0.2 Physics for Smart Systems, 2nd week

1. A violin string playing the note A oscillates at 440 Hz. What is its oscillation period?

2. Write expressions for simple harmonic motion:

   (a) with amplitude 10 cm, frequency 5.0 Hz and maximum displacement at $t = 0$,

   (b) with amplitude 2.5 cm, angular frequency 5.0 1/s and maximum velocity at $t = 0$.

3. An automobile suspension has an effective spring of constant 26 kN/m and car's suspended mass is 1900 kg. In the absence of damping, what frequency and period will the car undergo simple harmonic motion?

4. A mass ($m = 50$ g) is attached to a spring and undergoes simple harmonic motion. Its maximum acceleration is 15 $\frac{m}{s^2}$ and its maximum speed is 3.5 m/s. Determine

   (a) angular frequency,

   (b) spring constant,

   (a) amplitude.

5. Show that if $y(t) = D\cos(\omega t + \phi)$, where ω is a constant, then

$$y''(t) + \omega^2 y(t) = 0.$$

   This means that $y(t) = D\cos(\omega t + \phi)$ is a solution to the differential equation (Simple Harmonic Motion).

6. In a mass-spring system $m = 400$ g and $k = 7.888$ N/m. It will oscillate according to Simple Harmonic Motion given by

$$y(t) = A\sin(\omega t + \theta).$$

   (a) What is the period?

   (b) Find the constants A and θ, if the maximum displacement is 5 cm and the mass passes through $y = 0$ at time $t = 0$ in the positive direction.

   (c) Find the constants A and θ, if the maximum displacement is 5 cm and the mass passes through $y = 0$ at time $t = 0$ in the negative direction.

7. Consider the Simple Harmonic Motion

$$y''(t) + \omega^2 y(t) = 0.$$

   Let $m = 1.0$ kg and $k = 4.0$ N/m. Therefore $\omega = 2.0$ rad/s. The general solution is $y(t) = A\sin(\omega t + \theta)$. Find the constants A and θ, if

   (a) $y(0) = 0$ and $v(0) = y'(0) = 2$.

   (b) $y(0) = 1$ and $v(0) = y'(0) = 0$.

   What does the initial conditions in (a) and (b) mean physically?