Family Name (Please **print in BLOCK LETTERS**)	Given Name(s) **as on student card**	Student Number	Tutorial Group Code (*eg*. FAx)

PHY138Y

Second-Quarter Test — version 2

Tuesday, December 5, 2006

Duration - 80 minutes

PLEASE read carefully the following instructions.

Aids allowed: A non-programmable calculator without text storage, and **one original**, **handwritten** 8.5 by 11 inch sheet of paper written on both sides.

- **Turn off** any communication device (phone, pager, PDA, iPod, etc.) you may have and place it on the floor.
- **DO NOT separate the sheets of your question paper.** Work lost or unattributable because of separated sheets will not receive any credit. You can, however, ¡b¿carefully¡/b¿ tear off the blank pages at the end, as they do not not have to be handed in.
- Before starting, please **PRINT IN BLOCK LETTERS your name, student number, and tutorial group code** at the top of this page **and** on the answer sheet.
- Check that the test-version numbers at the top right of the answer sheet and in the title of your test paper match. If they do not, call an invigilator; if they do, **do not write anything on or near the circles**.

Scanned Area of the Answer Sheet:

1. **Use a dark-black, soft-lead pencil**.
2. Mark in your student number by shading the circles in the student number area.
3. Indicate your answer to a multiple-choice question by **thoroughly** filling the appropriate circle on the answer sheet and also by recording your answer on the test paper.
4. If you wish to modify an answer, erase your pencil mark thoroughly. Do not use white-out.
5. **Do not write anything else on the answer sheet.** Use the blank sheets at the end or the back of the question sheets for rough work.

The exam has **9** equally weighted multiple-choice questions, worth **63** marks in total, plus one multi-part problem worth **37** marks, for which fully worked solutions are required.

Multiple-choice questions:

- Each question has five possible answers, only one of which is correct.
- Each correct answer is awarded **7** marks.
- Blank or incorrect answers are ignored.
- Multiple answers for the same question are marked as incorrect.

Long-answer Problem: To be awarded maximum credit, you must provide fully worked solutions to all parts of the long-answer problem. In addition to showing your work, please put your answer(s) for each part in the boxes provided. You can use the back-side of the sheets and the blank pages at the end for your rough work which will not be graded or taken into account.

When the invigilators declare the test ended, **stop any writing or filling of circles** on the answer sheet immediately. Please put your answer sheet **inside your test paper** and have the paper ready for an invigilator to pick up.

Good luck!

MULTIPLE CHOICE (63 marks total)

Constants: In all questions you make take the acceleration due to gravity to be $g = 9.80$ m/s^2 and the speed of sound in air to be $v = 344$ m/s.

Question 1

What is the error in the quantity T^2/D for an oscillating metal hoop if T = period = 3.51 ± 0.05 s and D = mean diameter = 38.3 ± 0.2 cm?

(A) 0.5 s^2/m (B) 0.03 s^2/m (C) 2 s^2/m (D) 30 s^2/m (E) 0.9 s^2/m

Question 2

[Based on a question from *Examkrackers 1001 Questions in MCAT Physics* by Jonathan Orsay, Osote Publishing 2nd edition © 2001] Isaac Newton explained that light particles are strongly attracted to the surface of glass so that when they approach the surface from an angle, they receive an impulse that increases the component of their velocity perpendicular to the surface. This was most likely an attempt to use the particle theory of light to explain:

(A) diffraction (B) interference (C) reflection (D) absorption (E) refraction

Question 3

A massless spring is standing upright on a table with its bottom end fastened to the table. A block is held at a height of 2.0 cm above the top of the spring, and released from rest. The block sticks to the top end of the spring and then oscillates with an amplitude of 15.0 cm. You may assume that total energy of the system is conserved throughout the motion. What is the oscillation period, in seconds?

