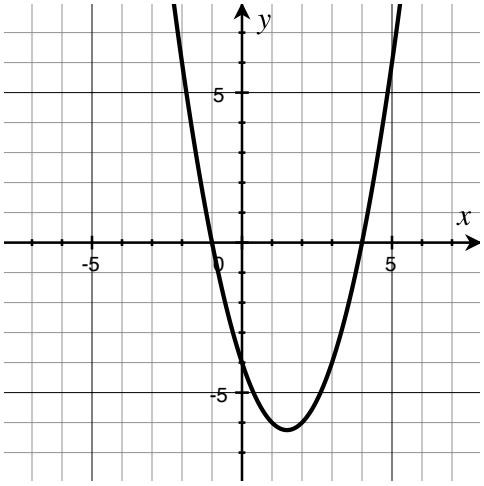
Warm-Up

CST/CAHSEE

The graph of the equation $y = x^2 - 3x - 4$ is shown below.



For what values of x is $y = 0$?

A $x = -1$ only

B $x = -4$ only

C $x = -1$ and $x = 4$

D $x = 1$ and $x = -4$

- Find the vertex of the parabola *exactly.*

Review

Which is one of the solutions to the equation $2x^2 - x - 4 = 0$?

A $\frac{1}{4} - \sqrt{33}$

B $-\frac{1}{4} + \sqrt{33}$

C $\frac{1+\sqrt{33}}{4}$

D $\frac{-1-\sqrt{33}}{4}$

- Write out the quadratic formula.

Current

What are the solutions for the quadratic equation $x^2 + 6x = 16$?

A $-2, -8$

B $-2, 8$

C $2, -8$

D $2, 8$

- Solve a second way.

Other

Leanne correctly solved the equation $x^2 + 4x = 6$ by completing the square.
Which equation is part of her solution?

A $(x+2)^2 = 8$

B $(x+2)^2 = 10$

C $(x+4)^2 = 10$

D $(x+4)^2 = 22$

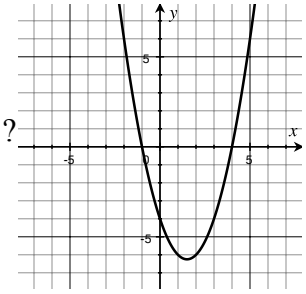
- Solve the problem completely.

CA State Standard 14.0: Students solve a quadratic equation by factoring or completing the square.
CA State Standard 20.0: Students use the quadratic formula.
CA State Standard 21.0: Students graph quadratic functions and know that their roots are *x*-intercepts.

Warm-Up: Solutions

CST/CAHSEE

The graph of the equation $y = x^2 - 3x - 4$ is shown below.



For what values of x is $y = 0$?

A $x = -1$ only

B $x = -4$ only

C $x = -1$ and $x = 4$

D $x = 1$ and $x = -4$

x-intercepts are points where y=0.
x-intercepts -are -1 and 4

*Find the vertex of the parabola *exactly*

Vertex is $\left(\frac{3}{2}, \frac{-25}{4}\right)$

Vertex: $x = \frac{-b}{2a} = \frac{3}{2}$

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

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

$y = \frac{9}{4} - \frac{18}{4} - \frac{16}{4}$

$y = \frac{9 - 18 - 16}{4}$

-25

Review

Which is one of the solutions to the equation $2x^2 - x - 4 = 0$?

A $\frac{1}{4} - \sqrt{33}$

B $-\frac{1}{4} + \sqrt{33}$

C $\frac{1 + \sqrt{33}}{4}$

D $\frac{-1 - \sqrt{33}}{4}$

$x = \frac{1 \pm \sqrt{1 - 4(2)(-4)}}{2(2)}$

$x = \frac{1 \pm \sqrt{1 - (-32)}}{4}$

$x = \frac{1 \pm \sqrt{33}}{4}$

$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

- Write out the quadratic formula.

Current

What are the solutions for the quadratic equation $x^2 + 6x = 16$?

A $-2, -8$

B $-2, 8$

C $2, -8$

D $2, 8$

$x^2 + 6x = 16$

$x^2 + 6x - 16 = 0$

$(x + 8)(x - 2) = 0$

$x + 8 = 0$ $\quad$ $x - 2 = 0$

$x + 8 - 8 = 0 - 8$ $\quad$ $x - 2 + 2 = 0 + 2$

$x = -8$ $\quad$ $x = 2$

- Solve a second way.

Other

Leanne correctly solved the equation $x^2 + 4x = 6$ by completing the square.
Which equation is part of her solution?

