Chapter 2

2.1 4.

x	$\frac{x^4-1}{x-1}$	x	$\frac{x^4-1}{x-1}$
0.9	3.439	1.1	4.641
0.99	3.940	1.01	4.060
0.999	3.9940	1.001	4.006

a. $\lim_{x \to 1^-} \left(\frac{x^3-1}{x-1} \right) = 4$

b. $\lim_{x \to 1^+} \left(\frac{x^3-1}{x-1} \right) = 4$

c. $\lim_{x \to 1} \left(\frac{x^3-1}{x-1} \right) = 4$

8. $\lim_{x \to 1} \frac{\sqrt{x}-1}{x-1}$

x	$\frac{\sqrt{x}-1}{x-1}$	x	$\frac{\sqrt{x}-1}{x-1}$
0.9	0.5132	1.1	0.4881
0.99	0.5013	1.01	0.4988
0.999	0.5001	1.001	0.4999

$\lim_{x \to 1} \frac{\sqrt{x}-1}{x-1} = 0.5$

16. $\lim_{x \to 3} \sqrt[3]{x^2 + x - 4}$

$= \sqrt[3]{3^2 + 3 - 4}$

$= \sqrt[3]{12} - 4$

20. $\lim_{s \to 4} (s^{3/2} - 3s^{1/2})$

$= 4^{3/2} - (3)(4^{1/2})$

$= 2$

24. $\lim_{x \to 1} \frac{x-1}{x^2 + x - 2}$

$\lim_{x \to 1} \left(\frac{x-1}{x(x+2)-(x+2)} \right)$

$= 1/_{1+2} = 1/3$

28. $\lim_{x \to -4} \frac{x^2 + 9x + 20}{x+4}$

$\lim_{x \to -4} \left(\frac{(x+5)\cancel{(x+4)}}{\cancel{x+4}} \right)$

$= -4 + 5 = 1$

32. $\lim_{h \to 0} \frac{x^2 h - x h^2 + h^3}{h}$

$\lim_{h \to 0} \left(\frac{\cancel{h} \times (x^2 - xh + h^2)}{\cancel{h}} \right)$

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

$x^2 - \cancel{x \times 0} + \cancel{0^2} = x^2$

36. a. 1

b. 3

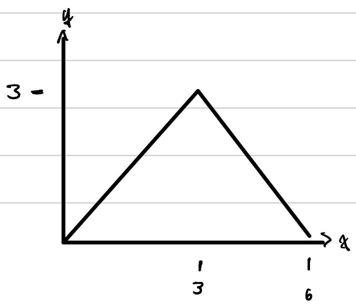
c. does not exist

40. a. 0

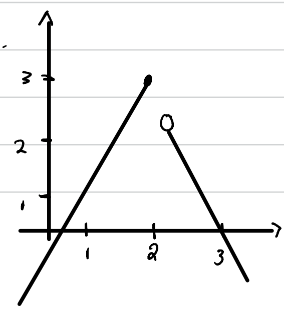
b. 0

c. 0

62.



66.



2.2

2. P_1: positive slope
P_2: negative slope
P_3: zero slope

4. P_1: positive slope
P_2: negative slope
P_3: zero slope

6. P_1: slope is 3
P_2: slope is $-1/2$

10. $\lim_{x \to 3} \sqrt[3]{x^2 + x - 4}$

$= \sqrt[3]{3^2 + 3 - 4}$

$= \sqrt[3]{12} - 4$

14. $\lim_{s \to 4} (s^{3/2} - 3s^{1/2})$

$= 4^{3/2} - (3)(4^{1/2})$

$= 2$

18. $\lim_{x \to 1} \frac{x - 1}{x^2 + x - 2}$

$\lim_{x \to 1} \left(\frac{x - 1}{x(x+2)-(x+2)} \right)$

$= 1/(1+2) = 1/3$

22. $\lim_{x \to -4} \frac{x^2 + 9x + 20}{x + 4}$

$\lim_{x \to -4} \left(\frac{(x+5)\cancel{(x+4)}}{\cancel{x+4}} \right)$

$= -4 + 5 = 1$

26. $\lim_{h \to 0} \frac{x^2h - xh^2 + h^3}{h}$

$\lim_{h \to 0} \left(\frac{\cancel{h} \times (x^2 - xh + h^2)}{\cancel{h}} \right)$

