0. **(0 points)** /opt/webwork/webwork2/conf/snippets/ASimpleCombinedHeaderFile.pg

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Assignment PHY141_WW6 due 10/21/2022 at 11:59pm EDT

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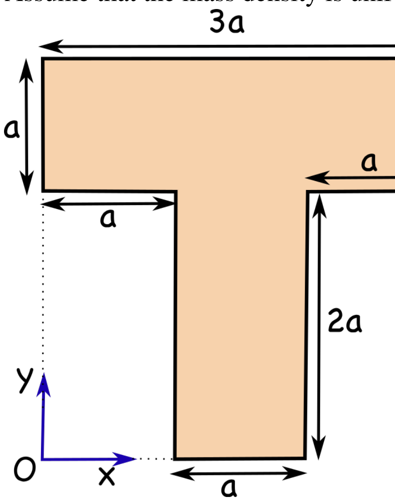
1. **(2 points)** setPHY141_WW6/T.pg

On superposition and center of mass

Calculate the center of mass of the object shown below.
Assume that the mass density is uniform.



The origin, O, is at the lower left. If the positive x-axis points to the right along the page, what is the x coordinate of the center of mass in terms of distance a?

Enter x coordinate of center of mass: _____ a.

If the positive y-axis points up along the page, what is the y coordinate of the center of mass in terms of a?

Enter y coordinate of center of mass: _____ a.

(Enter numbers accurate to 1 decimal place).

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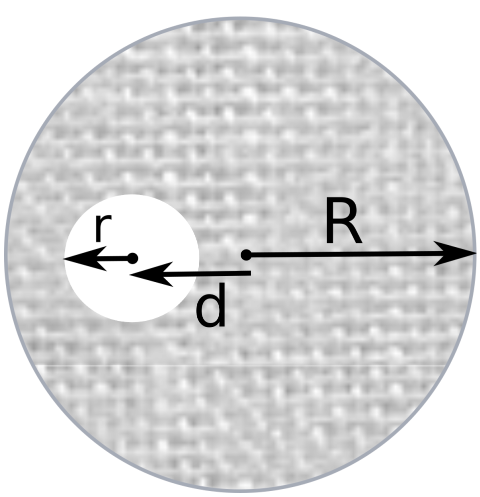
2. **(2 points)** setPHY141_WW6/disk.pg

On superposition and center of mass



A circular steel plate disk of radius $R = 1.5$ m, thickness $h = 0.01$ m, and density $\rho = 7000$ kg/m^3 has a circular hole of radius $r = 0.8$ m located halfway between the center and circumference of the disk (at $d = R/2$ from the center of the disk). Find the distance of the center of mass of the steel disk from its center.

Enter $d_{cm} =$: _____ m

How far is the center of mass from the center of the hole?

Enter this distance : _____ m

(Enter numbers correct to 2 decimal places) Check your signs!

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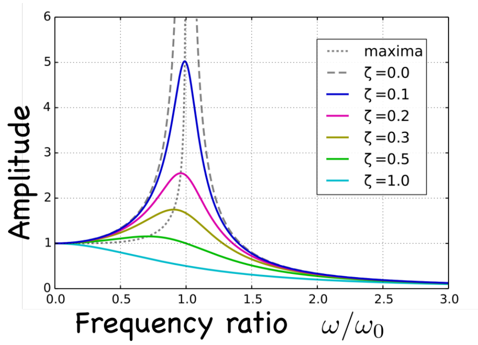
3. **(2 points)** setPHY141_WW6/driven_harmonic.pg

On a damped driven harmonic oscillator



The amplitude of a damped driven harmonic oscillator as a function of frequency. The x axis in this plot is the frequency ratio ω/ω_0 where ω is the driving frequency and ω_0 is the resonant frequency. The y axis shows the amplitude of the steady state sinusoidal solution (after transients have died away). Here ζ is a damping parameter. If the damping is low, the oscillator has a very large amplitude. The figure is from Wikimedia Commons.

The equation of motion for the driven harmonic oscillator (where motion is along the coordinate x) is

$$\frac{d^2x}{dt^2} + 2\zeta\omega_0\frac{dx}{dt} + \omega_0^2 x = \frac{F}{m}\sin(\omega t)$$

Here F is the driving force amplitude. The harmonic oscillator's natural frequency $\omega_0 = \sqrt{k/m}$ where k is a spring constant and m is the mass.

After reaching a steady state, the solution can be written like
$x(t) = A\sin(\omega t + \phi)$
with positive amplitude A and phase ϕ.

How does the amplitude of the peak depend on the damping parameter ζ?

To answer this we, drive the oscillator near peak or its resonant frequency, at $\omega = \omega_0$.

To make the calculation simpler we set the oscillator's resonant frequency $\omega_0 = 1$.

a) At $\omega = \omega_0 = 1$ what is the amplitude A in terms of m, F, ζ ?
Enter $A =$: _____
You need to enter a formula.
For example $m\zeta$ would be entered as m*zeta
F/ζ would be entered as F/zeta
$2F$ would be entered as 2*F
2π would be entered as 2*pi
$\frac{x}{yz}$ would be entered as x/(y*z)
help (formulas)
You would find A by inserting the solution into the equation of motion.
b) What is the phase ϕ?
Enter $\phi =$: _____ radians
Enter an angle in radians within $[0, 2\pi)$

It make be useful to use the sum formula $\sin(x+y) = \sin x \cos y + \cos x \sin y$.

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4. **(2 points)** `setPHY141_WW6/jupiter.pg`
On the center of mass of a star and planet system

Jupiter is in orbit about the Sun. Assume a mass ratio $M_J/M_\odot = 10^{-3}$ where M_J is the mass of Jupiter and $M_\odot = 2 \times 10^{30}$ kg is the mass of the Sun.
The distance between Jupiter and the Sun is approximately constant and is $a_J = 5.2$ AU where AU is an astronomical unit.
1 AU $\approx 1.5 \times 10^{11}$ m.
Compute the distance $r_\odot$ between the center of mass of the Sun-Jupiter system and the center of the Sun in meters.
Enter the distance $r_\odot$: _____ m
(Enter numbers correct to 1 decimal places)