



The coupled pendula shown above, each of length L , are free to move only in the x - y plane. The springs, each of spring constant k , are such that the pendula rest vertically in equilibrium at $x_1=0$ and $x_2=0$ respectively. As shown, there is no damping in the system.

- (a) Identify the normal co-ordinates and frequencies of the system in terms of x_1 and x_2 , in the small displacement limit.

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- (b) The left mass is displaced in the x -direction by Δ while the right mass is held fixed. At time $t=0$ both masses are released. Find the time τ at which the system first returns to the same instantaneous configuration, in terms of the constants given.
- (c) The center spring is replaced by a spring of the same spring constant but with damping. Give the limiting values (at very long times) of the amplitudes of the normal modes of the system after the same starting conditions as in (b).