Answer on Question #44794, Physics, Other

Task: State the principle of superposition. State the condition(s) which must be satisfied by the differential equation of SHM so that the principle of superposition holds. Two collinear simple harmonic oscillations, each of amplitude 4 cm, are superposed to obtain an oscillation of amplitude 4(2+ 2^1/2)^1/2 cm. If the initial phase difference between the superposing oscillations is now increased by 15°, what will be the amplitude of the resultant oscillation?

Solution:

$$x_1 = 4\sin(\omega t + \varphi_0)$$

$$x_2 = 4\cos(\omega t + \varphi_0)$$

$$x_1 + x_2 = 4\sin(\omega t + \varphi_0) + 4\cos(\omega t + \varphi_0) = 4\sqrt{2+\sqrt{2}}\,cm$$

$$x_1 = 4\sin(\omega t + \varphi_0 + 15^0)$$

$$x_2 = 4\cos(\omega t + \varphi_0 + 15^0)$$

$$x_1 + x_2 = 4\sin(\omega t + \varphi_0 + 15^0) + 4\cos(\omega t + \varphi_0 + 15^0) =$$

$$= 4(\sin(\omega t + \varphi_0)\cos 15^0 + \cos(\omega t + \varphi_0)\sin 15^0 + \cos(\omega t + \varphi_0)\cos 15^0 - \sin(\omega t + \varphi_0)\sin 15^0) =$$

$$= 4\cos 15^0(\sin(\omega t + \varphi_0) + \cos(\omega t + \varphi_0)) + 4\sin 15^0(\cos(\omega t + \varphi_0) - \sin(\omega t + \varphi_0)) =$$

$$= 4\sqrt{2+\sqrt{2}}\cos 15^0 + 4\sin 15^0(\cos(\omega t + \varphi_0) - \sin(\omega t + \varphi_0))$$