Here are the exams I wrote when teaching Math 115 in Fall 2018 at Ferris State University. Each exam is followed by its solutions.

Fall 2018 Exam 1

1. (a) Find the slope of the line passing through the points $(2, -5)$ and $(6, 3)$.
   (b) Find the slope of the line whose general equation is $3x - 5y = 30$.
   (c) Write an equation of the line passing through the point $(-1, -5)$ whose slope is 8.
   (d) Write an equation of the horizontal line passing through the point $(3, -1)$.
   (e) Suppose two lines are perpendicular. If the first line has slope -3, what is the slope of the second line?
2. (a) Sketch the graph of the line $4x - 3y = 12$.
   (b) Sketch the graph of the line $y = 4 + \frac{1}{4}(x + 5)$.
3. Solve each equation:
   (a) $4(x + 2) - 9 = 5(2x + 1)$
   (b) $|x + 4| = 9$
   (c) $ax + b = c(x + d)$
   Note: in this problem, solve for x in terms of the other variables
4. Solve each system:
   (a)
   $$\begin{cases} 3x + 7y &= 5 \\ 5x + 2y &= 18 \end{cases}$$
   (b)
   $$\begin{cases} x &= 2y - 3 \\ 2x - y &= 3 \end{cases}$$
5. Solve the following system:
   $$\begin{cases} x + y + z &= -3 \\ 2x - y + 3z &= -14 \\ 3x + 4y + 2z &= -3 \end{cases}$$
6. (a) A restaurant sells hot dogs. The restaurant incurs fixed costs of $\$240$, and it costs the restaurant $\$2$ to produce each hot dog. If the restaurant sells their hot dogs at $\$5$ each, how many hot dogs do they need to sell to break even?
   (b) A movie theater sells adult tickets at $\$10$ each and child tickets at $\$6$ each. If the theater sells 65 tickets and generates revenue of $\$490$, how many adult tickets were sold?

Fall 2018 Exam 1 - Solutions

1. (a) $m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{3-(-5)}{6-2} = \frac{8}{8} = 1$.

   (b) Solve the equation for y: first subtract $3x$ from both sides to get $-5y = -3x + 30$; then divide by -5 to get $y = \frac{3}{5}x - 6$. Thus the slope is $\frac{3}{5}$.

   (c) From the point-slope equation $y = y_0 + m(x - x_0)$, we get $y = -5 + 8(x - (-1))$, i.e. $y = -5 + 8(x+1)$.

   (d) Horizontal lines have equation $y = constant$, so this line must have equation $y = -1$.

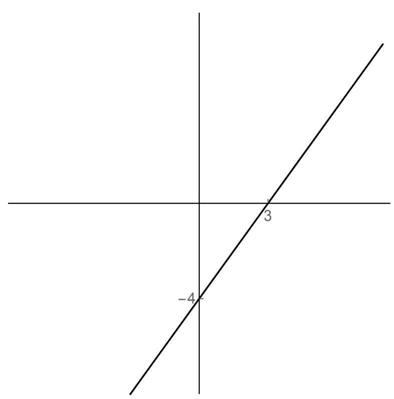
   (e) The slopes are negative reciprocals, so the other line has slope $\frac{1}{3}$.

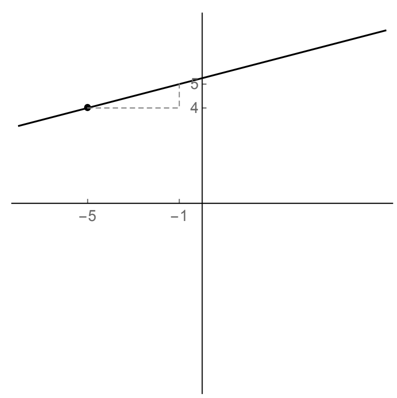
2. (a) The $x-$intercept can be found by setting $y = 0$: $4x - 3(0) = 12$ leads to $x = 3$, so the x-int is $(3, 0)$.

   The y-intercept can be found by setting $x = 0$: $4(0) - 3y = 12$ leads to $y = -4$, so the y-int is $(0, -4)$.

