Unit 08(A) Review (Simle Harmonic Motion)

1. A 0.3-kg mass is attached to a vertical spring. When the mass is attached, the spring stretches by 0.15 m. Calculate the spring constant of the spring.

Solution: Knowns/Unknowns: $m = 0.3$ kg, $d = -0.15$ m, $k = ?$.
Since the spring is being stretched by gravity, $F_S = F_G$. Therefore,

$$\begin{aligned} F_S &= F_G \\ -kd &= mg \\ -k(-0.15) &= (0.3)(9.8) \\ k &= 19.6\,\text{N/m} \end{aligned}$$

2. Calculate the period and frequency of a pendulum with length 1.4 m.

Solution: Knowns/Unknowns: $\ell = 1.4$ m, $T = ?$, $f = ?$.

$$T_P = 2\pi\sqrt{\frac{\ell}{g}} = 2(3.14)\sqrt{\frac{1.4}{9.8}} = 2.37\,\text{s}$$

$$f = \frac{1}{T} = \frac{1}{2.37} = 0.42\,\text{Hz}$$

3. A spring makes 9 oscillations in 15 s. The spring constant is 80 N/m. What mass is on the spring?

Solution: Knowns/Unknowns: $\#osc = 9$, $t = 15$ s, $k = 80$ N/m $m = ?$.
First, $T = \frac{15}{9} = 1.67\,\text{s}$. Then,

$$\begin{aligned} T_S &= 2\pi\sqrt{\frac{m}{k}} \\ 1.67 &= 6.28\sqrt{\frac{m}{80}} \\ 2.78 &= \frac{39.48m}{80} \\ 5.67\,\text{kg} &= m \end{aligned}$$

4. What are the four equations you need to have memorized?

Solution:

$$T = \frac{t}{\#osc} \qquad f = \frac{\#osc}{t} \qquad T = \frac{1}{f} \qquad f = \frac{1}{T}$$

5. Define the following:
   (a) amplitude

   Solution: the maximum displacement from equilibrium

   (b) equilibrium

   Solution: the point where restoring force is zero

   (c) frequency

   Solution: how many oscillations happen in a second

   (d) period

   Solution: the time of one oscillation

   (e) restoring force

   Solution: a force that pulls an object toward a fixed equilibrium point

   (f) spring constant

   Solution: k, a measure of the stregth of the spring. Measured in N/m.

6. Explain why an oscillator keeps moving when it gets to equilibrium, even though the net force there is zero.

Solution: the inertia carries it past

7. Why doesn't amplitude affect period?

Solution: Oscillators with a larger amplitude have a larger speed. They also travel a farther distance. These two effect counteract each other

8. What two factors affect the period of a spring? What two factors affect the period of a pendulum?

Solution: Mass and spring constant affect the period of a spring. Length and acceleration of gravity affect the period of a pendulum.