Conic Sections

General Quadratic Equation in Two Variables

The general quadratic equation in two variables can be written as

$$Ax^2 + Bxy + Cy^2 + Dx + Ey + F = 0$$

where at least one of the variables A, B, or C is not zero. In this class, we will only look at those cases where $B = 0$, that is, there is no *xy* term. The presence of an xy term results in a rotated graph and is covered in a Trigonometry or Analytic Geometry course.

The graph of the general quadratic equation in two variables can be one of nine things. Seven of these things can be formed slicing a double napped cone with a plane, so they're often called conic sections. There are graphs of these conic sections in your text.

Determining the type of graph

1. The type of graph can be determined by looking at the __________ terms.

2. If there are any linear terms, then you should ____________ ________ ____________ before determining the type of graph.

Example of completing the square.

$$x^2 + y^2 - 4x + 6y + 7 = 0$$
$$\left(x^2 - 4x + 4\right) + \left(y^2 - 6y + 9\right) = -7 + 4 + 9$$
$$\left(x - 2\right)^2 + \left(y - 3\right)^2 = 6$$

Squared terms are both positive - ellipses or circles

Here are some examples in standard form.

$$x^2 + y^2 = 4 \text{ or } \frac{x^2}{4} + \frac{y^2}{9} = 1 \text{ or } \frac{\left(x-3\right)^2}{9} + \frac{\left(y+2\right)^2}{4} = 1$$

Here are some examples that aren't in standard form, but are still easy to tell the type of graph by inspection.

$$3x^2 + 4y^2 = 8 \text{ or } x^2 + 2y^2 = -1$$

Here are two examples that may provide difficulty because there are linear terms. You really need to complete the square first before determining the type of graph.

$$x^2 + y^2 - 3x + 4y + 9 = 0 \text{ or } x^2 + 4y^2 + 2x - 4y + 4 = 0$$

3. If the x^2 and y^2 are both positive and have the same coefficient, then you have a _____________.

4. If the x^2 and y^2 are both positive but have different coefficients, then you have an _____________.

5. If the x^2 and y^2 are both positive but the right side is __________, then the graph is a point.

6. If the x^2 and y^2 are both positive but the right side is __________, then there is no graph.

Squared terms have different signs - hyperbola

Here are some examples in standard form.

$$x^2 - y^2 = 1 \text{ or } \frac{y^2}{4} - \frac{x^2}{9} = 1 \text{ or } \frac{(x-3)^2}{3} - \frac{(y+4)^2}{4} = 1$$

Here are some examples that aren't in standard form, but are still easy to tell the type of graph by inspection.

$$x^2 - 3y^2 = 4 \text{ or } 2y^2 = 5x^2$$

Here are some examples that you really need to complete the square on before determining the type of graph.

$$4x^2 - 3y^2 + 4x - 6y = 9 \text{ or } 5y^2 - 4x^2 - 3x + 2y - 9 = 0$$

7. If the x^2 and y^2 have different signs, then you have a _____________.

8. If the x^2 and y^2 have different signs, but the right side is ___________, then you have intersecting lines.

Only one variable is squared - parabolas

Here are some examples in standard form.

$$x^2 = 4y \text{ or } (y-2)^2 = 8(x+3)$$

Here are some examples that aren't in standard form, but are still easy to determine what the graph is by inspection.

$$5x^2 + 3x + 2y = 9 \text{ or } x^2 - x = 6 \text{ or } y^2 = -4$$

9. If one variable is squared and the other variable is ___________, then you have a parabola.

10. If one variable is squared and the other variable is ___________, then you have parallel lines.

11. It's possible to also get _______ __________ when only one variable is present. This would be when the solutions are complex numbers involving *i*.

12. You usually don't need to complete the square to determine the type of graph when only one variable is squared. The question is whether or not the second variable is _____________.

No variables are squared - lines

Examples of lines are

$$3x + 2y = 4 \text{ or } x = 6 \text{ or } y = 5x - 2$$

13. If neither variable is squared, then you have a _________.

Practice: Identify the type of graph by inspection.

_________	$3x^2 - 2y^2 = 4$	_________	$4x^2 - 3y = 2$
_________	$x^2 - 5x + 6 = 0$	_________	$x^2 + 5y^2 = 0$
_________	$x^2 + y^2 = 9$	_________	$3x^2 - 4y^2 = 0$
_________	$x^2 + 2y^2 = -3$	_________	$3x + 6y = 8$
_________	$x^2 + 3y^2 = 4$		

Circles

The standard form for a circle is $x^2 + y^2 = r^2$

14. The center of the circle is at the ___________.

15. The radius of the circle is ________.

16. You may shift the circle by replacing the x by ________ and the y by _______.

17. This will move the center to the point (_____ , _____)

The standard form for the shifted graph is $(x-h)^2 + (y-k)^2 = r^2$

18. Rather than memorizing the standard form with the $x-h$ and $y-k$ in it, just think about the translations we talked about in chapters 1, 3, and 4. If you see an $x+3$, think $x =$_____ and if you see $y-4$, think $y =$_____.

