

$$1. V_{\text{sphere}} = \frac{4}{3} \pi r^3$$

$$\frac{dV}{dt} = \frac{4}{3} \pi 3r^2 \frac{dr}{dt}$$

$$\frac{dV}{dt} = 4\pi r^2 \frac{dr}{dt}$$

$$\frac{-10 \text{ ft}^3}{\text{min}} = 4\pi (1 \text{ ft})^2 \frac{dr}{dt}$$

$$\frac{-5 \text{ ft}}{2\pi \text{ min}} = \frac{dr}{dt}$$



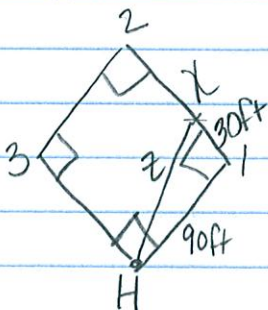
$$\frac{dV}{dt} = -10 \text{ ft}^3 / \text{min}$$

$$\frac{dr}{dt} = \text{---}$$

when  $r = 1 \text{ ft}$

$$2. \frac{-10 \text{ ft}^3}{\text{min}} = 4\pi (2 \text{ ft})^2 \frac{dr}{dt} \quad \frac{-10 \text{ ft}^3}{\text{min}} = 16\pi \text{ ft}^2 \frac{dr}{dt} \quad \frac{dr}{dt} = \frac{5 \text{ ft}}{8\pi \text{ min}}$$

3.



$$\frac{dx}{dt} = \frac{25 \text{ ft}}{\text{sec}}$$

Need  $\frac{dz}{dt}$  ---

$$(90 \text{ ft})^2 + x^2 = z^2$$

$$8100 + x^2 = z^2$$

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

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

$$\frac{30}{30\sqrt{10}} (25) \text{ min}$$

$$\frac{25}{\sqrt{10}} = \frac{5\sqrt{10}}{2}$$



$$90^2 + 30^2 = z^2$$

$$8100 + 900 = z^2$$

$$9000 = z^2$$

$$z = 30\sqrt{10}$$

$$90^2 + 45^2 = z^2$$

$$45\sqrt{5} = z$$

$$4. \frac{45}{45\sqrt{5}} (25) = \frac{dz}{dt}$$

$$5\sqrt{5} = \frac{dz}{dt}$$



5.  $V_{\text{cylinder}} = \pi r^2 h$

$V = 16\pi h$

$\frac{dV}{dt} = 16\pi \frac{dh}{dt}$

$8 = 16\pi \frac{dh}{dt} \quad \frac{dh}{dt} = \frac{1}{2\pi} \text{ ft/min}$



$r = 4 \text{ ft}$

$\frac{dV}{dt} = 8 \text{ ft}^3/\text{min}$

$\frac{dh}{dt} = \text{---}$

$h = 2$

b.



$V_{\text{cone}} = \frac{1}{3} \pi r^2 h$

$V = \frac{1}{3} \pi \left(\frac{1}{4}h\right)^2 h$

$V = \frac{1}{3} \pi \frac{1}{16} h^3$

$V = \frac{1}{3} \pi \frac{1}{16} (8h^2)$

$\frac{dV}{dt} = \frac{\pi}{16} h^2 \frac{dh}{dt}$

$3 = \frac{\pi}{16} (2)^2 \frac{dh}{dt}$

$\frac{4}{\pi} 3 = \left(\frac{\pi}{4} \frac{dh}{dt}\right) \frac{4}{\pi}$

$\frac{dh}{dt} = \frac{12}{\pi}$



7.  $V = \frac{1}{3} \pi r^2 (4r)$

$V = \frac{4}{3} \pi r^3$

$\frac{dV}{dt} = \frac{4}{3} \pi (3r^2) \frac{dr}{dt}$

$\frac{dV}{dt} = 4\pi r^2 \frac{dr}{dt}$

$3 = 4\pi \left(\frac{1}{2}\right)^2 \frac{dr}{dt}$

$\frac{3}{\pi} = 4\pi \left(\frac{1}{4}\right) \frac{dr}{dt}$

$\frac{dr}{dt} = \frac{3}{\pi}$



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

$h = 2 \text{ m}$

$\frac{dh}{dt} = \text{---}$

$r = 1/2$

$\frac{r}{h} = \frac{5}{20}$

$r = \frac{1}{4}h$

$4r = h$

$\frac{r}{2} = \frac{5}{20}$

$r = 1/2$

8.



