Last Name (Please **print in BLOCK LETTERS)**	First Name **as on student card**	Student Number	Practical Group Code (F1C =morning or F3C =afternoon)

PHY132H1F
Term Test 2 —version 2
Tuesday, November 16, 2010
Duration: 80 minutes

Aids allowed: A pocket calculator with no communication ability. A single aid-sheet prepared by the student, no larger than 8.5"x11", written on both sides.

- **Turn off** any communication device you may have and place it far from where you are sitting.
- **DO NOT separate the sheets of your question paper.** 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 **8** multiple-choice questions, worth 2 points each, or altogether 16 points. The test also has a set of free-form questions worth 12 points, for which fully worked solutions are required. The total possible number of points is 28.

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 helpful information for this test:

Coulomb's constant is $K = 8.99 \times 10^9$ N m^2/C^2 Fundamental unit of charge $e = 1.60 \times 10^{-19}$ C

$\int \sin(x)dx = -\cos(x)$ $\int \cos(x)dx = \sin(x)$ $\int \frac{dx}{\sqrt{x^2 + a^2}} = \ln\left(x + \sqrt{x^2 + a^2}\right)$

Prefixes: "c" = 10^{-2} "m" = 10^{-3} "μ" = 10^{-6} "n" = 10^{-9}

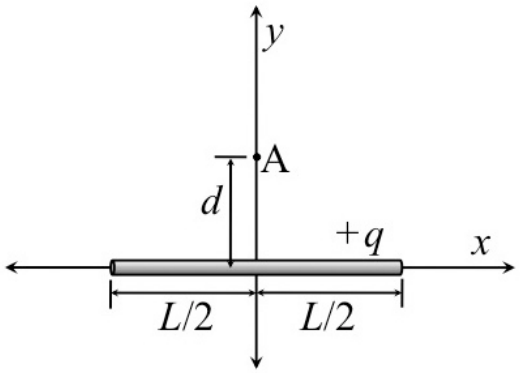
MULTIPLE CHOICE (16 points total)

1. The electron in a hydrogen atom maintains an average distance from the proton of 0.053 nm. What is the electric field at the position of the electron?
   A. 27 V/m, toward the proton
   B. 27 V/m, away from the proton
   C. 5.1×10^{11} V/m, toward the proton
   D. 8.2×10^{-8} V/m, toward the proton
   E. 5.1×10^{11} V/m, away from the proton

2. According to Wikipedia, *"In the field of cell biology, potassium channels are the most widely distributed type of ion channel and are found in virtually all living organisms."* [en.wikipedia.org/wiki/Potassium_channel] A Potassium ion is near a cell membrane and experiences the electric field of a dipole within the cell. This draws the ion directly toward the dipole. As the ion approaches the cell, its distance from the dipole decreases by a factor of ½. As this happens, the electric field strength experienced by the ion due to the dipole
   A. does not change.
   B. increases by a factor of 2.
   C. increases by a factor of 4.
   D. decreases by a factor of 2.
   E. increases by a factor of 8.

3. The electric potential inside a charged capacitor
   A. decreases linearly from the negative to the positive plate.
   B. decreases inversely with distance from the negative plate.
   C. increases linearly from the negative to the positive plate.
   D. is constant.
   E. decreases inversely with the square of the distance from the negative plate.

4. A finite rod of length L has total charge q, distributed uniformly along its length. The rod lies on the x-axis and is centered at the origin. Thus one endpoint is located at $(-L/2, 0)$, and the other is located at $(L/2, 0)$. Define the electric potential to be zero at an infinite distance away from the rod. What is V_A, the electric potential at point A (see the figure), located a distance d above the midpoint of the rod on the y-axis? [Note that in the expressions below, K is the Coulomb constant, and $\ln(x)$ is the natural logarithm of x.]



A. $\frac{2Kq}{L}\ln\left(\frac{L}{2d}+\sqrt{\frac{L^2}{4d^2}+1}\right)$

B. $\frac{2Kq}{L}\ln\left(\frac{L}{2}+\sqrt{\frac{L^2}{4}+d^2}\right)$

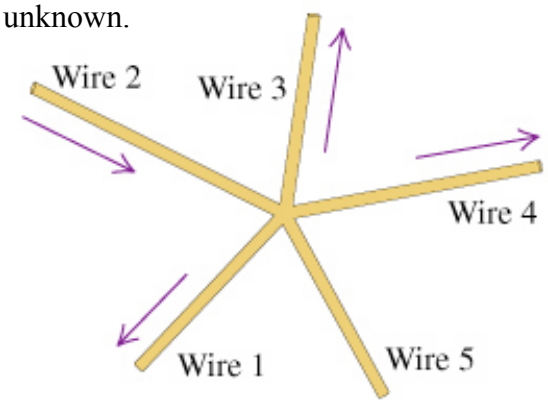
C. $\frac{2Kq}{Ld}\ln\left(\frac{L}{2}+\sqrt{\frac{L^2}{4}+d^2}\right)$

D. $\frac{Kq}{L}\ln\left(L+\sqrt{L^2+d^2}\right)$

E. $\frac{2Kq}{L}\ln\left(\frac{\sqrt{(L^2+4d^2)}+L}{2d}\right)$

5. Consider a junction of five wires, as shown in the figure. The arrows indicate the direction of current flow. The information about the magnitudes of the current density and the diameters for wires 1, 2, 3, and 4 is given in the table. Some of the values are unknown.

