Final Exam, FORM A

1. $y = -5x + 13$

2. $7 - 3x^2 - 6xh - 3h^2$

3. (a)

(b) 1; **(c)** 0; **(d)** No

4. -57

5. Does not exist

6. $\dfrac{1}{7}$

7. 5

8. 0

9. $f'(x) = -6x$

10. -5

11. $12x^3 + 10x$

12. $\dfrac{7}{5}x^{2/5}$

13. $-11x^{-12}$

14. $(3x^2)(3x^3 + 2)^{-2/3}$

15. $\dfrac{-3x^2 - 4x - 24}{(x^2 - 8)^2}$

16. $\dfrac{2x - 6}{x^2 - 6x + 1}$

17. $5x^4$

18. $11e^x$

19. $2(3x + 1)e^{3x^2 + 2x}$

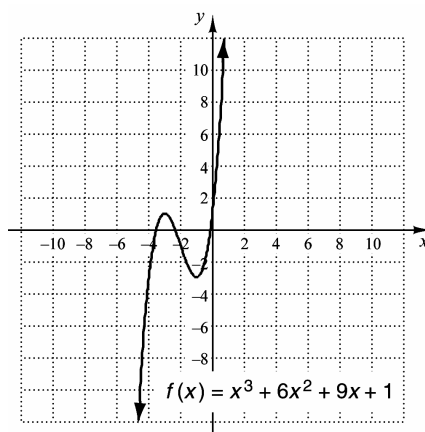**20.** $\dfrac{e^x}{e^x - 8}$

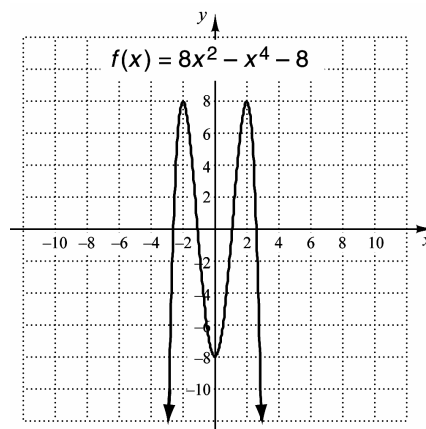**21.** $48x^2 + 6$

22. $-\$0.66/\text{box}$

23. $\dfrac{1}{8xy\sqrt{x}} - \dfrac{y}{2x}$

24. $y = 3x - 1$

25. Relative maximum at $(-3, 1)$; relative minimum at $(-1, -3)$; point of inflection at $(-2, -1)$; increasing on $(-\infty, -3)$ and $(-1, \infty)$; decreasing on $(-3, -1)$; concave up on $(-2, \infty)$; concave down on $(-\infty, 2)$
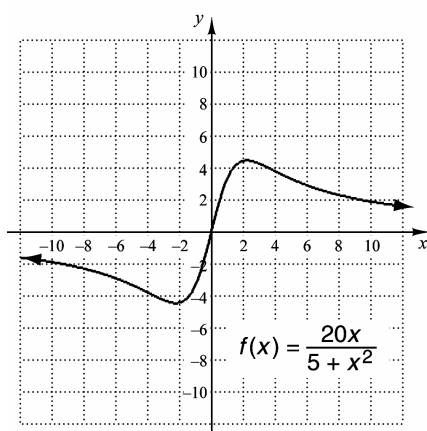

26. Relative maxima at $(-2, 8)$ and $(2, 8)$; relative minimum at $(0, -8)$; points of inflection at $\left(\frac{-2}{\sqrt{3}}, \frac{8}{9}\right)$ and $\left(\frac{2}{\sqrt{3}}, \frac{-8}{9}\right)$; increasing on $(-\infty, -2)$ and $(0, 2)$; decreasing on $(-2, 0)$ and $(2, \infty)$; concave down on $\left(-\infty, \frac{-2}{\sqrt{3}}\right)$ and $\left(\frac{2}{\sqrt{3}}, \infty\right)$; concave up on $\left(\frac{-2}{\sqrt{3}}, \frac{2}{\sqrt{3}}\right)$.
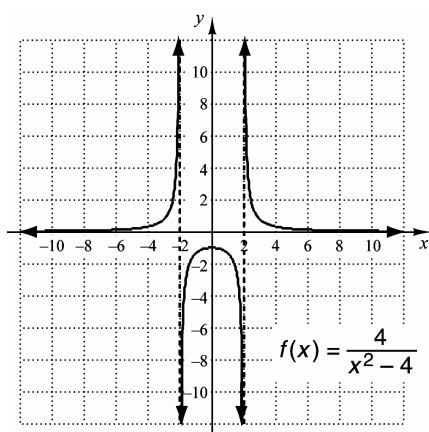
Final Exam, FORM A (Continued)

27. Relative minimum at $(-\sqrt{5}, -2\sqrt{5})$; relative maximum at $(\sqrt{5}, 2\sqrt{5})$; inflection points at $(-\sqrt{15}, -\sqrt{15}), (0, 0),$ and $(\sqrt{15}, \sqrt{15})$; increasing on $(-\sqrt{5}, \sqrt{5})$; decreasing on $(-\infty, -\sqrt{5})$ and $(\sqrt{5}, \infty)$; concave down on $(-\infty, -\sqrt{15})$ and $(0\sqrt{15})$; concave up on $(-\sqrt{15}, 0)$ and $(\sqrt{15}, 0)$; horizontal asymptote at $y = 0$.

28. Relative maximum at $(0, -1)$; no points of inflection; increasing on $(-\infty, -2)$ and $(-2, 0)$; decreasing on $(0, 2)$ and $(2, \infty)$; concave down on $(-2, 2)$; concave up on $(-\infty, -2)$ and $(2, \infty)$; vertical asymptotes at $x = -2$ and $x = 2$; horizontal asymptote at $y = 0$.

