

## Chapter 2

- The equation of the line tangent to the graph of  $f(x) = x^2 + 3x$  at  $x = 2$  is  
 A)  $y = 7x - 4$  B)  $y = 7x - 422$  C)  $y = 7x - 2$  D)  $y = 7x - 144$   
 Ans: A Difficulty: moderate Section: 2.1
- The equation of the line tangent to the graph of  $f(x) = x^2 + 8x$  at  $x = 7$  is  
 A)  $y = 22x - 49$  B)  $y = 22x - 2,744$  C)  $y = 22x - 7$  D)  $y = 22x - 343$   
 Ans: A Difficulty: moderate Section: 2.1
- The equation of the line tangent to the graph of  $f(x) = 3\sqrt{x}$  at  $x = 1$  is  
 A)  $y = \frac{1}{2}x - \frac{1}{2}$  B)  $y = \frac{1}{2}x + \frac{1}{2}$  C)  $y = \frac{3}{2}x + \frac{3}{2}$  D)  $y = \frac{3}{2}x - 1$   
 Ans: C Difficulty: moderate Section: 2.1
- For  $f(x) = 1 - x^2$ , find the slope of the secant line connecting the points whose  $x$ -coordinates are  $x = -4$  and  $x = -3.9$ . Then use calculus to find the slope of the line that is tangent to the graph of  $f$  at  $x = -4$ .  
 Ans: Slope of secant line: 7.9; Slope of tangent line: 8  
 Difficulty: moderate Section: 2.1
- For  $f(x) = -\frac{3}{\sqrt{x}}$ , find the average rate of change of  $f(x)$  with respect to  $x$  as  $x$  changes from 144 to 145. Then use calculus to find the instantaneous rate of change at  $x = 144$ . Round your answer to six decimal places, if necessary.  
 A) Average rate of change: 0.000864; Instantaneous rate of change:  $-0.125$   
 B) Average rate of change:  $-0.000864$ ; Instantaneous rate of change: 0.000868  
 C) Average rate of change:  $-0.000864$ ; Instantaneous rate of change: 0.125  
 D) Average rate of change: 0.000864; Instantaneous rate of change: 0.000868  
 Ans: D Difficulty: hard Section: 2.1
- If  $f(x)$  represents the price per barrel of oil in terms of time, what does  $\frac{f(x_0 + h) - f(x_0)}{h}$  represent? What about  $\lim_{h \rightarrow 0} \frac{f(x_0 + h) - f(x_0)}{h}$ ?  
 Ans: The average rate of change of oil price with respect to time on the time interval  $[x_0, x_0 + h]$ ; the instantaneous rate of change of oil price with respect to time at time  $x_0$ .  
 Difficulty: easy Section: 2.1
- True or False: Differentiating  $f(x) = x^3 - 3x + 1$  gives  $3x^2$ .  
 A) True B) False  
 Ans: B Difficulty: easy Section: 2.2

8. True or False: Differentiating  $f(x) = x^6 - 5x + 2$  gives  $6x^5$ .

A) True B) False

Ans: B Difficulty: easy Section: 2.2

9. Differentiate:  $f(x) = x^8 + 2$

A)  $8x^7 + 2$  B)  $8x^9 + 2x$  C)  $8x^7$  D)  $7x^7$

Ans: C Difficulty: easy Section: 2.2

10. Differentiate:  $f(x) = x^4 + 7$

A)  $4x^3$  B)  $4x^3 + 7$  C)  $4x^5 + 7x$  D)  $3x^3$

Ans: A Difficulty: easy Section: 2.2

11. True or False: Differentiating  $f(x) = \frac{1}{3}x^7 - 2x^5 + 9x - 8$  gives  $\frac{7x^6}{3} - 10x^4 + 9$ .

A) True B) False

Ans: A Difficulty: easy Section: 2.2

12. True or False: Differentiating  $f(x) = \frac{1}{5}x^6 - 3x^4 + 2x - 4$  gives  $\frac{6}{5}x^5 - 12x^3 + 2$ .

A) True B) False

Ans: A Difficulty: easy Section: 2.2

13. If  $f(x) = \sqrt[3]{x} - \frac{1}{\sqrt{x}}$ , differentiate  $f(x)$ .

Ans:  $f'(x) = \frac{1}{3x^{2/3}} + \frac{1}{2x^{3/2}}$

Difficulty: moderate Section: 2.2

14. Differentiate:  $f(x) = \sqrt{x} + \frac{1}{\sqrt{x}}$

A) 0 B)  $x$  C)  $\frac{1}{2\sqrt{x}} + \frac{1}{2\sqrt{x^3}}$  D)  $\frac{1}{2\sqrt{x}} - \frac{1}{2\sqrt{x^3}}$

