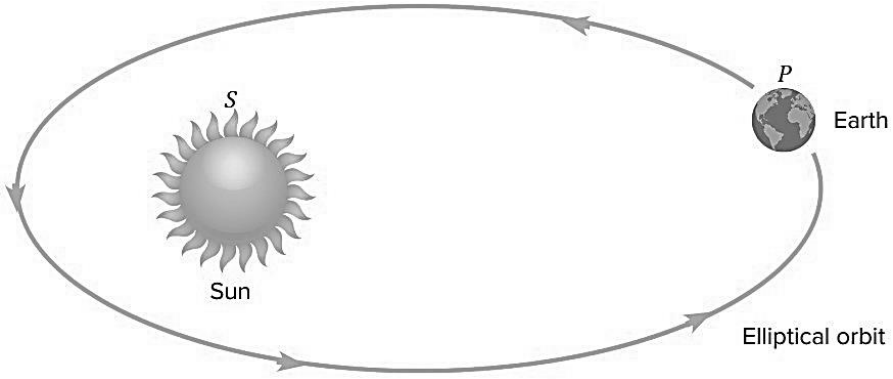
OSCILLATIONS

PERIODIC AND OSCILLATORY MOTIONS

PERIODIC MOTION

When something moves in a regular pattern and goes back to where it started at the same speed and in the same way every time, we call it periodic motion. So, if an object is doing periodic motion and it's at a certain place (let's call itx_1) with a particular speed (V_1) and how fast it's changing speed (acceleration,a_1), every time it comes back to x1, it will have the same speed (V_1) and change speed (a_1) as it did before.

Here are a few examples of periodic motion: the swinging of a pendulum, the movement of the clock's hands, and the way planets move in space.



Oscillatory Motion

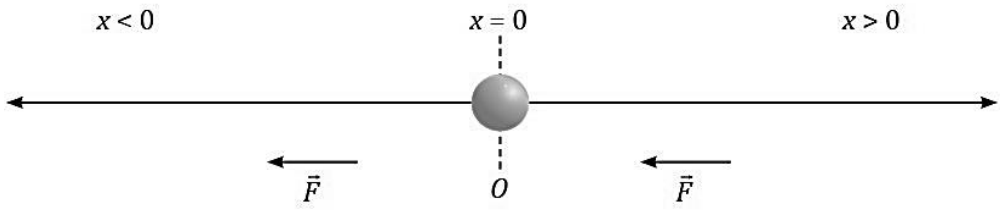
When an object repeatedly moves back and forth around one spot, it's called oscillatory motion.

- Not every kind of repeating motion is called oscillatory, but all oscillatory motions repeat.
- Think of a swinging pendulum or a playground swing as examples of oscillatory motion.
- When things like friction or other forces slow down a moving object, its energy decreases, and it might not swing or move in the same way every time. So, oscillatory motion can become less regular if those forces are involved.

To show back-and-forth motion, we can use plus and minus signs to say which way things like distance, speed, force, and how fast something is changing its speed are going.

Let us consider a scenario in which a particle experiences a force, F, that is directly proportional to the negative power of x, represented as $F \propto -xn$, where n is an integer, and x denotes the particle's displacement from its equilibrium position ($x = 0$). It's important to note that the value of x can assume positive, negative, or zero values.

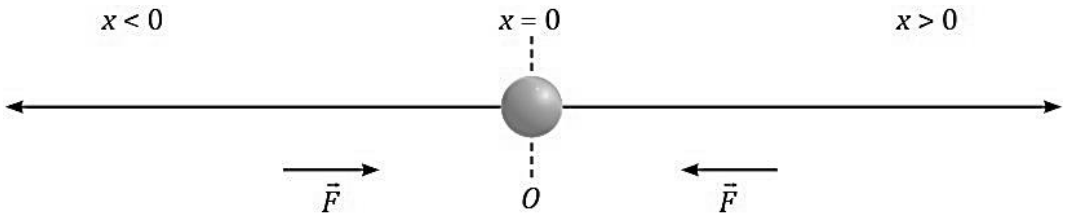
Case 1: n → even integer (0, 2, 4 ...)



For negative and positive displacements of the body, the force is always directed along the negative x-axis. This indicates that the body cannot perform oscillatory motion (to-and-fro motion) about its mean position.

Case 2: n → Odd integer (1, 3, 5...)

In this scenario, when the displacement is negative, the value of xn is negative. Given that the restoring force is proportional to −xn, it acts in the direction of the positive x-axis. Likewise, when the displacement is positive, the value of xn is positive, resulting in the force acting in the direction of the negative x-axis.



So, the force will always push in the opposite direction of the movement, causing the object to go back and forth around its middle point.

NOTE:

- A thing wants to go back to its middle because that's a safe and balanced spot where it has the least stored energy.
- Right in the middle, there's no push or pull on the object (net force is 0). So, it doesn't speed up or slow down there, it moves at its fastest.