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# NOTES: Section 4.3 – Solve $x^2 + bx + c = 0$ by Factoring

Goals: #1 - I can factor a quadratic in the form $ax^2 + bx + c$ when $a = 1$

#2 - I can factor a difference of two squares. 😎 😬 😢

#3 - I can factor a perfect square trinomial.

#4 - I can use the zero product property to solve $ax^2 + bx + c = 0$ by factoring when $a = 1$

*Homework: Lesson 4.3 Worksheet*

**Warm Up:** Graph each function on the same coordinate plane. Identify the graph's axis of symmetry, vertex, *y*-intercept, whether the graph opens up or down, and its maximum/minimum value.

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

AOS: $x = -2$

vertex: $(-2, 6)$

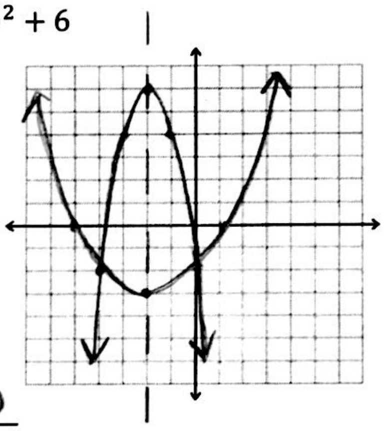
*y*-int: $(0, -2)$

opens: down ↷

[✓ max.]/min. value: $y = 6$

| $x$ | $-4$ | $-3$ | $-2$ | $-1$ | $0$ |
|---|---|---|---|---|---|
| $y$ | $-2$ | $4$ | $6$ | $4$ | $-2$ |

work: $y = -2(0+2)^2 + 6$
$= -2(4) + 6 = -2$



2. $g(x) = \frac{1}{3}(x - \overset{p}{1})(x + \overset{q}{5})$

x-int:
$(1, 0)$
$(-5, 0)$

AOS: $x = -2$

vertex: $(-2, -3)$

*y*-int: $(0, -1\frac{2}{3})$

$y = \frac{1}{3}(0-1)(0+5)$
$= \frac{1}{3}(-1)(5)$
$= -1\frac{2}{3}$

opens: up ↻

max./[✓ min.] value: $y = -3$

| $x$ | | | | | |
|---|---|---|---|---|---|
| $y$ | | | | | |

work: $x = \frac{p+q}{2} = \frac{-5+1}{2} = \frac{-4}{2} = -2$

$y = \frac{1}{3}(-2-1)(-2+5)$
$= \frac{1}{3}(-3)(3) = -3$

**Exploration #1:** Work with a partner. Find the product.

1. $(m-8)(m-9)$

$m^2 - 9m - 8m + 72$

$\boxed{m^2 - 17m + 72}$

2. $(y+20)(y-20)$

$y^2 - 20y + 20y - 400$

$\boxed{y^2 - 400}$

**CHALLENGE:** Can you go backwards? Break $x^2 - 9x + 20$ into factors.

$(x-5)(x-4)$

$x^2 - 5x - 4x + 20$

$x^2 - 9x + 20$

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**Notes:**

A monomial is an expression that is either a number, a variable, or the product of a number and one or more variables. (1 term)

Examples: $7,\ x,\ 5x,\ 4xy^2$

A binomial is the sum of two monomials. (2 terms)

Examples: $2x+7,\ x-y,\ 3xy^2+8nb^4$

A trinomial is the sum of three monomials. (3 terms)

Examples: $x+y+z,\ x^2+6x+5,\ 5x^2+\underbrace{4x+7x}+8,\ 5x^2+7y+1$

$5x^2+11x+8$

**Example #1:** Factor the expression.

1. $x^2-9x+20$

*looking for 2 numbers that add to $-9$ & multiply to $20$

$\boxed{(x-4)(x-5)}$

*Factors of 20:*

$1+20=21$

$2+10=12$

$4+5=9$

$\boxed{-4+-5=-9}$

Check:

$x^2-5x-4x+20$

$x^2-9x+20$ ✓

2. $x^2+3x-12$

$\boxed{\text{not factorable}}$

*Factors of -12:*

$1+-12=-11$

$3+-4=-1$

$2+-6=-4$

$-1+12=11$

$-3+4=1$

$-2+6=4$

3. $x^2-3x-18$

$\boxed{(x-6)(x+3)}$

*Factors of -18:*

$1+-18=-17$

$2+-9=-7$

$\boxed{3+-6=-3}$

Check:

$x^2+3x-6x-18$

$x^2-3x-18$ ✓

4. $r^2+2r-63$

$\boxed{(r-7)(r+9)}$

*Factors of -63:*

$1+-63=-62$

$-3+21=18$

$-9+7=-2$

$\boxed{9+-7=2}$

Check:

$(r-7)(r+9)$

$r^2+9r-7r-63$

$r^2+2r-63$ ✓

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**Notes:**

There are special factoring patterns we can look for!

