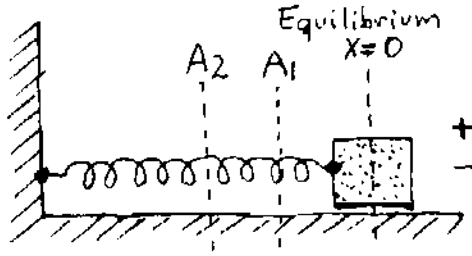
PHYSICS 116A
WINTER 1993
O.E.VILCHES

FIRST MIDTERM

YOUR NAME..

Please don't forget to write your name!!!! This test has one "choose the right picture" question, 9 multiple choice questions, and 2 relatively short problems. There is no penalty for choosing the wrong answer in the multiple choice questions. You should not spend more than 15 minutes in the picture and questions part, so you have adequate time to work the problems. In the problems, show your work. Partial credit will be given for right method or portions. You can work this test in any order you like. The scoring for the test is on the last page, 2nd problem.

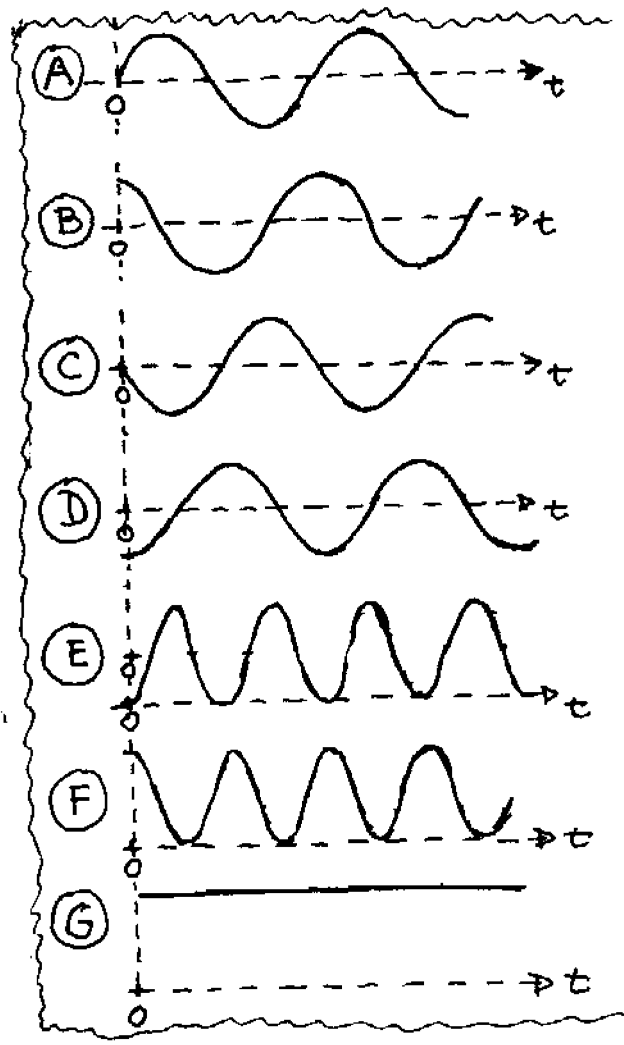
The first three questions refer to the same picture at right.



A simple harmonic oscillator is made of a spring (k) and a mass (M) permanently attached to the spring and able to slide on a frictionless surface. In a first try, the motion is started by compressing the spring to position A1 at time t = 0 when M is released. When the mass goes through the equilibrium position, its speed is V1.

QUESTION 1 (1 point for each right answer)

Some of the graphs on the right represent the statements below. Write the graph letter corresponding to each statement in the box at the end of the statement.



a) Position (x) of M versus time (t)

b) Velocity (v) of M versus time (t)

c) Acceleration (a) of M versus time (t)

d) Potential Energy (PE) of the system vs time (t)

e) Kinetic Energy (KE) of the system vs time (t)

f) Total Mechanical Energy (TME) of the system versus time (t)

In a second try, the spring is compressed to position A2 twice as far as A1 from the equilibrium position. After release, the velocity of the mass when it goes by the equilibrium position is V2.

