CURVILINEAR MOTION

Curvilinear motion is the motion of a particle moving along a curve. The velocity of the particle is tangential to the path. However, the acceleration is not usually tangential to the path

PROJECTILE MOTION

Initially, before the projection of the particle,
$x_o = y_o = z_o = 0$
All at the origin
$a_x = 0$, $a_y = -g$, $a_z = 0$

When projected,
$v_x = \int a_x \, dt$
$v_x = \int 0 \, dt$
$v_x = 0 + c$
$v_x = u_x$

The horizontal motion in a projectile motion is uniform. Therefore, there is no acceleration
$v_y = u_y - gt$
$x = u_x t$
$y = u_y t - \frac{1}{2} g t^2$
The motion in vertical is uniformly accelerated. Therefore there is a constant acceleration of (-g)

QUESTIONS ON PROJECTILES

VELOCITY VECTOR

The velocity vector of a particle is tangential to the path of the particle. Acceleration vector is not tangential.

The velocity is tangential to the path and therefore will also have its unit vector (e_t) tangential to the path

When two particles P and P` are moving, the relative velocity between them is

$\Delta v = v_2 - v_1$
Also comparing their unit vectors
$\Delta e_t = e_{t2} - e_{t1}$
The angle between these two tangential unit vectors is $\Delta\theta$

$$\Delta e_t = 2\sin\left(\frac{\Delta\theta}{2}\right)$$

The relationship between the tangential unit vector and the normal unit vector is given by the relation

$$\lim_{\Delta\theta \to 0} \frac{\Delta e_t}{\Delta\theta} = e_n$$

$$e_n = \frac{d e_t}{d\theta}$$

From the above, it can be seen that the velocity vector that is tangential is.

$$v = v\vec{e}_t$$

$$a = \frac{d\vec{v}}{dt}$$

$$a = \frac{d\left(v\vec{e}_t\right)}{dt}$$

From here, applying the product rule,

$$a = e_t\frac{dv}{dt} + v\frac{d\vec{e}_t}{dt}$$

$$\frac{d\vec{e}_t}{dt} = \frac{de}{d\theta}\cdot\frac{d\theta}{ds}\cdot\frac{ds}{dt}$$

$$e_n = \frac{d e_t}{d\theta}$$

$$\frac{d\theta}{ds} = \frac{1}{\rho}$$

$$\rho = Rotation - radius$$

$$\frac{dS}{dt} = v$$

$$\frac{d\vec{e}_t}{dt} = \frac{de}{d\theta}\cdot\frac{d\theta}{ds}\cdot\frac{ds}{dt}$$

$$\frac{d e_t}{dt} = e_n\cdot\frac{1}{\rho}\cdot v$$

$$a = \vec{e}_t\frac{dv}{dt} + \frac{v^2}{\rho}\vec{e}_n$$

$$a = a_t + a_n$$

a_t, the tangential acceleration (centripetal acceleration) reflects the change in speed of the particle

a_n, the normal acceleration (centrifugal acceleration) reflects the change of direction