A $(x + 2)^2 = 8$

B $(x + 2)^2 = 10$

C $(x + 4)^2 = 10$

D $(x + 4)^2 = 22$

$x^2 + 4x = 6$

$x^2 + 4x + 4 = 6 + 4$

$(x + 2)^2 = 10$

$\sqrt{(x + 2)^2} = \pm\sqrt{10}$

$x + 2 = \pm\sqrt{10}$

$x = -2 \pm \sqrt{10}$

- Solve the problem completely.

Investigating the Discriminant

Objective: Students will explore the meaning of the discriminant as it connects to the graph of a quadratic function and the solutions of the related quadratic equation.

Materials: Worksheets, graphing calculators, warm-ups and pencils.

Lesson Plan:

1. Have students complete the warm-up. Be sure to debrief the "Current" question with at least *two* solution methods and have students write down ALL methods. They will need to use them in the investigation.

2. Pass out the graphing calculators and review with students how to use them. If you have not used the graphing calculators before, ask your math coach for help in introducing them to your students. Be sure to include instructions on how to graph, look at the table and adjust the window.

3. Have students write out the quadratic formula. Then, have them take out a highlighter and highlight the discriminant. Have them write this equation at the top of the worksheet and tell them that we are going to investigate it's utility in the following lesson.

4. Walk the students through Section 1 as a class. Help them to graph, solve and evaluate the discriminant for the first equation. They should be using the graphing calculator to graph. Walk them through all necessary steps for each part. As you do this, take a piece of chart paper and turn it horizontally. Do the work on this sheet and put it on display.

5. Once Section 1 is complete, have students complete Section 2 and Section 3 in pairs. As students are finishing, select two pairs to place their work on the chart paper. Place these on display, next to the first poster of Section 1.

6. Once all three sections are complete and written on chart paper, hang them side-by-side and move on to Section 4. Complete the summary questions while referring to the posters. Help students to compare and contrast the graphs of each function. Also, ask students to think about how the value of the discriminant fits into the quadratic formula. Ask them to think about how this relates to the number of solutions they found in each Part B. Ask them to discuss how they think the discriminant could be helpful when solving quadratic equations. (Refer to all x-intercepts as roots, solutions and zeros interchangeably and be sure to explain that Section 2 contains a double root.)

7. Once all questions have been answered, ask students if they think that this information could help them to predict certain characteristics of the graph of a quadratic equation and the solutions of a quadratic function. Use questions 1-3 on Page 4 to help illustrate the utility of the discriminant.

8. If there is time, show students several CST Questions that are easily answered using the discriminant. Also, answer questions 4-6 on the investigation. These questions can act as a graphic organizer for students.

CST Released Questions: The Discriminant

Show students these questions after completing the investigation. Explain that the question will NOT direct them to use the discriminant. It is vital that they understand that the purpose/utility of the using the discriminant is to determine the nature and number of roots of a quadratic equation. They have to know *when* they will need the discriminant.

56 **Which statement *best* explains why there is no real solution to the quadratic equation $2x^2 + x + 7 = 0$?**

A The value of $1^2 - 4 \cdot 2 \cdot 7$ is positive.

B The value of $1^2 - 4 \cdot 2 \cdot 7$ is equal to 0.

C The value of $1^2 - 4 \cdot 2 \cdot 7$ is negative.

D The value of $1^2 - 4 \cdot 2 \cdot 7$ is not a perfect square.

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61 **How many times does the graph of $y = 2x^2 - 2x + 3$ intersect the x-axis?**

A none

B one

C two

D three

CSA10084

Investigating the Discriminant

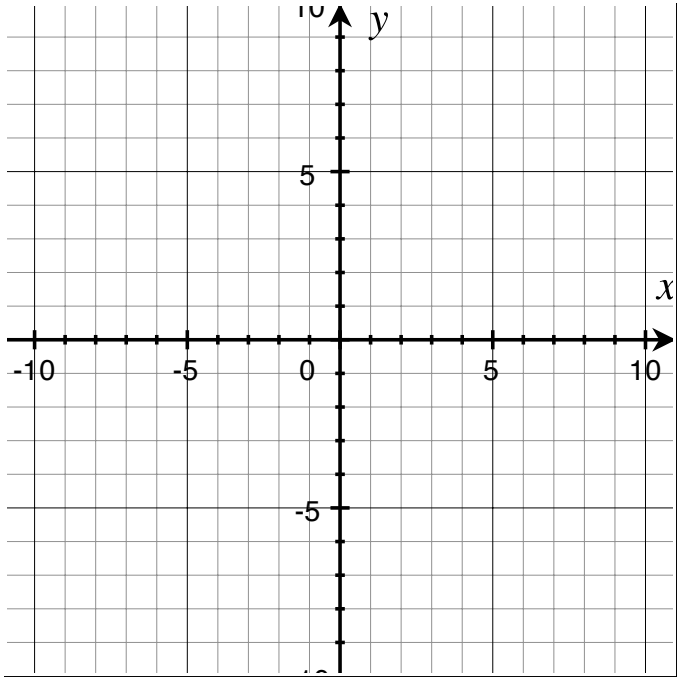
Discriminant:

Name: _____

Section 1/Part A: Graph!