   Plot these two intercepts, then connect to get the graph shown below at left:

   (b) Using the point-slope equation, this graph goes through $(-5, 4)$ and has slope $\frac{1}{4}$. Therefore you get the graph shown below at right.





3. (a) Distribute on both sides to get $4x + 8 - 9 = 10x + 5$, then combine like terms to get $4x - 1 = 10x + 5$. Combine the x-terms on the left and the constants on the right to get $-6x = 6$, then divide by -6 to get $x = -1$.

   (b) $|x+4| = 9$ means $x + 4 = \pm 9$. Subtract 4 from both sides to get $x = \pm 9 - 4$. The two solutions are therefore $x = 9 - 4 = 5$ and $x = -9 - 4 = -13$.

   (c) Distribute on the right-hand side to get $ax + b = cx + cd$; then combine the x-terms on the left and the constants on the right to get $ax - cx = cd - b$; then factor the left to get $x(a - c) = cd - b$ and divide to get $x = \frac{cd-b}{a-c}$.

4. (a) Multiply the equations by constants to eliminate the x:

$$\begin{cases} 3x + 7y &= 5 \\ 5x + 2y &= 18 \end{cases} \begin{matrix} \xrightarrow{\times 5} \\ \xrightarrow{\times -3} \end{matrix} \begin{cases} 15x + 35y &= 25 \\ -15x - 6y &= -54 \end{cases}$$

Then add the equations on the right to get $29y = -29$, i.e $y = -1$. Back-substitute into the first equation to get $3x + 7(-1) = 5$, i.e. $3x - 7 = 5$, i.e. $3x = 12$, i.e. $x = 4$. This gives the answer $(4, -1)$.

(b) Substitute the first equation into the second to get $2(2y - 3) - y = 3$, i.e. $4y - 6 - y = 3$, i.e. $3y - 6 = 3$, i.e. $3y = 9$, i.e. $y = 3$. Back-substitute into the first equation to get $x = 2(3) - 3 = 3$, so the answer is $(3, 3)$.

5. Multiply pairs of these equations by constants to eliminate x:

$$\left\{\begin{array}{ll} 2x + 2y + 2z & = -6 \\ -2x + y - 3z & = 14 \end{array}\right. \begin{array}{c} \overset{\times 3}{\longleftarrow} \\ \overset{\times -1}{\longleftarrow} \end{array} \left\{\begin{array}{ll} x + y + z & = -3 \\ 2x - y + 3z & = -14 \\ 3x + 4y + 2z & = -3 \end{array}\right. \begin{array}{c} \overset{\times 3}{\longrightarrow} \\ \\ \overset{\times -1}{\longrightarrow} \end{array} \left\{\begin{array}{ll} 3x + 3y + 3z & = -9 \\ \\ -3x - 4y - 2z & = 3 \end{array}\right.$$

Add the equations on the left to get $3y - z = 8$; add the equations on the right to get $-y + z = -6$. Then add these two equations to eliminate the z to get $2y = 2$, i.e. $y = 1$. Back-substitute into $-y + z = -6$ to get $z = -5$, then back-substitute into an original equation to get $x = 1$. Thus the answer is $(1, 1, -5)$.

6. (a) The restaurant makes $5 - 2 = 3$ dollars profit on each hot dog. Since their fixed costs are 240, their profit y is $y = 3x - 240$ where x is the number of hot dogs sold. To find the break even point, set $y = 0$ and solve for x: $0 = 3x - 240$ implies $x = 80$ hot dogs.

(b) Let x be the number of adult tickets sold and let y be the number of child tickets sold. From the given information in the problem, we have the system of equations at left below:

$$\left\{\begin{array}{ll} x + y & = 65 \\ 10x + 6y & = 490 \end{array}\right. \begin{array}{c} \overset{\times -10}{\longrightarrow} \\ \overset{\times 1}{\longrightarrow} \end{array} \left\{\begin{array}{ll} -10x - 10y & = -650 \\ 10x + 6y & = 490 \end{array}\right.$$

Adding the equations gives $-4y = -160$, i.e. $y = 40$. Back-substituting, we get $x = 25$ which is the number of adult tickets sold.

