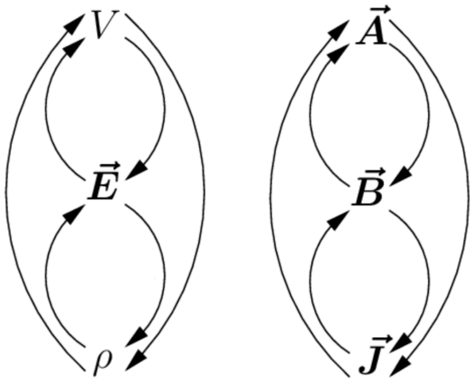
- Physics Content Learning Objectives

    1. Calculate electrostatic and magnetostatic fields from both discrete and continuous distributions of sources.



    2. Choose an origin, coordinates, and physical arguments like superposition to turn a generic iconic equation into an elaborated equation that could be evaluated with a computer.

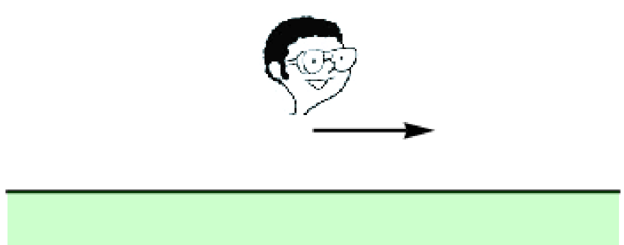
$$\vec{V}(\vec{r}) = k\frac{Q}{r} \tag{1}$$

$$\Rightarrow \frac{1}{4\pi\epsilon_0}\int \frac{\rho(r')\,d\tau'}{|\vec{r}-\vec{r}'|} \tag{2}$$

$$\Rightarrow \frac{1}{4\pi\epsilon_0}\frac{Q}{2\pi}\int_0^{2\pi} \frac{d\phi'}{\sqrt{s^2+R^2-2sR\cos(\phi-\phi')+z^2}} \tag{3}$$

$$\tag{4}$$

    3. Use symmetry arguments and Gauss's and Ampère's Laws in integral form to find electrostatic and magnetostatic fields in highly symmetric situations.



    4. Use Maxwell's equations in differential form to find sources from static fields.

$$\vec{\nabla}\cdot\vec{E} = \frac{\rho_0}{\epsilon_0}$$

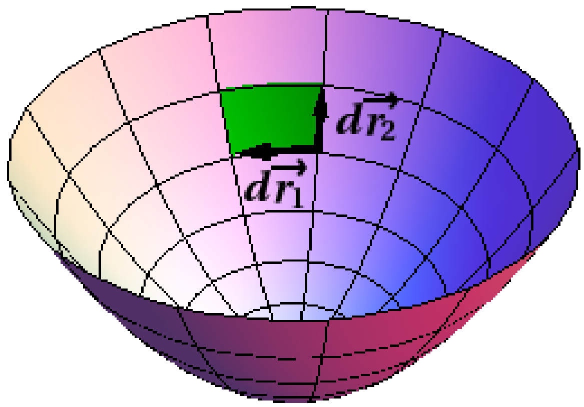
$$\vec{\nabla}\times\vec{B} = \mu_0\,\vec{J}$$

- Mathmatics Content Learning Objectives

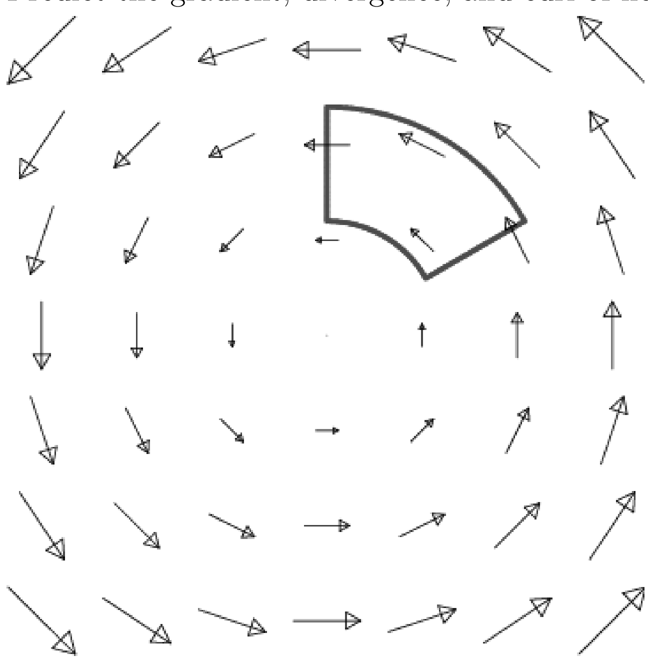
    1. Use power and Laurent series to approximate fields in regions very far or very near the sources.

