MITES 2008 : Physics III - Oscillations and Waves :: Check-in Quiz 1.

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This check-in quiz tries to gauge your understanding of damped simple harmonic motion (SHM):

$$\frac{d^2x}{dt^2} + 2\gamma\frac{dx}{dt} + \omega_0^2 x = 0 \qquad \text{(EOM for damped SHM)} \tag{1}$$

Recall that $\gamma \equiv \frac{b}{2m}$, where b is a positive constant called *damping constant*, measuring the "strength" of dissipative force. Also recall that $\omega_0 \equiv \sqrt{\frac{k}{m}}$ is the *natural angular frequency.*

Problem A. The complex number equivalent EOM of (1) is

$$\frac{d^2z}{dt^2} + 2\gamma\frac{dz}{dt} + \omega_0^2 z = 0 \tag{2}$$

By guessing the solution of eq'n (2) to be $z(t) = Aexp(i\omega t)$, where A is an arbitrary constant, and ω is yet to be identified parameter, show that our guess $z(t)$ is indeed a solution of EOM as long as a certain condition is satisfied by ω. Derive what this condition is.

Problem B.: State the conditions for the following three regimes of damping, in terms of ω_0 and γ:

(i.) "Weak" damping (underdamped SHM).
(ii.) Critical damping.
(iii.) "Strong" damping (overdamped SHM).