Ans: D Difficulty: easy Section: 2.2

15. Differentiate:  $f(x) = \sqrt{x} + \frac{5}{\sqrt{x}}$

A)  $\frac{1}{2\sqrt{x}} - \frac{5}{2\sqrt{x^3}}$  B) 0 C) 5 D)  $\frac{1}{2\sqrt{x}} + \frac{5}{2\sqrt{x^3}}$

Ans: A Difficulty: easy Section: 2.2

16. Differentiate:  $f(x) = \sqrt[7]{x} - \frac{3}{\sqrt{x}}$

Ans:  $\frac{1}{7}x^{-6/7} + \frac{3}{2}x^{-3/2}$

Difficulty: moderate Section: 2.2

17. Differentiate:  $f(x) = \frac{2}{3}x^6 - \frac{5x}{6} + \frac{2}{3x} - \sqrt[5]{x}$

Ans:  $f'(x) = 4x^5 - \frac{5}{6} - \frac{2}{3x^2} - \frac{1}{5x^{4/5}}$

Difficulty: easy Section: 2.2

18. Differentiate:  $f(x) = \frac{2}{3}x^6 - \frac{7}{3}x + \frac{8}{7x} - \sqrt[6]{x}$

Ans:  $4x^5 - \frac{7}{3} - \frac{8}{7x^2} - \frac{1}{6x^{5/6}}$

Difficulty: easy Section: 2.2

19. Find the equation of the tangent line to the curve  $f(x) = x^3 - x^2 + 7$  at the point (1, 7).

Ans:  $y = x + 6$ .

Difficulty: moderate Section: 2.2

20. Find the equation of the tangent line to the curve  $f(x) = x^3 - x^2 + 1$  at the point (1, 1).

Ans:  $y = x$

Difficulty: moderate Section: 2.2

21. Find the equation of the tangent to the graph of  $f(x) = x^2 - 9x + 16$  at the point (1, 8).

Ans:  $y = -7x + 15$

Difficulty: moderate Section: 2.2

22. Find the equation of the tangent to the graph of  $f(x) = x^2 + 2x + 9$  at the point (1, 12).

Ans:  $y = 4x + 8$

Difficulty: moderate Section: 2.2

23. Find the equation of the tangent line to the graph of  $f(x) = x^2 + 1$  at (1, 2).

A) Not defined B)  $y = 2$  C)  $x = 1$  D)  $y = 2x$

Ans: D Difficulty: moderate Section: 2.2

24. Find the equation of the tangent line to the graph of  $f(x) = x^2 + 1$  at the point (4, 17).

A)  $y = 8x - 15$  B) Not defined C)  $y = 17$  D)  $x = 4$

Ans: A Difficulty: moderate Section: 2.2

25. Find the equation of the line that is tangent to the curve  $f(x) = 5 + 3x^2 - x^5$  at the point (1, 7).

Ans:  $y = x + 6$

Difficulty: moderate Section: 2.2

26. Find the equation of the line that is tangent to the curve  $f(x) = 5 + 2x^2 - x^3$  at the point (1, 6).

Ans:  $y = x + 5$

Difficulty: moderate Section: 2.2

27. True or False: The equation of the line tangent to the graph of  $f(x) = \sqrt{x} + 3$  that passes through (1, 4) is  $y = 2x + 3$ .

A) True B) False

Ans: B Difficulty: moderate Section: 2.2

28. True or False: The equation of the line tangent to the graph of  $f(x) = \sqrt{x} + 2$  that passes through (25, 7) is  $y = 2x + 2$ .

A) True B) False

Ans: B Difficulty: moderate Section: 2.2

29. Find the equation of the tangent line to the graph of  $f(x) = \frac{1}{x}$  at  $\left(2, \frac{1}{2}\right)$ .

A)  $y = -\frac{x}{4} + 1$  B)  $y = -\frac{x}{2} + 1$  C)  $y = -x + 1$  D)  $y = \frac{x}{2} + 1$

Ans: A Difficulty: moderate Section: 2.2

30. Find the equation of the tangent line to the graph of  $f(x) = \frac{1}{x}$  at the point  $\left(6, \frac{1}{6}\right)$ .

A)  $y = -\frac{1}{36}x + \frac{1}{3}$  B)  $y = -\frac{1}{6}x + \frac{1}{3}$  C)  $y = \frac{1}{36}x$  D)  $y = \frac{1}{6}x + \frac{1}{3}$

Ans: A Difficulty: moderate Section: 2.2

31. Find the equation of the tangent line to the curve  $f(x) = \frac{4}{x} - x$  at the point where  $x = 1$ .

Ans:  $y = -5x + 8$ .

