# Lecture 1A – Kinematics of Particles

## Normal-Tangential Coordinates

We normally use the ______________________________________________
to define the motion of a particle when ________________________________,
i.e. a roller coaster car must travel along its track, an object transported along a conveyer belt, etc.

For a _____________________ (two dimensional) motion along the path ______ (see figure) there are ________ directions we need to look at

1. Tangential direction is the instantaneous direction of movement of the particle ______________ the fixed path. It is positive in the direction of increasing *s*. This direction is represented by the unit vector ___________.
2. Normal direction is ___________________ to the tangential direction and it points towards the centre of the circle when the particle is moving along a curved path. This direction is represented by the unit vector _____________.

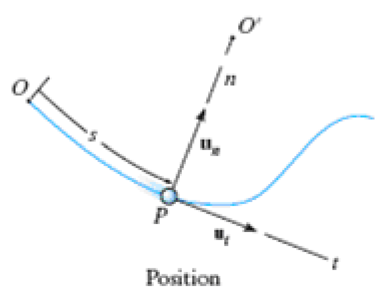


*Figure 1*

Suppose that a particle travels along a two dimensional path defined by the function ___________________, the radius of curvature of this path is given by

___________________

For a 2D motion, the velocity of a particle is given by

The acceleration is given by

where

Therefore, the acceleration is given by

## Dependent Motion

Dependent motions of two particles are normally associated with systems of ________________________________________ via inextensible ______________ and ________________________, such as one shown in the figure.

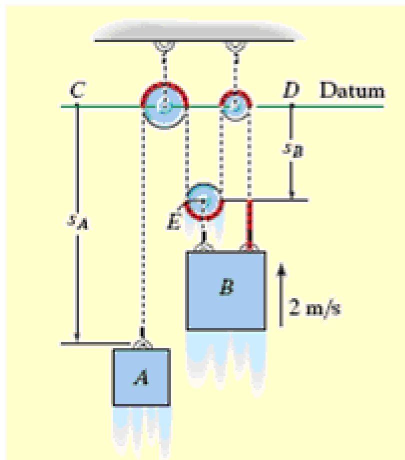


*Figure 2 An example of a system of connected masses*

Usually the analysis is based around the assumption that the cords used for connection are inextensible, i.e. their total lengths always ________________________________.
For example, the total length of the cord in the example shown (neglecting the parts without movements) is given by

__________________________ [EQN.1]

Let us now consider the velocity of the masses *A* and *B*, these can be computed by differentiating equation 1 with respect to time to obtain

__________________________ [EQN.2]

Finally, the accelerations of the masses can be found by further differentiating equation 2 with respect to time to obtain

__________________________ [EQN.3]