$A = \pi r^2$

$\frac{dA}{dt} = 2\pi r \frac{dr}{dt}$

$= 2\pi (5)(2)$

$\frac{dA}{dt} = 20\pi$



$\frac{dr}{dt} = 2 \frac{\text{m}}{\text{s}}$

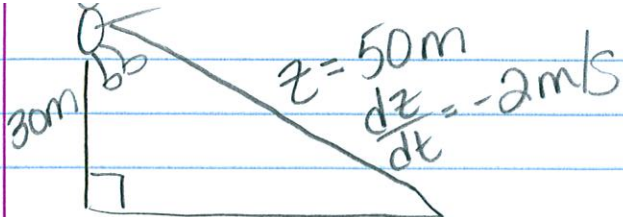
$\frac{dA}{dt} = \text{---}$

$r = 5$

9. 2



10.



$$\frac{dx}{dt} = \underline{\hspace{2cm}}$$

$$30^2 + x^2 = 50^2$$

$$x = 40$$

$$30^2 + x^2 = z^2$$

$$900 + x^2 = z^2$$

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

$$\frac{dx}{dt} = \frac{z}{x} \frac{dz}{dt}$$

$$\frac{dx}{dt} = \frac{50(-2)}{40}$$

$$= -\frac{5}{2} \text{ M/s}$$



11.

$$\frac{dx}{dt} = \frac{z}{x} \frac{dz}{dt}$$

$$= \frac{31(-2)}{\sqrt{61}}$$

$$z = 31 \text{ m}$$

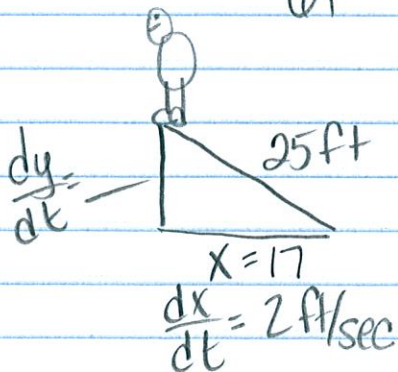
$$x = \sqrt{31^2 - 30^2}$$

$$x = \sqrt{61}$$

$$= -\frac{62\sqrt{61}}{61}$$



12.



$$\frac{dy}{dt} = \frac{-17}{4\sqrt{21}} (2)$$

$$\frac{dy}{dt} = -\frac{17\sqrt{21}}{2}$$



$$x^2 + y^2 = 25^2$$

$$2x \frac{dx}{dt} + 2y \frac{dy}{dt} = 0$$

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

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

$$13. \frac{dV}{dt} = -5 \text{ in}^3/\text{sec}$$

$$V = \frac{4}{3} \pi r^3$$

$$\frac{dr}{dt} = \text{---}$$

$$\frac{dV}{dt} = \frac{4}{3} (3r^2) \pi \frac{dr}{dt}$$

$$r = 5 \text{ inches}$$

$$\frac{dV}{dt} = 4r^2 \pi \frac{dr}{dt}$$

$$-5 = 4(25) \pi \frac{dr}{dt}$$

$$\frac{-5}{100\pi} = \frac{100\pi \frac{dr}{dt}}{100\pi}$$



$$\frac{-1}{20\pi} = \frac{dr}{dt}$$

$$14. \frac{dr}{dt} = 3 \text{ ft}/\text{min}$$

$$\frac{dA}{dt} = \text{---}$$

$$t = 10 \text{ min}$$

$$A = \pi r^2$$

$$\frac{dA}{dt} = \pi (2r) \frac{dr}{dt}$$

$$r = \frac{3 \text{ ft}}{\text{min}} (10 \text{ min})$$

$$r = 30 \text{ ft}$$

$$\frac{dA}{dt} = 2(30) \pi (3)$$

$$= 180\pi$$

