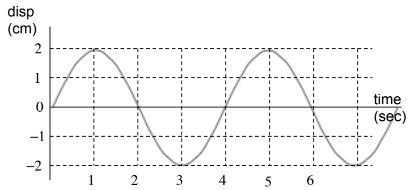
Important note: In class, we have graphed the motion of an oscillating body as a function of its angular displacement ωt . It is equally reasonable to graph the position of the body as a function of time. That is what this problem is about.

Problem 13.42



For the sine wave shown, determine:

a.) amplitude?

b.) period?

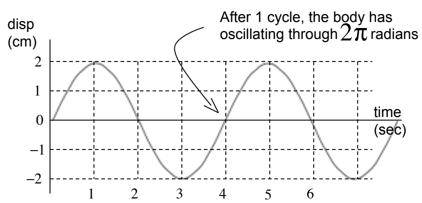
c.) angular frequency?

d.) maximum speed?

e.) maximum acceleration?

f.) 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?

According to the graph, one cycle spans a period of T = 4 seconds.

c.) angular frequency? (two ways to do this)

i.) from our general relationships:

$$\omega = 2\pi\nu = \frac{2\pi}{T} = \frac{2\pi}{4} = 1.57 \text{ rad/sec}$$

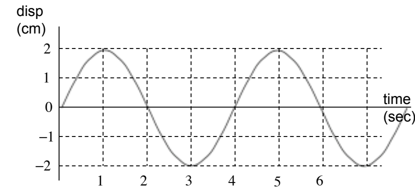
OR

ii.) After one cycle (i.e., after one period T, or when the motion is at the t = 4 second point on our graph), the angular displacement $\theta = \omega T$ of the motion MUST BE equal to 2π radians. That means:

$$\omega T = 2\pi \text{ (this comes from } \theta = \omega t)$$

$$\Rightarrow \quad \omega = \frac{2\pi}{4} = \frac{2(3.14 \text{ rad/cycle})}{(4 \text{ sec/cycles})} = 1.57 \text{ rad/sec}$$

Using *displacement versus time*:



d.) maximum speed?

$$v_{max} = \omega A$$
$$= (1.57 \text{ rad/sec})(.02 \text{ m})$$
$$= .0314 \text{ m/s}$$

e.) maximum acceleration?

$$a_{max} = \omega^2 A$$
$$= (1.57 \text{ rad/sec})^2 (.02 \text{ m})$$
$$= .049 \text{ m/s}^2$$

f.) position as a function of time relationship?

$$x = A\sin(\omega t + \phi)$$
$$= (.02 \text{ m})\sin(1.57t + 0)$$