29. Minimum $= 2$ at $x = 1$

30. No absolute extrema

31. Maximum $= \dfrac{32}{3}$ at $x = -1$

   Minimum $= \dfrac{-22}{2}$ at $x = 2$

32. $170 when 10 units are produced

33. 10 times; lot size 60

34. $\Delta y = 0.2406; f'(x)\Delta x = 0.24$

35. (a) $P(t) = 40,000e^{0.12t}$

   (b) 82,177

   (c) 5.8 hr

36. (a) $E(x) = \dfrac{2x}{25 - 2x}$;

   (b) $E(5) = \dfrac{2}{3}$; inelastic;

   (c) $E(8) = \dfrac{16}{9}$; elastic;

   (d) increase;

   (e) $x = \$6.25$

37. $\dfrac{x^9}{3} + C$

38. $4e^2 + 2$

39. $\dfrac{3}{4(2x + 3)} + \dfrac{1}{4}\ln|2x + 3| + C$

40. $6e^{x^2 + 4} + C$

41. $\left(\dfrac{x^2}{2} - 6x\right)\ln x - \dfrac{x^2}{4} + 6x + C$

42. $23\ln x + C$

43. 36

44. $\dfrac{48}{5}$

45. $54,143.74

46. $3607.16/year

47. Convergent, $\dfrac{1}{5120}$

48. $\dfrac{16}{5}$

Final Exam, FORM A (Continued)

49. 0.3721

50. (8, $289); $1258.67

51. $2\pi(e^4 - 1)$, or approximately 336.77

52. $y = C_1 e^{x^4/2}$, where $C_1 = \pm e^C$
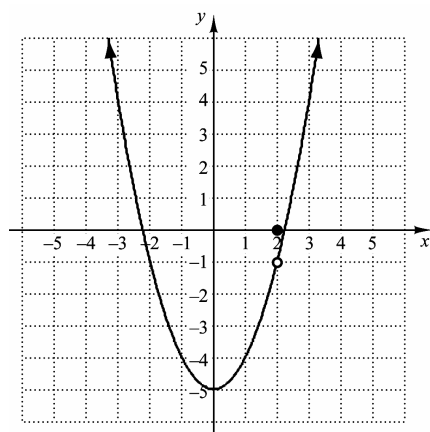
53. (a) $y = \dfrac{16}{7} x - 3$

  (b) $24,429$

54. $-\dfrac{3x}{y^2} + 2y$

Final Exam, FORM B

1. $y = \dfrac{-2}{3} x + 5$

2. $2x^2 + 4xh + 2h^2 + 4$

3. (a)

  (b) -1; (c) 0; (d) No

4. 141

5. Does not exist

6. $-\dfrac{1}{6}$

7. 8

8. 0

9. $f'(x) = 4x$

10. 7

55. e^x

56. Relative maximum = 6 at (0, 0)

57. Maximum $= \dfrac{21}{2}$ at $\left(\dfrac{5}{4}, \dfrac{5}{4}\right)$

58. $e - \dfrac{1}{e} - 2$

59. $2\ln(1 + e^x) + C$

60. -78

61. 8.89

11. $5x^4 + 3$

12. $\dfrac{5}{6} x^{-1/6}$

13. $-13x^{-14}$

14. $\dfrac{3}{2} x (3x^2 + 8)^{-3/4}$

15. $\dfrac{5x^2 - 4x + 15}{(3 - x^2)^2}$

16. $\dfrac{3x^2 + 7}{x^3 + 7x + 3}$

17. $3x^2$

18. $4e^x$

19. $2(x + 4)e^{x^2 + 8x}$

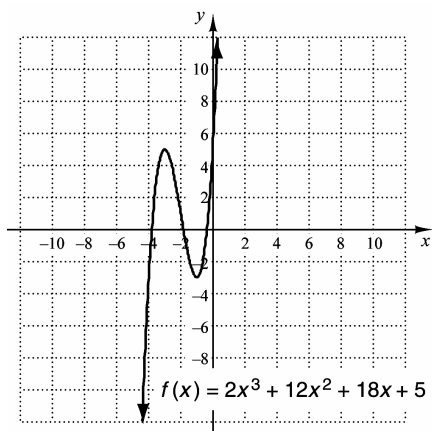**20.** $\dfrac{e^x}{-3 + e^x}$

21. $78x$

22. $-$0.05/box
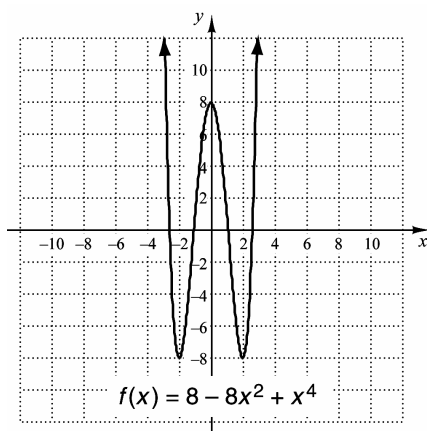
23. $2 + \dfrac{4}{x} - \dfrac{y}{x}$

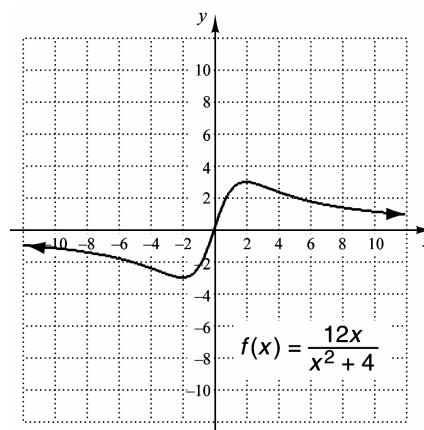**24.** $y = 3x + 2$

Final Exam, FORM B (Continued)

25. Relative minimum at $(-1, -3)$; relative maximum at $(-3, 5)$; point of inflection at $(-2, 1)$; increasing on $(-\infty, -3)$ and $(-1, \infty)$; decreasing on $(-3, -1)$; concave down on $(-\infty, -2)$; concave up on $(-2, \infty)$
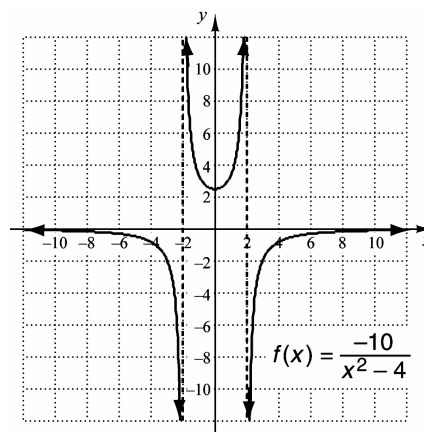

