Name: _____ Instructor:_____

Louisiana State University Physics 2102, Exam 1,

February 5, 2009.

• Please be sure to write your name and class instructor above.

• The test consists of 4 questions (multiple choice, no partial credit), and 4 problems (numerical).

• For the problems: Show your reasoning and your work. Note that in many of the problems, you can do parts (b) and (c) even if you get stuck on (a) or (b).

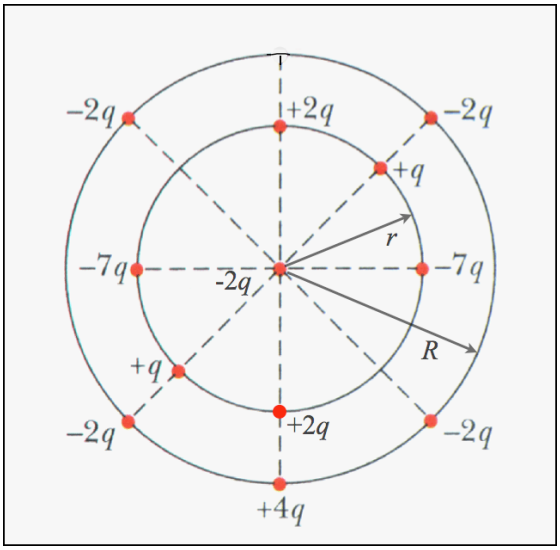
• You may use scientific or graphing calculators, but you must derive and explain your answer fully on paper so we can grade your work.

• Feel free to detach, use, and keep the formula sheet pages. No other reference material is allowed during the exam.

• **Good Luck!**

Question 1 [8 points]

The figure shows a central particle of charge –2q, surrounded by two circular rings of charged particles. The radii of the rings are r and R, as shown.



(i) (4 pts) What is the magnitude of the net electrostatic force on the central particle due to the other particles? Circle the right answer.

(a) $4kq/R^2$

(b) $4kq^2/R^2$

(c) $8kq/R^2$

(d) $8kq^2/R^2$

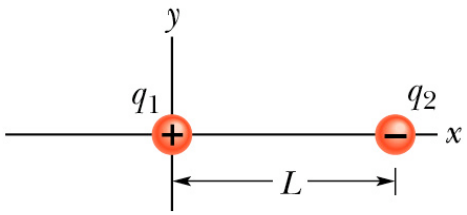
(e) zero

(ii) (4 pts) Which of the arrows labeled **A**, **B**, **C**, and **D** gives the correct direction of the net force that acts on the charge at the upper left corner? (circle the right answer):

(a) rightward
(b) upward
(c) leftward
(d) downward
(e) force is zero, no direction

Problem 1 [17 points]

The figure shows two charges $q_1 = +Q$ and $q_2 = -16Q$ which are held at separation L on an x-axis.



(i) (4 pts) Where on the x-axis can a charge $q_3 = -Q$ be placed so that it is in equilibrium? (Circle the right answer)

(a)To the left of q_1

(b) Between q_1 and q_2

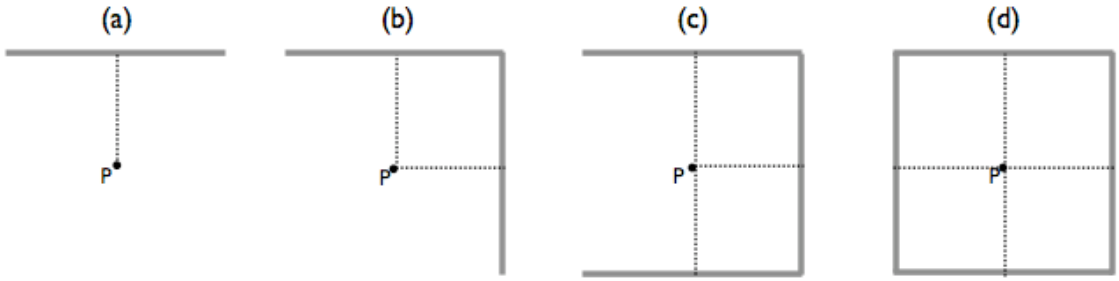
(c) To the right of q_2

(ii) (3 pts) Briefly explain your answer in (i)

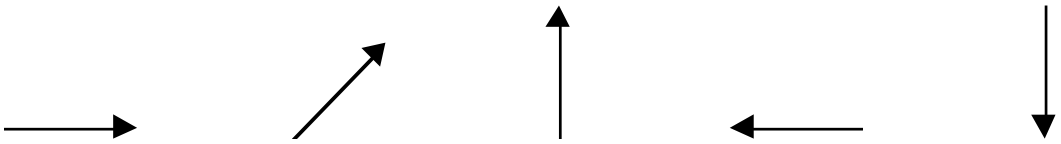
(iii) (10 pts) Give an expression for the x-coordinate of this point, in terms of L:

Question 2 [8 points]

Figure (a) shows a plastic rod which has charge –Q uniformly spread along its length. In Figures (b), (c), and (d) more plastic rods are added to form sides of a square, each rod has the same negative charge –Q. The point P is at the center of the square.



