PHYS 121: Third Hour Exam

June 25, 2008

Do not begin this exam until instructed to do so. Please complete this form and read the rules on this cover sheet now.

`Your Name:________________________________________________`

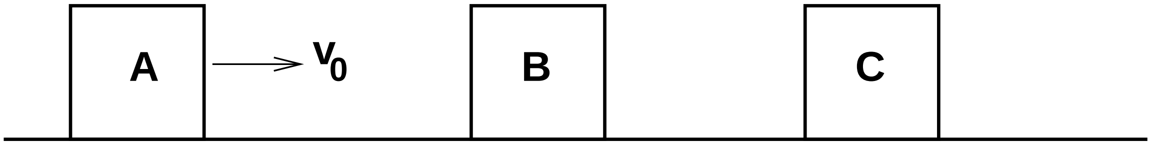
Rules for Exam:

This exam is worth either 10 or 15 percent of your grade. You have 80 minutes to complete the exam. You are allowed one textbook. You are also allowed one $8\frac{1}{2} \times 11$ sheet of hand-written notes (both sides). Answer all questions. Show your work. Partial credit will be awarded for cases where you have progressed toward the correct answer. If you have a question on the wording of a problem or the interpretation of a problem, raise you hand and a proctor will come to you. Write your answers on the pages provided. Calculators are okay, but no PDA's or laptops.

1. Relax. Don't panic.
2. Put a box around your final answer. Use English words.
3. Be as clear as possible when you are working the problems. It helps to draw a picture or say in a few words what you are doing. You will be awarded partial credit for knowing how to solve the problem even if you cannot successfully implement that solution. State clearly the central physics concept associated with each problem. Explain your work. The correct answer alone is worth nothing.
4. You will receive most of the points if you set up the problem clearly and correctly. If you make a math blunder or plug in the wrong numbers at the end, this will cost you a relatively small number of points.
5. Take your time. Do not rush your work. Presentation counts. Neatness counts. Illegible or very untidy answers will be graded as simply wrong. Irrelevant or hostile comments are grounds for lost points. Do not annoy the graders. Show that you care about your work. Go slow, take care, and pace yourself so that you can keep your work organized.

Problem 1	Problem 2	Problem 3	Problem 4	**–Total– Score**

Problem 1: Collisions (25 points)



Three blocks, *each* with mass m are placed on a frictionless surface as shown above. Block A has initial velocity v_0 while the other two blocks are *initially* at rest. Then the following happens:

- First Collision: Block A collides with Block B and this collision is *totally inelastic*.
- Second Collision: Block B collides with Block C and this collision is *totally elastic*.

Part (a): Determine the final velocity of every block immediately after the First Collision.

Part (b): Determine the final velocity of every block immediately after the Second Collision.

Part (c): Suppose we define V_{CM} as the velocity of the Center-of-Mass of the *entire system* of three blocks, A, B, and C. What is V_{CM} just *before* the First collision. What is V_{CM} just *after* this First Collision? What is V_{CM} just *after* this Second Collision?

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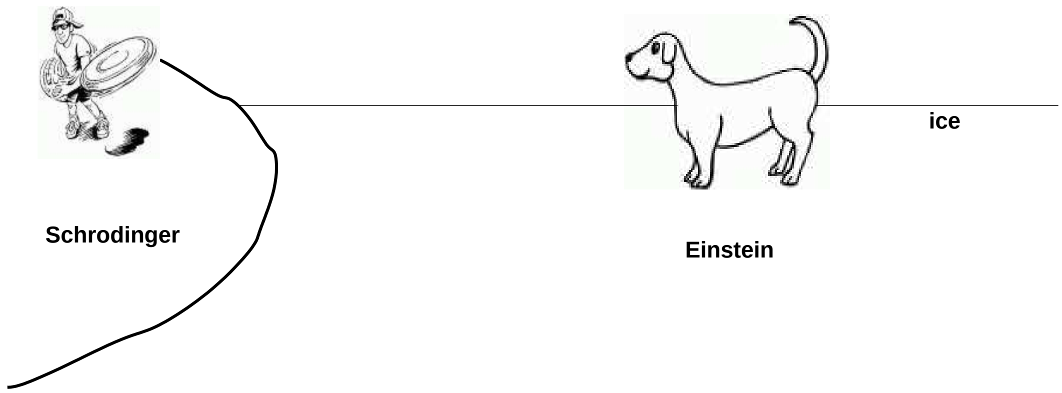
Problem 2: Rotations and Systems (25 points)



