SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

Find the center \((h, k)\) and radius \(r\) of the circle with the given equation.

1) \(x^2 + y^2 + 8x - 4y = 29\)

Write the standard form of the equation of the circle with radius \(r\) and center \((h, k)\).

2) \(r = \sqrt{11}; \ (h, k) = (-2, -4)\)

Solve the problem.

3) Find the equation of a circle in standard form that is tangent to the line \(x = -3\) at \((-3, 5)\) and also tangent to the line \(x = 9\).

Determine whether the equation defines \(y\) as a function of \(x\).

4) \(y^2 + x = 4\)

5) \(x^2 + 5y^2 = 1\)

Determine whether the relation represents a function. If it is a function, state the domain and range.

6) \{(-3.55, 10.35), (-3.555, -10.3), (23, 0), (0.67, -3)\}

Find the domain of the function.

7) \(f(x) = \sqrt{18 - x}\)

8) \(h(x) = -\frac{x - 4}{x^3 - 36x}\)

9) \(g(x) = \frac{3x}{x^2 - 16}\)

For the given functions \(f\) and \(g\), find the requested function and state its domain.

10) \(f(x) = 4x^3 + 1; \ g(x) = 4x^2 - 1\)
Find \(f \cdot g\).

11) \(f(x) = x + 7; \ g(x) = 3x\)
Find \(f - g\).

Based on the graph, find the range of \(y = f(x)\).

12) \(f(x) = \begin{cases} 4 & \text{if } -4 \leq x < -2 \\ \lfloor x \rfloor & \text{if } -2 \leq x < 7 \\ \frac{3}{\sqrt{x}} & \text{if } 7 \leq x \leq 13 \end{cases}\)

Solve the problem.

13) An electric company has the following rate schedule for electricity usage in single-family residences:

- Monthly service charge: $4.93
- Per kilowatt service charge:
  - 1st 300 kilowatts: $0.11589/kW
  - Over 300 kilowatts: $0.13321/kW

What is the charge for using 300 kilowatts in one month?
What is the charge for using 375 kilowatts in one month?
Construct a function that gives the monthly charge \(C\) for \(x\) kilowatts of electricity.

Suppose the point \((2, 4)\) is on the graph of \(y = f(x)\). Find a point on the graph of the given function.

14) \(y = 2f(x)\)

Find the function.

15) Find the function that is finally graphed after the following transformations are applied to the graph of \(y = \sqrt{x}\). The graph is shifted down 6 units, reflected about the \(x\)-axis, and finally shifted left 4 units.
Find the real zeros of the function. List the x-intercepts of the graph of the function.
16) \( H(x) = x^6 - 63x^3 - 64 \)
17) \( f(x) = x^4 - 81 \)

Determine where the function is increasing and where it is decreasing.
18) \( g(x) = 5x^2 + 120x + 695 \)

Find the vertex and axis of symmetry of the graph of the function.
19) \( f(x) = x^2 - 8x \)
20) \( f(x) = 2x^2 + 4x - 2 \)

Determine the maximum number of turning points of \( f \).
21) \( f(x) = 4x - x^3 \)

Use the x-intercepts to find the intervals on which the graph of \( f \) is above and below the x-axis.
22) \( f(x) = (x - 1)^2(x - 5)^5 \)

State whether the function is a polynomial function or not. If it is, give its degree. If it is not, tell why not.
23) \( f(x) = \frac{x^4 - 6}{x^2} \)
24) \( f(x) = 3x + 6x^2 \)

Form a polynomial whose zeros and degree are given.
25) Zeros: 0, -3, 2; degree 3

For the polynomial, list each real zero and its multiplicity. Determine whether the graph crosses or touches the x-axis at each x-intercept.
26) \( f(x) = \frac{1}{5}x^4(x^2 - 3) \)

Find the domain of the rational function.
27) \( f(x) = \frac{2x^2 - 4}{3x^2 + 6x - 45} \)

Give the equation of the oblique asymptote, if any, of the function.
28) \( f(x) = \frac{2x^3 + 11x^2 + 5x - 1}{x^2 + 6x + 5} \)
29) \( f(x) = \frac{x^2 - 4x + 7}{x + 8} \)