Difficulty: moderate Section: 2.2

32. Find the equation of the tangent line to the curve  $f(x) = \frac{4}{x} - x$  at the point where  $x = 1$ .

Ans:  $y = -5x + 8$

Difficulty: moderate Section: 2.2

33. Find the rate of change of the given function  $f(x)$  with respect for  $x$  for the prescribed value  $x = -1$ .

$$f(x) = x^3 + 4x - 3$$

A) 1   B) 7   C) 4   D) -2

Ans: B   Difficulty: moderate   Section: 2.2

34. Find the relative rate of change of  $f(x)$  with respect to  $x$  for the prescribed value  $x = 1$ .

$$f(x) = 5x^3 - x^2 + 5$$

A) 13   B)  $\frac{1}{13}$    C)  $\frac{9}{13}$    D)  $\frac{13}{9}$

Ans: D   Difficulty: moderate   Section: 2.2

35. The gross national product (GNP) of a certain country is  $N(t) = t^2 + 3t + 121$  billion dollars where  $t$  is the number of years after 1990. At what percentage rate will the GNP be changing with respect to time in 1995? Round your answer to one hundredth of a percent, if necessary.

Ans: 8.07%

Difficulty: hard   Section: 2.2

36. True or False: An environmental study of a certain suburban community suggests that  $t$  years from now the average level of carbon monoxide in the air will be  $Q(t) = 0.07t^2 + 0.2t + 2.8$  ppm. The rate that the carbon monoxide level will change with respect to time 2 years from now will be 0.048 ppm/yr.

A) True   B) False

Ans: B   Difficulty: hard   Section: 2.2

37. True or False: The gross annual earnings of a certain company were  $E(t) = 0.2t^2 + 9t + 30$  thousand dollars where  $t$  is the number of years since its formation in 1990. The gross annual earnings with respect to  $t$  in 1995 are growing at 13.75%.

A) True   B) False

Ans: A   Difficulty: hard   Section: 2.2

38. True or False: An environmental study of a certain suburban community suggests that  $t$  years from now the average level of carbon monoxide in the air will be

$Q(t) = 0.07t^2 + 0.6t + 2.8$  parts per million (ppm). The rate that the carbon monoxide level will change with respect to time 3 years from now will be 0.42 ppm/yr.

A) True   B) False

Ans: B   Difficulty: hard   Section: 2.2

39. An appliance store manager estimates that for  $x$  television ads run per day,  $R(x) = -0.01x^3 + x^2 - 3x + 200$  refrigerators will be sold per month. Find  $R'(4)$  and interpret what it tells us about sales.
- A)  $R'(4) = 203.36$ ; they'll sell about 203 refrigerators if they run 4 ads per day.  
 B)  $R'(4) = 4.52$ ; they'll sell about 5 refrigerators if they run 4 ads per day.  
 C)  $R'(4) = 4.52$ ; sales will be increasing at about 5 refrigerators per month per ad when they're running 4 ads.  
 D)  $R'(4) = 203.36$ ; the cost of refrigerators will be rising by \$203.36 if they're selling 4 per day.
- Ans: C Difficulty: easy Section: 2.2
40. An efficiency study at a certain factory indicates that an average worker who arrives on the job at 8:00 A.M. will have produced  $Q(t) = -t^3 + 6t^2 + 18t$  units  $t$  hours later. At what rate, in units/hour, is the worker's rate of production changing with respect to time at 9:00 A.M.?
- Ans: 27 units/hour  
 Difficulty: hard Section: 2.2
41. The displacement function of a moving object is described by  $s(t) = t^2 + 5t - 2$ . What is the object's acceleration?
- A)  $2t + 5$  B)  $2t$  C)  $t$  D) 2
- Ans: D Difficulty: hard Section: 2.2
42. The displacement function of a moving object is described by  $s(t) = t^2 + 3t - 7$ . What is the acceleration of the object as a function of time?
- A) 2 B)  $2t + 3$  C)  $2t$  D)  $t$
- Ans: A Difficulty: moderate Section: 2.2
43. If the position of an object moving along a straight line is given by  $s(t) = t^3 - 7t^2 + 8t$  at time  $t$ , find the object's velocity as a function of time.
- A)  $v(t) = 3t^2 - 7t + 8$  C)  $v(t) = t^2 - 7t + 8$   
 B)  $v(t) = t^2 - 14t$  D)  $v(t) = 3t^2 - 14t + 8$
- Ans: D Difficulty: moderate Section: 2.2
44. The displacement function of a moving object is described by  $s(t) = t^3 + 2t - 1$ . What is the velocity of the object as a function of  $t$ ?
- A)  $3t^2$  B)  $3t^2 + 2$  C) 3 D) 2
- Ans: B Difficulty: easy Section: 2.2