On a warm day in late winter Schrodinger is tired of playing with his cat. He takes his dog, Einstein to the lake which has frozen into glare ice (virtually no friction). Einstein stands on the frozen lake and Schrodinger stands on the shore and throws a Frisbee flying disk to him. The mass of the disk is 1.43 kg. The radius of the disk is 12.4 cm. The disk leaves Schrodinger's hand with a translational velocity of 6.37 meters per second and a rotational speed of 14.21 radians per second. Einstein catches the frisbee. His mass is 31.3 kg and his moment of inertia is 40 times that of the Frisbee.

For this problem (except possibly for part e) assume that the Frisbee travels in a straight horizontal line and ignore any vertical components of the motion of the Frisbee. Also ignore any horizontal forces due to air friction.

Part (a): What is Einstein's rotational velocity after catching the Frisbee? Explain your answer.

Part (b): What is the total kinetic energy of the Frisbee after it is thrown?

Part (c): What is the velocity of the center-of-mass v_{cm} for the Frisbee-Einstein system after the Frisbee has been caught, as seen in Schrodinger's frame of reference?

Part (d): What is the velocity of the center-of-mass v_{cm} for the Frisbee-Einstein system after the Frisbee has been caught as seen in Einstein's frame of reference?

Part (e): The Frisbee will not fly properly unless it is thrown with considerable spin. Explain this fact in three sentences or less. Hint: your answer should have something to do with angular momentum.

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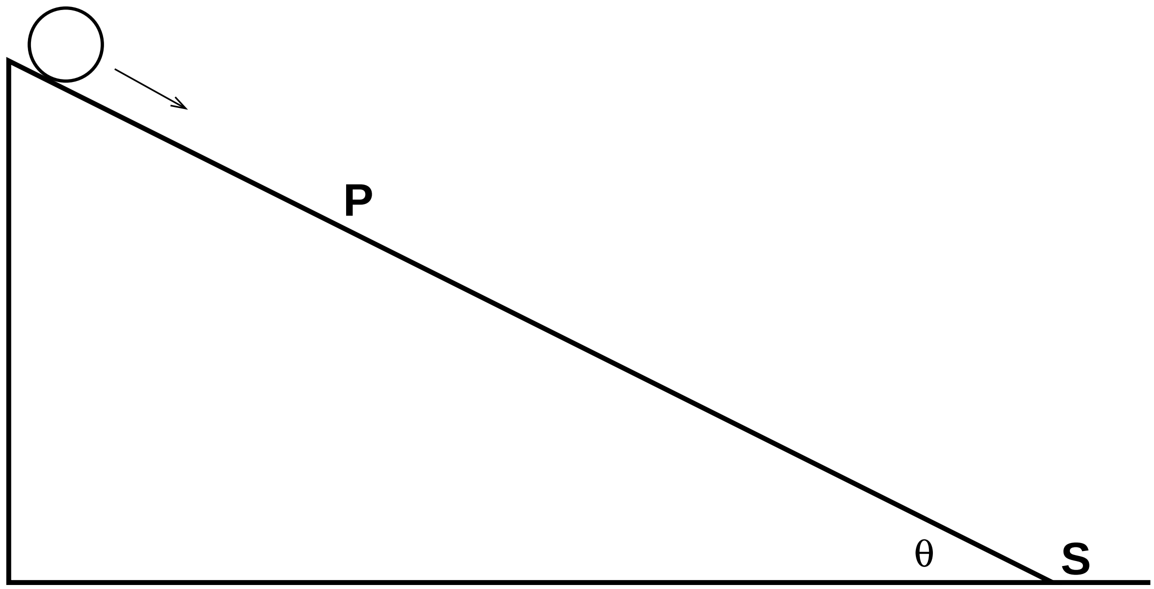
Problem 3: Sphere on a Ramp (25 points)