$$V(x,0,0) = \frac{Q}{4\pi\epsilon_0}\frac{2}{|x|}\left(1-\frac{1}{2}\frac{D^2}{x^2}+\frac{3}{8}\frac{D^4}{x^4}+...\right) \qquad \text{for}|x|>D$$

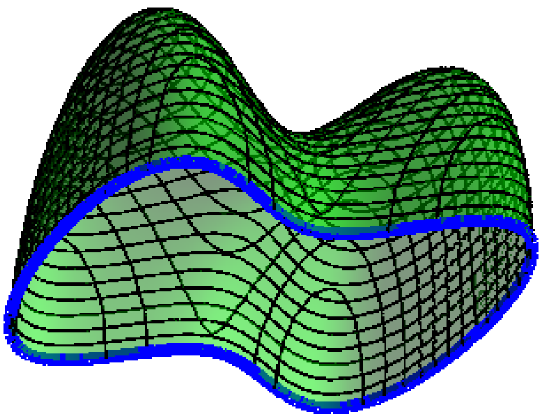
2. Use the "chop, multiply, add" method and $d\vec{r}$ to set up and analyze the structure of line, surface, flux, and volume integrals in rectangular, cylindrical, and spherical coordinates.



3. Predict the gradient, divergence, and curl of fields from graphical representations.

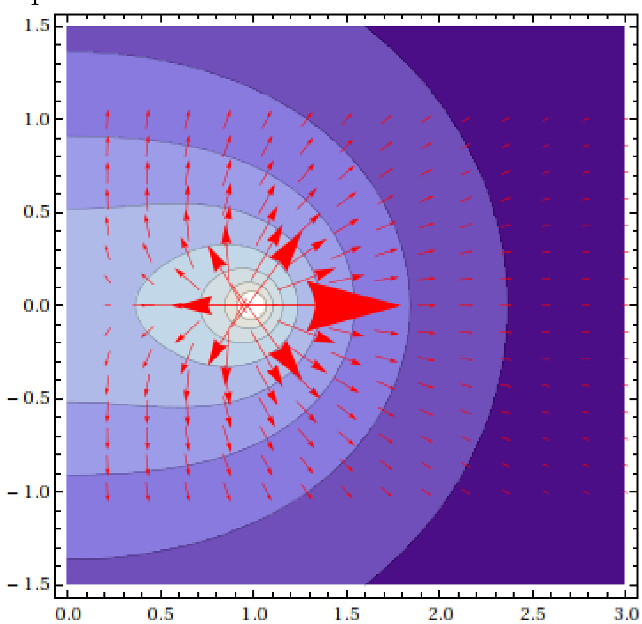


4. Experience how simple geometric arguments can be used to prove the big vector calculus theorems (Divergence and Stokes') and then how the theorems are used to transform the integral form of Maxwell's equations to the differential form.



- Sensemaking Learning Objectives

    1. Coordinate verbal, graphical, geometric, diagrammatic, and algebraic representations of sources and fields.
    2. Use physical situations with simple geometries as idealized building blocks for more complicated physical situations.
    3. Use the symmetries of physical situations to check the validity of symbolic and graphical representations of those situations.



    4. Without panicking, break up a complicated algebraic problem into separate pieces related to the physical situation.

$$\vec{B}(\vec{r}) = \frac{\mu_0}{4\pi}\int \frac{\vec{J}(\vec{r}') \times (\vec{r}-\vec{r}')\,d\tau'}{|\vec{r}-\vec{r}'|^3}$$