1. Use the piece-wise defined function \( f(x) = \begin{cases} 
  x^2 + 4x + 4 & \text{if } x < 0 \\
  -\frac{1}{2}x + 2 & \text{if } x \geq 2 
 \end{cases} \) to answer the following:

   a) Compute \( f(-3), f(-2), f(-1), f(2), \) and \( f(4). \)

   b) Plot the points you found above and sketch a complete graph of \( y = f(x). \)

   c) Find the domain of \( f. \) Write your answer using interval notation.

2. Use your graphing calculator to graph each of the functions below over the interval \( (-2, 2) \) and approximate any local extrema. Also, determine the intervals where the functions are increasing and decreasing. Round your answers to three decimal places where appropriate.

   a) \( f(x) = x^2 \)

   b) \( g(x) = (x - 1)^2(x + 1)^2 \)

   c) \( h(x) = \sqrt{|x|} \)

   d) \( k(x) = x(x - 1)(x + 1) \)

3. Determine the average rate of change of the functions between the given values of \( x. \)

   a) \( h(x) = 3x - 17 \) from \( x = -1 \) to \( x = 2 \)

   b) \( f(x) = \frac{2x}{3x + 1} \) from \( x = 1 \) to \( x = t \)

   c) \( g(x) = \frac{1}{\sqrt{x + 1}} \) from \( x = 0 \) to \( x = a \)

4. Write the equation of the function \( F(x) = \sqrt{x} \) transformed in the following ways:

   a) shifted 2 units to the left, and shifted up 3 units

   b) reflected about the \( x \)-axis, then shifted down 3 units

   c) shifted 1 unit to the right, and vertically stretched by a factor of 3

   d) shifted 1 unit to the left, then reflected about the \( y \)-axis

5. Given \( f(x) = \sqrt[3]{x + 5} \) and \( g(x) = \frac{1}{4x + 1} \) find:

   a) \( f \circ g \)

   b) \( g \circ f \)

   c) \( f \circ f \)

   d) \( g \circ g \)
6. Find the inverse of each function, state the domain and range of both the original function and its inverse.

   a) \( f(x) = 2x - 1 \)
   b) \( g(x) = x^3 + 1 \)
   c) \( k(x) = \frac{1}{x-3} \)
   d) \( h(x) = \frac{x}{5-2x} \)

7. Solve the following inequalities. Write your answer using interval notation.

   a) \( 5(1-2x) \leq 9(x-3) \)
   b) \( \frac{2}{3} - \frac{1}{2} x \geq \frac{1}{6} + x \)
   c) \( (x+3)^2 (x+1) < 0 \)
   d) \( \frac{x}{x+1} > 3x \)
   e) \( |4x+1| < 17 \)
   f) \( |2x-1| \geq 5 \)

8. Find all real zeros and the multiplicity of those zeros for the given polynomials, then find their y-intercepts and sketch the graph.

   a) \( p(x) = (2x-1)(x+1)(x+3) \)
   b) \( p(x) = \frac{1}{4} (x+1)^3 (x-3) \)
   c) \( p(x) = (x+1)^2 (x-3)^2 \)

9. Factor each polynomial, then use the factored form to find the zeros and the multiplicity of each zero.

   a) \( P(x) = x^3 + 2x^2 - 8x \)
   b) \( P(x) = x^5 - 9x^3 \)
   c) \( P(x) = x^3 + 3x^2 - 4x - 12 \)

10. Find all zeros (both real and complex) of the following polynomials.

    a. \( P(x) = x^5 + 7x^3 \)
    b. \( P(x) = x^3 - x - 6 \)
    c. \( P(x) = x^5 + x^3 + 8x^2 + 8 \)

11. Find a polynomial with integer coefficients having the following properties:

    a. Degree: 3  Zeros: 0, i
    b. Degree: 3  Zeros: -3, 1+i
12. Find all intercepts and asymptotes, then sketch the graph of each rational function.

