OSCILLATIONS

SIMPLE HARMONIC MOTION

SIMPLE HARMONIC MOTION:

Simple harmonic motion, or SHM for short, means when something moves, the force trying to pull it back is related to how far it's moved from the middle, and it always pulls it back toward the middle. It's a special kind of back-and-forth motion with a specific kind of force acting on it.

F = -kx

Where 'k' is just a number that tells us how strong the pullback force is in this specific kind of backand-forth motion, which we call simple harmonic motion.



Here, the force that pulls the object back will go the opposite way from where the object moved, and it will always try to bring the object to the middle position (x = 0).

You can understand how periodic and oscillatory motion are related by looking at this Venn diagram.



CLASS 11

SHM of a Body about Its Mean Position

Imagine an object moving back and forth between two points, let's call them +A and -A, with a force that tries to pull it back, F = -kx. The farthest it goes from the middle is called the 'amplitude' of this back-and-forth motion, which is A.

When you let the object go from its farthest point at +A, the pullback force is the strongest (F = - kA). So, the object accelerates the most $\left(\frac{kA}{M}\right)$, and it's trying to go back to the middle.



- As the object goes past the middle point, a force starts pulling it back. Because this force always goes the opposite way of how the object moved, it slows down the object. This slowing down is related to how far it's gone from the middle, like this: $a \propto -x$.
- So, as the object moves farther from the middle, it slows down faster. This slowing down gets faster as it goes further, and it finally stops (velocity is 0) when it reaches the farthest point at x = -A.
- At the very far end, at -A, the object is slowing down as much as it can, and it's trying to go back to the middle.
- The object begins its motion in a similar way, but it's now going the other direction. It starts from the far end at x = -A, and its speed keeps getting faster until it gets back to the middle.



• Because the object has the highest speed at the middle, it goes away from the middle. Then, the pullback force starts slowing it down, and it briefly stops at the far end where it began, and the whole process repeats as we talked about earlier.



The motion of the body is summarised in the following table:

Path	Direction of \vec{F}	$ \vec{F} $	Direction of \vec{a}	$ \vec{a} $	Direction of \vec{v}	$ \vec{v} $	Type of motion
A-0	\leftarrow	\downarrow	\leftarrow	↓	\leftarrow	↑	Accelerated
0-(-A)	\rightarrow	Ŷ	\rightarrow	1	\leftarrow	↓	Decelerated
(-A)-0	\rightarrow	\downarrow	\rightarrow	↓	\rightarrow	1	Accelerated
0-A	<i>~</i>	1	<i>~</i>	1	\rightarrow	↓	Decelerated