Which of the following would increase the oscillation frequency of a mass on an ideal spring:

A) Increasing the mass

B) Increasing the spring constant

C) Increasing the initial displacement

D) Both A and C

E) Both B and C

Office hours today:
3:30 - 5:00

Which of the following would increase the oscillation frequency of a mass on an ideal spring:

A) Increasing the mass

B) Increasing the spring constant

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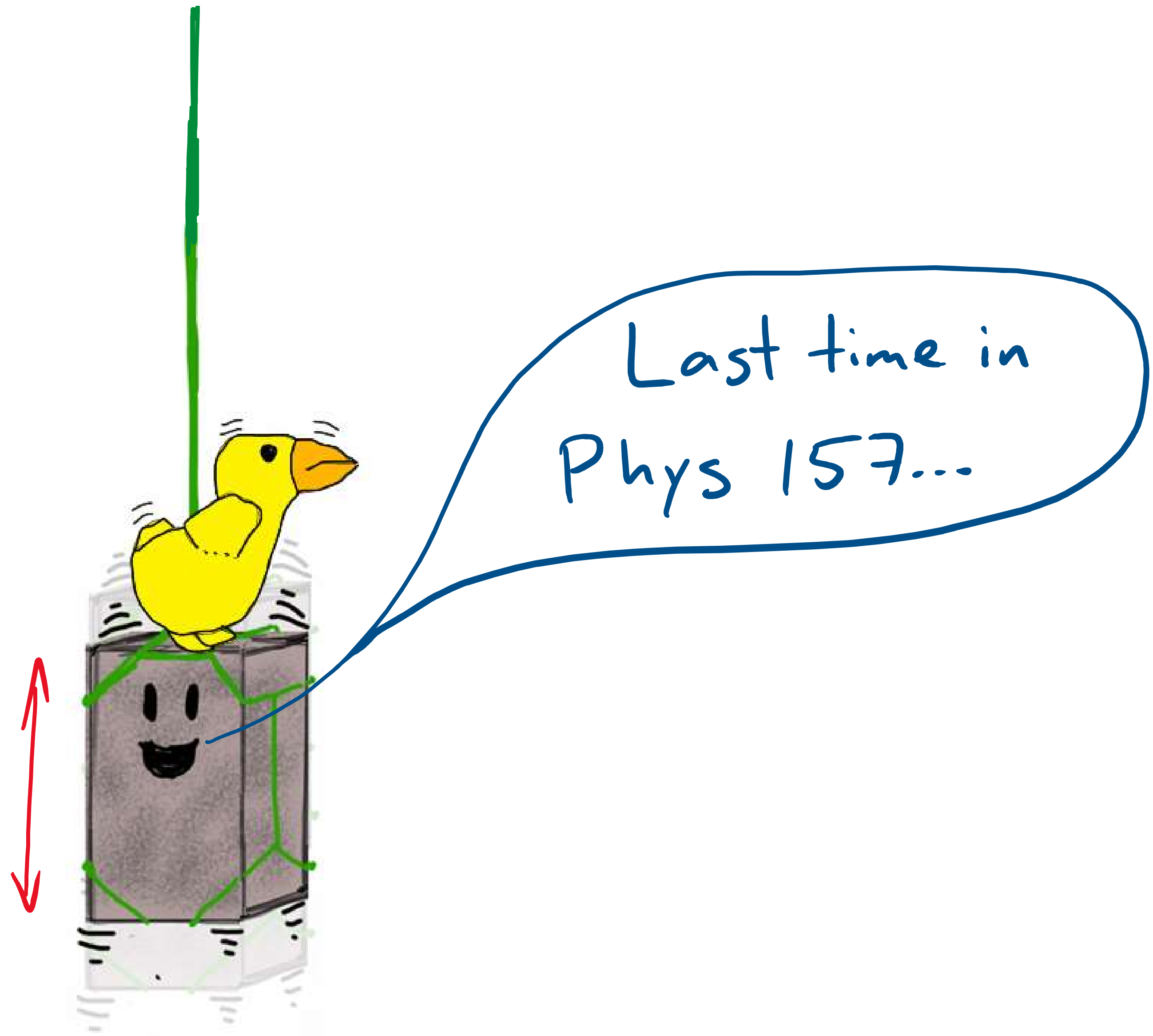
D) Both A and C

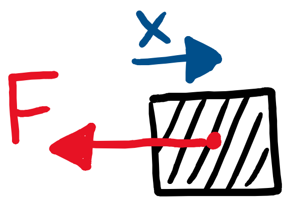
E) Both B and C

$\omega = \sqrt{\frac{k}{m}}$ - doesn't depend on displacement or amplitude

$\omega \uparrow$ if $k \uparrow$

Office hours today: 3:30 - 5:00


Last time in
Phys 157...



