ADLC

Mathematics 20-1

Unit 8: Course Review Workbook

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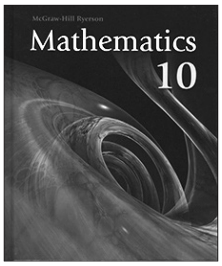

Pre-Calculus 11
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Mathematics 20-1
Workbook 8

Our Pledge to You:

Enrolling in this course is another step toward an Alberta High School Diploma. Everyone at Alberta Distance Learning Centre is committed to helping students achieve their educational goals. We welcome your contact in person or by phone, fax, e-mail, voice mail, or postal mail.

Advice:

Your achievement in this course is determined by your success in the assessments of each unit. Your responses to assignments indicate your understanding of outcomes established by Alberta Education.

- Before responding to the assigned questions, read all relevant directions for the Workbook and instruction in the course materials, including the appropriate Guide for Learning and any other resources provided.

- When you encounter difficulties, re-read the directions for the Workbook and review the relevant instruction in the Guide for Learning.

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Mathematics 20-1 Course Review

You have now learned all the concepts for Math 20-1. This *Course Review* includes a summary table of topics and review problems for each *Unit*. All the problems include a full solution located in the *Appendix* section of the *Review Workbook*. Your task is to solve all the problems in each of the *Unit* sections, ensuring you show all steps and necessary work; then, compare your solutions to the full solutions in the *Appendix*. Please **do not** send this *Workbook* in for marking.

Unit 1: Sequences and Series

Concepts	**I know how to do that**	**I'm going to review that topic**
Identify assumptions made when defining arithmetic or geometric sequences and series		
Determine whether a sequence is arithmetic, geometric, or neither		
Determine a rule for finding the general term of arithmetic and geometric sequences		
Describe the relationship between arithmetic sequences and linear functions		
Solve problems involving arithmetic and geometric sequences		
Derive a rule for determining the sum of *n* terms of arithmetic or geometric series		
Solve problems involving arithmetic and geometric series		
Explain why a geometric series is convergent or divergent		
Determine the sum of an infinite geometric series		

Unit 1: Sequences and Series Review Questions

1. Determine whether the sequences are arithmetic, geometric, or neither. Write the general term and determine t_{10} for the arithmetic and geometric sequences.

   a. $-81,\ 27, -3,\ 1, \ldots$

   b. $137,\ 151,\ 165,\ 179, \ldots$

   c. $16,\ 8,\ 2,\ 1, \ldots$

2. The population of a community was 150 000 at the beginning of 2010. The rate of growth has been approximately 3% per year since 2010.

   a. What will the population be at the beginning of 2025? Round to the nearest person.

   b. In what year will the population reach 500 000?

   c. What assumptions are you making in answering part b.?

   ____

   ____

3. Michael works in a grocery store with a starting wage of $10.00 per hour. Every year he is guaranteed a raise of $1.25 per hour.

   a. What is Michael's hourly wage at the start of his fifth year of work at the store?

   b. In what year will Michael earn at least $20.00 per hour?

   c. What assumptions are you making in answering part b.?

   ____

   ____

4. Determine the sum of each series.

a. $\frac{3}{5}+\frac{4}{5}+1+\frac{6}{5}+\ldots+\frac{23}{5}$

b. $12-24+48-96+\ldots-393\ 216$

5. Determine the sum of each infinite geometric series, if possible.

   a. $110 + 11 + 1.1 + 0.11 + \ldots$

   b. $0.11 + 1.1 + 11 + 110 + \ldots$

6. A bouncy ball bounces to 80% of its previous height when it is dropped on a hard surface. Suppose the ball is dropped from a height of 25 m.

   a. Draw a diagram of the situation.

   b. What height will the ball bounce back up to after the fifth bounce? Round to the nearest tenth of a metre.

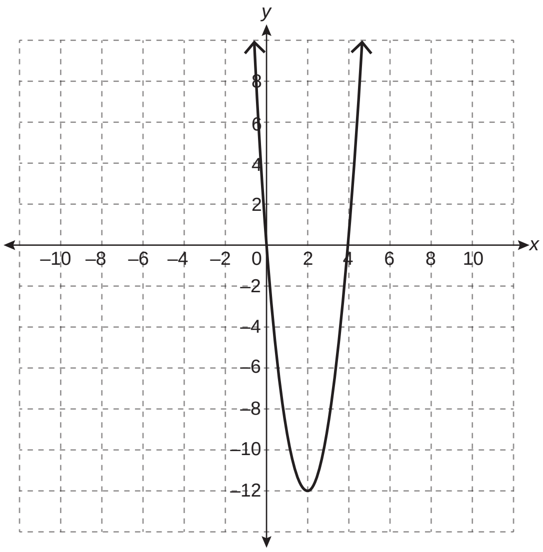
   c. What is the total vertical distance the ball travels if it bounces indefinitely?

Unit 2: Quadratic Functions and Equations

Concepts	**I know how to do that**	**I'm going to review that topic**
Analyze quadratic functions in vertex form with regards to		
• vertex		
• domain and range		
• direction of opening		
• axis of symmetry		
• *x*- and *y*-intercepts		
Factor trinomials		
Factor a difference of squares		
Analyze quadratic functions in standard form with regards to		
• vertex		
• domain and range		
• direction of opening		
• axis of symmetry		
• *x*- and *y*-intercepts		
Convert from standard form to vertex form by completing the square		
Solve quadratic equation/function problems using		
• technology		
• factoring		
• completing the square		
• the quadratic formula		
Determine the number of roots of a quadratic equation using the discriminant		

Unit 2: Quadratic Functions and Equations Review Questions

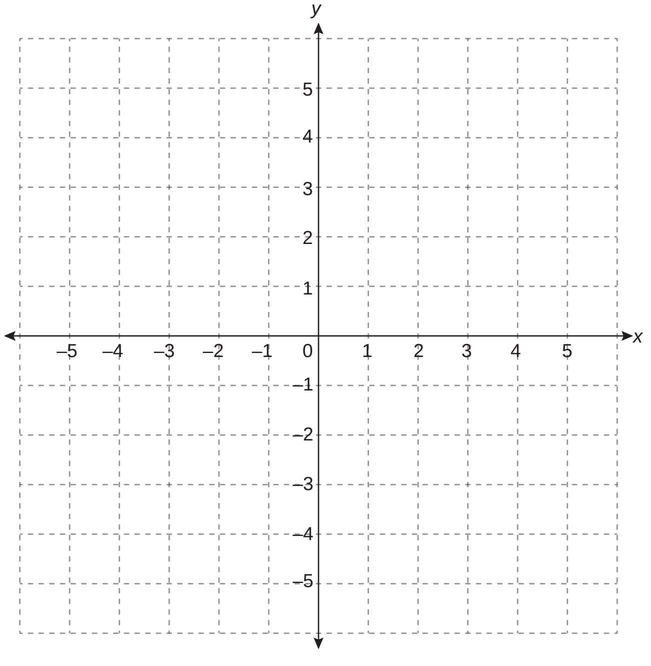
1. Fill in the table with the characteristics of the quadratic function shown. Write the equation of the function.



Vertex	
Domain	
Range	
Direction of opening	
Equation of the axis of symmetry	
***x*-intercept(s)**	
***y*-intercept**	
Point on the function	

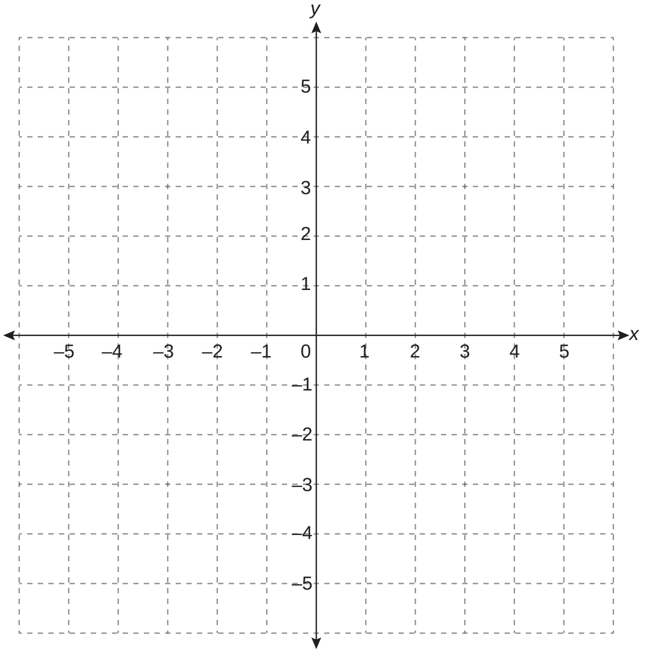
2. Fill in the table with the characteristics of the quadratic function $f(x) = -(x+2)^2 + 4$. Sketch the graph on the coordinate grid.

Vertex	
Domain	
Range	
Direction of opening	
Equation of the axis of symmetry	
***x*-intercept(s)**	
***y*-intercept**	



3. Fill in the table with the characteristics of the quadratic function $f(x) = 6x^2 - 3x - 3$. Sketch the graph on the coordinate grid.

Vertex	
Domain	
Range	
Direction of opening	
Equation of the axis of symmetry	
***x*-intercept(s)**	
***y*-intercept**	



4. Convert the quadratic function $y = 3x^2 + 18x + 20$ to vertex form by completing the square.

5. Factor the quadratic functions.

a. $f(x) = 49x^2 - 9$

b. $y = 8(x+5)^2 + 6(x+5) - 5$

6. Solve the quadratic equations by graphing, factoring, completing the square, or using the quadratic formula. Explain why you used the method you chose, and leave answers as exact values.

   a. $(x-4)^2 = 81$

   b. $2x^2 + 15 = 13x$

   c. $0 = 2x^2 - 8x + 1$

d. $5 = x^2 + 2x$

7. Determine the value of k required to make the quadratic equation $0 = 2x^2 + kx + 2$ have

a. One Real root

b. Two distinct Real roots

c. No Real roots

8. The height of a tennis ball follows a path defined by the function $h(d) = -\frac{1}{121}(d - 11)^2 + \frac{3}{2}$, where *h* is the height of the ball above the court, in metres, and *d* is the horizontal distance of the ball from the tennis player, in metres.

   a. At what height did the tennis player hit the ball?

   b. At what distance from the tennis player does the ball reach its maximum height?

   c. How far will the tennis ball have travelled when it hits the ground? Round to the nearest tenth of a metre.

9. Kirsten sells packages of farm fresh beef online. Currently, she sells quarter beef packages for \$500.00 to 75 customers. By experimenting with prices, she has found that if she raises the price by \$50.00, she will lose 5 customers. At what price should Kirsten sell the quarter beef packages in order to maximize her revenue?

Unit 3: Radical Expressions and Equations

Concepts	I know how to do that	I'm going to review that topic
Compare and order radicals		
Convert between entire radicals and mixed radicals, and vice versa		
Perform addition, subtraction, multiplication, and division to simplify radical expressions		
Rationalize the denominator of a radical expression		
Identify the restrictions on the variables within radical expressions and equations		
Determine the roots of a radical equation		
Determine the extraneous roots of a radical equation		
Solve problems involving radical equations		

Unit 3: Radical Expressions and Equations Review Questions

1. Order the radicals $6\sqrt[3]{3}$, $\sqrt[3]{514}$, $5\sqrt[3]{9}$, 9, $2\sqrt[3]{3}$ from least to greatest.

2. Simplify the radical expressions. Identify any restrictions on the variables, if necessary.

a. $\sqrt[4]{3} - 2\sqrt{3} + 5\sqrt[4]{3} + 7\sqrt{3}$

b. $\dfrac{2\sqrt{10c^3}}{\sqrt{5c}}$

c. $\dfrac{\sqrt[3]{25}\left(\sqrt[3]{10r}\right)}{\sqrt[3]{14r^2}}$

d. $\dfrac{(\sqrt{2}-8)(\sqrt{2}+5)}{\sqrt{2}-2}$

3. Solve the radical equations. Identify any restrictions on the variables, and verify the solutions.

a. $\sqrt{7x} = 2x$

b. $\sqrt{x-2}+4=x-4$

c. $\sqrt{x+3}+1=\sqrt{x+5}$

4. The amount of current, I, in amperes (A), that an appliance uses can be calculated using the formula $I = \sqrt{\frac{P}{R}}$, where P is the power in watts (W), and R is the resistance in ohms (Ω).

   a. How much current does an appliance use if $P = 120$ W and $R = 2\Omega$? Express your answer as an exact value.

   b. What is the resistance of an appliance if $I = 2\sqrt{5}$ A and $P = 120$ W?

Unit 4: Trigonometry

Concepts	**I know how to do that**	**I'm going to review that topic**
Sketch an angle in standard position		
Determine the reference angle for an angle in standard position		
Determine angles in standard position that have the same reference angle, from 0° to 360°		
Explain how any angle from 90° to 360° is the reflection in the *x*-axis and/or the *y*-axis of its reference angle		
Determine in which quadrant an angle in standard position terminates		
Draw an angle in standard position given the coordinates of a point on its terminal arm		
Show that the points (x,y), $(x,-y)$, $(-x,y)$, and $(-x,-y)$ are points on the terminal arm of angles in standard position that all have the same reference angle		
Use the Pythagorean Theorem to determine the distance from the origin to a point on the terminal arm of an angle		
Determine the exact value of $\sin\theta$, $\cos\theta$, and $\tan\theta$ for any point on the terminal arm of angle θ		
Determine the sign of a trigonometric ratio given the angle in standard position		
Solve basic trigonometric equations		
Sketch a diagram involving a triangle without a right angle		
Solve non-right triangles using primary trigonometric ratios, the sine law, and/or the cosine law		
Describe and apply the ambiguous case for the sine law		
Solve problems using trigonometry		

Unit 4: Trigonometry Review Questions

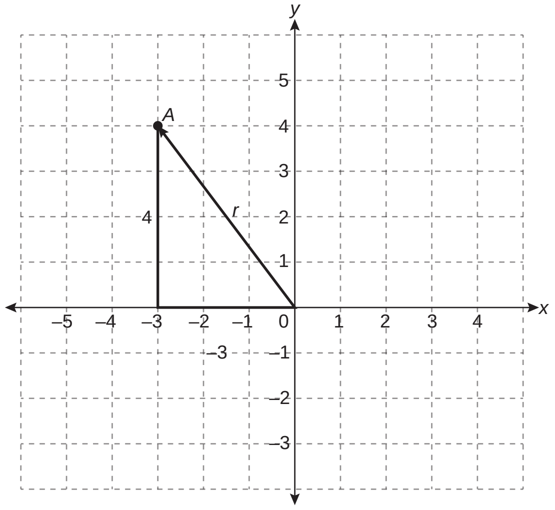
1. Sketch the angle in standard position, and determine the reference angle.

   a. 226°

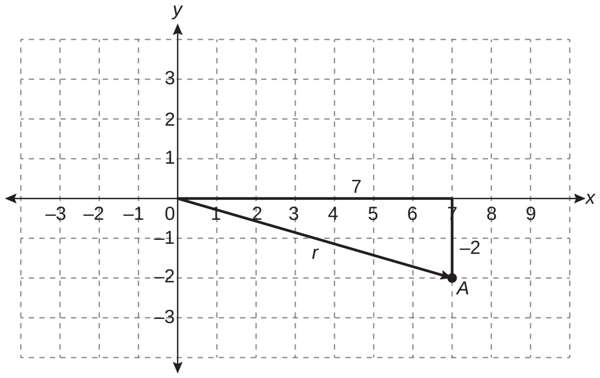
   b. 315°

2. Determine the values of $\sin\theta$, $\cos\theta$, and $\tan\theta$ for each point on the terminal arm of angle θ.

a. $P(-3, 4)$



b. $Q(7, -2)$



3. Determine the exact value of each trigonometric ratio.

a. $\sin 210^\circ$

b. $\tan 315^\circ$

4. Solve the trigonometric equation for $0^\circ \le \theta < 360^\circ$. Round to the nearest degree.

a. $\sin\theta = -1$

b. $\tan\theta = 1.9626$

5. Solve the triangle *ABC*, where $\angle A = 15^\circ,\ a = 2\text{ m},$ and $b = 7\text{ m}$.

   a. Draw a diagram of the possible triangle(s).

   b. Solve the triangle(s).

