1. a) \(3(x-2)(x+2)(x^2+1)\)
   - Roots (x-intercepts): -2, 2
   - Pt. between -2 & 2: 0
   - @ 0: \((+)(-)(+)(+)(+)<0\)
   - Leading term: \(3x^4\)

b) \(-2(x+2)(x-1)(x-4)\)
   - Roots (x-intercepts): -2, 1, 4
   - Pt. between -2 and 1: 0
   - @ 0: \((-)(+)(-)(-)<0\)
   - Pt. between 1 and 4: 2
   - @ 2: \((-)(+)(+)(-)>0\)
   - Leading term: \(-2x^3\)

c) \(x(x+1)(x^2+4)\)
   - Roots (x-intercepts): -1, 0
   - Pt. between -1 & 0: \(-\frac{1}{2}\)
   - @ \(-\frac{1}{2}\): \((-)(+)(+)<0\)
   - Leading term: \(x^5\)

d) \(-2(x+3)(x+1)(x-1)(x-5)(x^2+1)\)
   - Roots (x-intercepts): -3, -1, 1, 5
   - Pt. between -3 & -1: -2
   - @ -2: \((-)(+)(-)(-)(-)<0\)
   - Pt. between -1 & 1: 0
   - @ 0: \((-)(+)(+)(-)(+)>0\)
   - Pt. between 1 & 5: 3
   - @ 3: \((-)(+)(+)(+)(-)>0\)
   - Leading term: \(-2x^6\)

2. a) \(-2x^3+6x^2-2x+6\)
   - Factors of 6: 1, 2, 3, 6, -1, -2, -3, -6
   - Try 1: \(-2+6-2+6=-2\neq0\)
   - Try 2: \(-2(-8)+6(4)-2(-2)+6=-16+24+4+6=10\neq0\)
   - Try 3: \(-2(27)+6(9)-2(3)+6=-54+54-6+6=0\)
   - 3 is a root, so \(x-3\) is a factor.
2. a) (cont.)

3) $-2x^2 - 2x$

\[ \frac{-2x^3 + 6x^2 - 2x + 6}{x - 3} = -2x - 2 \]

Discriminant: $b^2 - 4ac = 0 - 4(-2)(-2) = -16 < 0$

so $-2x^2 - 2$ has no roots.

\[ (-2x^2 - 2) = -2(x^2 + 1) \]

b) $2x^3 + 11x - 20x + 7$

Factors of 7: 1, 7, -1, -7

Try: 2: $11 - 20 + 7 = 0$

1 is a root, so $x - 1$ is a factor

\[ 2 \left( \frac{11 - 20 + 7}{x - 1} \right) = 2x^3 + 11x - 20x + 7 \]

Discriminant: $b^2 - 4ac = 13^2 - 4(2)(-7) = 169 + 56 = 225 > 0$

so $2x^3 + 13x - 7$ has 2 roots.

Roots: \[ -13 \pm \sqrt{225} = -13 \pm 15 = \frac{-13 \pm 15}{4} = \frac{2}{4} = \frac{1}{2}, -7 \]

\[ 2(x - \frac{1}{2})(x + 7) \]

Complete factorization is \[ 2(x - 1)(x - \frac{1}{2})(x + 7) \]

b) $-2x^2 - 2x$

\[ \frac{-2x^3 + 6x^2 - 2x + 6}{x - 3} = -2x - 2 \]

Asymptotes: none

x-intercepts: $-1, 2$

Pt. between $-1$ & $2$, $0$

@ $0$: $(-)(-)(+)$

Leading term: $-3x^2$

\[ \frac{x^2}{x^2} = x^2 \]

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\[ \frac{x^2}{x^2} = x^2 \]
1. \( f(x) = 3^{x+1} - 4 \)  
\( \text{Graph } 3^x, \text{shift left 1, down 4} \)

2. \( \frac{f(x)}{2} \)

3. \( \frac{f(x)}{3} \)

4. \( f(x) = \begin{cases} 
-2x & \text{if } x \in (-\infty, 1) \\
2x & \text{if } x \in [-1, 1) \\
2-x & \text{if } x \in [1, \infty) 
\end{cases} \)

5. (a) \( \log_3\left(\frac{1}{8}\right) = \log_3\left(3^{-3}\right) = -3 \)
   (b) \( \log_5\left(\frac{1}{8}\right) = \log_5\left(\frac{1}{5}\right) = 3 \)
   (c) \( \log_8(64) = \log_8(8^2) = 2 \)
   (d) \( \log_3(e^\pi) = \pi \)

