1. (a) $C(x) = 9x + 200000,\ \ R(x) = 17x,\ \ P(x) = R(x) - C(x) = 17x - (9x + 200000) = 8x - 200000.$

1. (b) Breaking even occurs when $R(x) = C(x)$ or equivalently $P(x) = 0$. Solving the latter, we find:

$$P(x) = 0 \implies 8x - 200000 = 0 \implies 8x = 200000 \implies x = 25000.$$

So the manufacturer must produce 25000 units/month to break even.

2. $(f + g)(x) = (3x^2 + 2x + 1) + (x + 3) = 3x^2 + 3x + 4.$
$(f - g)(x) = (3x^2 + 2x + 1) - (x + 3) = 3x^2 + x - 2.$
$(fg)(x) = (3x^2 + 2x + 1)(x + 3) = 3x^3 + 9x^2 + 2x^2 + 6x + x + 3 = 3x^3 + 11x^2 + 7x + 3.$
$(f/g)(x) = (3x^2 + 2x + 1)/(x + 3).$
$(f \circ g)(x) = f(g(x)) = 3(x + 3)^2 + 2(x + 3) + 1 = 3x^2 + 18x + 27 + 2x + 6 + 1 = 3x^2 + 20x + 34.$

3. (a) $\displaystyle\lim_{s\to 0}(2s^2 - 1)(2s + 4) = \left(2\left(\lim_{s\to 0} s\right)^2 - 1\right)\left(2\left(\lim_{s\to 0} s\right) + 4\right) = (2(0)^2 - 1)(2(0) + 4) = -4.$

3. (b) $\displaystyle\lim_{x\to -1}\frac{\sqrt{x^2 + 8}}{2x + 4} = \frac{\sqrt{\left(\lim\limits_{x\to -1} x\right)^2 + 8}}{2\left(\lim\limits_{x\to -1} x\right) + 4} = \frac{\sqrt{(-1)^2 + 8}}{2(-1) + 4} = \frac{3}{2}.$

3. (c) $\displaystyle\lim_{x\to a}\sqrt[3]{5f(x) + 3g(x)} = \sqrt[3]{5\left(\lim_{x\to a} f(x)\right) + 3\left(\lim_{x\to a} g(x)\right)} = \sqrt[3]{5(3) + 3(4)} = \sqrt[3]{27} = 3.$

4. (a) $\displaystyle\lim_{x\to -5}\frac{x^2 - 25}{x + 5} = \lim_{x\to -5}\frac{(x - 5)(x + 5)}{x + 5} = \lim_{x\to -5}(x - 5) = -10.$

4. (b) $\displaystyle\lim_{x\to\infty}\frac{2x^2 - 1}{x^3 + x^2 + 1} = \lim_{x\to\infty}\frac{2x^2 - 1}{x^3 + x^2 + 1}\cdot\frac{\frac{1}{x^3}}{\frac{1}{x^3}} = \lim_{x\to\infty}\frac{\frac{2}{x} - \frac{1}{x^3}}{1 + \frac{1}{x} + \frac{1}{x^3}} = \frac{0 - 0}{1 + 0 + 0} = \frac{0}{1} = 0.$

5. (a) The function f is a rational function, so it is continuous except when its denominator is equal to zero. To find these x-values, solve: $x^2 - 2x + 3 = 0$. Using the quadratic formula,

$$x = \frac{-b^2 \pm \sqrt{b^2 - 4ac}}{2a} = \frac{-(-2) \pm \sqrt{(-2)^2 - 4(1)(3)}}{2(1)} = \frac{2 \pm \sqrt{4 - 12}}{2} = \frac{2 \pm \sqrt{-8}}{2} = \frac{2 \pm 2i\sqrt{2}}{2} = 1 \pm i\sqrt{2}.$$

Since these are two complex solutions, there are no real numbers that make the denominator zero. Hence, f is continuous on $(-\infty, \infty)$.

5. (b) Graphically, it is easy to see that: $\lim\limits_{x\to 3^+} g(x) = 5$, $\lim\limits_{x\to 3^-} g(x) = 3$, and thus $\lim\limits_{x\to 3} g(x)$ does not exist.

5. (c) Each piece of the function is a polynomial, and thus continuous wherever it is defined. We observed that $\lim\limits_{x\to 3} g(x)$ does not exist, and thus the function g is continuous on the interval $(-\infty, 3) \cup (3, \infty)$.

6. The function f is a polynomial, so it is continuous everywhere, and in particular for all $x \in [-1, 1]$. Notice that $f(-1) = (-1)^3 - 2(-1)^2 + 3(-1) + 2 = -4 < 0$ and $f(1) = 1^3 - 2(1)^2 + 3(1) + 2 = 4 > 0$ have different signs. Thus, by the Intermediate Value Theorem, the function f has at least one zero in the interval $(-1, 1)$.

7. (a) By the definition of the derivative:

$$\begin{aligned} f'(x) &= \lim_{h\to 0} \frac{f(x+h)-f(x)}{h} \\ &= \lim_{h\to 0} \frac{(2(x+h)^2+1)-(2x^2+1)}{h} \\ &= \lim_{h\to 0} \frac{2x^2+4xh+2h^2+1-2x^2-1}{h} \\ &= \lim_{h\to 0} \frac{4xh+2h^2}{h} \\ &= \lim_{h\to 0} (4x+2h) \\ &= 4x. \end{aligned}$$

7. (b) The slope of the tangent line at the point $(1, 3)$ is given by $m = f'(1) = 4(1) = 4$. We then use point-slope form to find the equation of the tangent line.

$$\begin{aligned} y - y_1 = m(x - x_1) &\implies y - 3 = 4(x-1) \\ &\implies y - 3 = 4x - 4 \\ &\implies y = 4x - 1. \end{aligned}$$

Bonus. Any number of answers is acceptable, as long as the depicted function is defined everywhere on the interval $[0, 10]$ and satisfies the specified "not continuous" and "not differentiable" requirements. In particular, at $x = 2, 4, 6$ the graph should display either a "jump" discontinuity, a "hole" discontinuity, or an "asymptotic" discontinuity, while at $x = 8$ the function should either have a vertical tangent line (meaning undefined slope) or some sort of kink or corner.