45. An object moves along a line in such a way that its position at time  $t$  is  $s(t) = t^3 - 39t^2 + 459t + 2$ . Find the velocity and acceleration of the object at time  $t$ . When is the object stationary?
- A)  $v(t) = 3t^2 - 78t + 459$ ;  $a(t) = 6t - 78$ ;  $t = 9$  and  $17$   
 B)  $v(t) = 3t^2 - 78t + 459$ ;  $a(t) = 6t - 78$ ;  $t = 13$   
 C)  $v(t) = 3t^2 - 26t + 459$ ;  $a(t) = 6t - 26$ ;  $t = 9$   
 D)  $v(t) = 3t^2 - 78t + 459$ ;  $a(t) = 6t - 78$ ;  $t = 9$   
 Ans: A Difficulty: moderate Section: 2.2
46. The displacement function of a moving object is described by  $s(t) = t^3 + 5t - 4$ . What is the velocity of the object as a function of time?
- A)  $3t^2 + 5$  B)  $3t^2$  C) 3 D) 2  
 Ans: A Difficulty: easy Section: 2.2
47. True or False: If the displacement of a moving object is  $s(t) = t^3$ , the acceleration is  $6t$ .
- A) True B) False  
 Ans: A Difficulty: easy Section: 2.2
48. True or False: If the displacement of a moving object is  $s(t) = 3t^3$ , the acceleration is  $18t$ .
- A) True B) False  
 Ans: A Difficulty: easy Section: 2.2
49. If an object moves in such a way that after  $t$  seconds, the distance from its starting point is  $D(t) = t^3 - 15t^2 + 80t$  meters, find the acceleration after 2 seconds in meters/s<sup>2</sup>.
- Ans:  $-18$  meters/s<sup>2</sup>  
 Difficulty: hard Section: 2.2
50. Differentiate:  $f(x) = (x^2 + 1)(x + 3)$
- A)  $2x + 1$  B)  $6x + 1$  C)  $3x^2 + 6x + 1$  D)  $x^2 + 1$   
 Ans: C Difficulty: moderate Section: 2.3
51. Differentiate:  $f(x) = (x^2 + 2)(x + 4)$
- A)  $3x^2 + 8x + 2$  B)  $2x + 1$  C)  $16x + 1$  D)  $x^2 + 1$   
 Ans: A Difficulty: moderate Section: 2.3
52. What is the rate of change of  $f(t) = \frac{7t - 4}{t + 3}$  with respect to  $t$  when  $t = 3$ ?
- A)  $\frac{25}{36}$  B)  $\frac{19}{6}$  C) 6 D)  $\frac{5}{3}$   
 Ans: A Difficulty: hard Section: 2.3

53. If  $f(x) = \frac{5x-1}{7x+5}$ , what is  $f'(x)$ ?

Ans:  $f'(x) = \frac{32}{(7x+5)^2}$

Difficulty: moderate Section: 2.3

54. If  $f(x) = \frac{3x-1}{x+1}$ , what is  $f'(x)$ ?

Ans:  $\frac{4}{(x+1)^2}$

Difficulty: moderate Section: 2.3

55. Differentiate:  $f(x) = \frac{x^2}{x-2}$

A)  $\frac{x^2-4x}{(x-2)^2}$  B)  $\frac{x^2+4x}{(x-2)^2}$  C)  $2x$  D)  $-x$

Ans: A Difficulty: moderate Section: 2.3

56. Differentiate:  $f(x) = \frac{x^2}{x-2}$

A)  $\frac{x^2-4x}{(x-2)^2}$  B)  $\frac{3x^2+4x}{(x-2)^2}$  C)  $2x$  D)  $-x$

Ans: A Difficulty: moderate Section: 2.3

57. If  $f(x) = \frac{4-5x^2}{x^3+6x-5}$ , what is  $f'(x)$ ?

Ans:  $f'(x) = \frac{5x^4-42x^2+50x-24}{(x^3+6x-5)^2}$

Difficulty: hard Section: 2.3

58. If  $f(x) = \frac{2-3x^2}{x^3+x-1}$ , what is  $f'(x)$ ?

Ans:  $\frac{3x^4-9x^2+6x-2}{(x^3+x-1)^2}$

Difficulty: hard Section: 2.3

59. True or False: The equation of the line that is tangent to the curve

$$f(x) = (3x^5 - 7x^2 + 5)(x^3 + x - 1) \text{ at the point } (0, -5) \text{ is } y = 5x - 5.$$

A) True B) False

Ans: A Difficulty: hard Section: 2.3

60. True or False: The equation of the tangent line to the curve

$$f(x) = (7x^5 - 6x^2 + 3)(x^3 + x - 1) \text{ at the point } (0, -3) \text{ is } y = 3x - 3.$$

A) True B) False

Ans: A Difficulty: hard Section: 2.3

61. Find the equation of the line that is tangent to the curve  $f(x) = \frac{5x^2 - 7x + 1}{5 - 4x^3}$  at the point

$(1, -1)$ .

Ans:  $y = -9x + 8$

Difficulty: hard Section: 2.3

62. Find the equation of the tangent line to the curve  $f(x) = \frac{4x^2 - 5x + 8}{6 - 5x^3}$  at the point  $(1, 7)$ .

