Vector Mechanics of Particles

Conservative & Non-Conservative Forces

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Goals for Chapter

- To use gravitational potential energy in vertical motion
- To use elastic potential energy for a body attached to a spring
- To solve problems involving conservative and nonconservative forces
- To determine the properties of a conservative force from the corresponding potential-energy function

Conservative Forces

- Conservative force is a such force for which the work done by this force on a particle moving between any two points is independent of the path taken by the particle or
- The work done by a conservative force on a particle moving through any closed path is zero
- Examples of conservative forces:
- Gravity , Spring force

Nonconservative Forces

- A nonconservative force does not satisfy the conditions of conservative forces
- Nonconservative forces acting in a system cause a change in the mechanical energy of the system
- Examples of nonconservative forces:
- Friction
- Tension

Important points about Forces

- A conservative force allows conversion between kinetic and potential energy. Gravity and the spring force are conservative.
- The work done between two points by any conservative force

a) is reversible.

b) is independent of the path between the two points.

c) is zero if the starting and ending points are the same.

- A force (such as friction) that is not conservative is called a nonconservative force, or a dissipative force.

Central Forces

- A **central force** is a force that is acting on an object which is directed along the line joining the object and the origin. The magnitude of the central force depends only on the distance of the object and the centre.
- Examples: gravitational force and spring force.

Centripetal Acceleration

- **Centripetal acceleration** is the rate of change of tangential velocity:
- The direction of the centripital acceleration is always inwards along the radius vector of the circular motion

Coriolis acceleration

- **Coriolis acceleration** is the **acceleration** due to the rotation of the earth, experienced by particles (water parcels, for example) moving along the earth's surface.
- Example:e. Ocean currents

Foucault pendulum

- The **Foucault pendulum** or **Foucault's pendulum** is a simple device named after French physicist Leon Foucault and conceived as an experiment to demonstrate the Earth's rotation .The pendulum was introduced in 1851 and was the first experiment to give simple, direct evidence of the earth's rotation.

General Topics

- Energy Equation & Energy Diagram
- Non-inertial frame of Reference

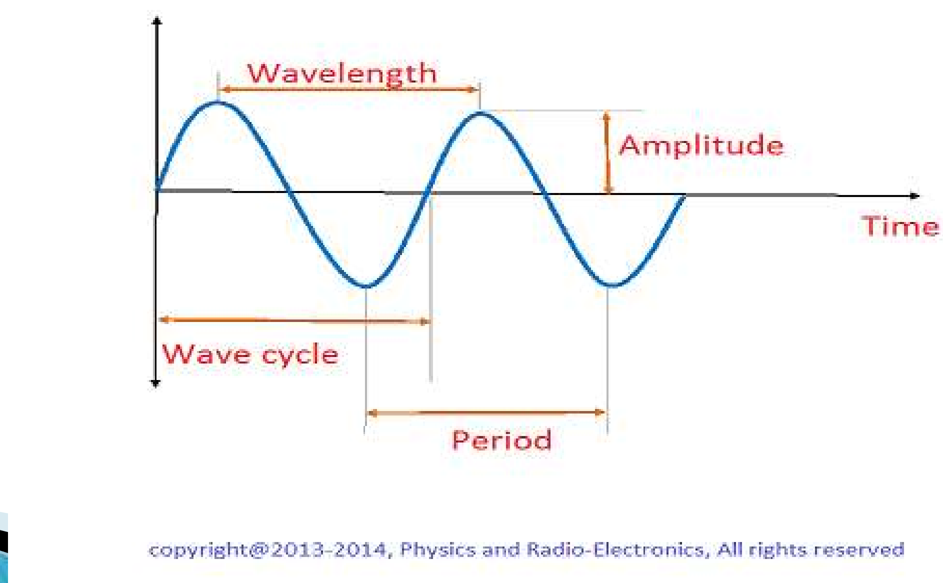
Simple harmonic motion, damped and forced simple harmonic