$F = -kx$

Linear restoring force: $F_{NET} = -kx$

↓ Newton's 2nd Law

$$a = -\frac{k}{m}x$$

↓

Simple harmonic motion

Simple Harmonic Motion

$$x(t) = A\cos(\omega t + \phi)$$

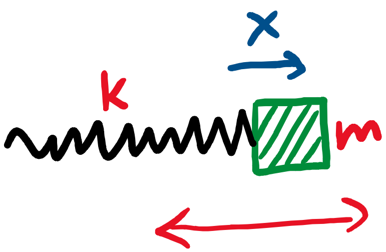
satisfies $\frac{d^2x}{dt^2} = -\omega^2 x$

$\omega^2 \leftarrow \frac{k}{m}$

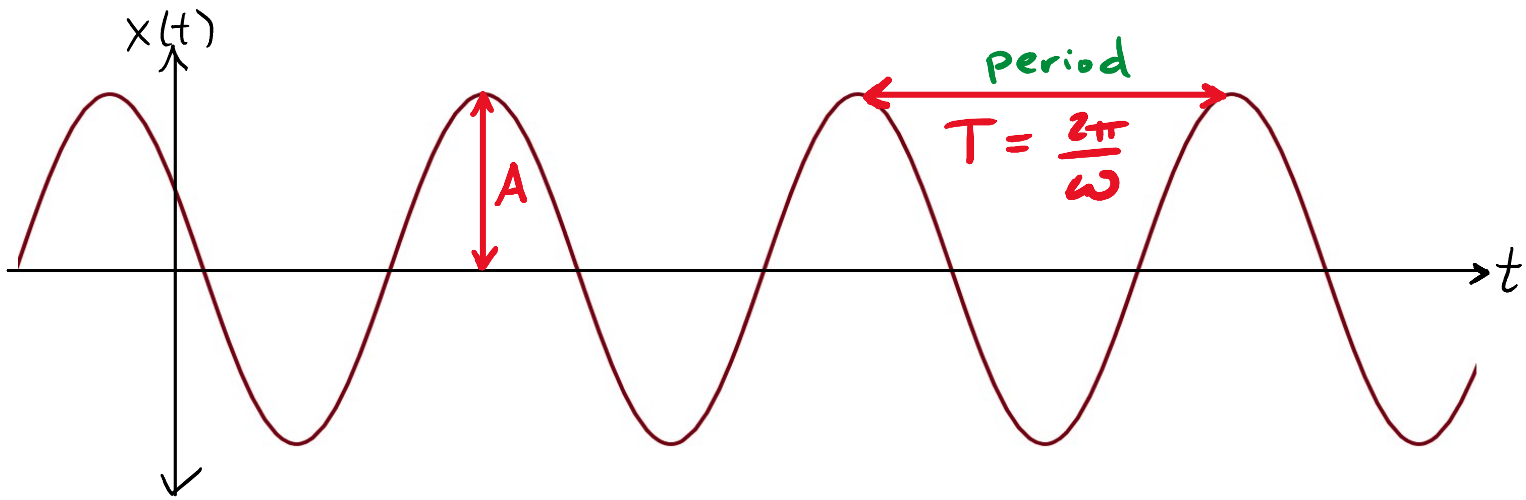
Amplitude

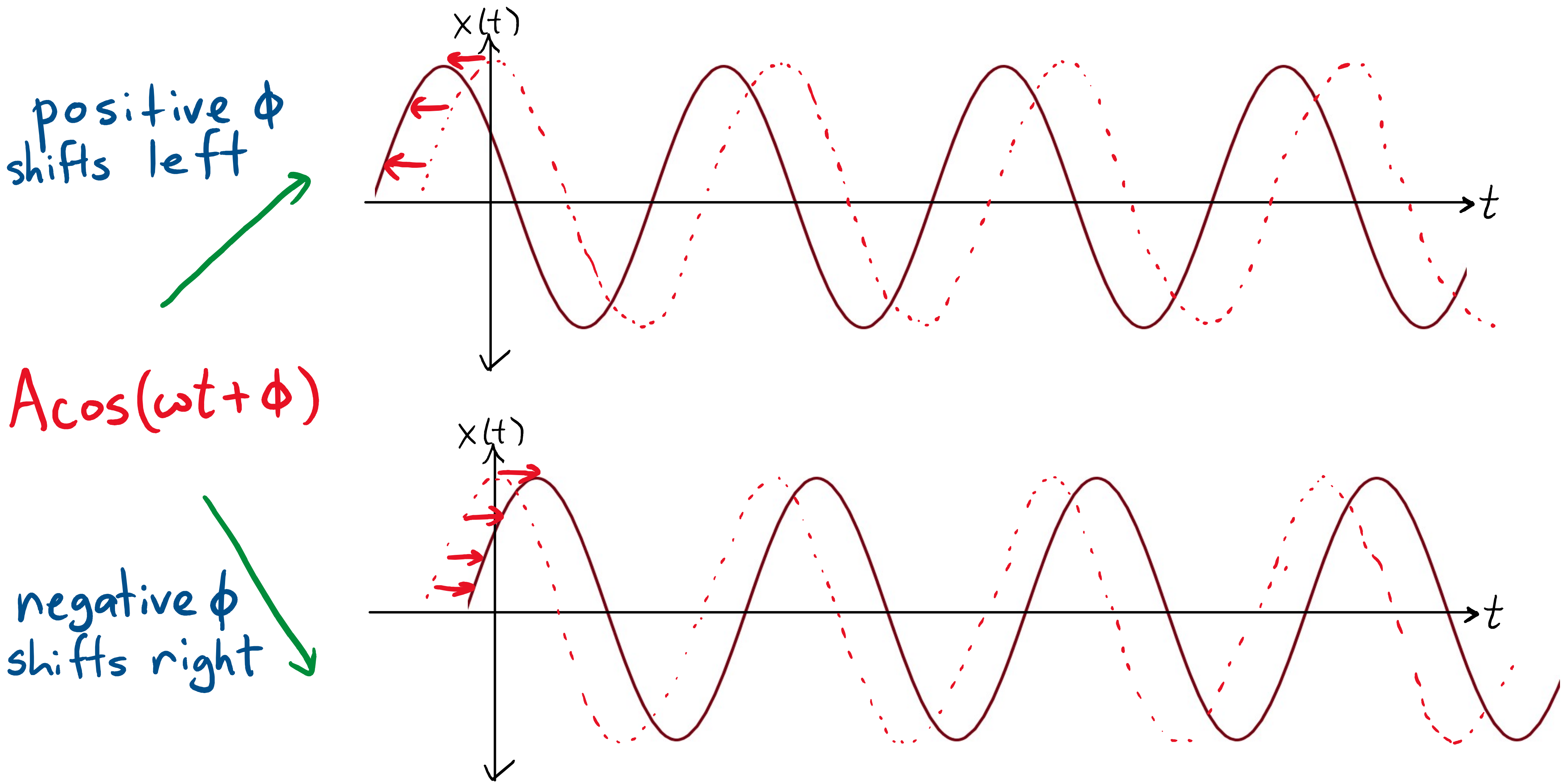
angular frequency

phase



