Precalculus **6.3 Modeling using Parametric Equations**

Vertical Motion

$$\boxed{s = -16t^2 + v_o t + s_o}$$

s = ht of object at time t
$-16t^2$ = effect of gravity
v_o = initial velocity
s_o = starting height

In Parametric Form:

→ X = 3 (any constant that will show on screen (btwn xmin + max)

$Y = -16T^2 + V_oT + S_o$

1. A distress flare is shot straight up from a ship's bridge 75 ft. above the water with an initial velocity of 86 ft/sec.

$S_o = 75$
$V_o = 86$

$X = 3$
$Y = -16T^2 + 86T + 75$

$0 \le T \le 10$ TSTEP .1
Ymax 200

a) What height does the flare reach? At what time?

190.56 ft @ t = 2.7 sec (use table)

b) When does the flare hit the water?

t = 6.14 sec (table)

2. Abby drops a penny from the top of the Empire State Building, from a height of 1250 feet. When does the penny hit the ground? (ignore air resistance)

$V_o = 0$
$S_o = 1250$

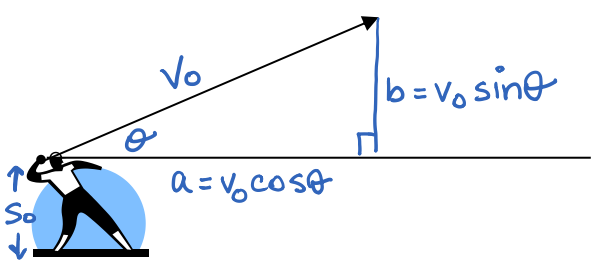
→ $X_1 = 3$
$Y_1 = -16T^2 + 1250$

$0 \le T \le 10$
Ymax = 1300

hits ground @ 8.84 sec (table)

Projectile Motion - Objects NOT launched straight up into the air

Suppose a baseball is thrown from a point s_o feet above the ground level with an initial velocity of v_o ft/sec at an angle of θ with the horizontal. The initial velocity can be represented by the vector:



$V_o = \langle V_o \cos\theta, V_o \sin\theta \rangle$

The path of the ball can be modeled by the parametric equations:

X = $V_o \cos\theta \cdot T$ and Y = $-16T^2 + V_o \sin\theta \cdot T + S_o$

The x-component is: horizontal component of vel. vector • T = $V_o \cos\theta \cdot T$

The y-component is made up of a combination:

$-16T^2$	$V_o \sin\theta \cdot T$	S_o
gravity	vert. component of vel. vector • Time	starting height

Let's Play Ball!!

3. Joey hits a baseball from 3ft above the ground with an initial velocity of 150 ft/sec at an angle of 18 degrees with the horizontal. Will the ball clear a 20-ft fence that is 400 ft away? Sketch a graph of the situation below.

$V_0 = 150$
$\theta = 18°$
$S_0 = 3$

PATH OF BALL: X = $150\cos 18° \cdot T$ Y = $-16T^2 + 150\sin 18° \cdot T + 3$

WALL: X = 400 Y = $-16T^2 + 20$

↳ like vertical motion

No Homer!

When $X_1 = 400$
$Y_1 = 7.71$ ft not over fence!
(Table)

4. Maddie hits a golf ball with an initial velocity of 160 ft/sec and an angle of 24 degrees, from the ground. Answer the following questions:

$S_0 = 0$
$V_0 = 160$
$\theta = 24°$

Maddie's Equations: X $160\cos 24° \cdot T$ Y = $-16T^2 + 160\sin 24° T$

How far does Maddie hit the ball?

$t = 4.07$ sec

Horizontal Motion

5. Track Invite. Hinsdale Central is attending the LT Track invitational. Lyons Township Richard can run the 100m dash at a constant speed of 15 meters per second. Hinsdale Central Ryan can run at a constant speed of 18 meters per second, but he gets a bad start and unintentionally starts 1 full second after LT Richard.

Write the parametric equations to model Ryan and Richard's distance traveled in terms of time (in seconds).

Rich → $X_1 = 15T$, $Y_1 = 2$

Ryan → $X_2 = 18(T-1)$, $Y_2 = 4$

Finish Line (vertical) $X_3 = 100$, $Y_3 = -16T^2 + 5$

Who will win the 100m dash?

Ryan crosses finish line at $t = 6.556$ sec, while Richard is at 98.34 meters. HC wins!