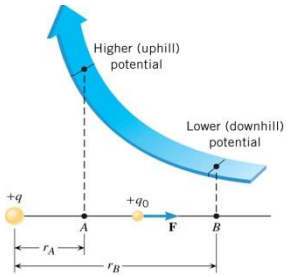
Physics 08-07 Electric Potential Due to a Point Charge and Equipotential Lines Name: _____

Electric Potential of a Point Charge

$$V = \frac{kq}{r}$$

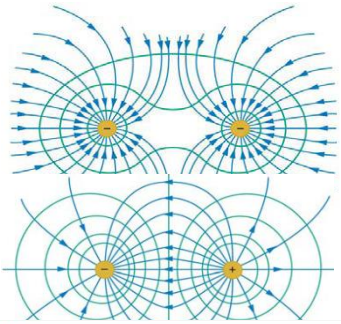


- V is _____ the _____ potential
- V _____ the potential difference if a test charge were _____ to a distance of r from _____
- Two or more charges
  - Find the _____ due to _____ charge at that location
  - _____ the potentials together to get the _____ potential

Two charges are 1 m apart. The charges are +2 μC and -4 μC. What is the potential 1/3 of the way between them?

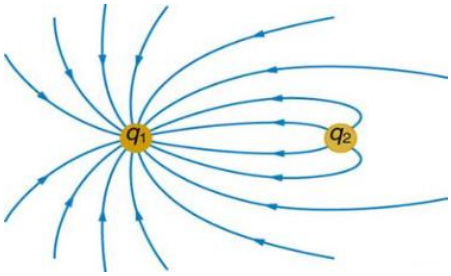
How much work is done ($-W = PE_f - PE_0$) to bring two electrons to a distance of 5.3×10^{-11} m to the nucleus of a Helium atom ($q = 3.2 \times 10^{-19}\ C$)?

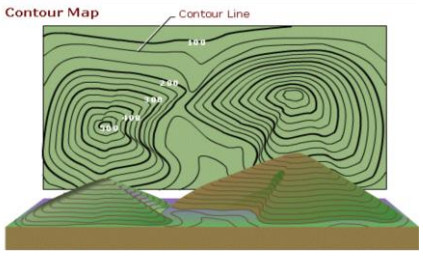
Equipotential Lines



- Lines where the electric _____ is the _____
- Perpendicular to _____
- No _____ is required to move charge along _____ line since $q\Delta V = 0$

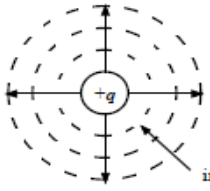
Sketch the equipotential lines in the vicinity of two opposite charges, where the negative charge is three times as great in magnitude as the positive.

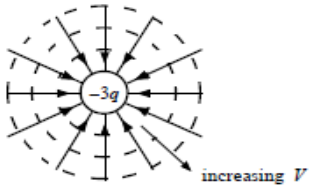




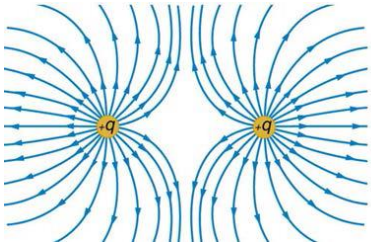
Homework

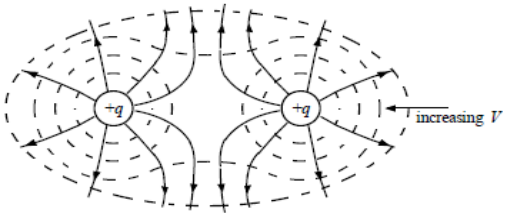
1. What is an equipotential line? What is an equipotential surface?
2. Explain in your own words why equipotential lines and surfaces must be perpendicular to electric field lines.
3. Can different equipotential lines cross? Explain.
4. Imagine that you are moving a positive test charge along the line between two identical point charges. With regard to the electric potential, is the midpoint on the line analogous to the top of a mountain or the bottom of a valley when the two point charges are (a) positive and (b) negative? Explain.
5. The potential at a point in space has a certain value, which is not zero. Is the electric potential energy the same for every charge that is placed at that point? Explain.
6. What is the potential 0.530×10^{-10} m from a proton (the average distance between the proton and electron in a hydrogen atom)? (OpenStax 19.25) **27.2 V**
7. (a) A sphere has a surface uniformly charged with 1.00 C. At what distance from its center is the potential 5.00 MV? (b) What does your answer imply about the practical aspect of isolating such a large charge? (OpenStax 19.26) **1.80 km**
8. How far from a 1.00 μC point charge will the potential be 100 V? At what distance will it be 2.00×10^2 V? (OpenStax 19.27) **90.0 m, 45.0 m**
9. What are the sign and magnitude of a point charge that produces a potential of –2.00 V at a distance of 1.00 mm? (OpenStax 19.28) $\mathbf{-2.22 \times 10^{-13}\ C}$
10. In nuclear fission, a nucleus splits roughly in half. (a) What is the potential 2.00×10^{-14} m from a fragment that has 46 protons in it? (b) What is the potential energy in MeV of a similarly charged fragment at this distance? (OpenStax 19.30) $\mathbf{3.31 \times 10^6\ V}$, **152 MeV**
11. (a) What is the potential between two points situated 10 cm and 20 cm from a 3.0 μC point charge? (b) To what location should the point at 20 cm be moved to increase this potential difference by a factor of two? (OpenStax 19.34) $\mathbf{135 \times 10^3\ V}$, **∞**
12. (a) Sketch the equipotential lines near a point charge $+q$. Indicate the direction of increasing potential. (b) Do the same for a point charge $-3q$. (OpenStax 19.36)



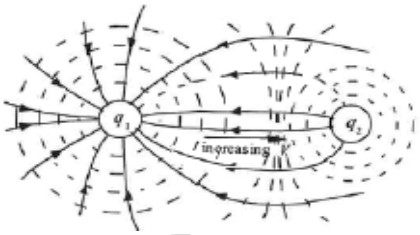


13. Sketch the equipotential lines for the two equal positive charges shown in the figure. Indicate the direction of increasing potential. (OpenStax 19.37)





14. The figure below shows the electric field lines near two charges q_1 and q_2, the first having a magnitude four times that of the second. Sketch the equipotential lines for these two charges, and indicate the direction of increasing potential. (OpenStax 19.38)



15. Sketch the equipotential lines a long distance from the charges shown in the figure below. Indicate the direction of increasing potential. (OpenStax 19.39)