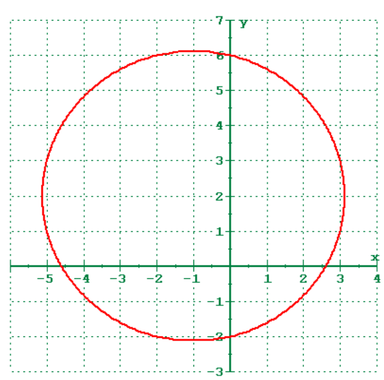
Practice: Find the center and radius of the following circles.

$(x+1)^2 + (y-2)^2 = 9$ $\qquad\qquad$ $x^2 + (y-7)^2 = 8$

Completing the square

Whenever you're working with circles that have linear terms in them, you're going to have to complete the square to find the center and radius.

Consider the circle $x^2 + y^2 + 2x - 4y - 12 = 0$



19. The first step is to move the _________ to the other side and then _________ the terms together by variable. Leave a space after the linear terms for the next step.

$x^2 + 2x +$ _____ $+ y^2 - 4y +$ ______ $= 12$

20. Now complete the square for both the *x* and *y* terms by taking ________ the linear coefficient and squaring it. Write that in the space you left in the previous step and add it to the other side as well.

$$x^2 + 2x + 1 + y^2 - 4y + 4 = 12 + 1 + 4$$

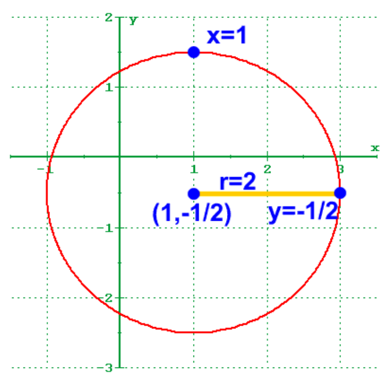
21. Now, ___________ the left side using perfect square trinomials and ___________ the right side.

$$(x+1)^2 + (y-2)^2 = 17$$

22. The center of that circle is (_____ , _____) and the radius is _______.

Practice: Find the center and radius of $x^2 + y^2 - 6x + 4y + 3 = 0$

Finding the equation of a circle from the graph.



23. The first step is to find out where the ________ is.

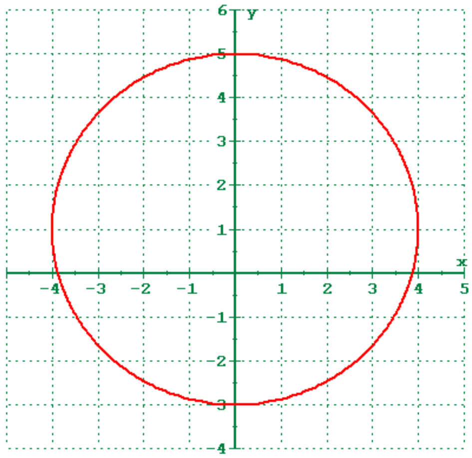
24. To do this, identify the _______ coordinate of the highest or lowest point and the _______ coordinate of the points furthest left or right. These two coordinates give you the center.

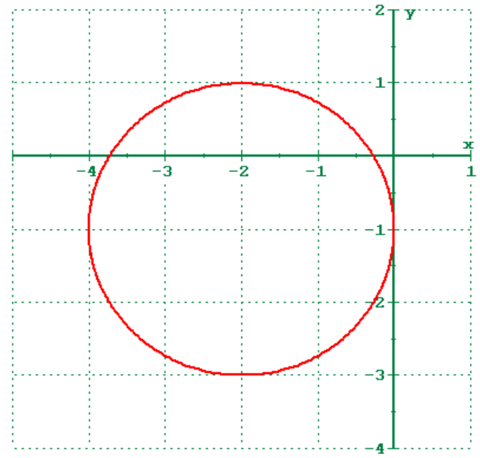
Now, put a point at the center and find out how far it is to any point on the graph. This is the radius. Finally, write the equation of the circle. Remember to square the radius.

The equation of that circle is $(x-1)^2 + \left(y + \frac{1}{2}\right)^2 = 4$

25. Another way to find the center is to draw ____________ and ____________ diameters through the circle. The center is the point where they ____________.

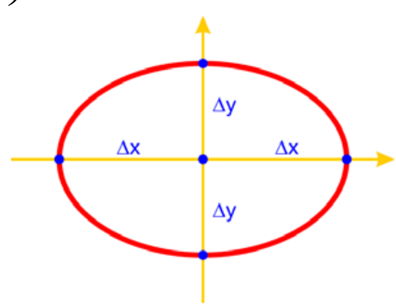
Practice: Find the equation of the circles





Ellipses

The best equation to conceptualize an ellipse is $\left(\frac{x}{\Delta x}\right)^2+\left(\frac{y}{\Delta y}\right)^2=1$.