Content

- Simple Harmonic Motion revision
- Displacement, velocity and acceleration in SHM
- Energy in SHM
- Damped harmonic motion
- Forced Oscillations
- Resonance

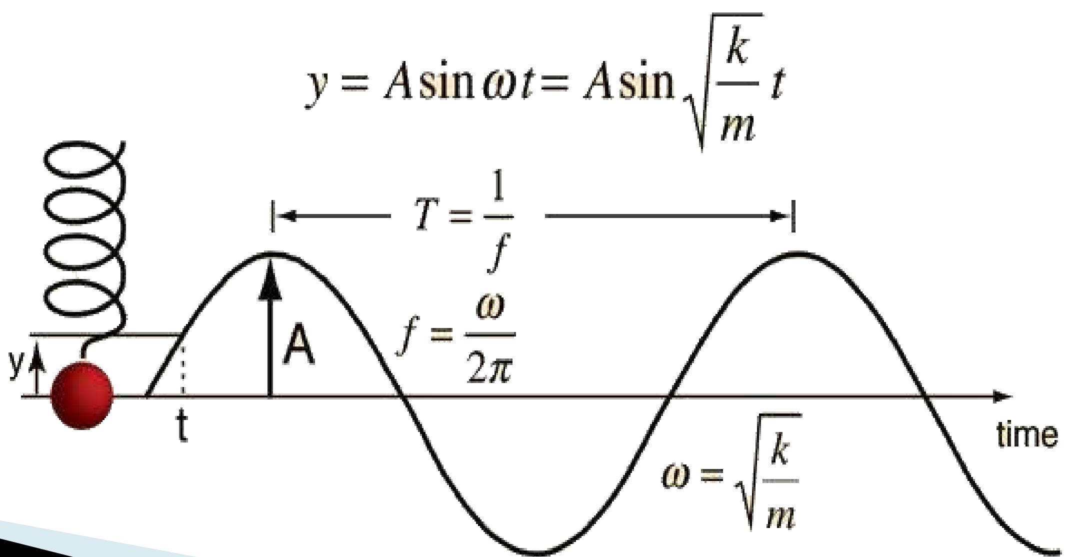
What is wave ?

- Wave is a disturbance that travels through a medium, transporting energy from one location to another location without transporting matter.

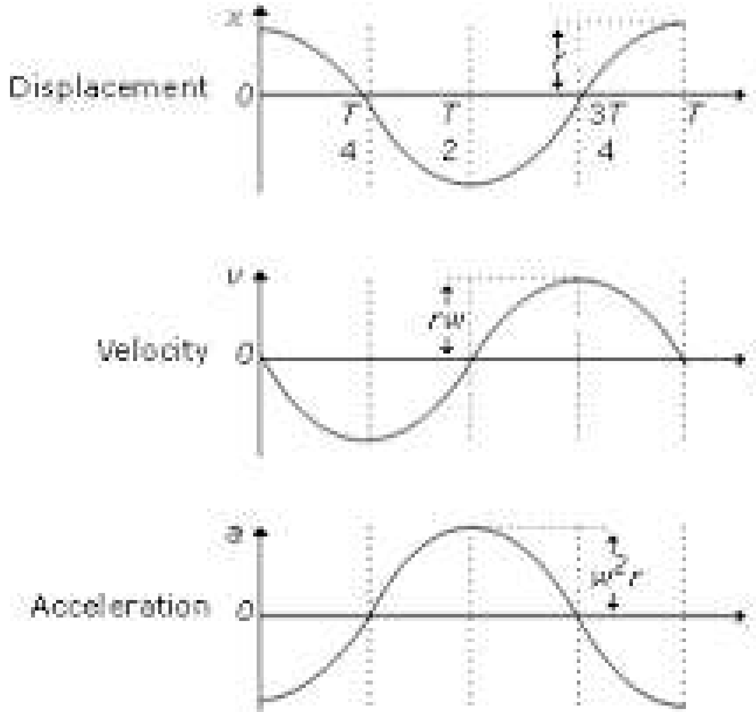


What is simple harmonic motion ?