6. (e) \( f(x) = \left(\frac{1}{3}\right)^{x-2} \)
\( \text{Graph } \left(\frac{1}{3}\right)^x, \text{shift right 2} \)

7. \( x \)
\( f(x) \)
\( \begin{array}{c|c|c}
0 & 4 & 2 \\
1 & 2 & 1 \\
2 & 1 & 2 \\
3 & \frac{1}{2} & 4 \\
4 & \frac{1}{4} & \frac{1}{2} \\
\end{array} \)

8. (f) \( f(x) = \log_2(x+3) - 2 \)
\( \text{Graph } \log_2(x), \text{shift left 3, down 2.} \)

9. (g) \( f(x) = \begin{cases} 
-x+2 & \text{if } x \leq 3 \\
x+1 & \text{if } x > 3 
\end{cases} \)

10. (h) \( f(x) = 1 \times 1 \)

11. (i) \( f(x) = -|x+2| - 1 \)
\( \text{Graph } |x|, \text{flip over x-axis, shift left 2, down 1.} \)

12. (j) \( f(x) = \log_2(x+3) - 2 \)
\( \text{Graph } \log_2(x), \text{shift left 3, down 2.} \)

13. (k) \( f(x) = \log_3\left(\frac{1}{8}\right) = \log_3\left(3^{-3}\right) = -3 \)

14. (l) \( f(x) = \log_5\left(\frac{1}{8}\right) = \log_5\left(\frac{1}{5}\right) = 3 \)

15. (m) \( f(x) = \log_8(64) = \log_8(8^2) = 2 \)

16. (n) \( f(x) = \log_3(e^\pi) = \pi \)
6. \( \log_{10} 269 \leq 2 \leq \log_{10} 1000 \)
   \[ \log_{10} 269 \leq 1.7 \leq \log_{10} 1000 \]
   \[ \log_{10} 269 \leq 2 \leq \log_{10} 1000 \]

   a) \( 100 \leq 269 \leq 1000 \)
   \[ \log_{10} 269 \leq \log_{10} 1000 \]
   \[ \log_{10} 269 \leq 2 \leq \log_{10} 1000 \]
   \[ \log_{10} 269 \leq 2 \leq \log_{10} 1000 \]

   b) \( \log_{10} 3 \geq 5 \)
   \[ \log_{10} 1 \leq \log_{10} 3 \leq \log_{10} 5 \]
   \[ \log_{10} 1 \leq \log_{10} 3 \leq \log_{10} 5 \]

   c) \( \log_{10} (\frac{1}{3}) \leq \frac{1}{3} \leq \frac{1}{16} \)
   \[ \log_{10} (\frac{1}{3}) \leq \log_{10} (\frac{1}{16}) \]
   \[ \log_{10} (\frac{1}{2}) \leq \log_{10} (\frac{1}{16}) \]

9. \( \log_4 (x) = -3 \)
   \[ x = 4^{-3} = \frac{1}{64} \]
   \[ x = \frac{1}{64} \]

10. a) \( |x+1| \leq 2 \)
   \[ -2 \leq x+1 \leq 2 \]
   \[ -3 \leq x \leq 1 \]

b) \( |3-2x| \leq 1 \)
   \[ -1 \leq 3-2x \leq 1 \]
   \[ -2 \leq -2x \leq 0 \]
   \[ 1 \leq 2x \leq 2 \]
   \[ x \in (1, 2) \]

11. a) \( x-y = 2 \Rightarrow y = x-2 \)
   \[ 2x+3y = 14 \Rightarrow 3y = -2x+14 \]
   \[ y = -\frac{2}{3}x+\frac{14}{3} \]
   \[ \text{Check: solve by substitution:} \]
   \[ y = x+1 \]
   \[ 2x+3(x-2) = 14 \Rightarrow 2x = 16 \Rightarrow x = 8 \]
   \[ y = x+1 = 9 \]
   \[ x = \frac{3}{2} \]
   \[ \text{2 parallel lines ⇒ no sol.} \]

b) \( 2x-2y = -2 \Rightarrow 2y = 2x+2 \Rightarrow y = x+1 \)
   \[ 3x+5y = 5 \Rightarrow 3y = 3x+5 \Rightarrow y = x+\frac{5}{3} \]
   \[ \text{Check: solve by substitution:} \]
   \[ y = x+1 \]
   \[ 3x+3(x+1) = 5 \Rightarrow 3x = 5 \]
   \[ 3 \neq 5 \text{, so no solution} \]