26. In this form, the center is at the __________.

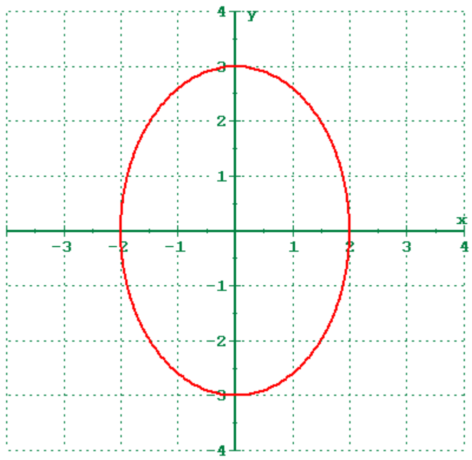
27. The distance you go from the center in the *x* direction is _______ and the distance you go from the center in the *y* direction is _______.

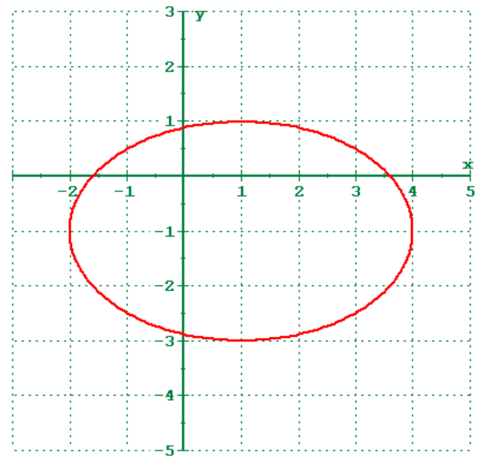
28. If the center isn't at the __________, then replace the *x* with $x-h$ and the *y* with $y-k$.

That gives you the equation $\left(\frac{x-h}{\Delta x}\right)^2+\left(\frac{y-k}{\Delta y}\right)^2=1$.

29. Notice that everything affecting the horizontal is grouped with the ______ and everything affecting the vertical is grouped with the ______.

Practice. Find the equation of the ellipse.





Sketching an Ellipse

30. To sketch an ellipse, start at the ___________.

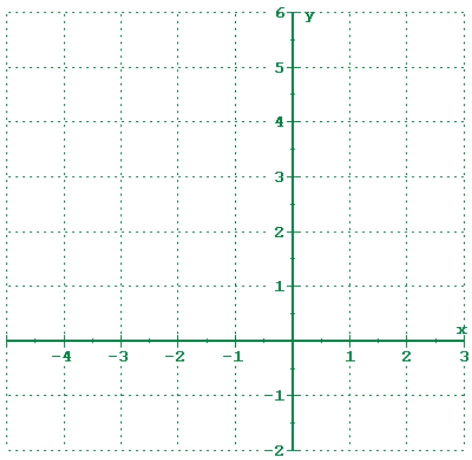
31. From the center, move Δx units to the ________ and _________ and put dots there. Move Δy units ________ and ________ and put dots there.

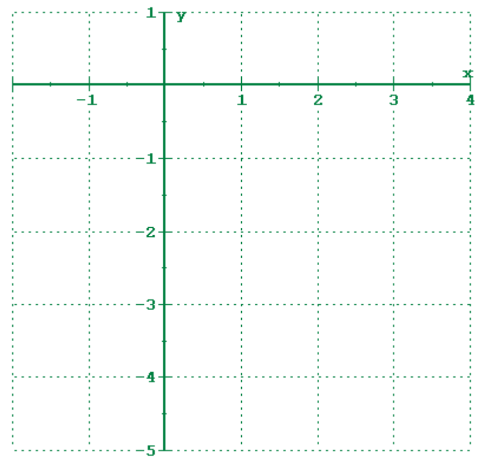
32. Draw an ellipse through the four ________.

Practice: Sketch the graph of the ellipses.

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

$$\frac{(x-1)^2}{5}+\frac{(y+2)^2}{7}=1$$





Standard Form for Ellipses

Horizontal Major Axis

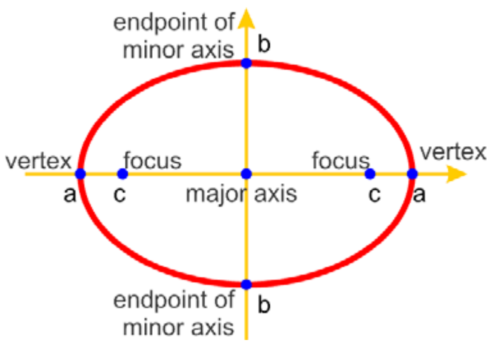
$$\left(\frac{x-h}{a}\right)^2+\left(\frac{y-k}{b}\right)^2=1$$

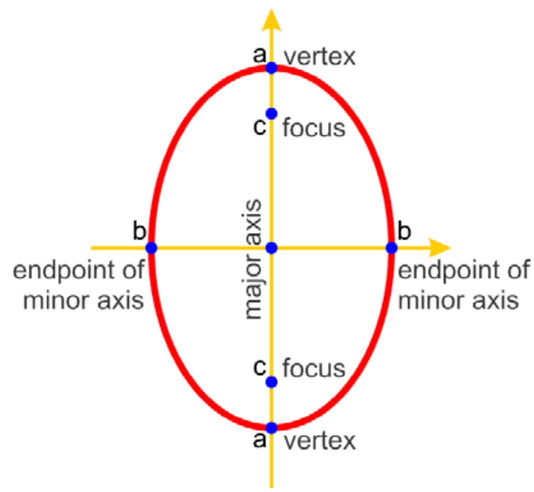
$$\frac{(x-h)^2}{a^2}+\frac{(y-k)^2}{b^2}=1$$

