Section 3-3 Name KEY!

What Does a Dog Do That a Man Steps In?

Complete each table and graph and answer the questions. For table cells and questions that are numbered, find your answer at the bottom of the page and cross out the letter above it (some are rounded). When you finish, the answer to the title question will remain.

FALLING STUFF. Suppose an object is dropped and gravity is the only force acting on on it. The height h of the object (in feet) is modeled by: $h = -16t^2 + c$, where t is the time since the object was dropped (in seconds) and c is the initial height of the object (in feet). We are ignoring air resistance.

The Clumsy Eagle

An eagle soaring over a river drops a stick from a height of 400 ft. Complete the table and graph to show how the height of the stick is related to the time since it was dropped.

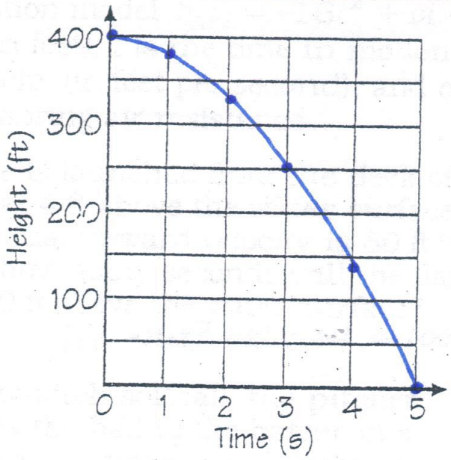
Let t = Time since stick was dropped (s)

h = Height of stick (ft)

$h = -16t^2 + 400$

Does your graph show the flight path of the stick as it falls? yes!

t (s)	h (ft)
0	400
1	384 (1)
2	336
3	256 (2)
4	144
5	0 (3)



Freefallin'

A skydiver jumps from a plane at an elevation of 12,000 ft. He waits 24 seconds before opening his parachute. Complete the table and graph to show how the height of the skydiver varies with the time since he jumped.

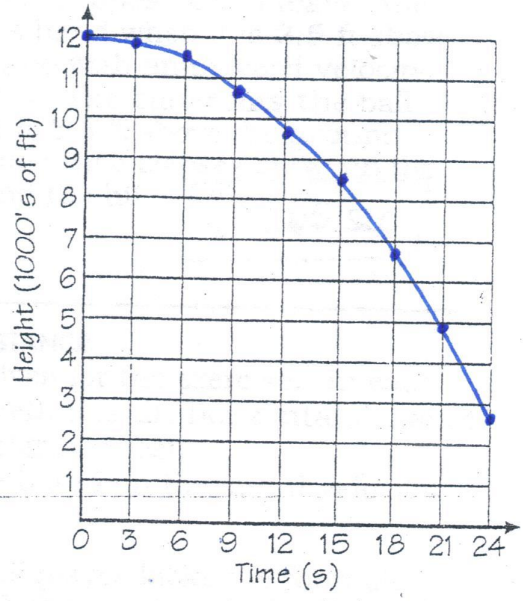
Let t = Time since skydiver jumped (s)

h = Height of skydiver (ft)

$h = -16t^2 + 12{,}000$

Why is this model not very accurate for this situation? Air resistance?

t (s)	h (ft)
0	12,000
3	11,856
6	11,424 (4)
9	10,704
12	9,696
15	8,400 (5)
18	6,816
21	4,944
24	2,784 (6)



7 Galileo dropped a cannonball from the top of the Leaning Tower of Pisa, which is 185 ft above the ground. How long did it take for the cannonball to hit the ground? $h = -16t^2 + 185$ $0 = 16t^2 + 185$ $t = 3.4$ sec

8 **Metric Units.** The height h of a falling object **in meters** is modeled by $h = -4.9t^2 + c$, where t is the time falling (in seconds) and c is the initial height (in meters). How long does it take for a diver to fall from a 10-meter platform to the water below? $h = -4.9t^2 + 10 = 0$ $t = 1.4$ sec

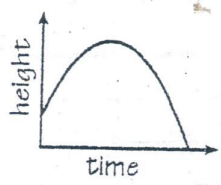
P	U	P	M	C	A	N	O	I	T	U	S	E
8400	3.4 s	2760	0	1.4 s	8332	4.5 s	384	2784	2.1 s	11,424	248	256

PANTS!

Which Italian Insects Most Often Fall in Love?

Cross out the letters above each correct answer. The remaining letters will answer the title question.