a. \( R(x) = \frac{x-2}{x^2-4x} \)
b. \( R(x) = \frac{x^2+3x}{x^2-x-6} \)
c. \( R(x) = \frac{x^3+4}{2x^2+x-1} \)

13. Solve the equation.

a. \( 2^{w+1} = 4^{2w-1} \)
b. \( 27^{x+9} = 81^x \)
c. \( 2 \ln(r) = \ln(15r+34) \)
d. \( \log_3(2x-1) = 2 \)
e. \( \log_3(x^2+24x) = 4 \)
f. \( e^{-2x} = 4 \)
g. \( \log_6(x^2+6x+41) = 2 \)
h. \( 3^{2x} - 3^{x+1} = -2 \)
i. \( 45^{2x+1} = 3^{x+3} \)

14. How much will be in an account after five years if $2000 is deposited into the account that yields 6\% compounded:
   a) semiannually?
   b) quarterly?
   c) monthly?
   d) daily?
   e) continuously?

15. Determine (correct to 3 decimal places) how long it will take for $2000 to double if it’s invested in an account that gives 6\% interest compounded:
   a) semiannually?
   b) quarterly?
   c) monthly?
   d) daily?
   e) continuously?

16. In the circle pictured below, \( r \) is the radius of the circle, \( \theta \) is the central angle of the sector, \( A \) is the area of the sector, and \( s \) is the length of the arc subtended by the central angle. Find,

a. \( A \) and \( s \) if \( r = 3 \) inches, and \( \theta = \frac{\pi}{3} \) radians
b. \( r \) and \( s \) if \( A = 2.25 \) square miles, and \( \theta = 36^\circ \)
c. \( A \) and \( \theta \) if \( r = 4 \) meters, and \( s = 12.57 \) meters
   d. \( r \) and \( A \) if \( s = 13 \) meters, and \( \theta = \frac{\pi}{4} \) radians
17. Use the given information to find the exact value of the six trigonometric functions of the angle $\theta$ in the picture.

a) $a = 8$, $b = 15$

b) $a = 12$, $c = 13$

c) $\sin \theta = \frac{2}{7}$

d) $\cot \theta = 3$

e) $\cos \theta = \frac{3}{5}$

f) $\csc \theta = \sqrt{5}$

18. For each part, determine the quadrant $\theta$ lies in and the values of the five remaining trigonometric functions.

a) $\csc \theta = -\sqrt{65}$ and $\cot \theta > 0$

b) $\sec \theta = -\frac{13}{4\sqrt{3}}$ and $\sin \theta > 0$

c) $\tan \theta = -\frac{35}{12}$ and $\cos \theta > 0$

19. A boat on a river travels downstream for 20 miles in one hour. The return trip back upstream takes 2.5 hours. How fast does the boat travel in still water, and how fast is the current?

20. A fruit stand sells a box of Strawberries for $7 and a box of Kiwi fruit for $10. If they sold a total of 135 boxes of fruit and had revenue of $1110, how many boxes of each fruit did they sell?

21. From the top of a 250 foot tall lighthouse, the angle of depression to a ship on the water is $27^\circ$. How far is the ship from the lighthouse? Round your answer to two decimal places.

22. Solve the following system of linear equations:

\[
\begin{align*}
x - 2y + 3z &= 1 \\
x + 2y - z &= 13 \\
3x + 2y - 5z &= 3
\end{align*}
\]

23. Complete the following tables. Use exact values only, no decimal approximations.

a) | Degrees | 225° | 480° |
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<td>$\frac{11\pi}{3}$</td>
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</table>

b) | 60° | $\frac{\pi}{4}$ | 210° | $\frac{3\pi}{2}$ | 315° |
<table>
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<td>$\cos \theta$</td>
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<tr>
<td>$\tan \theta$</td>
<td>$\sqrt{3}$</td>
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</tbody>
</table>
24. Evaluate each of the following. Give your answers in $a + bi$ form.
   a. $4(3-5i) - (7+2i)$
   b. $\left(\frac{1}{3} - 24i\right)\left(\frac{1}{6} + 12i\right)$
   c. $\frac{11-4i}{-3+8i}$
   d. $\frac{(4+9i)(3-8i)}{3-i}$

**Answers**
1. a) $f(-3)=1$, $f(-2)=0$, $f(-1)=1$, $f(2)=1$, $f(4)=0$  
   b) 
   c) $(-\infty, 0) \cup [2, \infty)$

2. a) Min: $(0,0)$; Increasing: $(0,2)$; Decreasing: $(-2,0)$
   b) Mins: $(-1,0) \cup (1,0)$; Max: $(0,1)$  
   Increasing: $(-1,0) \cup (1,2)$; Decreasing: $(-2,-1) \cup (0,1)$
   c) Min: $(0,0)$; Increasing: $(0,2)$; Decreasing: $(-2,0)$
   d) Min: $(0.578,-0.385)$; Max: $(-0.578,0.385)$
   Increasing: $(-2,-0.578) \cup (0.578,2)$; Decreasing: $(-0.578,0.578)$

3. a) $3$  
   b) $\frac{1}{6t+2}$
   c) $\frac{1-\sqrt{a+1}}{a\sqrt{a+1}}$

4. a) $y=\sqrt{x+2}+3$  
   b) $y=-\sqrt{x-3}$  
   c) $y=3\sqrt{x-1}$  
   d) $y=\sqrt{-x-1}$

5. a) $(f \circ g)(x) = \frac{3\sqrt{20x+6}}{\sqrt{4x+1}}$  
   b) $(g \circ f)(x) = \frac{1}{4\sqrt{x}+5+1}$  
   c) $(f \circ f)(x) = \frac{3\sqrt{2x+5}+5}{4\sqrt{x}}$  
   d) $(g \circ g)(x) = \frac{4x+1}{4\sqrt{x}+5}$

6. a) $f^{-1}(x) = \frac{x+1}{2}$  
   Domain $f(x) = (-\infty, \infty)$; Range $f(x) = (-\infty, \infty)$
   b) $g^{-1}(x) = \frac{3}{\sqrt{x}-1}$  
   Domain $g(x) = (-\infty, \infty)$; Range $g(x) = (-\infty, \infty)$
   c) $k^{-1}(x) = \frac{1}{x} + 3$  
   Domain $k(x) = (-\infty, 3) \cup (3, \infty)$; Range $k(x) = (-\infty, 0) \cup (0, \infty)$
   d) $h^{-1}(x) = \frac{5x}{1+2x}$  
   Domain $h(x) = \left(-\infty, \frac{5}{2}\right) \cup \left(\frac{5}{2}, \infty\right)$; Range $h(x) = \left(-\infty, -\frac{1}{2}\right) \cup \left(-\frac{1}{2}, \infty\right)$
7. a) \( \left[ \frac{32}{19}, \infty \right) \)  
   b) \( (-\infty, -\frac{1}{3}] \)  
   c) \( (-\infty, -3) \cup (-3, -1) \)  
   d) \( (-\infty, -1) \cup \left( -\frac{2}{3}, 0 \right] \)  
   e) \( \left( -\frac{9}{2}, 4 \right) \)  
   f) \( (-\infty, -2] \cup [3, \infty) \)

8. a) Zeros: \( \frac{1}{2} \) (multiplicity:1);  
        \(-1\) (multiplicity:1);  
        \(-3\) (multiplicity:1);  
        y-int: \( (0, -3) \)

8. b) Zeros: \(-1\) (multiplicity:3);  
        \(3\) (multiplicity:1);  
        y-int: \( (0, -\frac{3}{4}) \)

8. c) Zeros: \(-1\) (multiplicity:2);  
        \(3\) (multiplicity:2);  
        y-int: \( (0, 9) \)

