Engineering Physics I Name _____
PHYS 1210 Spring 2015

Discussion 12 – Periodic Motion (Ch 14)

Equations

$f = 1/T$

$\omega = 2\pi f$

f=rev/s=Hz

ω=rad/s=s-1

SHM:

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

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

Angular:

$\omega = \sqrt{\kappa / I}$

Simple Pendulum:

$\omega = \sqrt{g/L}$

$T = 2\pi\sqrt{L/g}$

Physical Pendulum:

$\omega = \sqrt{mgd/I}$

$T = 2\pi\sqrt{I/mgd}$

DHM:

$x = Ae^{-(b/2m)t}\cos(\omega' t + \phi)$

$\omega' = \sqrt{\frac{k}{m} - \frac{b^2}{4m^2}}$

Forcing / driving / resonance

$A = \frac{F_{\max}}{\sqrt{(k - m\omega_d^2)^2 + b^2\omega_d^2}}$

Problems (some from Young & Freedman 13e)

1) Jupiter orbits the Sun in 11.86 years. (Some calendrical astronomers / astronomy historians believe this is why Chinese/Asian/lunar horoscopes are based on a 12-year cycle.)
   a. What is Jupiter's average distance from the Sun?
   b. Galileo observed Jupiter's moon Europa when Jupiter and Earth are at their closest. If Europa's average distance from Jupiter is 671,100km, what would be Jupiter and Europa's maximum angular separation?
   c. Galileo also observed that Europa orbits Jupiter in 3.551 days. Using Europa's distance from Jupiter from above, what is Jupiter's mass?

14.16 • A 0.400-kg object undergoing SHM has $a_x = -2.70\ \text{m/s}^2$ when $x = 0.300$ m. What is the time for one oscillation?

If the maximum amplitude is 0.450m, and assuming SHM and a phase angle of 0, find the formula for position, velocity, and acceleration as a function of time. Graph all three.

14.15 • **BIO** **Weighing Astronauts.** This procedure has actually been used to "weigh" astronauts in space. A 42.5-kg chair is attached to a spring and allowed to oscillate. When it is empty, the chair takes 1.30 s to make one complete vibration. But with an astronaut sitting in it, with her feet off the floor, the chair takes 2.54 s for one cycle. What is the mass of the astronaut?

14.1 • **BIO** (a) **Music.** When a person sings, his or her vocal cords vibrate in a repetitive pattern that has the same frequency as the note that is sung. If someone sings the note B flat, which has a frequency of 466 Hz, how much time does it take the person's vocal cords to vibrate through one complete cycle, and what is the angular frequency of the cords? (b) **Hearing.** When sound waves strike the eardrum, this membrane vibrates with the same frequency as the sound. The highest pitch that typical humans can hear has a period of 50.0 μs. What are the frequency and angular frequency of the vibrating eardrum for this sound? (c) **Vision.** When light having vibrations with angular frequency ranging from 2.7×10^{15} rad/s to 4.7×10^{15} rad/s strikes the retina of the eye, it stimulates the receptor cells there and is perceived as visible light. What are the limits of the period and frequency of this light? (d) **Ultrasound.** High-frequency sound waves (ultrasound) are used to probe the interior of the body, much as x rays do. To detect small objects such as tumors, a frequency of around 5.0 MHz is used. What are the period and angular frequency of the molecular vibrations caused by this pulse of sound?

14.49 • After landing on an unfamiliar planet, a space explorer constructs a simple pendulum of length 50.0 cm. She finds that the pendulum makes 100 complete swings in 136 s. What is the value of g on this planet?