Unit 6 → Simple Harmonic Motion

Period of a simple harmonic motion

- Definitions
    - Simple Harmonic Motion
        - A repeated constant motion around a single point
    - Oscillation
        - A type of simple harmonic motion
        - Regular, repeated, variation in a position around a singular point
    - Equalibrium Position
        - The central point about which an object oscillates
    - Frequency
        - Number of waves, cycles, oscillations, or disturbances per unit of time
        - $f = \frac{\#\,of\ waves, oscillations, or\ disturbances}{time}$
        - Units: cps, Hz, s^{-1}
    - Period
        - Time for one complete wave, cycle, oscillation, or disturbance
        - $T = \frac{time}{\#\,of\ waves, oscillations, or\ disturbances}$
    - Linear restoring force
        - The F_{net} that forces the object back to its equilibrium position
- Reference Table
    - General period
        - $T = \frac{2\pi}{\omega} = \frac{1}{f}$
            - $T = period$
            - $\omega = angular\ speed/angular\ frequency\ (rad/s)$
                - $\omega = 2\pi f$
            - $f = frequency\ (Hz)$
    - Period of a pendulum
        - $T_P = 2\pi\sqrt{\frac{\ell}{g}}$
            - $T_P = period\ of\ the\ pendulum\ (s)$
            - $\ell = length\ of\ the\ string\ (m)$
            - $g = acceleration\ due\ to\ gravity\ (\frac{m}{s^2})$
    - Period of a spring
        - $T_S = 2\pi\sqrt{\frac{m}{k}}$
            - $T_S = period\ of\ the\ spring\ (s)$
            - $k = spring\ constant\ (\frac{N}{m})$
            - $m = mass\ (kg)$

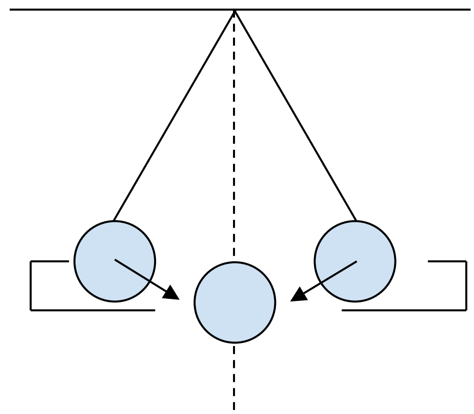
- What’s happening, where?
    - At maximum displacement from equilibrium
        - Amplitude = maximum
        - F_{net} = maximum
        - Acceleration = maximum
        - Velocity = zero
    - At equilibrium
        - Amplitude = zero
        - F_{net} = zero
        - Acceleration = zero
        - Velocity = maximum
- Reference Table
    - *THESE EQUATIONS MUST BE IN* ***<u>RADIAN MODE</u>***
    - Position of an object
        - $x = Acos(2\pi ft)$
            - $x = position\ (m)$
            - $A = amplitude\ (m)$
            - $f = frequency\ (Hz)$
            - $t = time\ (s)$
    - Velocity and acceleration
        - Base
            - $v(x) = 2\pi fx$
            - $a(x) = (2\pi f)^2x$
                - $a(x) = \omega^2x$
        - At maximum
            - $v(max) = 2\pi fA$
            - $a(max) = (2\pi f)^2A$
                - $a(max) = \omega^2A$

Energy of a simple harmonic motion

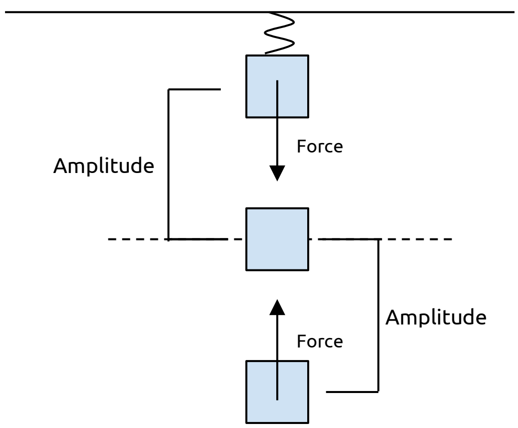
- Energy in a simple harmonic motion
    - Only applies to springs
    - Potential energy is based on position
        - The greater the distance from equilibrium, the greater the stored energy
    - Kinetic energy is based on speed
        - The greater the speed, the greater the kinetic energy
- Reference Table
    - At base
        - $K = \frac{1}{2}mv^2$
        - $U_s = \frac{1}{2}kx^2$
    - At maximum
        - $K_{max} = \frac{1}{2}mv_{max}^2$
        - $U_{s_{max}} = \frac{1}{2}kA^2$

Scenarios at Equilibrium

Pendulu



Vertical Spring



Horizontal Spring