Part 1 – "Intelligently Designing" an Electric Field

i. Create a simple (but not trivial) Electric field. Your E-field must have an x, y, and z component, a non-zero divergence ($\nabla \bullet \vec{E} \neq 0$), and must also vanish at infinity.

ii. Sketch your E-field. What charge distribution would cause this field?

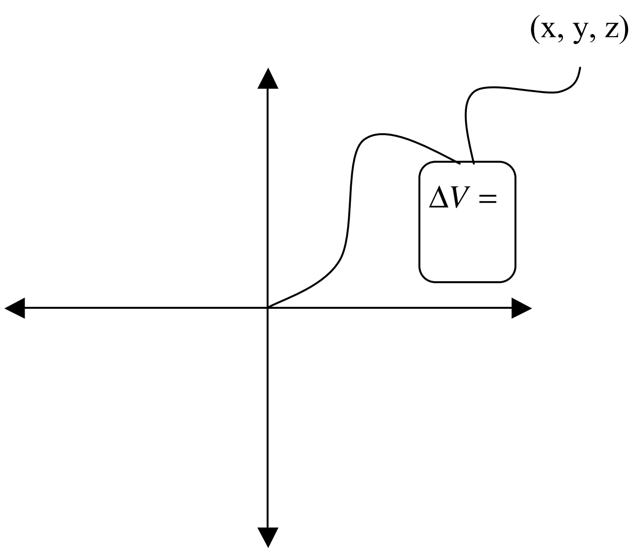
iii. Find the E-field flux through the surface of a closed volume (of your choice). Can you give a reason why you get a positive, negative, or zero answer?

iv. Static E-fields have zero curl, $\nabla \times \vec{E} = 0$. If need be, modify yours so that it satisfies this requirement. But make sure it still satisfies the previous requirements (i.e. it must still have an x, y, and z component, a non-zero divergence ($\nabla \bullet \vec{E} \neq 0$), and must also vanish at infinity).

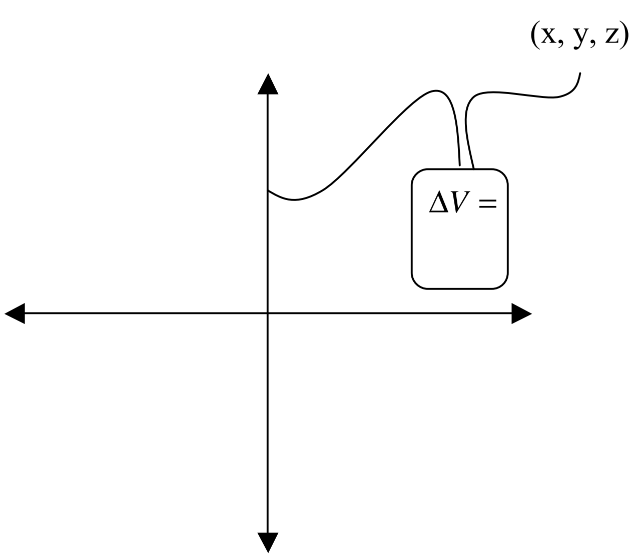
Part 2 – Measuring Electric Potential

Now, your Electric field is physically plausible. If you had a multimeter, you could measure potential differences between any two points in space (if you had long enough leads).

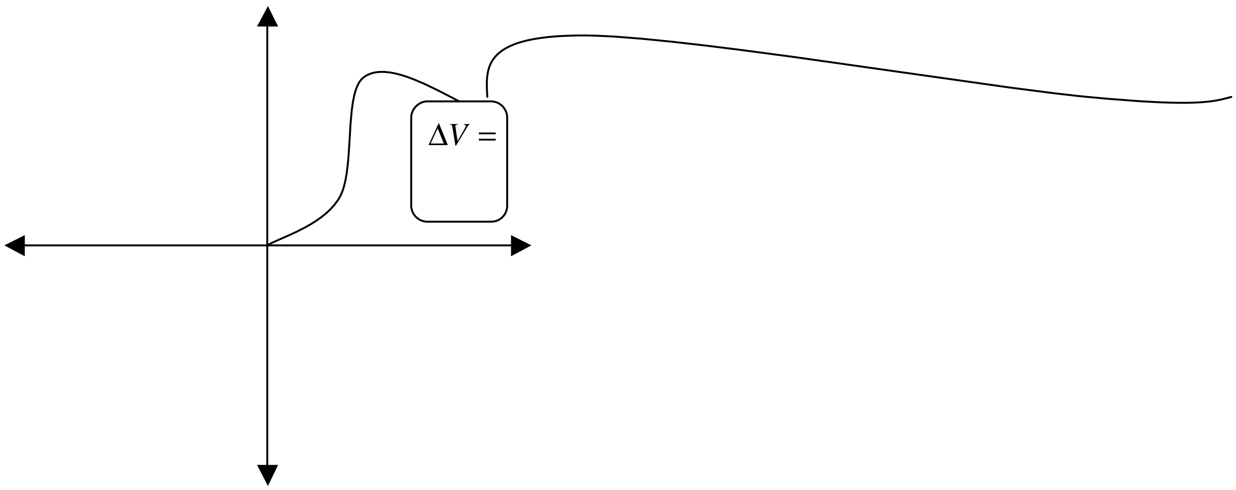
i. Calculate the potential difference you would expect to measure between the origin, and some arbitrary point (x, y, z). Choose two different paths to integrate over, and compare these two answers.



ii. Instead of using the origin as a reference point (ground) for your potential, use another point. How can you reconcile the previous answers with this one?



iii. Finally, if you had a really long lead, find the potential difference between the origin and far, far away. Why would someone choose far, far away as a reference point?



Challenge problem: