Show all work. Include units in your answers where appropriate.
Label window boundaries in each graph that is called for.

1. (5 points) Simplify $\frac{x^2 x^3}{x^4}$ (so that the variable $x$ appears only once, and with a positive exponent).

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

2. (5 points) Add and simplify: $\frac{5}{x+3} + \frac{13-4x}{(x-2)(x+3)}$.

$$\frac{5}{x+3} + \frac{13-4x}{(x-2)(x+3)} = \frac{5(x-2)}{(x-2)(x+3)} + \frac{13-4x}{(x-2)(x+3)}$$
$$= \frac{5x-10+13-4x}{(x-2)(x+3)}$$
$$= \frac{x+3}{x+3} = 1$$

3. (5 points) Simplify $\sqrt{16x^5 y^2}$ by removing as many factors as possible from under the radical.

$$\sqrt{16x^5 y^2} = \sqrt{4^2 x^4 y^2} = 4x^2 | y | \sqrt{x}$$

4. (8 points) For $f(x) = x^2 - 2$, find and simplify the difference quotient $\frac{f(x+h) - f(x)}{h}$. Be sure to use correct notation.

$$\frac{f(x+h) - f(x)}{h} = \frac{(x+h)^2 - 2 - [x^2 - 2]}{h}$$
$$= \frac{x^2 + 2xh + h^2 - 2 - x^2 + 2}{h}$$
$$= \frac{2xh + h^2}{h}$$
$$= \frac{h(2x + h)}{h} = 2x + h$$
5. (6 points) Give a complete description of the window shown, by specifying the following:

Xmin: -20
Xmax: 50
Xscl: 10
Ymin: -200
Ymax: 600
Yscl: 100

6. (6 points) In the window shown here, the x-scale and y-scale are both 10. Find the equation of the line shown in this window, and write it in slope-intercept form.

The line passes through (0,20) and (10,0), so the slope is \( m = \frac{0-20}{10-0} = -2 \). Since the y-intercept is 20, the equation is \( y = -2x + 20 \).

7. (6 points) Determine whether the table shown here represents a linear function.

- If it is linear, find its equation.
- If it is not linear, explain why.

The function represented by the table is linear, because for each increase of 1 unit in \( x \), \( y \) changes by -.5. Thus, the slope is -.5. Since the point (0, 3.5) is on the graph, the y-intercept is 3.5. Thus, the equation is \( y = -.5x + 3.5 \).
8. (8 points) The Pulsar Electronics Company determines that the cost of manufacturing 30 DVD players is $7,500 and the cost of manufacturing 35 DVD players is $8,300.

a) Determine the cost-volume equation.

The points (30, 7500) and (35, 8300) are on the graph, so the slope is

\[ m = \frac{8300 - 7500}{35 - 30} = \frac{800}{5} = 160. \]

Using the point-slope form for the equation of the line, we get \( y - 7500 = 160(x - 30) \). Solving for \( y \) gives \( y = 160x + 2700 \).

b) Find the fixed cost.

The fixed cost is the cost of producing 0 items—that is, the fixed cost is the \( y \)-intercept, $2,700.

c) Find the marginal cost.

The marginal cost is the rate of change (slope) of the line. Thus, marginal cost = $160 per television.

9. (6 points) Find the coordinates of the vertex of the parabola whose equation is

\[ y = 2x^2 - 8x + 4. \]

The \( x \)-coordinate of the vertex is \( x = \frac{-b}{2a} = \frac{-(-8)}{2 \cdot 2} = 2 \).

The \( y \)-coordinate is then \( y = 2(2)^2 - 8(2) + 4 = -4 \).

Thus, the vertex is \((2, -4)\).

10. (10 points)

a) Find the \( x \)-intercepts of the graph of \( y = 2x^2 - 11x + 5 \).

Set \( y = 0 \) and solve for \( x \):

\[ (2x - 1)(x - 5) = 0 \]

\[ \therefore x = \frac{1}{2}, 5 \]

Alternatively, you can use your calculator (2nd CALC ZERO)

b) Illustrate with a graph, using an appropriate window. Be sure to label the window boundaries.
11. (8 points) When a ball is thrown upward with an initial velocity of 80 feet per second from a height of 30 feet, its position \( s \) above the ground (in feet) after \( t \) seconds is given by \( s = -16t^2 + 80t + 30 \).

a) Determine the time when the ball will reach its maximum height.

The ball will reach maximum height at the vertex of the graph of \( s \), namely when \( t = \frac{-b}{2a} = \frac{-80}{-32} = 2.5 \) seconds.

b) Determine what the maximum height of the ball will be.

When \( t = 2.5 \), \( s = -16(2.5)^2 + 80(2.5) + 30 = 130 \) feet.

12. (10 points) The supply and demand for cotton candy at an amusement park are given by \( S(p) = 6p - 3 \) and \( D(p) = \frac{p^2}{3} - 6p + 26 \), where \( p \) is the price in dollars, \( p \leq 5 \), and quantities are measured in hundreds.

a) Graph these functions in an appropriate window. Be sure to label the window boundaries.

Since \( p \leq 5 \) and the price must, of course, be positive, the window should range from 0 to 5 in the \( x \)-direction.

b) Find the equilibrium price.

Using 2\textsuperscript{nd} CALC INTERSECT on the calculator, the \( x \)-coordinate of the point of intersection is \( 2.6051957 \approx 2.61 \).

13. (5 points) Find the distance between the points \((3, -2)\) and \((4, 1)\). Round your answer to 4 decimal places.

\[
d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2} = \sqrt{(4 - 3)^2 + (1 - (-2))^2} = \sqrt{1 + 9} = \sqrt{10} = 3.1623
\]
14. (8 points) The equation \( x^2 + y^2 + 4x - 6y + 12 = 0 \) represents a circle.

a) Using the technique of completing the square, write the equation in the standard form for a circle.

\[
\begin{align*}
(x^2 + 4x) + (y^2 - 6y) &= -12 \\
(x^2 + 4x + 4) + (y^2 - 6y + 9) &= -12 + 4 + 9 \\
(x + 2)^2 + (y - 3)^2 &= 1^2
\end{align*}
\]

b) Find the center and radius of the circle.

From the equation above, the center is \((-2, 3)\) and the radius is 1.

15. (4 points) Given the equation \((x - 2)^2 + (y + 1)^2 = 9\), solve for \(y\) to determine the formulas for the two functions represented by the equation.

\[
\begin{align*}
(y + 1)^2 &= 9 - (x - 2)^2 \\
y + 1 &= \pm \sqrt{9 - (x - 2)^2} \\
y &= -1 \pm \sqrt{9 - (x - 2)^2}
\end{align*}
\]

So the two functions are \(y = -1 + \sqrt{9 - (x - 2)^2}\) and \(y = -1 - \sqrt{9 - (x - 2)^2}\).