6. Tobias is training for a long distance race. Starting at his home, his training route takes him 2 km north, then 100° to the west, where he travels another 3 km. From this point, he returns to his starting point.

   a. Draw a diagram of Tobias' run.

   b. Determine the total length of the run. Round to the nearest tenth of a kilometre.

Unit 5: Rational Expressions and Equations

Concepts	**I know how to do that**	**I'm going to review that topic**
Determine any non-permissible values for rational expressions		
Write equivalent rational expressions by multiplying the numerator and denominator by the same factor		
Simplify rational expressions		
Determine and simplify the sum or difference of rational expressions with common denominators and with uncommon denominators		
Determine and simplify the product or quotient of rational expressions		
Simplify rational expressions involving more than one operation (addition/subtraction/multiplication/division)		
Solve rational equations algebraically, including verifying the solution to watch for extraneous roots		
Solve problems requiring the use of rational equations		

Unit 5: Rational Expressions and Equations Review Questions

1. Simplify the rational expressions. Identify any non-permissible values.

   a. $\dfrac{245a^2bc^3(a^2-b^2)}{25ab^3c^2(a-b)}$

b. $\dfrac{m+4}{m^2-4m+3}+\dfrac{m+5}{m^2-2m-3}$

c. $\dfrac{4x^2-17x+4}{3x^2+8x-3}\div\dfrac{4x^2+15x-4}{6x^2+x-1}$

d. $\dfrac{5x-1}{x-6}-\dfrac{x^2+x-2}{2x^2-17x+30}\bullet\dfrac{4x^2-25}{x^2-1}$

2. Solve the rational equations. Identify any non-permissible values and verify your solution(s).

   a. $\dfrac{x^2 - 1}{x^2 - 9} = 3$

b. $\frac{3x^2 + 16x + 10}{4x^2 - 7x - 2} = \frac{4x - 1}{x - 2} - 2$

3. Solve the rational equation $\frac{x-4}{3x^2+5x+2} = \frac{x+11}{x^2+4x+3}$. Identify any non-permissible values and verify your solution(s).

4. Leanne's washing machine fills in 3 minutes when just cold water is used, and it fills in 4 minutes when just hot water is used. How long does it take for the washing machine to fill if both cold and hot water are used at the same time? Round to the nearest tenth of a minute.

5. The first 5 km of Hilary's race are completed 2 km/h faster than the second 5 km of the race. If the entire 10 km race takes 1 hour, how fast was Hilary running in the first 5 km of the race? Round to the nearest kilometre per hour.

Unit 6: Absolute Value and Reciprocal Functions

Concepts	I know how to do that	I'm going to review that topic
Relate absolute value to distance from zero on a number line		
Determine the absolute value of positive and negative Real numbers		
Use absolute value to represent the distance between two points		
Evaluate expressions that include absolute values		
Order a set of values that includes absolute values		
Create a table of values for $y = \lvert f(x) \rvert$ given a table of values for $y = f(x)$		
Write absolute value functions using piecewise notation		
Sketch and describe the characteristics of the graph of $y = \lvert f(x) \rvert$		
Solve absolute value equations using technology		
Solve absolute value equations algebraically, and verify the solutions		
Explain why $\lvert f(x) \rvert < 0$ has no solution		
Determine and correct errors in a solution to an absolute value equation		
Solve problems using absolute values		
Compare the graph of $y = \frac{1}{f(x)}$ to the graph of $y = f(x)$		
Determine characteristics of the graph of $y = \frac{1}{f(x)}$ given $y = f(x)$		
Graph $y = \frac{1}{f(x)}$ given $y = f(x)$, and explain the strategy used		
Graph $y = f(x)$ given $y = \frac{1}{f(x)}$, and explain the strategy used		

Unit 6: Absolute Value and Reciprocal Functions Review Questions

1. Order the numbers from least to greatest.

   $-3,\ |7|,\ |-4|,\ 1,\ |-11|,\ 10,\ |6|$

2. Evaluate each expression.

   a. $|9-12|$

   b. $|-3(4)+2|-|6-2(8)|$

3. Use absolute value symbols to write an expression for the distance between -9.2 and 5.7 on a number line.

4. Rachel checks her bank statement online.

Date	**Balance**
Jan.3	$236.98
Jan. 10	$298.14
Jan. 15	$115.65
Jan. 19	$411.12
Jan. 23	$323.43
Jan. 30	$350.21

a. Use an absolute value expression to determine the total cumulative change in Rachel's bank account during the month of January.

b. How is this value different from the net change in Rachel's bank account over the month of January?

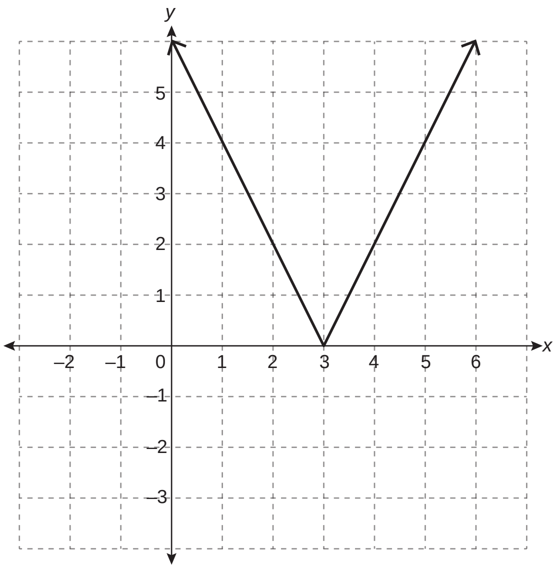
5. Graph each function.

   a. $y = |4x - 1|$

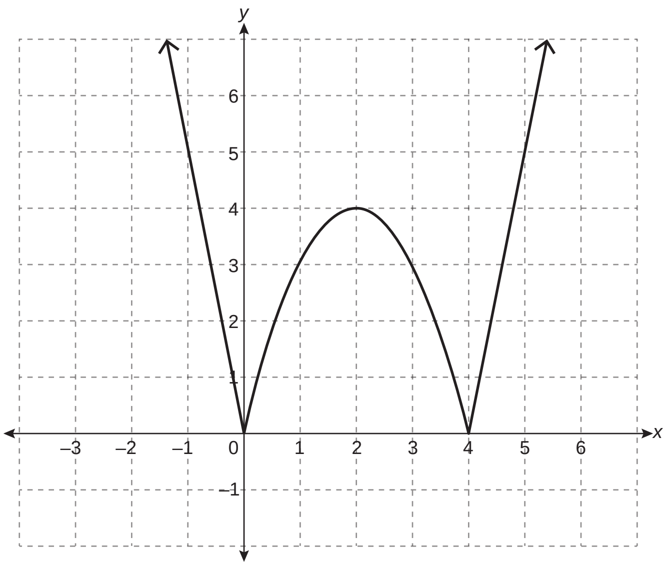
   b. $y = |x^2 + 4x - 12|$

6. Write the equation of each absolute value function using piecewise notation.

a.



b.



7. Solve each equation. Verify your solution(s).

   a. $|x + 4| = 8$

   b. $|3x + 1| = \frac{1}{2}x + 6$

c. $|x^2 + 4x| = x + 4$

8. Uncertainty is used with measuring tools to describe the accuracy of a measurement. The spheres used in ball bearings with a diameter of 0.3 mm have an uncertainty of ± 0.001 mm.

a. Determine an absolute value equation that describes the possible maximum and minimum diameters of the ball bearings.

b. What are the maximum and minimum diameters possible when measuring the diameter of the spheres?

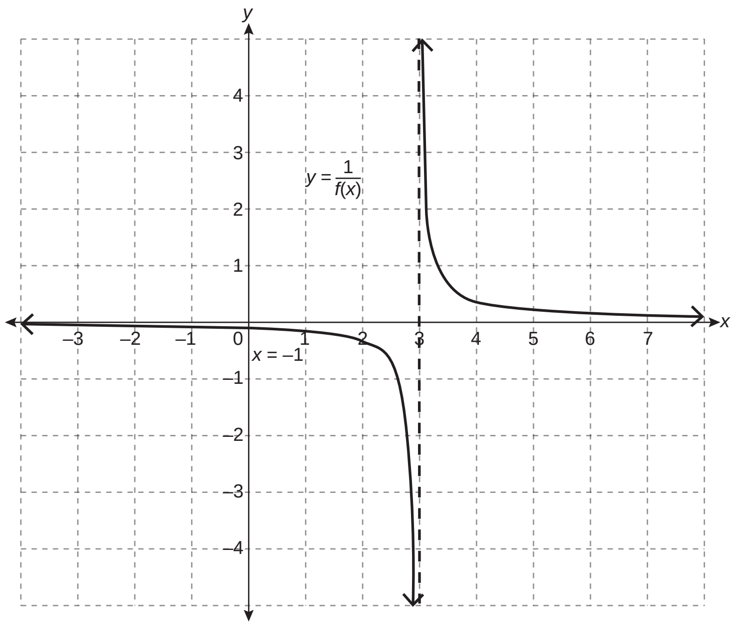
9. Sketch the graph of each reciprocal function. Give the equations of the vertical asymptotes.

a. $y = \dfrac{1}{3x - 4}$

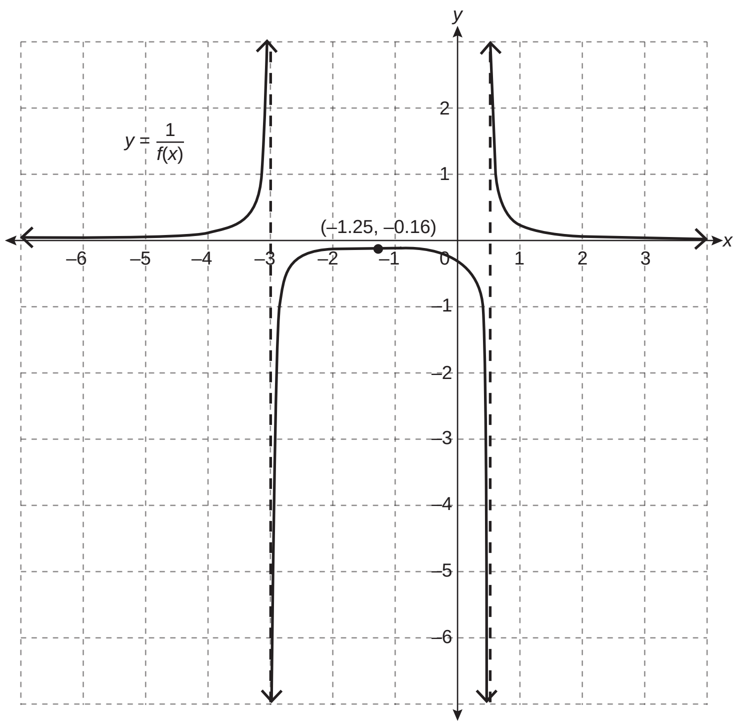
b. $y = \dfrac{1}{4x^2 - x - 5}$

10. Graph $f(x)$ given $\dfrac{1}{f(x)}$.

a.



b.



Unit 7: Equations and Inequalities

Concepts	I know how to do that	I'm going to review that topic
Determine and verify the solution to a system of linear-quadratic or quadratic-quadratic equations using technology		
Determine and verify the solution to a system of linear-quadratic or quadratic-quadratic equations algebraically		
Explain the meaning of points of intersection on the graph of a system of equations		
Explain why a system of linear-quadratic or quadratic-quadratic equations may have zero, one, two, or an infinite number of solutions		
Model a situation using a system of linear-quadratic or quadratic-quadratic equations		
Relate a system of linear-quadratic equations or quadratic-quadratic equations to the context of a given problem		
Solve a problem that involves a system of linear-quadratic or quadratic-quadratic equations, and explain the strategy used		
Explain how test points can be used to determine the solution region that satisfies an inequality		
Explain when a solid or broken line should be used in the graphical solution of an inequality		
Sketch the graph of a linear or quadratic inequality		
Solve a problem that involves a linear or quadratic inequality		
Determine the solution to a quadratic inequality using graphing, roots and test points, sign analysis, or case analysis		
Represent and solve a problem that involves a quadratic inequality in one variable		
Interpret the solution to a problem that involves a quadratic inequality in one variable		

Unit 7: Equations and Inequalities Review Questions

1. Determine the solution(s) to each system of equations using technology. Verify the solution(s) using substitution.

   a. $\begin{cases} -y + 2 = 3x \\ 3x^2 + 4x = -6 + y \end{cases}$

   b. $\begin{cases} 2 = 2x^2 + 5x + y \\ 3x - y = 2x^2 + 6 \end{cases}$

2. Determine the solution(s) to each system of equations using algebra. Verify the solutions using technology.

a. $\begin{cases} y - 3x = 5 \\ x^2 = 5 - y \end{cases}$

b. $\begin{cases} y = x^2 - x - 5 \\ y = -x^2 - 8x + 4 \end{cases}$

3. Determine the value(s) of k in $y = kx^2 + 3x - 4$ that will result in the intersection of the line $y = -x + 6$ with the quadratic at

   a. Two points

   b. One point

   c. No points

4. The path of an underground aquifer is given by the function $f(x) = 3x^2 + 15x - 28$. Two new houses need wells to be dug into this aquifer. The houses lie on a straight line defined by the function $g(x) = -\frac{1}{3}x + 3$. Determine the coordinates where the two wells should be dug. Round to the nearest hundredth of a unit.

5. Solve the inequality $-2x^2 + 3x + 5 < 0$ using zeros and test points. Show the answer using a number line.

6. Solve the inequality $10x^2 - 8x - 2 \geq 0$ using sign analysis. Show the answer using a number line.

7. Solve the inequality $-8x^2 - 10x + 3 < 0$ by graphing. Show the answer using a number line.

8. The length of a rectangle is 3 cm longer than the width. Write and solve an inequality to determine the minimum width required for the rectangle to have an area of at least 10 cm^2.

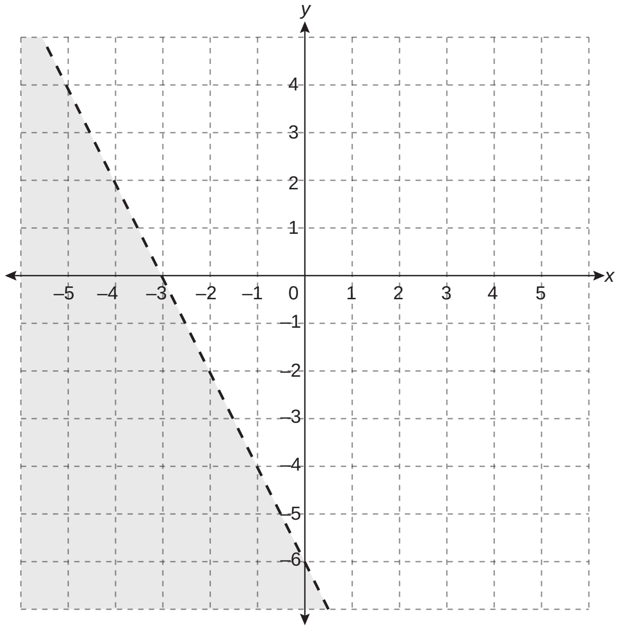
9. Sketch each inequality using test points, and determine if the point $(-3, 1)$ is a solution to each inequality.

   a. $y \geq 3x^2 - 3x - 60$

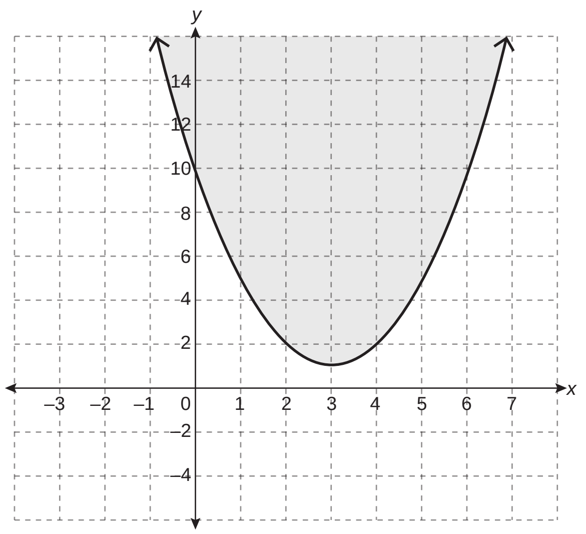
b. $y < -6x^2 + 13x + 5$

10. Determine the inequality represented by each of the given graphs.

a.



b.



11. Juno is buying DVDs and Blu-Ray discs. The DVDs cost $5.00 each and the Blu-Ray discs cost $10.00 each. She has $50.00 to spend.

    a. Write an inequality to represent the number of DVD's, *d*, and the number of Blu-Ray discs, *b*, that Juno can purchase.

    b. Graph the inequality.

    c. Give one example of a purchase Juno can make with her $50.00.

d. Can Juno purchase 5 DVDs and 3 Blu-Ray Discs with her $50.00?

After all the required components of *Units 1 to 8* have been completed, marked, and returned to you, please review the concepts. Contact your teacher to discuss any concepts that you are unsure about. When you are ready, contact your exam supervisor or your local ADLC campus to schedule an appointment to write the Final Exam.

Appendix

Unit 1: Sequences and Series Solutions

1. a. Geometric because $r = -\frac{1}{3}$.
   General term:
   $t_n = t_1 r^{n-1}$
   $t_n = -81\left(-\frac{1}{3}\right)^{n-1}$

   t_{10}:
   $t_n = -81\left(-\frac{1}{3}\right)^{n-1}$
   $t_{10} = -81\left(-\frac{1}{3}\right)^{10-1}$
   $t_{10} = \frac{1}{243}$

   b. Arithmetic because $d = 14$.
   General Term:
   $t_n = t_1 + (n-1)d$
   $t_n = 137 + (n-1)14$
   $t_n = 137 + 14n - 14$
   $t_n = 123 + 14n$

   t_{10}:
   $t_n = 123 + 14n$
   $t_{10} = 123 + 14(10)$
   $t_{10} = 263$

   c. This sequence is neither arithmetic nor geometric because there is neither a common difference nor common ratio.

2. a. What is given:
   - $t_1 = 150\ 000$
   - $n = 15$
   - $r = 1.03$

$$t_n = t_1 r^{n-1}$$
$$t_{15} = (150\ 000)(1.03)^{15-1}$$
$$t_{15} = 226\ 888.458...$$
$$t_{15} \doteq 226\ 888$$

At the beginning of 2025, the population will be approximately 226 888 people.

b. What is given:
   - $t_1 = 150\ 000$
   - $n = ?$
   - $r = 1.03$
   - $t_n = 500\ 000$

$$t_n = t_1 r^{n-1}$$
$$500\ 000 = (150\ 000)(1.03)^{n-1}$$
$$3.333... = (1.03)^{n-1}$$

$1.03^{40-1} = 3.167...$

$1.03^{41-1} = 3.262...$ very close

$1.03^{42-1} = 3.359...$ just above

At the beginning of 2052, the population will be greater than 500 000, so the population will reach 500 000 sometime in 2051.

c. The main assumption is that the growth rate of the community will not change over the next 41 years.

3. a. What is given:
- t_1 = \$10.00
- n = 5
- d = \$1.25

$$t_n = t_1 + (n-1)d$$
$$t_5 = 10 + (5-1)(1.25)$$
$$t_5 = 15$$

At the start of Michael's fifth year, his hourly wage will be \$15.00.

b. What is given:
- t_1 = \$10.00
- n = ?
- d = \$1.25
- t_n = \$20.00

$$t_n = t_1 + (n-1)d$$
$$20 = 10 + (n-1)(1.25)$$
$$10 = (n-1)(1.25)$$
$$8 = n-1$$
$$9 = n$$

It will take Michael 9 years to earn at least \$20.00 per hour.

c. One assumption is that Michael's rate of pay increase stays at \$1.25 per year for the 9 years. Also, it is assumed that Michael stays at this job for 9 years.

4. a. What is given:

- $t_1 = \frac{3}{5}$
- $n = ?$
- $d = \frac{1}{5}$
- $t_n = \frac{23}{5}$

Determine n.

$$\begin{aligned} t_n &= t_1 + (n-1)d \\ \frac{23}{5} &= \frac{3}{5} + (n-1)\frac{1}{5} \\ \frac{20}{5} &= (n-1)\frac{1}{5} \\ 20 &= n-1 \\ 21 &= n \end{aligned}$$

Determine S_{21}.

$$\begin{aligned} S_n &= \frac{n}{2}[t_1 + t_n] \\ S_{21} &= \frac{21}{2}\left[\frac{3}{5} + \frac{23}{5}\right] \\ S_{21} &= \frac{21}{2}\left(\frac{26}{5}\right) \\ S_{21} &= \frac{273}{5} \end{aligned}$$

b. What is given:

- $t_1 = 12$
- $S_n = ?$
- $r = -2$
- $t_n = -393\ 216$

Determine S_n.

$$\begin{aligned} S_n &= \frac{rt_n - t_1}{r-1} \\ S_n &= \frac{-2(-393\ 216) - 12}{-2-1} \\ S_n &= -262\ 140 \end{aligned}$$

5. a. Check the value of r first.

$$r = \frac{t_n}{t_{n-1}}$$
$$r = \frac{11}{110} = 0.1$$

Because of $-1 < r < 1$, the infinite series is convergent; therefore, a finite sum can be determined.

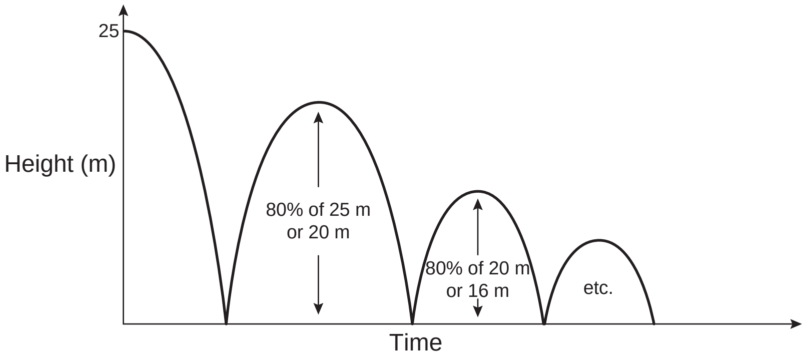
$$S_\infty = \frac{t_1}{1-r}$$
$$S_\infty = \frac{110}{1-0.1}$$
$$S_\infty = 122.\overline{2}$$

b. Check the value of r first.

$$r = \frac{t_n}{t_{n-1}}$$
$$r = \frac{1.1}{0.11} = 10$$

Because $r > 1$, this infinite series is divergent; therefore, a finite sum cannot be determined.

6. a.



b. Bounce 1, or t_1, results in a height of 20 m.
- $t_1 = 20$ m
- $r = 0.80$
- $n = 5$

$$t_n = t_1 r^{n-1}$$
$$t_5 = 20(0.8)^{5-1}$$
$$t_5 = 8.192$$
$$t_5 \doteq 8.2$$

After the fifth bounce, the ball will reach 8.2 m.

c. Because $-1 < r < 1$, an infinite sum can be determined.

$$S_\infty = \frac{t_1}{1-r}$$
$$S_\infty = \frac{20}{1-0.8}$$
$$S_\infty = 100$$

The sum of 100 m must be doubled because the ball rises and falls with each bounce. In addition, the original drop of 25 m must be added to the total vertical distance travelled.
$S = 25 + 2(100) = 225$
The total vertical distance the ball travels is 225 m.

Unit 2: Quadratic Functions and Equations Solutions

1.

Vertex	$(2, -12)$
Domain	$\{x \mid x \in \mathrm{R}\}$
Range	$\{y \mid y \geq -12, y \in \mathrm{R}\}$
Direction of opening	upwards
Equation of the axis of symmetry	$x = 2$
***x*-intercept(s)**	0 and 4
***y*-intercept**	0
Point on the function	$(0, 0)$

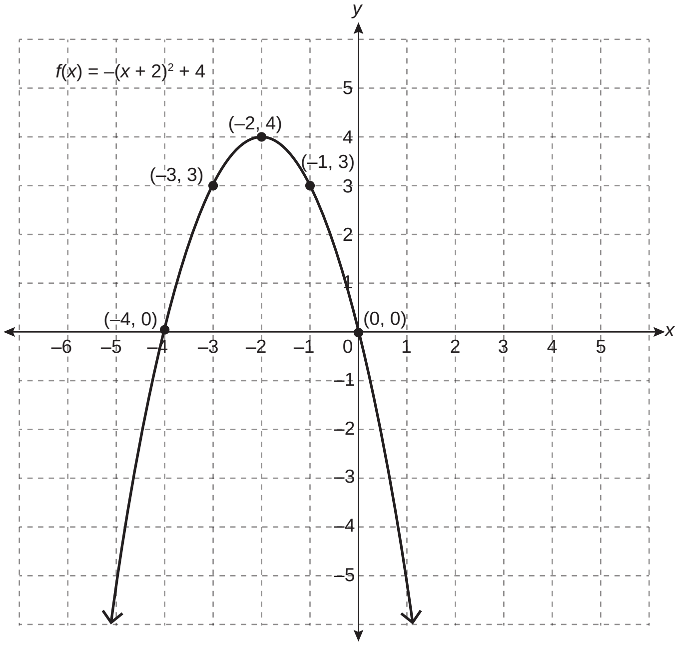
Equation of the function:

$$\begin{aligned} y &= a(x-p)^2 + q \\ 0 &= a(0-2)^2 - 12 \\ 12 &= 4a \\ 3 &= a \end{aligned}$$

$$y = 3(x-2)^2 - 12$$

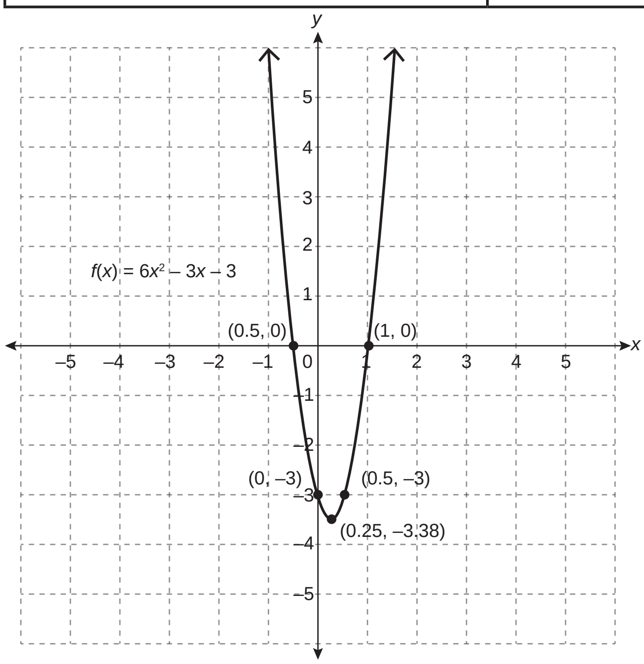
2.

Vertex	$(-2, 4)$
Domain	$\{x \mid x \in R\}$
Range	$\{y \mid y \leq 4, y \in R\}$
Direction of opening	downwards
Equation of the axis of symmetry	$x = -2$
***x*-intercept(s)**	$f(x) = -(x+2)^2 + 4$ $0 = -(x+2)^2 + 4$ $0 = -(x^2 + 4x + 4) + 4$ $0 = -x^2 - 4x - 4 + 4$ $0 = -x^2 - 4x$ $0 = -x(x+4)$ $x = 0$ and $x = -4$
***y*-intercept**	$f(x) = -(x+2)^2 + 4$ $y = -(0+2)^2 + 4$ $y = -4 + 4$ $y = 0$



3.

Vertex	$y = 6x^2 - 3x - 3$ $y = 6\left(x^2 - \frac{1}{2}x\right) - 3$ $y = 6\left[x^2 - \frac{1}{2}x + \left(-\frac{1}{4}\right)^2 - \left(-\frac{1}{4}\right)^2\right] - 3$ $y = 6\left(x - \frac{1}{4}\right)^2 - 3 - \frac{6}{16}$ $y = 6\left(x - \frac{1}{4}\right)^2 - \frac{27}{8}$ $\left(\frac{1}{4}, -\frac{27}{8}\right)$
Domain	$\{x \mid x \in \mathrm{R}\}$
Range	$\left\{y \mid y \geq -\frac{27}{8}, y \in \mathrm{R}\right\}$
Direction of opening	upwards
Equation of the axis of symmetry	$x = \frac{1}{4}$
***x*-intercept(s)**	$y = 6x^2 - 3x - 3$ $0 = 6x^2 - 3x - 3$ $0 = 3(2x^2 - x - 1)$ $0 = 3(2x + 1)(x - 1)$ $x = -\frac{1}{2}$ and $x = 1$
***y*-intercept**	-3



4. $y = 3x^2 + 18x + 20$
$y = 3(x^2 + 6x) + 20$
$y = 3(x^2 + 6x + 3^2 - 3^2) + 20$
$y = 3(x + 3)^2 + 20 - 27$
$y = 3(x + 3)^2 - 7$

5. a. This is a difference of squares.

