom of the circle, the yo-yo is moving at a velocity of 6 m/s. Draw a free body diagram at the bottom of the circle.

   d. [5pts] What is the tension in the string at the bottom of the circle?

   e. [4pts] What would the tension of the string be at the bottom of the circle if the yo-yo trick was being performed in an elevator accelerating downward at 2 m/s^2?

   f. [3 pts] What would the tension of the string be at the bottom of the circle if the yo-yo trick was being performed in an elevator moving upward at a constant velocity of 5 m/s?

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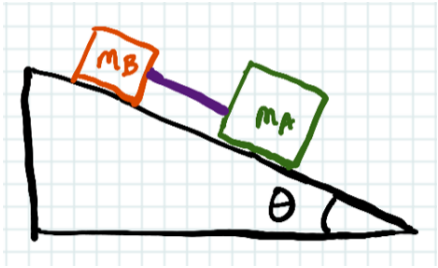
2. [30 pts] Two blocks are connected by a string as shown in the diagram on the right. Here m_A = 4.00 kg, m_B = 2.00 kg, μ_{kA} = 0.300, and μ_{kB} = 0.400. The ramp angle θ is 30 degrees.



a. [5 pts] Draw a free body diagram for block A. Label your forces.

b. [5pts] Draw a free body diagram for block B. Label your forces.

c. [5 pts] Which block experiences a larger net force? Explain your answer.

d. [8 pts] Find the acceleration of the system down the plane.

e. [7 pts] Find the tension in the connecting string.

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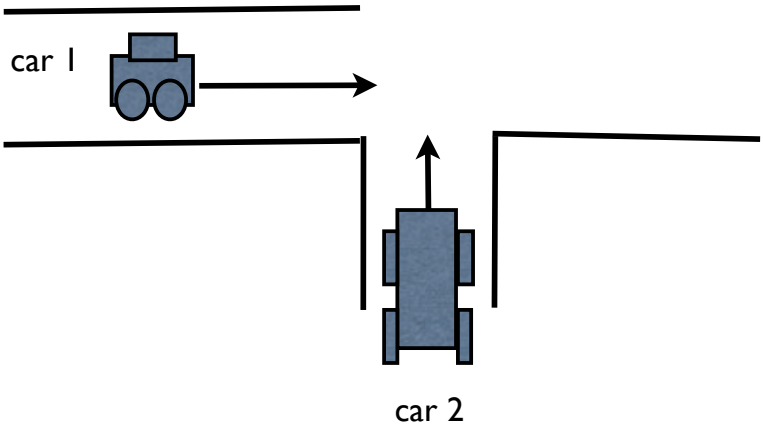
3. [25 pts] Car 1 of mass 900 kg traveling east at 22 m/s collides with a Car 2 of mass 1200 kg which is heading north at 28 m/s as shown in the diagram. After the collision the cars stick together to form a single wreck. Denote the easterly direction as the x axis and north as the y direction.



a) (5 pts) What are the x and y components of the total momentum of the system before the collision?

b) (5 pts) What will be the total x and y components of momentum after the collision? Calculate the speed of the combined wreck after the collision. At what angle (in degrees) relative to the x axis does the wreck move after the collision?

c) (5 pts) During the collision car 1 exerts an average force on car 2 whose magnitude F12 is 15000 N. What is the magnitude of the force exerted by car 2 on car 1? Describe the relative directions of these two forces.

d) (5 pts) If these forces act for approximately 0.5 s, calculate the impulse associated with F12.

e) (5pts) After the wreck, imagine that one of the passengers looks into the sky and sees a spaceship traveling at a significant fraction of the speed of light. The ship is moving at such a speed in the passenger's frame that its measured length is one-third its proper length. How fast is the spaceship moving relative to the passengers frame?

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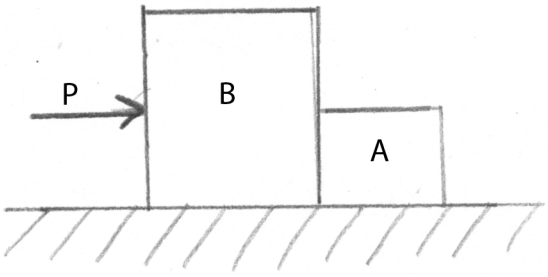
4. [25 pts] A truck flipped over and spilled its contents onto a frozen lake. Members of the clean-up crew are pushing boxes across the frictionless, flat surface of the frozen lake. Left the positive x-axis point to the right across the surface of the lake. *You must show all of your work to receive full credit.*

a) [4pts] A worker gives a little push to Box B (with mass m_B). She exerts a force F in the positive x direction over a time Δt. Write an expression for the velocity v_B of Box B after the push.

b) [4pts] Box B bumps into Box A, which is initially at rest. Box A has mass $m_A < m_B$. The two boxes stick together and continue to move across the ice. Write an expression for the velocity of the pair after they are touching one another.

c) [4 pts] The pair of boxes bump into another worker (with spiky shoes), who brings them to a complete stop. She then begins to push them together across the ice with force P, as shown in the figure. Draw the free body diagram for box A. Label your forces with 2 subscripts indicating which body the force acts on and which body is supplying the force.



d) [4 pts] Draw a free body diagram for box B. Label your forces as described in part a.

e) [4 pts] Which box experiences the larger net force? What is the direction of this force? Explain your answer.

f) [5 pts] If the mass of box A is 1/4 that of box B, the boxes accelerate at a rate a_1. If the mass of box A is ½ that of box B, what is the acceleration a_2 of the boxes? (Write a_2 in terms of a_1.)