$f(x) = 2x^3 + 12x^2 + 18x + 5$

26. Relative minima at $(-2, -8)$ and $(2, -8)$; relative maxima at $(0, -8)$; points of inflection at $\left(\frac{-2}{\sqrt{3}}, \frac{-8}{9}\right)$ and $\left(\frac{2}{\sqrt{3}}, \frac{-8}{9}\right)$; increasing on $(-2, 0)$ and $(2, \infty)$; decreasing on $(-\infty, -2)$ and $(0, 2)$; concave down on $\left(-\frac{2}{\sqrt{3}}, \frac{2}{\sqrt{3}}\right)$; concave up on $\left(-\infty, \frac{-2}{\sqrt{3}}\right)$ and $\left(\frac{2}{\sqrt{3}}, \infty\right)$

$f(x) = 8 - 8x^2 + x^4$

27. Relative maximum at $(2, 3)$; relative minimum at $(-2, -3)$; points of inflection at $\left(-2\sqrt{3}, -\frac{3\sqrt{3}}{2}\right)$, $(0, 0)$, and $\left(2\sqrt{3}, \frac{3\sqrt{3}}{2}\right)$; decreasing on $(-\infty, -2)$ and $(2, \infty)$; increasing on $(-2, 2)$; concave up on $(-2\sqrt{3}, 0)$ and $(2\sqrt{3}, \infty)$; concave down on $(-\infty, -2\sqrt{3})$ and $(0, 2\sqrt{3})$; horizontal asymptote at $y = 0$

$f(x) = \dfrac{12x}{x^2 + 4}$

28. Relative minimum at $\left(0, \frac{5}{2}\right)$; no points of inflection; increasing on $(0, 2)$ and $(2, \infty)$; decreasing on $(-\infty, -2)$ and $(-2, 0)$; concave down on $(-\infty, -2)$ and $(2, \infty)$; concave up on $(-2, 2)$; vertical asymptotes at $x = -2$ at $x = 2$; horizontal asymptote at $y = 0$

$f(x) = \dfrac{-10}{x^2 - 4}$

29. Minimum $= \dfrac{23}{24}$ at $x = \dfrac{5}{12}$

30. No absolute extrema

31. Minimum $= \frac{-16}{3}$ at $x = 2$; maximum $= \frac{28}{3}$ at $x = 4$

Final Exam, FORM B (Continued)

32. $108 when 4 units are produced

33. 10 times; lot size 80

34. $\Delta y = 0.3003;\ f'(x)\Delta x = 0.3$

35. **(a)** $P(t) = 10,000e^{0.1t}$

   (b) 13,499

   (c) 6.9 hr

36. **(a)** $E(x) = \dfrac{3x}{50-3x}$;

   (b) $E(10) = \dfrac{3}{2}$; elastic;

   (c) $E(5) = \dfrac{3}{7}$; inelastic;

   (d) decrease;

   (e) $x = \$8.33$

37. $\dfrac{5x^8}{8} + C$

38. $3e^4 + 5$

39. $\dfrac{12^x}{\ln 12} + C$

40. $\dfrac{1}{2}e^{x^4+2} + C$

41. $\left(\dfrac{x^2}{2} + 2x\right)\ln x - \dfrac{x^2}{4} - 2x + C$

42. $7\ln x + C$

43. $\dfrac{37}{6}$

44. 8

45. $44,043.17

46. $2957.21/year

47. Convergent, $\dfrac{1}{8}$

48. $\dfrac{8}{5}$

49. 0.3218

50. (2, $36); $26.67

51. $5\pi(e - e^{2/5})$, or approximately 19.2651

52. $y = C_1 e^{3x^4/2}$, where $C_1 = \pm e^C$

53. **(a)** $y = \dfrac{9}{7}x + \dfrac{67}{21}$

   (b) $16,048

54. $6 - 2x^3$

55. $4e^x - 12xy$

56. Relative maximum $= 8$ at $(0, 0)$

57. Maximum $= \dfrac{4429}{9}$ at $\left(\dfrac{55}{3}, \dfrac{80}{9}\right)$

58. $\ln 2 + \dfrac{1}{3}$

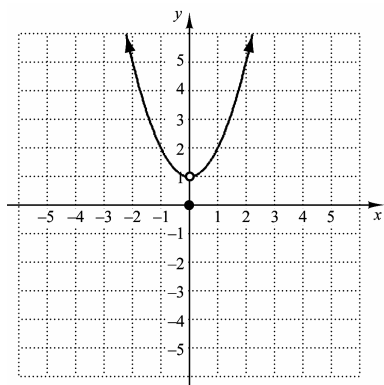**59.** $\dfrac{6x^2 + 2x}{(x + 2t)^2}$

60. $\ln(e^x + 1) + C$

61. $\dfrac{253}{12}$

`

Final Exam, FORM C

1. $y = \dfrac{3}{4}x - \dfrac{13}{2}$

2. $7 - x^2 - 2xh - h^2$

Final Exam, FORM C (Continued)

3. (a)

