Important Facts and Formulae.

(1) When a body is suspended from two light springs separately. The time period of vertical oscillations are T1 and T2 respectively.

$$T_1 = 2\pi\sqrt{\frac{m}{k_1}} \quad \therefore \quad k_1 = \frac{4\pi^2 m}{T_1^2} \qquad \text{and} \qquad T_2 = 2\pi\sqrt{\frac{m}{k_2}} \quad \therefore \quad k_2 = \frac{4\pi^2 m}{T_2^2}$$

When these two springs are connected in series and the same mass m is attached at lower end and then for series combination $\frac{1}{k} = \frac{1}{k_1} + \frac{1}{k_2}$

By substituting the values of k_1, k_2 $\frac{T^2}{4\pi^2 m} = \frac{T_1^2}{4\pi^2 m} + \frac{T_2^2}{4\pi^2 m}$

Time period of the system $T = \sqrt{T_1^2 + T_2^2}$

When these two springs are connected in parallel and the same mass m is attached at lower end and then for parallel combination $k = k_1 + k_2$

By substituting the values of k_1, k_2 $\frac{4\pi^2 m}{T^2} = \frac{4\pi^2 m}{T_1^2} + \frac{4\pi^2 m}{T_2^2}$

Time period of the system $T = \frac{T_1 T_2}{\sqrt{T_1^2 + T_2^2}}$

(2) The pendulum clock runs slow due to increase in its time period whereas it becomes fast due to decrease in time period.

(3) If infinite spring with force constant $k, 2k, 4k, 8k$.......... respectively are connected in series. The effective force constant of the spring will be $k/2$.

(4) If $y_1 = a \sin \omega t$ and $y_2 = b \cos \omega t$ are two S.H.M. then by the superimposition of these two S.H.M. we get

$$\vec{y} = \vec{y}_1 + \vec{y}_2$$

$$y = a \sin \omega t + b \cos \omega t$$

$$y = A \sin(\omega t + \phi)$$ This is also the equation of S.H.M.

Where $A = \sqrt{a^2 + b^2}$ and $\phi = \tan^{-1}(b/a)$

(5) If a particle performs S.H.M. whose velocity is v_1 at a x_1 distance from mean position and velocity v_2 at distance x_2

$$\omega = \sqrt{\frac{v_1^2 - v_2^2}{x_2^2 - x_1^2}}; \quad T = 2\pi\sqrt{\frac{x_2^2 - x_1^2}{v_1^2 - v_2^2}} \quad a = \sqrt{\frac{v_1^2 x_2^2 - v_2^2 x_1^2}{v_1^2 - v_2^2}};$$

$$v_{\max} = \sqrt{\frac{v_1^2 x_2^2 - v_2^2 x_1^2}{x_2^2 - x_1^2}}$$