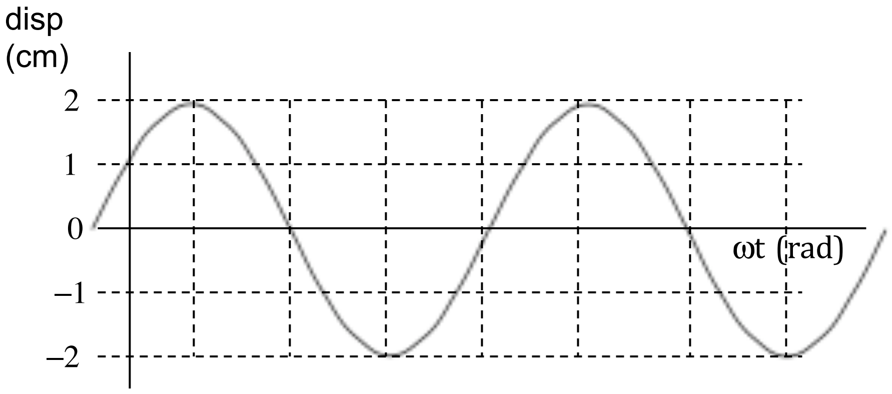
Important note: In class, we have graphed the motion of an oscillating body as a function of its angular displacement ωt. This original problem had the graph as position versus time. It has been modified to graph position versus angular displacement.

Problem 13.42 (modified)



For the sine wave shown, determine:

a.) amplitude?

b.) period?

c.) angular frequency?

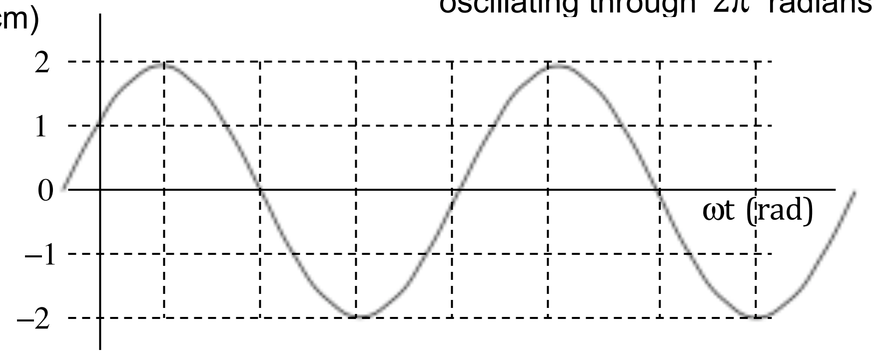
d.) maximum speed?

e.) maximum acceleration?

f.) phase shift?

g.) position as a function of time relationship?

Using *displacement versus time*:



a.) amplitude?

According to the graph, the maximum displacement (the amplitude) is 2 cm.

b.) period?

Can't get this from the graph. Need to use:

$$T = \frac{1}{\nu} = \frac{1}{20 \text{ cycles/sec}} = .05 \text{ sec/cycle}$$

c.) angular frequency?

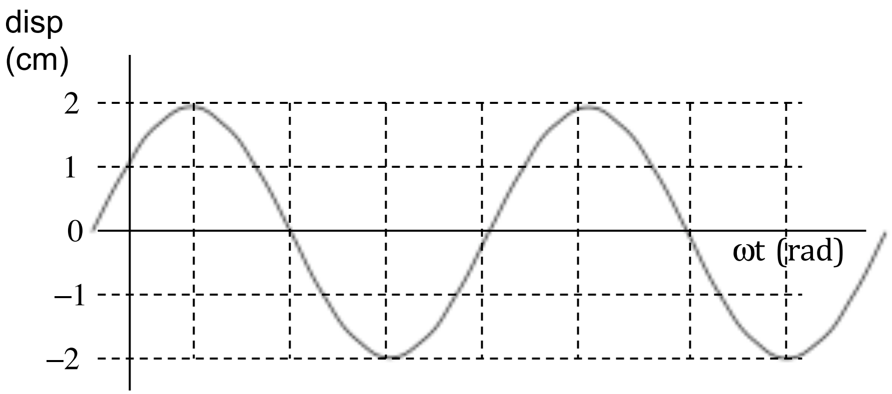
Can't get this from the graph. Need to use:

$$\omega = 2\pi\nu = 2\pi\left(20 \text{ cycles/sec}\right) = 40\pi \text{ rad/sec}$$

d.) maximum speed?

$$\begin{aligned} v_{max} &= \omega A \\ &= \left(40\pi \text{ rad/sec}\right)\left(.02 \text{ m}\right) \\ &= 2.51 \text{ m/s} \end{aligned}$$

Using *displacement versus time*:



e.) maximum acceleration?

$$a_{max} = \omega^2 A$$
$$= (40\pi \text{ rad/sec})^2 (.02 \text{ m})$$
$$= 316 \text{ m/s}^2$$

f.) phase shift?

Looking at the graph, at t = 0, x = A/2 going away from equilibrium . . . so:

$$x = A\sin(\omega t + \phi)$$
$$\Rightarrow \frac{\cancel{A}}{2} = \cancel{A}\sin(\cancel{40\pi}(0) + \phi)$$
$$\Rightarrow \frac{1}{2} = \sin(\phi) \Rightarrow \phi = .52 \text{ rad}$$

g.) position as a function of time relationship?

$$x = A\sin(\omega t + \phi)$$
$$= (.02 \text{ m})\sin(40\pi t + .52)$$