$f(x) = 49x^2 - 9$
$f(x) = (7x - 3)(7x + 3)$

b. Start by factoring a related function.
$y = 8c^2 + 6c - 5$, where $c = x + 5$.
$y = 8c^2 + 6c - 5$
$y = 8c^2 + 10c - 4c - 5$
$y = 2c(4c + 5) - (4c + 5)$
$y = (2c - 1)(4c + 5)$

Substitute $c = x + 5$ and simplify.
$y = [2(x + 5) - 1][4(x + 5) + 5]$
$y = (2x + 10 - 1)(4x + 20 + 5)$
$y = (2x + 9)(4x + 25)$

6. a. The simplest method here is to take the square root of both sides and solve for x.

$(x - 4)^2 = 81$
$x - 4 = \pm\sqrt{81}$
$x - 4 = \pm 9$
$x = 4 \pm 9$
$x = 13$ and $x = -5$

b. Factoring is used because once the $13x$ is moved to the other side of the equation, the resulting trinomial is easily factored using decomposition.

$$2x^2 + 15 = 13x$$
$$2x^2 - 13x + 15 = 0$$
$$(2x - 3)(x - 5) = 0$$
$$x = \frac{3}{2} \text{ and } x = 5$$

Note: Graphing could also have been used for this question.

c. This equation cannot easily be solved by factoring, so try using the quadratic formula.

$$a = 2,\ b = -8,\ c = 1$$
$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$
$$x = \frac{8 \pm \sqrt{(-8)^2 - 4(2)(1)}}{2(2)}$$
$$x = \frac{8 \pm \sqrt{56}}{4}$$
$$x = \frac{8 \pm 2\sqrt{14}}{4}$$
$$x = \frac{4 \pm \sqrt{14}}{2}$$
$$x = \frac{4 + \sqrt{14}}{2} \text{ and } x = \frac{4 - \sqrt{14}}{2}$$

d. This equation cannot easily be solved by factoring, so try using the quadratic formula.

$$0 = x^2 + 2x - 5$$
$$a = 1,\ b = 2,\ c = -5$$
$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$
$$x = \frac{-2 \pm \sqrt{2^2 - 4(1)(-5)}}{2(1)}$$
$$x = \frac{-2 \pm \sqrt{24}}{2}$$
$$x = \frac{-2 \pm 2\sqrt{6}}{2}$$
$$x = -1 \pm \sqrt{6}$$
$$x = -1 + \sqrt{6} \text{ and } x = -1 - \sqrt{6}$$

7. a. Use the discriminant to determine the value of *k*.

$$\begin{aligned} b^2 - 4ac &= 0 \\ k^2 - 4(2)(2) &= 0 \\ k^2 &= 16 \\ k &= \pm\sqrt{16} \\ k &= \pm 4 \end{aligned}$$

In order for the quadratic equation to have one Real root, $k = \pm 4$.

b. Use the discriminant to determine the value of *k*.

$$\begin{aligned} b^2 - 4ac &> 0 \\ k^2 - 4(2)(2) &> 0 \\ k^2 &> 16 \\ k &> \pm\sqrt{16} \\ k &> |4| \\ k &> 4 \text{ and } k < -4 \end{aligned}$$

In order for the quadratic equation to have two distinct Real roots, $k > 4$ or $k < -4$.

c. Use the discriminant to determine the value of *k*.

$$\begin{aligned} b^2 - 4ac &< 0 \\ k^2 - 4(2)(2) &< 0 \\ k^2 &< 16 \\ k &< \pm\sqrt{16} \\ k &< |4| \\ -4 < k &< 4 \end{aligned}$$

In order for the quadratic equation to have no Real roots, $-4 < k < 4$.

8. a. This will be where $d = 0$.

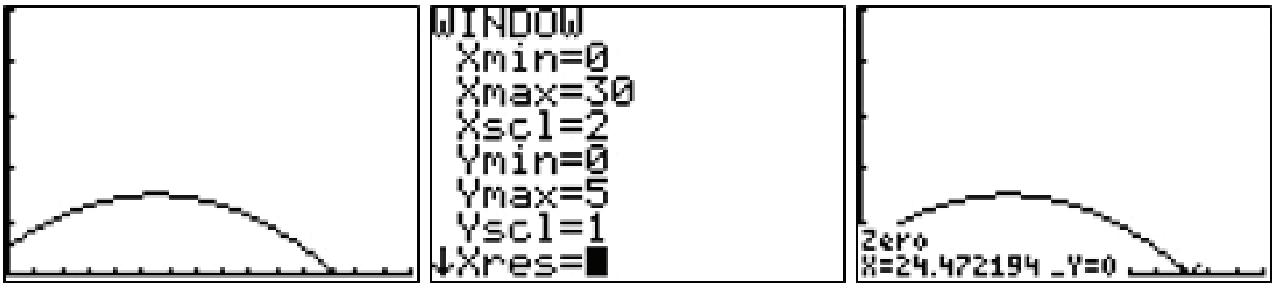
$$h(d) = -\frac{1}{121}(d - 11)^2 + \frac{3}{2}$$
$$h(0) = -\frac{1}{121}(0 - 11)^2 + \frac{3}{2}$$
$$h(0) = -\frac{1}{121}(-11)^2 + \frac{3}{2}$$
$$h(0) = -1 + \frac{3}{2}$$
$$h(0) = \frac{1}{2}$$

The tennis player hit the ball from a height of 0.5 m.

b. This is the value of d at the vertex, $\left(11, \frac{3}{2}\right)$, of the function.

Therefore, the tennis ball will hit its maximum height 11 m from the tennis player because $p = 11$.

c. This is the value of d when $h(d) = 0$.
Use graphing technology to solve this.



The tennis ball will have travelled approximately 24.5 m from the tennis player when it hits the ground.

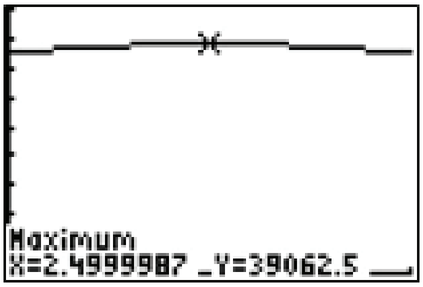
9. Let c represent the number of \$50.00 increases in price.
Revenue = (cost/quarter)(number of quarters sold)
Cost/quarter = \$500.00 + \$50.00c
Number of quarters sold = 75 – 5c

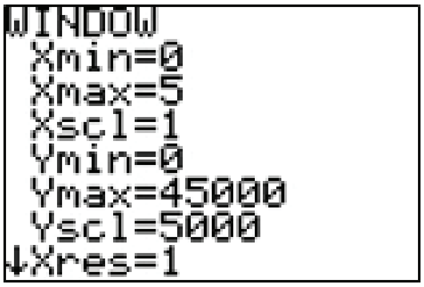
$R(c) = (500 + 50c)(75 - 5c)$

$R(c) = 37\ 500 + 1\ 250c - 250c^2$

$R(c) = -250c^2 + 1\ 250c + 37\ 500$

Graph the function to determine the maximum number of price increases.





Kirsten should raise the price by $\$500.00 + \$50(2.5) = \$625.00$ to maximize her revenue.

Unit 3: Radical Expressions and Equations Solutions

1. $6\sqrt[3]{3} = \sqrt[3]{(6)^3(3)} = \sqrt[3]{648}$
$\sqrt[3]{514}$
$5\sqrt[3]{9} = \sqrt[3]{(5)^3(9)} = \sqrt[3]{1\ 125}$
$9 = \sqrt[3]{9^3} = \sqrt[3]{729}$
$2\sqrt[3]{3} = \sqrt[3]{(2)^3(3)} = \sqrt[3]{24}$

The order of the radicals from least to greatest is
$\sqrt[3]{24},\ \sqrt[3]{514},\ \sqrt[3]{648},\ \sqrt[3]{729},\ \sqrt[3]{1\ 125}$
$2\sqrt[3]{3},\ \sqrt[3]{514},\ 6\sqrt[3]{3},\ 9,\ 5\sqrt[3]{9}$

2. a. $\sqrt[4]{3} - 2\sqrt{3} + 5\sqrt[4]{3} + 7\sqrt{3} = (1+5)\sqrt[4]{3} + (7-2)\sqrt{3}$
$= 6\sqrt[4]{3} + 5\sqrt{3}$

b. Because the index on the radical is even, c must be greater than or equal to zero. Because c is also found in the denominator, c cannot equal zero; therefore, the restriction is $c > 0$.

$$\begin{aligned}\frac{2\sqrt{10c^3}}{\sqrt{5c}} &= 2\sqrt{2c^2}\\ &= 2c\sqrt{2}\end{aligned}$$

c. $$\begin{aligned}\frac{\sqrt[3]{25}\left(\sqrt[3]{10r}\right)}{\sqrt[3]{14r^2}} &= \sqrt[3]{\frac{250r}{14r^2}}\\ &= \sqrt[3]{\frac{5^3 r}{7r^2}}\\ &= \frac{5\sqrt[3]{r}}{\sqrt[3]{7r^2}} \bullet \frac{\left(\sqrt[3]{7r^2}\right)^2}{\left(\sqrt[3]{7r^2}\right)^2}\\ &= \frac{5\sqrt[3]{7^2 r^5}}{7r^2}\\ &= \frac{5r\sqrt[3]{49r^2}}{7r^2}\\ &= \frac{5\sqrt[3]{49r^2}}{7r}, r \neq 0\end{aligned}$$

d. $$\begin{aligned}\frac{(\sqrt{2}-8)(\sqrt{2}+5)}{\sqrt{2}-2} &= \frac{2-3\sqrt{2}-40}{\sqrt{2}-2}\\ &= \frac{-3\sqrt{2}-38}{\sqrt{2}-2} \bullet \frac{(\sqrt{2}+2)}{(\sqrt{2}+2)}\\ &= \frac{-3(2)-44\sqrt{2}-76}{2-4}\\ &= \frac{-44\sqrt{2}-82}{-2}\\ &= 22\sqrt{2}+41\end{aligned}$$

3. a. $x \geq 0$

$$\sqrt{7x} = 2x$$
$$7x = (2x)^2$$
$$7x = 4x^2$$
$$0 = 4x^2 - 7x$$
$$0 = x(4x - 7)$$
$$x = 0 \text{ and } x = \frac{7}{4}$$

Verify:

$x = 0$

Left Side	Right Side
$\sqrt{7x}$	$2x$
$\sqrt{7(0)}$	$2(0)$
0	0
LS = RS	

$x = \frac{7}{4}$

Left Side	Right Side
$\sqrt{7x}$	$2x$
$\sqrt{7\left(\frac{7}{4}\right)}$	$2\left(\frac{7}{4}\right)$
$\sqrt{\frac{49}{4}}$	$\frac{7}{2}$
$\frac{7}{2}$	
LS = RS	

Both answers are possible; therefore, $x = 0$ and $x = \frac{7}{4}$.

b. $x - 2 \geq 0$

$x \geq 2$

$$\begin{aligned}
\sqrt{x-2} + 4 &= x - 4 \\
\sqrt{x-2} &= x - 8 \\
x - 2 &= (x-8)^2 \\
x - 2 &= x^2 - 16x + 64 \\
0 &= x^2 - 17x + 66 \\
0 &= (x-11)(x-6) \\
x &= 11 \text{ and } x = 6
\end{aligned}$$

Verify:
$x = 11$

Left Side	Right Side
$\sqrt{x-2} + 4$	$x - 4$
$\sqrt{11-2} + 4$	$11 - 4$
$\sqrt{9} + 4$	7
$3 + 4$	
7	
LS = RS	

$x = 6$

Left Side	Right Side
$\sqrt{x-2} + 4$	$6 - 4$
$\sqrt{6-2} + 4$	$6 - 4$
$\sqrt{4} + 4$	2
$2 + 4$	
6	
LS ≠ RS	

$x = 6$ is an extraneous root.
The solution to the equation is $x = 11$.

c. $x + 3 \geq 0$ $\quad x + 5 \geq 0$

$x \geq -3$ $\quad x \geq -5$

Because the area of overlap starts at $x \geq -3$, that is the restriction on the variable.

$$\begin{aligned}
\sqrt{x+3} + 1 &= \sqrt{x+5} \\
\left(\sqrt{x+3} + 1\right)^2 &= \left(\sqrt{x+5}\right)^2 \\
(x+3) + 2\sqrt{x+3} + 1 &= x + 5 \\
2\sqrt{x+3} &= 1 \\
\sqrt{x+3} &= \frac{1}{2} \\
\left(\sqrt{x+3}\right)^2 &= \left(\frac{1}{2}\right)^2 \\
x + 3 &= \frac{1}{4} \\
x &= -\frac{11}{4}
\end{aligned}$$

Verify:

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

Left Side	Right Side
$\sqrt{x+3} + 1$	$\sqrt{x+5}$
$\sqrt{-\frac{11}{4} + 3} + 1$	$\sqrt{-\frac{11}{4} + 5}$
$\sqrt{\frac{1}{4}} + 1$	$\sqrt{\frac{9}{4}}$
$\frac{1}{2} + 1$	$\frac{3}{2}$
$\frac{3}{2}$	
LS = RS	

The solution to the equation is $x = -\frac{11}{4}$.

4. a. $I = \sqrt{\dfrac{P}{R}}$

$I = \sqrt{\dfrac{120}{2}}$

$I = \sqrt{60}$

$I = 2\sqrt{15}\ \text{A}$

b. $I = \sqrt{\dfrac{P}{R}}$

$2\sqrt{5} = \sqrt{\dfrac{120}{R}}$

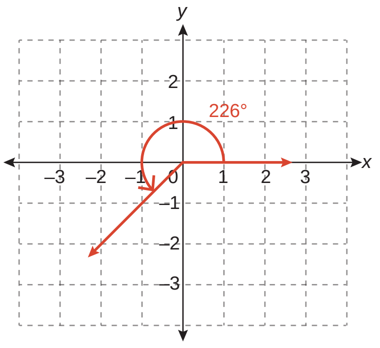
$4(5) = \dfrac{120}{R}$

$R = \dfrac{120}{20}$

$R = 6\ \Omega$

Unit 4: Trigonometry

1. a.



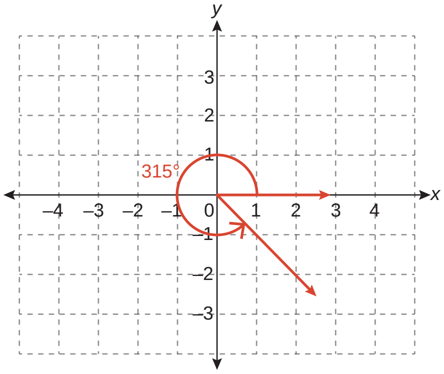
The reference angle is

$\theta_R = \theta - 180^\circ$

$\theta_R = 226^\circ - 180^\circ$

$\theta_R = 46^\circ$

b.



