Sec 13.5 The Parabola

1. **Parabola** – graph created by slicing a cone parallel to the side (generator) of the cone

2. **Equation of a Parabola in Standard Form**
   There are two equations for the parabola depending on the direction the parabola opens.

   a) **Opens up or down**

   - Vertex =
   - When “a” is positive, the parabola opens ________.  
   - When “a” is negative, the parabola opens ________.
   - Equation of axis of symmetry: ________________

   b) **Opens left or right**

   - Vertex =
   - When “a” is positive, the parabola opens ________.  
   - When “a” is negative, the parabola opens ________.
   - Equation of axis of symmetry: ________________

**Example 1** – State the vertex, equation of the axis of symmetry, domain and range of the parabola. Then, graph.

a) \( y = 3(x + 4)^2 \)

   - vertex =
   - axis of symmetry:
   - domain:
   - range:

b) \( x = -\frac{1}{2}(y - 3)^2 + 4 \)

   - vertex =
   - axis of symmetry:
   - domain:
   - range:
Your Turn 1 – State the vertex, equation of the axis of symmetry, domain and range of the parabola. Then, graph.

a) \[ y = -\frac{1}{3}(x - 2)^2 + 10 \]

vertex =  
axis of symmetry:  
domain:  
range:

b) \[ x = 2(y + 5)^2 + 1 \]

vertex =  
axis of symmetry:  
domain:  
range:

3. Writing the Equation

In order to write the equation of a parabola, you need the vertex and the “a” value which indicates the direction and width of the parabola. Usually, you will need to find the value of “a” so use the vertex, \((h, k)\), a point \((x, y)\) and the direction of opening or axis of symmetry to find it by substituting all the information into the standard form of the correct parabola.

Example 2 – Write the equation of a parabola in standard form with vertex \((-2, -3)\), passing through \((-5, 1)\) and a horizontal axis of symmetry.

Your Turn 2 – Write the equation of a parabola in standard form with vertex \((-6, 3)\), passing through \((4, -5)\) and opens to the right.
4. **Applications**

Here are some pointers to help you with the application problems.

1) Draw a picture using the given information.
2) Draw in the $x$ and $y$-axis, preferably with the vertex on one of the axes or even at the origin.
3) You will usually know a couple of points from the diagram so set up the equation of the parabola and solve for “$a$” by substituting the known points into the equation.

**Example 3** – The central cable of a suspension bridge forms a parabolic arch. The cable is suspended from the top of two supporting towers 250 m apart. The top of the towers is 50 m above the road and the lowest point on the cable is midway from the towers and 3 m above the road. Find the height of the cable above the road 30 m from a tower.

**Your Turn 3** – A ball thrown horizontally from the roof of a building 30 m above the road lands on the ground 45 m from the base of the building. If the ball falls in a parabolic path, find its equation relative to the position from which it was thrown.