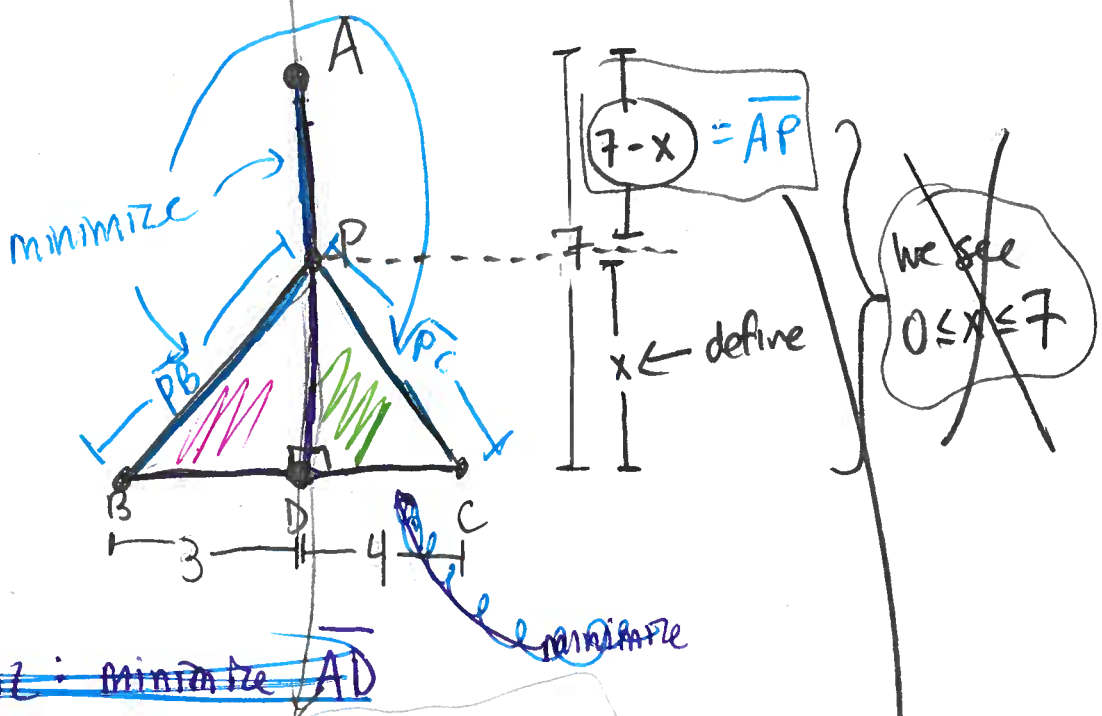
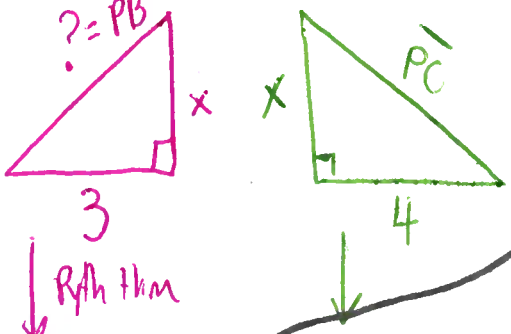
Ex: A point P needs to be located on the line AD so the total length of cables linking P to points A, B, C is minimized.




~~GOAL: minimize AD~~

GOAL: minimize $\overline{AP} + \overline{PB} + \overline{PC}$




Pyth thm

$3^2 + x^2 = \overline{PB}^2$

$\overline{PB} = \sqrt{9 + x^2}$

$x^2 + 4^2 = \overline{PC}^2$

$\overline{PC} = \sqrt{x^2 + 16}$

we need to minimize

$D = \overline{AP} + \overline{PB} + \overline{PC}$

$= (7 - x) + \sqrt{x^2 + 9} + \sqrt{x^2 + 16}$

minimize

$$D = 7 - x + \sqrt{x^2+9} + \sqrt{x^2+16}$$

$$\frac{dD}{dx} = -1 + \frac{d}{dx}\sqrt{x^2+9} + \frac{d}{dx}\sqrt{x^2+16}$$

$\frac{2x}{\sqrt{x^2+16}}$ ←

$$= -1 + \frac{d}{dx}(x^2+9)^{1/2} + \frac{2x}{\sqrt{x^2+16}}$$

$a^{-1/2} = \frac{1}{a^{1/2}} = \frac{1}{\sqrt{}}$

$$= -1 + \frac{d[x^2+9]}{dx}\frac{d}{d[x^2+9]}(x^2+9)^{1/2} + \frac{x}{\sqrt{x^2+16}}$$

$$= -1 + (2x)\left(\frac{1}{2}\right)(x^2+9)^{1/2-1} + \frac{x}{\sqrt{x^2+16}}$$

$$= -1 + \frac{x}{\sqrt{x^2+9}} + \frac{x}{\sqrt{x^2+16}} \overset{\text{set}}{=} 0$$

↓ mult by $\sqrt{x^2+9}$

$$-\sqrt{x^2+9} + x + \frac{x\sqrt{x^2+9}}{\sqrt{x^2+16}} = 0$$

↓ mult by $\sqrt{x^2+16}$

$$-(\sqrt{x^2+9})(\sqrt{x^2+16}) + x\left[\sqrt{x^2+16} + \sqrt{x^2+9}\right] = 0$$