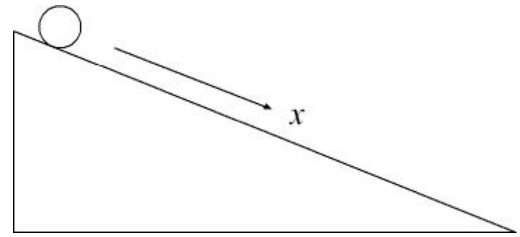
(A) 0.73 (B) 0.55 (C) 1.8 (D) 2.5 (E) 0.77

Question 4

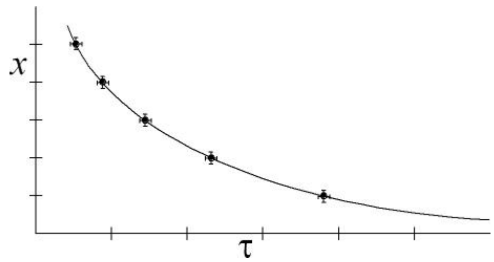
Two harmonic waves traveling in opposite directions interfere to produce a standing wave described by $y = 3 \sin(2x) \cos(5t)$ where x is in m and t is in s. What is the approximate wavelength in m of the interfering waves?

(A) 1 (B) 3 (C) 12 (D) 2 (E) 6

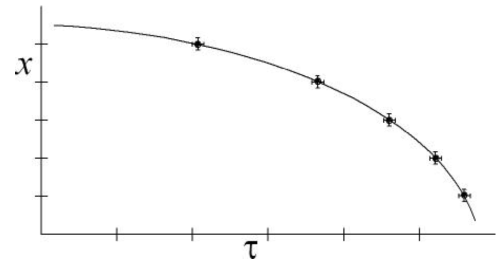
Question 5



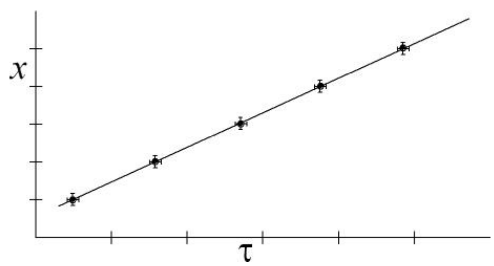
In your Acceleration experiment this semester you used a photogate to measure the passage time, τ, for the small ball at approximate positions x = 10, 20, 30, 40, and 50 cm. The photogate produces a beam of light that passes from one arm of the photogate to the other. When you place the device in GATE mode, it begins timing if the beam is interrupted by an object entering the gate and stops timing when the object exits the gate. The duration of time the ball spends in the gate is τ. The diameter of the ball is small compared to all values of x. Which of the following graphs most closely resembles the correct graph of x versus τ ?



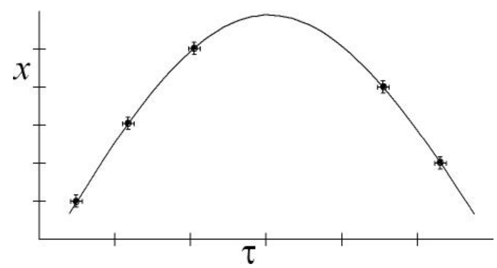
(A)



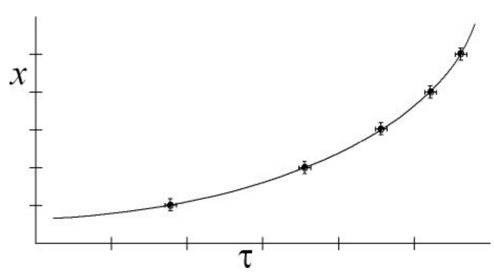
(B)



(C)



(D)



(E)

Question 6

A mass is pushed against a spring, compressing the spring from its equilibrium position. The mass sits on a frictionless surface. Which of the following accurately describes what will happen to the mass after it is released from rest, but before the spring reaches its equilibrium position?

(A) The magnitudes of the velocity and acceleration will continually increase.
(B) The magnitudes of the velocity and acceleration will continually decrease.
(C) The magnitude of the velocity will continually increase while the acceleration will remain constant.
(D) The magnitude of the velocity will continually decrease while the magnitude of the acceleration will continually increase.
(E) The magnitude of the velocity will continually increase while the magnitude of the acceleration will continually decrease.

Question 7

A speaker emits a very short single pulse of sound in all directions with a total power of 1.5×10^{-3} W. The pulse is emitted at time $t = 0$. At what time will the pulse have an intensity of 1.0×10^{-12} W/m^2 (the threshold of human hearing)?