9. a) \( P(x) = x(x+4)(x-2) \);  
        Zeros: \(0\) (multiplicity:1); \(-4\) (multiplicity:1); \(2\) (multiplicity:1)  
   b) \( P(x) = x^3(x+3)(x-3) \);  
        Zeros: \(0\) (multiplicity:3); \(-3\) (multiplicity:1); \(3\) (multiplicity:1)  
   c) \( P(x) = (x+3)(x-2)(x+2) \);  
        Zeros: \(2\) (multiplicity:1); \(-2\) (multiplicity:1); \(-3\) (multiplicity:1)

10. a) Zeros: \( i\sqrt{7} \); \(-i\sqrt{7} \)  
       Zeros: \(2\); \(-1+i\sqrt{2}\); \(-1-i\sqrt{2}\)  
       Zeros: \(-2\); \(i\); \(-i\); \(1+i\sqrt{3}\); \(1-i\sqrt{3}\)

11. a) \( P(x) = x^3 + x \);  
       b) \( x^3 + x^2 - 4x + 6 \)

12. a) no y-intercept, 
       x-intercept: \( (2, 0) \);  
       Horizontal Asymptote: \( y = 0 \);  
       Vertical Asymptotes: \( x = 0 \); \( x = 4 \)
b) **y-intercept: (0, 0)**

**x-intercepts:** (0, 0) & (−3, 0)

Horizontal Asymptote: \( y = 1 \)

Vertical Asymptotes: \( x = -2; x = 3 \)

12.c) **y-intercept: (0, −4)**

**x-intercepts:** \( \left( \sqrt[3]{-4}, 0 \right) \)

Slant Asymptote: \( y = \frac{1}{2} x - \frac{1}{4} \)

Vertical Asymptotes: \( x = -1; x = \frac{1}{2} \)

13. a. \( w = \frac{3}{2} \)  
   b. \( x = 27 \)  
   c. \( r = 17 \)  
   d. \( x = \frac{17}{2} \)  
   e. \( x = 3 \)  
   f. \( x = \frac{-\ln 4}{2} \)

   g. \( x = -5 \) or \( x = -1 \)

   h. \( x = \frac{\ln 2}{\ln 3} \) or \( x = 0 \)

   i. \( x = \frac{\ln 4 + \ln 5 - 3\ln 3}{\ln 3 - 2\ln 5} \)

14. a) $2687.83$  
   b) $2693.71$  
   c) $2697.70$  
   d) 2699.65  
   e) 2699.72

15. a) 11.725 yrs  
   b) 11.639 yrs  
   c) 11.581 yrs  
   d) 11.553 yrs  
   e) 11.552 yrs

16. a. \( s = 3.142 \) inches \( A = 4.712 \) in\(^2\)  
   b. \( r = 2.676 \) miles \( s = 1.681 \) miles

   c. \( \theta = \pi \) (radians) \( A = 25.13 \) m\(^2\)  
   d. \( r = 16.552 \) meters \( A = 107.589 \) m\(^2\)

17. a. \( \sin \theta = \frac{8}{17} \) \( \cos \theta = \frac{15}{17} \) \( \tan \theta = \frac{8}{15} \) \( \sec \theta = \frac{17}{8} \) \( \csc \theta = \frac{17}{15} \) \( \cot \theta = \frac{15}{8} \)

   b. \( \sin \theta = \frac{12}{13} \) \( \cos \theta = \frac{5}{13} \) \( \tan \theta = \frac{12}{5} \) \( \sec \theta = \frac{13}{12} \) \( \csc \theta = \frac{13}{5} \) \( \cot \theta = \frac{5}{12} \)