Fall 2018 Exam 2

1. Classify each statement as true or false:

(a) $\sqrt{x+y} = \sqrt{x} + \sqrt{y}$

(b) $\sqrt{x-y} = \sqrt{x} - \sqrt{y}$

(c) $\sqrt{xy} = \sqrt{x}\,\sqrt{y}$

(d) $\sqrt{\frac{x}{y}} = \frac{\sqrt{x}}{\sqrt{y}}$

(e) $\sqrt{x^2} = x$

(f) $\sqrt[3]{x^3} = x$

(g) $\sqrt{x^2+y^2} = x + y$

(h) $\left(\sqrt{x}\right)^2 = x$

2. Simplify/reduce each radical (writing as a complex number if necessary), and combine like terms:

(a) $\sqrt{18}$

(b) $\sqrt{400}$

(c) $3\sqrt{-49}$

(d) $\sqrt{20} + 3\sqrt{45}$

(e) $2\sqrt{40} - \sqrt{200} + \sqrt{90} + 8\sqrt{32}$

3. Factor each expression completely:

(a) $x^2 - 9x + 14$

(b) $4x^2 - 12x - 280$

(c) $3x^2 - 10x + 8$

(d) $x^3 - x^2 - 12x$

4. Solve each equation, simplifying your answer(s) and writing them as complex numbers if necessary:

(a) $2x^2 = 48$

(b) $x^2 + 2x - 15 = 0$

(c) $x^2 - 10x + 17 = 0$

(d) $x^2 + 25 = 6x$

5. Perform the indicated operations:

(a) $(2x^2 - 3x + 4)(x - 2)$

(b) $(x^3 + 3x - 8) - (2x^2 - 4x + 1)$

6. Consider the parabola whose equation is $y = 2x^2 - 12x - 32$.

(a) Find the x-intercept(s) of this parabola. If there aren't any, say so (with justification).

(b) Find the y-intercept(s) of this parabola.

(c) Find the coordinates of the vertex of this parabola.

(d) Sketch a crude graph of this parabola below. (To be eligible for credit on this part, you have to have done parts (a)-(c) correctly.)

Fall 2018 Exam 2 - Solutions

1. (a) FALSE
   (b) FALSE
   (c) TRUE
   (d) TRUE
   (e) FALSE ($\sqrt{x^2} = |x|$, not x)
   (f) TRUE
   (g) FALSE
   (h) TRUE

2. (a) $\sqrt{18} = \sqrt{9}\sqrt{2} = 3\sqrt{2}$.
   (b) $\sqrt{400} = 20$.
   (c) $3\sqrt{-49} = \sqrt{49}\sqrt{-1} = 7i$.
   (d) $\sqrt{20} + 3\sqrt{45} = \sqrt{5}\sqrt{4} + 3\sqrt{9}\sqrt{5} = 2\sqrt{5} + 3 \cdot 3\sqrt{5} = 2\sqrt{5} + 9\sqrt{5} = 11\sqrt{5}$.
   (e) $2\sqrt{40} - \sqrt{200} + \sqrt{90} + 8\sqrt{32} = 2\sqrt{4}\sqrt{10} - \sqrt{100}\sqrt{2} + \sqrt{9}\sqrt{10} = 2 \cdot 2\sqrt{10} - 10\sqrt{2} + 3\sqrt{10} = 7\sqrt{10} - 10\sqrt{2}$.