(i) (3 pts) Indicate the direction of the electric field at point P, for figure (c) (circle the right answer:



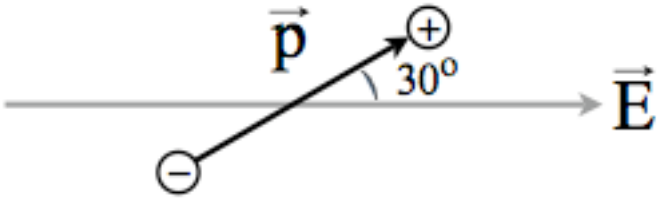
(ii) (5 pts) Rank the scenarios according to the magnitude of the electric field at point P (circle the right answer):

$E_a > E_b > E_c > E_d$ $E_b = E_c > E_a > E_d$ All tie

$E_b > E_a = E_c > E_d$ $E_d > E_c > E_b > E_a$

Problem 2 [17 points]

An electric dipole, with equal and opposite charges of magnitude 5.1 μC that are separated by 450 nm, is located in a uniform electric field of magnitude 10 V/m. The dipole is initially held at 30° with respect to the electric field, as indicated in the figure:



(a) (4 pts) Calculate the magnitude of the electric dipole moment:

(b) (3 pts) If the dipole were not held in place, in which direction would it rotate? Answer with words or indicate on the figure.

(c) (10 pts) Instead, the dipole is rotated from an angle of 30° to an angle of 115°. Calculate the change in the potential energy of the dipole.

Question 3 [10 points]

An isolated conductor of arbitrary shape has a net charge of +10 μC. Inside the conductor is a cavity within which is a point charge q = +3.0 μC

(i) (5 pts) What is the charge on the wall of the cavity? Circle the right answer.

+3.0 μC –3.0 μC +10 μC

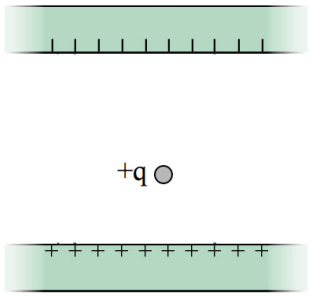
–10 μC +13 μC

(ii) (5 pts) What is the charge on the outer surface of the conductor? Circle the right answer:

+3.0 μC –3.0 μC +10 μC

+7 μC +13 μC

Problem 3 [17 points]
The figure shows (sections of) two very large conducting plates which have equal and opposite charge densities. A neon nucleus of charge $q = +1.6 \times 10^{-18}$ C and mass $m = 3.4 \times 10^{-26}$ kg is at rest in between the two plates, because the electrostatic force exactly balances the gravitational force. The electric field between the plates is uniform and is not altered by the presence of the neon nucleus.



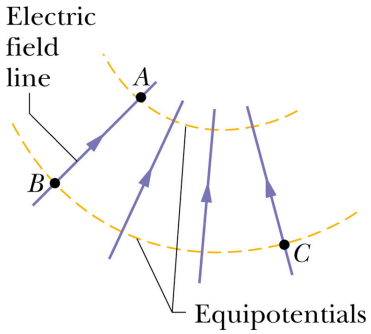
(a) (5 pts) Calculate the magnitude of the electric field between the plates:

(b) (7 pts) Calculate the surface charge density on each of the plates:

(c) (5 pts) What is the magnitude of the electric field in the air below the positively charged plate:

Question 4 [10 points]

When an electron moves from A to B along the electric field line in the figure below, the electric field does $+3.20 \times 10^{-19}$ J of work on it.



(i) (4pts.) What is the electric potential difference $V_B - V_A$?

a) 0 J/C
b) 2 J/C
c) –2 J/C
d) None of the above are even approximately correct

(ii) (3pts.)What is the electric potential difference $V_B - V_C$?

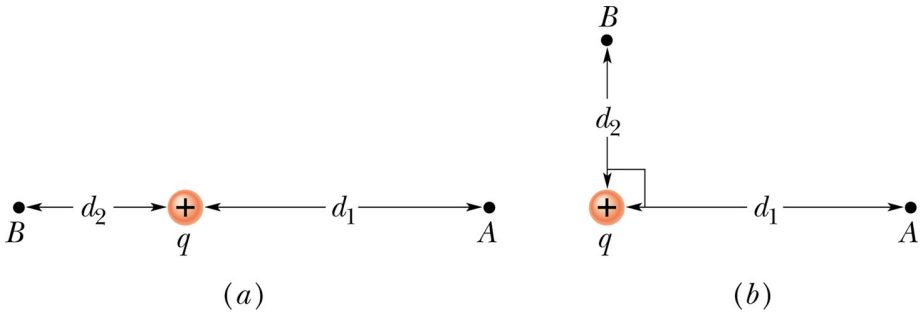
a) 0 J/C
b) 2 J/C
c) –2 J/C
d) None of the above are even approximately correct

(iii) (3pts.) What is the electric potential difference $V_A - V_C$?

a) 0 J/C
b) 2 J/C
c) –2 J/C
d) None of the above are even approximately correct

Problem 4 [12 points]

Consider a point charge q = 3.0 nC, point A at distance d_1 = 5.0 cm from q, and point A at distance d_2 = 2.5 cm.



(i) (3 pts.) Calculate the electric potential at point A, relative to $V = 0$ at infinity:

(ii) (4 pts) If A and B are opposite to each other as shown in figure (a), what is the electric potential difference $V_A - V_B$?

(iii) (5 pts.) What is the electric potential difference $V_A - V_B$, if A and B are located as in figure (b)?