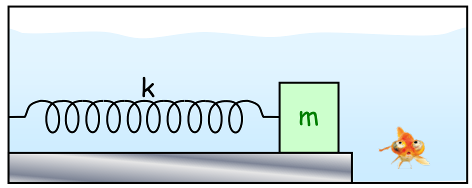
TM5 *3-2* Altered: Allow the motion of a *100 g* mass attached to a $k = 10^4$ *dyne/cm* initially displaced *3 cm* from the equilibrium point and released from rest to take place in a resisting medium. After oscillating for $10\tau_S$ (10 system periods), the maximum amplitude decreases to half the initial value. Find the

a) natural frequencies & period (ω_N, f_N, & τ_N) and

b) damping parameter β, and system frequencies and period (ω_S, f_S, & τ_S). Compare the with the undamped & damped values. 1 d = 1 g-cm/s^2 = 10^{-5} N but don't convert! **Stay in cgs!**

m =	100 g		
k =	1.00E+04 d/cm		
A_0 =	3 cm		
$A(n\tau_S)$ =	0.5 A_0		
n =	10		
R =	$A_0/A(10\tau_S)$ =	1/(1/2) =	2



a)

$$\omega_N = \frac{\sqrt{k}}{\sqrt{m}} = \mathbf{10.00}\ s^{-1}$$

$$\nu_N = \frac{\omega_N}{2\pi} = \mathbf{1.591549\ Hz}$$

$$\tau_N = \frac{1}{\nu_N} = \mathbf{0.628319\ s}$$

$$\beta^2 = \frac{[\ln(R)]^2}{(2\pi n)^2}[(\omega_n)^2 - b^2] = \frac{0.693147}{1974.614} = 0.000351\ s^{-1}$$

$$\beta = \mathbf{0.018736}\ s^{-1}$$

$$\beta^2/[2(\omega_N)^2] = 1.755E\text{-}06$$

b)

$$\omega_S = \sqrt{[(\omega_n)^2 - \beta^2]} = \mathbf{9.999982}\ s^{-1}$$

$$\nu_S = \frac{\omega_S}{2\pi} = \mathbf{1.591547\ Hz}$$

$$\nu_S/\nu_N = \mathbf{99.99982\%}$$

or

$$\nu_S = \nu_N\{1-\beta^2/[2(\omega_N)^2]\} = \nu_N\{1 - 1.755 \times 10^{-6}\}$$ **TINY Difference!!**

$$\tau_N = \frac{1}{\nu_S} = \mathbf{0.628320\ s}$$

The damping shortens the period by 0.00001 seconds!!