February 3, 2005

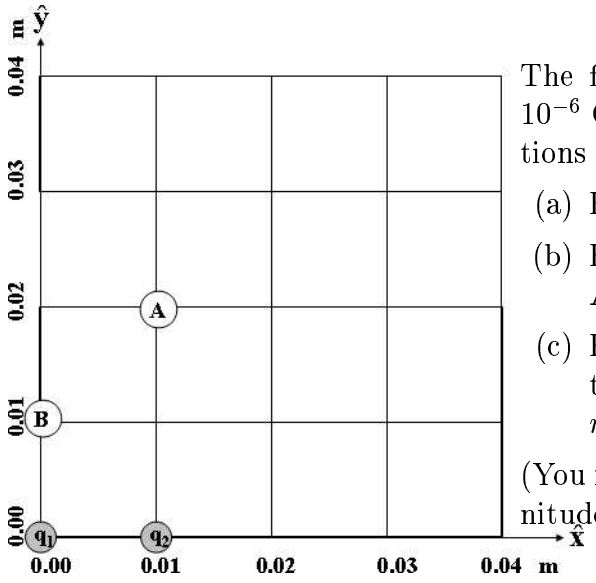
PHY 114 – First Hour Test

Note: This exam has 5 problems each worth 20 points. Please record all of your work (diagrams, mathematical manipulations, and numerical work) in the exam booklet. Please show your intermediate steps so that partial credit can be awarded if appropriate. When your work is completed, please turn in: (1) the exam booklet, (2) your equation sheet, and (3) this exam paper. It is assumed that all work will be done under the guidelines of the honor code.

Useful constants

Coulomb Constant: $k_e \equiv \frac{1}{4\pi\epsilon_0}$: 8.98755×10^9 N $\cdot$ m^2/C^2
Permittivity constant: ϵ_0: 8.854×10^{-12} C^2/N $\cdot$ m^2
Elementary charge e: 1.602177×10^{-19} C
Mass of electron m_e: 9.10939×10^{-31} kg
Mass of proton m_p: 1.6726×10^{-27} kg
Area of a circle of radius r: πr^2
Area of a sphere of radius r: $4\pi r^2$
Gravitational acceleration near Earth's surface g: 9.8 m/s^2

1.



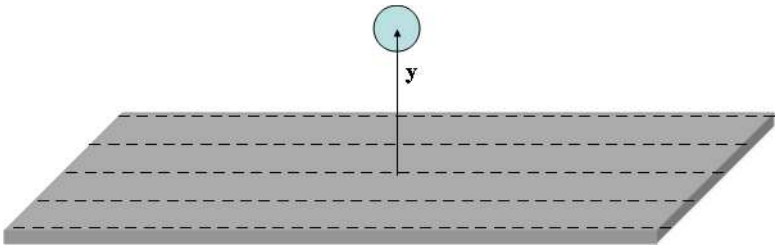
The figure on the left shows two charges, $q_1 = +3 \times 10^{-6}$ C, and $q_2 = -2 \times 10^{-6}$ C, placed at indicated positions on a grid.

(a) Find the electrostatic field **E** at the point **A**.

(b) Find the electrostatic potential V at the same point **A**.

(c) Find the work done by the electric field when a particle having a charge of $q = 1 \times 10^{-5}$ C and mass $m = 0.0001$ kg moves from position **A** to **B**.

(You may express vector quantities in terms of their magnitude and direction or in component form.)

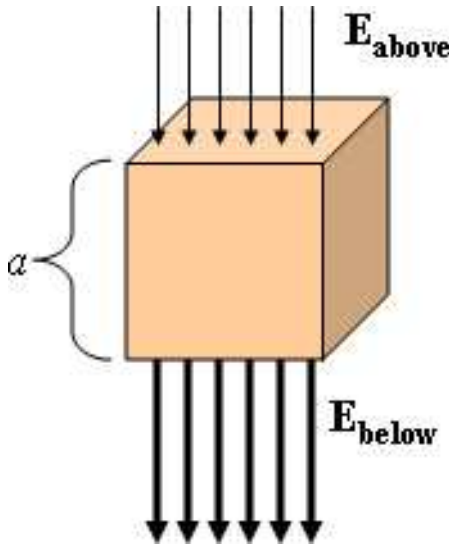
2. 

