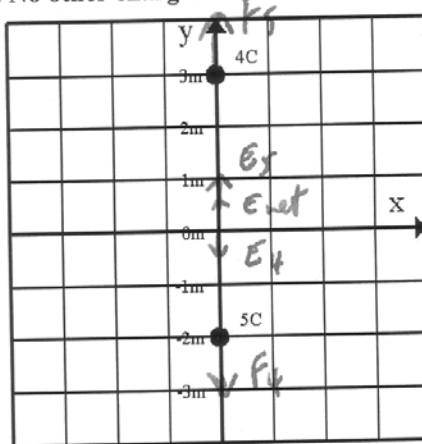


HOMEWORK #3 for Tuesday, June 21, 2005

Name _____ Section _____

1. A $4\text{-}\mu\text{C}$ charge is located at the point (0 m, 3 m), and a $5\text{-}\mu\text{C}$ charge is located at the point (0 m, -2 m). No other charges are around.



- A. What is the magnitude of the electrical force on the $4\text{-}\mu\text{C}$ charge due to the $5\text{-}\mu\text{C}$ charge, in newtons? Draw an arrow on the diagram to represent this force, and label it F_5 .

$$F = \frac{k(Q_1 Q_2)}{r^2} = \frac{9 \times 10^9 \times 4 \times 10^{-6} \times 5 \times 10^{-6}}{5^2} = 7.2 \times 10^{-3} \text{ N}$$

- B. What is the magnitude of the electrical force on the $5\text{-}\mu\text{C}$ charge due to the $4\text{-}\mu\text{C}$ charge, in newtons? Draw an arrow on the diagram to represent this force, and label it F_4 .

same magnitude, opposite direction

- C. What is the magnitude of the component of the electric field at the origin that is due only to the $5\text{-}\mu\text{C}$ charge (in N/C)? Draw an arrow on the diagram to represent this field, and label it E_5 .

$$E_5 = \frac{kQ_5}{r_5^2} = \frac{9 \times 10^9 \times 5 \times 10^{-6}}{2^2} \frac{\text{N}}{\text{C}} = 11.25 \times 10^3 \frac{\text{N}}{\text{C}} = 11,250 \frac{\text{N}}{\text{C}}$$

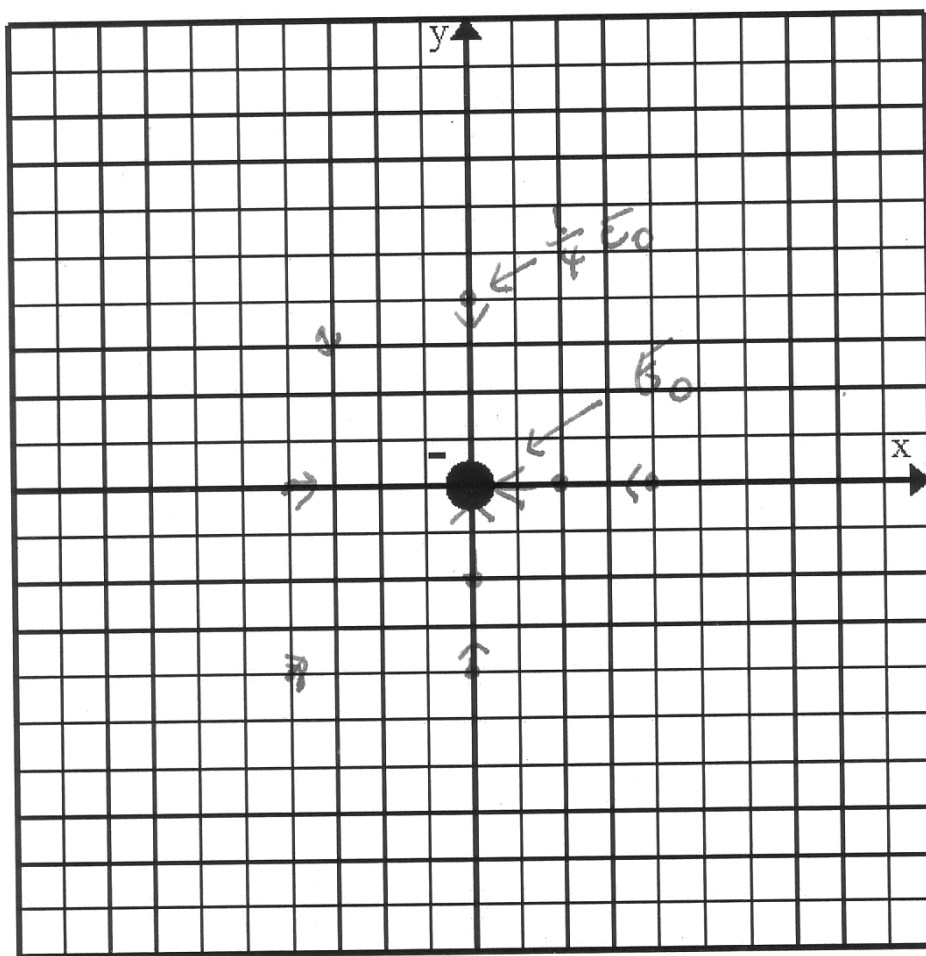
- D. What is the magnitude of the component of the electric field at the origin that is due only to the $4\text{-}\mu\text{C}$ charge (in N/C)? Draw an arrow on the diagram to represent this field, and label it E_4 .