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

$x^2 - \cancel{x \times 0} + \cancel{0^2} = x^2$

30. $f'(x) = \frac{d}{dx}(-3x + 5)$

$= \frac{d}{dx}(-3x) + \frac{d}{dx}(5)$

$= -3 + 0$

$= -3$

34. $f'(x) = \frac{d}{dx}(\pi) = 0$

38. $f'(x) = \frac{d}{dx}(x^4)$

$= 4x^3$

42. $f'(x) = 1/\sqrt{x}$

$= \frac{d}{dx}\left(\frac{1}{\sqrt{x}}\right)$

$= \frac{\frac{d}{dx}\sqrt{x}}{\sqrt{x}^2} = -\frac{\frac{1}{2\sqrt{x}}}{\sqrt{x}^2}$

46. $y = x + 1$

50. a) $f(x) = \frac{d}{dx}(2x - 9)$

$f'(x) = \frac{d}{dx}(2x) - \frac{d}{dx}(9)$

$= 2 - 0$

$= 2$

60. Substituting $h=0$ would make the denominator zero, and we can't divide by zero. That's we need to do some algebra on the difference quocient - to cancel the terms that are zero so that afterward we can evaluate by direct substitution.

2.3

4. $f'(x) = \frac{d}{dx}(x^{1000})$

$= 1000x^{999}$

8. $f'(x) = \frac{d}{dx} \frac{1}{3}x^9$

$= \frac{1}{3} \times \frac{d}{dx}(9x)^8$

$= 3x^8$

12. $h(x) = 4/x^3$

$h'(x) = \frac{d}{dx}\left(4/x^3\right)$

$h'(x) = -4 \times \frac{\frac{d}{dx}(x^3)}{(x^3)^2}$

$h'(x) = -4 \times \frac{3x^2}{(x^3)^2} = -\frac{12}{x^4}$

16. $f'(x) = \frac{1}{x^{2/3}}$

$= \frac{d}{dx}\left(\frac{1}{x^{\frac{2}{3}}}\right)$

$= -\frac{\frac{d}{dx}\left(x^{\frac{2}{3}}\right)}{\left(x^{\frac{2}{3}}\right)^2}$

$= -\frac{2}{3x\sqrt[3]{x^2}}$

20. $f'(x) = \frac{d}{dr} \frac{4}{3}\pi r^3$

$= \frac{4\pi}{3} \times \frac{d}{dr}(r^3)$

$= \frac{4\pi}{3} \times 3r^2$

$= 4\pi r^2$

24. $f'(x) = \frac{d}{dx}\left(\sqrt[3]{x} - \frac{1}{x}\right)$

$= \frac{d}{dx}\left(x^{\frac{1}{3}}\right) - \frac{d}{dx}\left(\frac{1}{x}\right)$

$= \frac{1}{3\sqrt[3]{x^2}} + \frac{1}{x^2}$

28. $f'(x) = \frac{d}{dx}\left(\frac{9}{2x^{\frac{2}{3}}} - 16\sqrt{x^5} - 14\right)$

$= -9 \times \frac{2 \times \frac{2}{3}x^{-\frac{1}{3}}}{\left(2x^{\frac{2}{3}}\right)^2} - 16 \times \frac{1}{2\sqrt{x^5}} \times 5x^4 - 0$