QUESTION 2 (circle right answer)

The relationship between the velocities of the second and first tries when the mass goes by the equilibrium position is:

a) V2 = 4 V1   b) V2 = 2 V1   c) V2 = V1

d) $V_2 = \frac{1}{2}V_1$ e) $V_2 = \frac{1}{4}V_1$

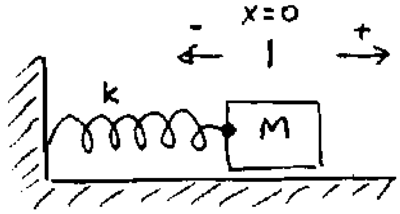
Phys 116
Summer 1994
O. E. Vilches

FIRST MIDTERM

Name...

Please do not forget to write your name!!!! This first midterm consists of 3 problems and a few questions. It may be worked out in any order. The problems have several sections. Partial credit will be given in most of the problems. The scoring for this test is summarized in the last page.

PROBLEM 1 (30 points)



The picture at right shows a simple harmonic oscillator constructed with a mass M and a spring of spring constant k=20 N/m. For parts (a) through (d) neglect friction. Write on back of this page if you run out of space.

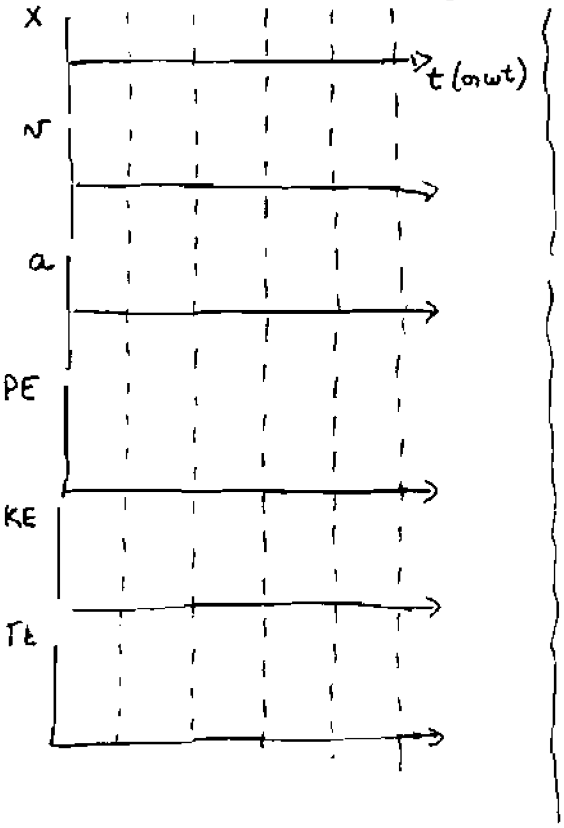
(6) a) Calculate M so the period of oscillation is 0.5 s.

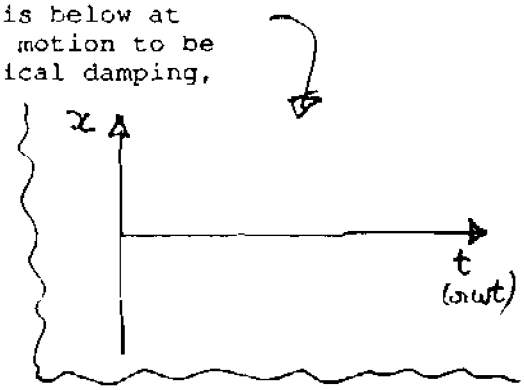
(6) b) Oscillations are started at x=0 and t=0 by giving a sharp tap to M to the right so the initial velocity is 0.2 m/s. Calculate how far the mass will move to the right of x=0 before it stops.

(6) c) How long does it take for the mass to travel from the center to the point furthest to the right? Write one line to explain your numerical answer.