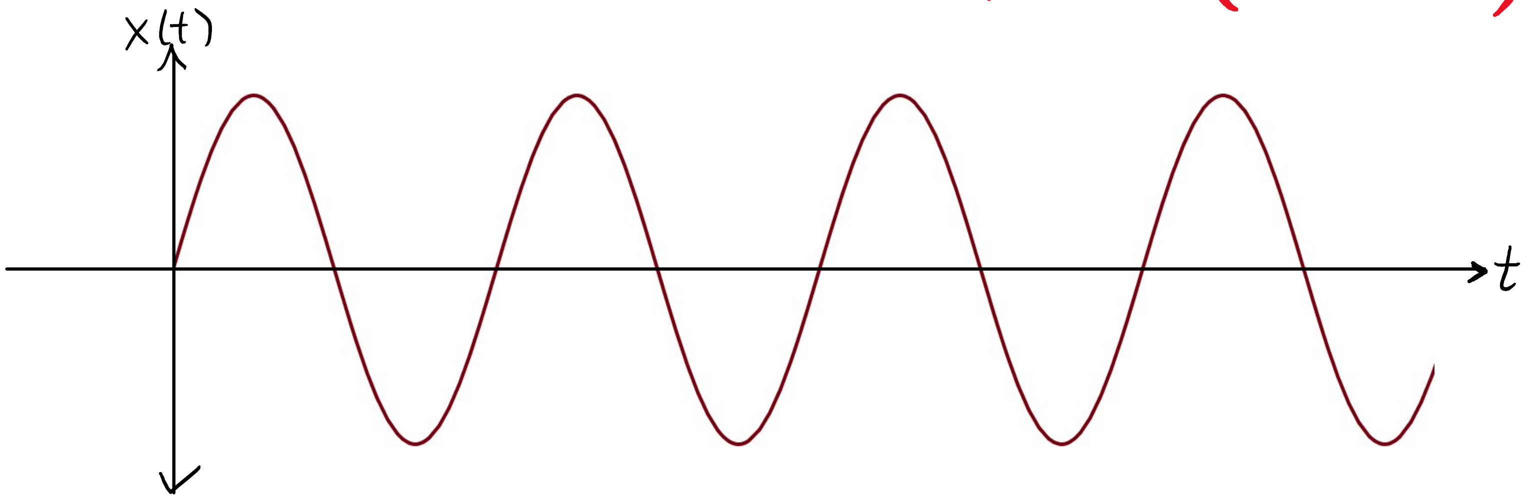
$$\omega = \sqrt{\frac{k}{m}}$$





* shift of 2π is a whole period *

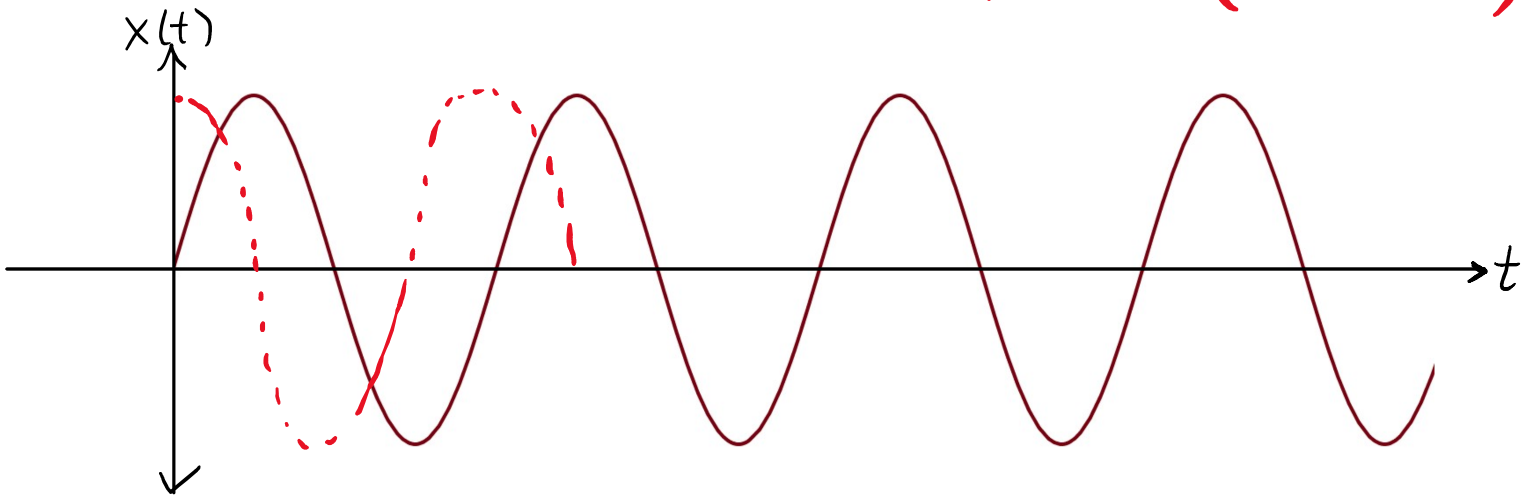
$$x(t) = A\cos(\omega t + \phi)$$



For the displacement graph shown, what is the phase ϕ?

A 0 B) π/2 C) π D) - π/2

$x(t) = A\cos(\omega t + \phi)$



shifts to the right by ¼ period

so $\phi = -\frac{1}{4} \times 2\pi$

$= -\frac{\pi}{2}$

For the displacement graph shown, what is the phase ϕ?

