

2.3a (Optional): GRAPH QUADRATIC FUNCTIONS USING TECHNOLOGY

“I Can...” Statements:

- I can use technology to model quadratic functions.

Example #1

Graph $f(x) = x^2 - 4$ and complete the table using a graphing calculator.

Press the **Y=** key. Enter the equation $y = x^2 - 4$. The **x,t,q,n** key should be used to enter the variable x . The **x²** key should be used for the exponent.

```
Plot1 Plot2 Plot3
\Y1=X2-4
\Y2=
\Y3=
\Y4=
\Y5=
\Y6=
```

If Plot1, Plot2 or Plot3 are highlighted it will not graph.

To turn off STAT PLOTS before you graph a function, press 2nd [STATPLOT]. Select 4:PlotsOff.

Students may use the (-) negative key instead of the subtract key when entering equations. This will cause an ERROR.

Check the window by pushing the **WINDOW** key.

The standard window should be:

```
WINDOW
Xmin=-10
Xmax=10
Xscl=1
Ymin=-10
Ymax=10
Yscl=1
Xres=█
```

- Xmin and Xmax set the boundaries for the x -axis
- Ymin and Ymax set the boundaries for the y -axis
- Xscl and Yscl settings determine the increment by which the axes are marked

If necessary, press the **2nd** **WINDOW** [TBLSET] key to access the Table Set menu.

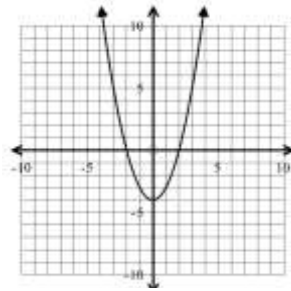
Make sure the Independent variable (x -value) is on “Auto” and the Dependent variable (y -value) is on “Auto” so the calculator will automatically give you the x -value and y -value. (Use the arrows and the enter key to change the values if necessary.)

```
TABLE SETUP
TblStart=0
ΔTbl=1
Indent: [Auto] Ask
Depend: [Auto] Ask
```

Students can also use **ZOOM** 6: ZStandard for the window.

Press the **GRAPH** key. Press **2nd** **GRAPH** [TABLE].

Use the arrows to scroll.

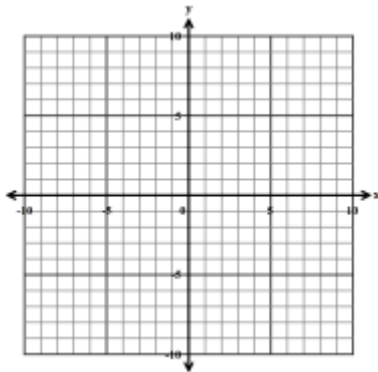


x	$f(x)$
-3	5
-2	0
-1	-3
0	-4
1	-3
2	0
3	5

Practice Exercises

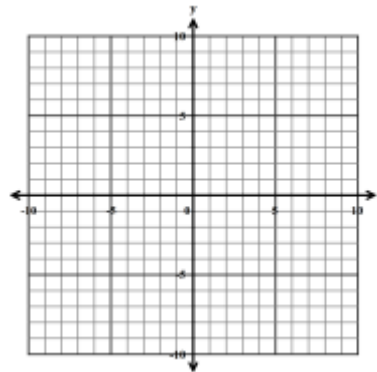
Graph each equation using a graphing calculator. Fill in the table of values.

