Kinnelon High School
Mathematics Department
Summer Guide in Preparation of the 2019-2020 School Year

Dear students and families,

Please use the summer months to review and/or complete this Summer Guide regarding upcoming math courses for the 2019-2020 school year. All textbooks will be provided to students through the school in September. Mandatory course materials must be purchased. Suggested course materials are optional.

Sincerely,
The KHS Math Department

Course Name	AP Calculus AB
Textbook(s)	Calculus by Finney
Mandatory Course Materials	Notebook, pencils, erasers
Suggested Course Materials	TI-83 or TI-84 Calculator
Guide Summary	Neatly complete all problems

CalculusAB Name_____ ID: 1

CalculusAB-SummerAssignment - Required

Date_____ Period____

Differentiate each function with respect to *x*.

1) $y = (-2x^4 + 1)^{-2}$

2) $y = (5x^3 + 1)^2$

3) $y = (3x + 2)^2$

4) $y = (3x^3 - 5)^{\frac{1}{2}}$

5) $y = (x - 1)^{-5}$

6) $y = (5x^2 + 4)^{\frac{1}{4}}$

7) $y = \sqrt{x^5 + 3}$

8) $y = (x^4 + 3)^{\frac{1}{4}}$

9) $y = (3x^2 + 2)^5$

10) $y = (2x^2 + 3)^4$

11) $y = (-4x^3 + 3)^{\frac{1}{4}}$

12) $y = (-5x^4 - 3)^{\frac{1}{4}}$

13) $y = \cos 4x^3$

14) $y = \tan 2x^2$

15) $y = \cot 2x^5$

16) $y = \tan 3x^3$

17) $y = \sin 5x^4$

18) $y = \sec 4x^4$

19) $y = \sec 2x^2$

20) $y = \cot 2x^4$

21) $y = \csc 5x^2$

22) $y = \cot 3x^4$

23) $y = \csc (4x^3 + 3)^2$

24) $y = \cos (5x^3 + 4)^2$

25) $y = \csc (\cot 5x^4)$

26) $y = \cot (5x^4 - 1)^2$

27) $y = \sin (4x^3 - 5)^3$

28) $y = \sec (x^3 - 4)^2$

29) $y = \cot (\csc 5x^3)$

30) $y = \sec (5x^5 + 4)^2$

31) $y = \sec^3 x^5$

32) $y = \cos (3x^2 + 2)^2$

33) $y = e^{x^5}$

34) $y = \ln 2x^2$

35) $y = e^{3x^5}$

36) $y = \ln x^2$

37) $y = e^{x^3}$

38) $y = e^{2x^4}$

39) $y = \ln x^3$

40) $y = e^{5x^5}$

41) $y = \ln 4x^5$

42) $y = \ln 5x^4$

43) $y = \log_2 3x^2$

44) $y = \log_5 2x^3$

45) $y = \log_3 x^3$

46) $y = 2^{3x^2}$

47) $y = 5^{3x^5}$

48) $y = \log_4 4x^4$

49) $y = \log_5 x^3$

50) $y = 4^{2x^4}$

51) $y = \log_5 4x^3$

52) $y = \log_3 2x^3$

53) $y = (x^4 - 1)(3x^4 + 4)$

54) $y = (4x^4 + 4)(2x^5 - 1)$

55) $y = (-x^4 + 2)(x^4 - 5)$

56) $y = (3x^4 - 2)(2x^5 + 5)$

57) $y = (3x^3 + 4)(x^4 + 3)$

58) $y = (2x^4 + 3)(-5x^3 + 3)$

59) $y = \dfrac{5x^3 + 3}{x^4 + 5}$

60) $y = \dfrac{2x^4 + 2x^3}{x^5 - 5}$

61) $y = \dfrac{5x^2 - 3}{5x^4 + 4}$

62) $y = \dfrac{5x^4 + 5}{x^4 - 3}$

63) $y = \dfrac{3x^5 - 5x^3}{4x^4 + 4}$

64) $y = \dfrac{x^3 + 2}{4x^2 + 5}$

For each problem, use implicit differentiation to find $\dfrac{dy}{dx}$ at the given point.

65) $5x = -y - x^3y + 4$ at $(-2, -2)$

66) $-5y + 3xy = 5x$ at $(2, 10)$

67) $5x^2 + 4y^2 = -2xy^3 + 4$ at $(-2, 2)$

68) $-2y - 3x^2y + 2 = 2x^3$ at $(2, -1)$

69) $x^3 = -3y - xy + 2$ at $(-2, 10)$

70) $2y = 3x + 4xy$ at $(2, -1)$

For each problem, find the open intervals where the function is increasing and decreasing.