FALLING STUFF. Suppose that an object is in flight and that gravity is the only force acting on it. A function $h(t)$ can be used to estimate the height of the object in terms of the time in motion t. A different function $h(d)$ can be used to estimate the height in terms of the horizontal distance d that the object has traveled.



HEIGHT AS A FUNCTION OF TIME IN MOTION

In Exercises 1-4, use the vertical motion model $h(t) = -16t^2 + vt + c$, where h is the approximate height (in feet), t is the time in motion (in seconds), v is the initial upward velocity (in feet per second), and c is the initial height (in feet). We are ignoring air resistance.

1 A baseball player hits a pitched ball when it is 4 ft above the ground. The initial upward velocity is 80 ft/s. How long will it take for the ball to hit the ground? $h = -16t^2 + 80t + 4 = 0$

$t = 5.05$ sec

2 A flare is launched from the deck of a lifeboat 4 ft above the water surface. The initial upward velocity is 80 ft/s. After how many seconds will the flare be 100 ft above the water surface?

$h = -16t^2 + 80t + 4 = 100$

intersects $t = 2$ sec, $t = 3$ sec

$\therefore$ 1 sec above 100 ft

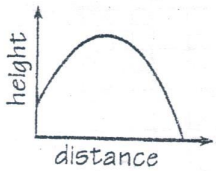
3 A basketball player shoots the ball with an initial upward velocity of 20 ft/s. The ball is 6 ft above the floor when it leaves her hands. How long will it take for the ball to reach the rim of the basket, 10 ft above the floor, on its way down?

$t = 1$ sec

EXTRA: What is the meaning of the second solution of your equation?

4 In slow-pitch softball, the pitcher pitches the ball to the batter in a high arc. Suppose a ball leaves the pitcher's hand when it is 2.5 ft above the ground with an upward velocity of 27 ft/s. The batter hits the ball when it is 3.5 ft above the ground. How much time elapses between the pitch and the hit?

$t = 1.65$ sec



HEIGHT AS A FUNCTION OF HORIZONTAL DISTANCE

In Exercises 5-6, use the model $h(d)$ given for the exercise. In each case, h is the approximate height (in feet), d is the horizontal distance traveled (in feet), and c is the initial height (in feet).

NOTE: Coefficients in each function are based on the initial velocity and release angle of the object.

5 A shot put champion releases the shot from 6 ft above the ground. The path of the shot is modeled by:

$h(d) = -0.02d^2 + 1.1d + c$ ($c = 6$)

How far does the shot travel before it hits the ground?

$d = 60$ ft.

6 A football player kicks the football from 2 ft above the ground. The path of the ball is modeled by:

$h(d) = -0.015d^2 + 1.8d + c$ ($c = 2$)

If the ball is not caught, how far does it travel before hitting the ground?

$d = 121.1$ ft

BU	GS	RO	SO	ME	AN	EW	LO	TS	VE
1.65 s	5.1 s	115 ft	121 ft	3 s, 4 s	56 ft	1 s	60 ft	2.2 s	2 s, 3 s

ROME ANTS!

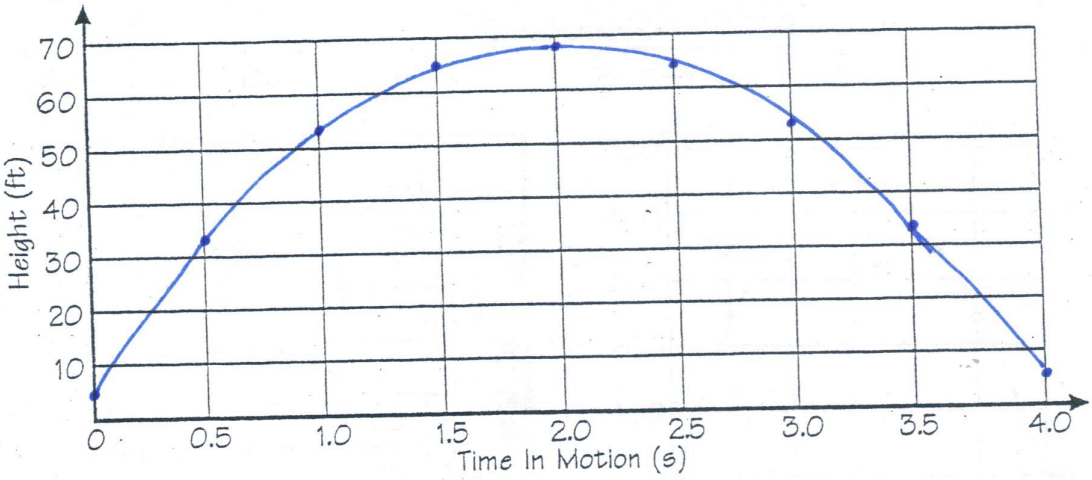
...s It a Home Run?