3. (a) $x^2 - 9x + 14 = (x-7)(x-2)$
   (b) $4x^2 - 12x - 280 = 4(x^2 - 3x - 70) = 4(x-10)(x+7)$
   (c) $3x^2 - 10x + 8 = (3x-2)(x-4)$
   (d) $x^3 - x^2 - 12x = x(x^2 - x - 12) = x(x-4)(x+3)$

4. (a) Divide both sides by 2 to get $x^2 = 24$, then take square roots to get $x = \pm\sqrt{24} = \pm 2\sqrt{6}$.
   (b) Factor to get $(x+5)(x-3) = 0$; we get $x + 5 = 0$ or $x - 3 = 0$, so $x = -5$ or $x = 3$.
   (c) Use the quadratic formula with $a = 1$, $b = -10$, $c = 17$ to get

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} = \frac{10 \pm \sqrt{100 - 4(1)(17)}}{2} = \frac{10 \pm \sqrt{32}}{2} = \frac{10 \pm 4\sqrt{2}}{2} = 5 \pm 2\sqrt{2}.$$

   (d) Move the $6x$ over to get $x^2 - 6x + 25 = 0$, then use the quadratic formula to get

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} = \frac{6 \pm \sqrt{36 - 4(25)}}{2} = \frac{6 \pm \sqrt{-64}}{2} = \frac{6 \pm 8i}{2} = 3 \pm 4i.$$

5. (a) FOIL and combine like terms to get $(2x^2 - 3x + 4)(x - 2) = 2x^3 - 4x^2 - 3x^2 + 6x + 4x - 8 = 2x^3 - 7x^2 + 10x - 8$.
   (b) Subtract like terms to get $(x^3 + 3x - 8) - (2x^2 - 4x + 1) = x^3 - 2x^2 + 7x - 9$.

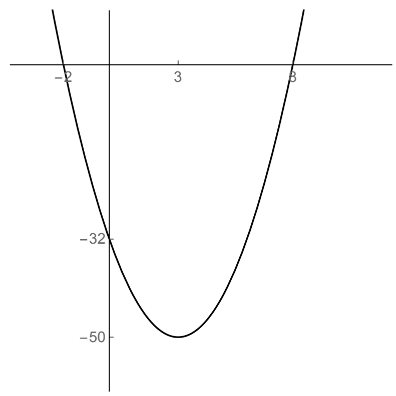
6. (14 pts) Consider the parabola whose equation is $y = 2x^2 - 12x - 32$.

   (a) Set $y = 0$ and solve for x: $0 = 2x^2 - 12x - 32 = 2(x^2 - 6x - 16) = 2(x-8)(x+2)$ so the x-ints are when $x - 8 = 0$ and $x + 2 = 0$, i.e. $x = 8$ and $x = -2$. These are the points $(8, 0)$ and $(-2, 0)$.

(b) Set $x = 0$ and find y: $y = 2(0) - 12(0) - 32 = -32$; this is the point $(0, -32)$.

(c) The x-coordinate of the vertex is h, the average of the x-intercepts: $h = \frac{1}{2}(8 + (-2)) = \frac{1}{2}(6) = 3$. The y-coordinate k is what you get when you plug in h for x: $y = 2(3)^2 - 12(3) - 32 = 18 - 36 - 32 = -50$. So the vertex is $(h, k) = (3, -50)$.

(d) Plot the points obtained in (a), (b) and (c) and connect to make a parabola:

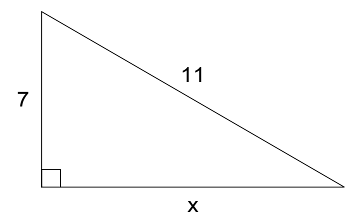


Fall 2018 Exam 3

1. Rewrite each expression so that it has the form $\Box x^{\Box}$, where the squares represent numbers:

   (a) $2x^2 \cdot 3x^8$
   (b) $(2x^5)^3$
   (c) $\frac{1}{x^4}$
   (d) $\frac{3}{\sqrt{x}}$
   (e) $\sqrt{100x}$

2. Find the value of x, if x is as indicated in the following picture:



3. (a) Perform the indicated operations and simplify:
$$(5\sqrt{x}+2x)(7\sqrt{x}-4)$$
   (b) Find the distance between the points $(6,2)$ and $(-3,-5)$.
   (c) Write the following expression in logarithmic form: $3^c = d$
   (d) Write the following expression in exponential form: $\ln 5 = y$
   (e) Write the following expression in exponential form: $\log_v 27 = w - 1$