$= -\frac{3}{x\sqrt[3]{x^3}} - 40x\sqrt{x}$

32. $f(-3) = (-3)^4 = -108$

36. $\left.\frac{df}{dx}\right| = -32$

40. $f(x) = x^2 - 4x + 6$ @ $x = 1$

$= 1^2 - 4 \times 1 + 6$

$f(1) = 3$

equation tangent

$y = -2x + 5$

$\lim_{h \to 0}\left(\frac{(a+h)^2 - 4(a+h) + 6 - (a^2 - 4a + 6)}{h}\right)$

$\lim_{h \to 0}\left(\frac{(1+h)^2 - 4(1+h) + 6 - (1^2 - 4 \times 1 + 6)}{h}\right)$

$m = -2$

$y - 3 = -2(x-1)$

2.4

4. $x^5(x^4+1)$

product rule $(f\cdot g)' = f'\cdot g + f\cdot g'$

$f = x^5, \quad g = x^4+1$

$= \frac{d}{dx}(x^5)(x^4+1) + \frac{d}{dx}(x^4+1)x^5$

$= 5x^4(x^4+1) + 4x^3x^5$

$= 9x^8 + 5x^4$

8. $f'(x) = \frac{d}{dx}(2x \times (x^4+1))$

$f'(x) = \frac{d}{dx}(2x) \times (x^4+1) + 2x \times \frac{d}{dx}(x^4+1)$

$f'(x) = 2(x^4+1) + 2x \times 4x^3$

$f'(x) = 10x^4 + 2$

12. $f'(x) = \frac{d}{dx}((x^3-1) \times (x^3+1))$

$f'(x) = \frac{d}{dx}(x^6-1)$

$f'(x) = \frac{d}{dx}(x^6) - \frac{d}{dx}(1)$

$f'(x) = 6x^5 - 0 = 6x^5$

16. $f'(x) = \frac{d}{dx}(x^3 \times (x^2-4x+3))$

$f'(x) = \frac{d}{dx}(x^3) \times (x^2-4x+3) + x^3 \times \frac{d}{dx}(x^2-4x+3)$

$f'(x) = 3x^2 \times (x^2-4x+3) + x^3 \times (2x-4)$

$f'(x) = 5x^4 - 16x^3 + 9x^2$

22. $f'(x) = \frac{d}{dx}\left(4x^{\frac{3}{2}} \times \left(2x^{\frac{1}{2}} - 1\right)\right)$

$f'(x) = \frac{d}{dx}\left(4x^{\frac{3}{2}}\right) \times \left(2x^{\frac{1}{2}} - 1\right) + 4x^{\frac{3}{2}} \times \frac{d}{dx}\left(2x^{\frac{1}{2}} - 1\right)$

$f'(x) = 4 \times \frac{3}{2}x^{\frac{1}{2}} \times \left(2x^{\frac{1}{2}} - 1\right) + 4x^{\frac{3}{2}} \times 2 \times \frac{1}{2}x^{-\frac{1}{2}}$

$f'(x) = 16x - 6\sqrt{x}$

26. $f'(x) = \frac{d}{dx}((x-6\sqrt{x}) \times (x-2\sqrt{x}+1))$

$f'(x) = \left(1+6 \times \frac{1}{2\sqrt{x}}\right) \times (x-2\sqrt{x}+1)$

$+ (x+6\sqrt{x}) \times \left(1-2 \times \frac{1}{2\sqrt{x}}\right)$

$f'(x) = 2x + 6\sqrt{x} - 11 + \frac{3}{\sqrt{x}}$

30. $\frac{d}{dx}\left(\frac{1}{x^4}\right) = -\frac{4}{x^5}$

34. $f'(x) = \frac{d}{dx}\left(\frac{x-1}{x+1}\right)$

$$f'(x) = \frac{\frac{d}{dx}(x-1) \times (x+1) - (x-1) \times \frac{d}{dx}(x+1)}{(x+1)^2}$$

$$f'(x) = \frac{1(x+1) - (x-1) \times 1}{(x+1)^2}$$