Physics

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1 Periodic Motion

1.1 Frequency

Definition 1.1 (Period)**.** The period T is the time to complete one cycle, measured in seconds.

Definition 1.2 (Angular Frequency)**.** Angular frequency ω is radians per second, with units s^{-1}. Radians are unitless.

$$\omega = \frac{2\pi}{T}.$$

Definition 1.3 (Frequency)**.** Frequency is a measure of cycles per second, or $\omega/2\pi$. It is measured in hertz (Hz) with units s^{-1}. Cycles are unitless.

Definition 1.4 (Restoring force)**.** The restoring force F_x relative to displacement from equlibrium x is

$$F_x = -kx.$$

k is the spring constant with units N/m.

Definition 1.5. The equation used to derive the equation for simple harmonic motion with respect to time is

$$\frac{d^2x}{dt^2} = -\frac{k}{m}x.$$

Eigen values for this equation are $\pm i\sqrt{\frac{k}{m}}$, so displacement from equilibrium for simple harmonic motion with respect to time is

$$x = c_1\cos\left(\sqrt{\frac{k}{m}}t\right) + c_2\sin\left(\sqrt{\frac{k}{m}}t\right).$$

In phase-amplitude form this equation is

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

Definition 1.6 (SHM frequency)**.** It follows from the displacement equation for SHM that angular frequency for SHM is

$$\omega = \sqrt{\frac{k}{m}}.$$

1.2 Energy in SHM

Definition 1.7 (Mechanical energy)**.** Work in Joules (Nm) is equal to displacement times force in simple scenarios. For forces that vary with one-dimensional displacement x from a to b, work is expressed by equation

$$E = \int_a^b F(x)dx.$$