

Homework 8: Harmonic Oscillator

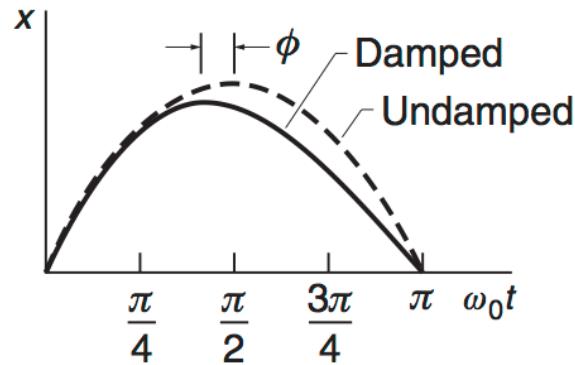
Due: Tuesday April 2nd, 13:00

Policy: Collaboration is allowed, but every student is required to hand in his/her own version of the solutions. Please include your name and student number on the solutions.

Problem 1. A round sphere with radius $R = 0.03\text{m}$ and density $\rho = 10^5/12\pi\text{ kg/m}^3$ performs simple harmonic motion with period $T_0 = \pi/5\text{ s}$ when the sphere moves in vacuum. When moved to a container of oil, the period of the sphere changes with 0.02%.

1. Give the differential equation for the last, damped, vibration.
2. Determine the viscosity η of the oil. (Recall the Stokes law for the friction force $\vec{F}_f = -6\pi\eta R\vec{v}$.)
3. With which factor does the amplitude reduce after 10 periods?

Problem 2. K. & K. 11.4



In an undamped free harmonic oscillator, the motion is given by $x(t) = A\sin(\omega_0 t)$. The displacement is maximum exactly midway between the zero crossings. In a damped oscillator the motion is no longer sinusoidal, and the maximum is advanced before the midpoint of the zero crossings. Show that the maximum is advanced by a phase angle ϕ given approximately by:

$$\phi = \frac{1}{2Q},$$

where we assume that Q is large.