71) $f(x) = x^4 + x^3 - 3x^2 + 4$

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

73) $f(x) = -x^4 + 2x^2 + 3$

74) $f(x) = x^4 - 3x^2 + 3$

75) $f(x) = -x^3 + 4x^2 - 4$

76) $f(x) = x^3 - x^2 + 1$

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

78) $f(x) = x^3 - 15x^2 + 72x - 107$

For each problem, find the open intervals where the function is concave up and concave down.

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

80) $f(x) = x^4 - 2x^3 - x^2 + 1$

81) $f(x) = x^4 - x^2 + 3$

82) $f(x) = -x^4 + 4x^2 - 3$

83) $f(x) = -x^4 + 3x^2 - 1$

84) $f(x) = -x^4 + 2x^2 + 1$

85) $f(x) = x^4 - 3x^2 + 4$

86) $f(x) = -x^4 + 3x^2$

A particle moves along a horizontal line. Its position function is $s(t)$ for $t \geq 0$. For each problem, find the velocity function $v(t)$, the acceleration function $a(t)$, the times t when the particle changes directions, the intervals of time when the particle is moving left and moving right, the times t when the acceleration is 0, and the intervals of time when the particle is slowing down and speeding up.

87) $s(t) = t^3 - 22t^2 + 121t$

88) $s(t) = t^3 - 4t^2 - 60t$

89) $s(t) = -t^3 + 16t^2 - 64t$

90) $s(t) = t^3 - 20t^2 + 100t$

91) $s(t) = -t^3 + 9t^2$

92) $s(t) = -t^3 + 20t^2 - 100t$

Solve each related rate problem.

93) A spherical balloon is deflated at a rate of $\frac{256\pi}{3}$ cm³/sec. At what rate is the radius of the balloon changing when the radius is 4 cm?

94) A spherical balloon is inflated at a rate of 36π cm³/sec. How fast is the radius of the balloon increasing when the radius is 4 cm?

95) Water leaking onto a floor forms a circular pool. The radius of the pool increases at a rate of 9 cm/min. How fast is the area of the pool increasing when the radius is 15 cm?

96) A spherical balloon is inflated so that its radius increases at a rate of 3 cm/sec. How fast is the volume of the balloon increasing when the radius is 3 cm?

97) A crowd gathers around a movie star, forming a circle. The area taken up by the crowd increases at a rate of 49π ft²/sec. How fast is the radius of the crowd increasing when the radius is 10 ft?

98) Water slowly evaporates from a circular shaped puddle. The radius of the puddle decreases at a rate of 8 in/hr. Assuming the puddle retains its circular shape, at what rate is the area of the puddle changing when the radius is 14 in?

99) Water slowly evaporates from a circular shaped puddle. The area of the puddle decreases at a rate of 36π in²/hr. Assuming the puddle retains its circular shape, at what rate is the radius of the puddle changing when the radius is 6 in?

100) A spherical snowball is rolled in fresh snow, causing it grow at a rate of $\frac{256\pi}{3}$ in³/sec. How fast is the radius of the snowball increasing when the radius is 7 in?

Solve each optimization problem.

101) A supermarket employee wants to construct an open-top box from a 14 by 30 in piece of cardboard. To do this, the employee plans to cut out squares of equal size from the four corners so the four sides can be bent upwards. What size should the squares be in order to create a box with the largest possible volume?

102) A supermarket employee wants to construct an open-top box from a 10 by 16 in piece of cardboard. To do this, the employee plans to cut out squares of equal size from the four corners so the four sides can be bent upwards. What size should the squares be in order to create a box with the largest possible volume?

103) A company has started selling a new type of smartphone at the price of $\$150 - 0.05x$ where x is the number of smartphones manufactured per day. The parts for each smartphone cost \$80 and the labor and overhead for running the plant cost \$7000 per day. How many smartphones should the company manufacture and sell per day to maximize profit?

104) A supermarket employee wants to construct an open-top box from a 16 by 30 in piece of cardboard. To do this, the employee plans to cut out squares of equal size from the four corners so the four sides can be bent upwards. What size should the squares be in order to create a box with the largest possible volume?

105) Engineers are designing a box-shaped aquarium with a square bottom and an open top. The aquarium must hold 256 ft^3 of water. What dimensions should they use to create an acceptable aquarium with the least amount of glass?

