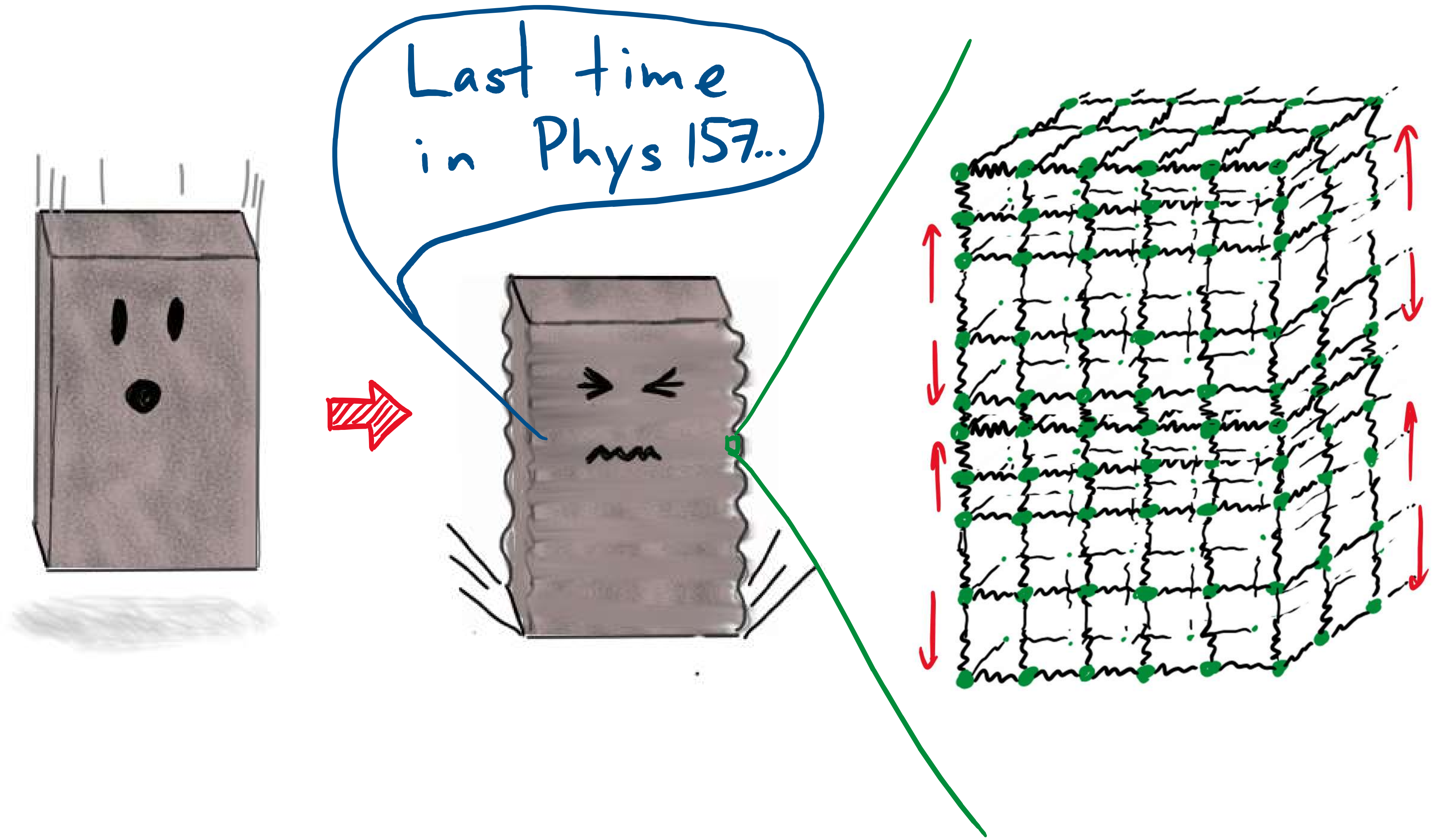
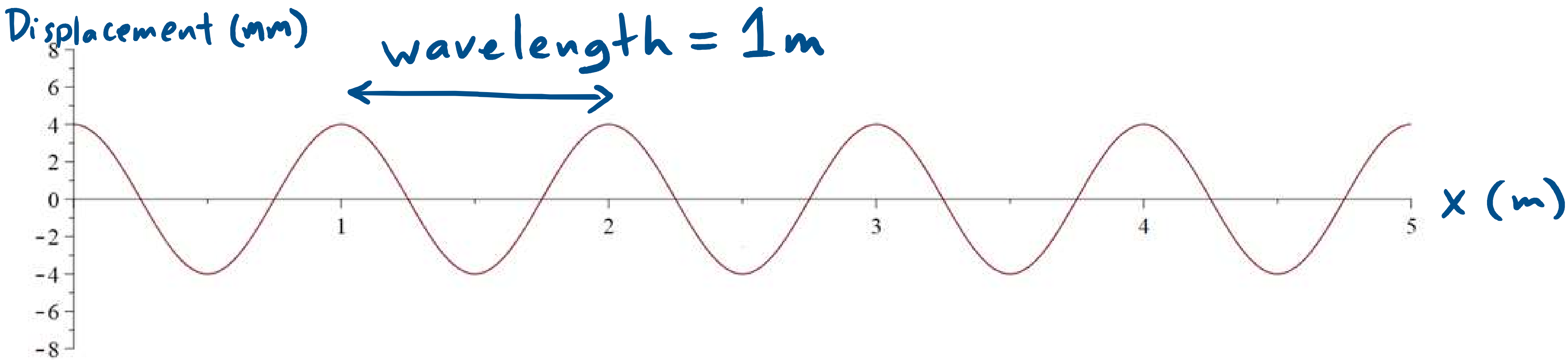
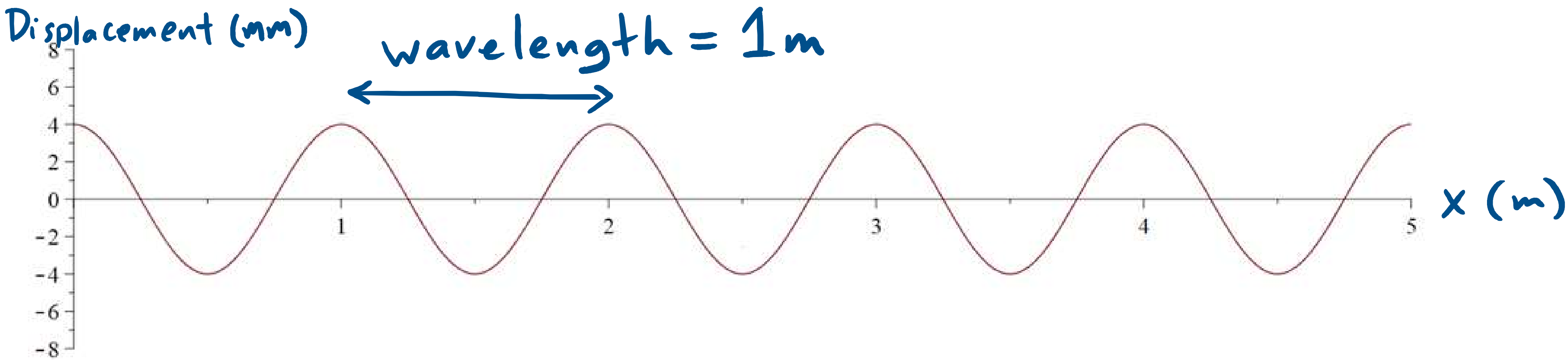

Last time in Phys 157...



The picture shows a wave on a string at some time t=0. Which of the following represents the displacement of the string as a function of position at t=0?