4. Evaluate each expression:

   (a) $\log_5 25$
   (b) $\log_2 64$
   (c) $\log_{1/2} 8$
   (d) $\log_7 \frac{1}{49}$
   (e) $\log_4 2^{14}$
   (f) $6^{\log_6 54}$
   (g) $\log_9 3$
   (h) $\log_{60} 1$

5. Solve each of these equations:

   (a) $4 \cdot e^x = 24$
   (b) $\log_x 9 = 2$
   (c) $4\log_3(x-2) = 8$
   (d) $\log_4(x+3) + \log_4(x-3) = 2$

6. A scientist is studying a new kind of bacteria. She initially places 300 bacteria into a petri dish; five hours later, there are 835 bacteria in the petri dish. Assuming that the number of bacteria grows according to an exponential model:

   (a) Find the number of bacteria that will be in the dish seven hours after the start of the experiment.
   (b) How long will it take for there to be 2150 bacteria in the dish?

Fall 2018 Exam 3 - Solutions

1. (a) $2x^2 \cdot 3x^8 = 6x^{10}$.
   (b) $(2x^5)^3 = 8x^{15}$.
   (c) $\frac{1}{x^4} = x^{-4}$.
   (d) $\frac{3}{\sqrt{x}} = 3x^{-1/2}$.
   (e) $\sqrt{100x} = 10x^{1/2}$.

2. Use the Pythagorean Theorem:

$$\begin{aligned} x^2 + 7^2 &= 11^2 \\ x^2 + 49 &= 121 \\ x^2 &= 72 \\ x &= \sqrt{72} \approx 8.48. \end{aligned}$$

3. (a) FOIL and combine like terms:

$$\begin{aligned} (5\sqrt{x} + 2x)(7\sqrt{x} - 4) &= 35x - 20\sqrt{x} + 14x\sqrt{x} - 8x \\ &= 27x - 20\sqrt{x} + 14x^{3/2}. \end{aligned}$$

   (b) Use the distance formula:

$$\begin{aligned} D &= \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2} \\ &= \sqrt{(-5-2)^2 + (-3-6)^2} \\ &= \sqrt{(-7)^2 + (-9)^2} \\ &= \sqrt{49 + 81} \\ &= \sqrt{130} \approx 11.4. \end{aligned}$$

   (c) $\log_3 d = c$
   (d) $e^y = 5$
   (e) $v^{w-1} = 27$

4. (a) $\log_5 25 = 2$ since $5^2 = 25$.
   (b) $\log_2 64 = 6$ since $2^6 = 64$.
   (c) $\log_{1/2} 8 = -3$ since $\left(\frac{1}{2}\right)^{-3} = 2^3 = 8$.
   (d) $\log_7 \frac{1}{49} = -2$ since $7^{-2} = \frac{1}{7^2} = \frac{1}{49}$.
   (e) $\log_4 2^{14} = 14$ by cancellation.
   (f) $6^{\log_6 54} = 54$ by cancellation.
   (g) $\log_9 3 = \frac{1}{2}$ since $9^{1/2} = \sqrt{9} = 3$.
   (h) $\log_{60} 1 = 0$ since $60^0 = 1$.

5. (a) First, divide by 4 to get $e^x = 6$. Then rewrite as a logarithm to get $x = \ln 6$.

(b) Rewrite in exponential form as $x^2 = 9$; take square root of both sides to get $x = \pm 3$. But since x is the base of a logarithm, x must be positive, so $x = 3$.

(c) Divide both sides by 4 to get $\log_3(x-2) = 2$. Then rewrite as an exponential to get $3^2 = x - 2$, i.e. $9 = x - 2$. Add 2 to both sides to get $x = 11$.

(d) Combine the logs using a log rule, then rewrite in exponential form:

$$\begin{aligned} \log_4(x+3) + \log_4(x-3) &= 2 \\ \log_4\left[(x+3)(x-3)\right] &= 2 \\ (x+3)(x-3) &= 4^2 \\ x^2 - 9 &= 16 \\ x^2 - 25 &= 0 \\ (x-5)(x+5) &= 0 \end{aligned}$$

Therefore $x = 5$ or $x = -5$. But $x = -5$ doesn't check (since you'd have to take a logarithm of a negative number in the original equation), so $x = 5$ is the only solution.