106) A geometry student wants to draw a rectangle inscribed in a semicircle of radius 9. If one side must be on the semicircle's diameter, what is the area of the largest rectangle that the student can draw?

107) A graphic designer is asked to create a movie poster with a 128 in^2 photo surrounded by a 4 in border at the top and bottom and a 2 in border on each side. What overall dimensions for the poster should the designer choose to use the least amount of paper?

108) A geometry student wants to draw a rectangle inscribed in a semicircle of radius 7. If one side must be on the semicircle's diameter, what is the area of the largest rectangle that the student can draw?

109) A geometry student wants to draw a rectangle inscribed in a semicircle of radius 4. If one side must be on the semicircle's diameter, what is the area of the largest rectangle that the student can draw?

110) A geometry student wants to draw a rectangle inscribed in a semicircle of radius 8. If one side must be on the semicircle's diameter, what is the area of the largest rectangle that the student can draw?

111) A graphic designer is asked to create a movie poster with a 98 in^2 photo surrounded by a 4 in border at the top and bottom and a 2 in border on each side. What overall dimensions for the poster should the designer choose to use the least amount of paper?

112) A graphic designer is asked to create a movie poster with a 72 in^2 photo surrounded by a 2 in border at the top and bottom and a 1 in border on each side. What overall dimensions for the poster should the designer choose to use the least amount of paper?

113) An architect is designing a composite window by attaching a semicircular window on top of a rectangular window, so the diameter of the top window is equal to and aligned with the width of the bottom window. If the architect wants the perimeter of the composite window to be 8 ft, what dimensions should the bottom window be in order to create the composite window with the largest area?

114) An architect is designing a composite window by attaching a semicircular window on top of a rectangular window, so the diameter of the top window is equal to and aligned with the width of the bottom window. If the architect wants the perimeter of the composite window to be 14 ft, what dimensions should the bottom window be in order to create the composite window with the largest area?

115) An architect is designing a composite window by attaching a semicircular window on top of a rectangular window, so the diameter of the top window is equal to and aligned with the width of the bottom window. If the architect wants the perimeter of the composite window to be 16 ft, what dimensions should the bottom window be in order to create the composite window with the largest area?

116) An architect is designing a composite window by attaching a semicircular window on top of a rectangular window, so the diameter of the top window is equal to and aligned with the width of the bottom window. If the architect wants the perimeter of the composite window to be 20 ft, what dimensions should the bottom window be in order to create the composite window with the largest area?

For each problem, find the equation of the line tangent to the function at the given point. Your answer should be in slope-intercept form.

117) $y = \frac{16x}{x^2 + 16}$ at $(0, 0)$

118) $y = -x^3 + 3x^2 - 5$ at $(-1, -1)$

119) $y = \frac{2}{x^2 - 9}$ at $\left(-2, -\frac{2}{5}\right)$

120) $y = -\frac{2}{x^2 - 4}$ at $\left(-1, \frac{2}{3}\right)$

121) $y = x^3 - 3x^2 - 1$ at $(-1, -5)$

122) $y = \frac{4}{x^2 + 1}$ at $(-1, 2)$

Evaluate each indefinite integral. You are answering the question "What function has this derivative?"