- **simple harmonic motion** is a special type of periodic **motion** or oscillation **motion** where the restoring force is directly proportional to the displacement and acts in the direction opposite to that of displacement.



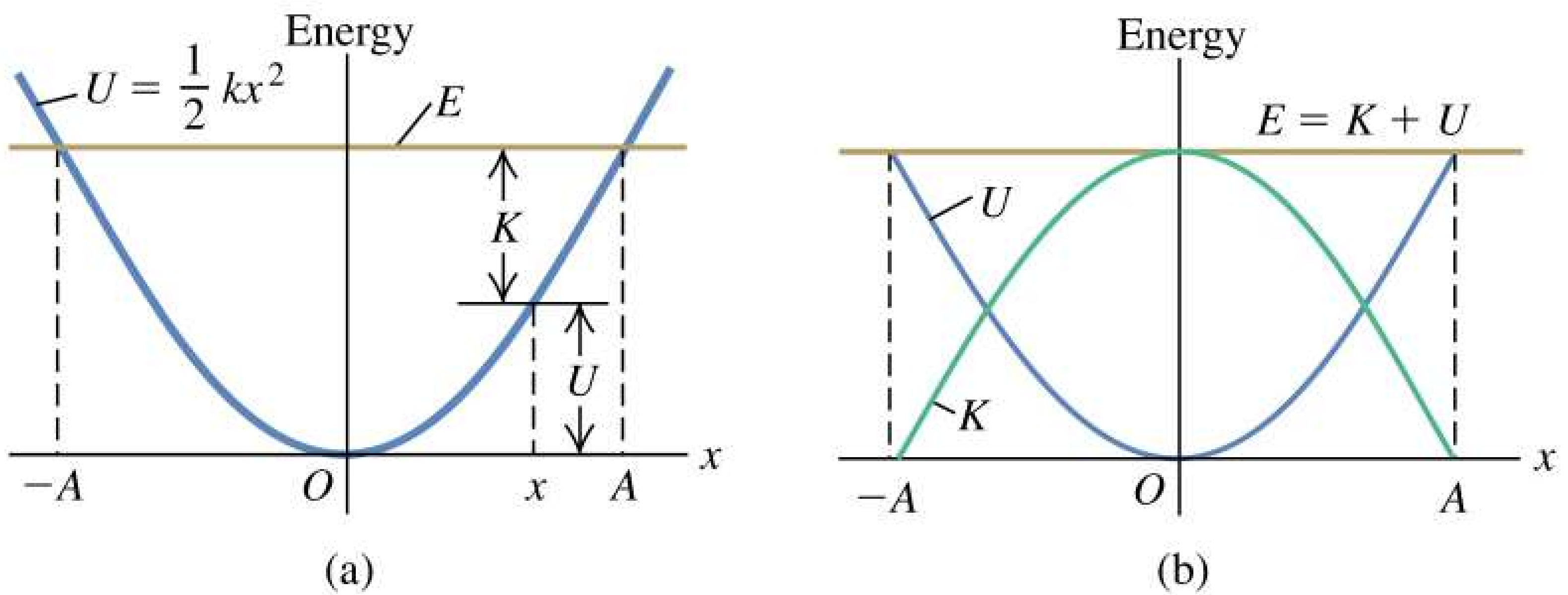
Velocity and acceleration in SHM



Energy in Simple Harmonic Motion

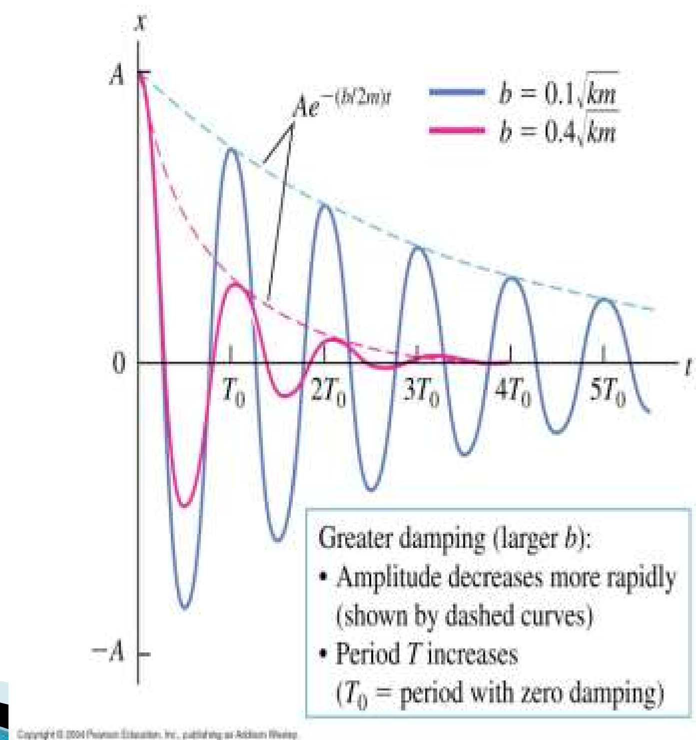
- The total energy that a particle possesses while performing simple harmonic motion is energy in simple harmonic motion. Take a pendulum for example. When it is at its mean position, it is at rest. When it moves towards its extreme position, it is in motion and as soon as it reaches its extreme position, it comes to rest again. Therefore, in order