   (b) 1; **(c)** 0; **(d)**   No

4. −229

5. Does not exist

6. $-\dfrac{1}{4}$

7. 9

8. 0

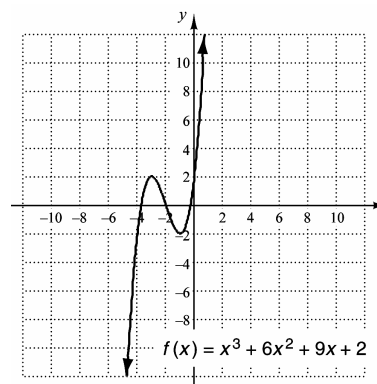**9.** $f'(x) = -2x$

10. −7

11. $5x^4 - 12x^2$

12. $\dfrac{2}{5}x^{-3/5}$

13. $-3x^{-4}$

14. $3x^4(3x^5 - 1)^{-4/5}$

15. $\dfrac{-3x^2 + 2x + 18}{(x^2 + 6)^2}$

16. $\dfrac{3x^2 - 2}{x^3 - 2x + 7}$

17. $7x^6$

18. $21e^x$

19. $(10x + 1)e^{5x^2 + x}$

20. $\dfrac{e^x}{5 + e^x}$
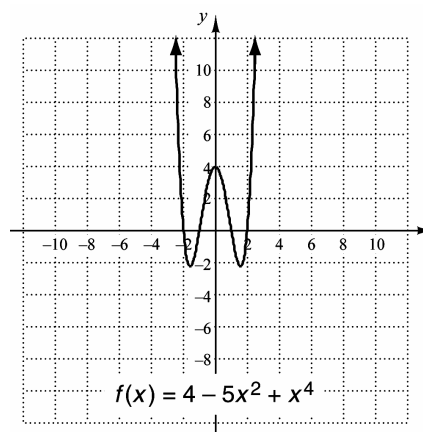
21. $60x^2$

22. −$0.83/box

23. $-\dfrac{1}{4x\sqrt{x}} - \dfrac{y}{x}$

24. $y = 6x - 7$

25. Relative minimum at $(-1, -2)$; relative maximum at $(-3, 2)$; point of inflection at $(-2, 0)$; increasing on $(-\infty, -3)$ and $(-1, \infty)$; decreasing on $(-3, -1)$; concave down on $(-\infty, -2)$; concave upon $(-2, \infty)$.
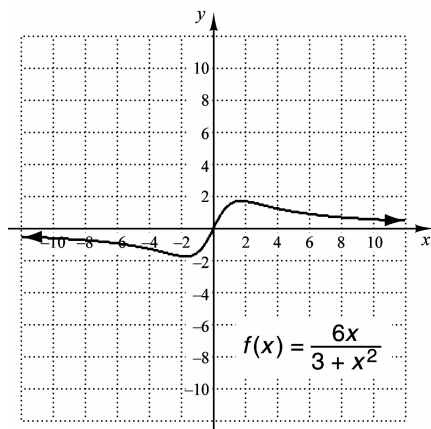

$f(x) = x^3 + 6x^2 + 9x + 2$

26. Relative minima at $\left(-\sqrt{\frac{5}{2}}, \frac{-9}{4}\right)$ and $\left(\sqrt{\frac{5}{2}}, \frac{-9}{4}\right)$; relative maximum at $(0, 4)$; inflection points at $\left(-\sqrt{\frac{5}{6}}, \frac{19}{36}\right)$ and $\left(\sqrt{\frac{5}{6}}, \frac{19}{36}\right)$; increasing on $\left(-\sqrt{\frac{5}{2}}, 0\right)$ and $\left(\sqrt{\frac{5}{2}}, \infty\right)$; decreasing on $\left(-\infty, -\sqrt{\frac{5}{2}}\right)$ and $\left(0, \sqrt{\frac{5}{2}}\right)$; concave down on $\left(-\sqrt{\frac{5}{6}}, \sqrt{\frac{5}{6}}\right)$; concave up on $\left(-\infty, -\sqrt{\frac{5}{6}}\right)$ and $\left(\sqrt{\frac{5}{6}}, \infty\right)$.
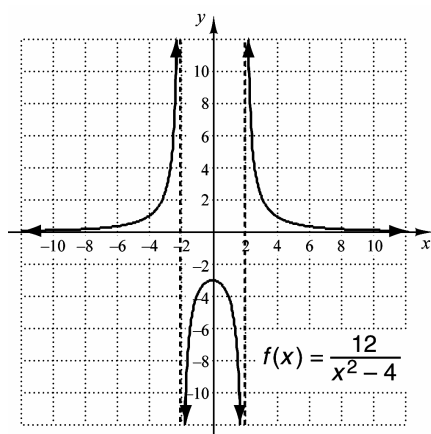

$f(x) = 4 - 5x^2 + x^4$

Final Exam, FORM C (Continued)

27. Relative minimum at $(-\sqrt{3}, -\sqrt{3})$; relative maximum at $(\sqrt{3}, \sqrt{3})$; inflection point at $\left(-3, \frac{-3}{2}\right), (0, 0),$ and $\left(3, \frac{3}{2}\right)$; increasing on $(-\sqrt{3}, \sqrt{3})$; decreasing on $(-\infty, -\sqrt{3})$ and $(\sqrt{3}, \infty)$; concave up in $(-3, 0)$ and $(3, \infty)$; concave down on $(-\infty, -3)$ and $(0, 3)$; horizontal asymptote at $y = 0$.

$f(x) = \dfrac{6x}{3 + x^2}$

28. Relative maximum at $(0, -3)$; no points of inflection; increasing on $(-\infty, -2)$ and $(-2, 0)$; decreasing on $(0, 2)$ and $(2, \infty)$; concave down on $(-2, 2)$; concave up on $(-\infty, -2)$ and $(2, \infty)$; vertical asymptotes at $x = -2$ and $x = 2$; horizontal asymptote at $y = 0$.

$f(x) = \dfrac{12}{x^2 - 4}$

29. Maximum $= \dfrac{-11}{4}$ at $x = \dfrac{3}{4}$

30. No absolute extrema

31. Minimum $= -9$ at $x = -3$; maximum $= \dfrac{25}{3}$ at $x = -1$

32. \$110 when 5 units are produced

33. 4 times; lot size 400

34. $\Delta y = 0.3003; \ f'(x)\Delta x = 0.3$

35. **(a)** $P(t) = 14{,}000e^{0.03t}$;

   (b) 18,898;

   (c) 23.1 yr;

36. **(a)** $E(x) = \dfrac{2x}{25 - 2x}$;

   (b) $E(4) = \dfrac{8}{17}$; inelastic;

   (c) $E(12) = 24$; elastic;

   (d) decrease;

   (e) $x = \$6.25$

37. $2x^4 + C$

38. $7 - \dfrac{5}{e}$

39. $\dfrac{1}{4}\ln\left|\dfrac{x}{3x + 4}\right| + C$

40. $\dfrac{1}{4}e^{x^4 + 3} + C$

41. $\left(\dfrac{x^2}{2} - 2x\right)\ln x - \dfrac{x^2}{4} + 2x + C$

42. $3\ln x + C$

43. 2

44. $\dfrac{37}{6}$

45. \$29,726.03

46. \$2914.47/ year

47. Convergent, $\dfrac{1}{24}$

Final Exam, FORM C (Continued)

48. 20

49. 0.4554

50. (5, $100); $291.67

51. $\dfrac{\pi}{2}(e^{-2} - e^{-6})$, or approximately 0.2087

52. $y = C_1 e^{2x^6/3}$, where $C_1 = \pm e^C$

53. (a) $y = \dfrac{7}{4}x + \dfrac{1}{4}$

    (b) $26,500

54. $5xy^4 - 7e^y$
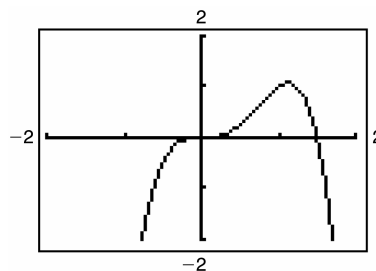
55. 12

56. Relative minimum = 6 at (0, 0)

57. Maximum = 89 at (8, 5)

58. $e - \dfrac{1}{e} + 4$

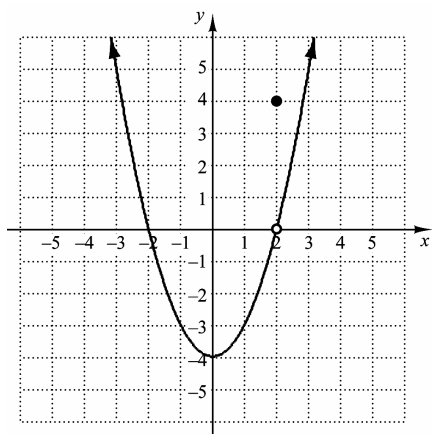**59.** $e^x\left(x + \dfrac{1}{x} + \ln x + 1\right)$

60. $\ln(5 + e^x) + C$

61.