Vertical Major Axis

$$\left(\frac{x-h}{b}\right)^2+\left(\frac{y-k}{a}\right)^2=1$$

$$\frac{(x-h)^2}{b^2}+\frac{(y-k)^2}{a^2}=1$$





33. The value of a is the ____________ of Δx and Δy. The value of b is the ___________ of Δx and Δy.

34. The __________ axis is whichever one is longer and the __________ axis is whichever axis is shorter.

35. That means that the length of the major axis is ________ and the length of the minor axis is ________.

36. The __________ are at the end of the major axis.

37. The direction of major axis depends on which value, Δx or Δy, is ___________.

38. The _________ always lie on the major axis within the ellipse.

39. The distance from the center to the vertices is _______.

40. The distance from the center to the endpoints of the minor axis is _____.

41. The distance from the center to the foci is _______.

There is a Pythagorean relationship between *a*, *b*, and *c*.

$a^2 = b^2 + c^2$

42. Notice the ___________ value goes on a side by itself.

Practice: Identify the center, whether the major axis is horizontal or vertical, and find the values of a, b, and c.

$$\frac{x^2}{25} + \frac{y^2}{16} = 1$$

$$\frac{(x+3)^2}{4} + \frac{(y-2)^2}{16} = 1$$

43. To find the coordinates of the vertices, start at the ________ and move *a* units in the direction of the major axis. If the major axis is ___________, then add and subtract *a* to (from) the *x* value. If the major axis is ___________, then add and subtract *a* to (from) the *y* value. Leave the other coordinate alone.

44. To find the coordinates of the foci, start at the center and move _______ units in the direction of the major axis.

As an example, if the center is at $(5,3)$, the length of major axis is 8, the focal length is $\sqrt{3}$, and there is a horizontal major axis, then we would proceed as follows.

45. Since the length of the major axis is 8, the value of *a* is ________ since the major axis has length of 2*a*.

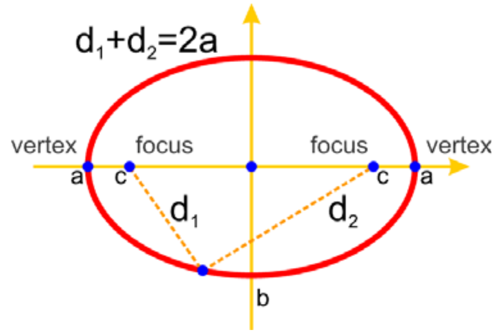
46. Since the major axis is horizontal, we change the _____ coordinates. $(5 \pm 4, 3)$ becomes $(5+4, 3)$ and $(5-4, 3)$, which is $(9,3)$ and $(1,3)$.

47. The foci are ________ units from the center and we once again change the ______ values, so the foci are at $(5 \pm \sqrt{3}, 3)$.

Definition of an Ellipse

We've done a lot of work with Ellipses, but we haven't defined them yet.

48. An ellipse is the set of all points in a plane such that the _______ of the distances from two fixed points is constant.



49. Those two fixed points are the _________.

50. The constant is the length of the __________ axis.

Completing the square

Sometimes, you'll need to complete the square to put the equation of the ellipse into standard form. You need to be really careful when you do this because now there are coefficients in front of the x^2 and y^2.

Complete the square and put into standard form.

$$4x^2 + 3y^2 - 8x + 12y + 4 = 0$$

51. Begin by moving the __________ to the other side and _________ the *x* and *y* terms together.

$$4x^2 - 8x + 3y^2 + 12y = -4$$

52. __________ the coefficient on the x^2 out of both *x*'s, even if it doesn't go in evenly. Do the same thing with the *y*'s. Leave space after the linear term but inside the parentheses.

$$4\left(x^2 - 2x + \_\_\_\_\_\right) + 3\left(y^2 + 4y + \_\_\_\_\_\right) = -4$$

53. Take ________ the linear coefficient and square it. Write that value in the spot you left in the previous step. However, remember that there is a constant that you factored out and that what you really just added was the constant times the number you wrote. Add that amount to the other side for both the *x* and the *y* terms.

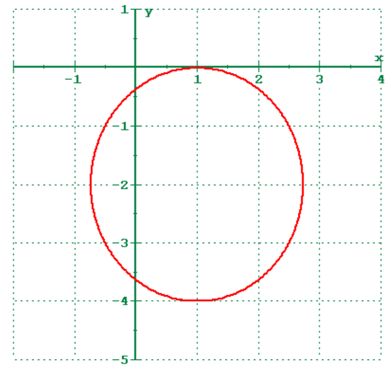
$$4\left(x^2 - 2x + 1\right) + 3\left(y^2 + 4y + 4\right) = -4 + 4 + 12$$

54. __________ the left side using perfect square trinomials and ___________ the right side.

$$4(x-1)^2 + 3(y+2)^2 = 12$$

55. Finally, divide by the right hand side to make it _________ and put the equation into standard form. Reduce any fractions so that the entire value is in the denominator.

