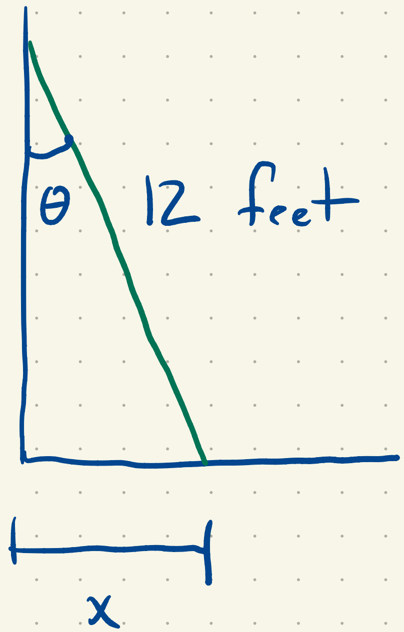
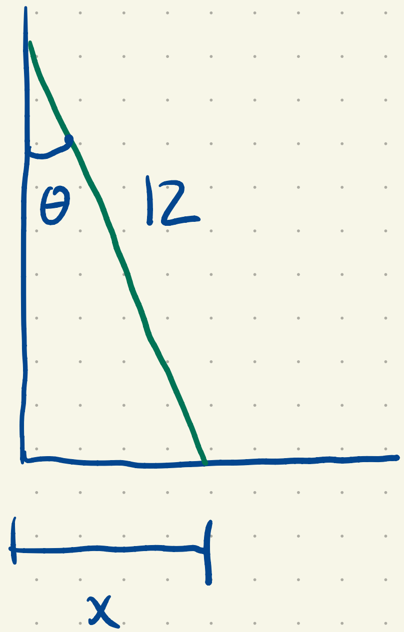
Last class:




$\theta = \frac{\pi}{3}$

$x = 12 \sin \theta$

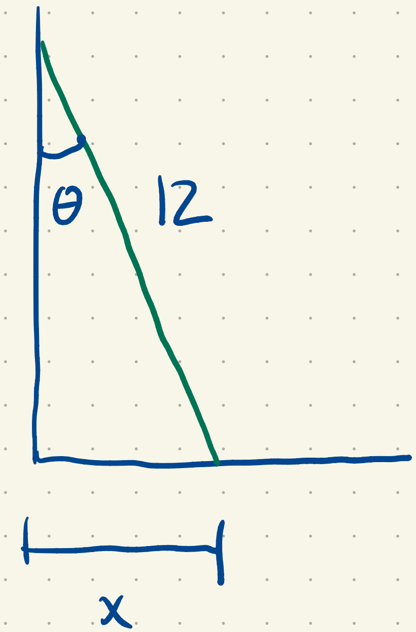
Last class:




$$x = 12 \sin\theta$$

$$\frac{d}{d\theta} x(\theta) = 12 \cos\theta$$

Last class:



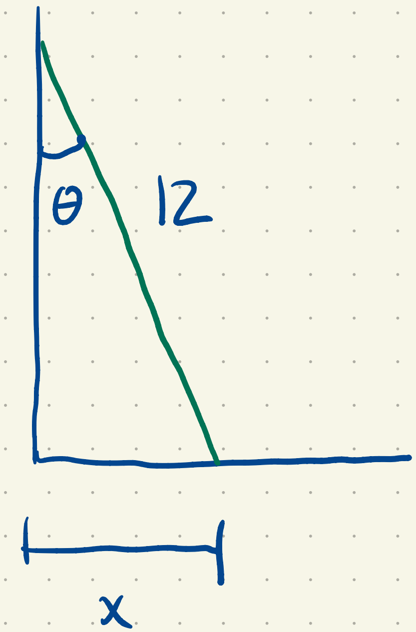

$$x = 12 \sin\theta$$

$$\frac{d}{d\theta}\, x(\theta) = 12\cos\theta$$

$$\frac{dx}{d\theta} = 12\cos\theta$$

$$\frac{\Delta x}{\Delta \theta}$$

Last class:




$$x = 12\sin\theta$$

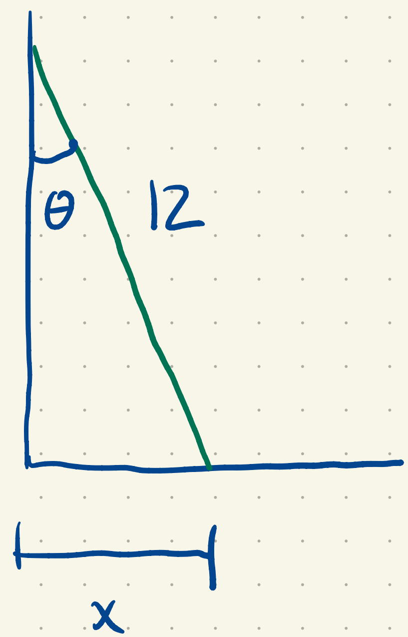
$$\frac{d}{d\theta}x(\theta) = 12\cos\theta$$

$$\frac{dx}{d\theta} = 12\cos\theta$$

If $\theta = \frac{\pi}{3}$, $\frac{dx}{d\theta} = 12\cos\left(\frac{\pi}{3}\right) = 12\frac{\sqrt{3}}{2} \approx 10.4 \frac{\text{ft}}{\text{radian}}$

rather: ft/degree

Last class:



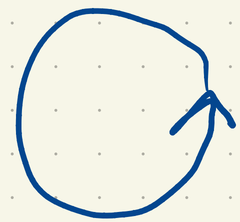

$$x = 12 \sin \theta$$

$$\underbrace{\frac{d}{d\theta} x(\theta)}_{\frac{dx}{d\theta}} = 12 \cos \theta$$

$$\frac{dx}{d\theta} = 12 \cos \theta$$

If $\theta = \frac{\pi}{3}$, $\frac{dx}{d\theta} = 12 \cos\left(\frac{\pi}{3}\right) = 12 \frac{\sqrt{3}}{2} \approx 10.4$

"If $\theta$ is $\frac{\pi}{3}$ radians and you change $\theta$, then $x$ changes at the rate of 10.4 feet/radian"

Conversion: $\dfrac{2\pi \text{ radians}}{360 \text{ degrees}}$ $\dfrac{\pi \text{ rad}}{180 \text{ deg}}$ 

$10.4 \ \dfrac{\text{feet}}{\text{radian}}$

Conversion: $\dfrac{2\pi \text{ radians}}{360 \text{ degrees}}$

$$10.4 \ \frac{\text{feet}}{\text{radian}} \cdot \frac{2\pi \text{ radians}}{360 \text{ degrees}} = 0.18 \text{ feet/degree}$$

Conversion: $\dfrac{2\pi \text{ radians}}{360 \text{ degrees}}$

$$10.4 \frac{\text{feet}}{\text{radian}} \cdot \frac{2\pi \text{ radians}}{360 \text{ degrees}} = 0.18 \text{ feet}/\text{degree}$$

---

$$w \text{ deg} \cdot \frac{2\pi \text{ rad}}{360 \text{ deg}}$$

$$\mathrm{SIN}(w) = \sin\left(w \cdot \frac{2\pi}{360}\right)$$

Conversion: $\dfrac{2\pi \text{ radians}}{360 \text{ degrees}}$

$$10.4 \ \frac{\text{feet}}{\text{radian}} \cdot \frac{2\pi \text{ radians}}{360 \text{ degrees}} = 0.18 \text{ feet}/\text{degree}$$

---

$$\text{SIN}(w) = \sin\left(w \cdot \frac{2\pi}{360}\right)$$

$$\text{SIN}(90) =$$

Conversion: $\dfrac{2\pi \text{ radians}}{360 \text{ degrees}}$

$$10.4 \,\frac{\text{feet}}{\text{radian}} \cdot \frac{2\pi \text{ radians}}{360 \text{ degrees}} = 0.18 \text{ feet}/\text{degree}$$

---

$$\text{SIN}(w) = \sin\left(w \cdot \frac{2\pi}{360}\right)$$

$$\text{SIN}(90) = \sin\left(90 \cdot \frac{2\pi}{360}\right) = \sin\left(\frac{\pi}{2}\right) = 1$$

