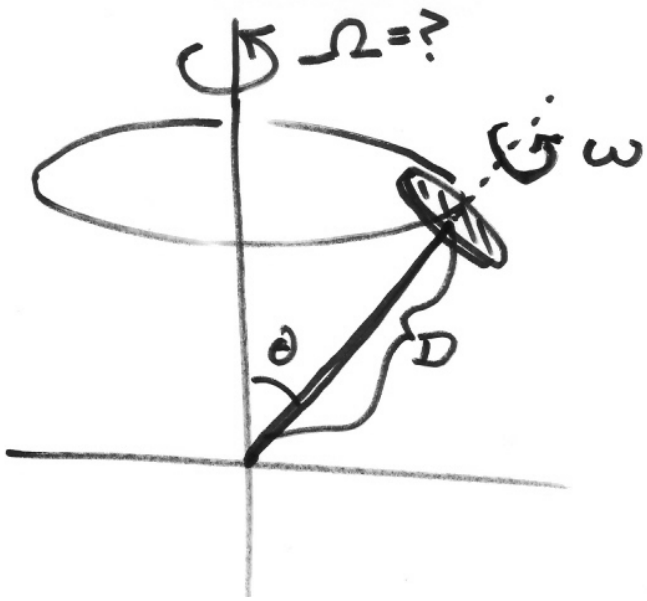
4A Final Exam Winter 2009 Name_____

1. (10 points) Two bodies (m_1 = 3 kg and m_2 = 6 kg) are about to make a one dimensional collision. In the lab frame, the initial velocity of m_1 is +4 m/s (let to the right be positive) and the initial velocity of m_2 is zero. After the collision the velocity of m_1 is -2 m/s. **Find the change in the total kinetic energy (from before to after the collision) of both masses together as the system in the center of mass frame and verbally interpret what kind of collision this is.** Your final answer would be a number. You may assume the two masses are not influenced by any external forces.

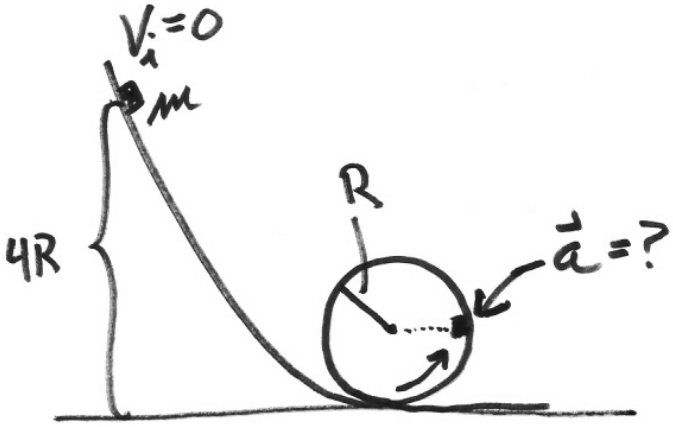
2. (10 points) **Derive the precessional angular velocity Ω of a disk** spinning with an angular velocity ω of mass M and radius R and rotational inertia ($I_{disk} = \frac{1}{2} M R^{2)}$ that makes an angle to the vertical given as θ.The disk rotates about a massless stick of length D.



3. (10 points) A mass *m* is attached to a spring of stiffness *k* such that it can undergo simple harmonic oscillation on a frictionless horizontal surface. Using Newton's second law and a proposed solution to it in this case of : $x(t) = A\sin(\omega t)$, (where $\omega = 2\pi f$), **derive the formula that gives the period, T, of the oscillation of the mass.**

4.(10 points) An object of mass *m* is in a circular orbit about a fixed planet of mass M with a radius of orbit R. From this orbital radius, **by what factor does its orbital speed (speed not given) need to be increased such that it will never return to the planet when infinitely far away?**

5. (10 points) A mass *m* is released from rest at a height above the ground of 4R. It slide down the ramp without friction and goes around the "loop" as shown in the diagram. **When the mass is at the "3 o'clock" position find the magnitude and direction of its acceleration vector.**



6. (10 points) There is friction in this problem. A mass *m* is at rest on an inclined plane. The plane is tilted at an increasing angle until the mass *just* begins to slip along the plane. The angle at which the mass just begins to slip is give as θ_{max}. From this information, **find the coefficient of static friction between the mass and the plane.**

7. (10 points) A mass is released from rest a vertical distance H above a relaxed spring (in a vertical position) of stiffness *k*. The mass hits the spring.and begins to compress it. **Find the maximum speed the mass ever attains.**