1. $f(x) = x^2 - 1$



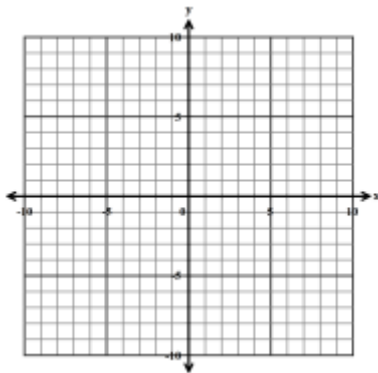
x	$f(x)$
-3	
-2	
-1	
0	
1	
2	
3	

2. $f(x) = x^2 + 1$



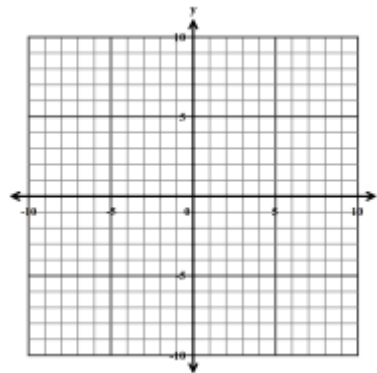
x	$f(x)$
-3	
-2	
-1	
0	
1	
2	
3	

3. $f(x) = (x-1)^2 + 3$



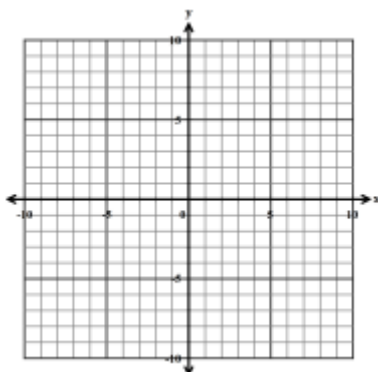
x	$f(x)$
-1	
0	
1	
2	
3	

4. $f(x) = -(x+1)^2$



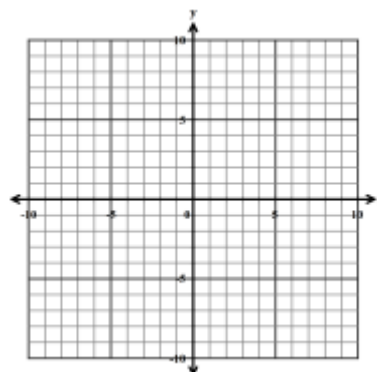
x	$f(x)$
-4	
-3	
-2	
-1	
0	
1	
2	

5. $f(x) = x^2 - 4$



x	$f(x)$
-3	
-2	
-1	
0	
1	
2	
3	

6. $f(x) = -x^2 + 2x + 1$



x	$f(x)$
-2	
-1	
0	
1	
2	
3	
4	

2.3: MODEL QUADRATIC FUNCTIONS USING TECHNOLOGY

"I Can..." Statements:

- I can use technology to model quadratic equations.

Example #1

Fred drops an egg from the top of a building 500 feet tall. The vertical distance fallen by a free-falling object is represented by the function $h(t) = -16t^2 + 500$ where $h(t)$ is the height of the egg, in feet, and t is the time, in seconds.

How long does it take for the egg to touch the ground?

- Press **Y=** and next to Y_1 enter $-16x^2 + 500$
*(remember to use the negative **(-)** key, not the **-** subtract key.)*
 Use the **x,t,q,n** to enter the variable x .

- Press **2nd** **GRAPH** **[TABLE]** to view values generated by the function.
 Use the values in the table to adjust the window size for the specific problem.
 You should see the following values in your table.

X	Y ₁
0	500
1	484
2	436
3	356
4	244
5	100
6	-76

X=0

When choosing values for your window setting, be sure to keep the original problem in mind. The x -axis represents *time*, therefore an appropriate minimum value on the x -axis would be 0. At $x = 0$ the egg is dropped.

Another thing to keep in mind, the y -axis represents the *height*, therefore an appropriate minimum value on the y -axis would be 0.

Notice the Y_1 values change from positive values to negative values between the X values of 5 and 6. Therefore, you can choose 6 or 7 for the X_{\max} .

The largest value in the Y_1 column is 500. Therefore, you should choose a value larger than 500 for the Y_{\max} . Values such as 550 or 600 are reasonable.

X	Y ₁
0	500
1	484
2	436
3	356
4	244
5	100
6	-76

X=0

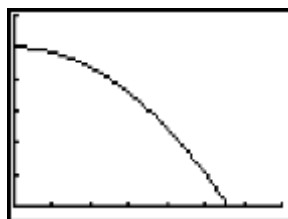
WINDOW
Xmin=0
Xmax=7
Xscl=1
Ymin=0
Ymax=600
Yscl=100
Xres=■

X_{scl} represents the number of tick marks on the graph along the x -axis.

Y_{scl} represents the number of tick marks on the graph along the y -axis.

3. Press **WINDOW** and adjust the values to fit your graph.
(remember to use the negative **(-)** key, not the **-** subtract key.)