A) $4\text{mm} \cdot \cos(x / 1\text{m})$
B) $4\text{mm} \cdot \cos(1\text{m} \cdot x)$
C) $4\text{mm} \cdot \cos(2\pi / 1\text{m} \cdot x)$
D) $4\text{mm} \cdot \cos(1\text{m} / 2\pi \cdot x)$
E) $4\text{mm} \cdot \cos(x - 1\text{m})$

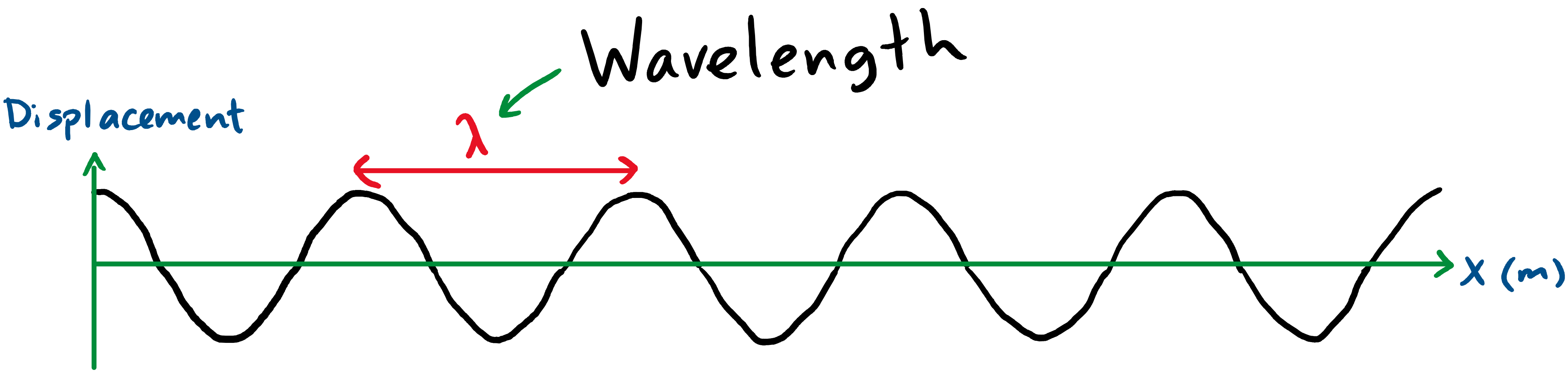


The picture shows a wave on a string at some time t=0. Which of the following represents the displacement of the string as a function of position at t=0?

Just like for D vs t in oscillator, but here t is replaced by x, and T is replaced by λ.

A) 4mm · cos(x / 1m)
B) 4mm · cos(1m · x)
C) 4mm · cos(2 π / 1m · x)
D) 4mm · cos(1m / 2 π · x)
E) 4mm · cos(x - 1m)

So $A \cdot \cos\left(\frac{2\pi}{\lambda} \cdot x\right)$

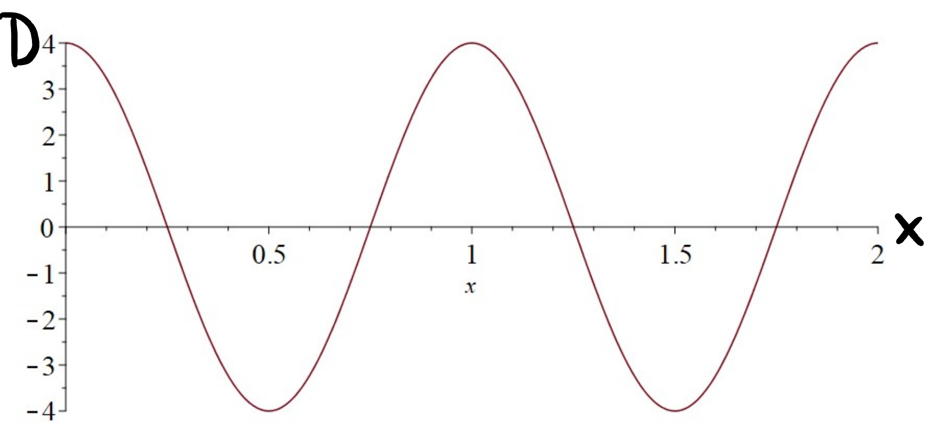


"Snapshot" graph: picture of the wave at an instant in time

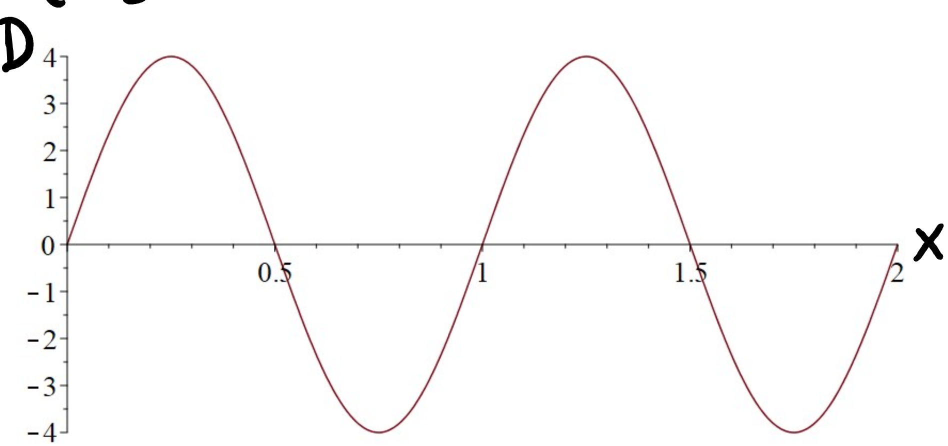
$$D(x) = A\cos(kx + \phi)$$

wave number: $k = \frac{2\pi}{\lambda}$

$t = 0s$



$t = 3s$



At t=0, the displacement as a function of position for the wave shown is

$$D(x) = 4\text{mm} \cdot \cos(2\pi / 1\text{m} \cdot x)$$

At t=3s, the wave has moved to the right, as shown in the second graph. The displacement as a function of position is now

A) $D(x) = 4\text{mm} \cdot \cos(2\pi / 1\text{m} \cdot x - 3\text{s})$

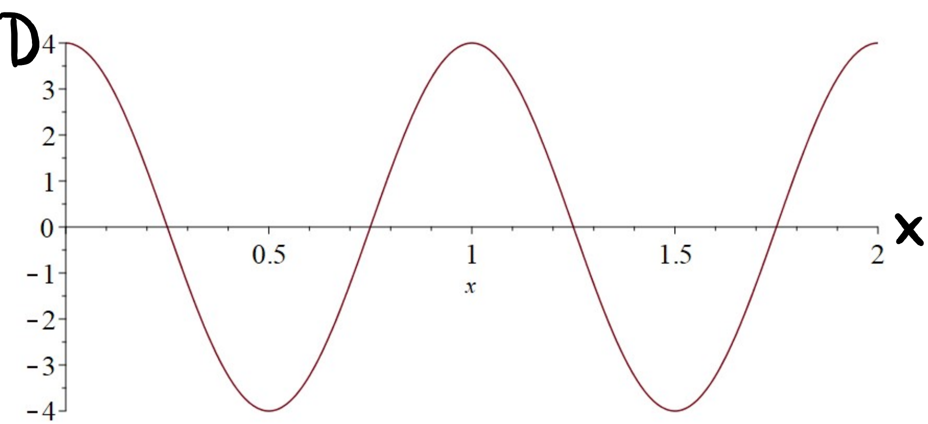
B) $D(x) = 4\text{mm} \cdot \cos(2\pi / 1\text{m} \cdot x + 3\text{s})$