123) $\int \frac{24\sqrt[5]{x}}{5}\,dx$

124) $\int \frac{8}{x^3}\,dx$

125) $\int 3\,dx$

126) $\int 8x^{-3}\,dx$

127) $\int -6x^{-3}\,dx$

128) $\int 5x^4\,dx$

129) $\int \frac{9x^{\frac{5}{4}}}{4}\,dx$

130) $\int 2x\,dx$

131) $\int \frac{12x^{\frac{1}{3}}}{3}\,dx$

132) $\int \frac{2}{x^2}\,dx$

133) $\int -\frac{36x^{\frac{5}{4}}}{4}\,dx$

134) $\int -4x^{-3}\,dx$

135) $\int -\frac{2}{\sin^2 x}\,dx$

136) $\int -\sec x \tan x\,dx$

137) $\int \frac{4}{\sin^2 x}\,dx$

138) $\int \frac{4\sin x}{\cos^2 x}\,dx$

139) $\int \frac{3}{\sec x}\,dx$

140) $\int -\frac{3\sin x}{\cos^2 x}\,dx$

141) $\int -\frac{1}{\csc x}\,dx$

142) $\int -\frac{1}{\sec x}\,dx$

143) $\int \frac{4}{\cos^2 x}\,dx$

144) $\int -2\csc x \cot x\,dx$

145) $\int 5\cos x \, dx$

146) $\int \frac{4}{\sec x} \, dx$

147) $\int 4\csc^2 x \, dx$

148) $\int \frac{4\cos x}{\sin^2 x} \, dx$

149) $\int -\frac{2\sin x}{\cos^2 x} \, dx$

150) $\int -\csc^2 x \, dx$

151) $\int -\frac{3}{\sin^2 x} \, dx$

152) $\int -\frac{1}{\sin^2 x} \, dx$

153) $\int 3\csc^2 x \, dx$

154) $\int -\cos x \, dx$

155) $\int \frac{4}{x} \, dx$

156) $\int -\frac{1}{x} \, dx$

157) $\int 3 \cdot 4^x \, dx$

158) $\int 5e^x \, dx$

159) $\int -e^x \, dx$

160) $\int -2e^x \, dx$

161) $\int 2e^x \, dx$

162) $\int \frac{2}{x} \, dx$

163) $\int -5e^x \, dx$

164) $\int \frac{3}{x} \, dx$

165) $\int 5^x \, dx$

166) $\int -\frac{2}{x} \, dx$

Evaluate each limit.

167) $\lim\limits_{x \to 3^+} \frac{x-1}{x^2-4x+3}$

168) $\lim\limits_{x \to -3^-} -\frac{2}{x^2-9}$

169) $\lim\limits_{x \to 1^-} \frac{x+2}{x^2-2x+1}$

170) $\lim\limits_{x \to -2^-} -\frac{x+2}{x^2-4}$

171) $\lim\limits_{x \to -\infty} -\frac{10}{x^2+2}$

172) $\lim\limits_{x \to \infty} \left(x^3-6x^2+9x-4\right)$

173) $\lim\limits_{x \to \infty} \left(x^5-3x^3+x+3\right)$

174) $\lim\limits_{x \to \infty} \frac{x^2}{2x+1}$

175) $\lim\limits_{x \to 0^-} f(x), f(x) = \begin{cases} -x+6, & x < 0 \\ \frac{x}{2}+\frac{3}{2}, & x \geq 0 \end{cases}$

176) $\lim\limits_{x \to -1^+} f(x), f(x) = \begin{cases} x^2+4x+4, & x \leq -1 \\ -x, & x > -1 \end{cases}$

177) $\lim_{x \to -2^+} f(x),\ f(x) = \begin{cases} x^2 + 8x + 17, & x < -2 \\ -2x + 1, & x \geq -2 \end{cases}$

178) $\lim_{x \to 1^-} f(x),\ f(x) = \begin{cases} 4, & x < 1 \\ x^2 - 6x + 9, & x \geq 1 \end{cases}$

179) $\lim_{x \to 2} \dfrac{x - 2}{x^2 - 5x + 6}$

180) $\lim_{x \to -2} -\dfrac{x + 2}{x^2 - 4}$

181) $\lim_{x \to 2} \dfrac{x - 2}{x^2 - 4}$

182) $\lim_{x \to -3} \dfrac{x + 3}{x^2 + 5x + 6}$

183) $\lim_{x \to \pi} -2\sin(2x)$

184) $\lim_{x \to -1} (x^3 + 4x^2 + 4x + 3)$

185) $\lim_{x \to 3} \dfrac{x + 7}{x^2 - x - 2}$

186) $\lim_{x \to 0} (-x^2 + 6)$

187) $\lim_{x \to 0} (-x^3 + 4x^2 - 6)$

188) $\lim_{x \to -1} -\sqrt[3]{x + 5}$

189) $\lim_{x \to -2} -\dfrac{x}{x^2 + x}$

190) $\lim_{x \to 3} x$

191) $\lim_{x \to -1} -\dfrac{x + 2}{x^2 + 7x + 10}$

192) $\lim_{x \to 2} \dfrac{6}{x^2 + 2}$

193) $\lim_{x \to 3} \sqrt{2x + 3}$

194) $\lim_{x \to -1} \dfrac{x + 2}{x^2 + 10x + 25}$

Answers to CalculusAB-SummerAssignment - Required (ID: 1)