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



56. The center is at (______ , ______). The change in the x direction is _________ and the change in the y direction is _________.

Be careful if you have fractions after you divide.

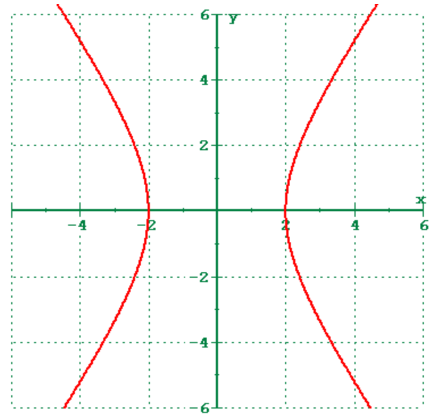
Write $\frac{3(x-1)^2}{4} + \frac{5(y+2)^2}{9} = 1$ as $\frac{(x-1)^2}{4/3} + \frac{(y+2)^2}{9/5} = 1$ instead.

You need to do this so that you can figure out what the a^2 and b^2 are. In this case, $a^2 = 9/5$ and $b^2 = 4/3$ (remember a is bigger than b). Take the square roots to get $a = \Delta y \approx 1.34$ and $b = \Delta y \approx 1.15$.

Practice: Complete the square; find the center, change in x and y, and coordinates of the vertices and foci.

$$25x^2 + 16y^2 + 100x - 96y - 156 = 0$$

Hyperbolas



57. The best equation to conceptualize a hyperbola that opens _______________ is $\left(\frac{x}{\Delta x}\right)^2 - \left(\frac{y}{\Delta y}\right)^2 = 1$.

58. The best equation to conceptualize a hyperbola that opens _______________ is $\left(\frac{y}{\Delta y}\right)^2 - \left(\frac{x}{\Delta x}\right)^2 = 1$.

59. In either form, the hyperbola opens in the direction of the __________ variable.

60. In these form, the center is at the ___________.

61. The distance you go from the center in the *x* direction is _______ and the distance you go from the center in the *y* direction is _______.

62. If the center isn't at the ___________, then replace the *x* with $x-h$ and the *y* with $y-k$.

That gives you the equation $\left(\frac{x-h}{\Delta x}\right)^2 - \left(\frac{y-k}{\Delta y}\right)^2 = 1$ or $\left(\frac{y-k}{\Delta y}\right)^2 - \left(\frac{x-h}{\Delta x}\right)^2 = 1$.

63. Notice that everything affecting the horizontal is grouped with the ______ and everything affecting the vertical is grouped with the ______.

64. Instead of having a major axis and a minor axis like an ellipse, the hyperbola has a _____________ axis and a ______________ axis.

65. The transverse axis is always in the direction of the ____________ variable.

66. The conjugate axis is always in the direction of the ____________ variable. The conjugate axis reminds us of complex conjugates from imaginary numbers. Likewise, the conjugate axis is imaginary, it's not really there on the graph.

Sketching a Hyperbola

Sketching a hyperbola starts off like sketching an ellipse.

67. You start at the __________.

68. From there move _______ units to the left and right and _______ units up and down.

69. Draw a ________________ around those four points, so that they are at the center of each side. This is not part of the actual graph, it's just an aid to help us sketch it.

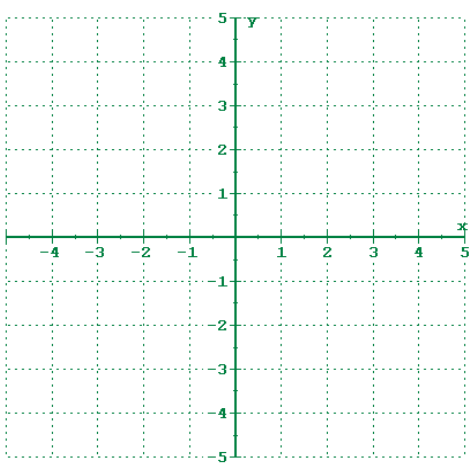
70. Draw dashed lines through the opposite corners of the box. These make _______________ that serve as guidelines for sketching the hyperbola. These are not part of the actual graph, just aids to help us sketch it.

71. The hyperbola touches the box on the sides of the __________ variable. If the x^2 is positive, it will touch on the left and right. If the y^2 is positive, it will touch on the top and the bottom.

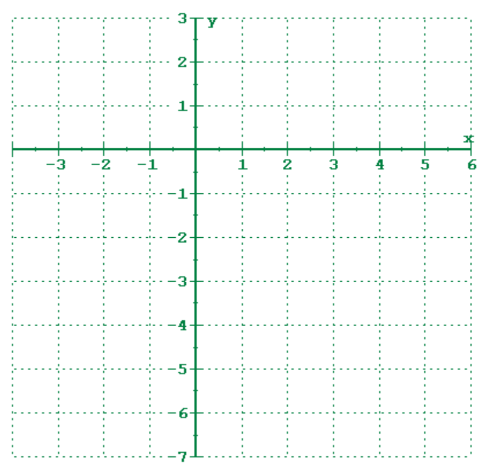
72. Sketch the hyperbola, making sure you don't cross the _______________.