C) $D(x) = 4\text{mm} \cdot \cos(2\pi / 1\text{m} \cdot x - \pi/2)$

D) $D(x) = 4\text{mm} \cdot \cos(2\pi / 1\text{m} \cdot x + \pi/2)$

E) $D(x) = 4\text{mm} \cdot \cos(2\pi / 1\text{m} \cdot x + 2\pi/3\text{s})$

t = 0s

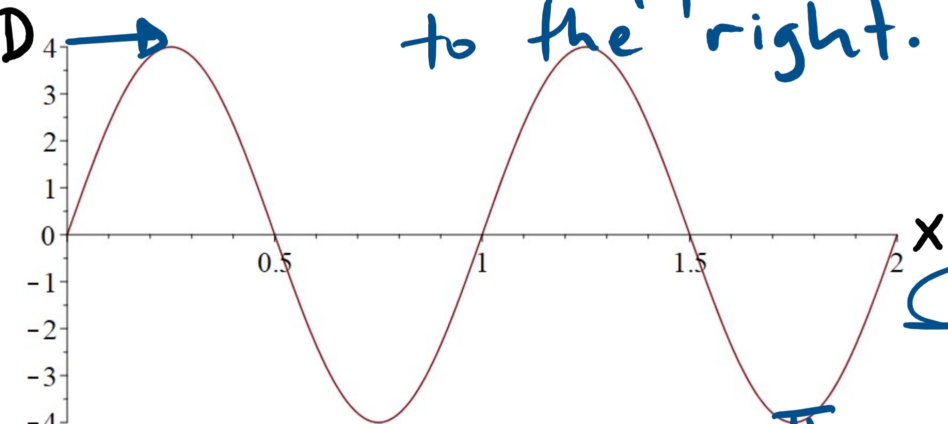


At t=0, the displacement as a function of position for the wave shown is

$$D(x) = 4\text{mm} \cdot \cos(2\pi / 1\text{m} \cdot x)$$

t = 3s

shifted $\frac{1}{4}$ period to the right.



So phase is $-\frac{\pi}{2}$

*this will increase as time passes

At t=3s, the wave has moved to the right, as shown in the second graph. The displacement as a function of position is now

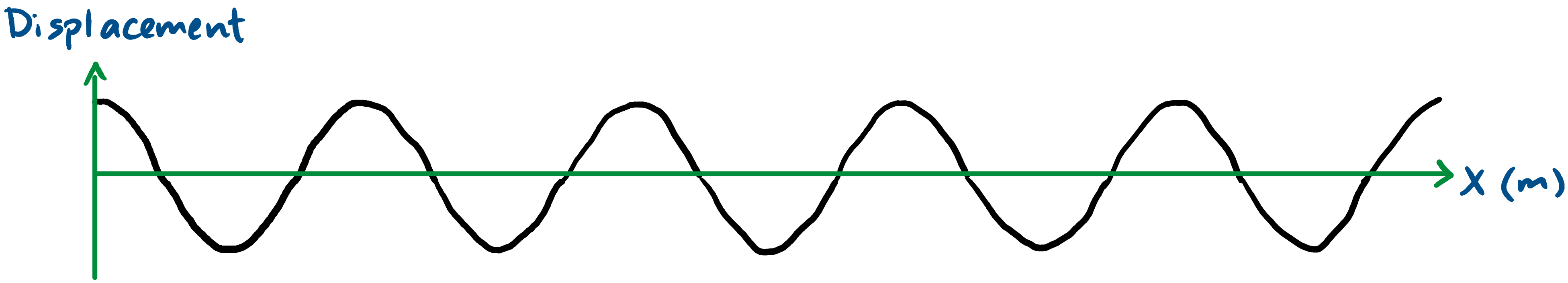
A) $D(x) = 4\text{mm} \cdot \cos(2\pi / 1\text{m} \cdot x - 3\text{s})$

B) $D(x) = 4\text{mm} \cdot \cos(2\pi / 1\text{m} \cdot x + 3\text{s})$

C) $D(x) = 4\text{mm} \cdot \cos(2\pi / 1\text{m} \cdot x - \pi/2)$

D) $D(x) = 4\text{mm} \cdot \cos(2\pi / 1\text{m} \cdot x + \pi/2)$

E) $D(x) = 4\text{mm} \cdot \cos(2\pi / 1\text{m} \cdot x + 2\pi/3\text{s})$

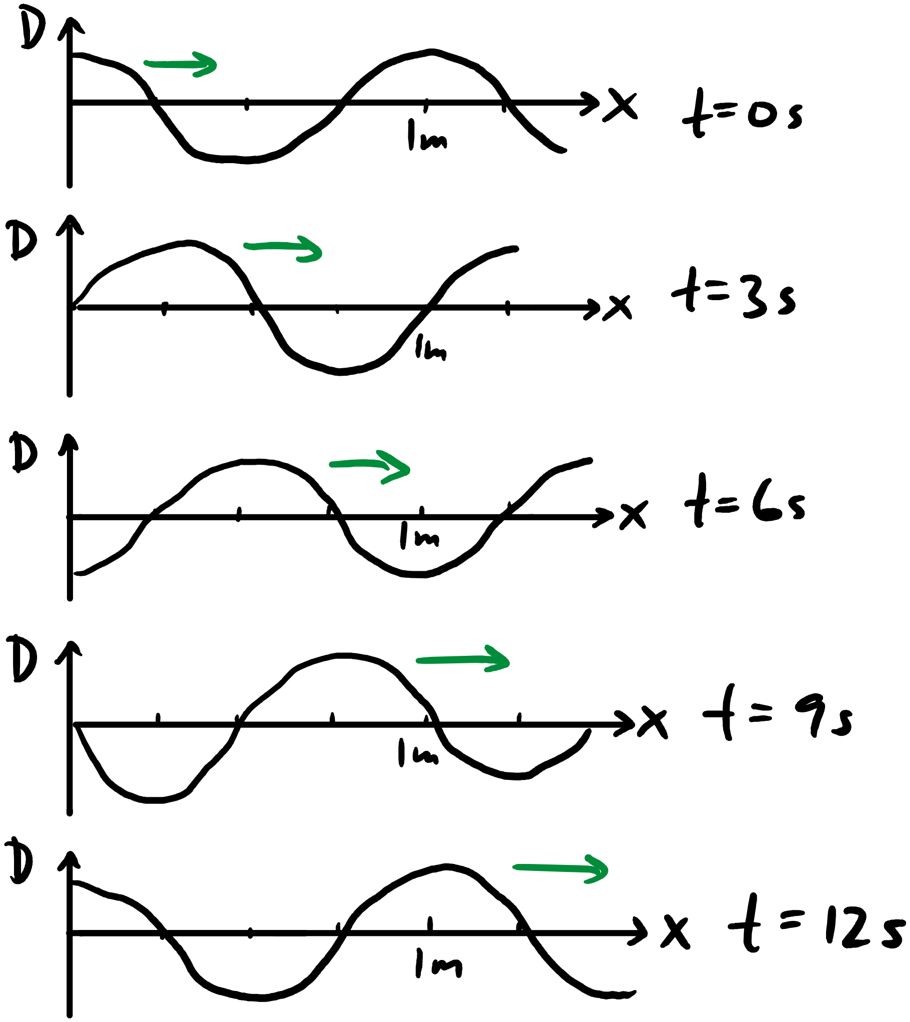


$$D(x) = A\cos(kx + \phi)$$

right moving wave: $\phi = -\text{constant} \times t$

left moving wave: $\phi = +\text{constant} \times t$

constant velocity: phase is proportional to time



Which of the following represents the displacement of the wave shown as a function of position

