ANSWERS

1. horizontal tangent lines at $x = -1$, $x = 0$ and $x = 2$
   relative maximum at $x = 0$; relative minima at $x = -1$ and $x = 2$
   absolute maximum on $[-2, 1]$: $\frac{8}{3} = f(-2)$ and
   absolute minimum on $[-2, 1]$: $-\frac{13}{12} = f(1)$

2. critical number: $x = 4$ only
   relative maximum value is $f(4) = -\frac{3}{16}$, no relative minima

3. (a) $f'(x) = \dfrac{2 - 2x}{x^2(3x - 2)^{2/3}}$
   (b) HTL: $y = 1$, VTL: $x = \frac{2}{3}$
   (c) $x = 1$ and $x = \frac{2}{3}$ ($f(x)$ has a vertical asymptote at $x = 0$ so not a critical number)
   (d) local maximum: $f(1) = 1$, no local minima

4. (a) $\dfrac{dC}{dt} = 600$ so cost is increasing by \$600 per day
   (b) Average cost $\overline{C}(x) = \dfrac{C(x)}{x}$ is decreasing on interval (0, 80) and
   increasing for $x > 80$ so average cost is minimized when 80 items are produced.

5. $P(x) = -0.02x^2 + 300x - 300,000$
   (a) When $x = 2000$, $MP = 220$ so the profit from the 2001st item is approximately \$220.
   (b) $\Delta P = P(2001) - P(2000) = 219.98$
   (c) increasing: $(0, 7500)$ and decreasing: $(7500, 20,000)$
   Profit is maximized when 7500 items are sold at a unit price of \$250.

6. $f'(x) = \dfrac{10x - 10}{3x^{1/3}}$
   relative maximum is $f(0) = 0$; relative minimum is $f(1) = -3$
   on $[-8, 0]$: absolute maximum is $f(0) = 0$ and absolute minimum is $f(-8) = -84$

7. maximum: $1 = f(0)$, minimum: $\dfrac{1}{e^{16}} = f(2)$

8. maximum: $1 = f(1)$, minimum: $4 - 8\ln 2 = f(2)$

9. (a) $v(t) = 3t^2 - 12t + 9$

   (b) $t = 1$ and $t = 3$ seconds

   (c) $(0, 1)$ and $(3, 6)$

   (d) 1 cm/sec

   (e) $a(t) = 6t - 12$; $a(3/2) = -3$ cm/sec^2

   (f) (1): (1, 2) and (3, 6)   (2): (0, 1) and (2, 3)

10. concave up: $\left(-\infty, -\frac{1}{\sqrt{2}}\right) \cup \left(\frac{1}{\sqrt{2}}, \infty\right)$, concave down: $\left(-\frac{1}{\sqrt{2}}, \frac{1}{\sqrt{2}}\right)$

    inflection points: $\left(-\frac{1}{\sqrt{2}}, \sqrt{e}\right)$ and $\left(\frac{1}{\sqrt{2}}, \sqrt{e}\right)$

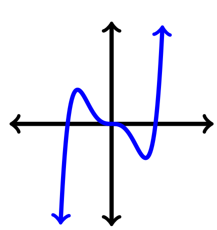
11. $(-\infty, -3)$ and $(-1, 0)$

12. $(2, \infty)$; inflection point is $\left(2, \ln 2 + \frac{1}{2}\right)$

13. maximum at $x = 1$, minimum at $x = -2$ and $x = 5$

14. $f(x)$ is increasing on interval $(-1, 4)$ and decreasing
    on interval $(\infty, -1)$ and $(4, \infty)$
    relative maximum at $x = 4$ and relative minimum at $x = -1$
    concave up: $(-\infty, 0)$ and $(1, 4)$, concave down: $(0, 1)$ and $(4, \infty)$
    inflection points at $x = 0$, $x = 1$ and $x = 4$

15. relative maxima: $x = -1$, relative minimum: $x = 1$
    inflection points at $x = \pm\frac{1}{\sqrt{2}}$, $x = 0$



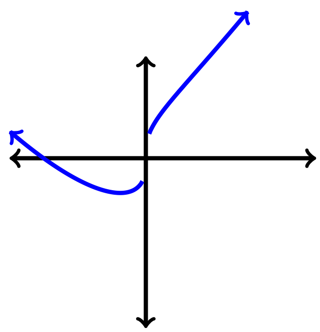
16. (a) after 20 minutes; population is $P(20) = 4200$ viruses
    (b) $t = 10$ minutes

17. Dimensions: $x = 550$ ft, $y = \dfrac{2200}{3}$ ft

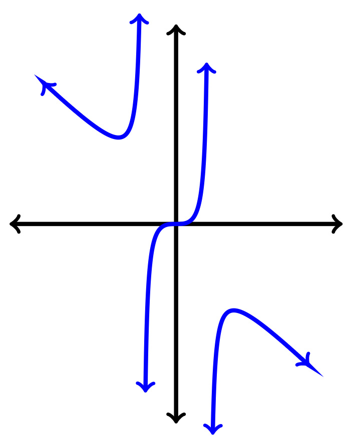
18. 45 items at a price of \$42 per unit

19. $R(x)$ is increasing on $(0, 400)$; maximum revenue is
$R(400) = \$3200$.
Point of diminishing returns: $(200, 1600)$ is an inflection point of the graph of $R(x)$.

20.



21.



22. graph has a relative minimum at $x = -1$ and a relative maximum at $x = 3$; inflection points at $x = 0$, $x = 1$ and $x = 2$

23. (a) $3^{(2x-1)^2}(\ln 3)(8x - 4)$ (b) $\dfrac{2x - 1}{(\ln 4)(x^2 - x)}$

24. A

25. A

26. A

27. E
28. C
29. A
30. C
31. E
32. B or D
33. C
34. B
35. B
36. (a) 0.3225 (b) 0.3
37. (a) revenue is decreasing by about \$150

    $\Delta R = R(1590) - R(1600) = -\$150.47$

    (b) revenue is increasing by \$450 per week

    (c) sell 3600 items at a price of \$15

38. $f(x) = \dfrac{2(1 + \ln x)}{x}$

39. (a) $\dfrac{3}{2}\ln 12$

    (b) $x + 4\sqrt{x} + \ln|x| + C$

    (c) $\dfrac{13}{3}$

    (d) $-\dfrac{e^{\frac{1}{2x-1}}}{2} + C$

    (e) $\dfrac{112}{9}$

    (f) $\dfrac{e^{12} - 1}{6}$

    (g) $\dfrac{2}{3}(x-1)^{3/2} + 2\sqrt{x-1}\Big]_2^5 = \dfrac{20}{3}$

40. $R(t) = 250e^{0.06t} - 240$

41. $R(x) = 100x + 0.2x^2 - 0.1x^3$;
    $p(x) = 100 + 0.2x - 0.1x^2$

42. $v(t) = -\dfrac{2}{t+1} + 2$ and $s(t) = -2\ln|t+1| + 2t$; after 2 seconds the object has moved $4 - 2\ln 3$ or $4 - \ln 9$ cm

43. Let $R(t)$ be the retail price of a Toyota t years after its introduction. Then $R(t) = \sqrt{3t^2+4} + 22$ and $R(2) = 26$ so price is \$26,000.

44. $s(t) = \dfrac{e^{2t}}{4} + \dfrac{5}{2}t + \dfrac{7}{4}$

45. Minimize Cost $= 6x^2 + 8xy$ if volume $x^2y = 12$: $x = 2$, $y = 3$ and minimum cost is \$72

46. 45 items at a price of \$42 per unit