Final Exam, FORM D

1. $y = -3x - \dfrac{5}{2}$

2. $8 + 5x^2 + 10xh + 5h^2$

3. (a)

    (b) 0; (c) 4; (d) No

4. 60

5. Does not exist

6. $x = \dfrac{-1}{7}$

7. 3

8. 0

9. $f'(x) = 10x$

10. -11

11. $7x^6 + 15x^2$

12. $\dfrac{3}{7}x^{-4/7}$

13. $-2x^{-3}$

14. $\dfrac{16}{3}x^7(2x^8 + 5)^{-2/3}$

15. $\dfrac{-3x^2 - 8x - 6}{(x^2 - 2)^2}$

16. $\dfrac{2x + 8}{x^2 + 8x + 5}$

17. 8

18. $-2e^x$

19. $2(3x - 1)e^{3x^2 - 2x}$

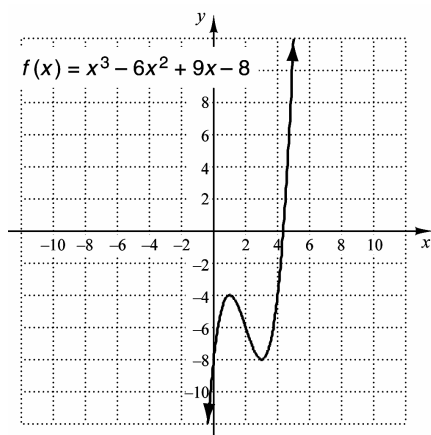**20.** $\dfrac{e^x}{4 + e^x}$

21. $60x$

22. $-$37.94/box
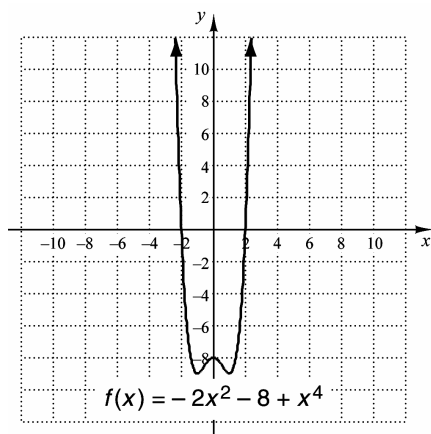
Final Exam, FORM D (Continued)

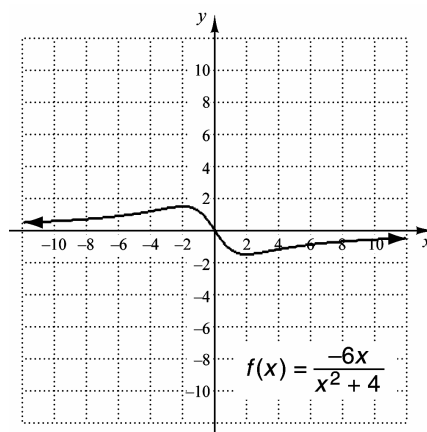**23.** $\dfrac{2x^2}{3y^2} - \dfrac{y}{3x}$

24. $y = 3x - 2$

25. Relative minimum at $(3, -8)$; relative maximum at $(1, -4)$; point of inflection at $(2, -6)$; increasing on $(-\infty, 1)$ and $(3, \infty)$; decreasing on $(1, 3)$; concave down on $(-\infty, 2)$; concave up on $(2, \infty)$
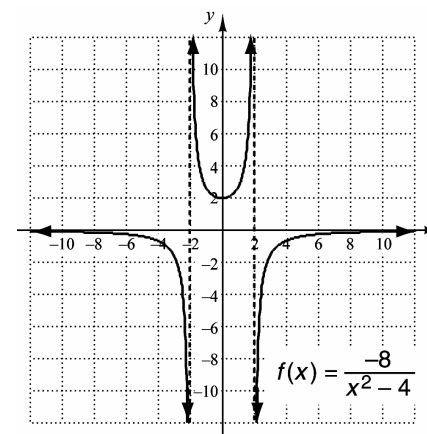

$f(x) = x^3 - 6x^2 + 9x - 8$

26. Relative minima at $(-1, -9)$ and $(1, -9)$; relative maximum at $(0, -8)$; inflection points at $\left(-\sqrt{\tfrac{1}{3}}, -\tfrac{77}{9}\right)$ and $\left(\sqrt{\tfrac{1}{3}}, -\tfrac{77}{9}\right)$; increasing on $(-1, 0)$ and $(1, \infty)$; decreasing on $(-\infty, -1)$ and $(0, 1)$; concave down on $\left(-\sqrt{\tfrac{1}{3}}, \sqrt{\tfrac{1}{3}}\right)$; concave up on $\left(-\infty, -\sqrt{\tfrac{1}{3}}\right)$ and $\left(\sqrt{\tfrac{1}{3}}, \infty\right)$

$f(x) = -2x^2 - 8 + x^4$

27. Relative maximum at $\left(-2, \tfrac{3}{2}\right)$; relative minimum at $\left(2, -\tfrac{3}{2}\right)$; inflection points $\left(-2\sqrt{3}, \tfrac{3\sqrt{3}}{4}\right)$, $(0, 0)$, and $\left(2, \sqrt{3}, \tfrac{-3\sqrt{3}}{4}\right)$; increasing on $(-\infty, -2)$ and $(2, \infty)$; decreasing on $(-2, 2)$; concave down on $(-2\sqrt{3}, 0)$ and $(2\sqrt{3}, \infty)$; concave up on $(-\infty, -2\sqrt{3})$ and $(0, 2\sqrt{3})$; horizontal asymptote at $y = 0$

