SAMPLE EXAMINATION
April 2008

DURATION: 3 HOURS No. of Students: **250**

Department Name & Course Number: **Physics PHYS1008**
Course Instructor(s) P. J. S. Watson

AUTHORIZED MEMORANDA

one 8.5x11 sheet, calculator

Students MUST count the number of pages in this examination question paper before beginning to write, and report any discrepancy to a proctor. This question paper has 6 pages.

This examination question paper MAY NOT be taken from the examination room.

In addition to this question paper, students require: an examination booklet yes X no
a Scantron sheet yes X no

Useful constants :

1 eV =1.6 x 10^{-19} J ;
g = 9.81 ms^{-2}
G = 6.67 x 10^{-11}N $kg^{-2}m^2$
k = $1/(4\pi\varepsilon_0)$ = 8.99x 10^9 Nm^2C^{-2}
ε_0 =8.85x$10^{-12}$$N^{-1}m^{-2}C^2$
μ_0 = $4\pi x10^{-7}$ TmA^{-1}
Electron/proton charge |e| = 1.6 x 10^{-19} C.
Electron Mass m_e = 9.1x10^{-31} kg.
Proton Mass m_p = 1.67x10^{-27} kg.
Speed of light c = 3.0 x 10^8 m/s ;
Atomic Mass unit u = 1.66x10^{-27} kg = 931.5 MeV/c^2 ;
Speed of Sound = 330 m/s ;
Speed of light c = 3.0 x 10^8 m/s ;
Planck's constant h = 6.63 x 10^{-34} Js ;
Ionization energy of H, E = 13.6 eV ;

This examination has 2 parts:
Part I: **Multiple Choice Questions:** attempt all 20. 2 marks each**,** no penalty for incorrect answers.
Part II: Problems: attempt 3 out of 5: 15 marks each.

Part I: **Multiple Choice Questions:** attempt all 20. Mark the correct answer on the Scantron sheet. If you feel that none of the answers are correct, write down your answer with an explanation on this

Scantron Instructions for Students

REMEMBER THE FOLLOWING:
- Always use a DARK lead pencil (HB #2 works well)
- Completely erase any changed answers with a soft eraser
- Mark your answers firmly and neatly
- DO NOT staple, fold, tear or crumple the form.

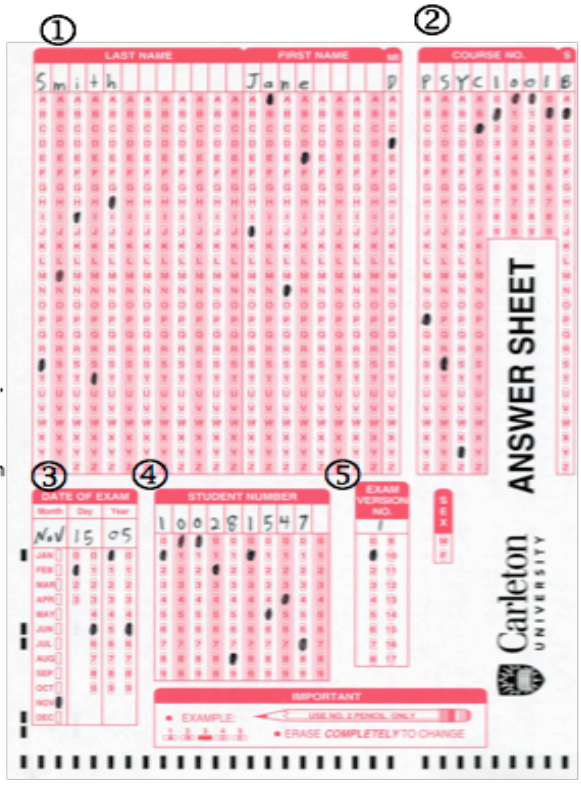
1) In the **FIRST NAME** and **LAST NAME** boxes CLEARLY PRINT your first and last name in the and fill in the appropriate boxes below.

2) The **COURSE NO**. field is for the full course code, i.e. "PSYC1001A". The first four boxes are for letters, the next four are numbers, and the last is for the section letter (A, B, V…). CLEARLY PRINT course code and fill in the appropriate boxes below.

3) In the **DATE of EXAM** boxes, CLEARLY PRINT the date of the exam and fill in the appropriate boxes below.

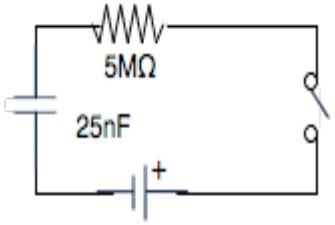
4) The **STUDENT NUMBER** field has ten spaces, please be sure to start at the left and CLEARLY PRINT your entire student number, including the '100', i.e., 100123456. This is an essential, but unfortunately frequently forgotten piece of identification. Instructors using the WebCT Gradebook to post their students' grades online require the entire nine digit student number, otherwise uploading the grades to WebCT may be problematic.