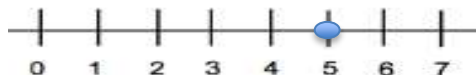
4. Press **GRAPH**, you should see the following graph.



The same graph with more detail would look like:



SIDE NOTE:



5. Calculate the x-intercept.

Notice the graph touches the x -axis between the values of **5** and **6**. This tells us the egg is at a height of *zero* between **5** and **6** seconds, but we want a *more accurate estimate* of the time when the egg hits the ground.

Press **2nd** **TRACE** **[CALC]** to calculate the x-intercept. Choose **2: zero**.

```
CALCULATE
1:value
2:zero
3:minimum
4:maximum
5:intersect
6:dy/dx
7:∫f(x)dx
```

Left Bound? appears in the lower left corner.

Type a value just to the left of the x-intercept, in this case **5**, and press **ENTER**.

Right Bound? appears in the lower left corner.

Type a value just to the right of the x-intercept, in this case **6**, and press **ENTER**.

Guess? appears in the lower left corner. Press **ENTER**.

The x-intercept is $x = 5.59$

How long does it take for the egg to touch the ground?

It takes the egg approximately 5.59 seconds to touch the ground.

Example #3



Fred jumps feet first from a diving board, springing up into the air and then dropping feet-first. The distance d in feet from his feet to the pool's surface t seconds after he jumps is $d(t) = -16t^2 + 18t + 2$.

- What is the maximum height of Fred's feet during this jump?
- When does the maximum height occur?
- When do Fred's feet hit the water?
- What does the constant term **2** in the equation tell you about Fred's jump?

1. Type the function into the calculator.

2. Use the TABLE to find appropriate values for your window.

X	Y ₁
0	2
1	4
2	-26

WINDOW
Xmin= 0
Xmax= 2
Xscl= 0.25
Ymin= 0
Ymax= 8
Yscl= 1

It may take a few adjustments to find a complete graph.

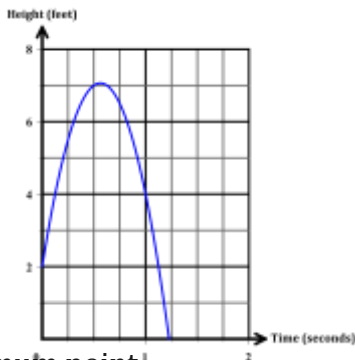
There are not exact values to choose for the window, but you must choose reasonable values to see a complete graph.

Notice the Y_1 values change from positive values to negative values between the X values of 1 and 2. Therefore, you can choose 2 for the X max.

The largest value in the Y_1 column is 4. Although, it is possible someone jumping on a diving board may bounce higher. Therefore, you should choose a value larger than 4 for the Y max. Values such as 8 or 10 are reasonable.

3. Press **WINDOW** and adjust the values to fit your graph.

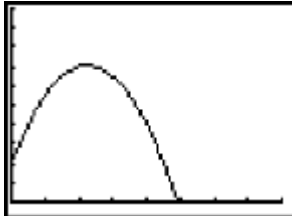
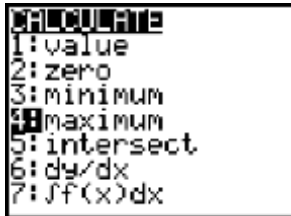
4. Press **GRAPH**, you should see the following graph.



5. Calculate the maximum point.

Press **2nd** **TRACE** [**CALC**] to calculate the maximum value.

Choose **4: maximum**.



Left Bound? appears in the lower left corner.

Type a value to the left of the *maximum* in this case **0**, and press **ENTER**.

Right Bound? appears in the lower left corner.

Type a value to the right of the *x-intercept*, in this case **1**, and press **ENTER**.

Guess? appears in the lower left corner. Press **ENTER**.

a) What is the maximum height of Fred's feet during this jump?

Fred's feet reach a height of 5.6 feet.

b) When does the maximum height occur?

The maximum height occurs at 0.56 seconds.

6. Calculate the *x*-intercept.

Press **2nd** **TRACE** [CALC] to calculate the *x*-intercept.

Choose **2: zero**.

Left Bound? appears in the lower left corner.

Type a value to the left of the *x*-intercept, in this case **1**, and press **ENTER**.

