

Graphing Projectile Motion

Using a special graphing technique it is possible to essentially “simulate” a projectile’s motion. Besides having a little fun with your calculator this activity should help increase your understanding of the component nature of projectiles. Follow these steps:

First you must set the graphing mode. Press the MODE button and choose Par or PARAMETRIC (instead of Func or FUNCTION – the typical graphing mode).

TI-82,83,84

```

Normal Sci Eng
Float 0123456789
Radian Degree
Func Par Pol Seq
Connected Dot
Sequential Simul
Real a+bt re^ti
Full Horiz G-T
    
```

TI-89

```

MODE
F1 F2 F3
Page 1 Page 2 Page 3
Graph.....>
Current Folder.....main->
Display Digits.....FLOAT 6->
Ans/le.....DEGREE->
Exponential Format.....NORMAL->
Complex Format.....REAL->
Vector Format.....RECTANGULAR->
Pretty Print.....ON->
Enter=SAVE ESC=CANCEL
USE < AND > OPEN CHOICES
    
```

Next press the Y= button to access the equation editing screen. Notice that there are now *pairs* of equations to graph. Each pair consists of two equations: x as a function of t and y as a function of t .

TI-82,83,84

```

Plot1 Plot2 Plot3
X1T=
Y1T=
X2T=
Y2T=
X3T=
Y3T=
X4T=
    
```

TI-89

```

F1- F2- F3- F4- F5- F6- F7-
Tools Zoom Edit All Style etc..
*PLOTS 1
xt1=8.354*cos(-1.402*t-2)
yt1=8.354*sin(-1.402*t-2)
xt2=|401-12*t*cos(20-|40
yt2=|401-12*t*sin(20-|40
6
Σ (-a[i].cos(ω[i].t)
xt1(t)=8.354*cos(-1.402*t...
MAIN DEG APPROX PAR
    
```

Enter the equations for the components of displacement: $d_x = v_{ix}t$ and $d_y = v_{iy}t + \frac{1}{2} a_y t^2$. In the example shown below the components are those for an initial velocity of 40.0 m/s, 60.0°. Note: the variable in the equation is T or t (NOT x).

TI-82,83,84

```

Plot1 Plot2 Plot3
X1T=20*T
Y1T=34.641*T-4.
9*T^2
X2T=
Y2T=
X3T=
Y3T=
    
```

TI-89

```

F1- F2- F3- F4- F5- F6- F7-
Tools Zoom Edit All Style etc..
*PLOTS
Plot 1: x:physics\data y:physics\data
x1t=20*t
y1t=34.641*t-4.9*t^2
xt2=|401-12*t*cos(20-|40
yt2=|401-12*t*sin(20-|40
6
xt1(t)=34.641*t-4.9*t^2
MAIN DEG APPROX PAR
    
```

Before you graph the set of parametric equations it is a good idea to set up the WINDOW with appropriate limits for x and y based on the range and maximum height of the projectile. Notice also you enter a range of time values and a time step value – this controls how many points the calculator will plot on the graph.

TI-82,83,84

```

WINDOW
Tmin=0
Tmax=8
Tstep=.2
Xmin=-10
Xmax=150
Xscl=0
Ymin=-10
Ymax=80
Yscl=0
    
```

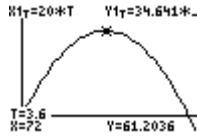
TI-89

```

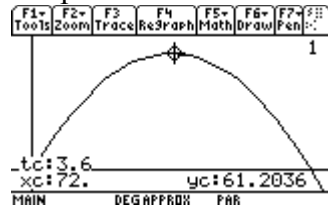
F1- F2-
Tools Zoom
tmin=0
tmax=8
tstep=.2
xmin=-10
xmax=150
xscl=0
ymin=-10
ymax=80
yscl=0
MAIN DEG APPROX PAR
    
```

Now hit GRAPH. By using the TRACE function you can follow the path of the projectile, noting the components of its displacement at any particular point in time.

TI-82,83,84



TI-89

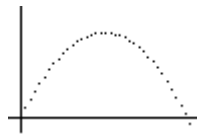


The calculator can plot the graph in a variety of ways. Use the Y= button and then choose the style of graphing. On TI-82,83,84 move the cursor to the far left and change the graphing style “icon”. On TI-89 this is done under the Style menu.

```

Plot1 Plot2 Plot3
X1t=20*T
Y1t=34.641*T-4.9*T^2
Z1t=
Z2t=
Z3t=
Z4t=

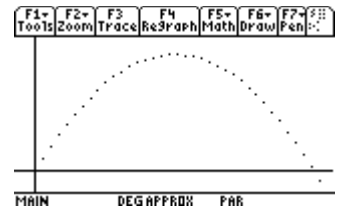
```



```

F1 Tools F2 Zoom F3 Edit F4 All F5 F6 F7 F8
Style: 1:Line 2:Dot 3:Square 4:Thick 5:Animate 6:Path 7:Inverse 8:Del Low
xt1=20*t
yt1=34.641*t
xt2=401-12*t
yt2=401-12*t
xt1(t)=20*t

```

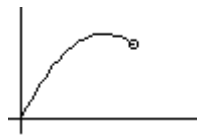


Here is another style, which basically creates a little “movie” of the projectile.

```

Plot1 Plot2 Plot3
X1t=20*T
Y1t=34.641*T-4.9*T^2
Z1t=
Z2t=
Z3t=
Z4t=

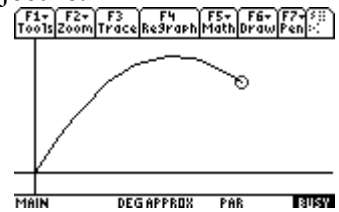
```



```

F1 Tools F2 Zoom F3 Edit F4 All F5 F6 F7 F8
Style: 1:Line 2:Dot 3:Square 4:Thick 5:Animate 6:Path 7:Inverse 8:Del Low
xt1=20*t
yt1=34.641*t
xt2=401-12*t
yt2=401-12*t
xt1(t)=20*t

```



One more thing to try – modify the equations to find the components “automatically” and to allow for variables of initial speed and direction. Then you can simply enter initial speed and direction by using the button STO→ to store the values of v and θ . This allows you to experiment with the resulting trajectory.

```

Plot1 Plot2 Plot3
X1t=v*cos(theta)*T
Y1t=v*sin(theta)*T-4.9*T^2
Z1t=
Z2t=
Z3t=
Z4t=

```



```

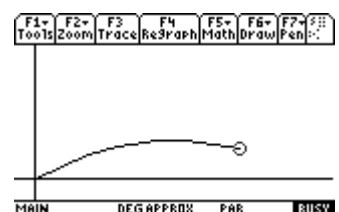
40→v
30→theta

```

```

F1 Tools F2 Zoom F3 Edit F4 All F5 F6 F7 F8
Style: 1:Line 2:Dot 3:Square 4:Thick 5:Animate 6:Path 7:Inverse 8:Del Low
xt1=v*cos(theta)*t
yt1=v*sin(theta)*t-4.9*t^2
xt2=401-12*t*cos(20-14)
yt2=401-12*t*sin(20-14)
xt1(t)=v*cos(theta)*t
yt1(t)=v*sin(theta)*t-4.9*t^2

```



```

F1 Tools F2 Zoom F3 Edit F4 All F5 F6 F7 F8
40→v
30→theta

```