$$E_4 = \frac{kQ_4}{r_4^2} = \frac{9 \times 10^9 \times 4 \times 10^{-6}}{3^2} = 4 \times 10^3 \frac{\text{N}}{\text{C}} = 4,000 \frac{\text{N}}{\text{C}}$$

E. What is the magnitude of the net electric field at the origin, due to both of the charges (in N/C)? Draw an arrow on the diagram to represent this field, and label it E_{net} .

$$E_{\text{net}} = E_5 - E_4 = 7250 \frac{\text{N}}{\text{C}}$$

2. A negative charge is located at the origin of the figure below. Draw arrows at different locations representing the magnitude and direction of the electrical field at those points. Use a ruler to ensure that the lengths and directions of your arrows correctly represent the field. Draw at least 8 arrows, using at least three different distances from the origin.

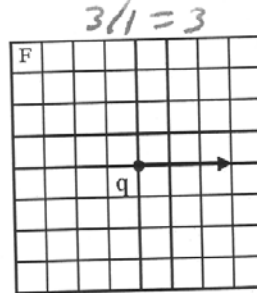
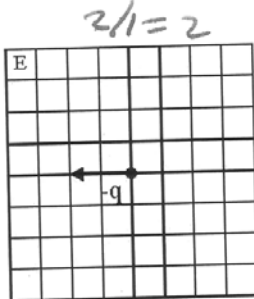
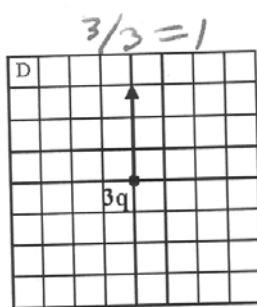
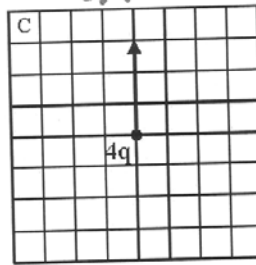
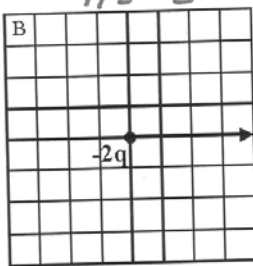
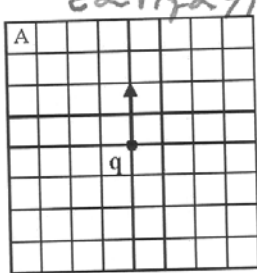


Lengths get smaller as distance increases.

3. The six diagrams below show the electric force acting on some charges. In each diagram the vector represents the direction and magnitude of this electric force. The charges are indicated; some are positive and some are negative. Use this

Rank the magnitudes of the electric fields in the six diagrams, from smallest magnitude to largest magnitude. Rank A, B, C, D, E, and F, starting with smallest magnitude to largest magnitude; if two or more are the same, put an "equals" sign ["="] between them; e.g., [A, B = C, D, E, F] means: A is smallest, F is largest, and B is equal to C, but smaller than D):

Ranking of E-field magnitude: (smallest) C, D, A=B=E, F
 (largest) E, D, F, A, B, C



In some cases the electric field is in the direction of the electric force vector, and in other cases it isn't. List them below, identifying them by A, B, C, D, E, and F:

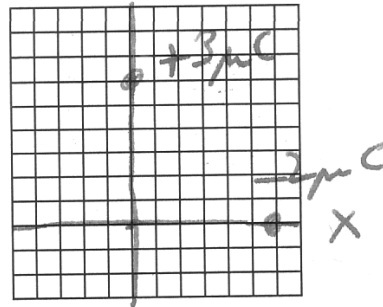
Force and field are in same direction: A, C, D, F (positive charges)

Force and field are in different directions: B, E (negative charges)

4. On the graph to the right, locate an origin and place the following charges:

A $-2 \mu\text{C}$ charge at $(3.0 \text{ m}, 0)$

A $+3 \mu\text{C}$ charge at $(0, 3.0 \text{ m})$



(a) Determine the contributions of each of these charges to the electric field at the origin, giving both the magnitude and direction.

The electric field at the origin due to the $-2 \mu\text{C}$ charge has:

$$\text{Magnitude: } \frac{kq}{r^2} = 9 \times 10^9 \times 2 \times 10^{-6} / 3^2 \text{ N/C} = 2000 \text{ N/C}$$

Direction: $+x$

The electric field at the origin due to the $+3 \mu\text{C}$ charge has:

$$\text{Magnitude: } \frac{kq}{r^2} = 9 \times 10^9 \times 3 \times 10^{-6} / 3^2 = 3000 \text{ N/C}$$

Direction: $-y$

(b) Determine the x and y components of the total electric field at the origin:

x component: 2000 N/C

y component: -3000 N/C

(c) Use the information in (b) to determine the magnitude and direction of the total electric field at the origin. Express the direction as an angle measured the usual way (counterclockwise from the positive x axis).

$$\text{Magnitude: } \sqrt{(2000)^2 + (3000)^2} \frac{\text{N}}{\text{C}} = 3600 \frac{\text{N}}{\text{C}}$$

$$\text{Direction: } \theta = \tan^{-1} \left(\frac{E_y}{E_x} \right) = \tan^{-1} \left(\frac{-3000}{2000} \right) = \tan^{-1}(-1.5) = -56^\circ$$