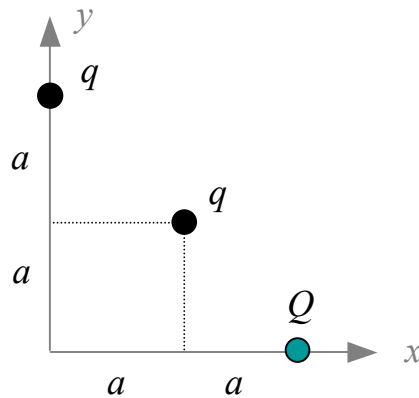


Two positive point charges q are fixed at the locations shown in the figure: one at $(x,y) = (0,2a)$ and the other at $(x,y) = (a,a)$. A positive test charge Q is placed on the x -axis at the position $(x,y) = (2a,0)$.



- 1) Calculate the components E_x and E_y of the electric field created by the two fixed charges at the location of the test charge Q . [8]

$$E_x = \frac{5kq}{8\sqrt{2}a^2}$$

$$E_y = -\frac{5kq}{8\sqrt{2}a^2}$$

Rubric:

Setup problem (e.g. add contributions...) (2)

Separate components (2)

magnitude (2)

direction (2)

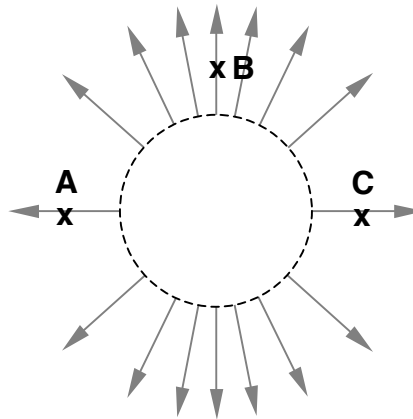
- 2) What is the **magnitude** of the **force** exerted on the test charge Q by the two fixed charges? [3]

$$|F| = \frac{5kqQ}{8a^2}$$

Rubric:

answer (3)

The figure below shows the **electric field lines** in the region of space surrounding the dashed circle. The electric field represented by these lines is caused by the “mystery” charged object or objects that are hidden under the circle.



- (3) Compare the magnitude of the electric field at the points **A**, **B**, and **C** marked on the figure. Indicate which points have the smallest and largest fields, and if the field strength at any two (or three) of the points is the same. Provide a brief but *clear* explanation of your reasoning. [4]

$$E_A = E_C < E_B$$

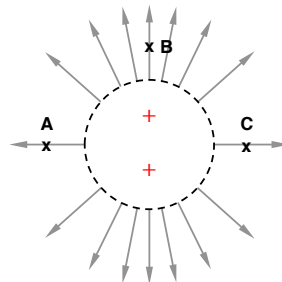
The field line densities are the same in A and C, and lower than in B.

Rubric:

answer (2)

explanation (2)

- (4) What sort of charged object or objects under the circle could have **produced** these field lines? Sketch and describe the object(s) you think might be responsible. [5]



multiple possible answers

Rubric:

answer (3)

explanation (2)