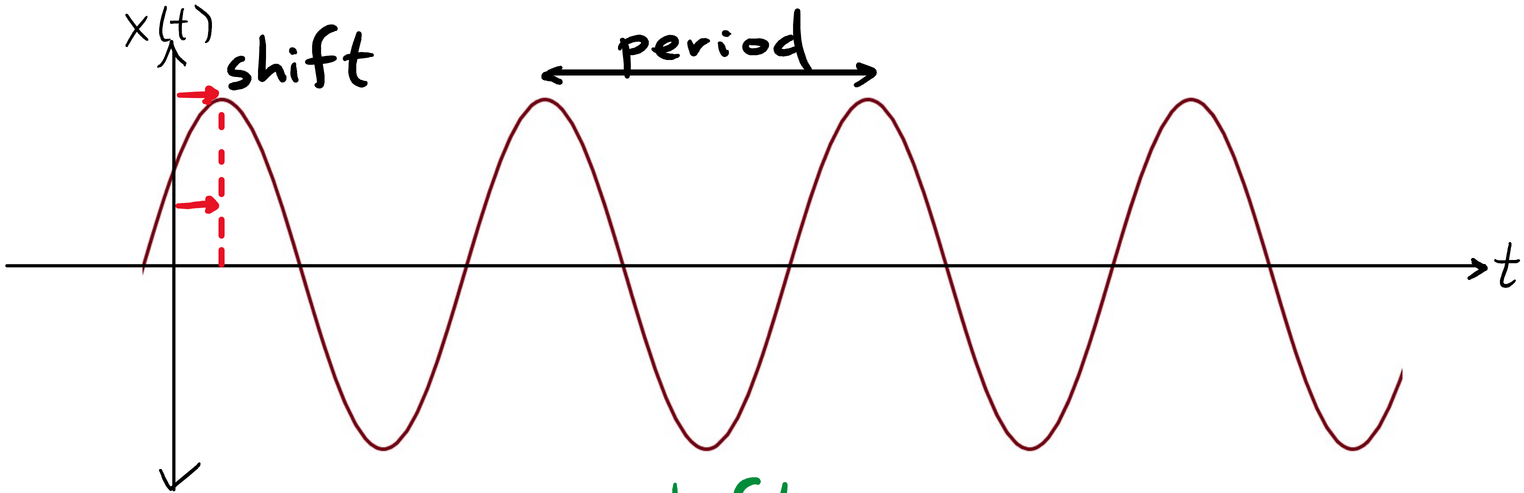
A 0

B) π/2

C) π

D) - π/2

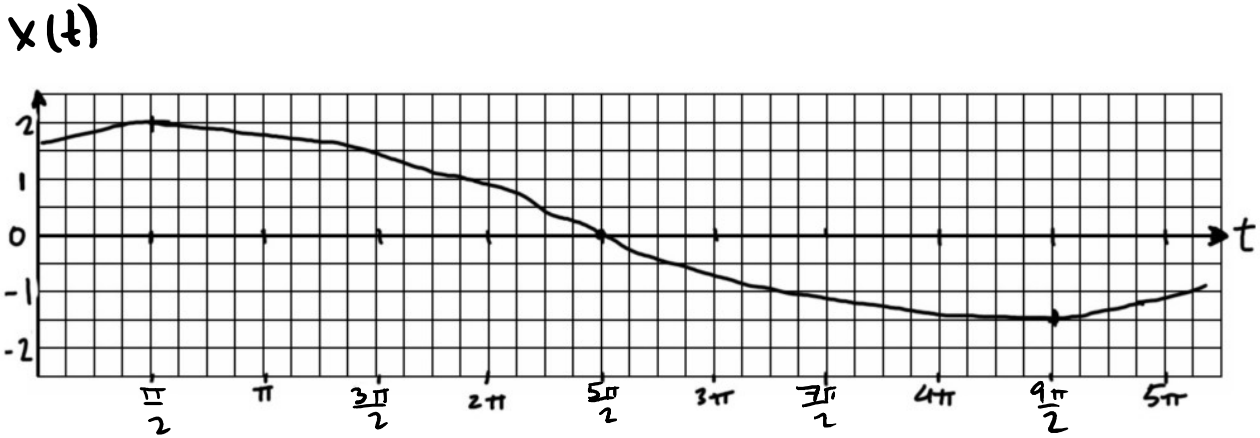
How to find ϕ



to the left

$$\phi = \pm 2\pi \times \frac{\text{shift}}{\text{period}}$$

to the right

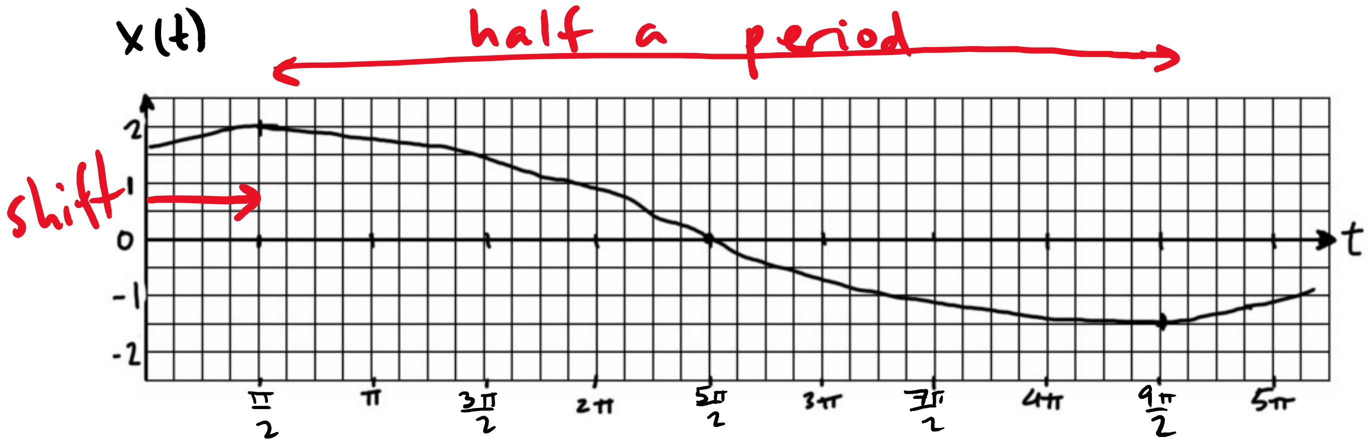


$$\phi = \pm 2\pi \cdot \frac{\text{shift}}{\text{period}}$$

$$x(t) = A\cos(\omega t + \phi)$$

For the displacement graph shown, what is the phase ϕ?

A) -π/8 B) -π/4 C) –π/2 D) π/4 E) π/8



$\phi = \pm 2\pi \cdot \frac{\text{shift}}{\text{period}}$