1) $\frac{dy}{dx} = \frac{16x^3}{(-2x^4+1)^3}$

2) $\frac{dy}{dx} = 30x^2(5x^3+1)$

3) $\frac{dy}{dx} = 6(3x+2)$

4) $\frac{dy}{dx} = \frac{9x^2}{2(3x^3-5)^{\frac{1}{2}}}$

5) $\frac{dy}{dx} = -\frac{5}{(x-1)^6}$

6) $\frac{dy}{dx} = \frac{5x}{2(5x^2+4)^{\frac{3}{4}}}$

7) $\frac{dy}{dx} = \frac{5x^4}{2(x^5+3)^{\frac{1}{2}}}$

8) $\frac{dy}{dx} = \frac{x^3}{(x^4+3)^{\frac{3}{4}}}$

9) $\frac{dy}{dx} = 30x(3x^2+2)^4$

10) $\frac{dy}{dx} = 16x(2x^2+3)^3$

11) $\frac{dy}{dx} = -\frac{3x^2}{(-4x^3+3)^{\frac{3}{4}}}$

12) $\frac{dy}{dx} = -\frac{5x^3}{(-5x^4-3)^{\frac{3}{4}}}$

13) $\frac{dy}{dx} = -12x^2 \sin 4x^3$

14) $\frac{dy}{dx} = 4x \sec^2 2x^2$

15) $\frac{dy}{dx} = -10x^4 \csc^2 2x^5$

16) $\frac{dy}{dx} = 9x^2 \sec^2 3x^3$

17) $\frac{dy}{dx} = 20x^3 \cos 5x^4$

18) $\frac{dy}{dx} = 16x^3 \sec 4x^4 \tan 4x^4$

19) $\frac{dy}{dx} = 4x \sec 2x^2 \tan 2x^2$

20) $\frac{dy}{dx} = -8x^3 \csc^2 2x^4$

21) $\frac{dy}{dx} = -10x \csc 5x^2 \cot 5x^2$

22) $\frac{dy}{dx} = -12x^3 \csc^2 3x^4$

23) $\frac{dy}{dx} = -24x^2 \csc(4x^3+3)^2 \cot(4x^3+3)^2 \cdot (4x^3+3)$

24) $\frac{dy}{dx} = -30x^2 \sin(5x^3+4)^2 \cdot (5x^3+4)$

25) $\frac{dy}{dx} = 20x^3 \csc(\cot 5x^4) \cot(\cot 5x^4) \csc^2 5x^4$

26) $\frac{dy}{dx} = -40x^3 \csc^2(5x^4-1)^2 (5x^4-1)$

27) $\frac{dy}{dx} = 36x^2 \cos(4x^3-5)^3 \cdot (4x^3-5)^2$

28) $\frac{dy}{dx} = 6x^2 \sec(x^3-4)^2 \tan(x^3-4)^2 \cdot (x^3-4)$

29) $\frac{dy}{dx} = 15x^2 \csc^2(\csc 5x^3) \csc 5x^3 \cot 5x^3$

30) $\frac{dy}{dx} = 50x^4 \sec(5x^5+4)^2 \tan(5x^5+4)^2 \cdot (5x^5+4)$

31) $\frac{dy}{dx} = 15x^4 \sec^3 x^5 \tan x^5$

32) $\frac{dy}{dx} = -12x \sin(3x^2+2)^2 \cdot (3x^2+2)$

33) $\frac{dy}{dx} = 5x^4 e^{x^5}$

34) $\frac{dy}{dx} = \frac{2}{x}$

35) $\frac{dy}{dx} = 15x^4 e^{3x^5}$

36) $\frac{dy}{dx} = \frac{2}{x}$

37) $\frac{dy}{dx} = 3x^2 e^{x^3}$

38) $\frac{dy}{dx} = 8x^3 e^{2x^4}$

39) $\frac{dy}{dx} = \frac{3}{x}$

40) $\frac{dy}{dx} = 25x^4 e^{5x^5}$

41) $\frac{dy}{dx} = \frac{5}{x}$

42) $\frac{dy}{dx} = \frac{4}{x}$

43) $\frac{dy}{dx} = \frac{2}{x \ln 2}$

44) $\frac{dy}{dx} = \frac{3}{x \ln 5}$

45) $\frac{dy}{dx} = \frac{3}{x \ln 3}$

46) $\frac{dy}{dx} = 3x \cdot 2^{3x^2+1} \ln 2$

47) $\frac{dy}{dx} = 3x^4 \cdot 5^{3x^5+1} \ln 5$

48) $\frac{dy}{dx} = \frac{4}{x \ln 4}$

49) $\frac{dy}{dx} = \frac{3}{x \ln 5}$

50) $\frac{dy}{dx} = 2x^3 \cdot 4^{2x^4+1} \ln 4$

51) $\frac{dy}{dx} = \frac{3}{x \ln 5}$

52) $\frac{dy}{dx} = \frac{3}{x \ln 3}$

53) $\frac{dy}{dx} = (x^4-1) \cdot 12x^3 + (3x^4+4) \cdot 4x^3$
$= 24x^7 + 4x^3$

54) $\frac{dy}{dx} = (4x^4 + 4) \cdot 10x^4 + (2x^5 - 1) \cdot 16x^3$
$= 72x^8 + 40x^4 - 16x^3$