(6) d) In the axis at left below, make qualitative graphs of the position, velocity, acceleration, kinetic energy, potential energy, and total energy corresponding to the motion of this particular oscillator.

(6) e) Now assume that there is friction between the mass and the surface where it slides. Imagine that the motion is started by pulling the mass to the right of zero (to say x=0.03m) and let go at t=0. In the axis below at right, superimpose three graphs showing what you expect the motion to be if the friction is small (underdamped), just right for critical damping, or the friction is large (overdamped).

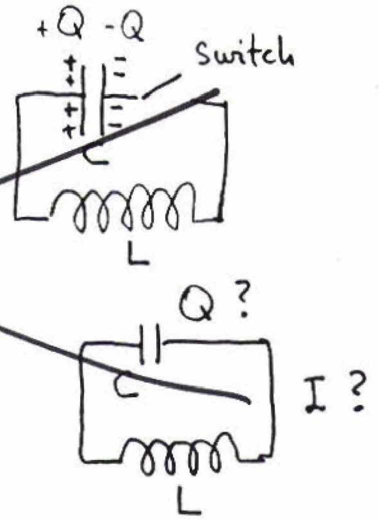




3 QUESTION 1

The capacitor in the circuit at right (top) has an initial charge Q of the sign indicated. At time t=0 the switch is closed. The circuit will generate charge and current oscillations of period T.

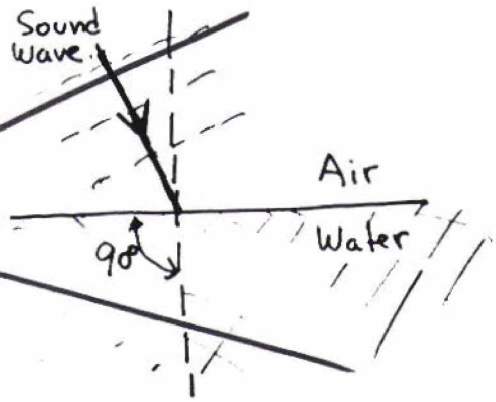
The "blank" circuit (bottom) is the same circuit but at time t=(3/4)T. Indicate with + and - signs, or write zero, what you expect the charge in the capacitor to be, and put arrows (⟶ or ⟵) or write zero (if there is none) for what you expect the direction of the current to be at this time of t=(3/4)T.



(2)

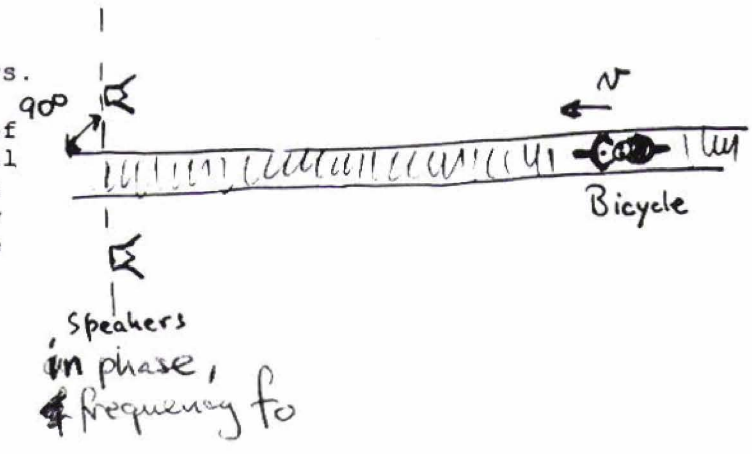
8 QUESTION 2

A sound wave emitted in the air is sent to an underwater detector. Sketch at right what you expect the sound wave to do at the air-water surface