Find the vertical asymptotes of the rational function.
30) \( g(x) = \frac{x}{x^3 - 8} \)
31) \( h(x) = \frac{x + 3}{x^2 + 64} \)

Give the equation of the oblique asymptote, if any, of the function.
32) \( f(x) = \frac{2x^3 + 11x^2 + 5x - 1}{x^2 + 6x + 5} \)

Find the domain of the rational function.
33) \( g(x) = \frac{7x}{(x - 9)(x - 8)} \)
34) \( R(x) = \frac{-3x^2}{x^2 + 6x - 16} \)

Solve the problem.
35) If the force acting on an object stays the same, then the acceleration of the object is inversely proportional to its mass. If an object with a mass of 36 kilograms accelerates at a rate of 9 meters per second per second by a force, find the rate of acceleration of an object with a mass of 6 kilograms that is pulled by the same force.

Solve.
36) The volume \( V \) of a given mass of gas varies directly as the temperature \( T \) and inversely as the pressure \( P \). A measuring device is calibrated to give \( V = 380 \text{ in}^3 \) when \( T = 380^\circ \) and \( P = 10 \text{ lb/in}^2 \). What is the volume on this device when the temperature is 220\(^\circ\) and the pressure is 20 \text{ lb/in}^2?
Find the x- and y-intercepts of f.
37) \( f(x) = 7x - x^3 \)

Use Descartes’ Rule of Signs and the Rational Zeros Theorem to find all the real zeros of the polynomial function. Use the zeros to factor f over the real numbers.
38) \( f(x) = x^3 + 2x^2 - 9x - 18 \)

Find the x- and y-intercepts of f.
39) \( f(x) = -x^2(x + 4)(x^2 + 1) \)
40) \( f(x) = 4x^4(x + 6)^5 \)

The equation has a solution \( r \) in the interval indicated. Approximate this solution correct to two decimal places.
41) \( x^4 - x^3 - 7x^2 + 5x + 10 = 0; \ 2 < r \leq 3 \)
42) \( x^3 - 8x - 3 = 0; \ -3 \leq r \leq -2 \)
43) \( x^3 - 8x - 3 = 0; \ -1 \leq r \leq 0 \)

List the potential rational zeros of the polynomial function. Do not find the zeros.
44) \( f(x) = x^5 - 6x^2 + 3x + 15 \)
45) \( f(x) = -4x^4 + 3x^2 - 4x + 6 \)
46) \( f(x) = -2x^3 + 4x^2 - 3x + 8 \)

Use the Factor Theorem to determine whether \( x - c \) is a factor of \( f \). If it is, write \( f \) in factored form, that is, write \( f \) in the form \( f(x) = (x - c)(\text{quotient}) \).
47) \( f(x) = 6x^3 + 11x^2 + 11x - 14; \ c = \frac{2}{3} \)

Use the Factor Theorem to determine whether \( x - c \) is a factor of \( f(x) \).
48) \( f(x) = x^4 - 12x^2 - 64; \ x - 8 \)

Use the Factor Theorem to determine whether \( x - c \) is a factor of \( f \). If it is, write \( f \) in factored form, that is, write \( f \) in the form \( f(x) = (x - c)(\text{quotient}) \).
49) \( f(x) = 2x^4 - 7x^3 + 15x^2 - 35x + 25; \ c = 1 \)

Find the x- and y-intercepts of f.
50) \( f(x) = \begin{cases} \ (-2, -12), (-4, -11), (-6, -10), (-8, -9) \end{cases} \)

Find the inverse of the function and state its domain and range.
51) \( f(x) = \begin{cases} \ (6, -12), (-2, -11), (-4, -10), (-6, -9) \end{cases} \)

Determine i) the domain of the function, ii) the range of the function, iii) the domain of the inverse, and iv) the range of the inverse.
52) \( f(x) = \frac{2}{2x + 3} \)

The function \( f \) is one-to-one. Find its inverse.
53) \( f(x) = 6x + 8 \)
54) \( f(x) = 8x \)

Solve the equation.
55) \( e^{3x} - 1 = (e^4)^{-x} \)

Find the domain of the function.
56) \( f(x) = \log_{1/2}(x + 4) \)
57) \( f(x) = \log_{7}(x + 5)^2 \)

Solve the exponential equation. Use a calculator to obtain a decimal approximation, correct to two decimal places, for the solution.
58) \( 3^7x = 2.6 \)

Solve the equation.
59) \( 2^x = 16 \)
60) \( 3 \cdot 5^{2t} - 1 = 75 \)
61) \( \log (x + 5) = \log (4x - 4) \)
62) \( \frac{1}{3} \log_2 (x + 6) = \log_8 (3x) \)
Solve the problem.