5) The **EXAM VERSION NO**. is used to indicate which version of the exam the student is writing. If the instructor has handed out different versions of the exam (either different questions or a different order), the EXAM VERSION NO. must be filled in, or the exam cannot be graded. If there is only one version of the exam, leave this box blank.



430 Tory Bldg, Carleton University, 1125 Colonel By Dr, Ottawa, Canada K1S-5B6;
Tel: 613.520.4433; Hours: 8:30 - 4:30 pm., Mon–Fri.; Email: edc@carleton.ca

1. A dipole consists of a charge of $1.6e^{-19}$C at x= 10^{-10} m and a charge $-1.6e^{-19}$C at x= -10^{-10} m . The electric potential at x = 10^{-9} m is
   a. 0 V
   b. $2.9x10^{8}$ V
   c. $-2.9x10^{8}$ V
   d. -0.29 nV
   e. 0.29 nV
2. A parallel-plate capacitor has an area of 0.2 m^2 with the plates separated by 30μ with air between the plates is connected across a 5V supply . The charge on it is
   a. 0.29 μC
   b. $3.33x10^{4}$ C
   c. 0.29 nC
   d. 20 μC
   e. 150 μC
3. An electron is in an electric field of $7x10^{3}$ Vm^{-1}. Its acceleration will be
   a. $1.23x10^{15}ms^{-2}$
   b. $1.23x10^{-15}ms^{-2}$
   c. $1.23x10^{5}ms$
   d. $1.23x10^{5}ms^{-2}$
   e. $1.23x10^{12}ms^{-2}$
4. A capacitor with C = 12 μF is connected to a V= 3.7 V battery. The energy stored in the capacitor, when it is fully charged is
   a. 82 nJ
   b. 82 μJ
   c. 82 J
   d. you need to know the area of the capacitor
   e. 4.4 μJ
5. A beam of protons in an accelerator moves at $3x10^{7}$ ms^{-1} and has a density of $2x10^{14}$ protons m^{-3}. If the area of the beam is $6x10^{-10}$ m^2 the current is
   a. 580 nA
   b. 58 A
   c. 12000 A
   d. 12 mA
   e. $1.2x10^{-14}$A
6. A circuit consists of a battery, a switch, a 25.0 nF capacitor and a 5.0 MΩ resistor as shown.



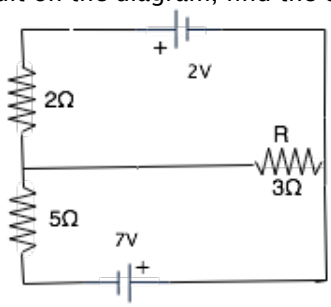
   When the switch is closed, the charge on the capacitor will reach 80% of its final value in
   a. 125 ms
   b. 1.29 s
   c. 125 s
   d. 5 ns
   e. 200 ms
7. A circuit has 3 resistors of 5Ω in series with a 8V battery. The total power consumed is
   a. .533 W
   b. 120 W
   c. 13.3 W
   d. 4.27 W
   e. 37 W

8. A loop of wire has an area of 5 cm^2 and has a constant magnetic field of 2 T passing through it at right angles. The induced EMF will be
    a. 0 V
    b. 1 mV
    c. 1000 V
    d. 10000 V
    e. 2.5×10^{-4} V
9. A circuit contains an inductance with L = 0.5mH, a resistance R = 10Ω and a capacitance of 7μF. The resonant frequency is at
    a. 16.9 kHz
    b. 1.69×10^8 Hz
    c. 1.69×10^4 Hz
    d. 2.69 MHz
    e. 2.69 kHz
10. If a material is diamagnetic it means that
    a. It is repelled by a magnetic field
    b. It is attracted by a magnetic field
    c. It will attract a ferromagnet
    d. It consists of electric dipoles
    e. It has a very large resistance
11. A particle of charge Q >0, with velocity v along the negative x axis, enters a magnetic field B pointing along the z axis. The particle moves in a circular trajectory of radius
    a. mv/(QB)
    b. mv^2 /(QB)
    c. QB/(mv)
    d. m^2v/(QB)
    e. mv^2 /(QB^2)
12. If someone's vision is myopic (short-sighted) in one eye, it would be corrected by using
    a. A telescope
    b. A microscope
    c. A concave lens
    d. A convex lens
    e. A convex mirror
13. Crown glass has a critical angle of 33.7°. This tells you its refractive index must be
    a. 1.33
    b. 1.4
    c. 1.0
    d. 1.8
    e. 1.5
14. If an object is infinitely far away from a lens, it produces an image at 30 cm. If an object is put 60 cm from the same lens, the image will be at
    a. 30 cm
    b. -30 cm
    c. 60 cm
    d. -60 cm
    e. ∞
15. Monochromatic light falls on a diffraction grating with 7000 lines/cm. If the first order spectrum occurs at 30°, the wavelength is
    a. 714 nm
    b. 532 nm
    c. 589 nm
    d. 200 nm
    e. 1416 nm

