

4.1 Solve Algebraic

Math 20-2

Solve quadratic equations algebraically:

- **Factoring:** quadratic equal zero, then factor and solve.
- **Quadratic Formula:** quadratic equal zero, then use the formula

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

Skills:

Show how to simplify the following radicals:

a) $\sqrt{24} = 2\sqrt{6}$

$$\underbrace{\sqrt{4}}_{\text{square}} \sqrt{6} = 2\sqrt{6}$$

b) $\sqrt{80} = 4\sqrt{5}$

$$\begin{array}{l} \sqrt{16} \sqrt{5} \\ 4 \sqrt{5} \end{array} \left\{ \begin{array}{l} \sqrt{4} \sqrt{20} \\ 2 \sqrt{20} \\ 2 \sqrt{4} \sqrt{5} \\ 2(2) \sqrt{5} \\ 4 \sqrt{5} \end{array} \right.$$

c) $\sqrt{36} = 6$

$\sqrt{\text{squares}} = \text{whole numbers ...}$
 $\sqrt{36} \neq \sqrt{6}$

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Examples: Solve by factoring.

1. $2x^2 + 11x + 12 = 0$

$\boxed{\quad\quad\quad}$ product

$$\begin{array}{r} 24 \\ 8 \times 3 \\ \hline 11 \end{array}$$

$$\underline{2x^2 + 8x} + \underline{3x + 12}$$

$2x \qquad 3$

$$2x(x+4) + 3(x+4) = 0$$

$$(x+4)(2x+3) = 0$$

$$x+4=0$$

$$x = -4$$

$$2x+3=0$$

$$2x = -3$$

$$x = -\frac{3}{2}$$

QUAD = ZERO
FACTOR = ZERO

SOLVE

2. $4x^2 = 12x - 9$

$$-12x + 9$$

QUAD = ZERO

$$4x^2 - 12x + 9 = 0$$

$$\boxed{4x^2 - 6x} \quad \boxed{-6x + 9}$$

$$\underline{4x^2 - 6x} \quad \underline{-6x + 9} = 0$$

$2x \qquad -3$ "keep sign"

$$\begin{array}{r} 36 \\ -6 \times -6 \\ \hline -12 \end{array}$$

$$\begin{array}{l} 1 \times 36 \\ 2 \times 18 \\ 3 \times 12 \\ 4 \times 9 \\ 6 \times 6 \end{array}$$

$$2x(2x-3) - 3(2x-3) = 0$$

$$(2x-3)(2x-3) = 0$$

$$2x-3=0 \quad 2x-3=0$$

add 3
÷ 2

$$x = \frac{3}{2}$$

$$x = \frac{3}{2}$$

OR

$$x = 1.5$$

"one equal answer"

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QUAD = ZERO

Examples: Solve with the quadratic formula (exact answers).

1. $2x^2 + 11x + 12 = 0$

$a=2$ $b=11$ $c=12$
 $b^2=121$

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

$$x = \frac{-11 \pm \sqrt{121 - 4(2)(12)}}{2(2)} \dots 121 - 96 = 25$$

$$x = \frac{-11 \pm \sqrt{25}}{4}$$

$$x = \frac{-11 + 5}{4}$$

$$x = \frac{-11 - 5}{4}$$

$$x = -\frac{6}{4}$$

$$x = -\frac{16}{4}$$

$$x = -\frac{3}{2}$$

$$x = -4$$

2. $4x^2 = 12x - 9$

QUAD = ZERO ... x^2 positive

$$4x^2 - 12x + 9 = 0$$

$a=4$ $b=-12$ $c=9$

$b^2=144$

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

$$x = \frac{12 \pm \sqrt{144 - 4(4)(9)}}{2(4)} \dots 144 - 144 = 0$$

$$x = \frac{12 \pm \sqrt{0}}{8}$$

$$x = \frac{12 + 0}{8}$$

$$x = \frac{12 - 0}{8}$$

$$x = \frac{12}{8}$$

$$x = \frac{12}{8}$$

$$x = \frac{3}{2}$$

$$x = \frac{3}{2}$$

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

quad = zero
 x^2 positive

$0 = x^2 - 5x - 2$

$a = 1$ $b = -5$ $c = -2$
 $b^2 = 25$

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

$x = \frac{5 \pm \sqrt{25 - 4(1)(-2)}}{2(1)}$... $25 + 8 = 33$

$$x = \frac{5 \pm \sqrt{33}}{2}$$

$\sqrt{33}$ does not simplify

OR

$$x = \frac{5 + \sqrt{33}}{2}$$

$$x = \frac{5 - \sqrt{33}}{2}$$

4. $4x^2 - 6x + 1 = 0$

quad = zero ✓

$a = 4$ $b = -6$ $c = 1$

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

$x = \frac{6 \pm \sqrt{36 - 4(4)(1)}}{2(4)}$... $36 - 16 = 20$

$x = \frac{6 \pm \sqrt{20}}{8}$ $\sqrt{20} = \sqrt{4} \sqrt{5} = 2\sqrt{5}$

$x = \frac{6 \pm 2\sqrt{5}}{8}$... all numbers $\div 2$

$$x = \frac{3 \pm \sqrt{5}}{4}$$

OR

$$x = \frac{3 + \sqrt{5}}{4}$$

$$x = \frac{3 - \sqrt{5}}{4}$$

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Examples: Solve with the quadratic formula (rounded answers to hundredths).

1. $2x^2 + 3x + 1 = 0$

$$ax^2 + bx + c = 0$$

$$a=2 \quad b=3 \quad c=1$$

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

$$x = \frac{-3 \pm \sqrt{9 - 4(2)(1)}}{2(1)}$$

$$9 - 8$$

$$x = \frac{-3 \pm \sqrt{1}}{2}$$

$$\sqrt{1} = 1$$

$$x = \frac{-3 \pm 1}{2}$$

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

$$x = -1$$

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

$$x = -2$$

2. $5x^2 = 3x + 10$

quad = zero ... x^2 pos

$$5x^2 - 3x - 10 = 0$$

$$a=5 \quad b=-3 \quad c=-10$$

$$b^2 = 9$$

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

$$x = \frac{3 \pm \sqrt{9 - 4(5)(-10)}}{2(5)} \dots 9 + 200$$

$$x = \frac{3 \pm \sqrt{209}}{10}$$

$$x = \frac{3 + \sqrt{209}}{10}$$

$$x = 1.7456$$

$$x = 1.75$$

$$x = \frac{3 - \sqrt{209}}{10}$$

$$x = -1.1456$$

$$x = -1.15$$