- Difference of two squares: $a^2 - b^2 = (a+b)(a-b)$

  Examples: $x^2 - 16$ $(x-4)(x+4)$  $x^2 - 64$ $(x+8)(x-8)$

- Perfect Square Trinomial: $a^2 + 2ab + b^2 = (a+b)^2$  $a^2 - 2ab + b^2 = (a-b)^2$

  Examples: $x^2 + \underbrace{6x}_{2(3)} + \underbrace{9}_{3^2}$ $(x+3)^2$  $x^2 - \underbrace{4x}_{2(2)} + \underbrace{4}_{(2)^2}$ $(x-2)^2$

**Example #2:** Factor the expression.

1. $x^2 - \underset{\overset{\uparrow}{7^2}}{49}$

   $\boxed{(x+7)(x-7)}$

   Check: $(x+7)(x-7)$ $= x^2 - 7x + 7x - 49$ $= x^2 - 49$ ✓

2. $d^2 + \underset{\overset{\uparrow}{2(6)}}{12d} + \underset{\overset{\uparrow}{6^2}}{36}$

   $\boxed{(d+6)^2}$

   Factors 36:
   $2 + 18 = 20$
   $3 + 12 = 15$
   $\boxed{6 + 6 = 12}$
   $(d+6)(d+6)$
   $= (d+6)^2$

3. $q^2 - \underset{\overset{\uparrow}{3^2}}{9}$

   $(q-3)(q+3)$

4. $y^2 + \underset{\overset{\uparrow}{2(8)}}{16y} + \underset{\overset{\uparrow}{8^2}}{64}$

   $(y+8)^2$

**Notes:**

We can use factoring to solve certain quadratic equations.

We set the quadratic equation equal to 0 and use the zero product property

- **Zero Product Property:** If $AB = 0$, the $A = 0$ OR $B = 0$

The solutions of a quadratic equation are called the roots of the equation.

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**Example #3:** Solve the equation.

1. $x^2 + 2x - 35 = 0$

$(x+7)(x-5)=0$

ZPP: $x+7=0$ OR $x-5=0$

$-7 \quad -7 \qquad\qquad +5 \quad +5$

$\boxed{x=-7} \qquad \boxed{x=5}$

2. $u^2 = -9u$

$+9u \quad +9u$

$u^2+9u=0$

$u(u+9)=0$

$\boxed{u=0}$ OR $u+9=0$

$-9 \quad -9$

$\boxed{u=-9}$

**Example #4:** Find the roots of the equation. (Solve)

1. $r^2 + 2r = 80$

$-80 \quad -80$

$r^2+2r-80=0$

$(r+10)(r-8)=0$

$r+10=0 \qquad r-8=0$

$-10 \quad -10 \qquad +8 \quad +8$

$\boxed{r=-10} \qquad \boxed{r=8}$

2. $a^2 - 49 = 0$

* difference of squares!

$(a+7)(a-7)=0$

$a+7=0 \qquad a-7=0$

$-7 \quad -7 \qquad +7 \quad +7$

$\boxed{a=-7} \qquad \boxed{a=7}$

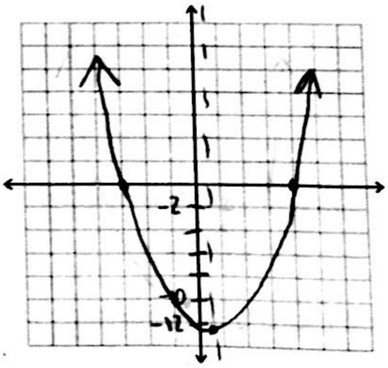
**Exploration #1:** Work with a partner and answer the following questions.

1. Rewrite the quadratic function in <u>intercept form</u>: $y = x^2 - x - 12$

$y=x^2-x-12$ $\qquad$ $y=a(x-p)(x-q)$

$y=(x-4)(x+3)$

2. Graph the function you found in #1.



a. $x$-int(s): (4,0) (-3,0)

$x=\frac{4+-3}{2}=\frac{1}{2}$

$y=(\frac{1}{2})^2-(\frac{1}{2})-12=-12.25$

b. What is the $y$-value of the $x$-intercepts?

0

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**Notes:**

Recall the intercept form of a quadratic function: $y = a(x-p)(x-q)$

Because quadratic function's values are 0 when $x = p$ and $x = q$, these are also called zeros of the function.

**Example #5:** Find the zeros of the function by rewriting the function in intercept form.

1. $y = x^2 + 12x + 36$

$y = (x+6)(x+6)$

$y = (x+6)^2$ x-int: (0, -6)

$0 = (x+6)^2$

$0 = x+6$ $\boxed{-6}$

$x = -6$

2. $y = x^2 - 7x - 30$

$y = (x-10)(x+3)$

x-int: (0, 10) (0, -3)

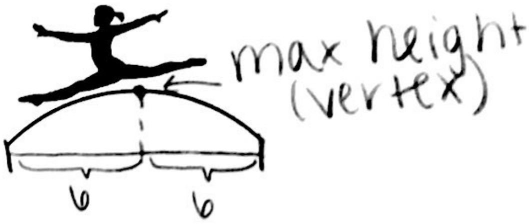
$\boxed{-3 \; ; \; 10}$

**Example #6:** The function $y = -1.17(x-6)^2 + 42$ models the leap of a gymnast where $x$ is the horizontal distance (in inches) and $y$ is the corresponding height (in inches). What is the gymnast's maximum height? How far does she leap?

vertex: $(\overset{\uparrow}{6}, \overset{\uparrow}{42})$
distance height

$y = \boxed{42 \text{ inches}}$ max height

$6 + 6 = \boxed{12 \text{ inches}}$ how far



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