GE\_IV\_2: **Superposition of two collinear oscillations having Equal frequencies:**

A particle (or a system) which executes simple harmonic motion is called a simple harmonic oscillator.

Let a particle is acted upon by two simple harmonic motion in the same direction, they have same frequency of vibration but they differ in phase.

Let y1 and y2 be the displacements produced by two simple harmonic motions(SHM). They are given by at any instant ‘t’,

y1 = a sin ωt , y2 = b sin (ωt + α )

The resultant displacement at any instant ‘t’ is the algebric sum of individual displacements y1 and y2 ,

i.e. Y = y1 + y2

= a sin ωt + b sin (ωt + α )

= a sin ωt + b sin ωt. cos α + b cos ωt. sin α

= sin ωt ( a + b cos α) + cos ωt (b sin α) … … … … … … … … (1)

Putting (a + b cos α) = A cosф and b sin α = A sinф … … … … … (2)

Equation (1) becomes,

Y = A ( sin ωt. cosф + cos ωt. sinф)

= A sin (ωt + ф) … … … … … … … … … … … … …(3)

This gives the equation of the resultant simple harmonic vibration of amplitude ‘A’ and initial phase ф.

From eqns. (2),

(A cosф)2 + (A sinф)2 = ((a + b cos α)2 + (b sin α)2

* A2 (sin2 ф + cos2 ф) = a2 + b2 cos2 α +2ab cos α + b2sin2 α
* A2 = a2 + b2 + 2ab cos α … … …. … …. … …. … … ..(4)

Again from eqns. (2).

(A sinф/ A cosф) = tanф = (b sin α / a + b cos α)

Or, ф = tan-1 (b sin α / a + b cos α) …. …. … …. ….(5)

The resultant motion is a SHM of the same frequency of the components.