The reference angle is

$\theta_R = 360° - \theta$

$\theta_R = 360° - 315°$

$\theta_R = 45°$

2. a. $r = \sqrt{x^2 + y^2}$

$r = \sqrt{(-3)^2 + (4)^2}$

$r = \sqrt{25}$

$r = 5$

The primary trigonometric ratios are:

$\sin\theta = \frac{\text{opp}}{\text{hyp}} = \frac{4}{5}$

$\cos\theta = \frac{\text{adj}}{\text{hyp}} = \frac{-3}{5} = -\frac{3}{5}$

$\tan\theta = \frac{\text{opp}}{\text{adj}} = \frac{4}{-3} = -\frac{4}{3}$

b. $r = \sqrt{x^2 + y^2}$

$r = \sqrt{(7)^2 + (-2)^2}$

$r = \sqrt{53}$

The primary trigonometric ratios are:

$\sin\theta = \frac{\text{opp}}{\text{hyp}} = \frac{-2}{\sqrt{53}} \bullet \frac{\sqrt{53}}{\sqrt{53}} = -\frac{2\sqrt{53}}{53}$

$\cos\theta = \frac{\text{adj}}{\text{hyp}} = \frac{7}{\sqrt{53}} \bullet \frac{\sqrt{53}}{\sqrt{53}} = \frac{7\sqrt{53}}{53}$

$\tan\theta = \frac{\text{opp}}{\text{adj}} = \frac{-2}{7} = -\frac{2}{7}$

3. a. This angle terminates in Quadrant III.

$\theta_R = \theta - 180^\circ$

$\theta_R = 210^\circ - 180^\circ$

$\theta_R = 30^\circ$

In Quadrant III, sine is negative, so

$\sin 210^\circ = -\sin 30^\circ = -\frac{1}{2}$.

b. This angle terminates in Quadrant IV.

$\theta_R = 360^\circ - \theta$

$\theta_R = 360^\circ - 315^\circ$

$\theta_R = 45^\circ$

In Quadrant IV, tangent is negative, so

$\tan 315^\circ = -\tan 45^\circ = -1$.

4. a. The sine ratio equals –1 at 270°.

$\sin\theta = -1$

$\theta = 270^\circ$

b. The tangent ratio is positive in Quadrants I and III.

Determine the reference angle, and then determine the angles in standard position in Quadrants I and III.

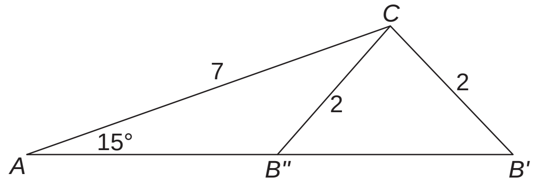
$\tan\theta_R = 1.9626$

$\theta_R = \tan^{-1}(1.9626)$

$\theta_R = 62.999...^\circ$

The two angles are approximately 63° and $180^\circ + 62.999...^\circ = 242.999...^\circ \doteq 243^\circ$.

5. a.



b. $\triangle AB'C$:

$$\frac{\sin A}{a} = \frac{\sin B}{b}$$
$$\frac{\sin 15^\circ}{2} = \frac{\sin B'}{7}$$
$$\frac{7\sin 15^\circ}{2} = \sin B'$$
$$0.905... = \sin B'$$
$$64.940... = {}^\circ B'$$

$$\begin{aligned} C &= 180^\circ - A - B \\ &= 180^\circ - 15^\circ - 64.940...^\circ \\ &= 100.059...^\circ \end{aligned}$$

$$\frac{\sin A}{a} = \frac{\sin C}{c}$$
$$\frac{\sin 15^\circ}{2} = \frac{\sin 100.059...^\circ}{c}$$
$$c = \frac{2\sin 100.059...^\circ}{\sin 15^\circ}$$
$$c = 7.608... \text{ m}$$

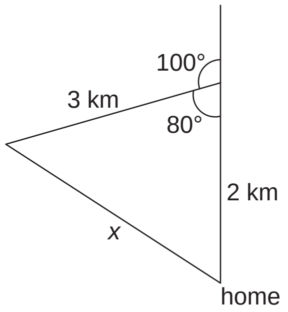
$\triangle AB''C$:

$$\begin{aligned} B'' &= 180^\circ - 64.940...^\circ \\ &= 115.059...^\circ \end{aligned}$$

$$\begin{aligned} C &= 180^\circ - A - B \\ &= 180^\circ - 15^\circ - 115.059...^\circ \\ &= 49.940...^\circ \end{aligned}$$

$$\frac{\sin A}{a} = \frac{\sin C}{c}$$
$$\frac{\sin 15^\circ}{2} = \frac{\sin 49.940...^\circ}{c}$$
$$c = \frac{2\sin 49.940...^\circ}{\sin 15^\circ}$$
$$c = 5.914... \text{ m}$$

6. a.



b. $c^2 = a^2 + b^2 - 2ab\cos C$

$x^2 = 2^2 + 3^2 - 2(2)(3)\cos 80°$

$x^2 = 10.916...$

$x = 3.303...$

The total length of the run is $2 + 3 + 3.303... = 8.303...$, or approximately 8.3 km.

Unit 5: Rational Expressions and Equations Solutions

1. a. NPV: $a \neq 0,\ b \neq 0,\ c \neq 0,\ a \neq b$

$$\frac{245a^2bc^3(a^2-b^2)}{25ab^3c^2(a-b)} = \frac{245a^2bc^3\cancel{(a-b)}(a+b)}{25ab^3c^2\cancel{(a-b)}}$$
$$= \frac{49ac(a+b)}{5b^2},\ a \neq 0,\ b \neq 0,\ c \neq 0,\ a \neq b$$

b. $\dfrac{m+4}{m^2-4m+3} + \dfrac{m+5}{m^2-2m-3} = \dfrac{m+4}{(m-3)(m-1)} + \dfrac{m+5}{(m-3)(m+1)}$

$m \neq \pm 1, 3$

LCD $= (m-3)(m-1)(m+1)$

$$\frac{[m+4](m+1)}{[(m-3)(m-1)](m+1)} + \frac{[m+5](m-1)}{[(m-3)(m+1)](m-1)} = \frac{(m+4)(m+1)}{(m-3)(m-1)(m+1)} + \frac{(m+5)(m-1)}{(m-3)(m-1)(m+1)}$$
$$= \frac{m^2+5m+4}{(m-3)(m-1)(m+1)} + \frac{m^2+4m-5}{(m-3)(m-1)(m+1)}$$
$$= \frac{2m^2+9m-1}{(m-3)(m-1)(m+1)},\ m \neq \pm 1, 3$$

c. $\dfrac{4x^2-17x+4}{3x^2+8x-3} \div \dfrac{4x^2+15x-4}{6x^2+x-1} = \dfrac{(4x-1)(x-4)}{(3x-1)(x+3)} \div \dfrac{(4x-1)(x+4)}{(3x-1)(2x+1)}$

$x \neq \frac{1}{3}, -3, -\frac{1}{2}$

$$\begin{aligned}\frac{(4x-1)(x-4)}{(3x-1)(x+3)} \div \frac{(4x-1)(x+4)}{(3x-1)(2x+1)} &= \frac{\cancel{(4x-1)}(x-4)}{\cancel{(3x-1)}(x+3)} \cdot \frac{\cancel{(3x-1)}(2x+1)}{\cancel{(4x-1)}(x+4)}, x \neq \frac{1}{4}, -4 \\ &= \frac{(x-4)(2x+1)}{(x+3)(x+4)}, x \neq -4, -3, -\frac{1}{2}, \frac{1}{4}, \frac{1}{3}\end{aligned}$$

d. $\dfrac{5x-1}{x-6} - \dfrac{x^2+x-2}{2x^2-17x+30} \cdot \dfrac{4x^2-25}{x^2-1} = \dfrac{5x-1}{x-6} - \dfrac{(x-1)(x+2)}{(2x-5)(x-6)} \cdot \dfrac{(2x-5)(2x+5)}{(x-1)(x+1)}$

$x \neq 6, \frac{5}{2}, \pm 1$

$$\begin{aligned}\frac{5x-1}{x-6} - \frac{\cancel{(x-1)}(x+2)}{\cancel{(2x-5)}(x-6)} \cdot \frac{\cancel{(2x-5)}(2x+5)}{\cancel{(x-1)}(x+1)} &= \frac{(5x-1)(x+1)}{(x-6)(x+1)} - \frac{(x+2)(2x+5)}{(x-6)(x+1)} \\ &= \frac{5x^2+4x-1}{(x-6)(x+1)} - \frac{2x^2+9x+10}{(x-6)(x+1)} \\ &= \frac{3x^2-5x-11}{(x-6)(x+1)}, x \neq \pm 1, \frac{5}{2}, 6\end{aligned}$$

2. a. $\dfrac{(x^2-1)}{(x-3)(x+3)}=3$

$x \neq \pm 3$

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

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

$$x^2-1=3(x^2-9)$$

$$x^2-1=3x^2-27$$

$$0=2x^2-26$$

$$0=2(x^2-13)$$

$$\pm\sqrt{13}=x$$

Verify:

$x=\sqrt{13}$

Left Side	Right Side
$\dfrac{x^2-1}{x^2-9}$ $\dfrac{(\sqrt{13})^2-1}{(\sqrt{13})^2-9}$ $\dfrac{13-1}{13-9}$ $\dfrac{12}{4}$ 3	3
LS = RS	

$x=-\sqrt{13}$

Left Side	Right Side
$\dfrac{x^2-1}{x^2-9}$ $\dfrac{(-\sqrt{13})^2-1}{(-\sqrt{13})^2-9}$ $\dfrac{13-1}{13-9}$ $\dfrac{12}{4}$ 3	3
LS = RS	

The solutions to this equation are $x=\pm\sqrt{13}$.

b. $\frac{3x^2+16x+10}{4x^2-7x-2}=\frac{4x-1}{x-2}-2$

$\frac{3x^2+16x+10}{(4x+1)(x-2)}=\frac{4x-1}{x-2}-2$

NPV: $x\neq -\frac{1}{4}, 2$

LCD: $(4x+1)(x-2)$

$$\left[\frac{3x^2+16x+10}{\cancel{(4x+1)(x-2)}}\right]\cancel{(4x+1)(x-2)}=\left[\frac{4x-1}{\cancel{x-2}}\right](4x+1)\cancel{(x-2)}-[2](4x+1)(x-2)$$

$$3x^2+16x+10=(4x-1)(4x+1)-2(4x+1)(x-2)$$

$$3x^2+16x+10=16x^2-1-2(4x^2-7x-2)$$

$$3x^2+16x+10=16x^2-1-8x^2+14x+4$$

$$0=5x^2-2x-7$$

$$0=(5x-7)(x+1)$$

$$x=\frac{7}{5},-1$$

Verify:
$x=\frac{7}{5}$

Left Side	Right Side
$\frac{3x^2+16x+10}{4x^2-7x-2}$	$\frac{4x-1}{x-2}-2$
$\frac{3\left(\frac{7}{5}\right)^2+16\left(\frac{7}{5}\right)+10}{4\left(\frac{7}{5}\right)^2-7\left(\frac{7}{5}\right)-2}$	$\frac{4\left(\frac{7}{5}\right)-1}{\left(\frac{7}{5}\right)-2}-2$
$\frac{\frac{147}{25}+\frac{112}{5}+10}{\frac{196}{25}-\frac{49}{5}-2}$	$\frac{\frac{28}{5}-1}{-\frac{3}{5}}-2$
$\frac{\frac{957}{25}}{\frac{-99}{25}}$	$\frac{23}{-3}-2$
$-\frac{29}{3}$	$-\frac{29}{3}$
LS = RS	

Verify:
$x=-1$

Left Side	Right Side
$\frac{3x^2+16x+10}{4x^2-7x-2}$	$\frac{4x-1}{x-2}-2$
$\frac{3(-1)^2+16(-1)+10}{4(-1)^2-7(-1)-2}$	$\frac{4(-1)-1}{(-1)-2}-2$
$\frac{3-16+10}{4+7-2}$	$\frac{-4-1}{-3}-2$
$\frac{-3}{9}$	$\frac{-5}{-3}-2$
$-\frac{1}{3}$	$-\frac{1}{3}$
LS = RS	

The solutions to this equation are $x=\frac{7}{5}$ and $x=-1$.

3. $$\frac{x-4}{3x^2+5x+2}=\frac{x+11}{x^2+4x+3}$$

$$\frac{x-4}{(3x+2)(x+1)}=\frac{x+11}{(x+1)(x+3)}$$

NPV: $x \neq -\frac{2}{3}, -1, -3$

$$\begin{aligned}
\frac{x-4}{(3x+2)(x+1)} &= \frac{x+11}{(x+1)(x+3)} \\
(x-4)\cancel{(x+1)}(x+3) &= (x+11)(3x+2)\cancel{(x+1)} \\
(x-4)(x+3) &= (x+11)(3x+2) \\
x^2-x-12 &= 3x^2+35x+22 \\
0 &= 2x^2+36x+34 \\
0 &= 2(x^2+18x+17) \\
0 &= 2(x+17)(x+1) \\
x &= -17, x = -1
\end{aligned}$$

Note that $x=-1$ is a non-permissible value; only verify $x=-17$.

Verify:
$x=-17$

Left Side	Right Side
$\frac{x-4}{3x^2+5x+2}$	$\frac{x+11}{x^2+4x+3}$
$\frac{(-17)-4}{3(-17)^2+5(-17)+2}$	$\frac{(-17)+11}{(-17)^2+4(-17)+3}$
$\frac{-21}{784}$	$\frac{-6}{224}$
$-\frac{3}{112}$	$-\frac{3}{112}$
LS = RS	

The solution to this equation is $x = -17$.

4. Let t represent the time it takes to fill the tub with both hot and cold.

$$\frac{1}{\text{time to fill the tub with cold water}}+\frac{1}{\text{time to fill the tub with hot water}}=\frac{1}{\text{time to fill the tub using both cold and hot water}}$$

$$\begin{aligned}\frac{1}{3}+\frac{1}{4}&=\frac{1}{t},\ t\neq 0\\ 4t+3t&=12\\ 7t&=12\\ t&=\frac{12}{7}\\ t&\doteq 1.7\text{ min}\end{aligned}$$

It will take approximately 1.7 minutes to fill the washing machine tub using both hot and cold water.

5. Let s represent Hilary's speed in the first 5 km of the race.

Portion of the Race	**Distance (km)**	**Speed (km/h)**	**Time (h)**
First 5 km	5	s	$\frac{5}{s}$
Second 5 km	5	$s-2$	$\frac{5}{s-2}$

The total time is 1 hour; therefore,

$\frac{5}{s}+\frac{5}{s-2}=1$, where $s\neq 0, 2$

$$\begin{aligned}\left[\frac{5}{\cancel{s}}\right](\cancel{s})(s-2)+\left[\frac{5}{\cancel{s-2}}\right](s)(\cancel{s-2})&=1(s)(s-2)\\ 5(s-2)+5s&=s(s-2)\\ 5s-10+5s&=s^2-2s\\ 0&=s^2-12s+10\end{aligned}$$

Use graphing technology or the quadratic formula to solve for s.

$a = 1,\ b = -12,\ c = 10$

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

$$s = \frac{12 \pm \sqrt{(-12)^2 - 4(1)(10)}}{2(1)}$$

$$s = \frac{12 \pm \sqrt{104}}{2}$$

$s = 11.099...$ and $s = 0.900...$

Because a speed of 1 km/h does not make sense given the second half of the race is run at a speed that is 2 km/h slower, s = 0.0900… km/h can be excluded as a solution value.

