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

UNIVERSITY OF TORONTO
Faculty of Arts and Science

DECEMBER 2009 EXAMINATION — version 2
PHY132H1F
Duration – 2 hours

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.

Before starting, please **PRINT IN BLOCK LETTERS your name, student number, and practical group code** at the top of this page **and** on the answer sheet.

DO NOT separate the sheets of your question paper, except the final 2 pages for "Rough Work" which may be removed gently. Your paper should have 9 pages including 2 blank sheets at the end. If this is not the case, call an invigilator.

Scanned Area of the Answer Sheet:

1. **Use a dark-black, soft-lead pencil or a black pen.**
2. **Print** your name, practical group code, and student number at the top of the sheet. **Locate your exam version number in the header at the top of the cover page, and shade in the corresponding version number on your answer sheet. No crosses, circles or ticks!**
3. Mark in your student number by shading the circles in the student number area.
4. Indicate the **most correct** answer to a multiple-choice question by **thoroughly** filling the appropriate circle on the answer sheet and also by recording your answer on the examination paper.
5. If you wish to modify an answer, erase your pencil mark thoroughly, or use dry tape white-out sparingly.
6. **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 examination consists of **12** multiple-choice questions, worth 2 points each, or altogether 24 points. The examination also has a set of free-form questions worth 16 points, for which fully worked solutions are required. The total possible number of points is 40.

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

Possibly useful constants and information:
Acceleration due to gravity near the surface of the Earth: $g = 9.80$ m/s^2
Speed of light in a vacuum: $c = 3.00 \times 10^8$ m/s.
The speed of sound in air (unless otherwise specified): $v = 343$ m/s
Mass of an electron: $m_e = 9.11 \times 10^{-31}$ kg
Fundamental unit of charge: $e = 1.60 \times 10^{-19}$ C
2π radians = 360°
$\pi = 3.14159$
Common Prefixes: nano- (n) = 10^{-9} , micro- (μ) = 10^{-6} , milli- (m) = 10^{-3}

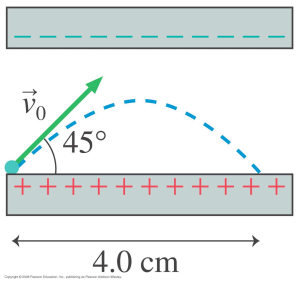
MULTIPLE CHOICE (24 points total)

1. Two harmonic waves, with the same frequency and amplitude, travel in opposite directions and interfere to produce a standing wave described by $y = 3 \sin(2x) \cos(5t)$, where x and y are in m and t is in s. What is the approximate wavelength in m of the interfering waves?
   A. 6
   B. 12
   C. 1
   D. 2
   E. 3

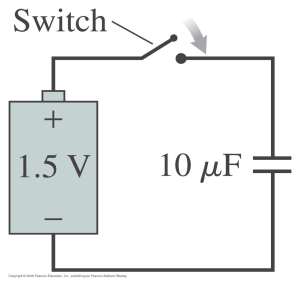
2. Electrons are sent through a double-slit apparatus, and an interference pattern is observed. If protons were sent through the same apparatus with the same speed as that of the electrons, the distance between the fringes would be
   A. the same.
   B. smaller.
   C. larger.

3. An electron is launched at an angle of $\theta = 45°$ and a speed of $v_0 = 5.0 \times 10^6$ m/s from the positive plate of a parallel-plate capacitor, as shown. The electron lands 4.0 cm away. The spacing between the plates is 2.5 cm. What is the voltage of the capacitor? [You may neglect the force of gravity on the electron in this problem.]

   A. 180 V
   B. 3.6×10^3 V
   C. 1.8×10^{-5} V
   D. 72 V
   E. 89 V



4. Initially, the switch shown is open and the capacitor is uncharged. How much charge flows through the switch after the switch is closed?



A. 6.7×10^{-5} C
B. 1.5 C
C. 1.5×10^{-6} C
D. 6.7×10^{-6} C
E. 1.5×10^{-5} C

5. A charged particle moving within a static, uniform magnetic field

A. may or may not experience a magnetic force, but this force, if it exists, can never cause the particle's speed to change.
B. will never experience a magnetic force.
C. will always experience a magnetic force, and this force can cause the particle's speed to change.
D. will always experience a magnetic force, but this force cannot cause the particle's speed to change.
E. may or may not experience a magnetic force, and this force, if it exists, can cause the particle's speed to change.