Wire	Current density [A/mm^2]	Diameter [mm]	Total Current [A]
1	2.1	1.3	???
2	???	2.0	5.9
3	3.9	0.73	???
4	1.0	???	12

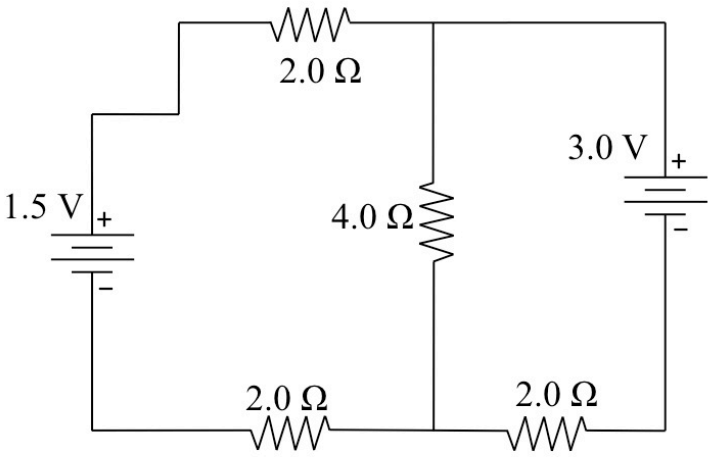


What is the current I_5 in wire 5? [Assume that the current out of the junction is positive and that the current into the junction is negative.]

A. −11 A
B. +9.1 A
C. +24 A
D. −24 A
E. +29 A

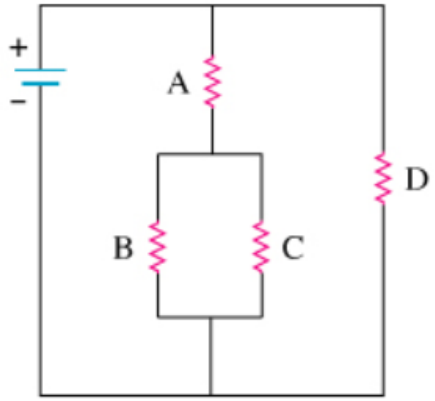
6. What is the magnitude of the current through the 4.0 Ω resistor in the circuit below?

A. 0.19 A
B. 0.47 A
C. 0.50 A
D. 0.15 A
E. 1.1 A



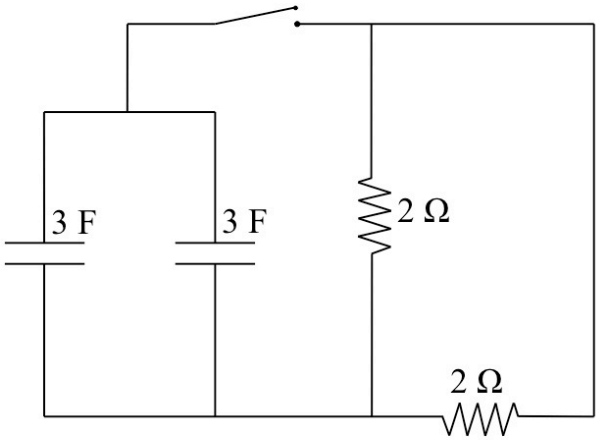
7. Rank the power consumption of the 4 identical resistors shown.

A. $P_D > P_B = P_C > P_A$
B. $P_A > P_B = P_C > P_D$
C. $P_D > P_A = P_B = P_C$
D. $P_B = P_A = P_C = P_D$
E. $P_D > P_A > P_B = P_C$



8. What is the time constant for the discharge of the capacitors in the figure below?

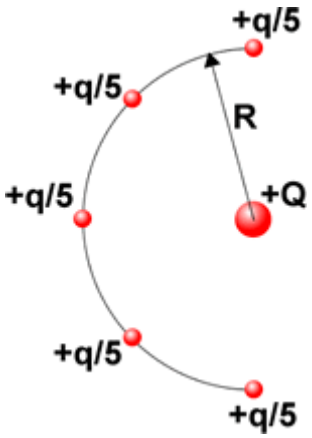
A. 0.17 s
B. 1.3 s
C. 6 s
D. 2×10^{-3} s
E. 24 s



FREE-FORM IN TWO UNRELATED PARTS (12 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

1. A point charge $+Q$ is located a distance R away from five identical point charges, each of charge $+q/5$, equally distributed along a semicircular arc of radius R as shown. What is the total force, magnitude and direction, exerted on $+Q$? [Please express your answer in terms of Q, q, R, the Coulomb constant, K, and numerical constants.]

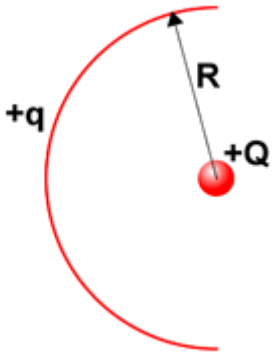


$\vec{F}$ =

2. A point charge $+Q$ is located a distance R away from a semicircular arc that is uniformly charged with a total charge of $+q$ as shown. The charge per length along the semicircle is:

$$\lambda = \frac{+q}{\pi R}$$

What is the total force, magnitude and direction, exerted on $+Q$? [Please express your answer in terms of Q, q, R, the Coulomb constant, K, and numerical constants.]



$\vec{F}$ =

PART B

The flash unit in a camera uses a 1.5 V battery to charge a 33 μF capacitor. The capacitor is then discharged through a flashlamp. The discharge takes 8.0 μs. During this time interval, what is the average power dissipated by the flashlamp?

P_{avg} =

ROUGH WORK (not marked)