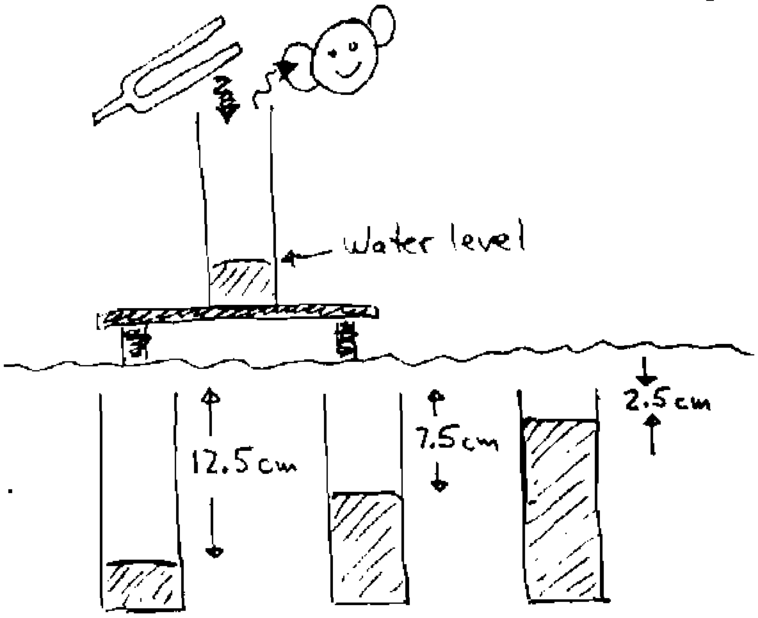
10 QUESTION 3

Two speakers are placed at equal distances from a straight bicycle path which is at 90 degrees from the line joining the speakers. Do you think a cyclist coming towards the speakers along the path will hear 1) sound of higher frequency, 2) beats, and/or 3) spatial constructive and destructive interference as she/he approaches the speakers? Write a very short sentence explaining your answer to the three topics mentioned



PROBLEM 2 (22 points)

A tunning fork generates a pure note at its fundamental frequency f. A Physics 116 student, with help from data in the formula page, decides to measure f by generating standing waves in a pipe which can be slowly filled with water. The student listens at the open end of the pipe and can clearly detect antinodes when the water level is at 12.5, 7.5, and 2.5 cm from the top.



6 a) In the three pictures of the pipe at right, sketch the standing wave patterns being set up at each water level. These are amplitude (not pressure) patterns.

8 b) Calculate f.

8 c) Imagine that the air above the water is replaced by helium gas. Calculate (again with help from the formula page) the distance between water levels when strong consecutive antinodes are heard.

Answers to sample problems.

Winter 1993

Question 1 (like a "multiple choice")

(a) D (b) A (c) B (d) F (e) E (f) G

Question 2 (a)

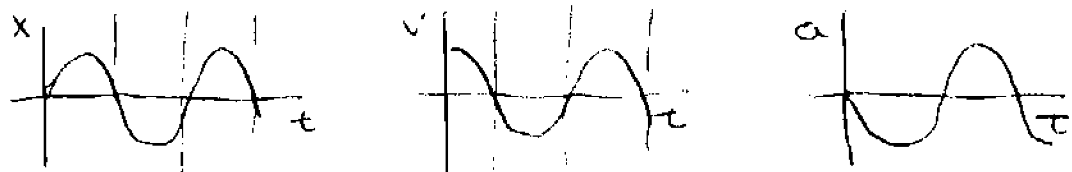
Summer 1994 Problem 1

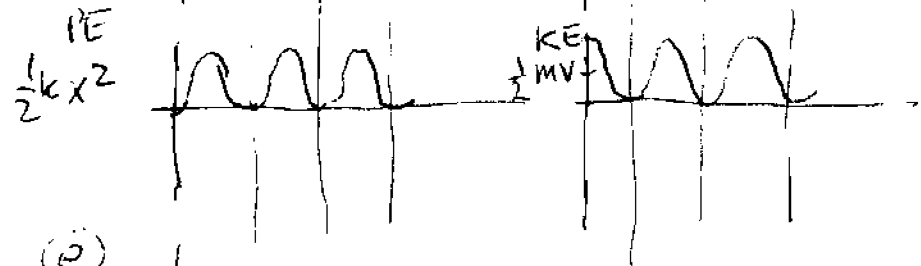
(a) $T = 2\pi\sqrt{\frac{M}{k}} \Rightarrow \frac{T^2}{4\pi^2}k = M$

(b) Use conservation of energy $\frac{1}{2}Mv_i^2 = \frac{1}{2}kA^2$ and calculate A.