Ans:  $y = 108x - 101$

Difficulty: hard Section: 2.3

63. What is the rate of change of  $f(t) = \frac{2t - 3}{t + 5}$  with respect to  $t$  when  $t = 5$ ?

A)  $\frac{13}{100}$  B)  $\frac{17}{10}$  C) 10 D)  $\frac{7}{10}$

Ans: A Difficulty: hard Section: 2.3

64. What is the rate of change of  $f(t) = \frac{8t - 3}{t + 6}$  with respect to  $t$  when  $t = 45$ ?

A)  $\frac{1}{51}$  B)  $-\frac{1}{51}$  C) 51 D) -51

Ans: A Difficulty: hard Section: 2.3

65. Find the equation of the normal line to  $f(x) = 4x^3 - 8x + 49$  at the point with  $x$ -coordinate  $-2$ .

Ans:  $y = -\frac{1}{40}x + \frac{659}{20}$

Difficulty: moderate Section: 2.3

66. Find an equation for the tangent line to the curve  $y = \sqrt{2 + \frac{1}{5}x}$  at the point where  $x = -1$ .

Ans:  $y = \frac{\sqrt{5}}{30}x + \frac{19\sqrt{5}}{30}$

Difficulty: hard Section: 2.3

67. Find  $f''(x)$ , where  $f(x) = \frac{3}{1+x^3}$ .

Ans:  $\frac{-18x(1-2x^3)}{(1+x^3)^3}$

Difficulty: hard Section: 2.3

68. Find  $f''(x)$ , where  $f(x) = x^3 + 4$ .

Ans:  $6x$

Difficulty: easy Section: 2.3

69. The temperature in degrees Fahrenheit inside an oven  $t$  minutes after turning it on can be modeled with the function

$$F(t) = \frac{400t + 70}{t + 1}. \text{ Find } F'(5) \text{ and interpret what it tells us about the temperature.}$$

Round your answer to 2 decimal places.

Ans:  $F'(5) = 9.17$ ; After 5 minutes, the temperature is increasing at the rate of 9.17 degrees per minute.

Difficulty: easy Section: 2.3

70. It is estimated that  $t$  years from now, the population of a certain suburban community will be  $p(t) = 20 - \frac{2}{4t+3}$  thousand people. At what rate will the population be growing 3 years from now?