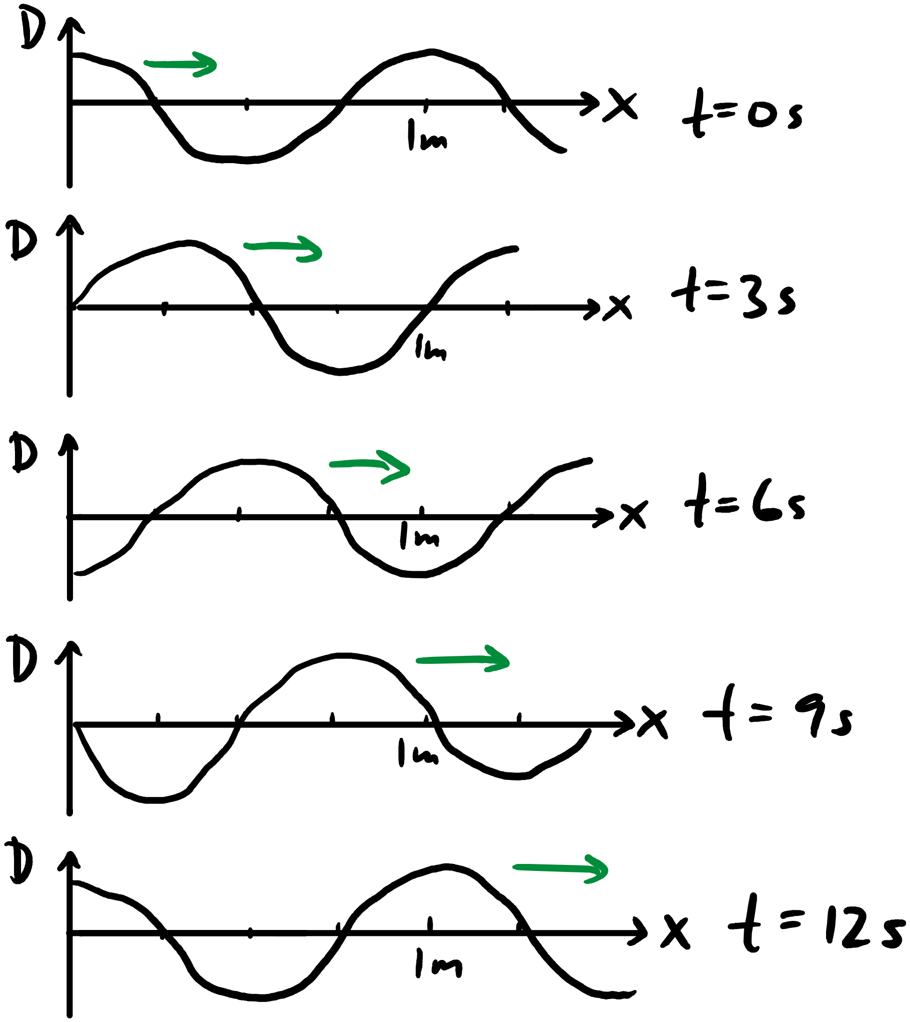
A) $D = A\cos\left(\frac{2\pi}{1m}\cdot x - \frac{t}{12s}\right)$

B) $D = A\cos\left(\frac{2\pi}{1m}\cdot x - 12s\cdot t\right)$

C) $D = A\cos\left(\frac{2\pi}{1m}\cdot x - \frac{2\pi}{12s}\cdot t\right)$

D) $D = A\cos\left(\frac{2\pi}{1m}\cdot x - \frac{12s}{2\pi}\cdot t\right)$

E) $D = A\cos\left(\frac{2\pi}{1m}\cdot x - \frac{\pi}{2}\cdot t\right)$



Which of the following represents the displacement of the wave shown as a function of position

A) $D = A\cos\left(\frac{2\pi}{1\text{m}}\cdot x - \frac{t}{12\text{s}}\right)$

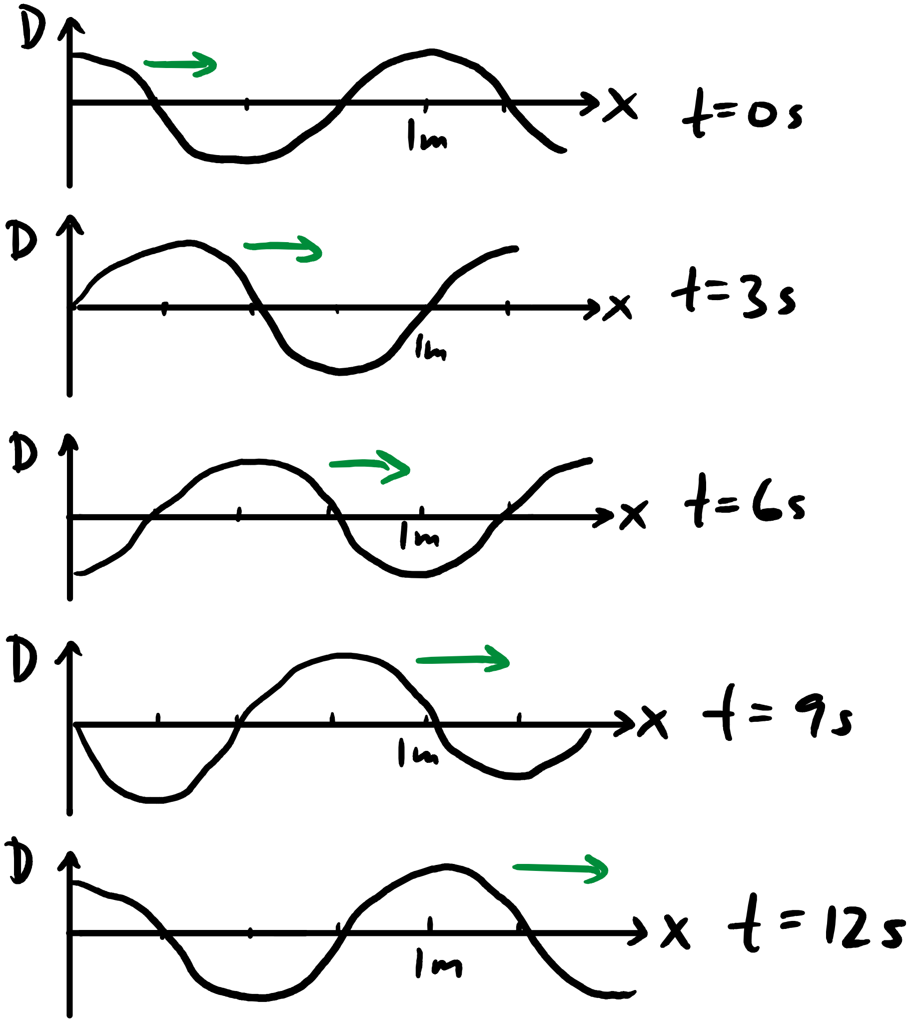
B) $D = A\cos\left(\frac{2\pi}{1\text{m}}\cdot x - 12\text{s}\cdot t\right)$

C) $D = A\cos\left(\frac{2\pi}{1\text{m}}\cdot x - \frac{2\pi}{12\text{s}}\cdot t\right)$

D) $D = A\cos\left(\frac{2\pi}{1\text{m}}\cdot x - \frac{12\text{s}}{2\pi}\cdot t\right)$

E) $D = A\cos\left(\frac{2\pi}{1\text{m}}\cdot x - \frac{\pi}{2}\cdot t\right)$

Shift by full period in 12s, so want phase -2π for $t = 12\text{s}$

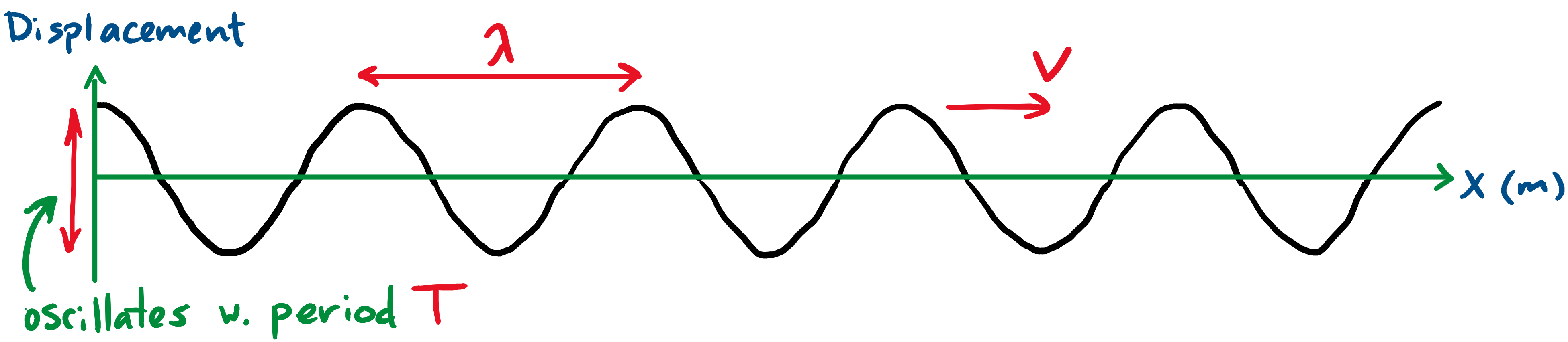


12s is the period T since each point on the string has made a complete oscillation

so $\frac{2\pi}{12\,s}$ is the angular frequency.