Practice: Sketch the following hyperbolas.

$$\frac{y^2}{4} - \frac{x^2}{9} = 1$$



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

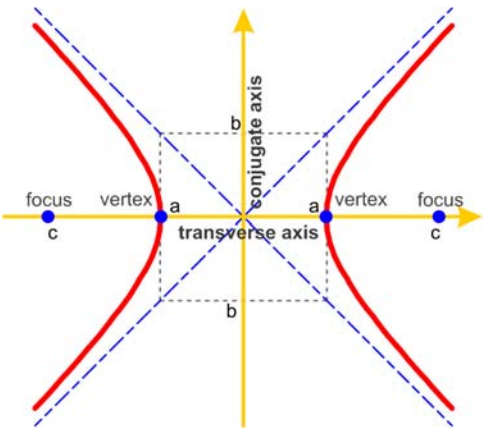


Standard Forms

Horizontal Transverse Axis

$$\left(\frac{x-h}{a}\right)^2-\left(\frac{y-k}{b}\right)^2=1$$

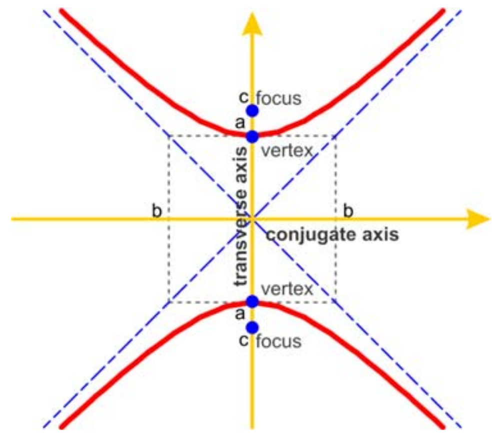
$$\frac{(x-h)^2}{a^2}-\frac{(y-k)^2}{b^2}=1$$



Vertical Transverse Axis

$$\left(\frac{y-k}{a}\right)^2-\left(\frac{x-h}{b}\right)^2=1$$

$$\frac{(y-k)^2}{a^2}-\frac{(x-h)^2}{b^2}=1$$



73. ______ is distance from the center to the vertices.

74. *a* is always associated with the _________ variable.

75. The vertices are at the ends of the transverse axis, so the length of the transverse axis is _______.

76. ______ is the distance from the center to the endpoints of the conjugate axis. Those endpoints don't actually show up on the graph, except to help us make the rectangle.

77. *b* is always associated with the _________ variable.

78. ______ is the distance from the center to the foci. The foci are always inside the curved portion of the hyperbola.

79. Since the ________ are the furthest of the three points from the center, the Pythagorean identity for a hyperbola is $c^2=a^2+b^2$.

80. Notice this is the same identity you're used to seeing from _____________.

Practice: Identify the center, whether the transverse axis is horizontal or vertical, and find the values of a, b, and c.

$$\frac{(x-3.1)^2}{0.64}-\frac{(y+1.2)^2}{0.36}=1 \qquad\qquad 4y^2-3x^2=12$$

81. To find the coordinates of the vertices, start at the ________ and move *a* units in the direction of the __________ variable.

82. To find the coordinates of the foci, start at the center and move _______ units in the direction of the positive variable.

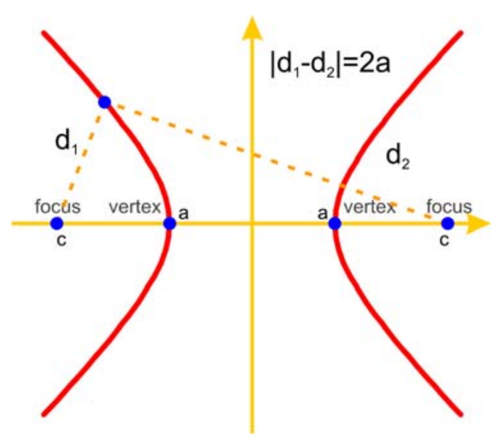
As an example, if the center is at $(4,2)$, $a=3$, $c=2\sqrt{5}$, and the *y* is the positive variable, then we would proceed as follows.

83. Since the ______ is the positive value, we will be changing the ______ value and leaving the ______ value alone.

84. The vertices are _______ units from the center. The coordinates of the vertex will be at $(4,2\pm3)$. This simplifies to $(4,5)$ and $(4,-1)$.

85. The foci are _______ units from the center. The coordinates of the foci will be $(4,2\pm2\sqrt{5})$.

Definition of a Hyperbola



86. A hyperbola is the set of all points in a plane such that the ______________ of the distances from two fixed points is a constant.

87. Those two fixed points are the ___________.

88. The constant is the length of the ___________ axis.

89. Notice the distance is written with an absolute value because we don't know whether d_1 or d_2 is ______________.

Completing the Square

This is very similar to completing the square for an ellipse, except one of the variables will have a negative constant factored out of it.