(A) 64 s (B) 32 s (C) 3.4×10^{5} s (D) 6.8×10^{5} s (E) 1.1×10^{4} s

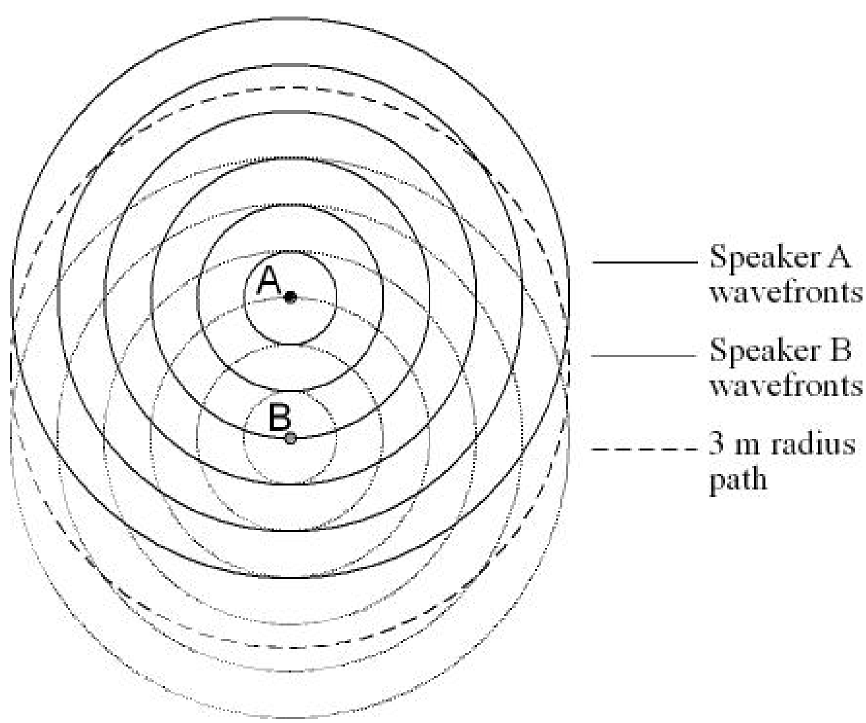
Question 8

A stationary speaker emits periodic pulses of sound into the air every 0.055 seconds. If you travel away from the speaker at a speed of 75 m/s, what will be the time between successive pulses that you hear?

(A) 0.045 s (B) 0.043 s (C) 0.067 s (D) 0.070 s (E) 0.055 s

Question 9

Two speakers, A and B, sit 1.5 m apart in the centre of a large room. They both emit a pure note, in phase, with a wavelength of 0.50 m. A large circle is traced out in the room, centred on the point between the two speakers, with a radius of 3 m. If an observer walks around the circle the sound intensity will rise and fall as she crosses the antinodal and nodal lines. If the observer walks around the complete circle, how many antinodal lines will she cross?



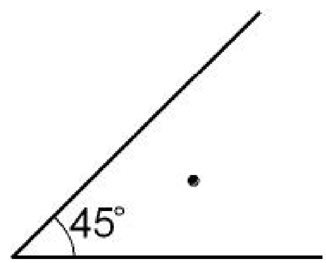
(A) 8
(B) 6
(C) 12
(D) 15
(E) 10

LONG ANSWER (37 marks total)

You must show correct reasoning for your answer in the space provided. A correct final answer without correct reasoning shown will not be awarded full credit. Use the thin lens approximation in all parts which involve lenses.

PART A (6 points):

Two plane mirrors intersect with an angle of 45°, as seen from above in the diagram below. A small circular object sits between them. How many images of the object will form? Please sketch the approximate locations of these images in the diagram.



Number of images =

Part B (10 points)

You wish to make a lens that is perfectly flat (no curvature) on one side, and has a focal length of −20 cm, using glass with index of refraction $n = 1.50$. What should be the radius of curvature of the other side, and should it be concave or convex (circle one in the box)?

$R =$
CONCAVE / CONVEX

Parts C and D both concern the following situation: A viewing screen sits parallel to the y-z plane at $x = 0$. A 1.0 cm tall object sits on the x-axis at $x = 110$ cm. A diverging lens with focal length −20 cm is centred on the x-axis, with its optical axis along the x-axis, at $x = 90$ cm.

Part C (10 points)
At what value of x will the image form? Is it a real or virtual image (circle one in the box)?

x_{object} =
REAL / VIRTUAL

Part D (11 points)
You wish to add a second lens to this system which will form an image on the screen that is well focused and 2.0 cm tall. What should be the position and focal length of the second lens? Will the final image be upright or inverted (circle one)?

x_{lens} =
f_{lens} =
UPRIGHT / INVERTED