phase for right moving wave is

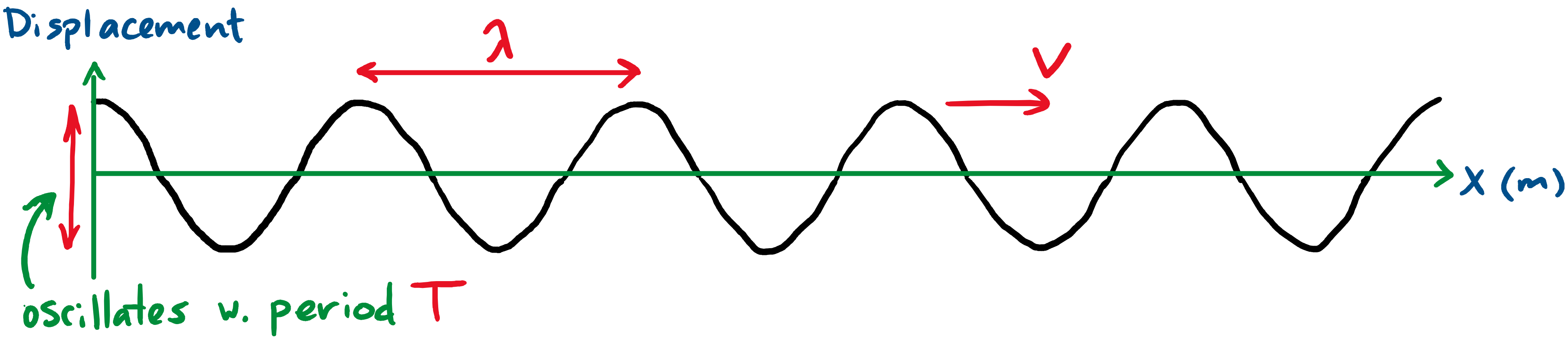
$$\phi = -\omega t$$



Right moving wave: $D(x,t) = A\cos(kx - \omega t)$

Left moving wave: $D(x,t) = A\cos(kx + \omega t)$

$$k = \frac{2\pi}{\lambda} \qquad \omega = \frac{2\pi}{T}$$

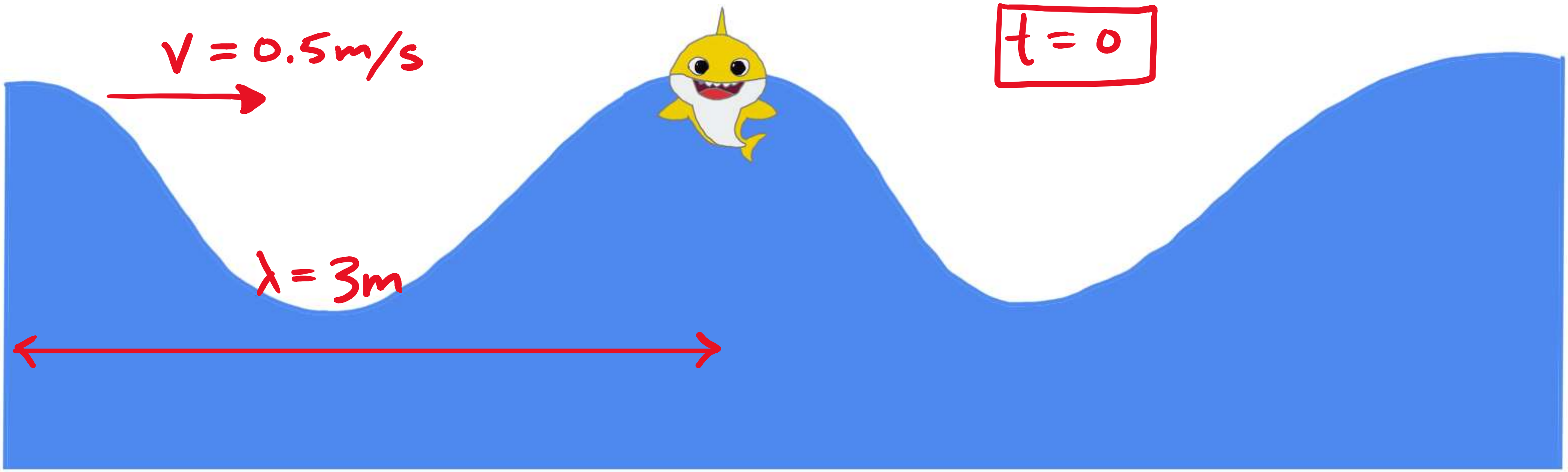


Right moving wave: $D(x,t) = A\cos(kx - \omega t)$

Left moving wave: $D(x,t) = A\cos(kx + \omega t)$

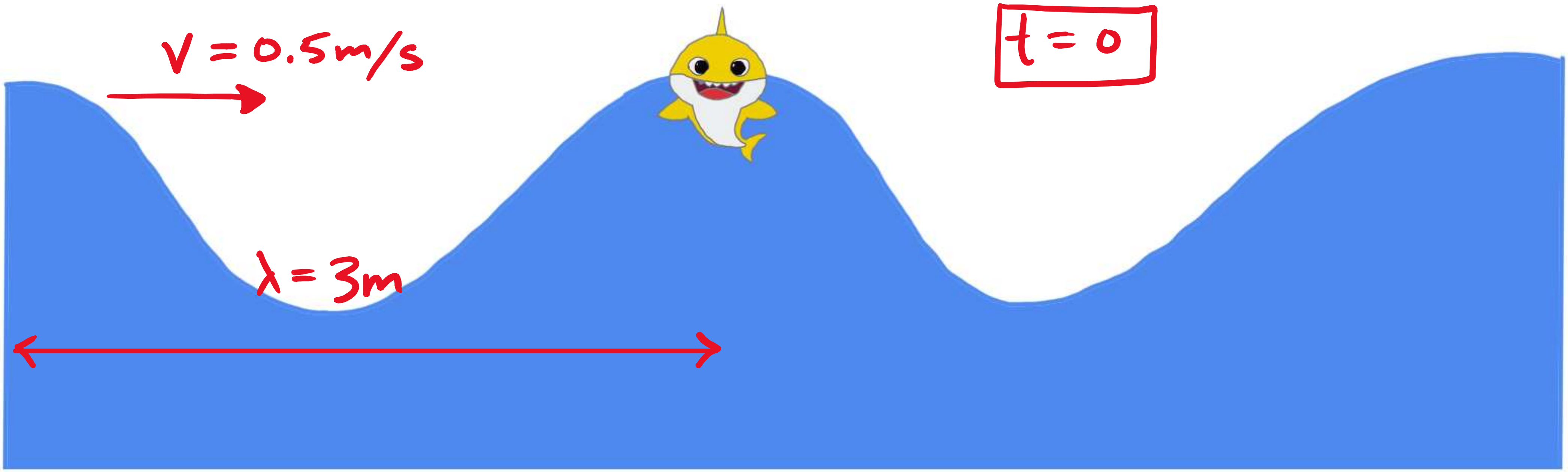
$$k = \frac{2\pi}{\lambda} \qquad \omega = \frac{2\pi}{T}$$

How is v related to ω and k?



Baby Shark is floating at the surface of the water as waves pass by. At what time will Baby Shark next reach a maximum height?

