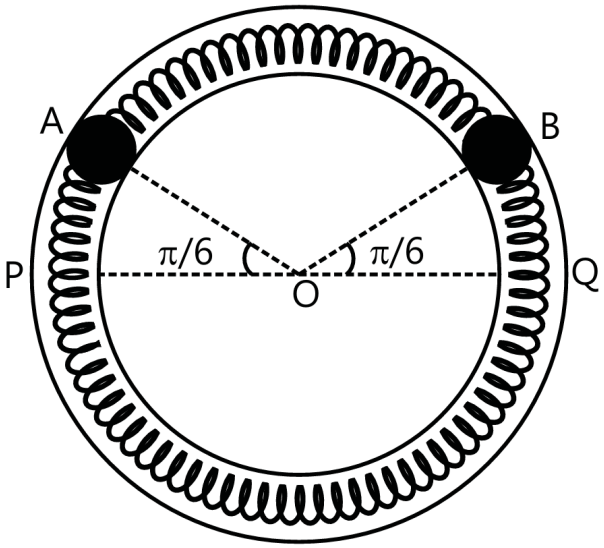
Tutorial 6

PHY 101 Monsoon 2024

Q1. A particle of mass m is moving in a potential $V(x) = ax^3 - bx^2$. Initially the particle is at rest at a stable point. What minimum speed to be given to the particle so that it reaches unstable point. Plot the potential vs x curve.

Q2. Two identical balls A and B, each of mass 0.1 kg are attached to two identical massless springs. The spring mass system is constrained to move inside a rigid smooth pipe bent in the form of a circle as shown in figure. The pipe is fixed in a horizontal plane. The centers of the balls can move in a circle of radius 0.06 m. Each spring has a natural length 0.06 π m and spring constant 0.1 N/m. Initially both the balls are displaced by angle π/6 radian with respect to the diameter PQ of the circle and released from rest.

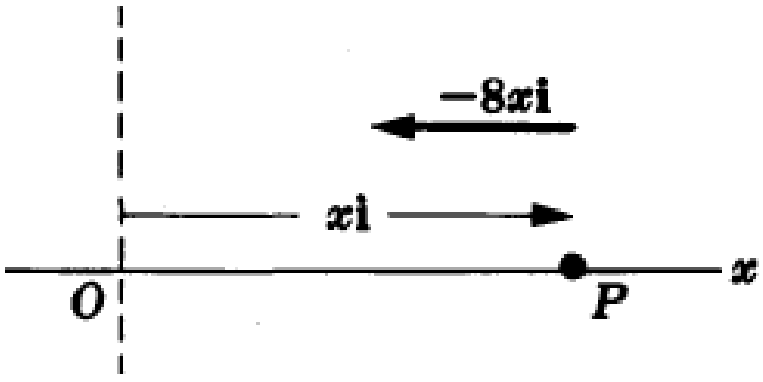


(a) Calculate the frequency of oscillation of ball B.

(b) Find the speed of the ball A when A and B are at the two ends of diameter PQ.

(c) What is the total energy of the system.

Q3.: A particle P of mass 2 unit moves along x-axis, as shown in figure, attracted toward origin O by a force whose magnitude is numerically equal to *8x*. If it is initially at rest at *x = 20* unit, find



(a) the differential equation of motion,

(b) the position of the particle at any time,

(c) the speed and velocity of the particle at any time, and

(d) the amplitude, period and frequency of the vibration.

Q4. Potential energy function describing the interaction between two atoms of a diatomic molecule is $U(r) = \frac{a}{r^{12}} - \frac{b}{r^6}$. For what value of distance r should the force acting between them will be zero. Given a = 1 and b = 2.

Q5. Let ω > 0. A damped sinusoid x(t) = Ae^{-at} cos(ωt) has "pseudo-period" 2π/ω. The pseudo-period, and hence ω, can be measured from the graph: it is twice the distance between successive zeros of x(t), which is always the same. Now what is the spacing between successive maxima of x(t)? Is it always the same, or does it differ from one successive pair of maxima to the next? Suppose that successive maxima of x(t) = Ae^{-at} cos(ωt) occur at t = t_0 and t = t_1. What is the ratio $x(t_1)/x(t_0)$? (Hint: Compare $\cos(\omega t_0)$ and $\cos(\omega t_1)$.) Does this offer a means of determining the value of a from the graph?

Q6. For what value of b does $\ddot{x} + b\dot{x} + x = 0$ exhibit critical damping? For this value of b, what is the solution $x_1$with $x_1(0) = 1$, $\dot{x_1}(0) = 0$? What is the solution $x_2$with $x_2(0) = 0$, $\dot{x_2}(0) = 1$? What is the solution such that x with $x(0) = 2$, $\dot{x}(0) = 3$?