Ans: 36 people/year

Difficulty: hard Section: 2.3

71. Find  $f^{(4)}(x)$  if  $f(x) = x^5 - 7x^4 + 4x^3 - 6x^2 + 11x - 7$ .

A)  $f^{(4)}(x) = 60x^2 - 168x + 24$

C)  $f^{(4)}(x) = x^2 - 7x$

B)  $f^{(4)}(x) = 120x - 168$

D)  $f^{(4)}(x) = x^2 - 7x + 4$

Ans: B Difficulty: moderate Section: 2.3

72. True or False: If  $f(x) = 3x^5 - 7x^3 + 2x^2 + 5$ , then  $f'''(x) = 180x^2 - 42$ .

A) True B) False

Ans: A Difficulty: moderate Section: 2.3

73. Find  $f'''(x)$  if  $f(x) = \frac{1}{\sqrt{3x}} - \frac{1}{x^2} + \sqrt{6}$ .

A)  $f'''(x) = -\frac{3}{8x^3\sqrt{3x}} + \frac{1}{x^3}$

C)  $f'''(x) = -\frac{15}{8x^3\sqrt{3x}} + \frac{24}{x^5}$

B)  $f'''(x) = -\frac{15}{16x^3\sqrt{3x}} + \frac{24}{x^5}$

D)  $f'''(x) = -\frac{5}{72x^3\sqrt{3x}} + \frac{24}{x^5}$

Ans: C Difficulty: moderate Section: 2.3

74. Find  $\frac{dy}{dx}$  if  $y = \sqrt[3]{u}$  and  $u = x^4 - 3x^3 - 7$ .

Ans:  $\frac{4x^3 - 9x^2}{3\sqrt[3]{(x^4 - 3x^3 - 7)^2}}$

Difficulty: hard Section: 2.4

75. Find  $\frac{dy}{dx}$  if  $y = u^3 + 2u^2 - 3$  and  $u = x^2 + x - 1$ .

Ans:  $6x^5 + 15x^4 + 8x^3 - 3x^2 - 4x - 1$

Difficulty: hard Section: 2.4

76. Find  $\frac{dy}{dx}$  if  $y = u^3 + 7u^2 - 6$  and  $u = x^2 + x - 8$ .

Ans:  $3(2x+1)(x^2+x-8)^2 + 28x^3 + 42x^2 - 210x - 112$

Difficulty: hard Section: 2.4

77. Find  $\frac{dy}{dx}$  if  $y = \sqrt[3]{u}$  and  $u = x^4 - 6x^3 - 2$ .

Ans:  $\frac{4x^3 - 18x^2}{3(x^4 - 6x^3 - 2)^{2/3}}$

Difficulty: hard Section: 2.4

78. Find  $\frac{dy}{dx}$  if  $y = \frac{1}{3u-1}$  and  $u = \frac{1}{x+2}$ .

Ans:  $\frac{3}{(1-x)^2}$

Difficulty: hard Section: 2.4

79. Find  $\frac{dy}{dx}$  if  $y = \frac{1}{7u-1}$  and  $u = \frac{1}{x+3}$ .

Ans:  $\frac{7}{(4-x)^2}$

Difficulty: hard Section: 2.4

80. True or False: If  $f(x) = \frac{(3-5x)^3}{(x^2+x-1)^2}$ , then  $f'(x) = -5(2x+1)$ .

A) True B) False

Ans: B Difficulty: moderate Section: 2.4

81. True or False: If  $f(x) = \frac{x^2-3x+5}{\sqrt{1-3x}}$ , then  $f'(x) = \frac{2x-3}{\sqrt{1-3x}}$ .

A) True B) False

Ans: B Difficulty: moderate Section: 2.4

82. True or False: An equation for the tangent line to the curve  $f(x) = \sqrt{3x^2+5x}$  at the point where  $x = 1$  is  $y = 2x - 1$ .

A) True B) False

Ans: B Difficulty: moderate Section: 2.4

83. An equation for the tangent line to the curve  $y = (x^2+x-1)^3$  at the point where  $x = 1$  is:

A)  $y = 9x - 8$  B)  $y = 9x$  C)  $y = 2x + 1$  D)  $y = 9x - 1$

Ans: A Difficulty: moderate Section: 2.4

84. Find an equation for the tangent line to the curve  $y = (7x^2+x-1)^3$  at the point where  $x = 0$ .

A)  $y = 14x + 1$  B)  $y = 24x + 3$  C)  $y = 3x + 1$  D)  $y = 3x - 1$

Ans: D Difficulty: moderate Section: 2.4

85. An equation for the tangent line to the curve  $y = (x^3+x-1)^3$  at the point where  $x = 1$  is

A)  $y = 12x - 11$  B)  $y = 12x$  C)  $y = 3x + 1$  D)  $y = 12x - 1$

Ans: A Difficulty: moderate Section: 2.4

86. An equation for the tangent line to the curve  $y = (3x^2+x-1)^5$  at the point where  $x = 0$  is

A)  $y = 5x - 1$  B)  $y = 10x + 1$  C)  $y = 5x + 1$  D)  $y = 10x - 1$

Ans: A Difficulty: moderate Section: 2.4

87. True or False: An equation for the tangent line to the curve  $f(x) = x^3(1-3x)^2$  at the point where  $x = -1$  is  $y = 72x + 56$ .

A) True B) False

Ans: A Difficulty: moderate Section: 2.4

88. Find an equation for the tangent line to the curve  $y = \sqrt{4 + \frac{x}{4}}$  at the point where  $x = -1$ .

Round numbers to two decimal places.

Ans:  $y = 0.06x + 2.00$

Difficulty: hard Section: 2.4

89. Find all points on the graph of the function  $f(x) = x^3(5x + 20)$  where the tangent line is horizontal.

Ans:  $(0, 0)$  and  $(-3, -135)$

Difficulty: moderate Section: 2.4

90. Find all points on the graph of the function  $f(x) = \frac{x^2}{x+2}$  where the tangent line is horizontal.

A) There are none. B)  $(2, 1)$  C)  $(0, 0)$  and  $(-4, -8)$  D)  $(0, 0)$

Ans: C Difficulty: moderate Section: 2.4

91. True or False: If  $f(x) = x\sqrt{2-x}$ , then  $f''(x) = 0$  at  $x = 0$  and  $x = 2$ .

A) True B) False

Ans: B Difficulty: hard Section: 2.4

92. True or False: If  $f(x) = \sqrt{1-3x^2}$ , then  $f''(x) = \frac{-3}{(1-3x^2)^{3/2}}$ .

A) True B) False

Ans: B Difficulty: moderate Section: 2.4

93. If  $g(y) = \sqrt{5y + y^2}$  represents the height in inches of a sapling  $y$  weeks after germination, find  $g'(6)$  and interpret what it tells us about the height of the tree. Round your answer to 1 decimal place.

Ans: after 6 weeks, the tree is growing at 1.0 inches per week.