A solid metallic sphere is placed on the top of a ramp as shown above and then rolls without slipping down the ramp, past point P to the bottom of the ramp at point Q. The angle of the ramp is given as θ. The initial position of the sphere is *unknown*, but the distance between P and Q is given by L and the speed of the sphere at point P is measured to be v_p. The rotational inertia of the sphere sphere is $I_s = \frac{2}{5}mR^2$ where m is the mass of the sphere and R is the radius of the sphere. Again, assume that θ, L, v_p, m, and R are all given and that the initial starting position of sphere is unknown. Neglect air resistance.

Part (a): (15 points) Determine the *linear speed* of the sphere v_q when it reaches point Q. Your answer should be in terms of the given parameters. Explain your work.

Part (a): (10 points) Conceptual question: Suppose that we replace the solid shell with a *hollow* spherical shell that has *half* the mass of the solid sphere but the same radius. What will be the impact of this change on the calculated speed v_q at point Q? Will the hollow shell be going faster, slower, or at exactly the same speed as we calculated for the solid sphere in Part (a)? Explain. Hint: You do *not* need to know the exact value of the rotational inertia of a hollow shell to determine the answer to this problem. No detailed calculations are required for this part.

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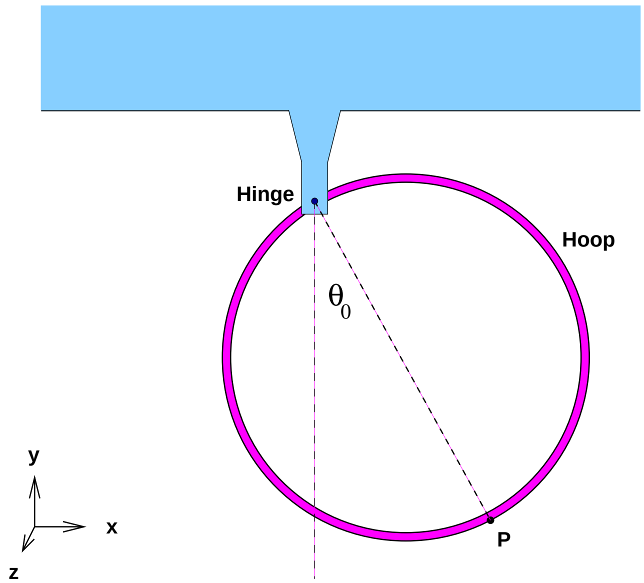
Problem 4: A New Pivot Point (25 points)



A hula-hoop of radius R and mass M is attached to an ideal hinge as shown in the figure above. The hoop is positioned at an angle θ_0 and released. Note that we define a coordinate system, where y is a vertical coordinate and z is the horizontal coordinate the points "out of the page".

Part (a): – [5 points] Determine the net torque on the hoop calculated about the hinge point immediately after it is released. Your answer should be given in term of given parameters R, M, and θ_0. You need to clearly indicate both the *magnitude* and the *vector direction* of the torque in terms of the coordinate system given. Explain your answer.

Part (b): – [10 points] What is the angular acceleration α of the hoop in the instant after it has been released? Explain your answer.

Part (c): – [10 points] Suppose there is a small fleck of paint on the outer edge of the hoop at point P as shown. What is the maximum speed of the paint fleck at some time after the hoop has been released? Explain your answer.

Extra Space for Problem 4:

More Extra Space for Problem 4: