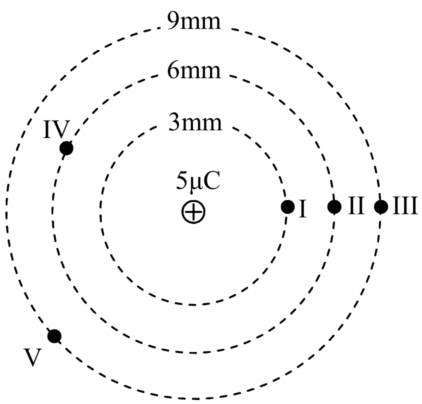
Due Wed., Feb 7

2011-12 PreAP Electrostatics 10

1. Let's learn something about electric potential (voltage) around positive charges.



A. Calculate the electric potential at point I.

B. Calculate the potential at point II.

C. Calculate the potential at point III.

D. At which point is the voltage the highest: I, II, or III?

E. So, as you get closer to a positive charge, the voltage increases or decreases?

F. What is the voltage at point V?

G. How much potential energy would a 2C charge have at point II?

H. What is the potential difference between point II and point IV?

I. How much work would be necessary to move the 2C charge from point II to point IV?

J. Draw some electric field lines around the + charge.

K. Put a + charge at point II. Would it move toward or away from the charge in the middle?

L. So + charges move from ______ voltage to _____ voltage.

M. Negative charges move from ______ voltage to _____ voltage.

1A: $V = \dfrac{k(5E-6)}{3E-3} = 1.5E7\text{V or J/C}$

1B: 7.5E6 J/C (notice, half as much since twice the distance)

1C: 3 times r = 1/3 V = 1.5E7/3 = 5E6 J/C

1D: point I (closest)

1E: increases

1F: same as III: 5E6J/C

1G: (7.5E6J/C)(2C) = 15E6J or 1.5E7J

1H: 0V, same potential at both.

1I: 0 J, same voltage.

1J: radially outward

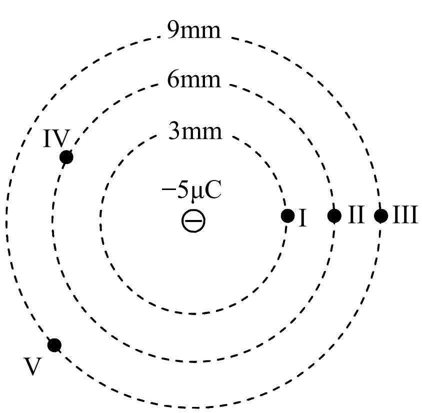
1K: away

1L: high; low

1M: low; high

As you already know, these dotted circles are really concentric spheres. These are known as equipotential lines: where the voltage (potential) is the same or equal. You never have to do work when you move a charge along an equipotential line. Also, you should see that equipotential lines are always perpendicular to electric field lines.

2. Now, the positive charge is replaced by a negative charge.



A. Realizing that voltage can be negative, calculate the electric potential at point I.

B. Calculate the potential at point II.

C. Calculate the potential at point III.

D. At which point has the highest voltage: I, II, or III?

E. So, as you get closer to a negative charge, the voltage increases or decreases?

F. What is the voltage at point IV?

G. What is the potential difference between point II and point IV?

H. How much work would be necessary to move the 2C charge from point II to point IV?

I. Draw electric field lines around the − charge.

J. Would a + charge go toward or away from the charge?

K. So + charges move from ______ voltage to _____ voltage.

L. Negative charges move from ______ voltage to _____ voltage.

2A: $V = \dfrac{k(-5E-6)}{3E-3} = -1.5E7\text{V or J/C}$

2B: −7.5E6 J/C (notice, half as much since twice the distance)

2C: 3 times r = 1/3 V = −1.5E7/3 = −5E6 J/C

2D: III, less neg is more positive and higher V.

2E: decreases (more −)

2F: same as II: −7.5E6J/C

2G: 0 Volts, again

2H: 0 volts

2I: radially inward

2J: toward

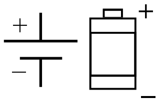
2K: high, low

2L: low, high

Again, you see the equipotential lines, which are perpendicular to the electric field lines. Now you should know that voltage is more + closer to + charges and more − closer to − charges.

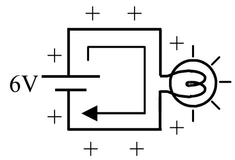
As you know a battery gives voltage. Actually, a battery creates a constant change of voltage (potential difference) between its + and − sides.

High voltage



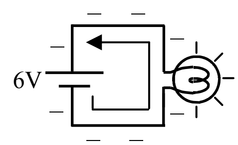
Low voltage

Conventional current.

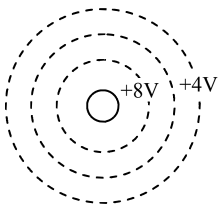


So, a battery makes it easy to remember that + charges move toward lower voltages (high to low)…

What's really happening.



…and − charges go toward higher voltages (low to high V).



3. The dashed lines on the diagram at the left show the equipotential lines (which you should now recognize) around an unknown charge.

A. Do positive charges move toward higher or lower electric potential?

B. Remembering that electric field lines point the direction a + charge would move, draw the electric field lines around the charge.

C. Is the unknown charge positive or negative?

D. Draw the correct sign in the circle.

3A: lower

3B: radially outward, toward lower voltage

3C: Obviously positive

3D: +