(c) The time is $\frac{1}{4}$ of the period of oscillation $\Rightarrow \Delta t = \frac{1}{4}T$

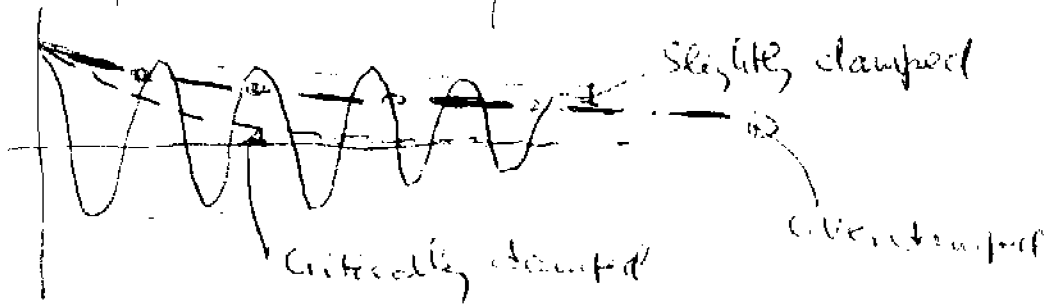
(d)





$E = PE + KE = \text{constant}$
$= PE_{max} = KE_{max}$

(e)

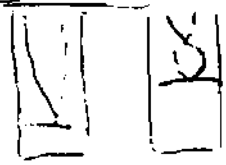


Question 3 (a) Source stationary, moving receiver towards source

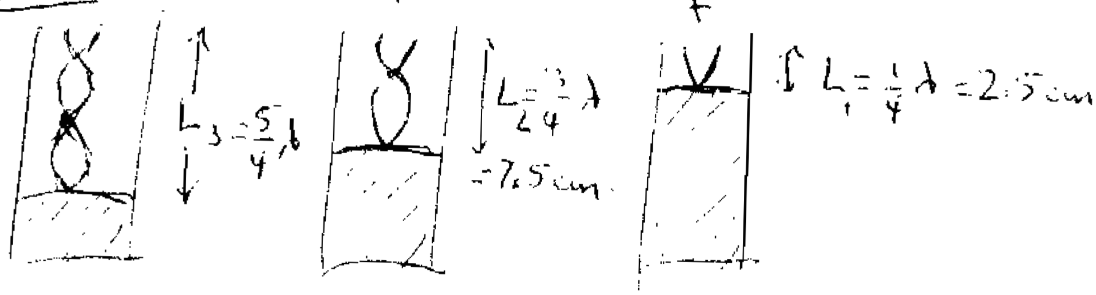
For (b) one needs two different frequencies - For (c) one needs different path lengths

Problem 2

(a)



Problem 2



(a) Since f is the same and v_{sound} (air) is the same (343 m/s) then λ is the same. So student is setting (or hearing) the fundamental and the next two odd harmonics.

(b) One can use anyone to calculate f

$$f = \frac{v}{\lambda} = \frac{343 \text{ m/s}}{4 \times 2.5 \times 10^{-2} \text{ m}} = 3430 \text{ Hz}$$

or $$f = \frac{343 \text{ m/s}}{4 \times 0.075 \text{ m}} \times 3 = 3430 \text{ Hz}, \text{ etc}$$

(c) Speed of sound in Helium gas is 965 m/s. For the same frequency of part (b) the new distances are

$$L_1 = \frac{1}{4}\lambda = \frac{1}{4} \times \frac{965 \text{ m/s}}{3430 \text{ Hz}} = 0.07 \text{ m}$$

$$L_2 = \frac{3}{4}\lambda = \frac{3}{4} \frac{965 \text{ m/s}}{3430 \text{ 1/s}} = 0.21 \text{ m} \quad \text{etc} \ldots$$