55) $\frac{dy}{dx} = (-x^4 + 2) \cdot 4x^3 + (x^4 - 5) \cdot -4x^3$
$= -8x^7 + 28x^3$

56) $\frac{dy}{dx} = (3x^4 - 2) \cdot 10x^4 + (2x^5 + 5) \cdot 12x^3$
$= 54x^8 - 20x^4 + 60x^3$

57) $\frac{dy}{dx} = (3x^3 + 4) \cdot 4x^3 + (x^4 + 3) \cdot 9x^2$
$= 21x^6 + 16x^3 + 27x^2$

58) $\frac{dy}{dx} = (2x^4 + 3) \cdot -15x^2 + (-5x^3 + 3) \cdot 8x^3$
$= -70x^6 + 24x^3 - 45x^2$

59) $\frac{dy}{dx} = \frac{(x^4 + 5) \cdot 15x^2 - (5x^3 + 3) \cdot 4x^3}{(x^4 + 5)^2}$

60) $\frac{dy}{dx} = \frac{(x^5 - 5)(8x^3 + 6x^2) - (2x^4 + 2x^3) \cdot 5x^4}{(x^5 - 5)^2}$

61) $\frac{dy}{dx} = \frac{(5x^4 + 4) \cdot 10x - (5x^2 - 3) \cdot 20x^3}{(5x^4 + 4)^2}$

62) $\frac{dy}{dx} = \frac{(x^4 - 3) \cdot 20x^3 - (5x^4 + 5) \cdot 4x^3}{(x^4 - 3)^2}$

63) $\frac{dy}{dx} = \frac{(4x^4 + 4)(15x^4 - 15x^2) - (3x^5 - 5x^3) \cdot 16x^3}{(4x^4 + 4)^2}$

64) $\frac{dy}{dx} = \frac{(4x^2 + 5) \cdot 3x^2 - (x^3 + 2) \cdot 8x}{(4x^2 + 5)^2}$

65) $\left.\frac{dy}{dx}\right|_{\substack{x=-2 \\ y=-2}} = -\frac{19}{7}$

66) $\left.\frac{dy}{dx}\right|_{\substack{x=2 \\ y=10}} = -25$

67) $\left.\frac{dy}{dx}\right|_{\substack{x=-2 \\ y=2}} = -\frac{1}{8}$

68) $\left.\frac{dy}{dx}\right|_{\substack{x=2 \\ y=-1}} = -\frac{6}{7}$

69) $\left.\frac{dy}{dx}\right|_{\substack{x=-2 \\ y=10}} = -22$

70) $\left.\frac{dy}{dx}\right|_{\substack{x=2 \\ y=-1}} = \frac{1}{6}$

71) Increasing: $\left(\frac{-3 - \sqrt{105}}{8}, 0\right), \left(\frac{-3 + \sqrt{105}}{8}, \infty\right)$ Decreasing: $\left(-\infty, \frac{-3 - \sqrt{105}}{8}\right), \left(0, \frac{-3 + \sqrt{105}}{8}\right)$

72) Increasing: $(-\infty, -1), (0, 1)$ Decreasing: $(-1, 0), (1, \infty)$

73) Increasing: $(-\infty, -1), (0, 1)$ Decreasing: $(-1, 0), (1, \infty)$

74) Increasing: $\left(-\frac{\sqrt{6}}{2}, 0\right), \left(\frac{\sqrt{6}}{2}, \infty\right)$ Decreasing: $\left(-\infty, -\frac{\sqrt{6}}{2}\right), \left(0, \frac{\sqrt{6}}{2}\right)$

75) Increasing: $\left(0, \frac{8}{3}\right)$ Decreasing: $(-\infty, 0), \left(\frac{8}{3}, \infty\right)$

76) Increasing: $(-\infty, 0), \left(\frac{2}{3}, \infty\right)$ Decreasing: $\left(0, \frac{2}{3}\right)$