63) The amount of a certain drug in the bloodstream is modeled by the function
\[ y = y_0 e^{-0.40t}, \]
where \( y_0 \) is the amount of the drug injected (in milligrams) and \( t \) is the elapsed time (in hours). Suppose that 10 milligrams are injected at 10:00 A.M. If a second injection is to be administered when there is 1 milligram of the drug present in the bloodstream, approximately when should the next dose be given? Express your answer to the nearest quarter hour.

64) The half-life of radium is 1690 years. If 150 grams is present now, how long (to the nearest year) till only 100 grams are present?

65) A culture of bacteria obeys the law of uninhibited growth. If 140,000 bacteria are present initially and there are 609,000 after 6 hours, how long will it take for the population to reach one million?

66) The population of a particular country was 28 million in 1983; in 1996, it was 38 million. The exponential growth function \( A = 28e^{kt} \) describes the population of this country \( t \) years after 1983. Use the fact that 13 years after 1983 the population increased by 10 million to find \( k \) to three decimal places.

Solve the system.

\[
\begin{align*}
\begin{cases}
x - 4y &= 3 \\
-4x + 16y &= -12
\end{cases}
\end{align*}
\]

Solve the problem using matrices.

68) Find the function \( f(x) = ax^3 + bx^2 + cx + d \) for which \( f(0) = -2, f(1) = 5, f(-1) = 3, f(2) = 4. \)

Solve each system of equations using matrices (row operations). If the system has no solution, say that it is inconsistent.

\[
\begin{align*}
\begin{cases}
8x - 3y - z &= 35 \\
x + 7y - 3z &= 49 \\
8x + y + z &= 77
\end{cases}
\end{align*}
\]

Write the augmented matrix for the system.

\[
\left\{ \begin{array}{cc}
2x + 8z &= 4 \\
7y + 8z &= 15 \\
3x + 9y + 9z &= 12
\end{array} \right. 
\]

Write the system of equations associated with the augmented matrix. Do not solve.

\[
\left[ \begin{array}{ccc|c}
2 & 2 & 4 & -2 \\
7 & 0 & 8 & 4 \\
2 & 2 & 0 & 2
\end{array} \right]
\]

Perform the matrix multiplication.

72) Let \( A = \begin{bmatrix} 0 & -3 & 1 \\ 5 & -1 & 0 \end{bmatrix} \) and \( B = \begin{bmatrix} 1 & 2 \\ 0 & 1 \\ 1 & -1 \end{bmatrix} \). Find \( AB \).

73) Let \( A = \begin{bmatrix} -1 & 3 \\ 2 & 2 \end{bmatrix} \) and \( B = \begin{bmatrix} -2 & 0 \\ -1 & 2 \end{bmatrix} \). Find \( AB \).

Perform the indicated operation, whenever possible.

74) Let \( A = \begin{bmatrix} 7 & 4 & 8 \\ -6 & 5 & -1 \\ 0 & 6 & -3 \end{bmatrix} \) and \( B = \begin{bmatrix} -2 & -6 & -1 \\ -7 & -4 & 3 \\ -3 & -9 & -5 \end{bmatrix} \). Find \( A - B \).

75) \[
\begin{bmatrix}
1 & 8 & 5 & -4 \\
6 & -1 & 3 & -3 \\
6 & 3 & 8 & 8
\end{bmatrix}
\]

Perform the indicated operation, whenever possible.

72) Let \( A = \begin{bmatrix} 0 & -3 & 1 \\ 5 & -1 & 0 \end{bmatrix} \) and \( B = \begin{bmatrix} 1 & 2 \\ 0 & 1 \\ 1 & -1 \end{bmatrix} \). Find \( AB \).

