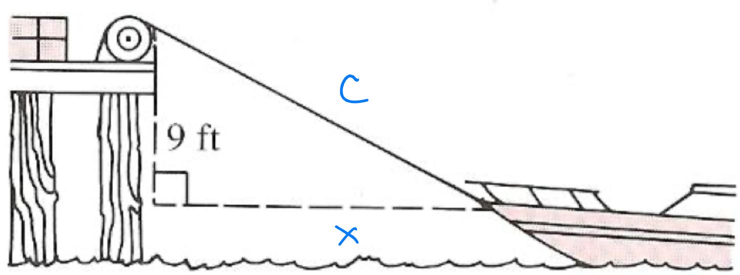
Directions: Begin at any cell and write it #1. Answer the question. Search for the numeric part of your answer. When you find it, mark it #2. Continue in this manner until you complete the circuit. Additional paper may be necessary! No technology is needed!

Answer: $\frac{4\pi}{45}$

#__________: A boat is being pulled toward a dock by means of a cable attached to a windlass 9 feet above the deck of the boat. The cable is being wound in at the rate of 6π feet per second. How fast is the boat approaching the dock when its horizontal distance to the dock is 12 feet?



① $\frac{dc}{dt} = -6\pi$ ft/sec

② $\left.\frac{dx}{dt}\right|_{x=12,\ c=15} = ?$

③ $x^2 + 9^2 = c^2$

④ $\cancel{2}x\frac{dx}{dt} + 0 = \cancel{2}c\frac{dc}{dt}$

⑤ $12\frac{dx}{dt} = 15(-6\pi)$

$\frac{dx}{dt} = \frac{15(-6\pi)}{12}$

Answer: $\dfrac{1}{40\sqrt{3}}$

#__________: A rock dropped into still water sends out concentric ripples. If the radius of the ripples increase at a rate of 2 feet per second, how fast is the area of the disturbed surface increasing when it is 6 feet in diameter?

① $\dfrac{dr}{dt} = 2$ ft/sec

② $\left.\dfrac{dA}{dt}\right|_{r=3 \text{ feet}} = ?$

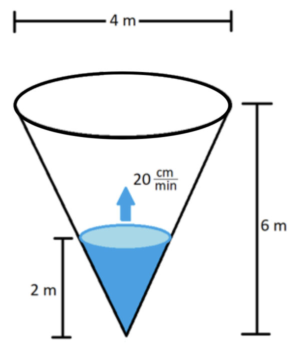
③ $A = \pi r^2$

④ $\dfrac{dA}{dt} = 2\pi r \dfrac{dr}{dt}$

⑤ $\dfrac{dA}{dt} = 2\pi(3)(2) = 12\pi$

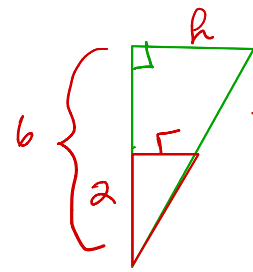
Answer: 12π

#_________: Water is being added to an inverted conical tank. The tank has a height of 6 meters and the diameter at the top is 4 meters. If the water level is rising at a rate of 20 centimeters per minute (or $\frac{1}{5}m$ per minute), find the rate at which water is being pumped into the tank when the height of the water is 2 meters. *Hint: 2 equations are needed for 2 unknowns...before differentiating, express the Volume of the Water as a function of the height of the water*



① $\frac{dh}{dt} = \frac{1}{5}$ m/min

② $\left.\frac{dV}{dt}\right|_{h=2\,m}$



$\frac{r}{h} = \frac{2}{6}$

$r = \frac{h}{3}$

③ $V = \pi r^2 h$

$r = \frac{h}{3}$

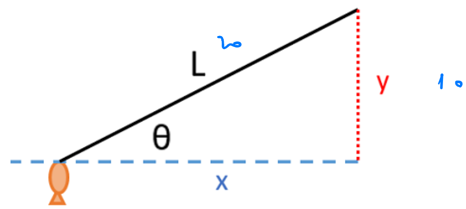
$V = \frac{\pi}{3}\left(\frac{h}{3}\right)^2 h = \frac{\pi h^3}{27}$

④ $\frac{dV}{dt} = \frac{\pi}{9} h^2 \frac{dh}{dt}$

⑤ $\frac{dV}{dt} = \frac{\pi}{9}(2)^2\left(\frac{1}{5}\right) = \frac{4\pi}{45}$

Answer: $-\dfrac{15\pi}{2}$

#__________: A fish is reeled in at a rate of 6 inches per second (or $\frac{1}{2}$ ft/sec) from a point 10 feet above the water. At the moment when the the fishing line L measures 20 feet, At what rate (in radians per second) is the angle between the water and the line θ changing?



① $\dfrac{dL}{dt} = -\dfrac{1}{2}$ ft/sec

② $\left.\dfrac{d\theta}{dt}\right|_{L=20,\ \theta=\frac{\pi}{6}}$

③ $\sin\theta = \dfrac{10}{L} = 10L^{-1}$

$\cos\theta \dfrac{d\theta}{dt} = \dfrac{-10}{L^2}\dfrac{dL}{dt}$

$\dfrac{\sqrt{3}}{2} \cdot \dfrac{d\theta}{dt} = \dfrac{-10}{400} \cdot \dfrac{-1}{2}$

$\dfrac{d\theta}{dt} = \dfrac{-10}{400} \cdot \dfrac{-1}{2} \cdot \dfrac{2}{\sqrt{3}} = \dfrac{+1}{40\sqrt{3}}$