77) Increasing: $\left(0, \frac{2}{3}\right)$ Decreasing: $(-\infty, 0), \left(\frac{2}{3}, \infty\right)$

78) Increasing: $(-\infty, 4), (6, \infty)$ Decreasing: $(4, 6)$

79) Concave up: $\left(-\frac{\sqrt{6}}{3}, \frac{\sqrt{6}}{3}\right)$ Concave down: $\left(-\infty, -\frac{\sqrt{6}}{3}\right), \left(\frac{\sqrt{6}}{3}, \infty\right)$

80) Concave up: $\left(-\infty, \frac{3 - \sqrt{15}}{6}\right), \left(\frac{3 + \sqrt{15}}{6}, \infty\right)$ Concave down: $\left(\frac{3 - \sqrt{15}}{6}, \frac{3 + \sqrt{15}}{6}\right)$

81) Concave up: $\left(-\infty, -\frac{\sqrt{6}}{6}\right), \left(\frac{\sqrt{6}}{6}, \infty\right)$ Concave down: $\left(-\frac{\sqrt{6}}{6}, \frac{\sqrt{6}}{6}\right)$

82) Concave up: $\left(-\frac{\sqrt{6}}{3}, \frac{\sqrt{6}}{3}\right)$ Concave down: $\left(-\infty, -\frac{\sqrt{6}}{3}\right), \left(\frac{\sqrt{6}}{3}, \infty\right)$

83) Concave up: $\left(-\frac{\sqrt{2}}{2}, \frac{\sqrt{2}}{2}\right)$ Concave down: $\left(-\infty, -\frac{\sqrt{2}}{2}\right), \left(\frac{\sqrt{2}}{2}, \infty\right)$

84) Concave up: $\left(-\frac{\sqrt{3}}{3}, \frac{\sqrt{3}}{3}\right)$ Concave down: $\left(-\infty, -\frac{\sqrt{3}}{3}\right), \left(\frac{\sqrt{3}}{3}, \infty\right)$

85) Concave up: $\left(-\infty, -\frac{\sqrt{2}}{2}\right), \left(\frac{\sqrt{2}}{2}, \infty\right)$ Concave down: $\left(-\frac{\sqrt{2}}{2}, \frac{\sqrt{2}}{2}\right)$

86) Concave up: $\left(-\frac{\sqrt{2}}{2}, \frac{\sqrt{2}}{2}\right)$ Concave down: $\left(-\infty, -\frac{\sqrt{2}}{2}\right), \left(\frac{\sqrt{2}}{2}, \infty\right)$

87) $v(t) = 3t^2 - 44t + 121$, $a(t) = 6t - 44$

Changes direction at: $t = \left\{\frac{11}{3}, 11\right\}$, Moving left: $\frac{11}{3} < t < 11$, Moving right: $0 \le t < \frac{11}{3}, t > 11$

Acceleration zero at: $t = \left\{\frac{22}{3}\right\}$, Slowing down: $0 \le t < \frac{11}{3}, \frac{22}{3} < t < 11$, Speeding up: $\frac{11}{3} < t < \frac{22}{3}, t > 11$

88) $v(t) = 3t^2 - 8t - 60$, $a(t) = 6t - 8$

Changes direction at: $t = \{6\}$, Moving left: $0 \le t < 6$, Moving right: $t > 6$

Acceleration zero at: $t = \left\{\frac{4}{3}\right\}$, Slowing down: $\frac{4}{3} < t < 6$, Speeding up: $0 \le t < \frac{4}{3}, t > 6$

89) $v(t) = -3t^2 + 32t - 64$, $a(t) = -6t + 32$

Changes direction at: $t = \left\{\frac{8}{3}, 8\right\}$, Moving left: $0 \le t < \frac{8}{3}, t > 8$, Moving right: $\frac{8}{3} < t < 8$

Acceleration zero at: $t = \left\{\frac{16}{3}\right\}$, Slowing down: $0 \le t < \frac{8}{3}, \frac{16}{3} < t < 8$, Speeding up: $\frac{8}{3} < t < \frac{16}{3}, t > 8$

90) $v(t) = 3t^2 - 40t + 100$, $a(t) = 6t - 40$

Changes direction at: $t = \left\{\frac{10}{3}, 10\right\}$, Moving left: $\frac{10}{3} < t < 10$, Moving right: $0 \le t < \frac{10}{3}, t > 10$

Acceleration zero at: $t = \left\{\frac{20}{3}\right\}$, Slowing down: $0 \le t < \frac{10}{3}, \frac{20}{3} < t < 10$, Speeding up: $\frac{10}{3} < t < \frac{20}{3}, t > 10$

