Tutorial Sheet - 2

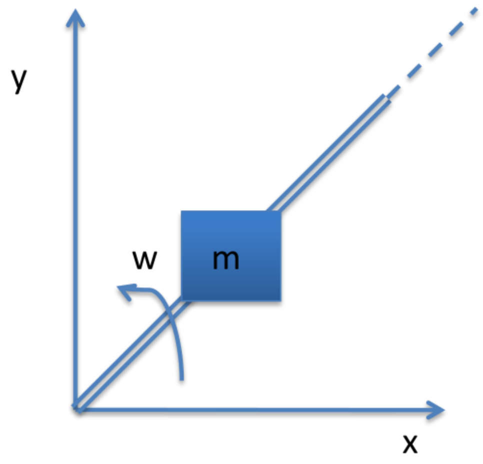
FIRST SEMISTER 2014
PHYSICS-101

Date: 11.08.2014 Tut. Sheet **02**

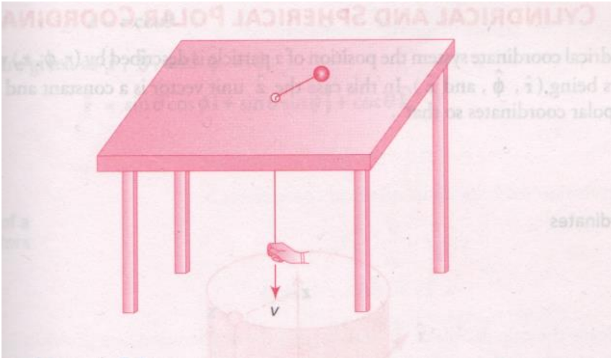
1. Consider two situations given below:
   (i) a particle moving in circle, and
   (ii) a particle moving in the positive y-direction along the line x=2 with speed v.

   Using polar coordinates, calculate the acceleration of the particle in the two given cases.

2. A bead of mass m can slide without friction on a straight thin wire moving with constant angular speed w in a horizontal plane. If the bead is released at r=R with zero initial radial velocity, describe its subsequent motion and also find the horizontal force applied by the wire on the bead.



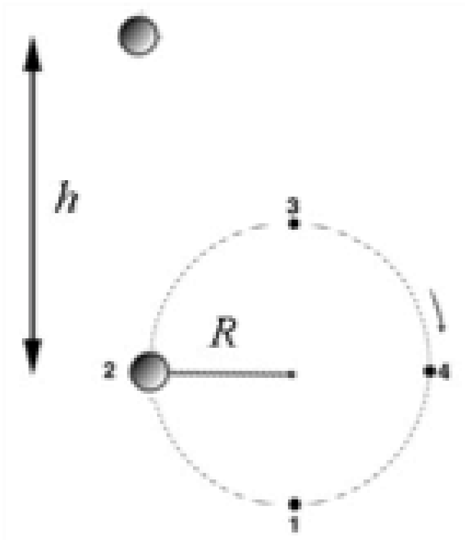
3. A particle, tied to a string, is moving on a smooth frictionless table in a circle of radies ‘r ‘with an angular speed ‘w’. The string is pulled in slowly through a hole in the middle of the table with constant speed ‘v’. Find the change in its speed as a function of time and also the force required for the string to be pulled.



4. A particle moves outward along a spiral. Its trajectory is given by $r = A\theta$, where A is a constant. $A = (1/\pi)$ m/rad. θ increases in time according to $\theta = \alpha t^2/2$, where α is a constant.

    a. Sketch the motion, and indicate the approximate velocity and acceleration at a few points.
    b. Show that the radial acceleration is zero when $\theta = 1/\sqrt{2}$ rad.
    c. At what angles do the radial and tangential accelerations have equal magnitude?

5. A stone (or a ball in the demo), attached to a wheel and held in place by a string, is whirled in circular orbit of radius R in a vertical plane. Suppose the string is cut when the stone is at position 2 in the figure, and the stone then rises to a height h above the point at position 2. What was the angular velocity of the stone when the string was cut? Give your answer in terms of R , h and g .



6. Express the force (along the radial and tangential directions) of an object in terms of polar co-ordinates.
   (*Hint: Use the derivation discussed in the class for acceleration*).

7. In the class, we learnt about centripetal acceleration and understood its importance with the help of a real time example. Using these principles, you have to show that the centripetal acceleration of a particle moving in a circle is $\frac{v^2}{r}$.
   (*Hint: To do this, draw the position and velocity vectors at two nearby times, and then make use of similar triangles*).

8. Adelina Sotnikova (know who?) moves in a circle of constant radius 3 meters with a constant angular velocity of 2 radians per second. Use the polar co-ordinates and find out the expressions for the position, velocity and acceleration as functions of time.

9. Find the Cartesian equation of the curve $\frac{2}{r} = (1 + \cos\theta)$