Family Name (Please **print in BLOCK LETTERS)**	Given Name(s) **as on student card**	Student Number	Tutorial Group Code (F1C or F3C)

PHY132H1F
Test 1 —version 1
Tuesday, October 6, 2009
Duration: 50 minutes

PLEASE read carefully the following instructions.

Aids allowed: A non-programmable calculator without text storage. A single, hand-written aid-sheet prepared by the student, no larger than 8.5"x11", written on both sides.

- **Turn off** any communication device (phone, pager, PDA, iPod, etc.) you may have and place it far from where you are sitting.

- **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, "carefully" tear off the blank page at the end, as it does 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 under the shaded circle 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 or a black pen.**
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, or use dry tape white-out sparingly.
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 test consists of **5** multiple-choice questions, worth 2 points each, or altogether 10 points. The test also has a set of free-form questions worth 8 points, for which fully worked solutions are required. The total possible number of points is 18.

Multiple-choice questions:

- Please choose the best answer.
- Blank or incorrect answers are worth zero points.
- Multiple answers for the same question result in zero points for that question.

Free-form Questions: To be awarded maximum credit, you must provide fully worked solutions to all parts of the free-form questions. 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.

Possibly useful constants, conversions and equations:
The speed of sound in air (unless otherwise specified): $v = 343$ m/s
Quadratic equation: If $ax^2 + bx + c = 0$, then $x = \dfrac{-b \pm \sqrt{b^2 - 4ac}}{2a}$
Planck's constant: $h = 6.63 \times 10^{-34}$ J s
1 nm = 10^{-9} m
Comfortable near-point for normal vision: $s = 25$ cm
2π radians = 360°
$\pi = 3.14159$

MULTIPLE CHOICE (10 points total)

1. Consider a string of total length L, made up of three segments of equal length. The mass per unit length of the first segment is μ, that of the second is 4μ, and that of the third is μ. The third segment is tied to a wall, and the string is stretched by a force of magnitude T_s applied to the first segment; T_s is much greater than the total weight of the string. How long will it take a transverse wave to propagate from one end of the string to the other?
   A. $2L\sqrt{\dfrac{\mu}{T_s}}$
   B. $\dfrac{L}{3}\sqrt{\dfrac{\mu}{T_s}}\left(\dfrac{3}{2}+\sqrt{2}\right)$
   C. $L\sqrt{\dfrac{\mu}{T_s}}\left(2+\sqrt{2}\right)$
   D. $\dfrac{4L}{3}\sqrt{\dfrac{\mu}{T_s}}$
   E. $\dfrac{L}{3}\sqrt{\dfrac{\mu}{T_s}}\left(1+\sqrt{\dfrac{3}{2}}\right)$

2. A form of sound-proofing is a wire mesh which is held at a fixed distance from a flat wall. When sound waves are normally incident on the wall, they first encounter the mesh. About half of the sound intensity is reflected, and half is transmitted. The transmitted sound waves can then travel the distance, d, reflect off the wall, travel the distance d again, and then combine with the original reflected sound from the wire mesh. If the two sound waves are exactly out of phase at this point, they will destructively interfere, reducing the total reflected sound intensity. If $d = 3.24$ cm, what is the minimum frequency for which the sound-proofing will work properly?
   A. 26 Hz
   B. 141 Hz
   C. 1110 Hz
   D. 2650 Hz
   E. 10,600 Hz

3. A fish tank whose bottom is a mirror is filled with water to a depth, d. A small fish floats motionless, a distance y under the surface of the water. The index of refraction of the water is n. What is the apparent depth of the reflection of the fish in the bottom of the tank when viewed at normal incidence?
   A. $\frac{2y-d}{n}$
   B. $\frac{d-y}{n}$
   C. $\frac{2d-y}{n}$
   D. $\frac{y}{n}$
   E. $\frac{d-y}{2n}$

4. Sanjay has hyperopia. The near point of his left eye is 110 cm. What power lens will restore normal vision? [Neglect the small space between the lens and his eye.]
   A. +3.1 D
   B. +3.3 D
   C. –3.3 D
   D. –3.1 D
   E. +0.91 D

5. Each photon in a dental X-ray has an energy of 12 keV, or 1.9×10^{-15} J. How many microwave photons with a frequency of 2.45×10^{9} Hz would have the same total energy as the energy of one dental X-ray photon?
   A. 5.4×10^{23}
   B. 1.2×10^{9}
   C. 1.9×10^{3}
   D. 5.4×10^{11}
   E. 9.7×10^{3}

FREE-FORM IN TWO UNRELATED PARTS (8 points total)

Clearly show your reasoning and work as some part marks may be awarded. Write your final answers in the boxes provided.

PART A (3 points)

A metal pipe, open at both ends, can create a standing wave in the second harmonic with a frequency of 483 Hz. What is the length of the pipe?

$L =$

PART B (5 points)

A 2.00 cm tall object and a viewing screen are held at a fixed distance of 1.20 m, and a focusing lens with diameter $D = 5.00$ cm and focal length $f = 0.250$ m is placed part-way between them. At what distance (or distances) must the lens be held away from the object in order to form a focused image on the viewing screen? What is the height of the image (or images)? [Please show solution within the box provided, and clearly draw a box around your final numerical answer or answers.]

ROUGH WORK (not marked)