$x(t) = A\cos(\omega t + \phi)$

period is

$T = 2 \times \left(\frac{9\pi}{2} - \frac{\pi}{2}\right)$

$\Rightarrow T = 8\pi$

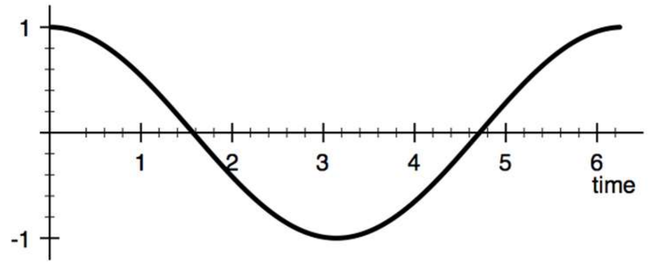
shift is by $\frac{\pi}{2}$

For the displacement graph shown, what is the phase ϕ?

A) -π/8 B) -π/4 C) –π/2 D) π/4 E) π/8

phase is : $\phi = -2\pi \times \frac{\text{shift}}{\text{period}} = -2\pi \times \frac{\pi/2}{8\pi} = -\frac{\pi}{8}$

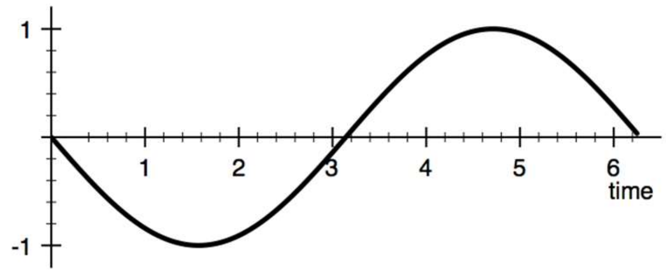
Position:



$$x(t) = A\cos(\omega t + \phi)$$

$\Big\downarrow \dfrac{d}{dt}$ (slope)