A major league batter smashes a pitch toward the left field fence, which is 10 ft high and 350 ft from homeplate. Complete each table and graph to show the height of the ball as a function of time and then as a function of horizontal distance traveled.

1. HEIGHT AS A FUNCTION OF TIME IN MOTION

Modeled by the function: $h(t) = -16t^2 + 64t + 4$, where $h(t)$ is the height of the ball (in feet) t seconds after being hit.

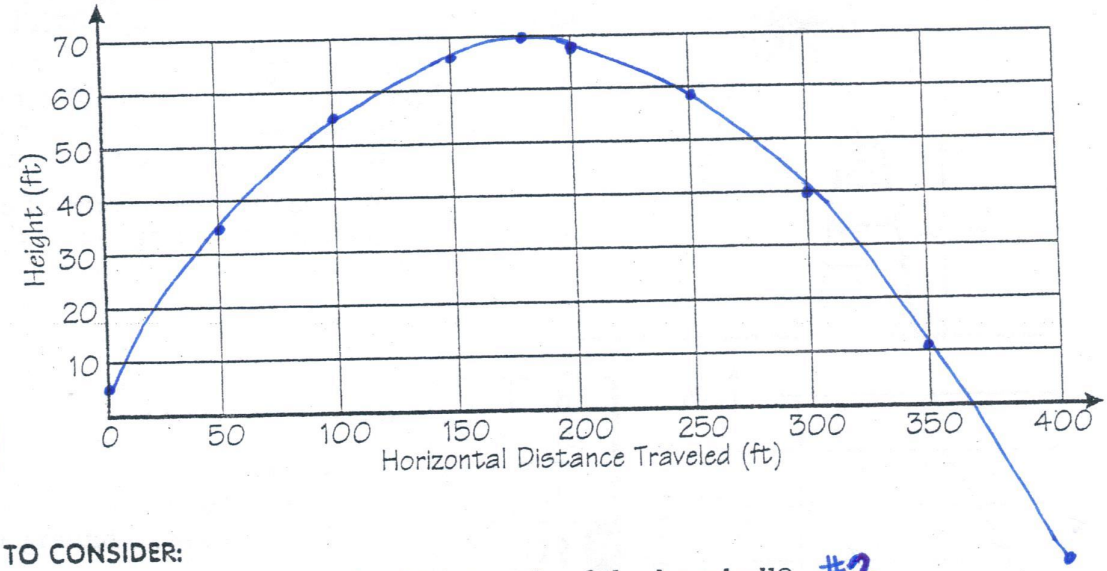
t (s)	$h(t)$ (ft)
0	4
0.5	32
1.0	52
1.5	64
2.0	68
2.5	64
3.0	52
3.5	32
4.0	4



2. HEIGHT AS A FUNCTION OF HORIZONTAL DISTANCE TRAVELED

Modeled by the function: $h(d) = -0.002d^2 + 0.72d + 4$, where $h(d)$ is the height of the ball (in feet) after traveling d feet horizontally.

d (ft)	$h(d)$ (ft)
0	4
50	35
100	56
150	67
200	68
250	59
300	40
350	11
400	−28



3. QUESTIONS TO CONSIDER:

a. Which of the two graphs shows the flight path of the baseball? #2

b. Which graph would be the same even if the ball were hit straight up? Why? #1

c. What is the height of the ball when hit? What is the initial upward velocity? 4ft., 64 ft/sec

d. What is the meaning or significance of the vertex point of each graph?

e. The left field fence is 10 ft high and 350 ft from homeplate. Is it a home run? Yes! @ 350ft the ball is 11 ft high.

→ #1: time the ball reaches max height
#2: the horz distance the ball has traveled @ the max height

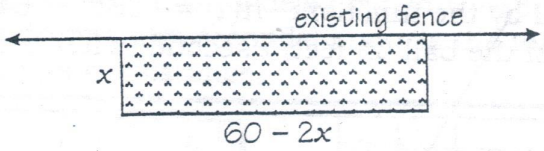
What Did Dax Do When a Roll of Tape Came Flying at Him?

