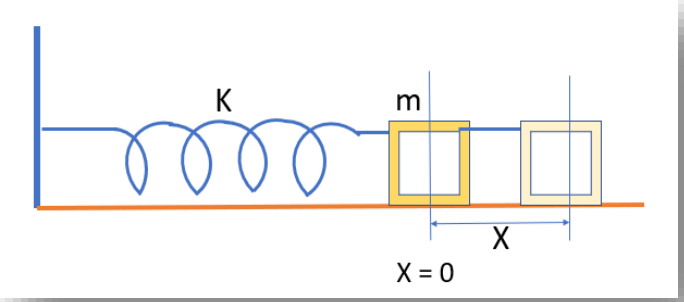
Mass-Spring System:

It consists of a block of mass m and a spring of spring constant *k*. *It has two types:*

(i) Horizontal Mass-Spring System
(ii) Vertical Mass-Spring System

(i) Horizontal Mass-Spring System:

Consider a horizontal mass-spring system of a block of mass m and a spring of spring constant k, as shown in the figure below.



Let the system be displaced through a distance X. (***Note***: You are also free to use small letter 'x' for displacement for consistency through the chapter of SHM). Then a restoring force is developed such that the system has the tendency to come back to the mean position.

It is found that the restoring force is directly proportional to the displacement from the mean position and is opposite to it .

i.e. $F \propto X$

or, $F = -kX$, k being a constant of proportion, and is called the spring constant.

or, $ma = -kX$

Substituting the value of acceleration, we get

$$m\frac{d^2X}{dt^2} + kX = 0$$

$$\boxed{\frac{d^2X}{dt^2} + \omega^2 X = 0} \quad (1)$$

$$where, \omega = \sqrt{\frac{k}{m}}$$

(the angular frequency)

Equation (1) is the required differential equation of SHM. Hence the motion of the horizontal mass-spring system is simple harmonic.

To find the time period:

Since the time period is given by

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

And from above, we have

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

So,

$$T = 2\pi\sqrt{\frac{m}{k}}$$