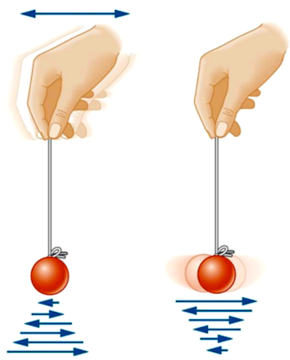
This class

Continue the topic : Driven Oscillations & Resonance



1. Finish Tutorial
2. Response to periodic driving forces: amplitude and phase.
3. Resonance: concept, Q factor

Consider the general solution for an underdamped, driven oscillator:

Which term dominates for large t?

$$x(t) = \underbrace{C_1 e^{-\beta t} e^{+\sqrt{\beta^2-\omega_0^2}\,t}}_{\text{term A}} + \underbrace{C_2 e^{-\beta t} e^{-\sqrt{\beta^2-\omega_0^2}\,t}}_{\text{term B}} + \underbrace{A\cos(\omega t-\delta)}_{\text{term C}}$$

D) Depends on the particular values of the constants

Challenge questions: Which term(s) matters most at small t? Which term “goes away” first?

2

Consider the amplitude

$$A^2 = \frac{f_0^{\ 2}}{(\omega_0^2 - \omega^2)^2 + 4\beta^2\omega^2}$$

In the limit as ω goes to infinity, A

A. Goes to zero
B. Approaches a constant
C. Goes to infinity
D. I don't know!

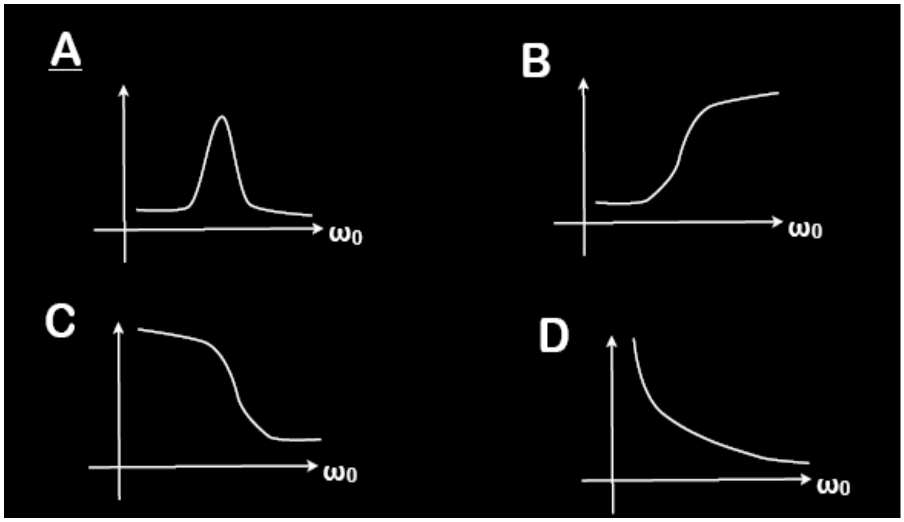
Consider the amplitude

$$A^2 = \frac{f_0^{\ 2}}{(\omega_0^2 - \omega^2)^2 + 4\beta^2\omega^2}$$

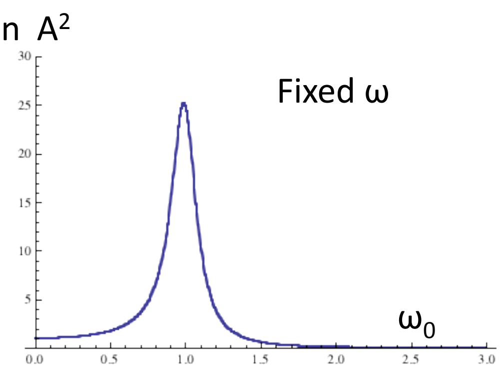
In the limit of no damping, A

A. Goes to zero
B. Approaches a constant
C. Goes to infinity
D. I don't know!

What is the shape of $$A = \frac{1}{\sqrt{\left(\omega_0^2 - \omega^2\right)^2 + 4\beta^2\omega^2}}$$



If you have a damped, driven oscillator, and you increase damping, β, (leaving everything else fixed) what happens to the curve shown?



A) It shifts to the LEFT, and the max value increases.
B) It shifts to the LEFT, and the max value decreases.
C) It shifts to the RIGHT, and the max value increases.
D) It shifts to the RIGHT, and the max value decreases.
E) Other/not sure/???

6

$$L\frac{d^2Q}{dt^2} + R\frac{dQ}{dt} + \frac{Q}{C} = 0$$

Given the differential equation for an RLC circuit, which quantity is analagous to the damping term in a mechanical oscillator?

A) R, resistance
B) L, inductance
C) C, capacitance

Challenge questions: Which quantity is analogous to the mass

7

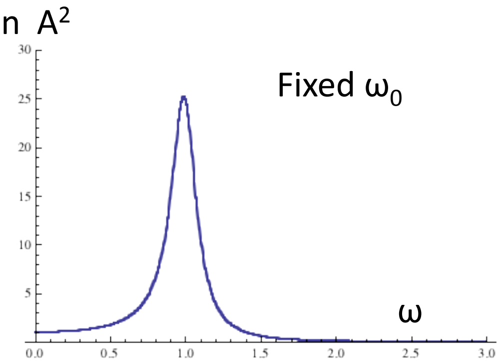
$$L\frac{d^2Q}{dt^2} + R\frac{dQ}{dt} + \frac{Q}{C} = 0$$

What is ω_0?

A) C
B) 1/C
C) 1/Sqrt[C]
D) 1/LC
E) 1/Sqrt[LC]

8

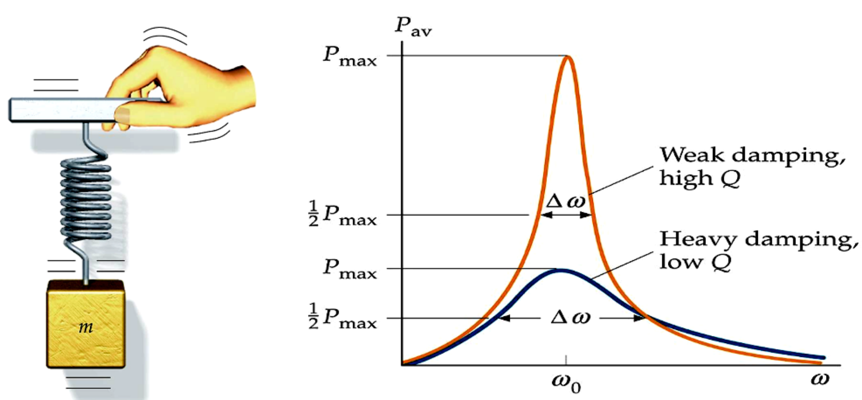
If you have a damped, driven oscillator, and you increase damping, β, (leaving everything else fixed) what happens to the curve shown?



A) It shifts to the LEFT, and the max value increases.
B) It shifts to the LEFT, and the max value decreases.
C) It shifts to the RIGHT, and the max value increases.
D) It shifts to the RIGHT, and the max value decreases.
E) Other/not sure/???

9

Driven Oscillations & Resonance



The Q-factor characterizes the sharpness of the peak

Can you break a wine glass with a human voice if the person sings at precisely the resonance frequency of the glass?

A) Sure. I could do it
B) A highly trained opera singer might be able to do it.
C) No. Humans can't possibly sing loudly enough or precisely enough at the right frequency. This is just an urban legend.

Myth Busters video http://video.google.com/videoplay?docid=7765557442856739526#