Right Bound? appears in the lower left corner.

Type a value just to the right of the *x*-intercept, in this case **1.7**, and press **ENTER**.

Guess? appears in the lower left corner. Press **ENTER**.

c) When do Fred's feet hit the water?

Fred's feet hit the water at approximately 1.2 seconds.

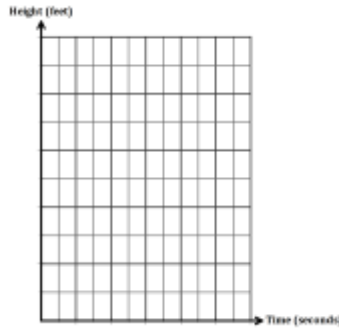
d) What does the constant term **2** in the equation tell you about Fred's jump?

He jumps from a diving board 2-feet from the surface of the water

Practice Exercises A

1. A ball is thrown from the top of a hill. The height, in feet, of a ball t seconds after being thrown is modeled by the function $h(t) = -4.9(t - 2)^2 + 45$. Use a graphing calculator to graph the function and answer the questions below.

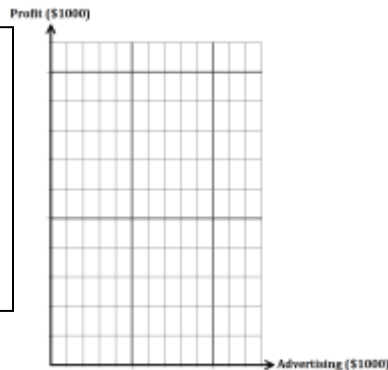
WINDOW Xmin= Xmax= Xscl= Ymin= Ymax= Yscl=
--



- a) What height is the ball thrown?
- b) What is the maximum height of the ball?
- c) When does the ball reach the maximum height?
- d) How long it takes the ball to hit the ground.
 It takes the ball approximately _____ to hit the ground.

2. Each year, a sporting goods store has a budget for advertising to generate more sales and thus profit. Analysis has found that the profit can be modeled by the function $P(x) = -2x^2 + 20x + 50$ where x is the advertising budget and $P(x)$ is the profit, both in thousands of dollars.

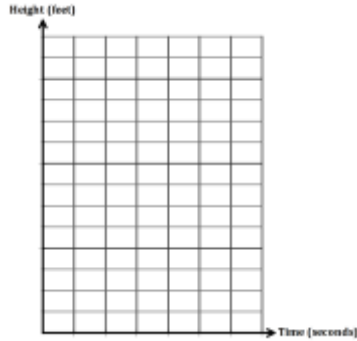
WINDOW Xmin= Xmax= Xscl= Ymin= Ymax= Yscl=
--



- a) What amount of advertising will produce the maximum profit?
- b) What is the maximum profit?

3. From the top of a 48 foot tall building, a ball is thrown straight up with an initial velocity of 32 feet per second as represented by the function $h(t) = -16t^2 + 32t + 48$.

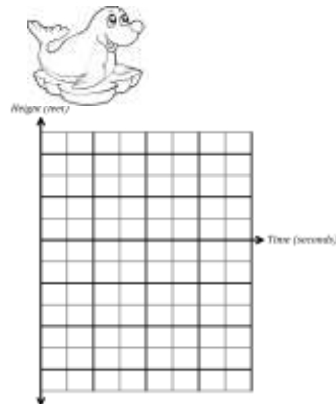
WINDOW
Xmin=
Xmax=
Xscl=
Ymin=
Ymax=
Yscl=



- What height is the ball thrown?
- What is the maximum height of the ball?
- When does the ball reach the maximum height?
- How long does it take the ball to land?
It takes the ball _____ to hit the ground.

4. From the top of a 3-foot podium a sea lion jumps into a large tank of water. The height of the sea lion at any time t is modeled by the function $h(t) = 0.5t^2 - 4t + 3$.

WINDOW
Xmin=
Xmax=
Xscl=
Ymin=
Ymax=
Yscl=



- What is the height the sea lion jumps from the podium?
- What is the minimum height the sea lion reaches?
- When does the sea lion reach the minimum height?
- When is the seal lion at the surface of the water?
The sea lion is at the surface of the water at _____ and again at _____