Difficulty: easy Section: 2.4

94. At a certain factory, the total cost of manufacturing  $q$  units during the daily production run is  $C(q) = 0.3q^2 + 0.8q + 800$  dollars. It has been determined that approximately  $q(t) = t^2 + 80t$  units are manufactured during the first  $t$  hours of a production run. Compute the rate at which the total manufacturing cost is changing with respect to time 2 hours after production begins.  
 Ans: It is increasing at \$8,332.80/hour  
 Difficulty: hard Section: 2.4
95. When toasters are sold for  $p$  dollars apiece, local consumers will buy  $D(p) = \frac{57,600}{p}$  toasters a month. It is estimated that  $t$  months from now, the price of the toasters will be  $p(t) = 0.03t^{3/2} + 22.08$  dollars. Compute the rate at which the monthly demand for the toasters will be changing with respect to time 16 months from now.  
 Ans: Decreasing by 18 toasters/month  
 Difficulty: hard Section: 2.4
96. True or False: When a certain commodity is sold for  $p$  dollars per unit, consumers will buy  $D(p) = \frac{30,000}{p}$  units per month. It is estimated that  $t$  months from now, the price of the commodity will be  $p(t) = 0.3t^{5/2} + 5.4$  dollars per unit. The monthly demand will be decreasing 40 months from now.  
 A) True B) False  
 Ans: A Difficulty: hard Section: 2.4
97. When a certain commodity is sold for  $p$  dollars per unit, consumers will buy  $D(p) = \frac{31,500}{p}$  units per month. It is estimated that  $t$  months from now, the price of the commodity will be  $p(t) = t^{2/3} + 5.15$  dollars per unit. The approximate rate at which the monthly demand will be changing with respect to time in 27 months is  
 A) -35 units per month C) -32 units per month  
 B) 35 units per month D) -132 units per month  
 Ans: A Difficulty: hard Section: 2.4
98. It is estimated that  $t$  years from now, the population of a certain suburban community will be  $p(t) = 50 - \frac{7}{2t+1}$  thousand people. At what rate, in people/year will the population be growing 3 years from now?  
 Ans: 286 people/year  
 Difficulty: hard Section: 2.4

99. True or False: It is estimated that  $t$  years from now, the population of a certain suburban community will be  $p(t) = 30 - \frac{7}{2t+1}$  thousand. An environmental study indicates that the average daily level of carbon monoxide in the air will be  $C(p) = 0.3\sqrt{p^2 + p + 30}$  parts per million (ppm) when the population is  $p$  thousand. The rate at which the level of pollution is changing with respect to time 3 years from now is about 0.084 ppm per year.  
 A) True B) False  
 Ans: A Difficulty: hard Section: 2.4

100. It is estimated that  $t$  years from now, the population of a certain community will be  $p(t) = 14 - \frac{6}{3+t}$  thousand. An environmental study indicates that the average daily level of carbon monoxide in the air will be  $C(p) = 0.5\sqrt{p^2 + 2p + 30}$  units when the population is  $p$  thousand. The rate at which the level of carbon monoxide will be changing 3 years from now is  
 A)  $-0.078$  ppm per thousand people C)  $1.000$  ppm per thousand people  
 B)  $0.078$  ppm per thousand people D)  $-1.000$  ppm per thousand people  
 Ans: B Difficulty: hard Section: 2.4

101. True or False: The function  $f(x) = \frac{x}{2x+1} - 5$  will decrease by approximately 0.6 as  $x$  decreases from 3 to 2.7.  
 A) True B) False  
 Ans: B Difficulty: hard Section: 2.5

102. The largest percentage error you can allow in the measurement of the radius of a sphere if you want the error in the calculation of its surface area using the formula  $S = 4\pi r^2$  to be no greater than 6 percent is about:  
 A) 6% B) 3% C) 1% D) 2%  
 Ans: B Difficulty: hard Section: 2.5

103. You measure the side of a cube to be 14 centimeters long and conclude that the volume of the cube is  $14^3 = 2,744$  cubic centimeters. If your measurement of the side is accurate to within 5%, approximately how accurate is your calculation of this volume? Round to two decimal places, if necessary.  
 A) Maximum error in volume is about  $\pm 29.4 \text{ cm}^3$   
 B) Maximum error in volume is about  $\pm 411.6 \text{ cm}^3$   
 C) Maximum error in volume is about  $\pm 2.1 \text{ cm}^3$   
 D) Maximum error in volume is about  $\pm 5,762.4 \text{ cm}^3$   
 Ans: B Difficulty: moderate Section: 2.5

104. If the total cost of manufacturing  $q$  units of a certain commodity is  $C(q) = (3q + 1)(5q + 7)$ , use marginal analysis to estimate the cost of producing the 19th unit, in dollars.

Ans: 596 dollars

Difficulty: hard Section: 2.5

105. An efficiency study of the morning shift at a certain factory indicates that an average worker arriving on the job at 8:00 A.M. will have assembled  $f(x) = -x^3 + 10x^2 - 3x$  transistor radios  $x$  hours later. Approximately how many radios will the worker assemble between 10:00 and 10:15 A.M.?