- Using your graphing calculator, graph the quadratic equation.
- Find the **vertex** and ***x*-intercepts** and sketch the graph as you see it on your graphing calculator.

Graph $y = x^2 - x - 6$



How many *x*-intercepts do you see? _____

What are the *x*-intercepts? (Write them as ordered pairs!)

_____

Part B: Solve any way you choose.

$$0 = x^2 - x - 6$$

How many solutions?

_____

The solutions are:

_____

Look back…What do you notice?

_____

_____

Part C: Value of the Discriminant

- Identify *a, b* and *c* and calculate the discriminant.
- Give the value of the discriminant and state whether it is positive, negative or zero.

$$y = x^2 - x - 6$$

a= *b*= *c*=

The value of the discriminant is:

_____

It is

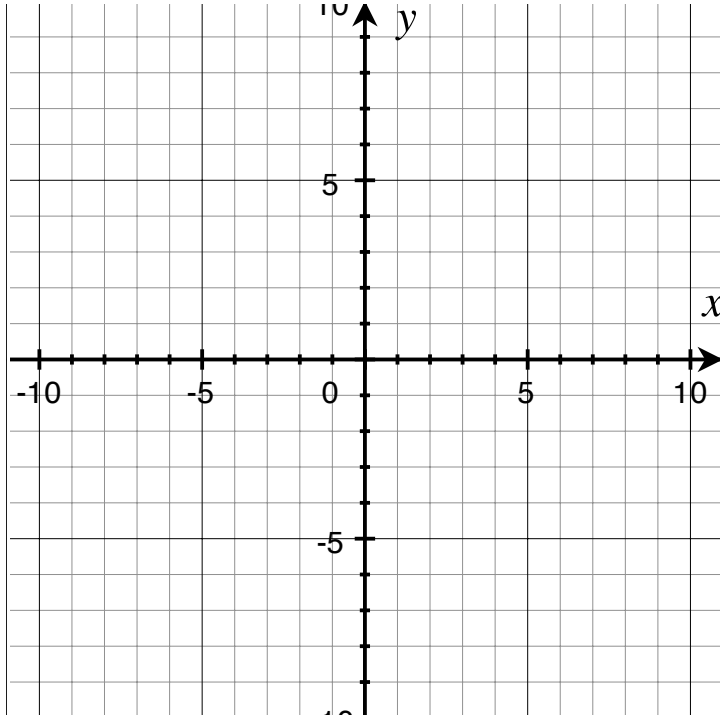
_____

(Positive, negative or zero.)

Section 2/Part A: Graph!

- Using your graphing calculator, graph the quadratic equation.
- Find and the **vertex** and ***x*-intercepts** and sketch the graph as you see it on your graphing calculator.

Graph $y = x^2 + 10x + 25$



How many *x*-intercepts do you see? _____

What are the *x*-intercepts? (Write them as ordered pairs!)

_____

Part B: Solve any way you choose.

$$0 = x^2 + 10x + 25$$

How many solutions?

_____

The solutions are: (This has a special name!)

_____

Look back…What do you notice?

_____

_____

Part C: Value of the Discriminant

- Identify *a, b* and *c* and calculate the discriminant.
- Give the value of the discriminant and state whether it is positive, negative or zero.

$$y = x^2 + 10x + 25$$

a= *b*= *c*=

The value of the discriminant is:

_____

It is

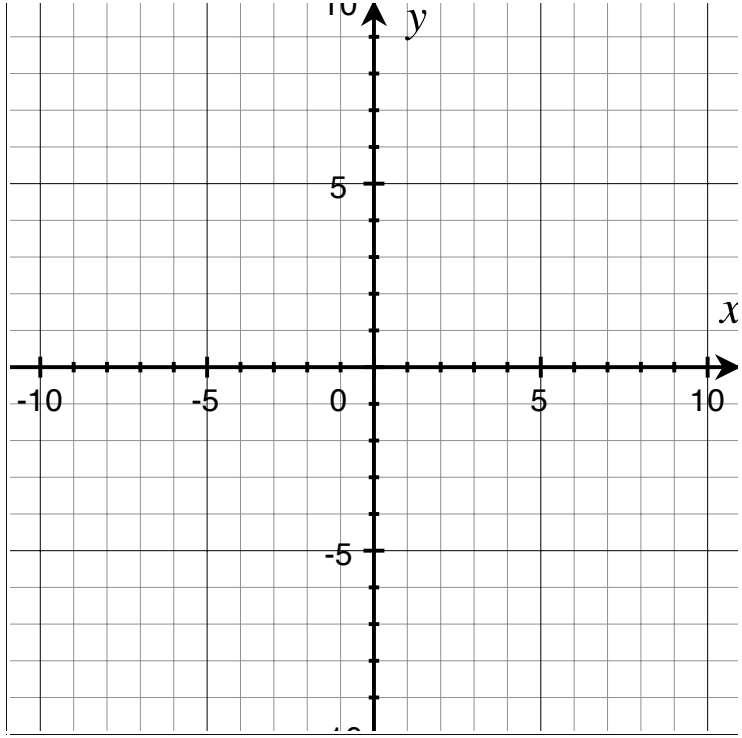
_____

(Positive, negative or zero.)

Section 3/Part A: Graph!

- Using your graphing calculator, graph the quadratic equation.
- Find the **vertex** and ***x*-intercepts** and sketch the graph as you see it on your graphing calculator.

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



How many *x*-intercepts do you see? _____

What are the *x*-intercepts? (Write them as ordered pairs!)

_____

Part B: Solve any way you choose.

$$0 = x^2 - 4x + 8$$

How many solutions?

_____

The solutions are:

_____

Look back…What do you notice?

_____

_____

Part C: Value of the Discriminant

- Identify *a, b* and *c* and calculate the discriminant.
- Give the value of the discriminant and state whether it is positive, negative or zero.

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

a= *b*= *c*=

The value of the discriminant is:

_____

It is

_____

(Positive, negative or zero.)

Section 4: Summary and problems! Answer the questions below. Look back at the previous pages if you need help!

Consider $y = x^2 - x - 6$ (Section 1)	Consider $y = x^2 + 10x + 25$ (Section 2)	Consider $y = x^2 - 4x + 8$ (Section 3)
When the discriminant was _____, there were _____ solutions and _____ x-intercepts.	When the discriminant was _____, there was _____ solution and _____ x-intercept.	When the discriminant was _____, there were _____ solutions and _____ x-intercepts.

- **How does finding the value of the discriminant help us to determine the number of solutions to a quadratic equation?**

_____

- Use the discriminant to answer the questions below. Keep in mind that x-intercepts are also called solutions, roots and zeros.

1. Determine the nature and the number of solutions for the quadratic equation $0 = x^2 + 12x + 11$.

If you were to graph this function, how many x-intercepts would there be? Why?

_____

2. How many x-intercepts does the graph of $y = x^2 + 6x + 9$ have?

What do we call this type of root?

_____

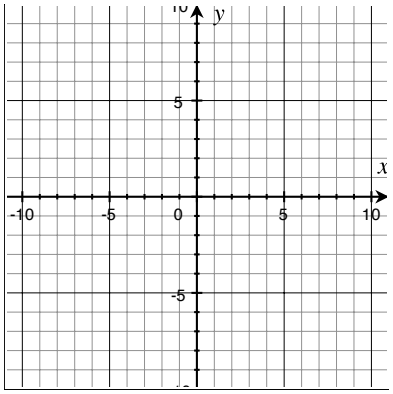
3. Use the discriminant to verify that there are no real number solutions for the quadratic equation shown below.

$$0 = 3x^2 + 5x + 3$$

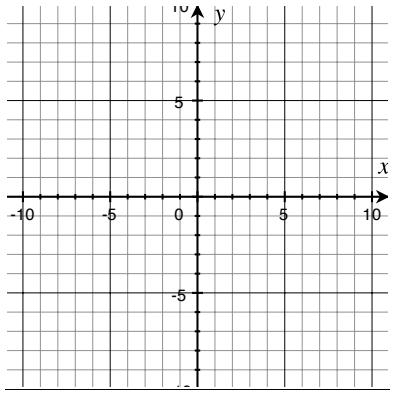
If you were to graph this function, how many x-intercepts would there be? Why?

_____

4. Sketch a graph of a quadratic function that has 2 zeros.



5. Sketch a graph of a quadratic function that has 1 zero.



6. Sketch a graph of a quadratic function that has no real zeros.