6. (a) Start with the exponential model equation $y = y_0 \cdot b^x$; y_0 is the initial number of bacteria which is 300. We are told that $y = 835$ when $x = 5$, so plug those numbers in and solve for b:

$$\begin{aligned} 835 &= 300 \cdot b^5 \\ \frac{835}{300} &= b^5 \\ \sqrt[5]{\frac{835}{500}} &= b \\ 1.108 &= b \end{aligned}$$

Then, to solve the problem, let $x = 7$ and solve for y:

$$y = 300 \cdot 1.1.08^7 \approx 615.$$

(b) Continuing with the same equation, we let $y = 2150$ and solve for x:

$$\begin{aligned} 2150 &= 300 \cdot 1.108^x \\ \frac{2150}{300} &= 1.108^x \\ 7.166 &= 1.108^x \\ \log_{1.108} 7.166 &= x \end{aligned}$$

To get a decimal approximation to x, use the change of base formula:

$$x = \frac{\log 7.166}{\log 1.108} \approx 19.2.$$

Fall 2018 Final Exam

1. (a) Find the slope of the line passing through the points $(5,1)$ and $(17,9)$.
   (b) Write the equation of the line that passes through the points $(3,-4)$ and $(3,5)$.
   (c) Write the equation of the line that passes through the points $(2,-3)$ and $(5,2)$.
   (d) Sketch the graph of the equation $y = 2x - 3$.
   (e) Sketch the graph of the equation $5x + 2y = 20$.

2. Rewrite each expression so that it has the form $\square x^{\square}$, where the squares represent numbers:

   (a) $10x \cdot (2x^2)^4 \cdot 3x^2$
   (b) $x\sqrt[3]{x}$
   (c) $\frac{5}{x^2}$
   (d) $\frac{4x^2}{x^6}$
   (e) $\sqrt{49x^8}$

3. Evaluate each expression:

   (a) $\log_{1/3} \frac{1}{9}$
   (b) $\log_2 32$
   (c) $\log_6 \frac{1}{6^8}$
   (d) $\log 10$
   (e) $\log_{60} 1$

4. Solve each equation. Find exact answers (no decimals) and simplify:

   (a) $3(2x-1) + 7 = 2(x+3)$
   (b) $x^2 - 7x - 44 = 0$
   (c) $4x^2 - 12x + 1 = 0$
   (d) $e^{x-2} = 14$
   (e) $6\log_5(x+9) = 12$

5. Throughout this question, assume $f(x) = 3 - 5x$ and $g(x) = 2x + 5$.

   (a) Compute and simplify $f(-4)$.
   (b) Find all x such that $g(x) = 17$.
   (c) Compute and simplify $(f+g)(x)$.
   (d) Compute and simplify $(g \circ f)(-2)$.
   (e) Compute and simplify $(f \circ g)(x)$.

6. Throughout this question, let math be the function $\text{math}(x) = 2x^2 - x - 4$.

   (a) Compute math $3 + 5$.
   (b) Compute math $5-$ math 4.
   (c) Compute $\text{math}^2 2$.
   (d) Compute 3 math $2 + 1$.
   (e) Compute math $5 \cdot 0$.

7. In each part of this question, you are given a function F. Write an arrow diagram which decomposes F into its elementary components.

   As a worked out example, if $F(x) = e^x + 2$, then the arrow diagram would be $x \xrightarrow{e^x} \xrightarrow{x+2} F(x)$.