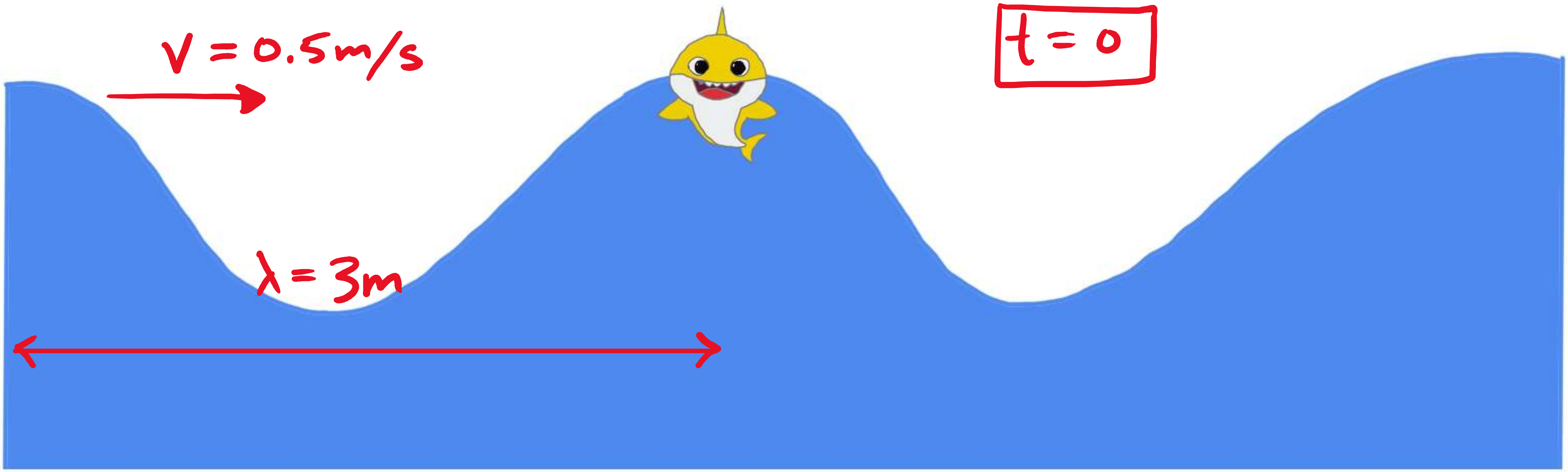
A) 0.17s B) 1.5s B) 3s D) 6s E) 12s



Baby Shark is floating at the surface of the water as waves pass by. At what time will Baby Shark next reach a maximum height?

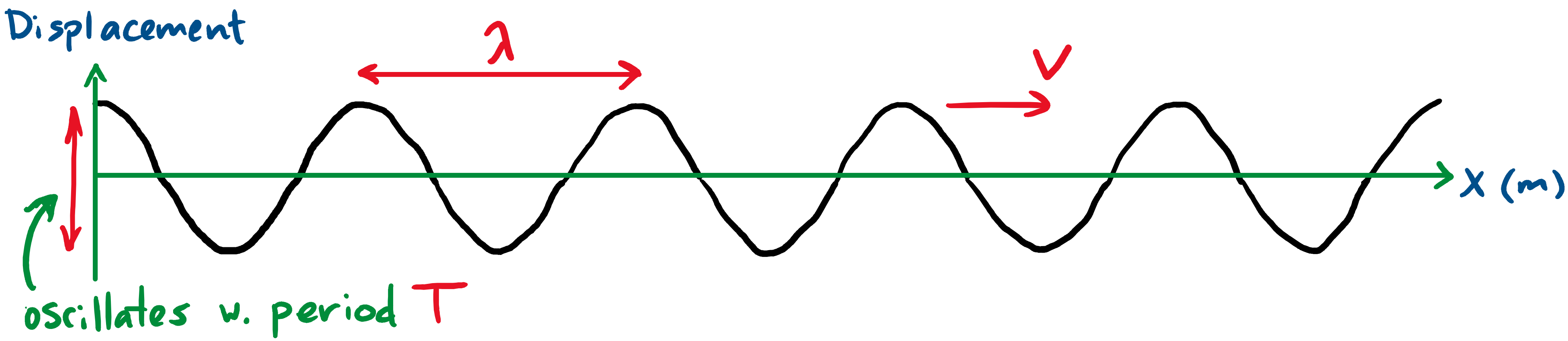
A) 0.17s B) 1.5s B) 3s D) 6s E) 12s

Baby Shark will be at max height again when wave moves distance $\lambda = 3m$. This takes time $T = \frac{\lambda}{v} = \frac{3m}{0.5m/s} = 6s$



Key point: $T = \frac{\lambda}{v}$ gives relation between period, wavelength, and velocity.

Wave velocity = velocity of the peaks



$$v = \frac{\lambda}{T} \quad \text{or} \quad v = \lambda \cdot f \quad \text{or} \quad v = \frac{\omega}{k}$$

Properties of waves:

A: amplitude

period/frequency/angular frequency

T

f ω

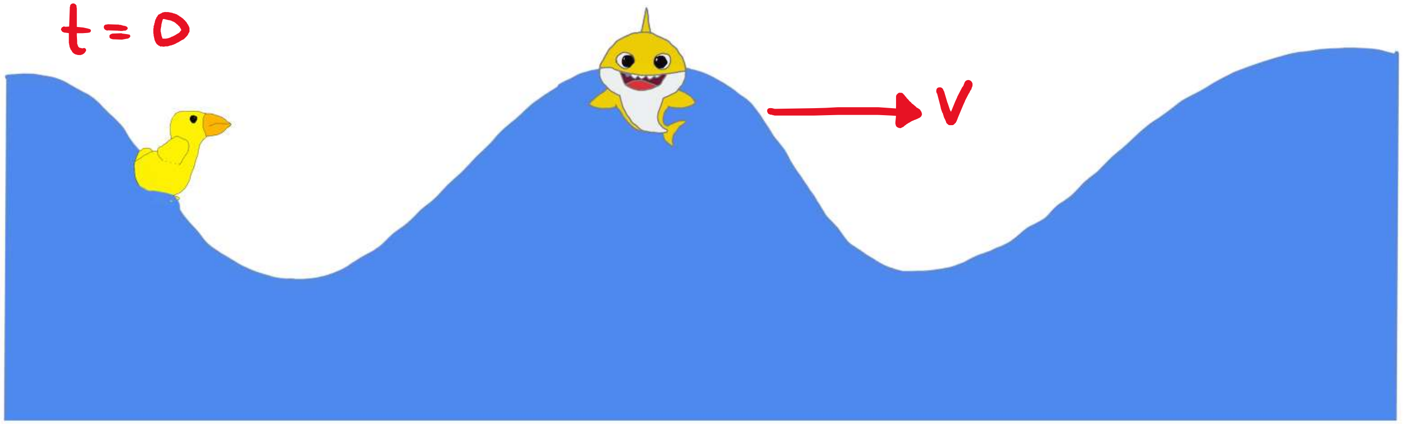
$\lambda \longleftrightarrow k$

wavelength/wave number

$$v = \frac{\lambda}{T}$$

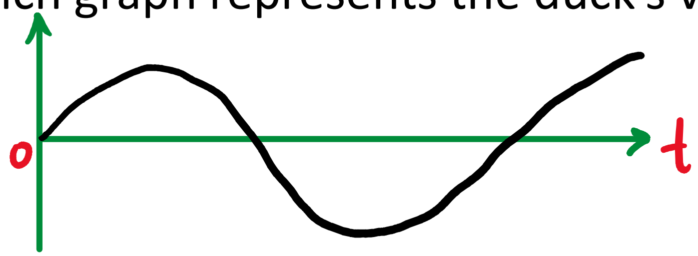
v

velocity

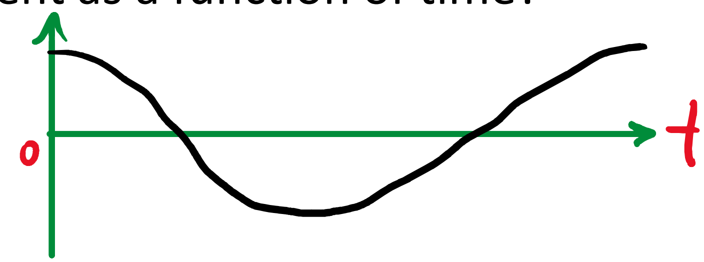


Which graph represents the duck's vertical displacement as a function of time?