   c. \( \sin \theta = \frac{2}{7} \) \( \cos \theta = \frac{\sqrt{45}}{7} \) \( \tan \theta = \frac{2}{\sqrt{45}} \) \( \sec \theta = \frac{7}{2} \) \( \csc \theta = \frac{7}{\sqrt{45}} \) \( \cot \theta = \frac{\sqrt{45}}{2} \)

   d. \( \sin \theta = \frac{1}{\sqrt{10}} \) \( \cos \theta = \frac{3}{\sqrt{10}} \) \( \tan \theta = \frac{1}{3} \) \( \sec \theta = \sqrt{10} \) \( \csc \theta = \frac{\sqrt{10}}{3} \) \( \cot \theta = 3 \)

   e. \( \sin \theta = \frac{4}{5} \) \( \cos \theta = \frac{3}{5} \) \( \tan \theta = \frac{4}{3} \) \( \sec \theta = \frac{5}{4} \) \( \csc \theta = \frac{5}{3} \) \( \cot \theta = \frac{3}{4} \)

   f. \( \sin \theta = \frac{1}{\sqrt{5}} \) \( \cos \theta = \frac{2}{\sqrt{5}} \) \( \tan \theta = \frac{1}{2} \) \( \sec \theta = \sqrt{5} \) \( \csc \theta = \frac{\sqrt{5}}{2} \) \( \cot \theta = 2 \)
18. a. \( \theta \) is in Quadrant III; \( \sin \theta = -\frac{1}{\sqrt{65}} \) \( \cos \theta = -\frac{8}{\sqrt{65}} \) \( \tan \theta = \frac{1}{8} \)
\( \csc \theta = -\sqrt{65} \) \( \sec \theta = -\frac{\sqrt{65}}{8} \) \( \cot \theta = 8 \)

b. \( \theta \) is in Quadrant II; \( \sin \theta = \frac{11}{13} \) \( \cos \theta = -\frac{\sqrt{48}}{13} \) \( \tan \theta = -\frac{11}{\sqrt{48}} \)
\( \csc \theta = \frac{13}{11} \) \( \sec \theta = -\frac{13}{\sqrt{48}} \) \( \cot \theta = -\frac{\sqrt{48}}{11} \)

c. \( \theta \) is in Quadrant IV; \( \sin \theta = -\frac{35}{37} \) \( \cos \theta = \frac{12}{37} \) \( \tan \theta = -\frac{35}{12} \)
\( \csc \theta = -\frac{37}{35} \) \( \sec \theta = \frac{37}{12} \) \( \cot \theta = -\frac{12}{35} \)

19. Boat’s speed in still water = 14mph; Current’s speed = 6mph

20. 80 boxes of Strawberries; 55 boxes of Kiwi fruit

21. 490.65 feet

22. (3,7,4)

23. a)

<table>
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<th>150°</th>
<th>660°</th>
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<td>( \frac{11\pi}{3} )</td>
<td>( \frac{\pi}{10} )</td>
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</table>

b)

<table>
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<th>( \frac{\pi}{4} )</th>
<th>210°</th>
<th>( \frac{3\pi}{2} )</th>
<th>315°</th>
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<tbody>
<tr>
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<td>( \frac{1}{\sqrt{2}} )</td>
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<td>-1</td>
<td>-( \frac{1}{\sqrt{2}} )</td>
</tr>
<tr>
<td>( \cos \theta )</td>
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<td>( \frac{1}{\sqrt{2}} )</td>
<td>-( \frac{\sqrt{3}}{2} )</td>
<td>0</td>
<td>( \frac{1}{\sqrt{2}} )</td>
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<tr>
<td>( \tan \theta )</td>
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<td>( \frac{1}{\sqrt{3}} )</td>
<td>undefined</td>
<td>-1</td>
</tr>
</tbody>
</table>

24.a) \( 5 - 22i \)  
24.b) \( \frac{5185}{18} \)  
24.c) \( -\frac{65}{73} - \frac{76i}{73} \)  
24.d) \( \frac{257}{10} + \frac{69i}{10} \)