6. How much work W must be done on a particle of mass m to accelerate it from a speed of 0.980 c to a speed of 0.990 c?

A. 5.03 mc^2
B. 7.09 mc^2
C. 1.03 mc^2
D. 1.44 mc^2
E. 2.06 mc^2

7. A mother hawk screeches as she dives at you, while you sit, stationary relative to the air. You recall from biology that female hawks screech at 750 Hz, but you hear the screech at 820 Hz. How fast is the hawk approaching?
A. 56 m/s
B. 660 m/s
C. 29 m/s
D. 32 m/s
E. 38 m/s

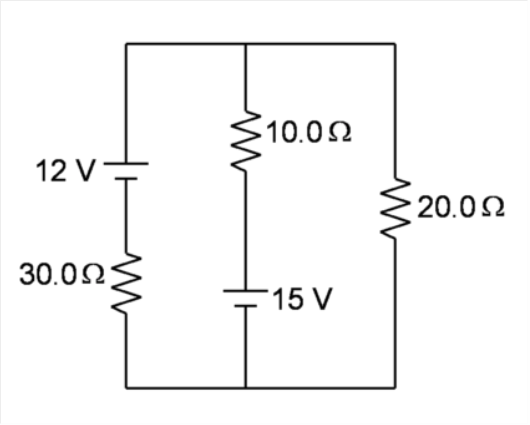
8. Martina has myopia. The far point of her left eye is 230 cm. What power lens will restore normal vision? [Neglect the small space between the lens and her eye.]
A. +0.91 D
B. +3.3 D
C. –3.3 D
D. –3.1 D
E. –0.43 D

9. Two point charges are located on the x-axis: one charge, $q_1 = -5$ nC, is located at $x_1 = -2$ m; the second charge, $q_2 = 7$ nC, is at the origin ($x_2 = 0$). What is the net force exerted by these two charges on a third charge $q_3 = 9$ nC placed at $x_3 = -1$ m?
   A. -1×10^{-6} N
   B. $+3 \times 10^{-5}$ N
   C. -500 N
   D. -3×10^{-5} N
   E. -5×10^{-7} N

10. What is the magnitude of the change in electric potential along the length of a 12 m long wire in the walls of your house? [The wire is made of solid aluminum, has a diameter of 2.0 mm, and carries 8.0 A of current. The resistivity of aluminum is 2.8×10^{-8} Ω m.]
   A. 6.8 V
   B. 19 V
   C. 0.21 V
   D. 0.86 V
   E. 1.6 V

11. What is the magnitude of the current through the 10.0 Ω resistor in the circuit shown?

   A. 0.55 A
   B. 5.0 A
   C. 0.020 A
   D. 0.20 A
   E. 0.46 A



12. Initially unpolarized light of intensity 350 W/m^2 travels through three polarizing filters. The axis of the first is vertical, the axis of the second is 30.0° from vertical, and the axis of the third is horizontal. What is the intensity of the light which emerges from the third filter?

   A. 180 W/m^2
   B. zero
   C. 33 W/m^2
   D. 44 W/m^2
   E. 66 W/m^2

FREE-FORM IN FOUR UNRELATED PARTS (16 points total)

Clearly show your reasoning and work as some part marks may be awarded. Please draw a box around your final answer for each question.

PART A (4 points)

An object is located 25.0 cm from a certain converging lens. The lens forms a real image that is exactly twice as high as the object.

1. What is the focal length of the lens?

2. Now replace the lens used in part A.1 with another lens. The new lens is a diverging lens whose focal points are at the same distance from the lens as the focal points of the first lens. If the object is 5.00 cm high, what is the magnitude of the height of the image formed by the new lens? The object is still located 25.0 cm from the lens.

PART B (3 points)

Two identical particles of mass m and charge q are very far apart, and traveling directly toward one another. When the distance between the particles is very large, they both have speed v. Assume v is much less than c. How close will the particles be to one another at the moment they stop, just before they turn around?

PART C (3 points)

CNFY "The Edge" broadcasts from the top of the CN Tower at 102.1 MHz with a power of 35 kW. Assume that the radiation is emitted uniformly in all directions. Here in this room at U of T, we are 2.1 km away from the top of the CN Tower.

1. What is the intensity of the CFNY signal in this room?

2. What is the electric field amplitude of the CFNY signal in this room?

PART D (6 points)

Earth and Mars are 7.8×10^{10} m apart at the closest approach in their orbits. Imagine a space shuttle which travels along this shortest straight line from Earth to Mars at a constant speed of 2.90×10^{8} m/s. [You may neglect the relatively small orbital velocities of Earth and Mars in this problem.]

1. How long does it take the shuttle to travel from Earth to Mars, as measured in the reference frame of the Sun?

2. How long does it take the shuttle to travel from Earth to Mars, as measured in the reference frame of an observer on the moving shuttle?

3. What is the distance from Earth to Mars, as measured in the reference frame of an observer on the moving shuttle?

ROUGH WORK (not marked)

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