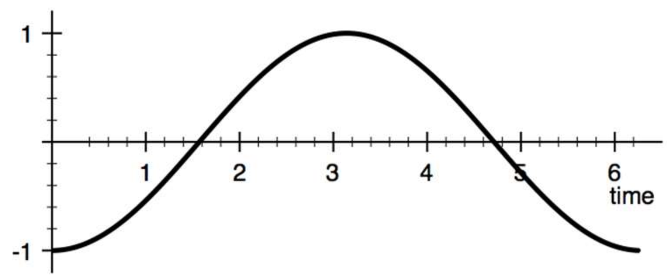
Velocity:



$$v(t) = -A\omega \sin(\omega t + \phi)$$

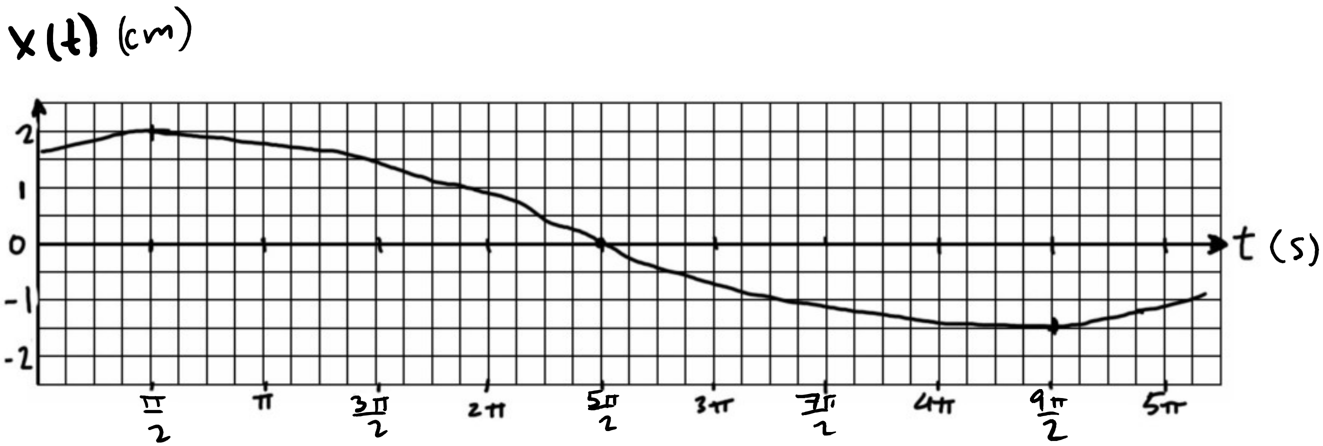
$\Big\downarrow \dfrac{d}{dt}$ (slope)

Acceleration:



$$a(t) = -A\omega^2 \cos(\omega t + \phi) = -\omega^2 x(t)$$

$$\omega = \frac{2\pi}{T}$$



$$x(t) = A\cos(\omega t + \phi)$$

For the displacement graph shown, what is the maximum magnitude of velocity, in cm/s?

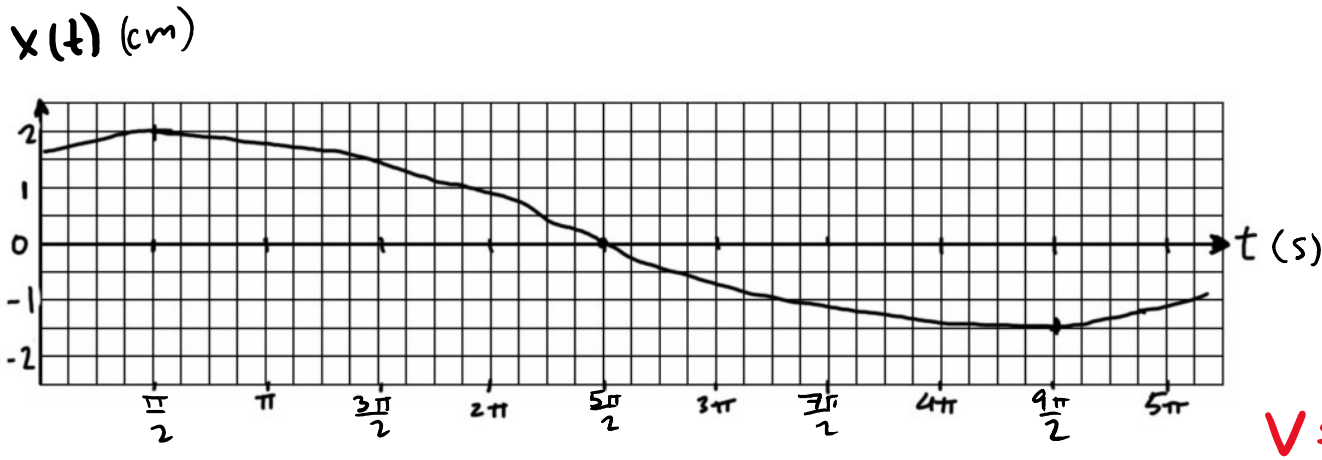
A) 4

B) 2

C) 1

D) 1/2

E) 1/4



$\omega = \frac{2\pi}{T}$

$v = \frac{dx}{dt}$

$x(t) = A\cos(\omega t + \phi)$

$= -A\omega \sin(\omega t + \phi)$

For the displacement graph shown, what is the maximum magnitude of velocity, in cm/s?

