



$$f(x) = \begin{cases} 5x^2 - 7 & \text{if } x < 1 \\ 3x + 4 & \text{if } 1 \leq x \leq 3 \\ 10 + x & \text{if } x > 3 \end{cases}$$

Find any discontinuities & 1-sided limits at any discontinuity.

$$\lim_{x \rightarrow 1^-} f(x) = 5 \cdot 1^2 - 7 = 5 - 7 = -2$$

$$\lim_{x \rightarrow 1^+} f(x) = 3 \cdot 1 + 4 = 7 \quad \leftarrow \begin{matrix} \uparrow \\ f \text{ is not} \\ \text{continuous at } x=1. \end{matrix}$$

$$\lim_{x \rightarrow 3^-} f(x) = 3 \cdot 3 + 4 = 13$$

$$\lim_{x \rightarrow 3^+} f(x) = 10 + 3 = 13 \leftarrow \text{same!}$$

so it is cont. at  $x=3$ .

---

I'm a sherpa -

I get paid \$10/lb for loads up to 100 lbs,  
if it's <sup>equal or</sup> over 100, it's only \$7 per lb.

Write a formula for  $f(x)$  = total cost for  $x$  lbs.

$$f(x) = \begin{cases} 10x & \text{if } x < 100 \\ 7x & \text{if } x \geq 100 \end{cases}$$

---

\$10 for any lbs under 100,  
\$7 for each additional lb.

$$f(x) = \begin{cases} 10x & \text{if } x < 100 \\ \frac{1000}{\uparrow \text{first 100 lbs}} + \frac{7(x-100)}{\uparrow \text{any additional lbs.}} & \text{if } x \geq 100 \end{cases}$$

derivative of  $f(x) = x + 3x^2$

$$f'(x) = 1 + 6x$$

$$\begin{aligned} f'(x) &= \lim_{h \rightarrow 0} \frac{f(x+h) - f(x)}{h} \\ &= \lim_{h \rightarrow 0} \frac{x+h + 3(x+h)^2 - (x + 3x^2)}{h} \\ &= \lim_{h \rightarrow 0} \frac{x+h + 3(x^2 + 2xh + h^2) - x - 3x^2}{h} \\ &= \lim_{h \rightarrow 0} \frac{\cancel{x} + h + \cancel{3x^2} + 6xh + 3h^2 - \cancel{x} - \cancel{3x^2}}{h} \\ &= \lim_{h \rightarrow 0} \frac{h + 6xh + 3h^2}{h} \\ &= \lim_{h \rightarrow 0} \frac{\cancel{h}(1 + 6x + 3h)}{\cancel{h}} = 1 + 6x + 3 \cdot 0 \\ &= \boxed{1 + 6x} \end{aligned}$$

---

As I watch the MLP movie,  
my regrets increase.

# of regrets at minute  $t$  is  $f(t)$

$f(10) = 3$  means: after 10 mins, I have 3 regrets.

$f'(10) = 3$  means:

at 10 mins, my # of regrets is increasing by 3 reg/min.

$$\lim_{t \rightarrow \infty} f(t) = 43$$

As I watch MLP more & more,  
my regrets approach 43.

---

3.4 #24

$$f(x) = \frac{-3}{x+1}$$