to calculate the energy in simple harmonic motion, we need to calculate the kinetic and potential energy that the particle possesses.

Energy in Simple Harmonic Motion

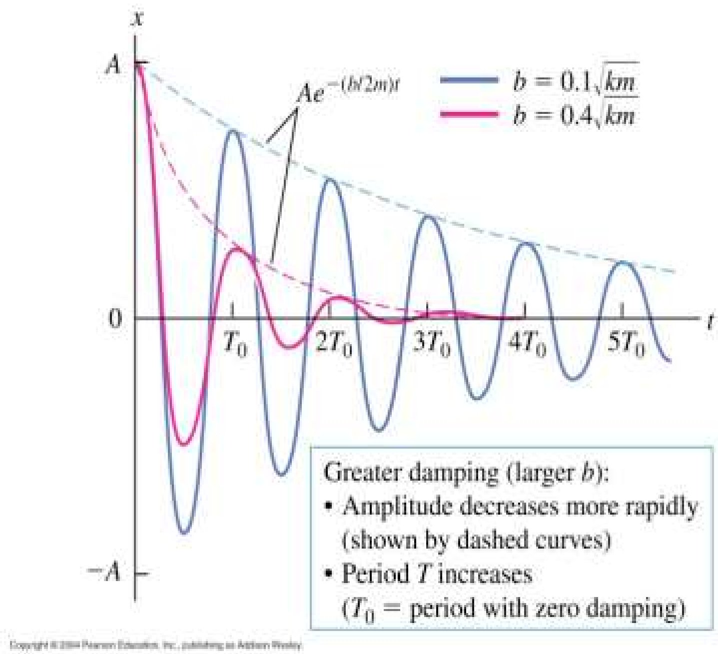


Damped oscillations

- In this case, amplitude of oscillation is not constant, but *decays* with time



Damped oscillations



For damped oscillations, simplest case is when the damping force is proportional to the velocity of the oscillating object
In this case, amplitude decays exponentially:

Forced Mechanical Oscillator

- FMO is one in which
- Restoring Force is directly proportional to displacement
- Frictional Force is proportional to velocity
- External applied force
- Total force acting on the body=F1+F2+F3