Complete the square and put into standard form: $5y^2 - 6x^2 + 12x - 20y - 16 = 0$

90. Begin by moving the _____________ to the right hand side and __________ the *x* and *y* terms together.

$$5y^2 - 20y - 6x^2 + 12x = 16$$

91. ____________ the coefficients on the squared terms out of both terms for each variable. Be sure to factor a negative sign out with the *x*'s in this case. Leave space for another number to go inside the parentheses.

$$5\left(y^2 - 4y + \_\_\_\_\_\_\right) - 6\left(x^2 - 2x + \_\_\_\_\_\_\right) = 16$$

92. Take ________ the linear term and square it. Write that in the space you left in the previous step. Multiply the value you added by the constant in front of the parentheses and add this to the other side of the equation.

$$5\left(y^2 - 4y + 4\right) - 6\left(x^2 - 2x + 1\right) = 16 + 20 - 6$$

93. Notice in the last step that one of the terms was actually subtracted from both sides. Now ____________ the left side using perfect square trinomials and simplify the right side.

$$5(y-2)^2 - 6(x-1)^2 = 30$$

94. Finally, divide through by the right hand side to make it __________. Reduce any fractions so the coefficients are completely in the denominator.

$$\frac{(y-2)^2}{6} - \frac{(x-1)^2}{5} = 1$$

Practice: Complete the square; find the center, change in x and y, and coordinates of the vertices and foci.

$$16x^2 - 9y^2 + 96x + 18y - 9 = 0$$

Asymptotes

95. The asymptotes of a hyperbola are a pair of intersecting ___________.

96. The ____________ of the asymptotes will be $\pm\frac{\Delta y}{\Delta x}$.

97. The asymptotes will pass through the ____________ of the hyperbola.

98. The ____________ of the asymptotes are $(y-k) = \pm\frac{\Delta y}{\Delta x}(x-h)$.

99. The further the graph is from the ____________, the closer it gets to the asymptotes.

100. The graph of the hyperbola will ___________ cross the asymptotes.

101. The equations of the asymptotes don't depend on which ___________ the hyperbola opens.

Practice: Find the equations of the asymptotes of the hyperbola.

$$\frac{x^2}{9} - \frac{y^2}{16} = 1$$

$$\frac{(y+2)^2}{4} - \frac{(x-3)^2}{25} = 1$$

Parabolas

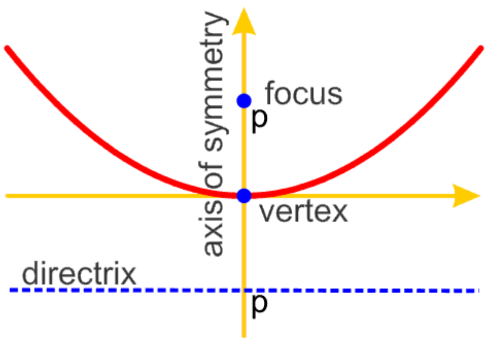
102. Parabolas are easy to spot because both variables are present, but only one variable is __________.

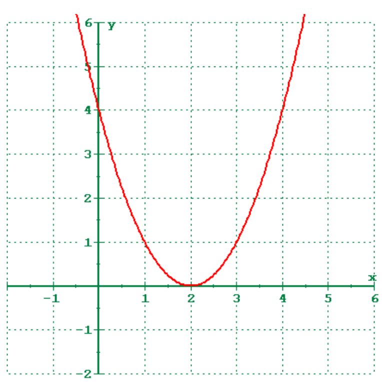
Standard Form

Vertical Axis of Symmetry

$x^2 = 4py$

$(x-h)^2 = 4p(y-k)$



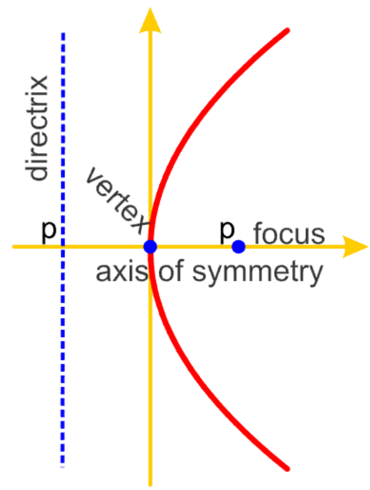


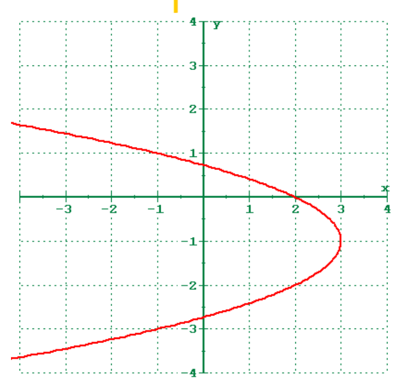
$(x-2)^2 = y$

Horizontal Axis of Symmetry

$y^2 = 4px$

$(y-k)^2 = 4p(x-h)$





$(y+1)^2 = -(x-3)$

103. In the simplest form of a parabola (without the *h* and *k*), the vertex is at the _________.

104. The focus always lies __________ the parabola.

105. ______ is the distance from the vertex to the focus and is called the focal length.

106. The same distance as the focus, but on the other side of the vertex is a line called the ____________.

107. The axis of symmetry passes through the __________ and __________ and is perpendicular to the _____________.

108. The direction of the axis of symmetry is determined by which variable is ______ squared.

109. The parabola will open in the positive direction (up or right) if *p* is __________ and in the negative direction (down or left) if *p* is ___________.

