

Physics 102 Homework # 1

first draft due Wednesday, January 18th
final draft due Sunday, January 22nd

1. If it takes 0.45s for a pendulum to swing back and forth, what is the pendulum's frequency (in Hz)?

The period of the pendulum is $T = 0.45\text{s}$, so the frequency is $f = \frac{1}{0.45\text{s}} = \mathbf{2.2\text{Hz}}$.

2. If an oscillator has a frequency of $f = 6\text{ Hz}$, how long does it take to undergo 27 cycles?

Frequency means “cycles per second”, so it goes through 6 cycles every second; its period is $T = \frac{1}{6}\text{s/cyc}$. If there are 27 cycles, then the total time for it to take is

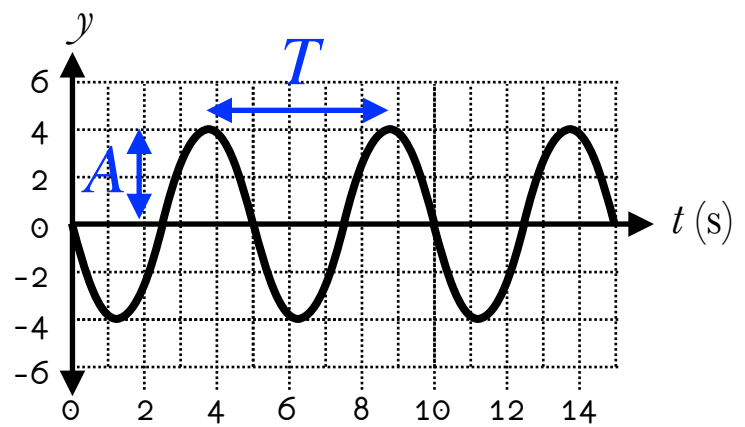
$$\frac{1}{6} \frac{\text{s}}{\text{cyc}} \times 27 \text{ cyc} = \frac{27}{6} \text{s} = \mathbf{4.5\text{s}}$$

Notice how paying attention to units can be useful here.

3. This is a history graph of an oscillator.

a. What is the oscillation's period T ?

There are three cycles in 15 seconds, so 5 seconds in each cycle. Thus $T = 5\text{s}$.



b. What is the oscillation's amplitude?

The graph goes up to a maximum of $y = 4$, so the amplitude is $A=4$.

c. What is the oscillation's initial phase ϕ_0 ?

Matching the graph to the textbook, we see that $\phi_0 = \frac{\pi}{2}$.

4. The displacement of an oscillator is given by the formula

$$y(t) = 3 \cos\left(\frac{\pi t}{4}\right).$$

a. What is the oscillator's amplitude?

Compare this with $y(t) = A \cos(2\pi ft + \phi_0)$.

The amplitude is the number in front of the cosine, so **A=3**.

b. What is the oscillator's frequency?

The standard form of the displacement formula is $y(t) = A \cos(2\pi ft + \phi_0)$. If we match the first term inside the parenthesis (the one with t), we see that

$$2\pi ft = \frac{\pi t}{4} \implies 2\pi f = \frac{\pi}{4} \implies f = \mathbf{0.125\text{Hz}}.$$

c. Give me *one* time t when this oscillator is at its equilibrium point. (There are an infinite number of correct answers! Just give me one.)

The oscillator is at its equilibrium point when $y(t) = 0$. A cosine is zero if the thing inside it is $\frac{\pi}{2}, \frac{3\pi}{2}, \frac{5\pi}{2}, \dots$, or more generally $\frac{n\pi}{2}$ where $n = 1, 3, 5, \dots$ is an odd number.

Let's choose the first one: $\frac{\pi t}{4} = \frac{\pi}{2} \implies t = \frac{4}{2} = \mathbf{2\text{s}}$.

Or more generally, $\frac{\pi t}{4} = \frac{n\pi}{2} \implies t = 2n$, so twice any odd number will do: **6s, 10s, 14s,**