The figure above shows a sheet of material containing negative charge totaling $Q = -1 \times 10^{-5}$ C, uniformly distributed throughout its entire area $A = 0.3$ m^2. Above the sheet at a height $y = 0.02$ m, is a small particle of mass $m = 0.001$ kg and charge $q = -2 \times 10^{-8}$ C.

(a) Find the electrostatic field **E** produced by the charged sheet at the location of the particle.

(b) Find the electrostatic force that the sheet exerts on the particle.

(c) Find the total force acting on the particle and discuss how it would move if it were not constrained.

3. 

The figure on the left shows a cube of length $a = 1.3$ m on each side. An electric field passes through the top and bottom faces of the cube and is parallel to the front, back, and left and right sides of the cube. The magnitude of the fields are $E_{\text{above}} = 5000$ N/C and $E_{\text{below}} = 8000$ N/C.

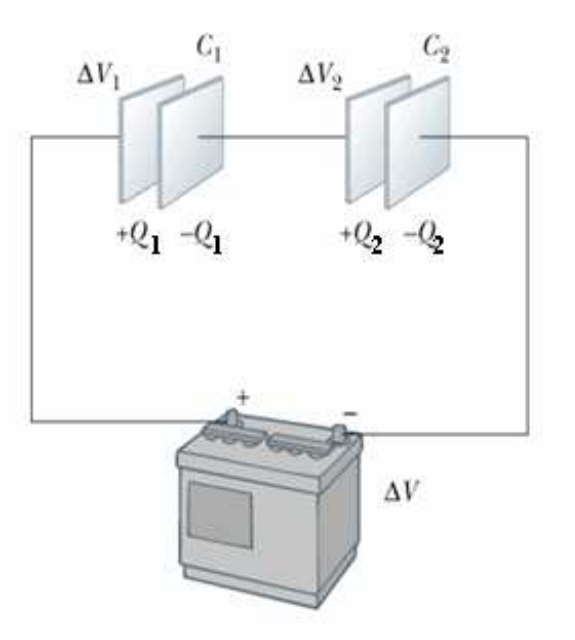
(a) Find the electrostatic flux which passes through the top face of the cube.

(b) Find the electrostatic flux which passes through the bottom face of the cube.

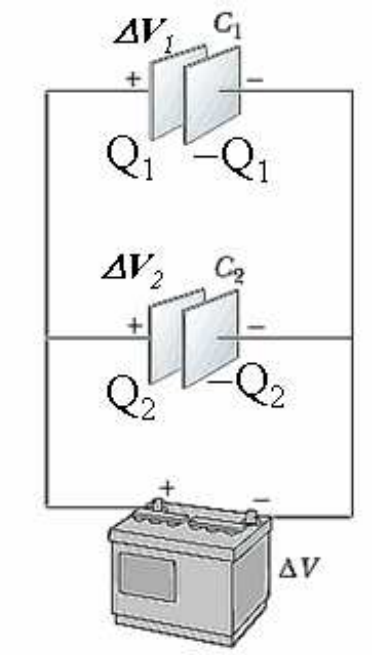
(c) Find the net flux which passes through the cube.

(d) Find the total charge within the cube.

4.



Series configuration



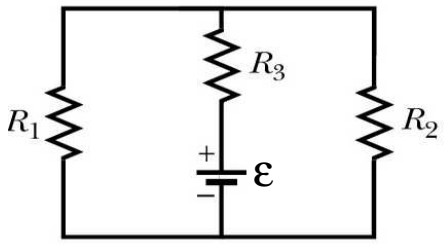
Parallel configuration

The figure above shows two capacitors with $C_1 = 7 \times 10^{-6}$ F and $C_2 = 2 \times 10^{-6}$ F connected to a voltage source $\Delta V = 100$ V in two different circuits.

(a) Find the voltages ΔV_1 and ΔV_2 and charges Q_1 and Q_2 on the two capacitors in the series configuration.

(b) Find the voltages ΔV_1 and ΔV_2 and charges Q_1 and Q_2 on the two capacitors in the parallel configuration.

5.



The figure on the left shows a circuit containing a voltage source $\mathcal{E} = 100$ V and resistances $R_1 = 2\Omega$, $R_2 = 7\Omega$, and $R_3 = 5\Omega$. For solving this problem, we will neglect internal and wire resistances.

(a) Find the voltage changes V_1, V_2, and V_3 across each of the resistors.

(b) Find the currents I_1, I_2, and I_3 flowing through each of the resistors.

********************End of Exam*********************