

**Parabolas:**

- A. A parabola is the graph of a quadratic equation. In other words, it is the graph of the function  $y = ax^2 + bx + c$ , sometimes written  $y = a(x - h)^2 + k$ .
- B. When dealing with parabolas we are concerned with 3 things: x-intercepts, y-intercept, and the vertex.

**C. X-intercepts**

1. To find out how many x-intercepts there are, use the discriminant:  $b^2 - 4ac$ . If the discriminant = 0, then there is 1 x-intercept. If the discriminant  $> 0$ , then there are 2 x-intercepts. If the discriminant  $< 0$ , there are 0 x-intercepts.
2. To find the x-intercepts, factor the equation and solve for  $y = 0$ . So the answer will always be  $(n,0)$  where n is the value(s) you get when solving for 0.

Ex [1] The graph of the equation  $y = 2x^2 - 4x + 3$  has how many x-intercepts? \_\_\_\_\_

- a. We use the discriminant:  $b^2 - 4ac$ .
- b.  $(-4)^2 - 4(2)(3) = 16 - 24 = -8$ . Since this value is less than 0, the answer is 0 x-intercepts.

Ex [2] If the smallest x-intercept of the function  $y = x^2 - 4x - 5$  is  $(a,b)$  then  $a =$  \_\_\_\_\_

- a. This time, we should factor the equation and solve for  $y = 0$ .
- b. Factoring we get:  $(x - 5)(x + 1) = 0$ . Solving both expressions we get  $x = 5$  and  $x = -1$ . The smallest value is -1.
- c. The x-intercept is  $(-1,0)$  so  $a = -1$ .

\*Note: If a question ever asks for the 'b' value, the answer is always 0.

**D. Y-intercepts**

1. Y-intercepts are easy. Simply use  $x=0$  and solve for y. If the expression is written as  $ax^2 + bx + c$ , the answer is  $(0,c)$ . Otherwise, the answer is  $(0,n)$ , where n is the value you get when solving for  $x = 0$ .

Ex [1] The y-intercept of the function  $y = 5x^2 - 3x + 4$  is (a,b).  
Then b = \_\_\_\_\_

a. The answer is simply 4.

Ex [2] The y-intercept of the function  $y = 2(x-3)^2 + 2$  is (a,b).  
Then b = \_\_\_\_\_

a. In this case, use  $x = 0$  and solve for y.

b.  $2(0-3)^2 + 2 = 2(9) + 2 = 20$ .

c. The answer is 20.

\*Note: If the question ever asks for the 'a' value, the answer is always 0.

### E. Vertex

1. The vertex of the parabola is the highest (or lowest) point in the graph. It is written as the point (h,k). If the equation is written as  $y = a(x - h)^2 + k$ , finding the vertex is very easy. However, if the equation is written as  $y = ax^2 + bx + c$ , then do the following:

a. To find 'h', use:  $-b/2a$ .

b. To find 'k', you can plug 'h' into the equation and solve for y, or you can

use:  $-\frac{(b^2 - 4ac)}{4a}$ . Notice, the numerator is the same formula as the discriminant so this equation should be easy to remember.

Ex [1] If the vertex of the parabola,  $y = 2(x-3)^2 + 4$  is (h,k),  
then k = \_\_\_\_\_.

a. The answer is simply 4.

Ex [2] If the vertex of the parabola,  $y = 4x^2 - 5x - 1$  is (h,k),  
then k = \_\_\_\_\_.

a. To find k, we need to first find the discriminant or  $(-5)^2 - 4(4)(-1) = 25 + 16 = 41$ .

b. The denominator is  $4a = 4(4) = 16$ .

c. The answer is  $-\frac{41}{16}$ . If the question had asked for 'h' the answer would be  $-\frac{b}{2a}$  or  $-\frac{(-5)}{2(4)} = \frac{5}{8}$ .