Finding the Vertex and Focal Length

Consider the parabola $x^2 + 8y = 4$

110. Get the __________ term by itself.

$$x^2 = -8y + 4$$

111. Factor the right hand side so the coefficient on the linear variable is ______.

$$x^2 = -8\left(y - \frac{1}{2}\right)$$

112. The constant on the right hand side will be ______. So divide that by 4 to find *p*.

$$4p = -8$$
$$p = -2$$

113. This parabola has opens down because the ______ is the linear variable and *p* is negative.

114. The vertex is at (______, ______) and the focal length is _________.

115. Since the focus is 2 units below the vertex, the directrix is ________ units above the vertex.

116. The equation of the directrix is y = ____________ .

Completing the Square

Consider the parabola $y^2 - 3x - 2y + 5 = 0$

117. Determine which variable is __________. Move the constant and the linear variable to the other side.

$$y^2 - 2y = 3x - 5$$

118. If the coefficient on the squared variable isn't _______, then divide through by that value. In this case, we don't need to do that. Leave space for a third number on the left hand side.

$$y^2 - 2y + \_\_\_\_\_ = 3x - 5$$

119. Take _________ the linear coefficient and square it. Add that amount to both sides.

$$y^2 - 2y + 1 = 3x - 5 + 1$$

120. _________ the left side using perfect square trinomials and simplify the right side. Factor a constant out of the right side if the coefficient isn't one.

$$(y-1)^2 = 3x - 4$$

$$(y-1)^2 = 3\left(x - \frac{4}{3}\right)$$

Now it's in standard form and $4p = 3$, so $p = \frac{3}{4}$

121. The parabola has a _____________ axis of symmetry because the *x* is the linear variable.

122. The vertex is at (______ , ______).

123. The focus is 3/4 units to the __________ of the vertex. That puts it at $\left(\frac{4}{3} + \frac{3}{4}, 1\right)$ or $\left(\frac{25}{12}, 1\right)$

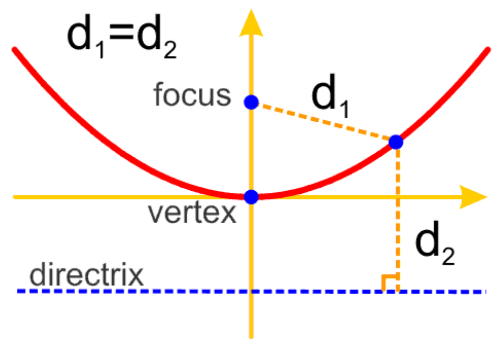
124. The directrix is 3/4 units to the _________ of the vertex. That puts it at

$$x = \frac{4}{3} - \frac{3}{4} = \frac{7}{12}$$

Practice: Find the vertex, focus, and directrix and give the direction the parabola opens.

$x^2 = 2y$ $\qquad\qquad$ $y^2 - 2x + 4y = 0$

Definition of a parabola



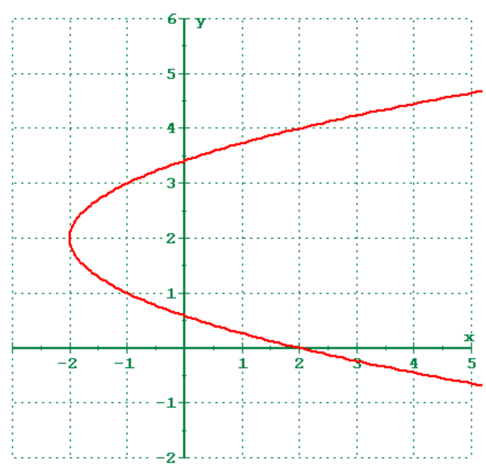
125. A parabola is the set of all points in a plane __________ from a fixed point and a line.

126. The fixed point is called the ____________.

127. The line is called the ____________.

128. Distances from a point to a line are always measured ______________ to the line.

Finding the equation of the parabola from the graph



129. The first thing to do is determine the general form of the parabola based on which direction it _________.

130. Since this graph opens to the ________, the general form is $y^2 = 4px$.

131. Determine where the vertex is and make substitutions into the equation if it's not at the origin. Here, the vertex is at (______ , ______), so replace *x* with $x+2$ and *y* with $y-2$.

$$(y-2)^2 = 4p(x+2)$$

132. Find another _________ on the parabola and use it for *x* and *y*. Here the point (2,0) is on the parabola.

$$(0-2)^2 = 4p(2+2)$$

133. Solve the equation for __________ to find the focal length.

$$4 = 4p(4)$$

$$4 = 16p$$

$$p = \frac{1}{4}$$

134. Double check to make sure the ________ on p agrees with the direction the parabola opens. If the parabola opens down or to the left, then p should be _________. If the parabola opens up or to the right, then p should be __________.

135. Finally, substitute the value for p into the equation and ____________.

$$(y-2)^2 = 4\left(\frac{1}{4}\right)(x+2)$$

$$(y-2)^2 = x+2$$

Practice: Find the equation of the following parabolas.