Fields and Waves

Lesson 3.3

MAGNETOSTATICS
- the Vector Potential

Darryl Michael/GE CRD

Introduction to Vector Potential, $\vec{A}$

Previous lesson we used: $\oint \vec{H} \bullet d\vec{l} = \int \vec{j} \bullet d\vec{s} = I_{net}$

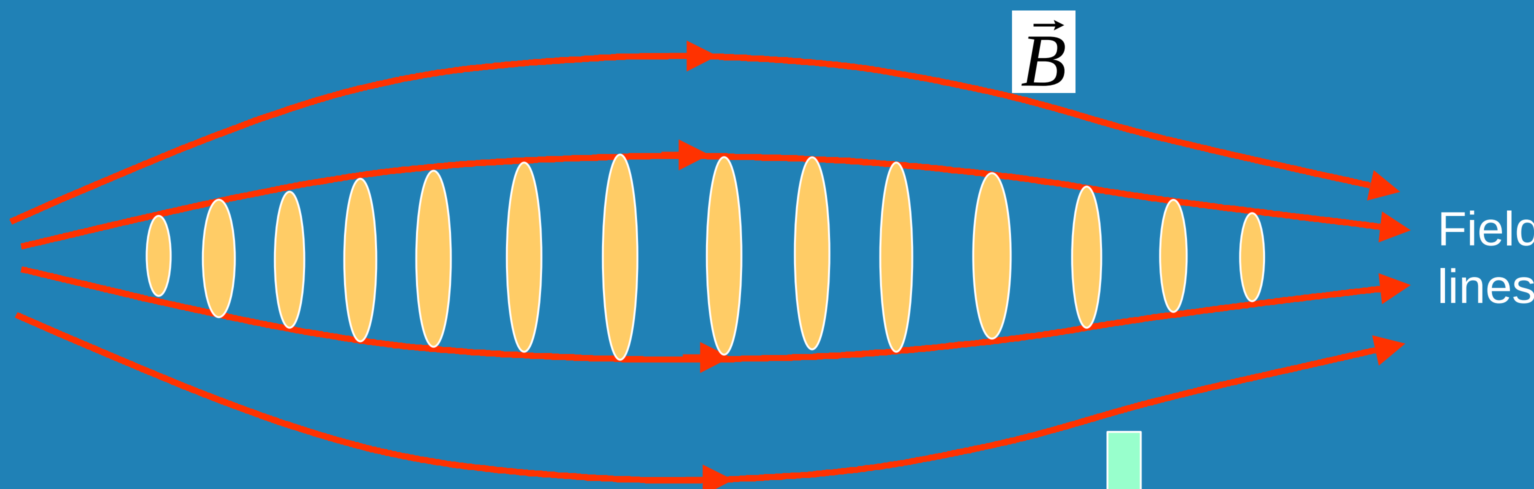
This lesson we will look at the effect of

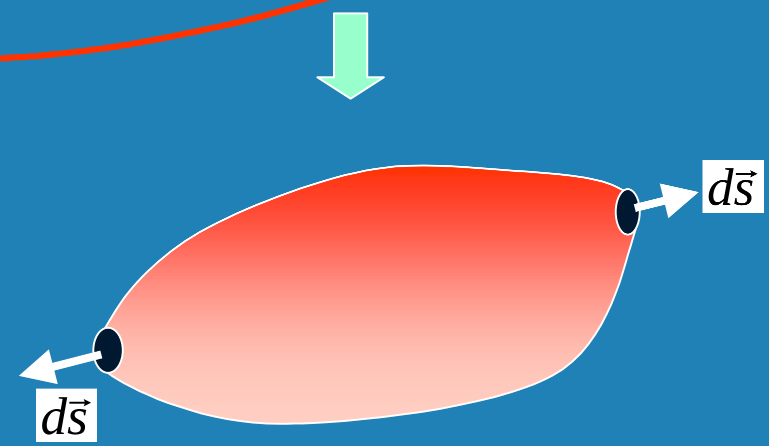
$$\nabla \bullet \vec{B} = 0 \Rightarrow \oint \vec{B} \bullet d\vec{s} = 0$$

This surface integral encloses the volume

Recall, $\nabla \bullet \vec{B} = 0 \Rightarrow \int \nabla \bullet \vec{B} \cdot dv = \oint \vec{B} \bullet d\vec{s} = 0$

Concept of Flux Tubes





Along sides: $\vec{B}\perp d\vec{s}$

$$\therefore \vec{B}\bullet d\vec{s} = 0$$

$$\therefore \oint \vec{B}\bullet d\vec{s} = \int_{left} \vec{B}\bullet d\vec{s} + \int_{right} \vec{B}\bullet d\vec{s}$$

Define Flux, $\Psi \equiv \int \vec{B}\bullet d\vec{s}$, enters from left and leaves to the right

Concept of Flux Tubes

Do Problem 1:

- implications are that, $\vec{B}$ lines close on themselves
  - no beginning or end

- in contrast, static $\vec{E}$ lines start & end on charges

Do Problem 2a

Magnetic Vector Potential, $\vec{A}$

In electrostatics: $\nabla \times \vec{E} = 0 \Rightarrow \vec{E} = -\nabla V$

In magnetostatics: $\nabla \bullet \vec{B} = 0$

- there is a math theorem that states :

$$\nabla \bullet \left(\nabla \times \vec{F} \right) = 0$$, for any $\vec{F}$

- this means that you can find $\vec{A}$, with $\vec{B} \equiv \nabla \times \vec{A}$

Note: • *more than one* $\vec{A}$ *possible*

• *like* V , $\vec{A}$ *can be easier to work with than the field*

Flux and Vector Potential

Do problems 2b and 2c

$\vec{A}$ is related to Flux

$$\Psi = \int \vec{B} \bullet d\vec{s} = \int \nabla \times \vec{A} \bullet d\vec{s} = \oint \vec{A} \bullet d\vec{l}$$

After some math….

Alternative way to find FLUX