91) $v(t) = -3t^2 + 18t$, $a(t) = -6t + 18$

Changes direction at: $t = \{6\}$, Moving left: $t > 6$, Moving right: $0 < t < 6$

Acceleration zero at: $t = \{3\}$, Slowing down: $3 < t < 6$, Speeding up: $0 < t < 3, t > 6$

92) $v(t) = -3t^2 + 40t - 100$, $a(t) = -6t + 40$

Changes direction at: $t = \left\{\frac{10}{3}, 10\right\}$, Moving left: $0 \le t < \frac{10}{3}, t > 10$, Moving right: $\frac{10}{3} < t < 10$

Acceleration zero at: $t = \left\{\frac{20}{3}\right\}$, Slowing down: $0 \le t < \frac{10}{3}, \frac{20}{3} < t < 10$, Speeding up: $\frac{10}{3} < t < \frac{20}{3}, t > 10$

93) $-\frac{4}{3}$ cm/sec

94) $\frac{9}{16}$ cm/sec

95) 270π cm²/min

96) 108π cm³/sec

97) $\frac{49}{20}$ ft/s

98) -224π in²/hr

99) -3 in/hr

100) $\frac{64}{147}$ in/sec

101) 3 in

102) 2 in

103) 700

104) $\frac{10}{3}$ in

105) 8 ft by 8 ft by 4 ft tall

106) 81

107) 12 in wide by 24 in tall

108) 49

109) 16

110) 64

111) 11 in wide by 22 in tall

112) 8 in wide by 16 in tall

113) $\frac{16}{4+\pi}$ ft (width) by $\frac{8}{4+\pi}$ ft (height)

114) $\frac{28}{4+\pi}$ ft (width) by $\frac{14}{4+\pi}$ ft (height)

115) $\frac{32}{4+\pi}$ ft (width) by $\frac{16}{4+\pi}$ ft (height)

116) $\frac{40}{4+\pi}$ ft (width) by $\frac{20}{4+\pi}$ ft (height)

117) $y = x$

118) $y = -9x - 10$

119) $y = \frac{8}{25}x + \frac{6}{25}$

120) $y = -\frac{4}{9}x + \frac{2}{9}$

121) $y = 9x + 4$

122) $y = 2x + 4$

123) $4x^{\frac{6}{5}} + C$

124) $-\frac{4}{x^2} + C$

125) $3x + C$

126) $-\frac{4}{x^2} + C$

127) $\frac{3}{x^2} + C$

128) $x^5 + C$

129) $x^{\frac{9}{4}} + C$

130) $x^2 + C$

131) $3x^{\frac{4}{3}} + C$

132) $-\frac{2}{x} + C$

133) $-4x^{\frac{9}{4}} + C$

134) $\frac{2}{x^2} + C$

135) $2\cot x + C$

136) $-\sec x + C$

137) $-4\cot x + C$

138) $4\sec x + C$

139) $3\sin x + C$

140) $-3\sec x + C$

141) $\cos x + C$

142) $-\sin x + C$

143) $4\tan x + C$

144) $2\csc x + C$

145) $5\sin x + C$

146) $4\sin x + C$

147) $-4\cot x + C$

148) $-4\csc x + C$

149) $-2\sec x + C$

150) $\cot x + C$

151) $3\cot x + C$

152) $\cot x + C$

153) $-3\cot x + C$

154) $-\sin x + C$

155) $4\ln|x| + C$

156) $-\ln|x| + C$

157) $\frac{3 \cdot 4^x}{\ln 4} + C$

158) $5e^x + C$

159) $-e^x + C$

160) $-2e^x + C$

161) $2e^x + C$

162) $2\ln|x| + C$

163) $-5e^x + C$

164) $3\ln|x| + C$

165) $\frac{5^x}{\ln 5} + C$

166) $-2\ln|x| + C$

167) ∞

168) $-\infty$

169) ∞

170) $\frac{1}{4}$

171) 0

172) ∞

173) ∞

174) ∞

175) 6

176) 1

177) 5

178) 4

179) -1

180) $\frac{1}{4}$

181) $\frac{1}{4}$

182) -1

183) 0

184) 2

185) $\frac{5}{2}$

186) 6

187) -6

188) $-\sqrt[3]{4}$

189) 1

190) 3

191) $-\frac{1}{4}$

192) 1

193) 3

194) $\frac{1}{16}$