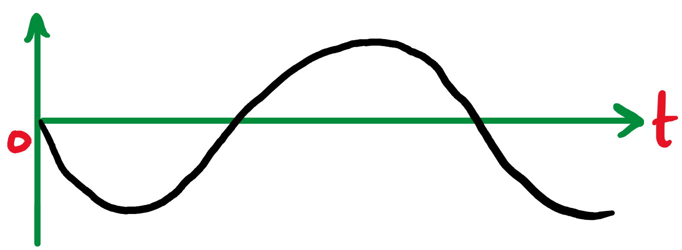
A)



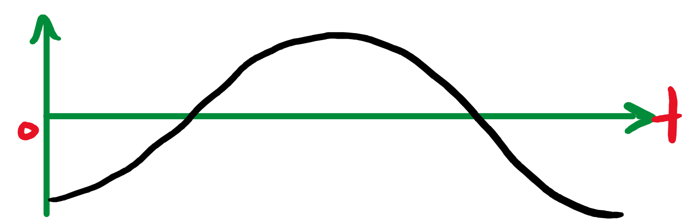
B)

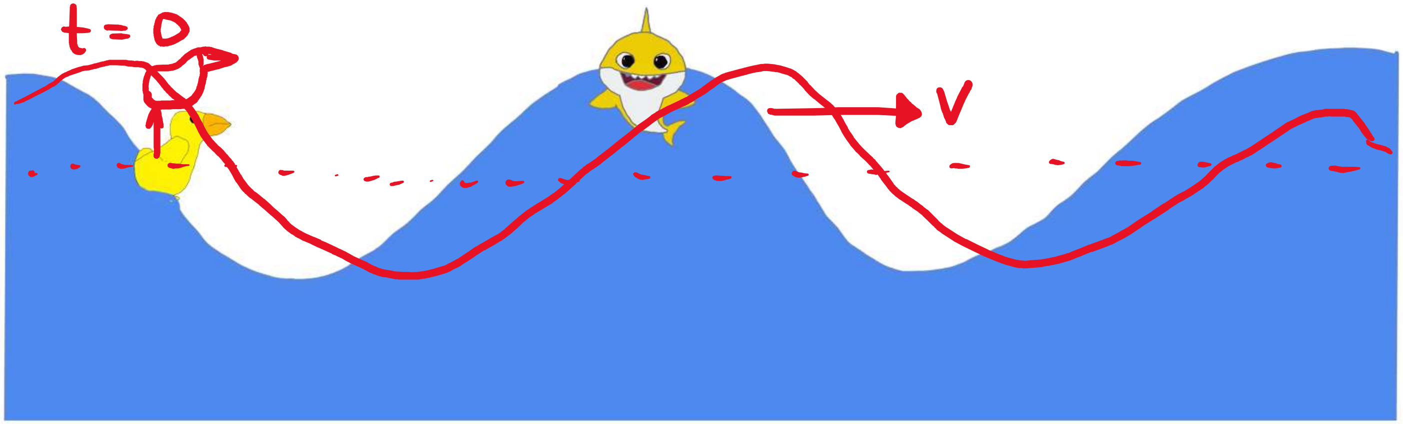


C)



D)

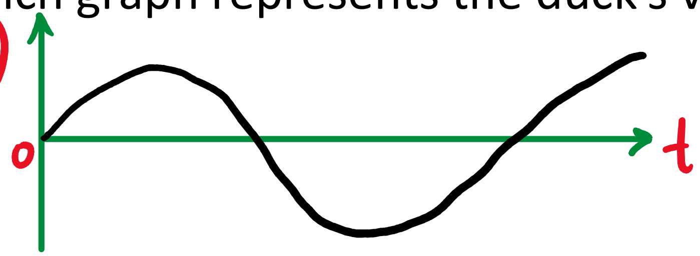




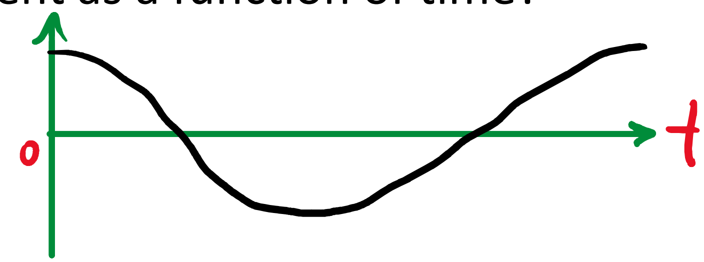
After short amount of time, duck moves up. Eventually, will be lower than original height.

Which graph represents the duck's vertical displacement as a function of time?

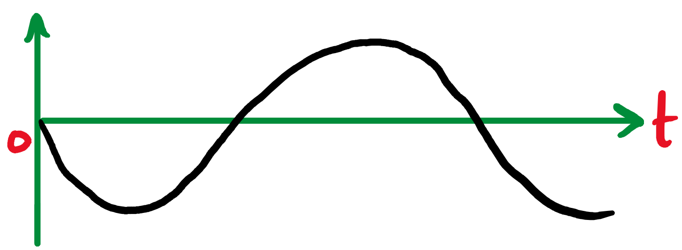
A)



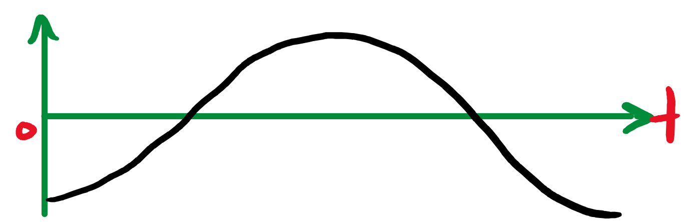
B)

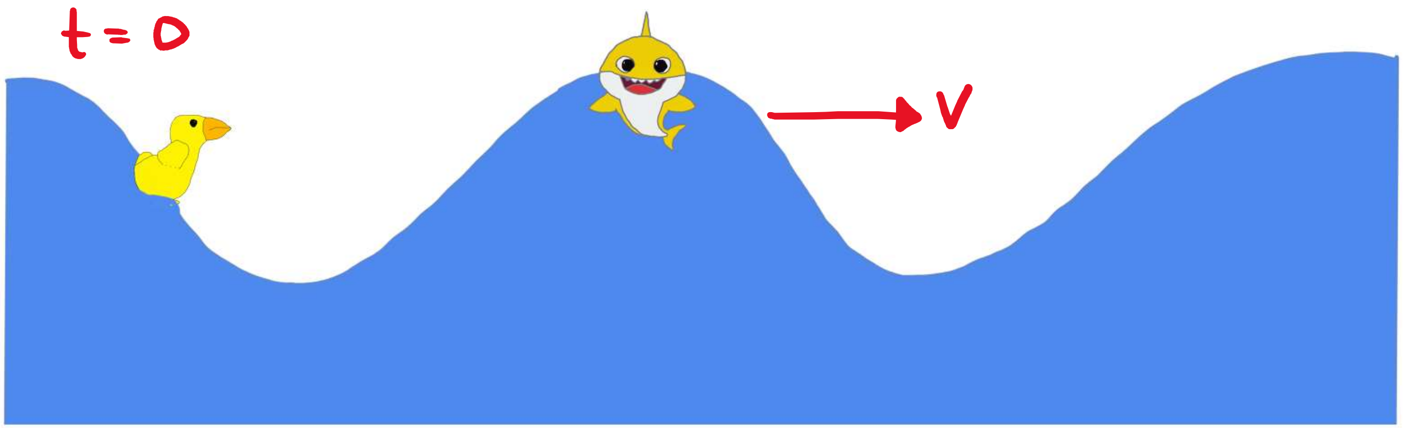


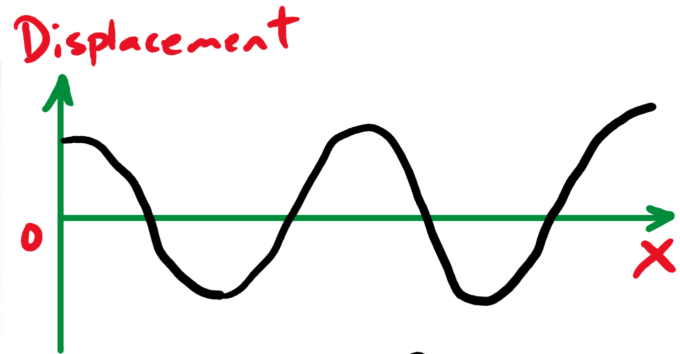
C)



