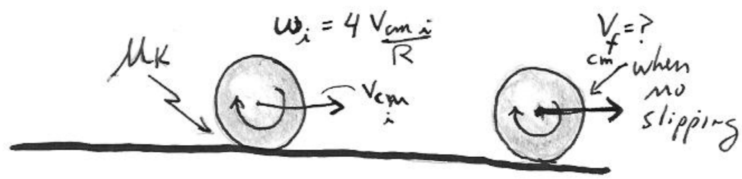
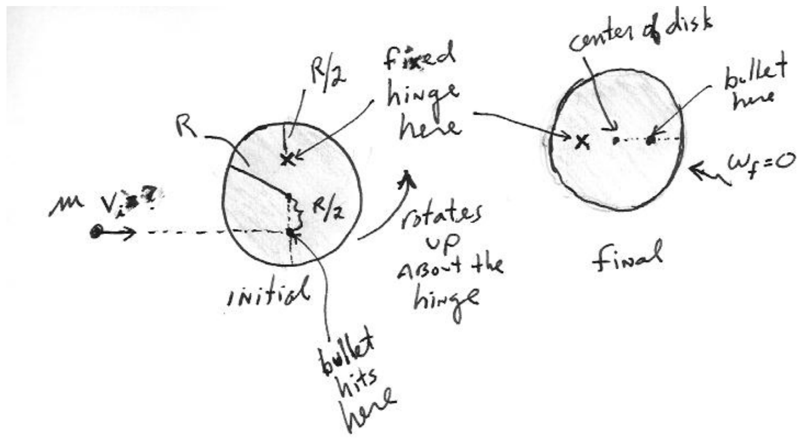
Physics 4A Exam 2 Fall 2011 Name___________________________

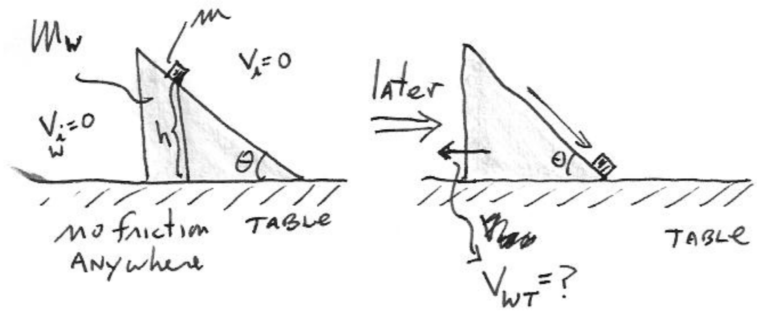
1. (25 points) A bowling ball is given a forward angular velocity and a forward center of mass velocity such that they are related by the equation $\omega_i = 4\, V_{cm\ i} / R$. Where R is the radius of the ball. Let the rotational inertia of the ball be $2/5MR^2$. The ball is given this initial motion as it touches the ground and there is sliding friction with μ given. Note that the relation between the initial angular velocity and the center of mass initial velocity (which is not zero!) means that necessarily there must be slipping between the ball and the ground. Eventually the ball will stop slipping and will then roll with no slipping. **Find the velocity of the center of mass when the ball starts to roll without slipping.** Your final answer will be in terms of the initial velocity of the center of mass only.



2. (25 points) A disk (rotational inertial about an axis through its center of $I_{cm} = \frac{1}{2} M R^2$) is hinged to rotate about an axis that is halfway between its rim and its center. A bullet of mass m_b has an unknown velocity aimed toward the disk such that it will embed in the disk at a point that is a vertical distance below the center of the disk that is halfway between the center and the bottom of the disk's rim. The bullet hits the disk, imbeds in the disk, and then the two together rotate about the hinge upward. **Find the initial speed of the bullet (before the bullet hits the disk, gravity on the bullet is irrelevant *before* it hits the disk) such that the two rotate up to where the bullet is horizontally even with the hinge but no farther.** Treat the bullet as a point mass.



3. (25 points) A wedge of mass M_w makes and angle θ as shown in the diagram. There is no friction in this problem. A mass *m* is a distance *h* above the table that the wedge rests on. The mass is released from rest and slides down the wedge to its bottom at the table's surface, but the wedge is free to slide horizontally along the table (the wedge is not held fixed by any applied forces and the initial velocity of the wedge is also zero). **Find the speed of the wedge just before the mass touches the table.**



4. (25 points) Refer to the diagram. Two "massless" springs of equal stiffness, *k*, are attached to a bead of mass M that is constrained to move only in the horizontal direction by a wire. There is no friction in this problem and gravity is irrelevant. By the diagram, when the bead is at the position L, both springs are relaxed and the bead is in an equilibrium position. But if the bead was released from rest a distance D to the left of the equilibrium position, the springs would be stretched and would pull the bead back to the equilibrium position and the bead would then have a velocity at the position L. **Find the speed of the bead when it returns to the position L after having been released from rest at D.**