$f(x) = \dfrac{-6x}{x^2 + 4}$

28. Relative minimum at $(0, 2)$; no inflection points; increasing on $(0, 2)$ and $(2, \infty)$; decreasing on $(-\infty, -2)$ and $(-2, 0)$; concave down on $(-\infty, -2)$ and $(2, \infty)$; concave up on $(-2, 2)$; vertical asymptotes at $x = -2$ and $x = 2$; horizontal asymptote at $y = 0$

$f(x) = \dfrac{-8}{x^2 - 4}$

Final Exam, FORM D (Continued)

29. Maximum $= 0$ at $x = \dfrac{1}{3}$

30. No absolute extrema

31. Minimum $= -59\dfrac{2}{3}$ at $x = 5$;

 maximum $= 173\dfrac{2}{3}$ at $x = 10$

32. $180 when 20 units are produced

33. 5 times; lot size 60

34. $\Delta y = 0.2404$; $f'(x)\Delta x = 0.24$

35. (a) $P(t) = 400e^{0.08t}$;

 (b) 890;

 (c) 8.7 yr

36. (a) $E(x) = \dfrac{x}{5-x}$;

 (b) $E(1.75) = \dfrac{7}{13}$; inelastic;

 (c) $E(3) = \dfrac{3}{2}$; elastic;

 (d) decrease

 (e) $x = 2.50

37. $\dfrac{2x^6}{3} + C$

38. $2e^2 + 2$

39. $\ln\left|\dfrac{x}{3x+1}\right| + C$

40. $3e^{x^5+2} + C$

41. $\left(\dfrac{x^2}{2} + 5x\right)\ln x - \dfrac{x^2}{4} - 5x + C$

42. $-11\ln x + C$

43. 8

44. 6

45. $47,711.39

46. $4428.58/year

47. Convergent, $\dfrac{1}{4}$

48. $\dfrac{81}{32}$

49. 0.4435

50. (4, $49); $133.33

51. $\dfrac{\pi}{4}(e^{20}-1)$ or approximately $381,047,852.6$

52. $y = C_1 e^{-x^4/4}$, where $C_1 = \pm e^C$

53. (a) $y = \dfrac{3}{2}x + 3$

 (b) $25,500

54. $2x + 2y$

55. $3e^x$

56. No relative extrema

57. Minimum $= -67.75$ at $(-6, 8.5)$

58. $3e - \dfrac{3}{e} + 1$

59. $\dfrac{1 + \frac{1}{x} - x - \ln x}{e^x}$
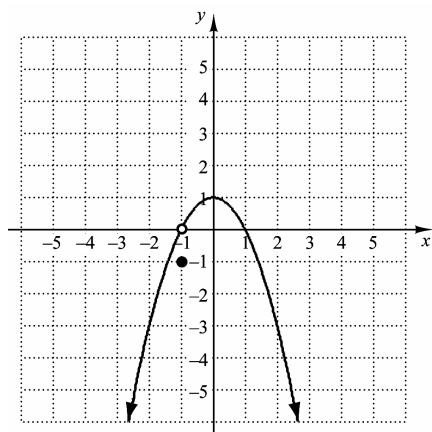
60. 27

61. $\dfrac{64}{3}$

Final Exam, FORM E

1. $y = \dfrac{1}{3}x + \dfrac{5}{3}$

2. $9x^2 + 18xh + 9h^2 - 1$

Final Exam, FORM E (Continued)

3. (a)

    (b) 0; **(c)** -1; **(d)** No

4. 3

5. Does not exist

6. 1

7. 4
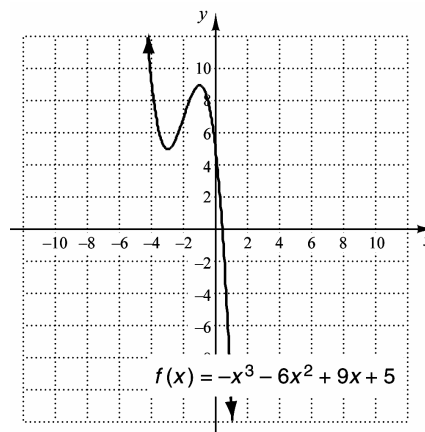
8. 0

9. $f'(x) = 18x$

10. 13

11. $20x^3 + 2$

12. $\dfrac{5}{8}x^{-3/8}$

13. $-12x^{-13}$

14. $\dfrac{7}{4}x^6(x^7 + 4)^{-3/4}$

15. $\dfrac{-3x^2 + 8x + 15}{(x^2 + 5)^2}$
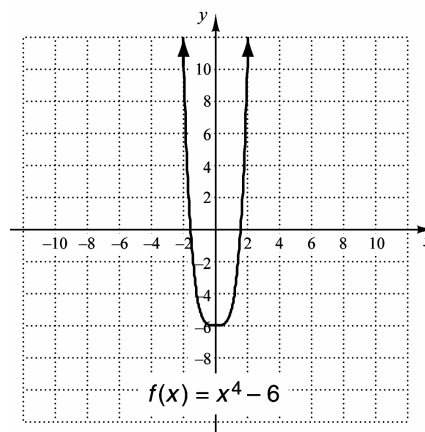
16. $\dfrac{5x^4 - 6x}{x^5 - 3x^2}$

17. 10

18. $-8e^x$

19. $3(x^2 + 1)e^{x^3 + 3x}$

20. $\dfrac{e^x}{e^x - 7}$

21. $40x^3 - 6$

22. $-\$0.36/\text{box}$

23. $\dfrac{x^7}{y} - \dfrac{y}{x}$

24. $y = 2x - 2$

25. Relative minimum at $(-3, 5)$; relative maximum at $(-1, 9)$; inflection point at $(-2, 7)$; increasing on $(-3, -1)$; decreasing on $(-\infty, -3)$ and $(-1, \infty)$; concave down on $(-2, \infty)$; concave up on $(-\infty, -2)$
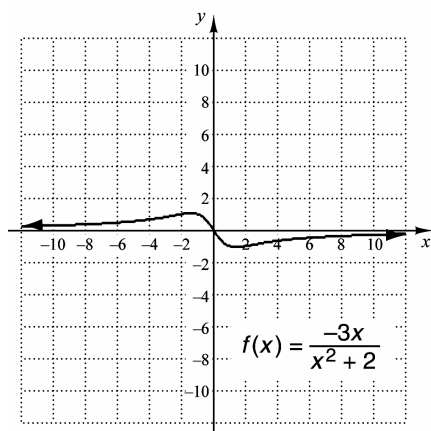