Therefore, Hilary was travelling at a speed of approximately 11 km/h in the first 5 km of the race.

Unit 6: Absolute Value and Reciprocal Functions Solutions

1. $$\begin{aligned} -3 &= -3 \\ |7| &= 7 \\ |-4| &= 4 \\ 1 &= 1 \\ |-11| &= 11 \\ 10 &= 10 \\ |6| &= 6 \end{aligned}$$

   From least to greatest, the order is $-3,\ 1,\ |-4|,\ |6|,\ |7|,\ 10,\ |-11|$.

2. a. $|9 - 12| = |-3| = 3$

   b. $$\begin{aligned} |-3(4) + 2| - |6 - 2(8)| &= |-12 + 2| - |6 - 16| \\ &= |-10| - |-10| \\ &= 10 - 10 \\ &= 0 \end{aligned}$$

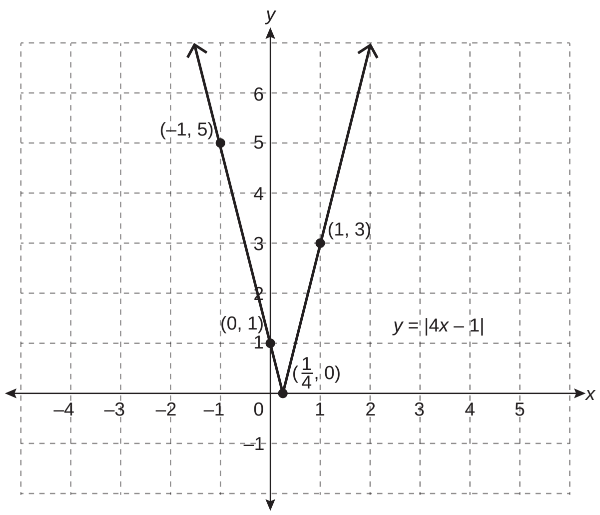
3. $|-9.2| + |5.7| = 9.2 + 5.7 = 14.9$

4. a.

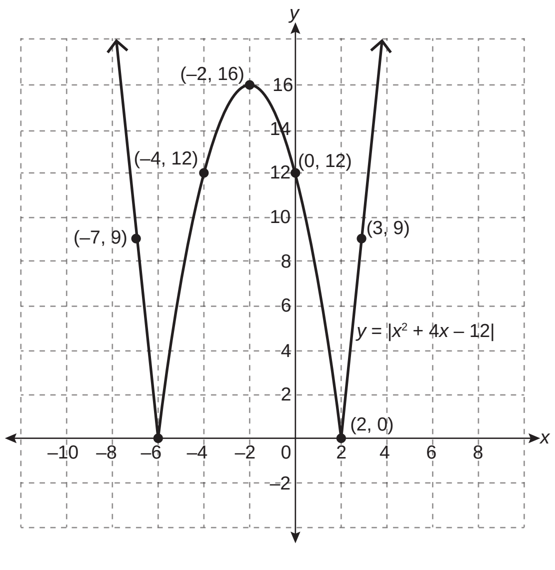
$$\text{Total Change} = |298.14 - 236.98| + |115.65 - 298.14| + |411.12 - 115.65| + |323.43 - 411.12| + |350.21 - 323.43|$$
$$= 61.16 + 182.49 + 295.47 + 87.69 + 26.78$$
$$= \$653.59$$

b. The net change is $\$350.21 - \$236.98 = \$113.23$, which represents the difference between the starting balance and the ending balance. The total change indicates how much Rachel's bank account balance changed throughout the month, both increasing in value as well as decreasing in value.

5. a.



b.



6. a. There are two linear functions that correspond to the given graph of an absolute value function. One function can be found using two points with *x* values greater than 3, and the other can be found using two points with *x* values less than 3. For example, $(4,2)$ and $(5,4)$, and $(2,2)$ and $(1,4)$.

First, calculate each slope.

$$m = \frac{y_2 - y_1}{x_2 - x_1} \qquad m = \frac{y_2 - y_1}{x_2 - x_1}$$

$$m = \frac{4-2}{5-4} \qquad m = \frac{4-2}{1-2}$$

$$m = 2 \qquad m = -2$$

Then, determine the equation of each line.

$$2 = \frac{y-2}{x-4} \qquad -2 = \frac{y-2}{x-2}$$

$$2x - 8 = y - 2 \qquad -2x + 4 = y - 2$$

$$2x - 6 = y \qquad -2x + 6 = y$$

The absolute value function is either $y = |2x - 6|$ or $y = |-2x + 6|$.
Written piecewise, the function is

$$y = \begin{cases} 2x - 6, \ x \geq 3 \\ -2x + 6, \ x < 3 \end{cases}$$

b. There are two quadratic functions that correspond to the given graph of an absolute value function. One function has a vertex at $(2, 4)$, and the other function has a vertex at $(2, -4)$. Another point on either quadratic function, that is also on the absolute value function, is $(0, 0)$.

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

$$y = a(x-2)^2 + 4 \qquad y = a(x-2)^2 - 4$$

$$0 = a(0-2)^2 + 4 \qquad 0 = a(0-2)^2 - 4$$

$$-1 = a \qquad 1 = a$$

or

$$y = -(x-2)^2 + 4 \qquad y = (x-2)^2 - 4$$

$$y = -(x^2 - 4x + 4) + 4 \qquad y = (x^2 - 4x + 4) - 4$$

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

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

The absolute value function is either $y = |-x^2 + 4x|$ or $y = |x^2 - 4x|$.
Written piecewise, the function is

$$y = \begin{cases} x^2 - 4x, \ x \leq 0 \text{ and } x \geq 4 \\ -x^2 + 4x, \ 0 < x < 4 \end{cases}$$

7. a. Case 1: $x + 4 \geq 0,$ or $x \geq -4$

$x + 4 = 8$

$x = 4$

Case 2: $x + 4 < 0,$ or $x < -4$

$-(x + 4) = 8$

$x + 4 = -8$

$x = -12$

Verify:

$x = 4$

Left Side	Right Side
$\lvert x + 4 \rvert$ $\lvert (4) + 4 \rvert$ $\lvert 8 \rvert$ 8	8
LS = RS	

$x = -12$

Left Side	Right Side
$\lvert x + 4 \rvert$ $\lvert (-12) + 4 \rvert$ $\lvert -8 \rvert$ 8	8
LS = RS	

The solutions to this equation are $x = 4$ and -12.

b. Case 1: $3x+1 \geq 0$, or $x \geq -\frac{1}{3}$

$$3x+1=\frac{1}{2}x+6$$
$$\frac{5}{2}x=5$$
$$x=2$$

Case 2: $3x+1<0$, or $x<-\frac{1}{3}$

$$-(3x+1)=\frac{1}{2}x+6$$
$$-3x-1=\frac{1}{2}x+6$$
$$-\frac{7}{2}x=7$$
$$x=-2$$

Verify.
$x=2$

Left Side	Right Side
$\|3x+1\|$ $\|3(2)+1\|$ $\|6+1\|$ 7	$\frac{1}{2}x+6$ $\frac{1}{2}(2)+6$ 7
LS = RS	

$x=-2$

Left Side	Right Side
$\|3x+1\|$ $\|3(-2)+1\|$ $\|-6+1\|$ 5	$\frac{1}{2}x+6$ $\frac{1}{2}(-2)+6$ 5
LS = RS	

The solutions to this equation are $x=\pm 2$.

c. Case 1: $x^2 + 4x \geq 0$

$$\begin{aligned} x^2 + 4x &= x + 4 \\ x^2 + 3x - 4 &= 0 \\ (x-1)(x+4) &= 0 \\ x &= 1, -4 \end{aligned}$$

The values 1 and –4 may be part of the solution. Verification is required to ensure they are not extraneous.

$x = 1$

Left Side	Right Side
$\lvert x^2 + 4x \rvert$	$x + 4$
$\lvert (1)^2 + 4(1) \rvert$	$(1) + 4$
$\lvert 1 + 4 \rvert$	5
5	
LS = RS	

$x = -4$

Left Side	Right Side
$\lvert x^2 + 4x \rvert$	$x + 4$
$\lvert (-4)^2 + 4(-4) \rvert$	$-4 + 4$
$\lvert 16 - 16 \rvert$	0
0	
LS = RS	

Case 2: $x^2 + 4x < 0$

$$\begin{aligned} -(x^2 + 4x) &= x + 4 \\ -x^2 - 4x &= x + 4 \\ 0 &= x^2 + 5x + 4 \\ 0 &= (x + 4)(x + 1) \\ x &= -4, -1 \end{aligned}$$

The value –4 has already been verified as a solution. Verification is required to ensure –1 is not extraneous.

$x = -1$

Left Side	Right Side
$\lvert x^2 + 4x \rvert$ $\lvert (-1)^2 + 4(-1) \rvert$ $\lvert 1 - 4 \rvert$ 3	$x + 4$ $(-1) + 4$ 3
LS = RS	

The solutions to this equation are $x = \pm 1, -4$.

8. a. The absolute value equation is $\lvert d - 0.3 \rvert = 0.001$.

b. If $d - 0.3 \geq 0$, then

$$\begin{aligned} \lvert d - 0.3 \rvert &= 0.001 \\ d - 0.3 &= 0.001 \\ d &= 0.301 \text{ mm} \end{aligned}$$

If $d - 0.3 < 0$, then

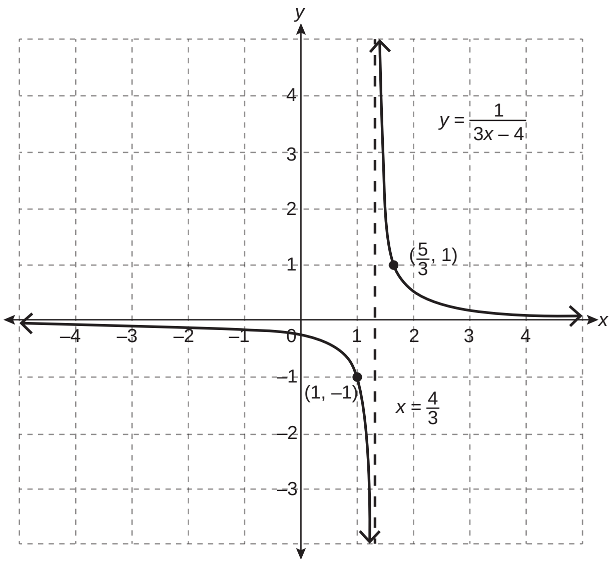
$$\begin{aligned} \lvert d - 0.3 \rvert &= 0.001 \\ -(d - 0.3) &= 0.001 \\ -d + 0.3 &= 0.001 \\ d &= 0.299 \text{ mm} \end{aligned}$$

The maximum and minimum diameters are 0.301 mm and 0.299 mm, respectively.

9. a. $x \neq \frac{4}{3}$; therefore, $x = \frac{4}{3}$ is the vertical asymptote.

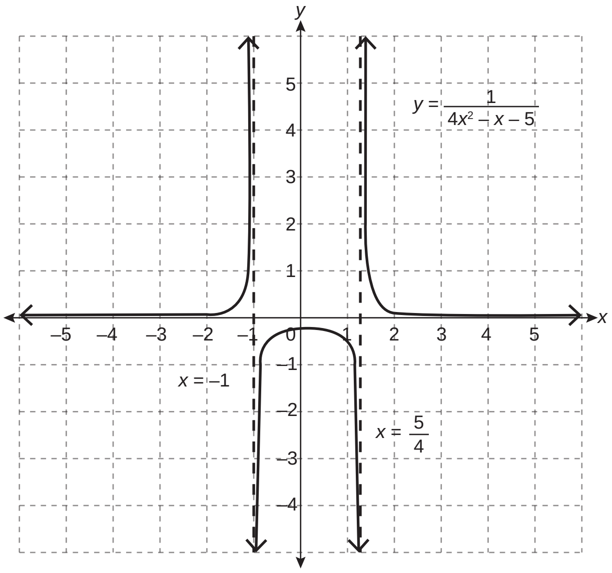
The invariant points are:

$$\begin{aligned} y &= \frac{1}{3x-4} \\ 1 &= \frac{1}{3x-4} \\ 3x-4 &= 1 \\ 3x &= 5 \\ x &= \frac{5}{3} \end{aligned} \qquad \begin{aligned} y &= \frac{1}{3x-4} \\ -1 &= \frac{1}{3x-4} \\ 3x-4 &= -1 \\ 3x &= 3 \\ x &= 1 \end{aligned}$$

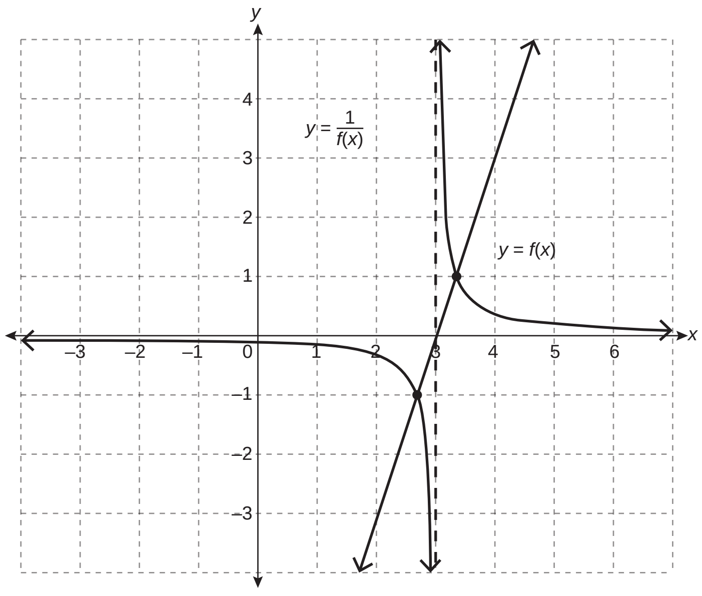


b. $y = \dfrac{1}{4x^2 - x - 5} = \dfrac{1}{(4x-5)(x+1)}, x \neq \dfrac{5}{4}, -1$

Therefore, the vertical asymptotes are at $x = \dfrac{5}{4}$ and $x = -1$.

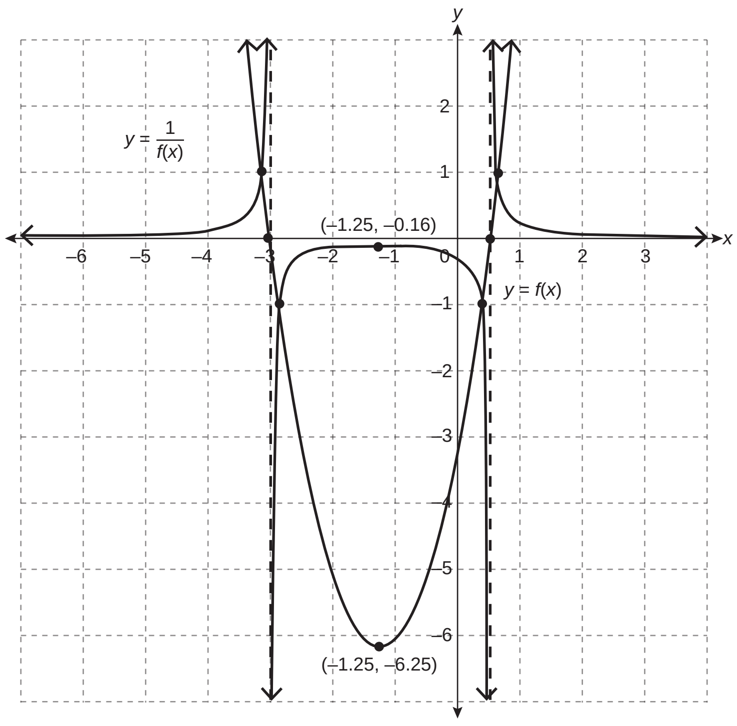


10. a.