A) Approximately 25 radios

C) Approximately 6 radios

B) Approximately 375 radios

D) Approximately 26 radios

Ans: C Difficulty: moderate Section: 2.5

106. True or False: If  $x^3 + y^3 = x + y$ , then  $\frac{dy}{dx} = \frac{3x^2 - 1}{3y^2 - 1}$ .

A) True B) False

Ans: B Difficulty: moderate Section: 2.6

107. Find  $\frac{dy}{dx}$ , where  $xy^3 - 3x^2 = 7y$ .

A)  $y^3 - 6x - 7$  B)  $\frac{6x - y^3}{3xy^2 - 7}$  C)  $y^3 - 6x$  D)  $\frac{6x^2}{y^3}$

Ans: B Difficulty: moderate Section: 2.6

108. Find  $\frac{dy}{dx}$ , where  $\sqrt{x} + \sqrt{y} = xy$ .

Ans:  $\frac{\sqrt{y}(2\sqrt{xy} - 1)}{\sqrt{x}(1 - 2x\sqrt{y})}$

Difficulty: moderate Section: 2.6

109. Find  $\frac{dy}{dx}$ , where  $\frac{3}{x} + \frac{1}{2y} = 5$ .

Ans:  $-\frac{6y^2}{x^2}$

Difficulty: moderate Section: 2.6

110. True or False: If  $x^2 + 3xy + y^2 = 15$ , then  $\frac{dy}{dx} = 2x + 3y$ .

A) True B) False

Ans: B Difficulty: moderate Section: 2.6

111. True or False: If  $x^2y + xy^2 = 7$ , then  $\frac{dy}{dx} = 2xy + y^2$ .

A) True B) False

Ans: B Difficulty: moderate Section: 2.6

112. True or False: If  $x^2 + 2y^2 = 5$ , then  $\frac{dy}{dx} = 2x$ .

A) True B) False

Ans: B Difficulty: moderate Section: 2.6

113. Find an equation for the tangent line to the curve  $x^3 + xy + y^3 = x$  at the point  $(1, 0)$ .

Ans:  $y = -2x + 2$

Difficulty: hard Section: 2.6

114. Find the slope of the tangent line to the curve  $x^2 + 3xy - y^2 = 3$  at the point  $(1, 1)$ .

A) 5 B) 1 C) -5 D) 3

Ans: C Difficulty: hard Section: 2.6

115. Find an equation for the tangent line to the curve  $x^2 + y^3 = xy + 1$  at the point  $(1, -1)$ .

Ans:  $y = -\frac{3}{2}x + \frac{1}{2}$

Difficulty: hard Section: 2.6

116. Find the equation of the tangent line to the given curve at the specified point:

$x^2y^5 - 4xy = 3x + y - 8$ ;  $(0, 8)$

A)  $y = \frac{1}{35}x + 8$  B)  $y = -\frac{1}{35}x + 8$  C)  $y = -35x + 8$  D)  $y = 35x + 8$

Ans: C Difficulty: moderate Section: 2.6

117. True or False: The equation for the tangent line to the curve  $x^2 + 2xy = y^3$  at the point  $(1, -1)$  is  $y = -1$ .

A) True B) False

Ans: A Difficulty: hard Section: 2.6

118. Use implicit differentiation to find  $\frac{d^2y}{dx^2}$  for  $4x^5 + 11y = 100$ .

A)  $80x^3$  B)  $-\frac{80}{11}x^3$  C)  $60x^2 + 11$  D)  $60x^2 - 100$

Ans: B Difficulty: easy Section: 2.6

119. In a certain factory, output  $Q$  is related to inputs  $x$  and  $y$  by the equation  $Q = 3x^3 + 5x^2y^2 + 2y^3$ . If the current levels of input are  $x = 255$  and  $y = 155$ , use calculus to estimate the change in input  $y$  that should be made to offset a decrease of 0.6 unit in input  $x$  so that output will be maintained at its current level. Round your answer to two decimal places, if necessary.
- A) An increase of 0.37                      C) It cannot be determined  
B) A decrease of 0.37                     D) No change
- Ans: A    Difficulty: moderate    Section: 2.6
120. The output at a certain plant is  $Q = 0.06x^2 + 0.15xy + 0.05y^2$  units per day, where  $x$  is the number of hours of skilled labor used and  $y$  is the number of hours of unskilled labor used. Currently 60 hours of skilled labor and 150 hours of unskilled labor are used each day. Use calculus to estimate the change in unskilled labor that should be made to offset a 1 hour increase in skilled labor so that output will remain the same. Round your answer to two decimal places, if necessary.
- A) An increase of 1.24 hours                C) It cannot be determined  
B) A decrease of 1.24 hours                D) No change
- Ans: B    Difficulty: hard    Section: 2.6
121. Suppose the output at a certain factory is  $Q = 4x^2 + 3x^3y^3 + y^5$  units, where  $x$  is the number of hours of skilled labor used and  $y$  is the number of hours of unskilled labor. The current labor force consists of 30 hours of skilled labor and 10 hours of unskilled labor. Use calculus to estimate the change in unskilled labor  $y$  that should be made to offset a 1-hour increase in skilled labor  $x$  so that output will be maintained at its current level. Round you answer to two decimal places, if necessary.
- A) -0.33 hours    B) -1 hours    C) -3.01 hours    D) 3.01 hours
- Ans: A    Difficulty: moderate    Section: 2.6