26. No relative maximum; relative minimum at $(0, -6)$; no inflection points; increasing on $(0, \infty)$; decreasing on $(-\infty, 0)$; concave up on $(-\infty, \infty)$
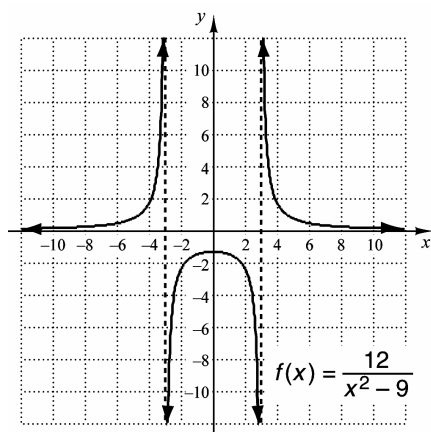
Final Exam, FORM E (Continued)

27. Relative maximum at $\left(-\sqrt{2}, \frac{3\sqrt{2}}{4}\right)$; relative

minimum at $\left(\sqrt{}\ \frac{-3\sqrt{2}}{4}\right)$ inflection point at

$\left(-\sqrt{6}, \frac{3\sqrt{6}}{8}\right)$, $(0, 0)$, and $\left(\sqrt{6}, \frac{-3\sqrt{6}}{8}\right)$; increasing

on $(-\infty, -\sqrt{2})$ and $(\sqrt{2}, \infty)$; decreasing on

$(-\sqrt{2}, \sqrt{2})$; concave down on $(-\sqrt{6}, 0)$ and

$(\sqrt{6}, \infty)$ concave up on $(-\infty, -\sqrt{6})$ and

$(0, \sqrt{6})$; horizontal asymptote at $y = 0$

$f(x) = \dfrac{-3x}{x^2 + 2}$

28. Relative maximum at $\left(0, \frac{-4}{3}\right)$; no inflection

points; increasing on $(-\infty, -3)$ and $(-3, 0)$;
decreasing on $(0, 3)$ and $(3, \infty)$; concave down
on $(-3, 3)$; concave up on $(-\infty, -3)$ and
$(3, \infty)$; vertical asymptotes at $x = -3$ and
$x = 3$; horizontal asymptote at $y = 0$

$f(x) = \dfrac{12}{x^2 - 9}$

29. Minimum $= \dfrac{-46}{5}$ at $x = -\dfrac{4}{5}$

30. No absolute extrema

31. Minimum $= \dfrac{-44}{3}$ at $x = -2$;

maximum $= \dfrac{10}{3}$ at $x = 1$

32. $170 when 30 units are produced

33. 10 times; lot size 40

34. $\Delta y = 0.3003$; $f'(x)\Delta x = 0.3$

35. (a) $P(t) = 8500e^{0.06t}$;

(b) 33,787;

(c) 11.6 yr;

36. (a) $E(x) = \dfrac{x}{25 - x}$;

(b) $E(15) = \dfrac{3}{2}$, elastic;

(c) $E(12) = \dfrac{12}{13}$; inelastic;

(d) increase;

(e) $x = \$12.50$

37. $\dfrac{2x^7}{7} + C$

38. $4e^2 - 4e + 9$

39. $\ln\left|x + \sqrt{x^2 + 9}\right| + C$

40. $\dfrac{1}{3}e^{x^3 + 1} + C$

41. $\left(\dfrac{x^2}{2} - 8x\right)\ln x - \dfrac{x^2}{4} + 8x + C$

42. $5\ln x + C$

43. $\dfrac{45}{2}$

44. 4

45. $39,579.74

46. $4964.88/year

Final Exam, FORM E (Continued)

47. Convergent, $\dfrac{1}{324}$

48. $\dfrac{3}{2}$

49. 0.6326

50. (7, $121); $653.33

51. $\pi(e^{10}-1)$, or approximately 69,195.04

52. $y = C_1 e^{-x^8}$, where $C_1 = \pm e^C$

53. **(a)** $y = \dfrac{11}{6}x + \dfrac{17}{6}$
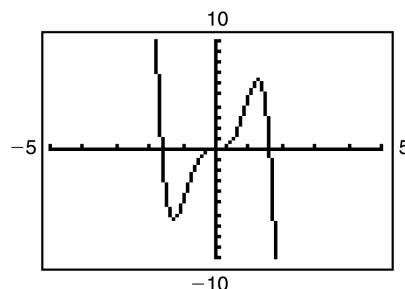
 (b) $48,667

54. $4y + 3xy^2$

55. $2e^x$

56. No relative extrema **57.**
 Maximum $= 4$ at $(3,1)$

58. $-\dfrac{2}{e} - 4$

59. $\dfrac{8x^3 t + 24x^2 + t^2}{(xt+2)^2}$

60. $7\ln(7+e^x) + C$

61.

Final Exam, FORM F

1. $y = 7x + 25$

2. $3 - 6x^2 - 12xh - 6h^2$

3. **(a)**

 (b) 3; **(c)** 1; **(d)** No

4. -222

5. Does not exist

6. $-\dfrac{1}{7}$

7. 2

8. 0

9. $f'(x) = -2x$

10. 6

11. $21x^6 - 2x$

12. $\dfrac{2}{9}x^{-7/9}$

13. $-7x^{-8}$

14. $\dfrac{5}{6}x^4(x^5 - 2)^{-5/6}$

15. $\dfrac{10x^3 - 24x^2 - 15}{(x^3+3)^2}$

16. $\dfrac{2x+3}{x^2+3x+9}$

17. $15x^{14}$

18. $-6e^x$

19. $2(2x^3 - 1)e^{x^4 - 2x}$

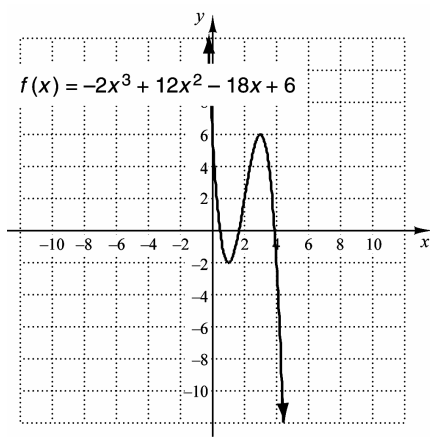**20.** $\dfrac{e^x}{e^x + 8}$

21. $36x$

Final Exam, FORM F (Continued)
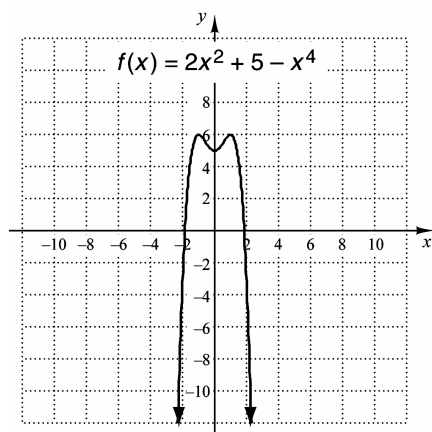
22. −$0.07/box