   (a) $F(x) = 7\ln(3-2x)$

   (b) $F(x) = |x^2 - 5|$

   (c) $F(x) = \log^2 x^3$

   (d) $F(x) = \sqrt{e^{5x}} + 2$

8. Use log rules to rewrite each expression as a single logarithm:

   (a) $\ln A + \ln B$

   (b) $4\ln x - 3\ln y$

9. Simplify/reduce each radical as much as possible, and combine like terms:

   (a) $\sqrt{12}$

   (b) $3\sqrt{36}$

   (c) $\sqrt{288}$

   (d) $7\sqrt{40} - 2\sqrt{360}$

   (e) $\sqrt{18} - 3\sqrt{2}$

10. Perform the indicated operations and simplify (by combining like terms):

    (a) $2(x-3)(x+7)$

    (b) $(x^2+3x-2)(x-5)$

    (c) $(x^3+3x^2-4x-1) - (x^2-5x-3)$

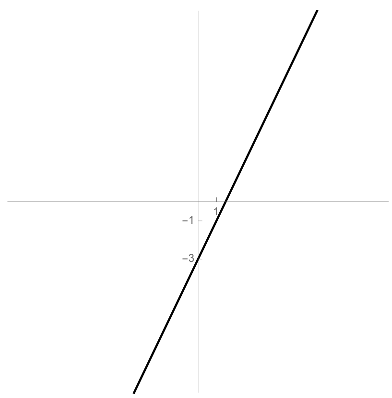
Fall 2018 Final Exam - Solutions

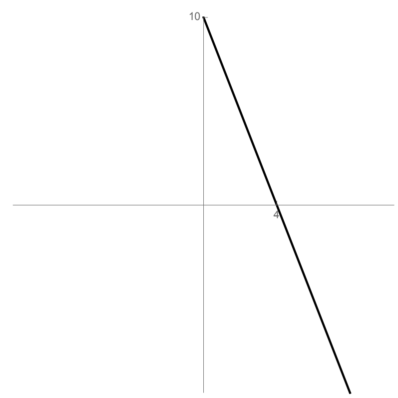
1. (a) $m = \frac{y_2-y_1}{x_2-x_1} = \frac{9-1}{17-5} = \frac{8}{12} = \frac{2}{3}$.

   (b) The slope is $m = \frac{5-(-4)}{3-3} = \frac{9}{0}$ which is undefined; that means the line is vertical and has equation $x =$ a constant; in this problem, the equation must be $x = 3$.

   (c) The slope is $m = \frac{2-(-3)}{5-2} = \frac{5}{3}$, so by the point-slope formula the equation is $y = -3 + \frac{5}{3}(x-2)$ (if you use the other point, you get $y = 2 + \frac{5}{3}(x-5)$).

   (d) This is a line with slope 2 and y-intercept $(0, -3)$ (shown below at left):





   (e) Find the intercepts: first, set $x = 0$ and solve for y to get $5(0) + 2y = 20$, i.e. $2y = 20$, i.e. $y = 10$ (this is the point $(0, 10)$). Second, set $y = 0$ and solve for x to get $5x + 2(0) = 20$, i.e. $5x = 20$, i.e. $x = 4$ (this is the point $(4, 0)$). Connect these points to get the line shown above at right.

2. (a) $10x \cdot (2x^2)^4 \cdot 3x^2 = 10x \cdot 16x^8 \cdot 3x^2 = 480x^{11}$.

   (b) $x\sqrt[3]{x} = xx^{1/3} = x^{1+1/3} = x^{4/3}$.

   (c) $\frac{5}{x^2} = 5x^{-2}$

   (d) $\frac{4x^2}{x^6} = 4x^{4-6} = 4x^{-2}$.

   (e) $\sqrt{49x^8} = (49x^8)^{1/2} = 7x^4$.

3. (a) $\log_{1/3} \frac{1}{9} = 2$ (since $\left(\frac{1}{3}\right)^2 = \frac{1}{9}$).

   (b) $\log_2 32 = 5$ (since $2^5 = 32$).

   (c) $\log_6 \frac{1}{6^8} \log_6 6^{-8} = -8$ by cancellation.

   (d) $\log 10 = 1$ (since $10^1 = 10$).

   (e) $\log_{60} 1 = 0$ (since $60^0 = 1$).

4. (a) Distribute to get $6x - 3 + 7 = 2x + 6$, i.e. $6x + 4 = 2x + 6$. Collect the x-terms on the left and the constant terms on the right to get $4x = 2$; then $x = \frac{2}{4} = \frac{1}{2}$.