16. A photon with a frequency of $5x10^{19}$ Hz Compton scatters off a stationary electron, giving it a final energy of 50 keV. The frequency of the photon after scattering is
    a. 157 keV
    b. $3.8x10^{19}$ Hz
    c. 50 keV
    d. $3.8x10^{-19}$ Hz
    e. 45 MHz
17. The de Broglie wavelength for an electron moving at v= $4.0x10^{5}$ m/s is
    a. 1.82 nm
    b. 0.403 nm
    c. 4 nm
    d. 4000 nm
    e. 22 nm
18. The number of all different n=4 states in a hydrogen atom is
    a. 32
    b. 16
    c. 8
    d. 18
    e. 2
19. The nucleus ^{9}Be consists of
    a. 4 protons, 5 neutrons
    b. 5 protons, 4 neutrons
    c. 9 protons, 9 neutrons
    d. 9 protons, 0 neutrons
    e. 4 protons, 5 neutrons and 5 electrons
20. A metal has a work function of 2.7 eV. If ultra-violet light with a frequency of $2x10^{15}$ Hz hits it, the maximum energy of the ejected electrons will be
    a. 2.7 eV
    b. 330 eV
    c. $1.3e^{-18}$ eV
    d. $3x10^{15}$ eV
    e. 5.58 eV

Part Ii: Problems: Each problem contains a qualitative part (5 marks) and and a quantitative part (10 marks). The qualitative part must be answered clearly and you must give a systematic explanation in clear English: simply writing a formula is not adequate. Attempt 4 (out of the 6) questions. If you do more than 4, cross out the ones you don't want marked

1. Explain the meaning of Kirchoff's laws. For the circuit on the diagram, find the current (magnitude and direction) through the 3Ω resistor.



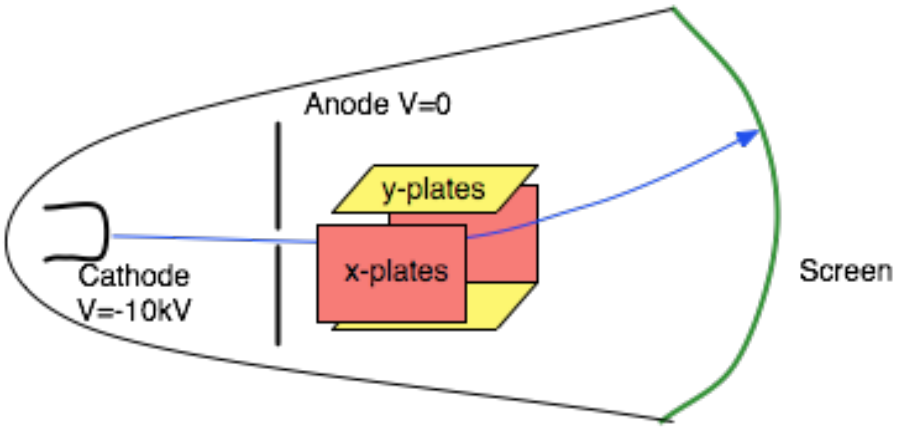
2. Two very long parallel wires are a distance d= 8 cm apart. The currents through the wires are I_1 = 2.0 A and I_2 = 3.0 A in the same direction.
    a. Sketch the field and the force on the wire carrying the 3.0A current, and explain how the force arises.
    b. Calculate the magnitude of force per unit length on the wire carrying the 3.0A current.
    c. A third wire, parallel to the two wires, is placed between the first two wires carrying a current I_3. Where should the wire be placed so that it is in in equilibrium?

3. A microscope consists of a 0.5cm focal length objective and a 2.5 cm focal length eyepiece. It is used to study a cell at a distance of 0.51 cm from the The barrel (distance between the lenses) is 28 cm long.
    a. Draw a ray diagram showing how the final image is formed
    b. Where is the image produced by the objective?
    c. Where is the final image?
    d. What is the overall magnification of the system, taking your near-point to be 20 cm.

4. Ionized helium (He^+) has a spectrum similar to H. The charge on the nucleus is Z=2, and it has just one electron.
    a. Explain how the Bohr theory would apply to it.
    b. Find the energy of the photon emitted in the n=6 to n=4 transition
    c. What wavelength does this correspond to?
    d. What kind of electromagnetic radiation is this?

5. Explain the difference between α and β decay. A radioactive source with a half-life of 30 seconds initially has 10^{15} atoms.
    a. What is the decay constant λ?
    b. How many atoms will be left after 20 minutes?
    c. What will the initial activity be (in Bq)

6. The diagram shows a schematic oscilloscope. Electrons are accelerated from the cathode (at -10kV) , through a hole in the anode at 0V and are then deflected by x and y-plates.



a. Explain how you used this to measure a periodic signal.
b. What is the speed of the electrons as they pass through the anode?
c. How long do the electrons take to pass between the plates if they have a length of 4 cm?
d. What is the field between the plates, if they have a PD of 1500V and are separated by 2 cm.?