D)

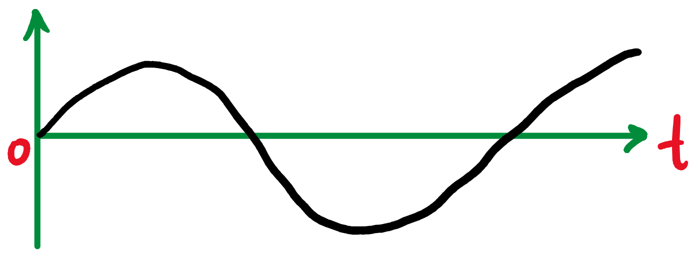




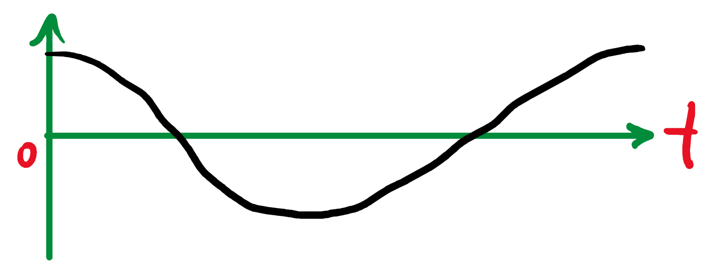


★ Snapshot Graph ★

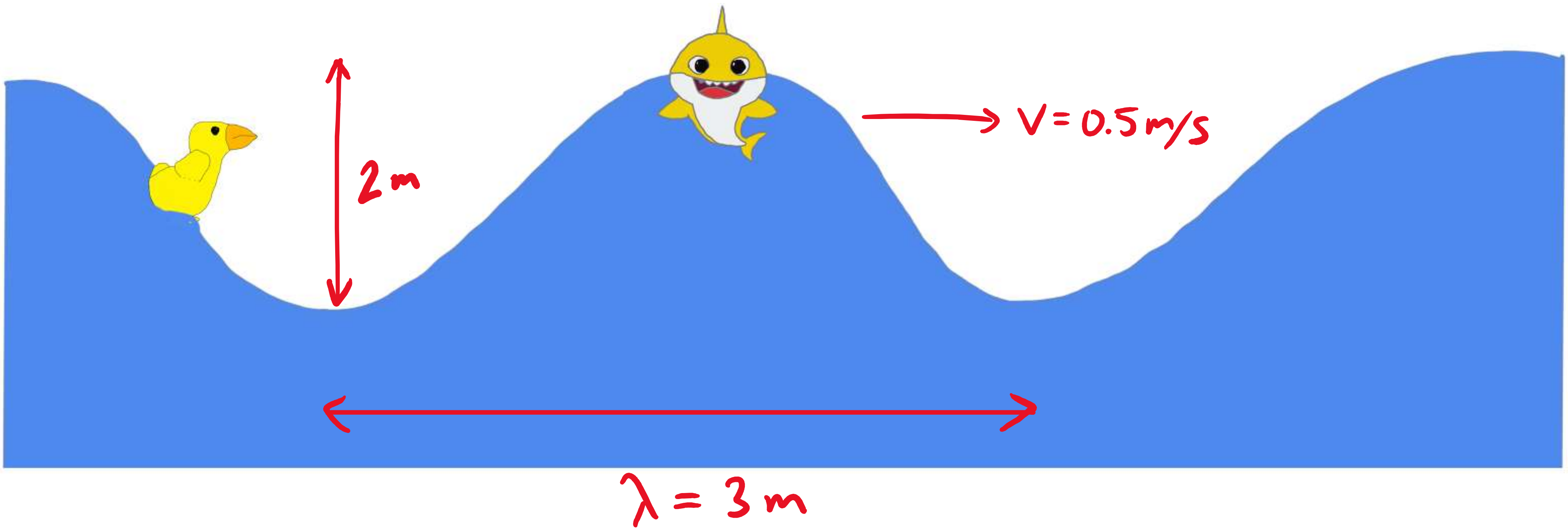
★ History Graphs ★



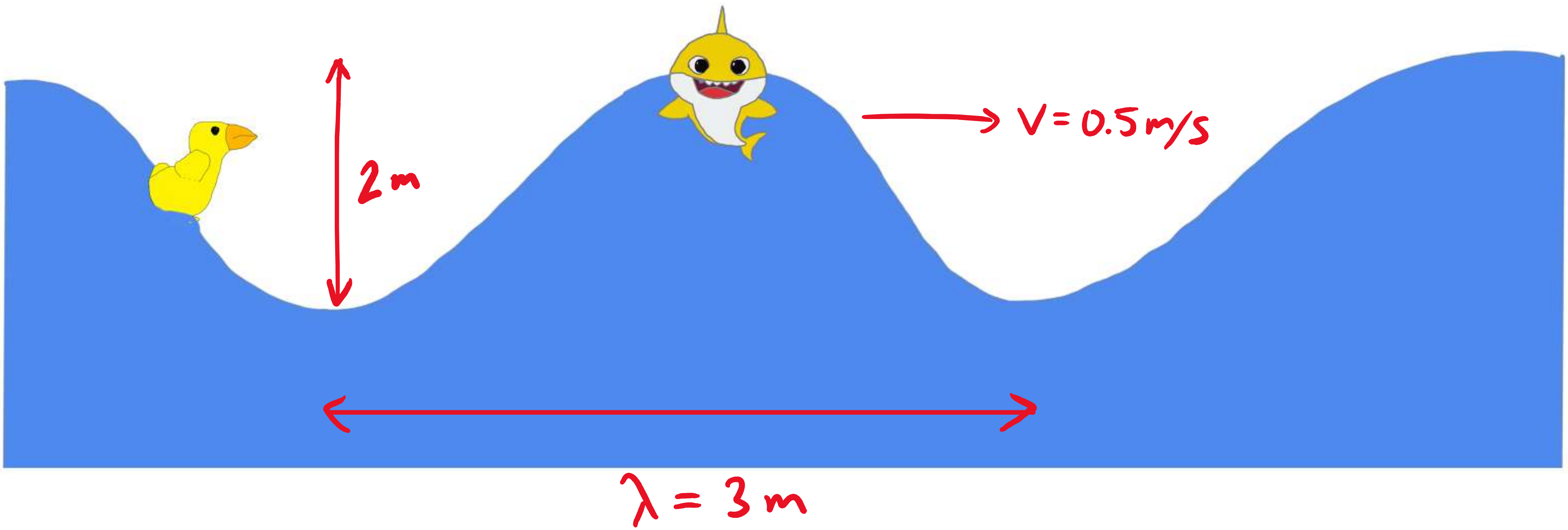
Duck



Baby Shark



Discussion question: what will be Baby Shark's maximum vertical velocity?



Discussion question: what will be Baby Shark's maximum vertical velocity?

Shark is in simple harmonic motion, $D = A\cos(\omega t+\phi)$. Velocity is $\frac{dD}{dt} = -A\omega\sin(\omega t+\phi)$. Max v is $A\omega = A\cdot\frac{2\pi}{T} = A\cdot\frac{2\pi}{\lambda/v}$

$$= 1m\cdot\frac{2\pi}{6s} = \frac{\pi}{3}\ \frac{m}{s}$$