Family Name, Given Name (Please print)	Student Number	Tutorial Leader's Name

PHY293 – Oscillations – Practice Midterm

September 28, 2010

PLEASE read carefully the following instructions.

Aids allowed: A non-programmable calculator without text storage.

Before starting, please **print** your name, tutorial group, and student number **at the top of this page and on the cover of your answer booklet**.

There are three questions on this midterm test. Each question is worth one-third of the total grade.

Partial credit will be given for partially correct answers, so show any intermediate calculations that you do and write down, **in a clear fashion**, any relevant assumptions you are making along the way.

POSSIBLY USEFUL EQUATIONS:

	Amplitude	Velocity	Power
Peak Frequency	$\omega = \omega_0\sqrt{1-1/(2Q^2)}$	$\omega = \omega_0$	$\omega = \omega_0$
Peak Value	$a_m = \frac{a_0 Q}{\sqrt{1-\frac{1}{4Q^2}}}$	$v_m = a_0\omega_0 Q$	$P_m = \frac{1}{2}ma_0^2\omega_0^3 Q$
General	$a(\omega) = \frac{a_0\omega_0^2}{\sqrt{(\omega_0^2-\omega^2)^2+(\gamma\omega)^2}}$	$v(\omega) = \frac{a_0\omega_0^2}{\sqrt{(\omega_0^2-\omega^2)^2/\omega^2+\gamma^2}}$	$< P(\omega) >= P_{\rm m}\frac{\gamma^2}{(\omega_0^2-\omega^2)^2/\omega^2+\gamma^2}$
	$\tan\delta = \frac{\omega\gamma}{(\omega_0^2-\omega^2)}$		$< P >= P_{\rm m}\frac{\gamma^2/4}{(\omega_0-\omega)^2+\gamma^2/4} \quad Q \gg 1$

Do no separate the two stapled sheets of the question paper. Hand in the question sheets with your exam booklet at the end of the test.

Good luck!

1. Explain succinctly (ie. in three sentences or less) the meaning *and* significance of each of the following, in the context of harmonic oscillations we've discussed in this class. Your answer should make clear not only what the term, or concept, *is*, but also put it in the context of this course and make it clear why it is *important*.

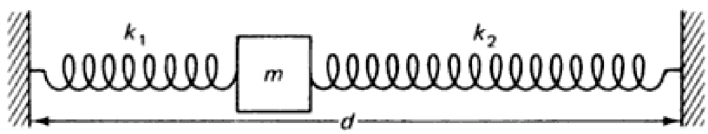
   (a) Natural frequency;

   (b) Resonance in an LRC circuit;

   (c) Power resonance;

   (d) The Q of an oscillator.

2. Suppose that a mass m is attached between two walls a distance d apart:



   The springs have spring constants k_1 and k_2 and equilibrium lengths l_1 and l_2, respectively.

   (a) Is it necessary for $d = l_1 + l_2$, if not, why not?

   (b) Derive an expression for the equilibrium position of the mass between the walls, x_{equil}.

   (c) If the springs were identical ($k_1 = k_2$ and $l_1 = l_2$) where would you expect the equilibrium position to be? Show that your result from part (b) agrees with this physical intuition.

   (d) By considering the forces on the mass (you can assume it slides on a frictionless surface) derive the equation of motion and show that it will execute simple harmonic motion.

   (e) What is the period of oscillation for this mass?

   (f) How does the period of oscillation depend on d?

3. An object of mass 1 kg hangs from a spring of negligible mass. The spring is extended by 5 cm when the object is attached. The top end of the spring is oscillated up and down in a simple harmonic manner with an amplitude of 2 mm. The Q of the system is 25.

   (a) What is the natural frequency ω_0 for this system?

   (b) What is the (distance) amplitude of the forced oscillations of the mass at $\omega = \omega_0$?

   (c) What is he mean power input to maintain the forced oscillations at a frequency that is 1% greater than ω_0? [You can use the near-resonance approximation we discussed in class]