Physics 102 (S15) **Q3D**

corrected to 150 g

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

1. A +18 μC point charge **A** is fixed in the space.
(1) A positively charged particle **B** with 6 μC starts to move toward charge **A** with an intial speed 98 m/s and could come as close as 1 mm from charge **A**. The mass of particle **B** is 220 g. What is the initial distance between these two charges? [5]

Let us assume that the initial position of B is L away from charge A.
Initial potential energy Ui = kQAQB/L = (9 x 10^9) (18 x 10^{-6}) (6 x 10^{-6})/L = 0.972/L.
Initial kinetic energy K = (1/2) mv^2 = (1/2) 0.15 x 98^2 = 720 J.
Final potential energy Uf = (9 x 10^9) (18 x 10^{-6}) (6 x 10^{-6})/(1 x 10^{-3}) = 972 J.
Energy conservation tells us:

Ui + K = Uf + 0,

so

0.972/L = 972 - 720 -> L = 0.972/ 152 = 0.00442

That is, 4.4 mm.

(2) When charge **B** comes to a halt 1mm from charge **A**, you wish to push charge **B** further to a point P that is 0.5 mm away from charge **A**. What work should you do? [5]

The potential energy initially is 972 J as computed in (1).
The final potential energy must be twice as large as this, so 972 J work you must do.

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

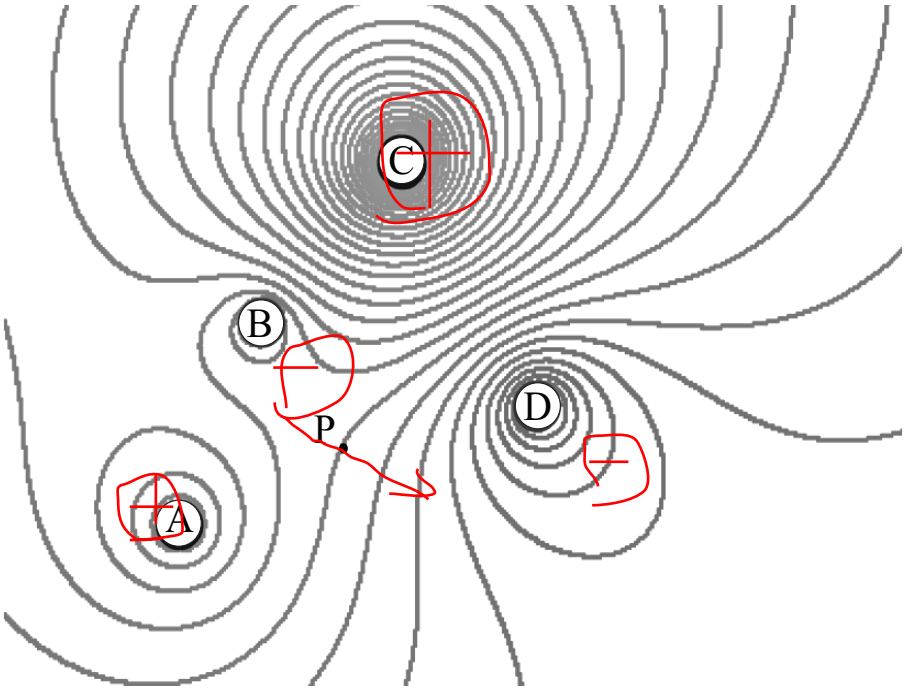

Figure 1:

(1) Suppose A is positively charged. State the signs of all the remaining charges B - D.

(2) Which charge has the largest magnitude? You must explain your answer succinctly.

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(3) Indicate the direction of the electric field at P.

Since A is positive and D is negative, the potential is generally lower to the right. Also the field line must be perpendicular to the equipotential curve.