Physics 102 (F16)

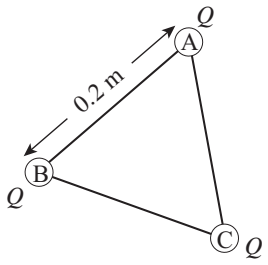
Q3B

Name: _____ **Section:** _____ **Score:** _____/20

1. Initially, three identical charges of Q are at the vertices of an equilateral triangle ABC of edge length 0.2 m as illustrated below. To construct this charge configuration from three chrages Q mutally far away apart you have to do 36 J.

superposition
pairwise potential kQQ'/r

Therefore,
3kQ^2/r = 36 J.



(1) What work do you have to do to squish the tiriangle to an equilateral triangle of edge length 0.1 m (that is, to make the edge sizes half)? [5]

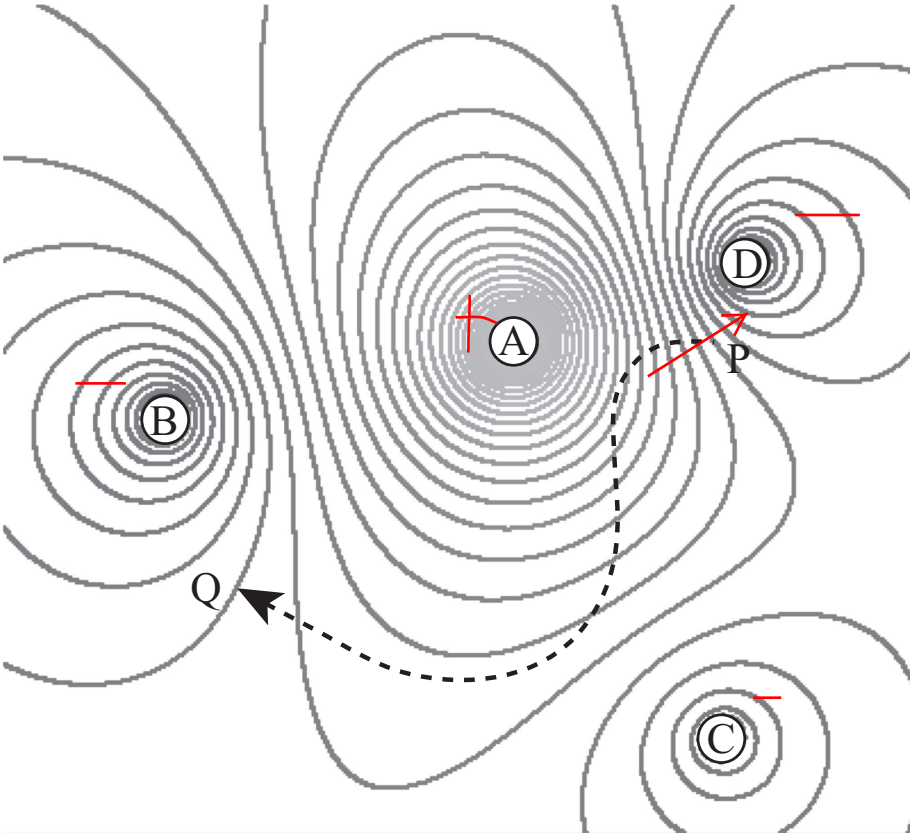
Now, r -> r', so the final energy must be doubled to 72 J.
You must supply the difference: W = 36 J.

(2) Now, all the charges are gently released, and they fly apart. What is their speed v far away from the triangle ABC, if all the charges have the same mass m? Assume the stored potential energy is E (i.e., you may identify the answer to (1) with E.) [5]

Energy conservation
(1/2) mv^2 + E_f = E_i

The initial potential energy = 72 J = E.
The final potential energy is 0.
We may assume all the particles have the same speed.
E/3 = (1/2) mv^2 -> v = sqrt{2E/3m}.

2. There are four charges A - D on the plane. The equipotential curves are described in the following figure.



(1) One charge has a different sign from the other three. What is this charge? [3].

A, because B, C, are connected via cols.

(2) Assume A is positive. Indicate the direction of the electric field at P. You must justify your answer very briefly. [3]

E is + to -, and perpendicular to the contour.

(3) If a charge of 0.3 C is moved from P to Q along the dashed curve, what is the work you must do, if the contour spacing is 20 V? [4]

W = q delta V

Notice that Q has a lower voltage than P (by 40 V), so two spacing =
delta V = Vf - Vi = -40 (downhill).
W = -0.3 x 40 = -12 J.