Complete each table and graph and answer the questions asked about each situation. For table cells with letters, write the letter in the corresponding box at the right.

144	450	110	350	128	250	80	400
H	E			D	U	C	T

Situation #1 - Horsing Around

Pecos has 60 yd of fencing to build a rectangular corral for his horse. He already has a fence along one side of his property, and he plans to use part of this existing fence for one side of the corral. For the other three sides, he plans to use the 60 yd of fencing that he owns.



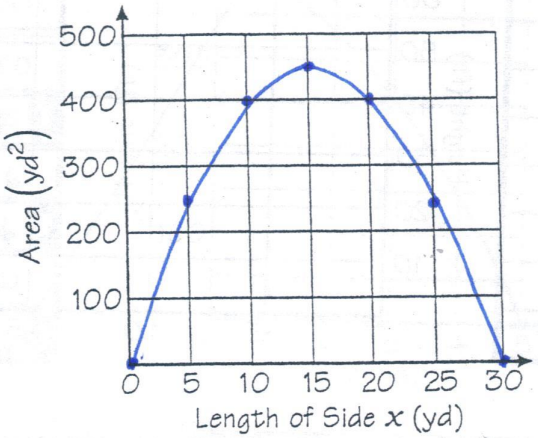
Let x be the distance that the corral extends away from the existing fence, and let A be the area of the corral.

Write an equation for A in terms of x.

$A = x(60-2x)$

Complete the table and graph to show how A depends on x.

x (yd)	A (yd^2)
5	250 U
10	400
15	450 E
20	400 T
25	250

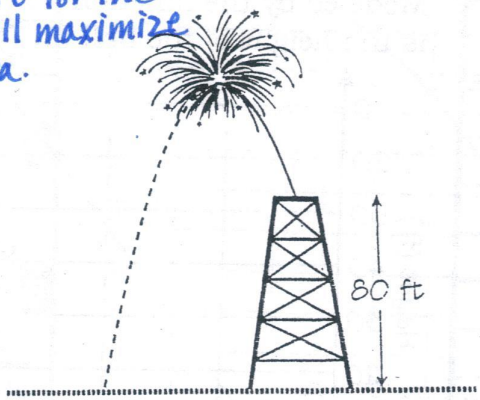


What is the vertex of the graph of your equation? What is the meaning of the vertex?

(15,450) Using 15ft for the width will maximize the area.

Situation #2 - Fired Up!

To celebrate July 4, the town of Trigon has hired Pyro Tech, Inc. to launch fireworks rockets from an 80-foot tower in the center of town. The rockets can be fired with an initial upward velocity of 64 feet per second.



Pyro Tech uses a function $h(t)$ that estimates the rocket's height above ground in terms of the time t since the launch. If t is in seconds and $h(t)$ is in feet, then

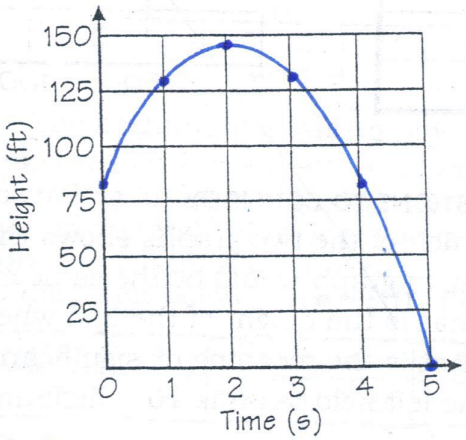
$$h(t) = -16t^2 + 64t + 80$$

Pyro Tech needs to know:

1. How long will it take for a rocket to reach its highest point? 2 sec.
2. How high will the rocket go? 144 ft.
3. How long after the launch will the rocket debris hit the ground? 5 sec.

Use the function $h(t)$ to complete the table and graph. Then find answers for the three questions above. Why do the numbers "64" and "80" appear in the function? Does your graph show the flight path of the rocket?

t (s)	h (ft)
0	80
1	128 D
2	144 H
3	128
4	80 C
5	0



Finally, let $h(t) = 0$ and solve the resulting equation. What do the solutions tell you?

↳ t=-.5 @ t=5 sec, the rocket hit the ground.