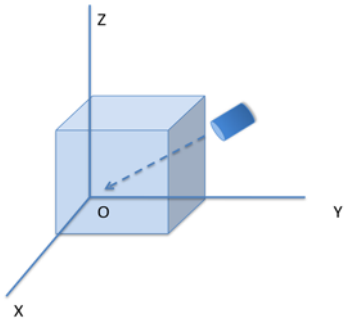
Mahindra ÉCOLE CENTRALE
College Code XJ

Tutorial Sheet
FIRST SEMISTER 2014
PHYSICS-101

Date: 05.08.2014 Tut. Sheet **01**

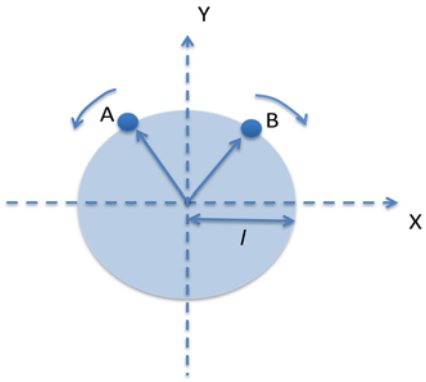
1. Bond angle of methane molecule can be calculated by assuming that the methane molecule fits in a cube such that the carbon atom is at the centre and four H atoms at non-adjacent corners of the cube. Calculate angle between two C-H bonds.

2. A rectangular room is 5 m long, 4 m wide and 4m high. Take one of the corners of the room to be the origin, and set up an XYZ coordinate system there. A fly sitting at the centre of the floor of this room has a speed of 0.5m/sec. Consider cases where it flies straight towards one of the corners of the room.

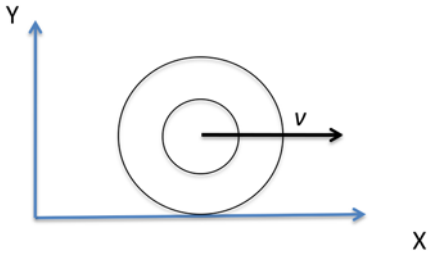


3. A golfer takes three putts to get the ball into the hole. The first putt displaces the ball 3.66 m north, the second 1.83 m south- east, and the third 0.91 m southwest. What are (a) the magnitude and (b) the direction of the displacement needed to get the ball into the hole on the first putt?

4. Particles A and B move in opposite directions around a circle with angular speed ω, as shown in fig 1.30. At t=0, both the particles are at $\hat{i}\hat{j}$. Find the velocity of A with respect to B at a later time t.



5. A tire rolls in a straight line with out slipping. Its centre of mass moves with constant speed V. A small pebble lodged in the tread of the tire touches the road at t=0. Find the pebble's position, velocity and acceleration as functions of time.



6. Jai is at x = 0 m at t = 0 s when he sees Viru at x = 6 m.

    a. Jai begins to run towards her at v = 5 m/s. Viru, in turn, begins to accelerate towards him at a = -2m/s^2. When and where will they cross? Sketch their motions by measuring time on the horizontal axis and position on the vertical axis.
    b. Suppose, instead, that Viru moved away from Jai with *positive* acceleration a. Find a_{max}, the maximum acceleration for which Jai can catch up with him. For this case find the time t of their meeting. Show that for smaller values of a these star-crossed lovers cross twice. Draw a sketch for this case. Explain in words why they cross twice.

7. At t=0 an object is released from rest at the top of a tall building. At the time t_0 a second object is dropped from the same point.

    a. Ignoring air resistance, show that the time at which the objects have a vertical separation s is given by

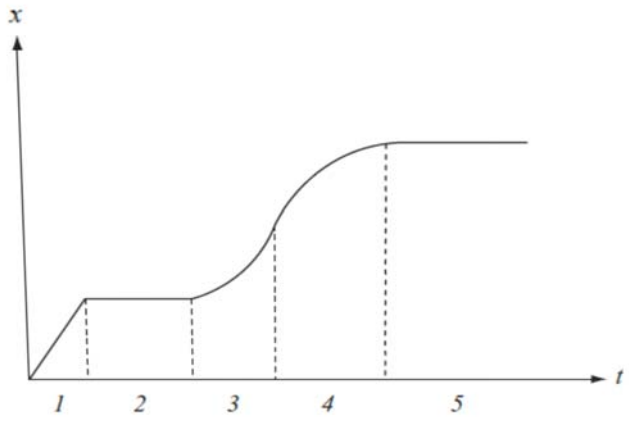
$$t = \frac{s}{gt_0} + \frac{t_0}{2}$$

How do you interpret this result for $s < \frac{gt_0^2}{2}$?

b. The above formula implies that there is an optimum value of t_0 such that the separation s reaches some specified value s_0 at the earliest possible value of t. Calculate this optimum value of t_0 and interprets the result.

8. A mass M moves under the influence of a force F=(-3t ***j***+ 4t^2 ***i***) N, where t is the time in seconds. It starts from the origin at t=0, Finds: (a) its velocity; (b) its position; and (c) r×v, for any time later

9. Below is the plot of position vs. time for a car. Explain what the car is doing in each numbered interval.



10. Argue that that A · (A × B) = 0. In three dimensions find the expression of A × B in terms of vector components and ***i***, ***j***, and ***k***.