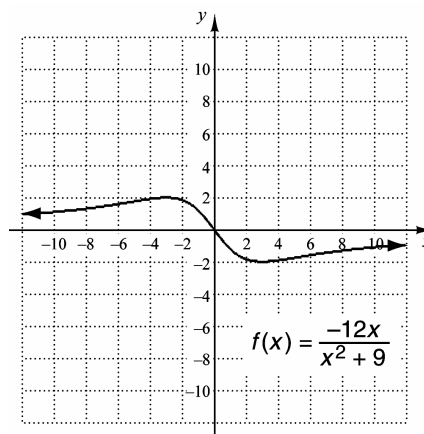**23.** $\dfrac{1}{y^3} - \dfrac{y}{4x}$

24. $y = -6x + 4$

25. Relative minimum at $(1, -2)$; relative maximum $(3, 6)$; inflection point at $(2, 2)$; increasing on $(1, 3)$; decreasing on $(-\infty, 1)$ and $(3, \infty)$; concave down on $(2, \infty)$; and concave up on $(-\infty, 2)$

26. Relative maxima at $(-1, 6)$ and $(1, 6)$; relative minimum at $(0, 5)$; inflection point at $\left(-\sqrt{\tfrac{1}{3}}, \tfrac{50}{9}\right)$ and $\left(\sqrt{\tfrac{1}{3}}, \tfrac{50}{9}\right)$; increasing on $(-\infty, -1)$ and $(0, 1)$; decreasing on $(-1, 0)$ and $(1, \infty)$; concave down on $\left(\sqrt{\tfrac{1}{3}}, \infty\right)$ and $\left(-\infty, -\sqrt{\tfrac{1}{3}}\right)$; concave up on $\left(-\sqrt{\dfrac{1}{3}}, \sqrt{\dfrac{1}{3}}\right)$

27. Relative maximum at $(-3, 2)$; relative minimum at $(3, -2)$; inflection points at $(-3\sqrt{3}, \sqrt{3}), (0, 0)$ and $(3\sqrt{3}, -\sqrt{3})$; increasing on $(-\infty, -3)$ and $(3, \infty)$; decreasing on $(-3, 3)$; concave down on $(-3\sqrt{3}, 0)$ and $(3\sqrt{3}, \infty)$; concave up on $(-\infty, -3\sqrt{3})$ and $(0, 3\sqrt{3})$; horizontal asymptote at $y = 0$
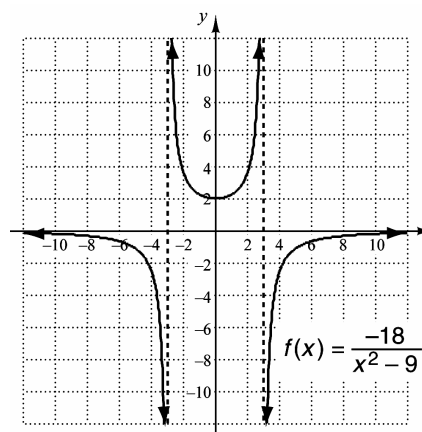

(c) $E(5) = \dfrac{5}{7}$; inelastic;

(d) increase;

(e) $x = \$6$

28. Relative minimum at $(0, 2)$; no inflection points; increasing on $(0, 3)$ and $(3, \infty)$; decreasing on $(-\infty, -3)$ and $(-3, 0)$; concave down on $(-\infty, -3)$ and $(3, \infty)$; concave up on $(-3, -3)$; vertical asymptotes at $x = -3$ and $x = 3$; horizontal asymptote at $y = 0$

Final Exam, FORM F (Continued)

29. Minimum $= -8$ at $x = -1$

30. No absolute extrema

31. Minimum $= -10$ at $\ = -3$;

   maximum $= \dfrac{22}{3}$ at $x = -1$

32. \$15 when 5 units are produced

33. 8 times; lot size 30

34. $\Delta y = 0.4808$; $f'(x)\Delta x = 0.48$

35. **(a)** $P(t) = 8000e^{0.15t}$;

   (b) 19,677;

   (c) 4.6 hr;

36. **(a)** $E(x) = \dfrac{x}{12 - x}$;

   (b) $E(7.50) = \dfrac{5}{3}$, elastic;

   (c) $E(5) = \dfrac{5}{7}$; inelastic;

   (d) increase;

   (e) $x = \$6$

37. $\dfrac{6x^5}{5} + C$

38. $8e^2 - 8e + 7$

39. $\ln\left| x + \sqrt{x^2 - 25} \right| + C$

40. $\dfrac{1}{4}e^{x^4 + 6} + C$

41. $\left(\dfrac{x^2}{2} + 6x \right)\ln x - \dfrac{x^2}{4} - 6x + C$

42. $-9\ln x + C$

43. $\dfrac{3}{8}$

44. 28

45. \$78,125.57

46. \$4,489.15/year

47. Convergent, $\dfrac{1}{4}$

48. 2

49. 0.5925

50. $(3, \$81)$; \$90

51. $\dfrac{\pi}{6}(e^{36} - 1)$, or approximately 2.257×10^{15}

52. $C_1 e^{3x^5/5}$, where $C_1 = \pm e^C$

53. **(a)** $y = \dfrac{5}{2}x + \dfrac{85}{6}$

54. $\dfrac{1}{x} - 12y$

55. $\dfrac{2y}{x^3}$

56. Relative minimum $= 2$ at $(0, 0)$.

57. Maximum $= 34$ at $(-5, 4)$

58. $2e^4 - 2e^2 + 2$

59. 48

60. $3x^2 + x + 2x\ln x$

61. 6.66