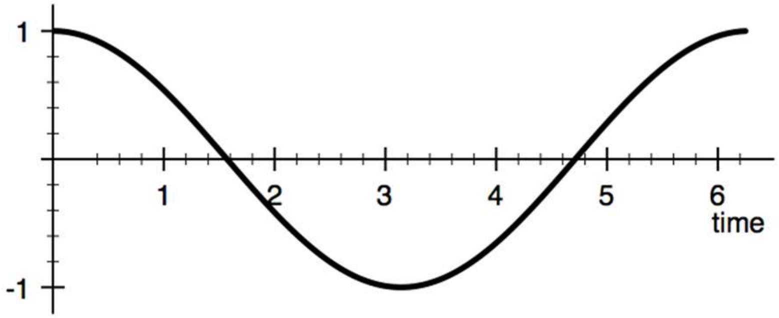
sin goes from -1 to 1, so max value of v is $A\omega$

A) 4 B) 2 C) 1 D) 1/2 E) 1/4

$A = 2\text{cm}$, $\omega = \frac{2\pi}{T} = \frac{2\pi}{8\pi} = \frac{1}{4}$ $A\omega = \frac{1}{2}$

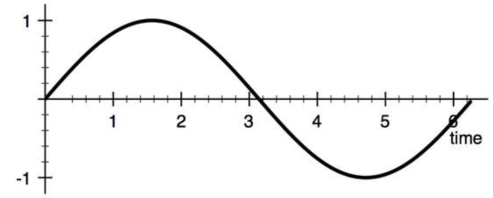
Simple Harmonic Motion:

a(t)

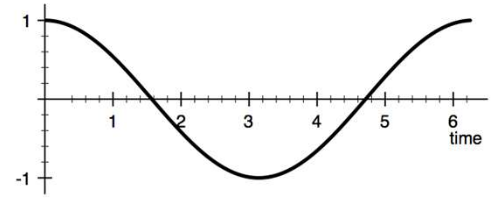


A plot of upward ***acceleration*** (in cm/s) as a function of time (in s) is shown above for a mass hanging from a spring. Which of the pictures to the right could represent x(t)?

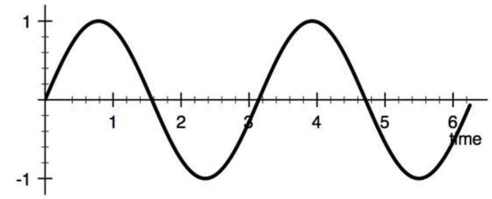
A



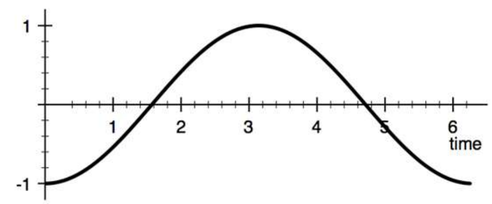
B



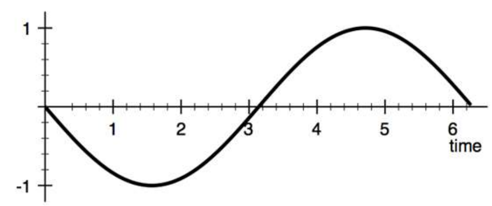
C



D

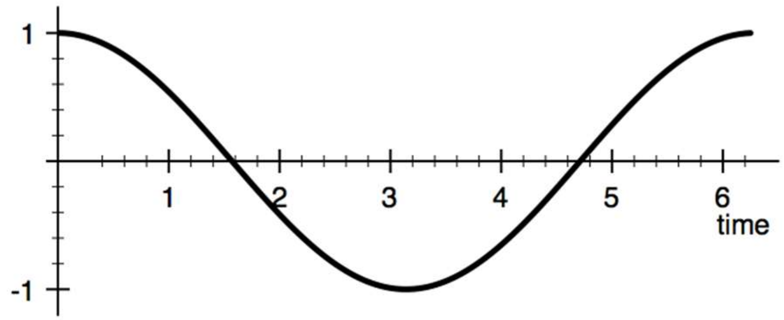


E



Simple Harmonic Motion:

a(t)



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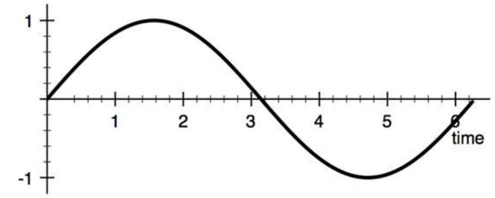
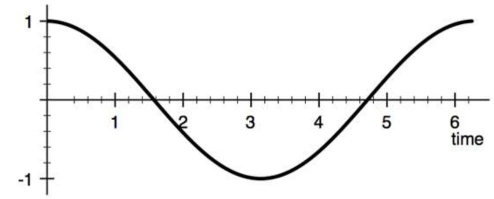
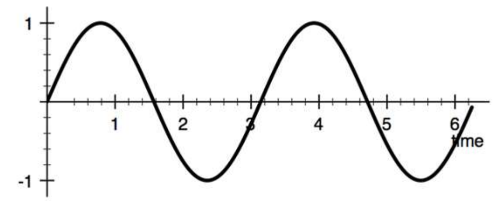
A