$f(x)$ is a linear function because there is only one vertical asymptote, at $x = 3$. Graphing $f(x)$ is done by simply connecting the invariant points found at $y = \pm 1$, and extending the line.

b.



$f(x)$ is a quadratic function because there are two vertical asymptotes, at $x = -3$ and $x = \frac{1}{2}$.

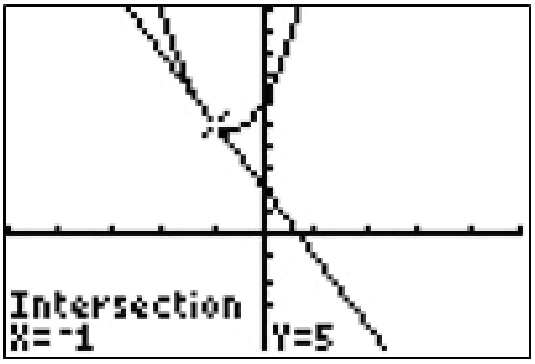
Locate the invariant points, where $y = \pm 1$, as well as the x-intercepts of $f(x)$ (the vertical asymptotes).

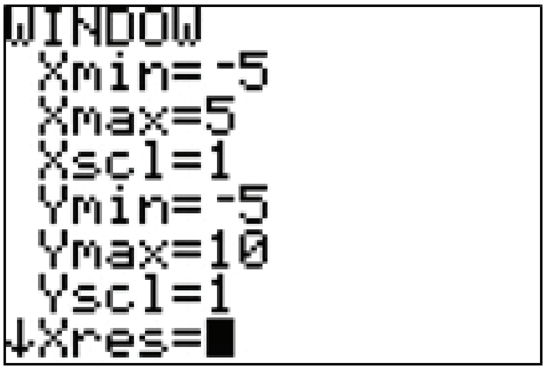
The minimum will be found at $\left(-1.25, \frac{1}{y}\right) = \left(-1.25, \frac{1}{-0.16}\right) = (-1.25, -6.25)$.

Graphing $f(x)$ is done by drawing a smooth curve through the invariant points, x-intercepts, and the minimum point (vertex).

Unit 7: Equations and Inequalities Solutions

1. a. $\begin{cases} y = 2 - 3x \\ y = 3x^2 + 4x + 6 \end{cases}$





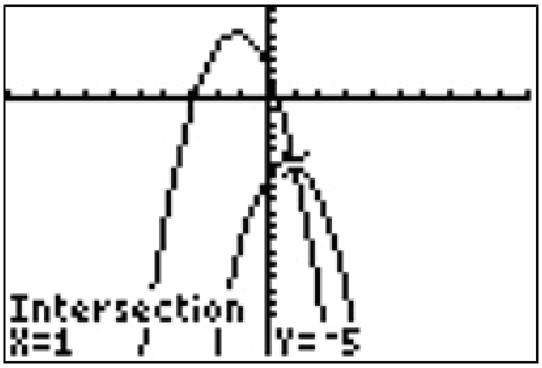
Verify $(-1, 5)$.

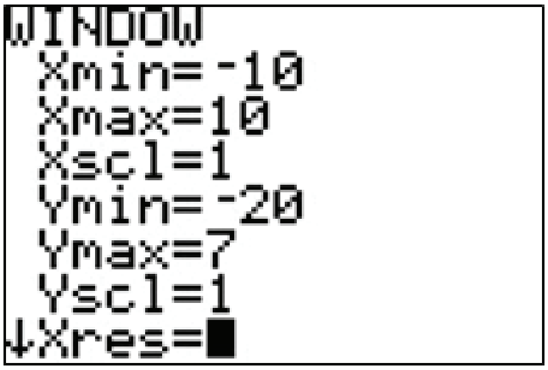
Left Side	Right Side
$-y + 2$	$3x$
$-(5) + 2$	$3(-1)$
-3	-3
LS = RS	

Left Side	Right Side
$3x^2 + 4x$	$-6 + y$
$3(-1)^2 + 4(-1)$	$-6 + (5)$
$3 - 4$	-1
-1	
LS = RS	

The solution to the system is (–1, 5).

b. $\begin{cases} y = 2 - 2x^2 - 5x \\ y = 3x - 2x^2 - 6 \end{cases}$





Verify $(1, -5)$.

Left Side	Right Side
2	$2x^2 + 5x + y$
	$2(1)^2 + 5(1) - 5$
	$2 + 5 - 5$
	2
LS = RS	

Left Side	Right Side
$3x - y$	$2x^2 + 6$
$3(1) - (-5)$	$2(1)^2 + 6$
$3 + 5$	$2 + 6$
8	8
LS = RS	

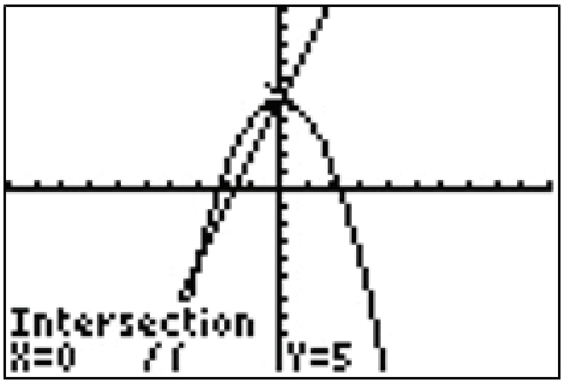
The solution to the system is (1, –5).

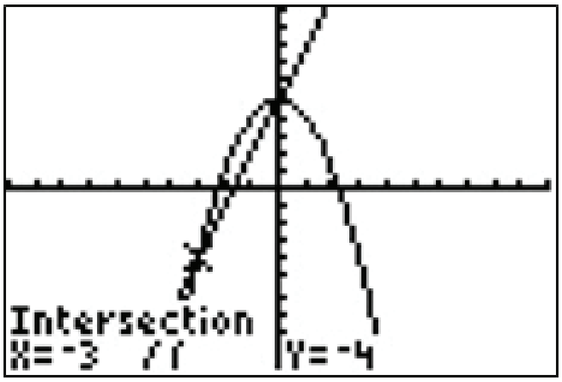
2. a. $\begin{cases} y = 3x + 5 \\ y = -x^2 + 5 \end{cases}$

$$3x + 5 = -x^2 + 5$$
$$x^2 + 3x = 0$$
$$x(x + 3) = 0$$
$$x = 0, -3$$

For $x = 0$:
$y = 3x + 5$
$y = 3(0) + 5$
$y = 5$

For $x = -3$:
$y = 3x + 5$
$y = 3(-3) + 5$
$y = -4$





The two solutions are $(0, 5)$ and $(-3, -4)$.

b. $x^2 - x - 5 = -x^2 - 8x + 4$

$$2x^2 + 7x - 9 = 0$$

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

$$x = \frac{-7 \pm \sqrt{(7)^2 - 4(2)(-9)}}{2(2)}$$

$$x = \frac{-7 \pm \sqrt{121}}{4}$$

$$x = \frac{-7 \pm 11}{4}$$

$$x = 1, -\frac{9}{2}$$

For $x = 1$:

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

$$y = (1)^2 - (1) - 5$$

$$y = -5$$

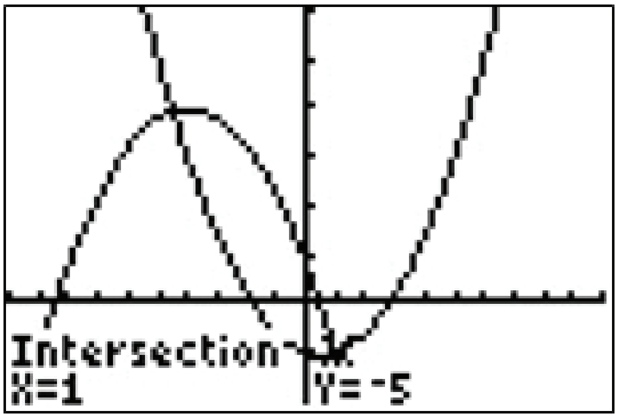
For $x = -\frac{9}{2}$:

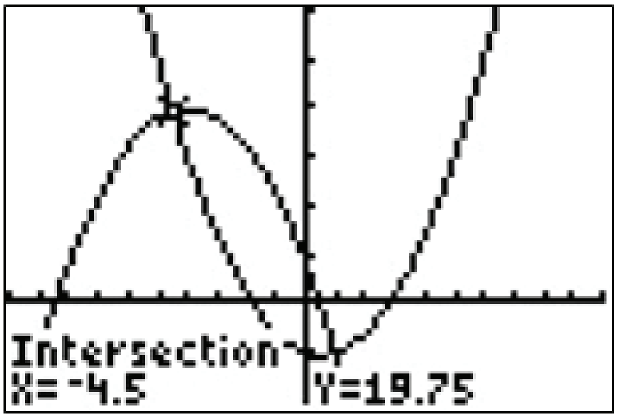
$$y = x^2 - x - 5$$

$$y = \left(-\frac{9}{2}\right)^2 - \left(-\frac{9}{2}\right) - 5$$

$$y = \frac{81}{4} - \frac{1}{2}$$

$$y = \frac{79}{4} = 19.75$$





The two solutions are $(1, -5)$ and $\left(-\frac{9}{2}, \frac{79}{4}\right)$.

3. a. Start by equating the two functions and simplifying.

$$kx^2 + 3x - 4 = -x + 6$$
$$kx^2 + 4x - 10 = 0$$

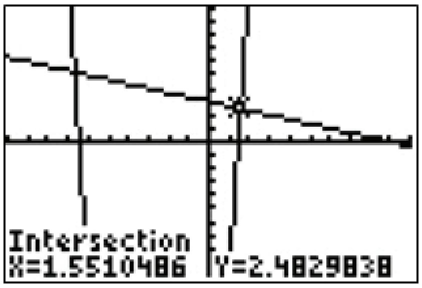
If this new equation has two zeros, then the discriminant will be greater than zero.

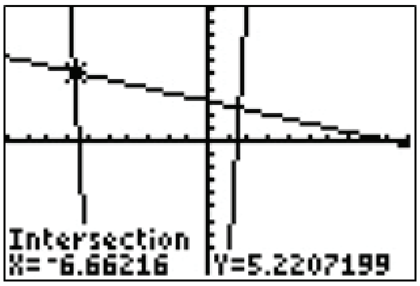
$$b^2 - 4ac > 0$$
$$(4)^2 - 4(k)(-10) > 0$$
$$16 + 40k > 0$$
$$40k > -16$$
$$k > -\frac{16}{40}$$
$$k > -\frac{2}{5}$$

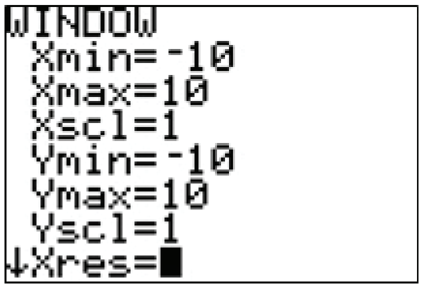
b. For this case, the discriminant must equal zero. Therefore, $k = -\frac{2}{5}$.

c. For this case, the discriminant must be less than zero. Therefore, $k < -\frac{2}{5}$.

4. This question is most easily answered using technology.



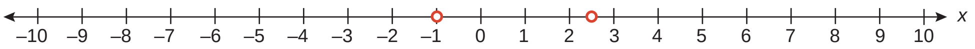




The two wells should be dug at approximately (1.55, 2.48) and (–6.66, 5.22).

5. Start by factoring.

$$\begin{aligned} -2x^2+3x+5&=0\\ -(2x^2-3x-5)&=0\\ -(2x-5)(x+1)&=0\\ x&=\frac{5}{2},-1 \end{aligned}$$



Use test points for the ranges: less than –1, between -1 and $\frac{5}{2}$, and greater than $\frac{5}{2}$.

For $x<-1$, try $x=-2$:

Left Side	Right Side
$-2x^2+3x+5$ $-2(-2)^2+3(-2)+5$ $-8-6+5$ -9	0
LS < RS	

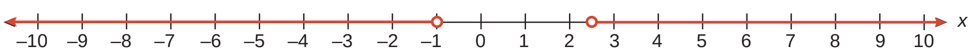
For $-1<x<\frac{5}{2}$, try $x=0$:

Left Side	Right Side
$-2x^2+3x+5$ $-2(0)^2+3(0)+5$ 5	0
LS > RS	

For $x>\frac{5}{2}$, try $x=3$:

Left Side	Right Side
$-2x^2+3x+5$ $-2(3)^2+3(3)+5$ $-18+9+5$ -4	0
LS < RS	

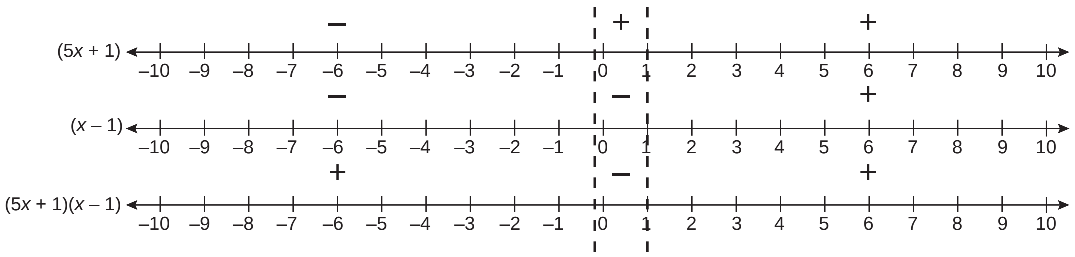
Therefore, the solution is $\left\{x \mid x<-1 \text{ and } x>\frac{5}{2}, x\in \mathrm{R}\right\}$.



