PHYS 1220-02 Group Work Sheet
Electric Potential

Some useful physical constants:

Permittivity of free space	ε_0	$8.854\times10^{-12}\ C^2/(N\cdot m^2)$
Coulomb constant	$k = 1/(4\pi\varepsilon_0)$	$8.9876\times10^{9}\ N\cdot m^2/C^2$
Elementary charge	e	$1.6022\times10^{-19}\ C$

23.1 A point charge $q_1 = +2.40\ \mu C$ is held stationary at the origin. A second point charge $q_2 = -4.30\ \mu C$ moves from the point $x = 0.150$ m, $y = 0$ to the point $x = 0.250$ m, $y = 0.250$ m. How much work is done by the electric force on q_2?

23.3 How much work is needed to assemble an atomic nucleus containing three protons if we model it as an equilateral triangle of side 2.00×10^{-15} m with a proton at each vertex? Assume that the protons started from very far away.

23.22 Two positive point charges, each of magnitude q, are fixed on the y-axis at the points $y = +a$ and $y = -a$. Take the potential to be zero at infinite distance from the charges.

a. Show the positions of the charges in a diagram.

b. What is the potential V_0 at the origin?

c. Show that the potential at any point on the x-axis is $V = \frac{1}{4\pi\epsilon_0}\frac{2q}{\sqrt{a^2+x^2}}$

d. Graph the potential on the x-axis as a function of x over the range from $x = -4a$ to $x = +4a$.

e. What is the potential when $x \gg a$? Explain why this result is obtained.

23.29 A uniform electric field has magnitude E and is directed in the negative x-direction. The potential difference between point a (at $x = 0.60$ m) and point b (at $x = 0.90$ m) is 240 V.

a. Which point, a or b, is at the higher potential?

b. Calculate the value of E.

c. A negative point charge $q = -0.200\ \mu$C is moved from b to a. Calculate the work done on the point charge by the electric field.

23.61 A long metal cylinder with radius a is supported on an insulating stand on the axis of a long, hollow, metal tube with radius b. The positive charge per unit length on the inner cylinder is λ, and there is an equal negative charge per unit length on the outer cylinder.

a. Calculate the potential $V(r)$ for

i. $r < a$;

ii. $a < r < b$;

iii. $r > b$.

Take $V = 0$ at $r = b$.

b. Show that the potential of the inner cylinder with respect to the outer is $V_{ab} = \frac{\lambda}{2\pi\epsilon_0}\ln\left(\frac{b}{a}\right)$.

c. Show that the electric field at any point between the cylinders has the magnitude $E(r) = \frac{V_{ab}}{ln(b/a)}\frac{1}{r}$.

d. What is the potential difference between the cylinders if the outer cylinder has no net charge?

23.68 Alpha particles (mass = 6.7×10^{-27} kg, charge = +2*e*) are shot directly at a gold foil target. We can model a gold nucleus as a uniform sphere of charge and assume that it does not move. If the radius of the gold nucleus is 5.6×10^{-15} m, what minimum speed do the alpha particles need when they are far away to reach the surface of the gold nucleus?