(b) Factor to get $(x-11)(x+4)=0$; from the first factor we get $x=11$ and from the second factor we get $x=-4$.

(c) Use the quadratic formula $x=\frac{-b\pm\sqrt{b^2-4ac}}{2a}$ to get

$$x=\frac{12\pm\sqrt{12^2-4(4)(1)}}{2(4)}=\frac{12\pm\sqrt{128}}{8}=\frac{12\pm 8\sqrt{2}}{8}=\frac{3}{2}\pm\sqrt{2}.$$

(d) Rewrite in logarithmic form as $x-2=\ln 14$; then $x=2+\ln 14$.

(e) Divide both sides by 6 to get $\log_5(x+9)=2$. Then rewrite in exponential form as $x+9=5^2=25$; that means $x=25-9=16$.

5. (a) $f(-4)=3-5(-4)=3+20=23$.

(b) $g(x)=17$ means $2x+5=17$, i.e. $2x=12$, i.e. $x=6$.

(c) $(f+g)(x)=f(x)+g(x)=3-5x+2x+5=8-3x$.

(d) $(g\circ f)(-2)=g(f(-2))=g(3-5(-2))=g(3+10)=g(13)=2(13)+5=26+5=31$.

(e) $(f\circ g)(x)=f(g(x))=f(2x+5)=3-5(2x+5)=3-10x-25=-10x-22$.

6. (a) math $3+5=$ math $(3)+5=[2(3^2)-3-4]+5=[18-7]+5=16$.

(b) math $5-$ math $4=[2(5)^2-5-4]-[2(4)^2-4-4]=[50-9]-[32-8]=41-24=17$.

(c) math$^2 2=$ [math $2]^2=[2(2^2)-2-4]^2=[8-6]^2=2^2=4$.

(d) 3 math $2+1=3$[math $2]+1=3[2(2^2)-2-4]+1=3[2]+1=7$.

(e) Compute math $5\cdot 0=$ math $0=2(0^2)-0-4=0-0-4=-4$.

7. (a) $x\xrightarrow{-2x}\xrightarrow{x+3}\xrightarrow{\ln x}\xrightarrow{7x}F(x)$.

(b) $x\xrightarrow{x^2}\xrightarrow{x-5}\xrightarrow{|x|}F(x)$.

(c) $x\xrightarrow{x^3}\xrightarrow{\log_2 x}F(x)$.

(d) $x\xrightarrow{5x}\xrightarrow{e^x}\xrightarrow{\sqrt{x}}\xrightarrow{x+2}F(x)$.

8. (a) The sum of logs is the log of the product: $\ln A+\ln B=\ln AB$.

(b) First, bring the constants inside the logs as exponents, then use the fact that the difference of logs is the log of a quotient: $4\ln x-3\ln y=\ln x^4-\ln y^3=\ln\frac{x^4}{y^3}$.

9. (a) $\sqrt{12}=\sqrt{4\cdot 3}=\sqrt{4}\cdot\sqrt{3}=2\sqrt{3}$.

(b) $3\sqrt{36}=3\cdot 6=18$.

(c) $\sqrt{288}=\sqrt{144\cdot 2}=\sqrt{144}\cdot\sqrt{2}=12\sqrt{2}$.

(d) $7\sqrt{40}-2\sqrt{360}=7\cdot 2\sqrt{10}-2\cdot 6\sqrt{10}=14\sqrt{10}-12\sqrt{10}=2\sqrt{10}$.

(e) $\sqrt{18} - 3\sqrt{2} = 3\sqrt{2} - 3\sqrt{2} = 0$.

10. (a) FOIL to get $2(x-3)(x+7) = (2x-6)(x+7) = 2x(x)+2x(7)-6x-6(7) = 2x^2 + 14x - 6x - 42 = 2x^2 + 8x - 42$.

(b) Distribute to get $(x^2+3x-2)(x-5) = x^2(x) - 5x^2 + 3x^2 - 15x - 2x + 10 = x^3 - 2x^2 - 17x + 10$.

(c) Combine like terms to get $(x^3+3x^2-4x-1)-(x^2-5x-3) = x^3+2x^2+x+2$.