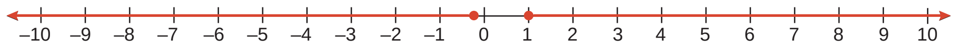
6. Start by factoring.

$$10x^2 - 8x - 2 \geq 0$$
$$2(5x^2 - 4x - 1) \geq 0$$
$$2(5x + 1)(x - 1) \geq 0$$

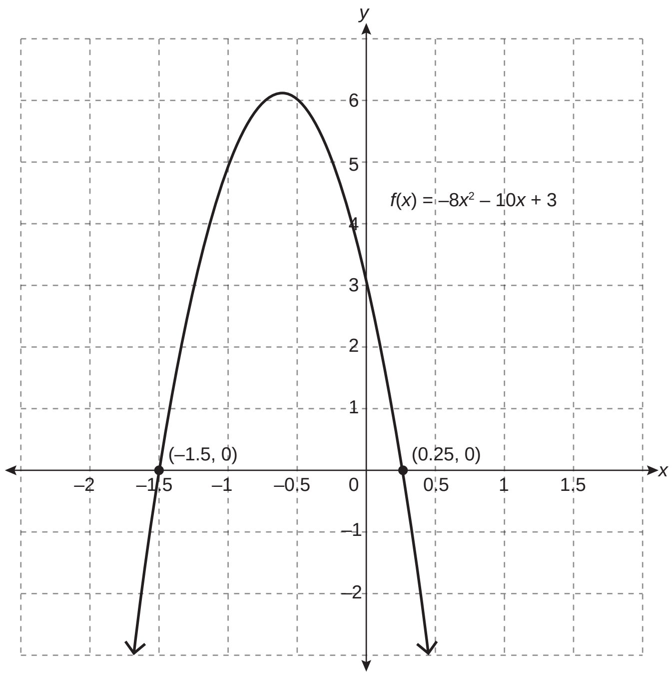
For each factor, determine the intervals where it is positive and negative, and then where the product of the two factors is positive and negative.



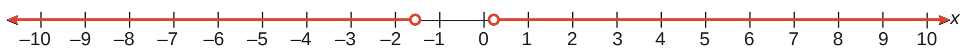
Therefore, the solution to this inequality is $\left\{x \mid x \leq -\frac{1}{5} \text{ and } x \geq 1, x \in \mathrm{R}\right\}$.



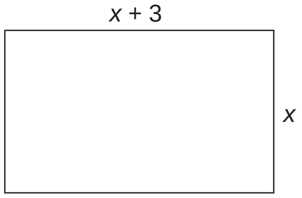
7.



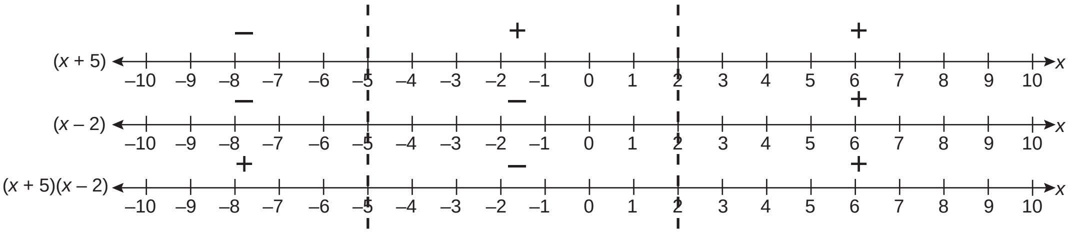
The regions of the graph that are below zero are $\{x \mid x < -1.5 \text{ and } x > 0.25, x \in \mathrm{R}\}$.



8. First, sketch the diagram.

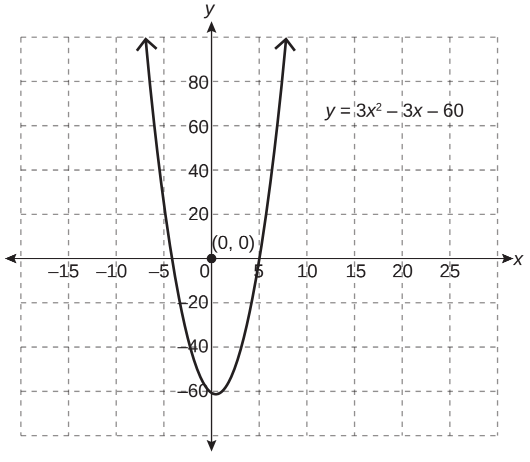


$$lw = A$$
$$(x+3)(x) \geq 10,\ x > 0$$
$$x^2 + 3x - 10 \geq 0$$
$$(x+5)(x-2) \geq 0$$



Because length and width must be greater than zero, the values less than –5 can be disregarded. The solution is $\{x \mid x \geq 2,\ x \in \mathrm{R}\}$.

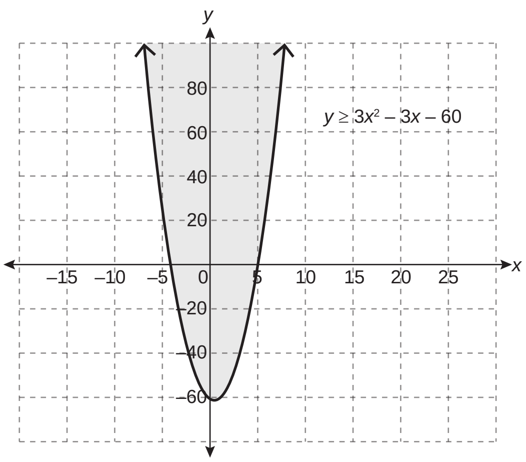
9. a. Sketch the curve using a solid line because the inequality is not strict.



Use the test point $(0, 0)$ to determine which side of the curve to shade.

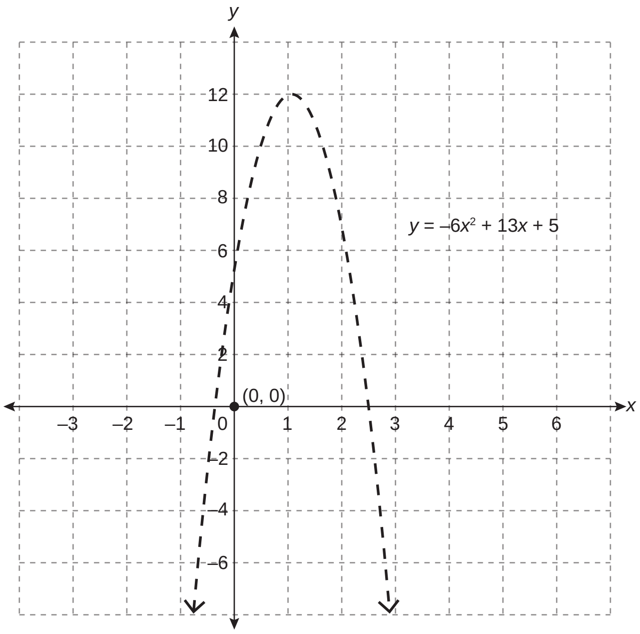
Left Side	Right Side
y	$3x^2 - 3x - 60$
0	$3(0)^2 - 3(0) - 60$
	-60
LS > RS	

The point (0, 0) is included in the solution region; therefore, shade above the curve.



Point $(-3, 1)$ is within the shaded region; therefore, it is a solution to the inequality.

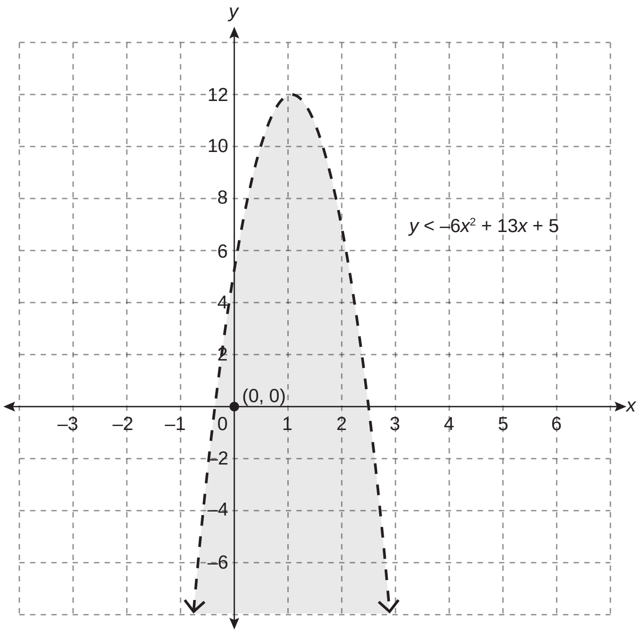
b. Sketch the curve using a dashed line because the inequality is strict.



Use the test point $(0, 0)$ to determine which side of the curve to shade.

Left Side	**Right Side**
y	$-6x^2 + 13x + 5$
0	$-6(0)^2 + 13(0) + 5$
	5
LS < RS	

The point (0, 0) is included in the solution region; therefore, shade below the curve.



Point $(-3, 1)$ is not within the shaded region; therefore, it is not a solution to the inequality.

10. a. The equation of the boundary line can be found using two points, $(0, -6)$ and $(-3, 0)$.

$$m = \frac{0-(-6)}{-3-0}$$
$$m = \frac{6}{-3}$$
$$m = -2$$

$$y = mx + b$$
$$y = -2x - 6$$

Because the boundary line is dashed, it is not included in the solution. Also, the graph is shaded below the line; therefore, the solution is less than the line.

$$y < -2x - 6$$

b. The equation of the boundary curve can be determined using the vertex, $(3, 1)$, and another point on the curve, $(0, 10)$.

$$y = a(x-p)^2 + q$$
$$10 = a(0-3)^2 + 1$$
$$9 = 9a$$
$$1 = a$$

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

The curve is solid and shaded above; therefore, the inequality is

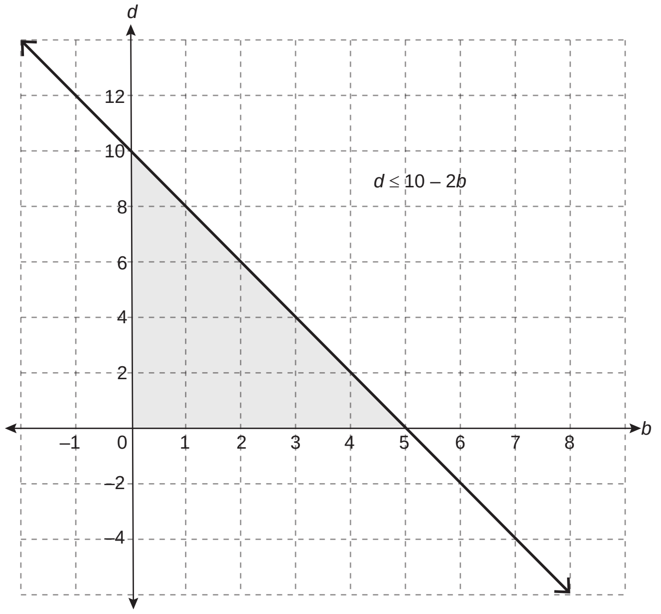
$y \geq (x-3)^2 + 1$ or $y \geq x^2 - 6x + 10$

11. a. $5d + 10b \leq 50$
$b > 0$
$d > 0$

b. $5d + 10b \leq 50$

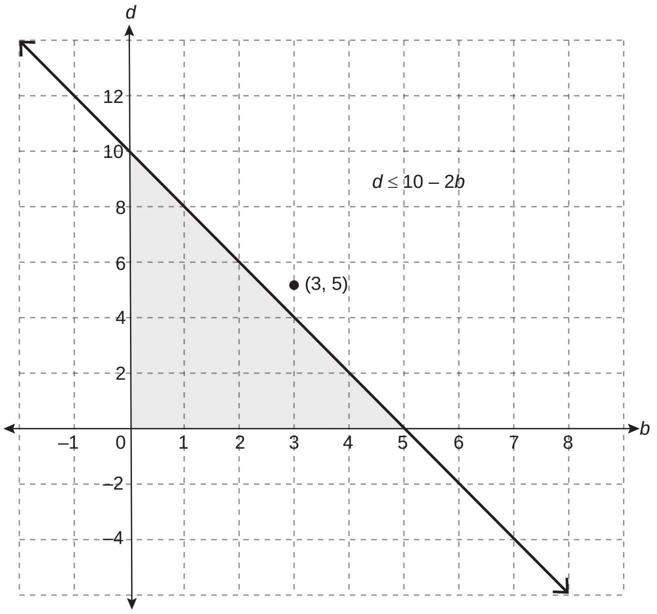
$$5d \leq 50 - 10b$$

$$d \leq 10 - 2b$$



c. Note that both *b* and *d* must be greater than or equal to zero.
Answers will vary.
Some examples are 5 Blu-Ray Discs and 0 DVDs, 10 DVDs and 0 Blu-Ray Discs, 2 Blu-Ray Discs and 2 DVDs, or any pair of values shaded in Quadrant I.

d. You can either substitute $d = 5$ and $b = 3$ into the inequality, or you can use the graph to solve this question.



Either way, this purchase is outside of the shaded area; therefore, it is not possible for Juno to purchase 5 DVDs and 3 Blu-Ray Discs with $50.00.

STOP After all the required components of *Units 1 to 8* have been completed, marked, and returned to you, please review the concepts. Contact your teacher to discuss any concepts that you are unsure about. When you are ready, contact your exam supervisor or your local ADLC campus to schedule an appointment to write the Final Exam. STOP

Mathematics 20-1 Formula Sheet

Sequences and Series

Arithmetic Sequence	Geometric Sequence
$t_n = t_1 + (n-1)d$	$t_n = t_1 r^{n-1}$
Arithmetic Series	**Geometric Series**
$S_n = \frac{n(t_1 + t_n)}{2}$ $S_n = \frac{n}{2}[2t_1 + (n-1)d]$	$S_n = \frac{t_1(r^n - 1)}{r - 1}$ $S_n = \frac{rt_n - t_1}{r - 1}$
	Convergent Geometric Series
	$S_\infty = \frac{t_1}{1 - r}$

Quadratic Functions and Equations

Vertex Form	Quadratic Formula
$f(x) = a(x-p)^2 + q$	$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$
Standard Form	**Discriminant**
$f(x) = ax^2 + bx + c$	$b^2 - 4ac$

Trigonometry

Primary Trigonometric Ratios	Cosine Law
$\sin\theta = \frac{\text{opposite}}{\text{hypotenuse}}$ $\cos\theta = \frac{\text{adjacent}}{\text{hypotenuse}}$ $\tan\theta = \frac{\text{opposite}}{\text{adjacent}}$	$a^2 = b^2 + c^2 - 2bc\cos A$ $b^2 = a^2 + c^2 - 2ac\cos B$ $c^2 = a^2 + b^2 - 2ab\cos C$ $\cos A = \frac{b^2 + c^2 - a^2}{2bc}$ $\cos B = \frac{a^2 + c^2 - b^2}{2ac}$ $\cos C = \frac{a^2 + b^2 - c^2}{2ab}$
Pythagorean Theorem	**Sine Law**
$a^2 + b^2 = c^2$ $(\text{leg}_1)^2 + (\text{leg}_2)^2 = (\text{hypotenuse})^2$	$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$ $\frac{\sin A}{a} = \frac{\sin B}{b} = \frac{\sin C}{c}$

Rational Expressions and Equations

Distance, Speed, and Time		
$d = st$ $s = \frac{d}{t}$ $t = \frac{d}{s}$	**OR**	$\text{distance} = \text{speed} \cdot \text{time}$ $\text{speed} = \frac{\text{distance}}{\text{time}}$ $\text{time} = \frac{\text{distance}}{\text{speed}}$

Work Problems

$$\frac{1}{\text{time taken by } A} + \frac{1}{\text{time taken by } B} + \frac{1}{\text{time taken by } C} = \frac{1}{\text{time taken by } A,\ B,\ \text{and } C \text{ together}}$$

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