

## Section 1.3 – Quadratic Graphics

### Quadratic Function

A function  $f$  is a **quadratic function** if  $f(x) = ax^2 + bx + c$

#### Formula

#### Vertex of a Parabola

The **vertex** of the graph of  $f(x)$  is

$$V_x \text{ or } x_v = -\frac{b}{2a}$$

$$V_y \text{ or } y_v = f\left(-\frac{b}{2a}\right)$$

$$\text{Vertex Point } \left(-\frac{b}{2a}, f\left(-\frac{b}{2a}\right)\right)$$

#### Axis of Symmetry:

$$x = V_x = -\frac{b}{2a}$$

#### Minimum or Maximum Point

If  $a > 0 \Rightarrow f(x)$  has a **minimum** point

If  $a < 0 \Rightarrow f(x)$  has a **maximum** point  
@ vertex point  $(V_x, V_y)$

#### Range

$$\text{If } a > 0 \Rightarrow [V_y, \infty)$$

$$\text{If } a < 0 \Rightarrow (-\infty, V_y]$$

**Domain:**  $(-\infty, \infty)$

#### Example

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

$$x = -\frac{b}{2a} = -\frac{-4}{2(1)} = 2$$

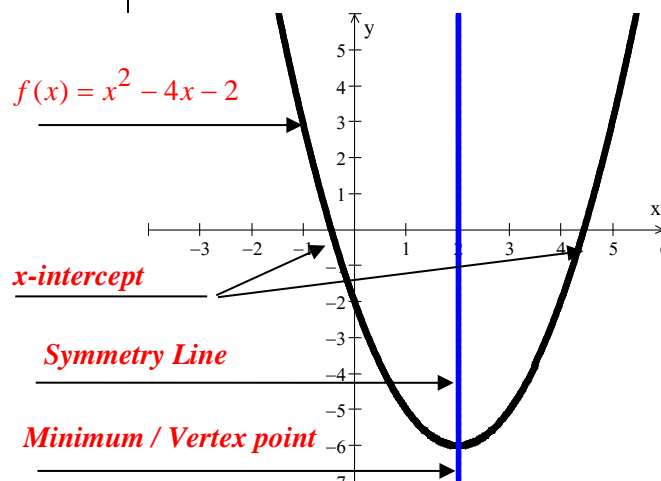
$$\begin{aligned} y &= f\left(-\frac{b}{2a}\right) = f(2) \\ &= (2)^2 - 4(2) - 2 \\ &= -6 \end{aligned}$$

Vertex point:  $(2, -6)$

Axis of Symmetry:  $x = 2$

Minimum point @  $(2, -6)$

$$[-6, \infty)$$



### Example

For the graph of the function  $f(x) = -x^2 - 2x + 8$

- a. Find the vertex point

$$x = -\frac{-2}{2(-1)} = -1$$

$$y = f(-1) = -(-1)^2 - 2(-1) + 8 = 9$$

**Vertex** point  $(-1, 9)$

- b. Find the line of symmetry:  $x = -1$

- c. State whether there is a maximum or minimum value *and* find that value

Minimum point, value  $(-1, 9)$

- d. Find the  $x$ -intercept

$$x = -4, 2$$

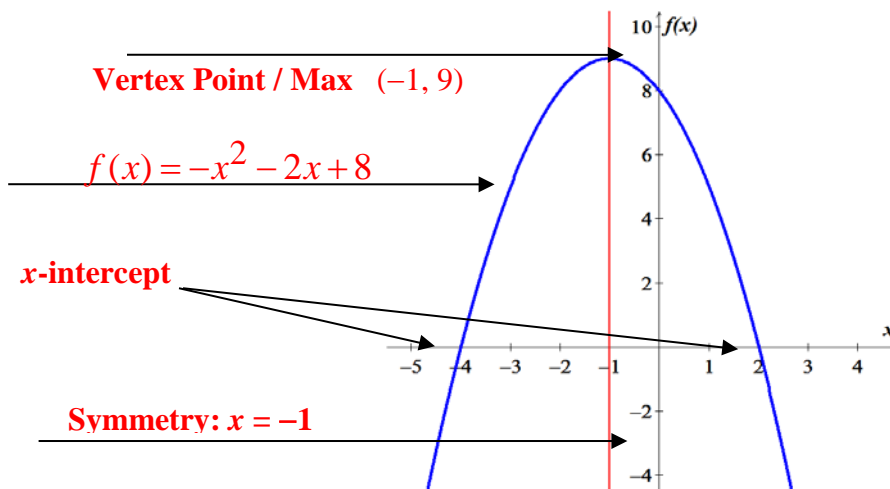
- e. Find the  $y$ -intercept

$$y = 8$$

- f. Find the range and the domain of the function.

$$\text{Range: } (-\infty, 9] \quad \text{Domain: } (-\infty, \infty)$$

- g. Graph the function and label, show part a thru d on the plot below



- h. On what intervals is the function increasing? Decreasing?

Increasing:  $(-\infty, -1)$       Decreasing:  $(-1, \infty)$

### ***Example***

Find the axis and vertex of the parabola having equation  $f(x) = 2x^2 + 4x + 5$

### **Solution**

$$\begin{aligned}x &= -\frac{b}{2a} \\&= -\frac{4}{2(2)} \\&= -1\end{aligned}$$

Axis of the parabola:  $x = -1$

$$\begin{aligned}y &= f(-1) \\&= 2(-1)^2 + 4(-1) + 5 \\&= 3\end{aligned}$$

Vertex point:  $(-1, 3)$

## **Exercises**      **Section 1.3 – Quadratic Functions**

(1 – 21) For the Given functions

- a) Find the vertex point
- b) Find the line of symmetry
- c) State whether there is a *maximum* or *minimum* value *and* find that value
- d) Find the zeros of  $f(x)$
- e) Find the y-intercept
- f) Find the *range* and the *domain* of the function.
- g) Graph the function and label, show part *a* thru *d*
- h) On what intervals is the function *increasing*? *decreasing*?

1.  $f(x) = x^2 + 6x + 3$

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

15.  $f(x) = -x^2 - 3x + 4$

2.  $f(x) = x^2 + 6x + 5$

9.  $f(x) = x^2 + 6x + 3$

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

3.  $f(x) = -x^2 - 6x - 5$

10.  $f(x) = x^2 - 10x + 3$

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

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

11.  $f(x) = x^2 - 3x + 4$

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

5.  $f(x) = -2x^2 + 16x - 26$

12.  $f(x) = x^2 - 3x - 4$

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

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

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

20.  $f(x) = -3x^2 + 3x + 7$

7.  $f(x) = x^2 - 8x + 5$

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

21.  $f(x) = -x^2 + 2x - 2$