SESSION VI
PROJECTILE MOTION

- **Introduction:**

We need know V_0 and θ

$X = X_0 + V_{0x}t + ½\ a_x\ t^2$

But $X_0 = 0$ & $a_x = 0$ then

$X = V_{0X}\ t$

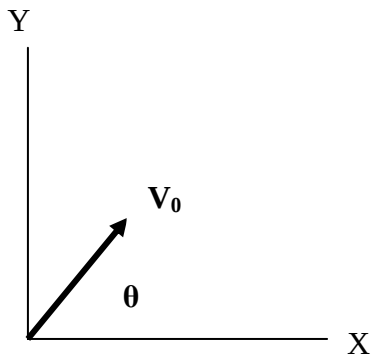
$X(t) = V_0 \cos(\theta)\ t$……(1)

$Y = Y_0 + V_{0Y}t + 1/2\ a_Y\ t^2$

$Y = Y_0 + V_{0Y}t - 1/2\ g\ t^2$

$Y(t) = V_0 \sin(\theta)\ t - 1/2\ g\ t^2$. ……(2)

Substitute eqn. (1) into eqn. (2)



$$Y(X) = V_0 \sin(\theta)\ \frac{X}{V_0 \cos(\theta)} - ½\ g\ \frac{X^2}{V_0^2 \cos^2(\theta)}$$

$$Y(X) = X \tan(\theta) - g\ \frac{X^2}{2V_0^2 \cos^2(\theta)}$$

- **FORTRAN 90**

```
Program projectile
Implicit none

Real    v0          !the launch velocity of particle
Real    theta       !the launch angle in degrees
Real    a           !the launch angle in radians
Real    x           !the horizontal –distance of particle with time
Real    y           !the vertical-distance of particle with time
Real    tmax        !the time of flight
Real    range       !the horizontal range of the projectile
Real    g           !the acceleration due to gravity
Real    i           !the counter of data loop, i takes the values of time t
Real    j           !the counter of data loop, j takes the values of the launch angle a
Read*, V0
Read*, theta
a=theta*(pi/180.0)
```

tmax = $(2*V_0*\sin(a))/g$

PART ONE: "Generating a data for t, x, y using the values of launch velocity and the launch angle".

■Opening a file to save t, x, y data on it

Open (1,file='xytdata.dat')

■ Making a loop to generate data for x, y, t

Do i = 0.0, tmax, tmax/15

■ applying the projectile relations to find x and y using V0, t, g and the angle a

$X = v_0 * \cos(a) * i$

$Y = v_0$ **sin (a) i- 0.5g**(i**2)

■ Writing values of t, x and y on the file

PART TWO: "Generating a data for the relation between launch angle and the horizontal range and time of flight"

■ Opening a file to save the angle and range and time of flight data on it.

Open (2,file='rangedata.dat')

■ making a loop to generate a data for launch angle and the range and time of flight [tmax]

Do j=0.0,pi/2,pi/30

■ applying the equations to find the range and time of flight when the launch angle varied

Range= $2*(v_0 **2)*(\cos(j)**2)*\tan(j)/g$

tmax=$(2* v_0*\sin(j))/g$

- ## Exercises and lab works:

Ex.1: Give the physical meaning for the following:

■ ***Part One*:**

1) **Plotting Y versus time (t).**
2) **Plotting X versus time (t).**
3) **Plotting Y versus X.**
4) **Plotting Y versus X with different initial velocities and Launch angles at the same graph.**

■ ***Part One*:**

1) **Plotting Range versus Launch angle (radian).**
2) **Plotting tmax versus Launch angle.**

Note: you can vary the initial velocities and launch angles

Ex.2: Write this program by using "*MATHEMATICA*".