1. A 5 Kg mass moves under the influence of a force $\mathbf{F} = (4t^2\mathbf{i} - 3t\mathbf{j})$ N where $t$ is time in seconds. It starts from the origin at $t = 0$ with zero velocity. Find: (a) its velociy; (b) its position; and (c) $\mathbf{r} \times \mathbf{v}$, for any later time.

2. A particle of mass $m$, tied by an inextensible light string is rotating in a circular trajectory in a vertical plane. The speed at the top of the trajectory is $v_0$. See diagram.

   (a) Draw free body force diagram for the particle.

   (b) Write down the equations of motion in polar coordinates.

   (c) Find the tension in the string as a function of the angle $\theta$.

3. A mass $m$ is connected to a vertical revolving axle by two strings of length $l$, each making an angle of 45° with the axle. Both the axle and mass are moving with a constant angular velocity $\omega$.

   (a) Draw a force diagram for $m$.

   (b) Find the tension in the upper string, $T_{up}$ and lower string, $T_{low}$.

4. A 45° wedge is being pushed along a table with constant acceleration $A$. A mass $m$ slides without friction on the wedge. Find its acceleration.

5. A car is driven on a large revolving platform which rotates with constant angular speed $\omega$. At $t = 0$, the car leaves the origin and follows a line painted radially outwards on the platform with constant speed $v_0$. Total weight of the car is $W$ and the coefficient of friction between car and the platform is $\mu$.

   (a) Find the acceleration of the car as a function of time.

   (b) Find the time at which the car starts to skid.

   (c) Find the direction of the frictional force when the car starts to skid.

6. A particle of mass $m$ is free to slide on a thin rod. The rod rotates in a plane about one of its ends with constant angular velocity $\omega$. Show that the motion is given by $r = Ae^{-\omega t} + Be^{\omega t}$. Neglect gravity.

   Show that for a perticular choice of intial position and velocity, it is possible to obtain a solution such that $r$ decreases, but for any other choice, the $r$ will eventually increase.

7. A block of mass $m$ slides on a frictionless table. It is constrained to move inside a ring of radius $l$ which is fixed to the table. At $t = 0$, the block is moving along the inside of the ring with a tangential velocity $v_0$. The coefficient of friction between ring and the block is $\mu$. Find the velocity and position of the block at later times.

8. The system of massless pulleys and ropes is shown in the figure. The coefficient of friction between the masses and horizontal surfaces is $\mu$. Assume that both $M_1$ and $M_2$ are sliding. Draw force diagrams. Find the tension in the rope.

unaware of gravity. Which "mechanical" experiment will help him decide whether his frame is inertial or not?