Cornell University

Department of Physics

Phys 214 August 23, 2006

# Waves, Optics, and Particles, Fall 2006

## Homework Assignment # 1

(Due Thursday, August 31 at 5:00pm *sharp*.)

## Agenda and readings for the weeks of August 21, 28:

Skills to be mastered:

- Review arithmetic of complex numbers
- Be able to go back and forth between a graph of simple harmonic motion and the values of $x_{\rm eq}$, $A$, $\omega_o$, $f$, $T$, $\phi_o$.

Lectures and Readings:

Readings marked LN are from the course lecture notes to be found at http://people.ccmr.cornell.edu/~muchomas/P214; optional readings marked VW are from the *optional* class text *Vibrations and Waves*; and optional readings marked YF are from the optional class text Young and Freedman, *University Physics*, 11th edition.

- Lec 1, 08/26 (Thu): General class introduction; Introduction to simple harmonic motion (SHM).
  **Readings: LN "Simple Harmonic Motion," Secs. 1–3; YF 13.1–13.3**
- Lec 2, 08/31 (Tue): General and particular solutions for SHM.
  **Readings: LN "Simple Harmonic Motion," Sec. 4; VW, pp. 6-7; Sections 2-4 from Alan Giambattista's Oscillations chapter (link on course home page).**
- Lec 3, 09/02 (Thu): Complex representation for SHM.
  **Readings: LN "Simple Harmonic Motion," Sec. 5; VW, pp. 7-16**

## Contents

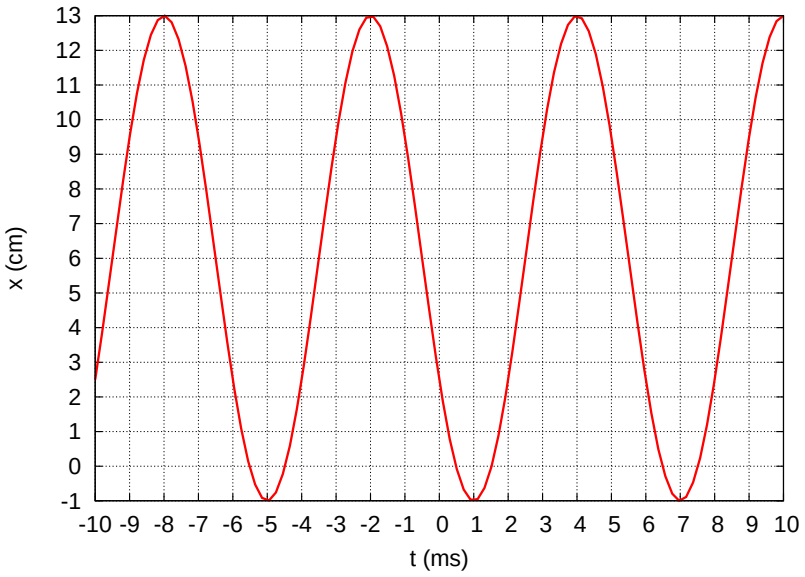


Figure 1: Position of a mass in simple harmonic motion as a function of time.

# 1 Review of complex numbers

For $x = -7 - 24i$ and $y = -8 + 15i$, express the following *both* in Cartesian form $(a + bi)$ and polar form $(Ae^{i\phi})$:

(a) $x$ and $y$; (b) $x - y$; (c) $xy$; (d) $\frac{y}{x}$; (e) $e^y$; (f) $|x|$; (g) $|y|$.

**Hint:** Note that once you've converted $x$ and $y$ to polar form, some of these operations are easier to do in polar form.

Compute the following by *direct evaluation* (again, some are easier in polar and some easier in Cartesian):

(h) $xx^*$, where $x^*$ is the complex conjugate of $x$. (Compare to $|x|^2$ !)
(i) $x^*y^*$ (Compare to $(xy)^*$!)
(j) $e^{y^*}$ (Compare to $(e^y)^*$!)
(k) $|xy|$ (Compare to $|x| \cdot |y|$ !)
(l) $\left|\frac{y}{x}\right|$ (Compare to $|y|/|x|$ !)

# 2 Basic characterization of harmonic motion

## 2.1

Sketch a graph of $x(t) = -10.0 \text{ cm} - (10.0 \text{ cm}) \cos\left((125.7 \frac{\text{rad}}{\text{sec}})t + (\frac{2\pi}{3} \text{ rad})\right)$. Label axes and show at least 2 complete cycles. What are the amplitude $A$, period $T$ and frequency $f$ (in Hz) of this motion?

## 2.2

(b) Determine values of $x_{\text{eq}}$, $A$, $\omega_o$, $f$, $T$, $\phi_o$ from the graph of $x(t) = x_{\text{eq}} + A\cos(\omega_o t + \phi_o)$ in Figure 1. Approximate answers to one or two significant figures are fine. Be sure to provide units for your answers!!! (Note that, in this class, we always **require** units but normally won't remind you.)