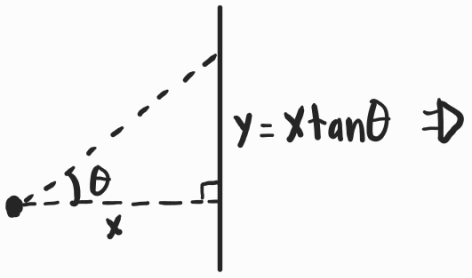
# 2E. Related rates

2)

$x = 4$ mi

$\frac{d\theta}{dt} = 6\pi$ rad/s




$$\frac{dy}{dt} = \frac{dx}{dt}\tan\theta + \sec^2\theta \frac{d\theta}{dt} x$$

$$= \sec^2\theta \frac{d\theta}{dt} x$$

$$= \sec^2\left(\frac{\pi}{3}\right) \cdot 6\pi \cdot 4$$

$$= \boxed{301.59 \text{ mi/min}}$$

3)

not enough information. need to also know the relative starting y position

5)

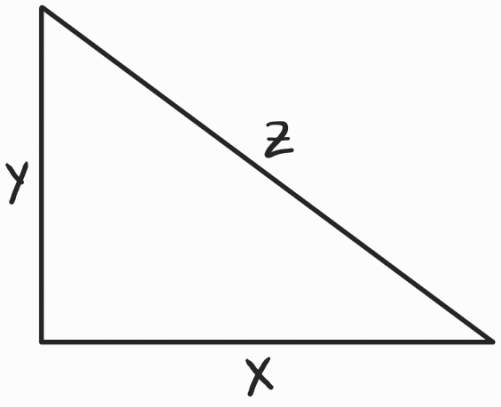
$x = 20$ ft

$y = 10$ ft

$z = \sqrt{20^2 + 10^2} = \sqrt{500}$

$\frac{dy}{dt} = -4$ ft/s

$\frac{dz}{dt} = 4$ ft/s




$$x^2 = z^2 - y^2$$

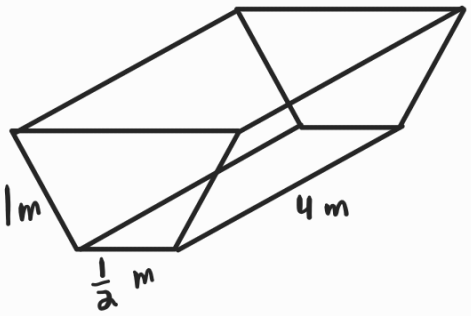
$$2x\frac{dx}{dt} = 2z\frac{dz}{dt} - 2y\frac{dy}{dt}$$

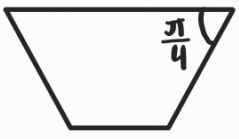
$$x\frac{dx}{dt} = z\frac{dz}{dt} - y\frac{dy}{dt}$$

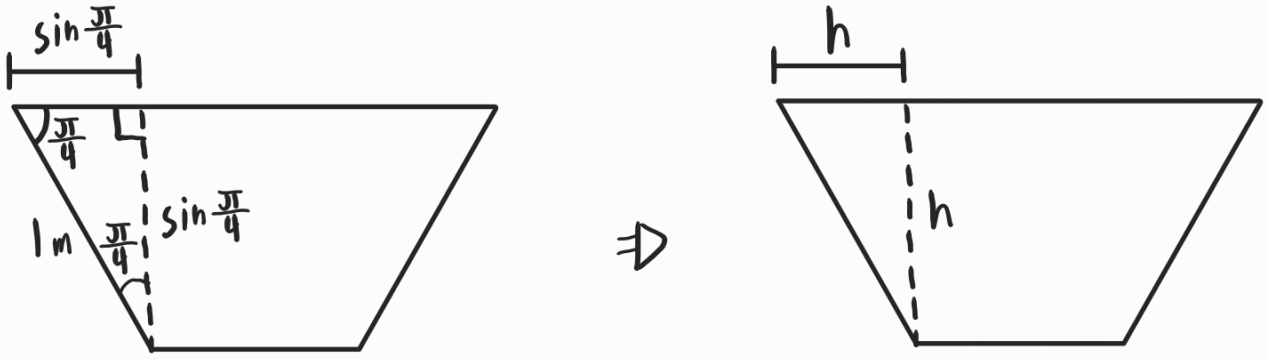
$$\frac{dx}{dt} = \frac{\sqrt{500}(4) - 10(-4)}{20} = \boxed{6.47 \text{ ft/s}}$$

7)

$\frac{dV}{dt} = 1 \text{ m}^3/\text{s}$






$$V = 4\left(h^2 + \frac{h}{2}\right) = 4h^2 + 2h$$

$$\frac{dV}{dt} = 8h\frac{dh}{dt} + 2\frac{dh}{dt} = \frac{dh}{dt}(8h + 2)$$

$$1 = \frac{dh}{dt}\left(8 \cdot \frac{1}{2} + 2\right) \Rightarrow \boxed{\frac{dh}{dt} = \frac{1}{6}\ m/s}$$