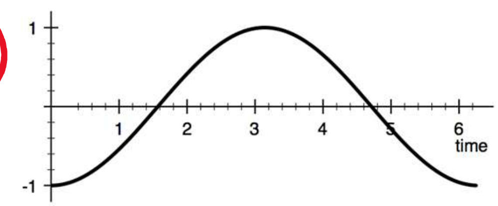
B



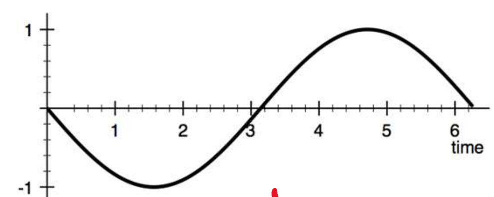
C



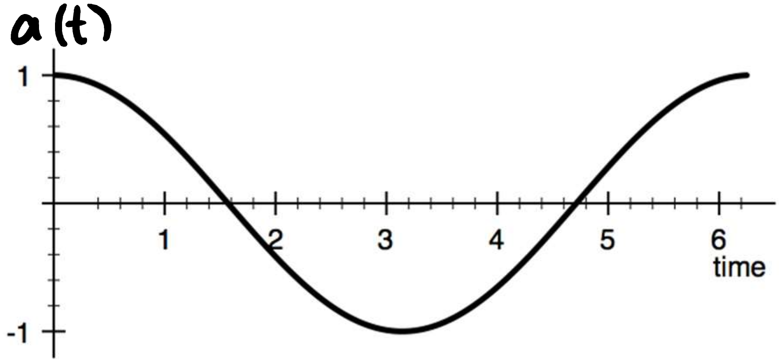
D

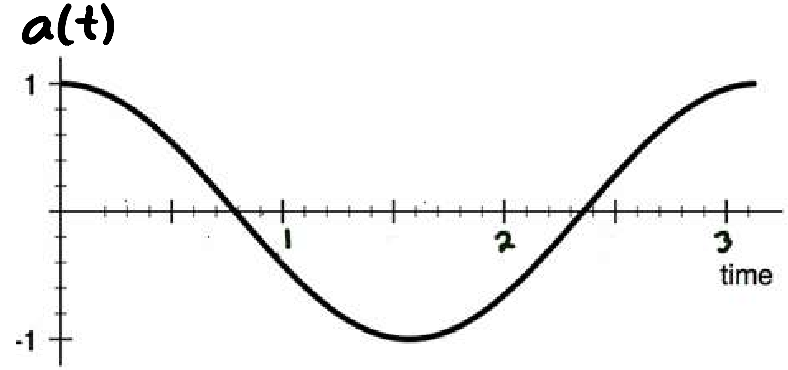


E



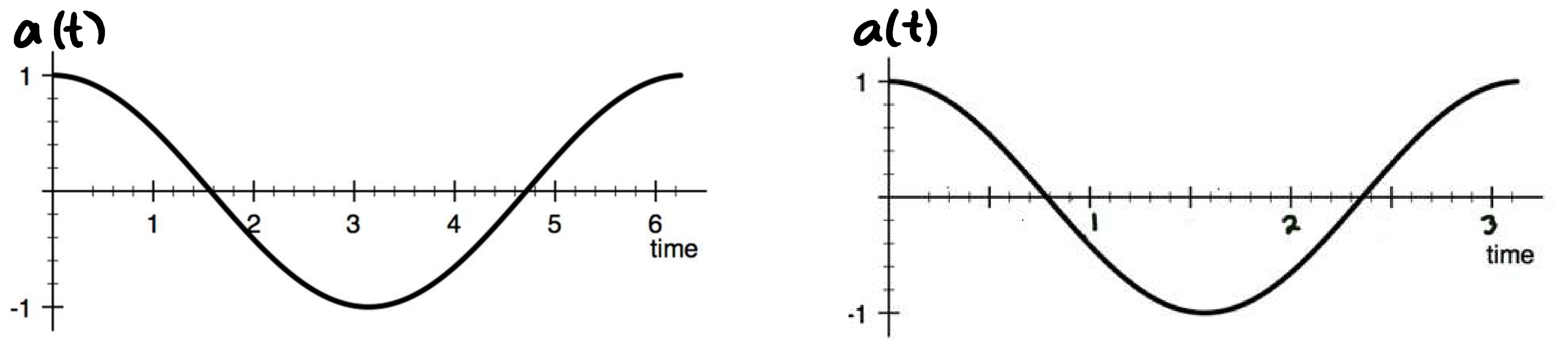
Have $a = -\omega^2 x$ for SHM, so x is maximum when a is minimum





The graphs show **acceleration** as a function of time for two different harmonic oscillators. The amplitude of the **displacement** in the first case is 1cm. For the second oscillator, the amplitude of the **displacement** is

A) 4cm B) 2cm C) 1cm D) 0.5 cm E) 0.25 cm



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Have $a = -\omega^2 x$, so $x = -\frac{a}{\omega^2}$. T is half in 2nd case so ω is double, so amplitude of x is $\frac{1}{4}$