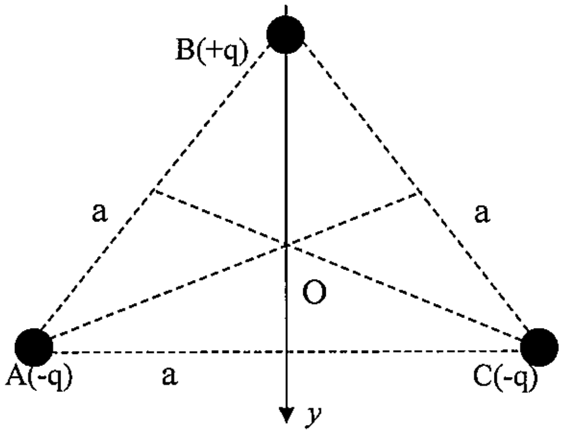
NAME : .... FIRSTNAME:.. GROUP :........

Physics Midterm 1

Calculators and extra-documents are not allowed.
Please answer only on exam sheets

Exercise 1 (8 points)

Three pointlike charges -q, +q and - q (with q > 0) are respectively at points A, B and C of an **equilateral** triangle whose edge length is a. AB = BC = CA = a.



1- Sketch above the electric field vectors $\vec{E}_A(O)$, $\vec{E}_B(O)$ and $\vec{E}_C(O)$ which are generated by the three charged particles at center O of the triangle.

2- Express the norm of each vector $\vec{E}_A(O)$, $\vec{E}_B(O)$, $\vec{E}_C(O)$. Then write the norm of the total field vector $E(O)$ in terms of k, q, a.

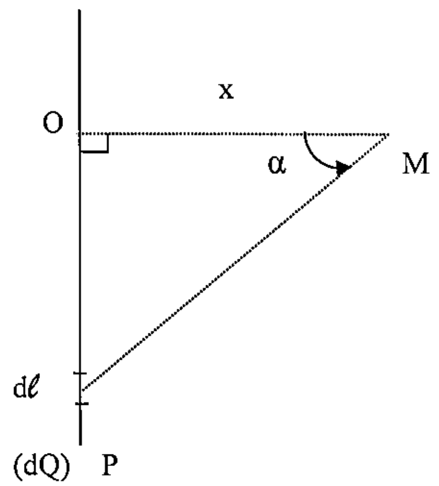
3- A negative charge (-q) is put at point O. Deduce the direction, the orientation and the norm of the electric force acting on it.

4-a) Express the potentials V(A), V(B) and V(O) in terms of k, q and a (now consider the charge (-q) at point O).

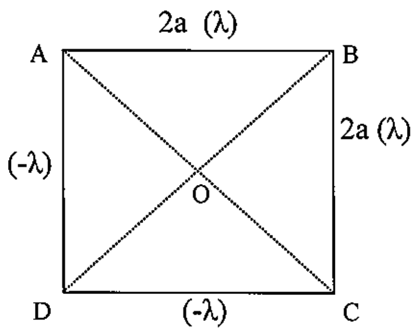
b) Deduce the potential energy of the charge (-q) at point O.

__Exercise 2__ **(6 points)**

It can be proven that a length element $d\ell$ of charge dQ creates an elementary electric field at point M which reads $dE_x(M) = \frac{k.\lambda}{x}\cos(\alpha)d\alpha$, where OM = x is the distance between M and the wire.



1-a) Use the latter formula to express the **norms** of the electric field vectors generated separately by each wire AB, BC, CD and DA at center O of the square of length 2a. The wires AB, BC are charged with a positive constant density λ whereas the wires CD and DA are charged with a negative constant density –λ.



b) Sketch vectors $\vec{E}_{AB}(O)$, $\vec{E}_{BC}(O)$, $\vec{E}_{CD}(O)$ and $\vec{E}_{DA}(O)$.

2- a) Deduce the expression of the norm of the total field $\vec{E}(O)$.

b) Sketch it.

Exercise 3 Parts I and II are independent **(6 points)**

I- One considers the electric potential which reads $V(x,y,z) = 2x^2y - \frac{zy^3}{x}$.

1- Express the components E_x, E_y and E_z of the electric field which is generated by this distribution.

2- Deduce the norm of the electric field $\vec{E}$ at point P (1, 1,1).

II- An electric dipole (-Q, +Q) creates at some point M of the plan (xOy) an electrostatic potential which reads: $V(r,\theta) = k.Q.a.\frac{\cos(\theta)}{r^2}$; where k, Q, a are positive constants.

The gradient in polar coordinates is given by: $\vec{grad}\left(\frac{\partial}{\partial r}, \frac{1}{r}.\frac{\partial}{\partial \theta}\right)$

1- Write the electric field components generated at point M.

2- Give in terms of k, Q, a and r_0 the components of $\vec{E}(M_0)$, where *M0* is defined such that: $r = r_0$ and $\theta_0 = \pi/4$.