Conversion: $\dfrac{2\pi \text{ radians}}{360 \text{ degrees}}$

$$10.4 \ \frac{\text{feet}}{\text{radian}} \cdot \frac{2\pi \text{ radians}}{360 \text{ degrees}} = 0.18 \text{ feet/degree}$$

---

$$\mathrm{SIN}(w) = \sin\left(w \cdot \frac{2\pi}{360}\right)$$

$$\mathrm{SIN}(90) = \sin\left(90 \cdot \frac{2\pi}{360}\right) = \sin\left(\frac{\pi}{2}\right) = 1$$

$$\mathrm{SIN}(45) =$$

Conversion: $\frac{2\pi \text{ radians}}{360 \text{ degrees}}$

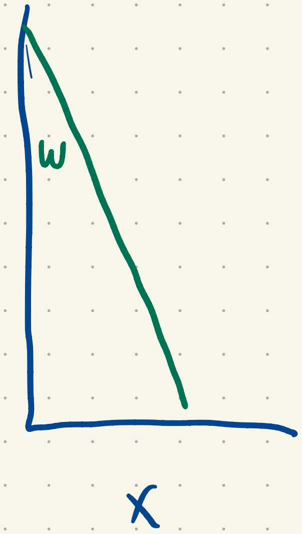
$$10.4 \frac{\text{feet}}{\text{radian}} \cdot \frac{2\pi \text{ radians}}{360 \text{ degrees}} = 0.18 \text{ feet/degree}$$

---

$$\text{SIN}(w) = \sin\left(w \cdot \frac{2\pi}{360}\right)$$

$$\text{SIN}(90) = \sin\left(90 \cdot \frac{2\pi}{360}\right) = \sin\left(\frac{\pi}{2}\right) = 1$$

$$\text{SIN}(45) = \sin\left(45 \cdot \frac{2\pi}{360}\right) = \sin\left(\frac{90}{360} \cdot \pi\right) = \sin\left(\frac{\pi}{4}\right) = \frac{\sqrt{2}}{2}$$




$w$: degrees

$$x = 12 \cdot \sin\left(w \cdot \frac{2\pi}{360}\right)$$

$$\frac{d}{dw} x = \frac{d}{dw}\, 12 \sin\left(w \cdot \frac{2\pi}{360}\right)$$

$$= 12 \frac{d}{dw} \sin\left(w \cdot \frac{2\pi}{360}\right)$$

$$\boxed{\begin{gathered} \frac{d}{dw} \sin(w) = \cos(w) \\ \frac{d}{dw}\, w \cdot \frac{2\pi}{360} = \frac{2\pi}{360} \end{gathered}}$$

$$= 12 \cos\left(w \cdot \frac{2\pi}{360}\right) \cdot \frac{d}{dw}\left(w \cdot \frac{2\pi}{360}\right)$$

$$= 12 \cos\left(w \cdot \frac{2\pi}{360}\right) \cdot \frac{2\pi}{360}$$

# Chain Rule

$$\frac{d}{dx} f(\underbrace{g(x)}_{\text{inside function}}) = f'(g(x)) \cdot \frac{d}{dx} g(x)$$

$$= f'(g(x)) \cdot g'(x)$$

outside function

$$\boxed{\frac{d}{dx} e^{2x} = e^{2x} \cdot 2}$$

$f(x) = e^x \qquad f'(x) = e^x$

$g(x) = 2x \qquad g'(x) = 2$

$e^x \cdot e^x \qquad 2e^{2x}$

$$\frac{d}{dx} e^{-x} = e^{-x} \cdot (-1)$$

$$= -e^{-x}$$

$f(x) = e^{x}$ $\quad f'(x) = e^{x}$

$g(x) = -x$ $\quad g'(x) = -1$

---

$f'(g(x)) \cdot g'(x)$

$f(g(x)) = f(-x) = e^{-x}$

$$\frac{d}{dx} \sin(x^2) = \cos(x^2) \cdot 2x$$

$$= 2x \cos(x^2)$$

$f(x) = \sin(x)$ $\quad f'(x) = \cos(x)$

$g(x) = x^2$ $\quad g'(x) = 2x$