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

Solve the problem.

1) The population of a particular country was 21 million in 1985; in 1997, it was 27 million. The exponential growth function \( A = 21e^{kt} \) describes the population of this country \( t \) years after 1985. Use the fact that 12 years after 1985 the population increased by 6 million to find \( k \) to three decimal places.

2) 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/kWh
  - Over 300 kilowatts: $0.13321/kWh

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.

3) 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.

4) 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?

5) 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?

6) 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 \( x = 9 \).

7) 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 16 kilograms accelerates at a rate of 3 meters per second per second by a force, find the rate of acceleration of an object with a mass of 2 kilograms that is pulled by the same force.

Solve the equation.

8) \( 4^x = 16 \)

9) \( e^{2x - 1} = (e^4)^{-x} \)

10) \( \frac{1}{3} \log_2 (x + 6) = \log_8 (3x) \)

11) \( \log (x + 5) = \log (5x + 4) \)

12) \( 3 \cdot 5^{2t} - 1 = 75 \)

Solve the system.

\[
\begin{align*}
\begin{cases}
x + 5y &= -3 \\
4x + 20y &= -12
\end{cases}
\end{align*}
\]

Give the equation of the oblique asymptote, if any, of the function.

14) \( f(x) = \frac{2x^3 + 11x^2 + 5x - 1}{x^2 + 6x + 5} \)

15) \( f(x) = \frac{2x^3 + 11x^2 + 5x - 1}{x^2 + 6x + 5} \)

16) \( f(x) = \frac{x^2 - 3x + 8}{x + 4} \)

Perform the matrix multiplication.

17) Let \( A = \begin{bmatrix} -1 & 3 \\ 2 & 2 \end{bmatrix} \) and \( B = \begin{bmatrix} -2 & 0 \\ -1 & 4 \end{bmatrix} \). Find \( AB \).

18) Let \( A = \begin{bmatrix} 0 & -3 & 1 \\ 5 & -1 & 0 \end{bmatrix} \) and \( B = \begin{bmatrix} 1 & 2 \\ 0 & 1 \end{bmatrix} \). Find \( AB \).
Solve the exponential equation. Use a calculator to obtain a decimal approximation, correct to two decimal places, for the solution.

19) \(36^x = 2.2\)

For the polynomial, list each real zero and its multiplicity. Determine whether the graph crosses or touches the \(x\)-axis at each \(x\)-intercept.

20) \(f(x) = \frac{1}{4} x^4 (x^2 - 3)\)

Find the real zeros of the function. List the \(x\)-intercepts of the graph of the function.

21) \(H(x) = x^6 - 26x^3 - 27\)

22) \(f(x) = x^4 - 625\)

Find the inverse. Determine whether the inverse represents a function.

23) \{(6, -8), (3, -7), (1, -6), (-1, -5)\}

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

24) \(f(x) = 4x^3 - 3; \ g(x) = 6x^2 - 1\)

Find \(f \cdot g\).

25) \(f(x) = x + 2; \ g(x) = 6x^2\)

Find \(f - g\).

The function \(f\) is one-to-one. Find its inverse.

26) \(f(x) = 4x\)

27) \(f(x) = 7x + 7\)

Find the domain of the rational function.

28) \(R(x) = \frac{-3x^2}{x^2 + 2x - 35}\)

29) \(f(x) = \frac{2x^2 - 4}{3x^2 + 6x - 45}\).

30) \(h(x) = \frac{6x^2}{(x - 1)(x - 4)}\)

Find the domain of the function.

31) \(h(x) = \frac{x - 1}{x^3 - 36x}\)

32) \(f(x) = \log_6 (x + 2)^2\)

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

34) \(f(x) = \sqrt{17 - x}\)

35) \(f(x) = \log_{1/2}(x + 4)\)

Determine the maximum number of turning points of \(f\).

36) \(f(x) = 7x - x^3\)

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

37) \(x^2 + y^2 + 4x - 18y = -81\)

Find the vertical asymptotes of the rational function.

38) \(g(x) = \frac{x + 3}{x^2 + 36}\)

39) \(g(x) = \frac{x}{x^3 - 125}\)

Form a polynomial whose zeros and degree are given.

40) Zeros: 0, -7, 6; degree 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.

41) \(f(x) = x^3 + 3x^2 - 4x - 12\)

Use the \(x\)-intercepts to find the intervals on which the graph of \(f\) is above and below the \(x\)-axis.

42) \(f(x) = \left(x + \frac{1}{9}\right)^2 (x - 2)^3\)

Use the Factor Theorem to determine whether \(x - c\) is a factor of \(f(x)\).

43) \(f(x) = x^4 - 21x^2 - 100; \ x - 10\)
Determine whether the equation defines \( y \) as a function of \( x \).

44) \( y^2 + x = 8 \)

45) \( x^2 - 3y^2 = 1 \)

List the potential rational zeros of the polynomial function. Do not find the zeros.

46) \( f(x) = -4x^4 + 3x^2 - 2x + 6 \)

47) \( f(x) = -2x^3 + 3x^2 - 4x + 8 \)

48) \( f(x) = x^5 - 5x^2 + 2x + 21 \)

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

49) \( y = 3f(x) \)

Find the \( x \)- and \( y \)-intercepts of \( f \).

50) \( f(x) = -x^2(x + 5)(x^2 + 1) \)

51) \( f(x) = 2x^3(x + 6)^3 \)

52) \( f(x) = 6x - x^3 \)

Find the vertex and axis of symmetry of the graph of the function.

53) \( f(x) = x^2 - 10x \)

54) \( f(x) = -4x^2 - 8x + 9 \)

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

55) \[
\begin{array}{cccc}
4 & 9 & 5 & -2 \\
6 & 0 & 8 & 4 \\
3 & 5 & 0 & 2 \\
\end{array}
\]

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 \( f(x) = (x - c)(\text{quotient}) \).

56) \( f(x) = 4x^4 - 9x^3 + 9x^2 - 9x + 5; c = 1 \)

57) \( f(x) = 12x^3 + 17x^2 + 23x - 7; c = \frac{1}{4} \)

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

58) \[
\begin{array}{c|c|c}
4 & \text{if } -4 \leq x < -2 \\
|x| & \text{if } -2 \leq x < 8 \\
3 \sqrt{x} & \text{if } 8 \leq x \leq 12 \\
\end{array}
\]

The equation has a solution \( r \) in the interval indicated. Approximate this solution correct to two decimal places.

59) \( x^4 - x^3 - 7x^2 + 5x + 10 = 0; \ 2 < r \leq 3 \)

60) \( x^3 - 8x - 3 = 0; \ -1 \leq r \leq 0 \)

61) \( x^3 - 8x - 3 = 0; \ -3 \leq r \leq -2 \)

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

62) \( r = \sqrt{17}; \ (h, k) = (8, 7) \)

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

63) \( \{(7.22, 11.72), (7.222, -11.7), (\frac{5}{7}, 0), (0.71, -7)\} \)

State whether the function is a polynomial function or not. If it is, give its degree. If it is not, tell why not.

64) \( f(x) = \frac{x^5 - 7}{x^6} \)

65) \( f(x) = 5x + 2x^4 \)

Find the inverse of the function and state its domain and range.

66) \( \{(3, -10), (1, -9), (-1, -8), (-3, -7)\} \)
Solve each system of equations using matrices (row operations). If the system has no solution, say that it is inconsistent.

67) \[
\begin{align*}
8x - 3y - z &= 35 \\
x + 7y - 3z &= 49 \\
8x + y + z &= 77
\end{align*}
\]

Perform the indicated operation, whenever possible.

68) \[
\begin{bmatrix}
6 & -8 \\
4 & 1 \\
5 & 1
\end{bmatrix}
\begin{bmatrix}
4 & 2 \\
7 & 7 \\
2 & -8
\end{bmatrix}
\]

69) 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 \( A - B \).

Write the augmented matrix for the system.

70) \[
\begin{align*}
5x + 3z &= 28 \\
3y + 5z &= 11 \\
6x + 8y - 2z &= 44
\end{align*}
\]

Find the function.

71) Find the function that is finally graphed after the following transformations are applied to the graph of \( y = \sqrt[3]{x} \). The graph is shifted down 7 units, reflected about the x-axis, and finally shifted left 3 units.

Solve.

72) 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 \( V = 340 \text{ in}^3 \) when \( T = 340^\circ \) and \( P = 10 \text{ lb/in}^2 \). What is the volume on this device when the temperature is \( 180^\circ \) and the pressure is \( 20 \text{ lb/in}^2 \)?

Determine where the function is increasing and where it is decreasing.

73) \( g(x) = 7x^2 + 84x + 203 \)

Solve the problem using matrices.

74) Find the function \( f(x) = ax^3 + bx^2 + cx + d \) for which \( f(0) = -2, f(1) = 5, f(-1) = 3, f(2) = 4 \).
1) 0.021  
2) $39.70  
   $49.69  
   \[ C(x) = \begin{cases} 
   4.93 + 0.11589x 
   & \text{if } 0 \leq x \leq 300 
   
