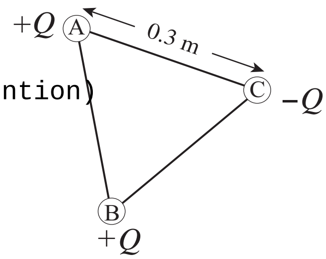
Physics 102 (S16)

Q3C

Name: ____________________ **Section:** __________ **Score:** __________/**20**

1. Three charges of $+Q$, $+Q$ and $-Q$ ($Q > 0$) are placed at the three vertices of equilateral triangle of edge length 0.3 m as shown below. The total work you have to do to construct this charge configuration from three charges apart far away from each other is -3.0 J.

superposition
pairwise potential energy kQQ'/r

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Total potential energy (according to our energy convention)
kQ^2/r + kQ(-Q)/r + kQ(-Q)/r = -kQ^2/r = - 3 J.
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(1) What is the magnitude of Q? [5]

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Q = sqrt{3r/k} = sqrt{0.9/9x10^9} = sqrt{10^{-10}}= 10^{-5} = 10 microC.
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(2) Now, you wish to remove charge B (move it far away from other charges). How much work do you have to do? [5]

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Obviously 0, since AB and BC pairs store +3 and -3 J.
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2. There are four charges on the plane. The equipotential curves are described in the following figure.

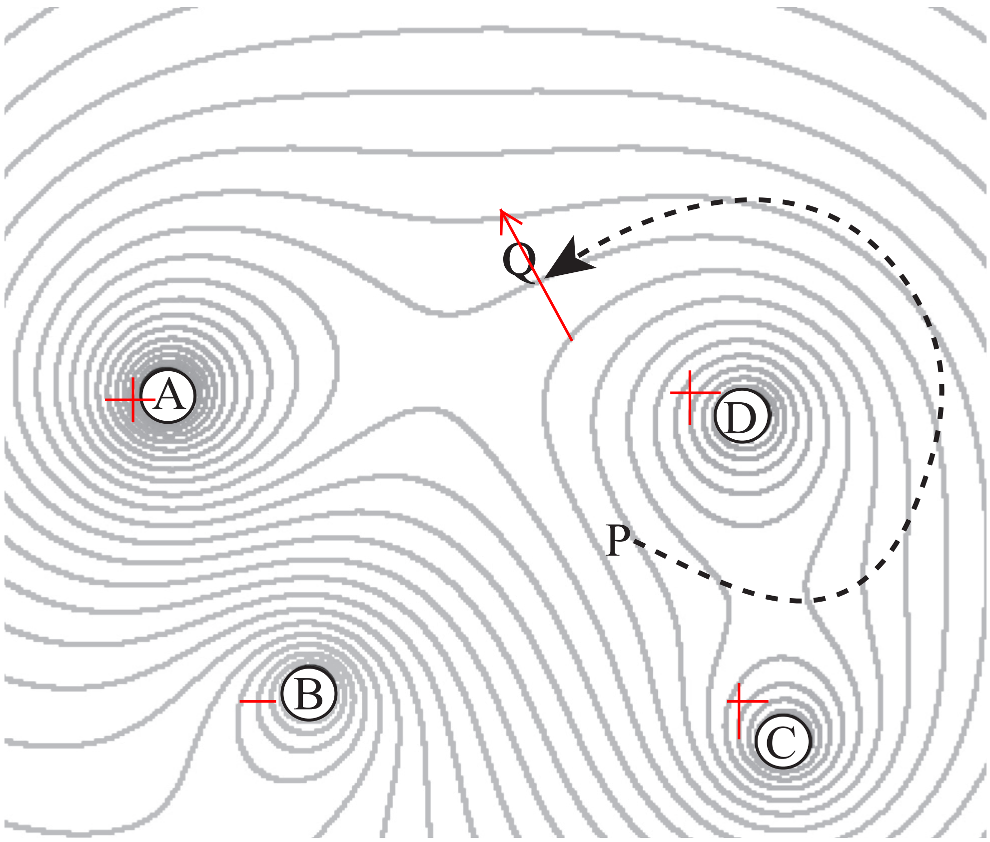

Figure 1:

(1) One charge has a different sign fromthe other three. What is this charge? [4]

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B, because the other three are connected by a mountain ridge.
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(2) Assume A is positive. Indicate the direction of the electric field at Q. You must justify your answer briefly. [2]?

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+ is higher and E must be downhill, perpendicular to the contour at the point.
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(3) If you move a charge of +1 C from P to Q, how much work W do you have to supply, if the contour spacing is 20 V? [W need not be positive.] [4]

W = q x delta V

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P has a higher voltage than Q by 20 V, so it is downhill, two spacings = 40 V down.
W = 1 x (-40) = -40 J.
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