73) Let \( A = \begin{bmatrix} -1 & 3 \\ 2 & 2 \end{bmatrix} \) and \( B = \begin{bmatrix} -2 & 0 \\ -1 & 2 \end{bmatrix} \). Find \( AB \).

Perform the indicated operation, whenever possible.

74) Let \( A = \begin{bmatrix} 7 & 4 & 8 \\ -6 & 5 & -1 \\ 0 & 6 & -3 \end{bmatrix} \) and \( B = \begin{bmatrix} -2 & -6 & -1 \\ -7 & -4 & 3 \\ -3 & -9 & -5 \end{bmatrix} \). Find \( A - B \).

75) \[
\begin{bmatrix}
1 & 8 & 5 & -4 \\
6 & -1 & 3 & -3 \\
6 & 3 & 8 & 8
\end{bmatrix}
\]
1) \((h, k) = (-4, 2); r = 7\)
2) \((x + 2)^2 + (y + 4)^2 = 11\)
3) \((x - 3)^2 + (y - 5)^2 = 36\)
4) not a function
5) not a function
6) function
   domain: \([3.55, 3.555,\frac{2}{3}, 0.67]\)
   range: \([10.35, -10.3, 0, -3]\)
7) \(y = 18\)
8) \(x \neq \pm 6, 0, 6\)
9) \(x \neq -4, 4\)
10) \((f \cdot g)(x) = 16x^5 - 4x^3 + 4x^2 - 1\); all real numbers
11) \((f - g)(x) = -3x^2 + x + 7\); all real numbers
12) \((0, 7)\)
13) 39.70
14) \((2, 8)\)
15) \(y = -\sqrt{x + 4} + 6\)
16) \(x = 4, y = -1\)
17) \(x = -3, x = 3\)
18) decreasing on \((-\infty, -12)\)
   increasing on \((-12, \infty)\)
19) \((4, -16); x = 4\)
20) \((-1, -4); x = -1\)
21) 2
22) above the \(x\)-axis: \((5, \infty)\)
   below the \(x\)-axis: \((-\infty, 1), (1, 5)\)
23) No; it is a ratio of polynomials
24) Yes; degree 2
25) \(f(x) = x^3 + x^2 - 6x\) for \(a = 1\)
26) 0, multiplicity 4,
   touches \(x\)-axis;
   \(\sqrt{3},\) multiplicity 1,
   crosses \(x\)-axis;
   \(-\sqrt{3},\) multiplicity 1,
   crosses \(x\)-axis
27) \(y = 2x - 1\)
28) \(y = x - 12\)
29) \(x = 2\)
30) none
31) \(y = 2x - 1\)
32) \(x \neq 9, 8\)
33) \(x \neq -8, 2\)
34) 54 meters per second
35) \(V = 110\) in
36) \(x\)-intercepts: 0, \(-\sqrt{7}, \sqrt{7}; y\)-intercept: 0
37) 2.24
38) -3, -2, 3; \(f(x) = (x + 3)(x + 2)(x - 3)\)
39) \(x\)-intercepts: -4, 0;
   \(y\)-intercept: 0
40) \(x\)-intercepts: 0, -6;
   \(y\)-intercept: 0
41) 6.26
42) 0.38
43) \(1, \pm 5, \pm 3, \pm 15\)
44) \(\pm 1, \pm 2, \pm 2, \pm 4, \pm 8\)
45) \(x = 2, \pm 2, \pm 3, \pm 6\)
46) \(x = 2, \pm 2, \pm 2, \pm 4, \pm 8\)
47) \(f(x) = (x - 1)(2x^3 - 5x^2 + 10x - 25)\)
48) Yes; degree 2
49) \(f(x) = (x - 1)(2x^3 - 5x^2 + 10x - 25)\)
50) \([(-12, -2), (-11, -4), (-10, -10)]; D = [-12, -11, -10, -9]; R = [-2, -4, -6, -8]\)
51) \([(-12, 6), (-11, -2), (-10, -4), (-9, -6)]; a function\)