   -0.266 + 0.13321x 
   & \text{if } x > 300 
   \end{cases} \]  
3) 3:45 P.M  
4) 989 years  
5) 8.024 hours  
6) \((x - 3)^2 + (y - 5)^2 = 36\)  
7) 24 meters per second  
   per second  
8) \(\left\{ \frac{1}{6} \right\} \)  
9) \(\left\{ \frac{3}{2} \right\} \)  
10) \(\left\{ 3 \right\} \)  
11) \(\left\{ 0.25 \right\} \)  
12) \(\left\{ -1 \right\} \)  
13) \(y = -\frac{x}{5} - 3\), where \(x\)  
is any real number  
14) \(y = 2x - 1\)  
15) \(y = 2x + 1\)  
16) \(y = x - 7\)  
17) \(\left[ \begin{array}{c} -1 \\
   12 \\
   \hline
   -6 \\
   8 \end{array} \right] \)  
18) \(\left[ \begin{array}{c} 1 \\
   -4 \\
   \hline
   5 \\
   9 \end{array} \right] \)  
19) \(\left\{ 0.12 \right\} \)  
20) 0, multiplicity 4,  
touches \(x\)-axis;  
\(\sqrt{3}\), multiplicity 1,  
crosses \(x\)-axis;  
\(-\sqrt{3}\), multiplicity 1,  
crosses \(x\)-axis  
21) \(x = 3, x = -1\)  
22) \(x = -5, x = 5\)  
23) \((-8, 6), (-7, 3), (-6, 1), (-5, -1)\); a  
    function  
24) \(f \cdot g(x) = 24x^5 - 4x^3  
   - 18x^2 + 3\); all real numbers  
25) \(f - g(x) = -6x^2 + x  
   + 2\); all real numbers  
26) \(f^{-1}(x) = \frac{x}{4} \)  
27) \(f^{-1}(x) = \frac{x - 7}{7} \)  
28) \(\{x | x \neq -7, 5\} \)  
29) \(\{x | x \neq 3, x \neq -5\} \)  
30) \(\{x | x \neq 1, 4\} \)  
31) \(\{x | x \neq -6, 0, 6\} \)  
32) \((\infty, -2) \text{ or } (-2, \infty) \)  
33) \(\{x | x \neq -3, 3\} \)  
34) \(\{x | x \leq 17\} \)  
35) \((-4, \infty) \)  
36) \(2 \)  
37) \((h, k) = (-2, 9); \ r = 2 \)  
38) none  
39) \(x = 5 \)  
40) \(f(x) = x^3 + x^2 - 42x \)  
   for \(a = 1\)  
41) \(-3, -2, 2; \ f(x) = (x + 3)(x + 2)(x - 2) \)  
42) above the \(x\)-axis: \((2, \infty) \)  
   below the \(x\)-axis:  
   \[\left[ -\infty, -\frac{1}{9} \right] \cup \left[ -\frac{1}{9}, 2 \right] \]  
43) No  
44) not a function  
45) not a function  
46) \(\pm \frac{1}{4}, \pm \frac{1}{2}, \pm \frac{3}{4}, \pm \frac{3}{2},  
    \pm 1, \pm 2, \pm 3, \pm 6 \)  
47) \(\pm \frac{1}{2}, \pm 1, \pm 2, \pm 4, \pm 8 \)  
48) \(\pm 1, \pm 7, \pm 3, \pm 21 \)  
49) \((2, 12) \)  
50) \(x\)-intercepts: \(-5, 0\),  
y-intercept: 0  
51) \(x\)-intercepts: \(0, -6\),  
y-intercept: 0  
52) \(x\)-intercepts: \(0, \sqrt{6}, -\sqrt{6}; \ y\)-intercept: 0  
53) \((5, -25); \ x = 5 \)  
54) \((-1, 13); \ x = -1 \)  
55) \(\begin{cases}  
   4x + 9y + 5z = -2 \\
   6x + 8z = 4 \\
   3x + 5y = 2 \end{cases} \)  
56) Yes; \(f(x) = (x - 1)(4x^3  
   - 5x^2 + 4x - 5) \)  
57) Yes; \(f(x) = \left\{ \begin{array}{c}
   x - \frac{1}{4} \\
   \frac{1}{6} \end{array} \right\} \)  
   \(\{ \begin{array}{c}
   x \leq 0 \\
   \frac{1}{6} \end{array} \right\} \)  
58) \([0, 8) \)  
59) 2.24  
60) -0.38  
61) -2.62  
62) \((x - 8)^2 + (y - 7)^2 = 17 \)  
63) function  
   domain: \([7.22, 7.222, 5 \frac{5}{7}, 0.71] \)  
   range: \([11.72, -11.7, 0, -7] \)  
64) No; it is a ratio of  
   polynomials  
65) Yes; degree \(4 \)  
66) \((-10, 3), (-9, 1), (-8, -1), (-7, -3)\);  
   \(D = \{ -10, -9, -8, -7 \}; R = \{ 3, 1, -1, -3 \} \)  
67) \(x = 8, y = 8, z = 5 \)  
68) \(\begin{array}{c}
   10 \ 8 \\
   9 \ 9 \end{array} \)  
69) \(\begin{array}{c}
   1 \ 2 \ 2 \end{array} \)  
70) \(\begin{array}{c}
   5 \ 3 \ 28 \end{array} \)  
71) \(y = -\sqrt{x + 3} + 7 \)  
72) \(V = 90 \text{ in}^3 \)  
73) decreasing on \((-\infty, -6) \)  
   increasing on \((-6, \infty) \)  
74) \(f(x) = -\frac{10}{3}x^3 + 6x^2 +  
   \frac{13}{3}x - 2 \)