Physics 221. Electromagnetics

Lecture 1.

Assignment #1: Due Friday.
2.5, 2.9. 2.19, 2.22.
2.25.

- Course Introduction.

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http://www.sfu.ca/~mxchen/

TA: Mehran Shaghaghi

Course webpage:

Textbook + CD Rom.

Grading:
5% Attendence of Tutorial.
10% Homework.
15% Midterm #1. (May 30.)
20% Midterm #2 (July 4)

Final Exam: 50% OR More.

Suggestion: Review Math 251.

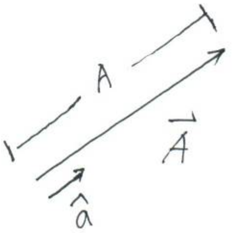
On how to deal with vectors

why? $\vec{E}$, $\vec{B}$ are vectors.

Review of Vector Algebra.

- Definition

vector $\vec{A}$



$\vec{A} = A\,\hat{a}$: magnitude : $A = |\vec{A}|$

direction : $\hat{a}$ (unit vector along $\vec{A}$)

$$\hat{a} = \frac{\vec{A}}{A}, \quad |\hat{a}| = 1.$$

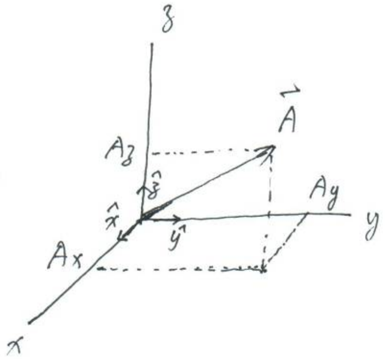
Cartesian components.

$\vec{A} = A_x\,\hat{x} + A_y\,\hat{y} + A_z\,\hat{z}$

$\hat{x}$, $\hat{y}$, $\hat{z}$ — base vectors

$(\vec{i}, \vec{j}, \vec{k})$

A_x, A_y, A_z — components



- Addition and subtraction of vectors.

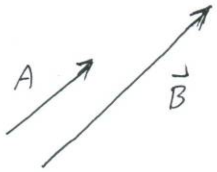
Method 1. Tip-to-tail.

Method 2. use components. — most useful.

- Multiplication

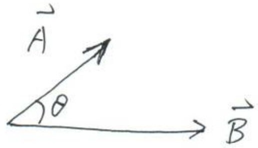
— Simple product.

$$\vec{B} = \underset{\text{scalar}}{k} \cdot \underset{\text{vector}}{\vec{A}}$$



— Dot product (scalar product)

$$\vec{A} \cdot \vec{B} = A\,B \cos\theta$$



e.g.: work by a force $\vec{F}$.

$$W = \vec{F} \cdot \Delta\vec{X}$$

$\Delta\vec{x}$ — displacement.
(distance)

Component form:

$$\vec{A} \cdot \vec{B} = A_x B_x + A_y B_y + A_z B_z \ .$$

- Cross product (vector product)

$$\vec{A} \times \vec{B} = \hat{n}\, AB \sin\theta$$

$\hat{n}$ — normal to the plane containing $\vec{A}$ and $\vec{B}$

$\vec{A} \times \vec{B}$: The result is a vector.

Direction obeys the right-hand rule.

magnitude $= A \cdot B \cdot \sin\theta$ (area of parallelogram).

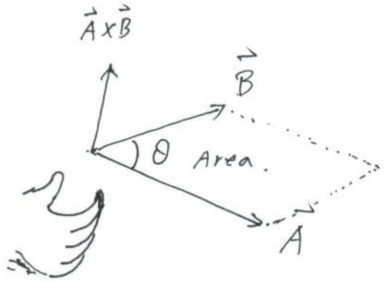
θ — angle between $\vec{A}$ and $\vec{B}$

$\hat{n} \perp \vec{A}$

$\hat{n} \perp \vec{B}$

($(\vec{A} \times \vec{B}) \perp \vec{A}$

$(\vec{A} \times \vec{B}) \perp \vec{B}$

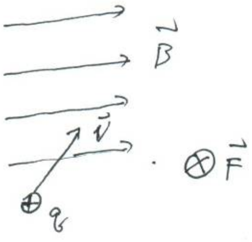


e.g. A charge q moving in a magnetic field $\vec{B}$

The force on q is:

$$\vec{F} = q \vec{v} \times \vec{B}.$$

$\vec{F}$: into the page.



From the right-hand rule.

$$\vec{A} \times \vec{B} = -\vec{B} \times \vec{A} \quad (\text{anticommutative})$$

$$(\vec{A} \times \vec{B} \neq \vec{B} \times \vec{A})$$

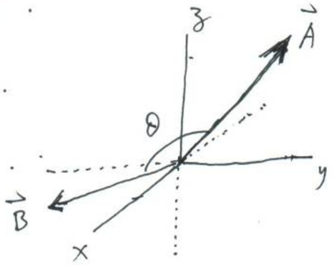
Component form:

$$\vec{A} \times \vec{B} = \begin{vmatrix} \hat{x} & \hat{y} & \hat{z} \\ A_x & A_y & A_z \\ B_x & B_y & B_z \end{vmatrix}$$

e.g. Given $\vec{A} = 2\hat{x} + 3\hat{y} + 3\hat{z}$.

$\vec{B} = -\hat{x} - 5\hat{y} - \hat{z}$.

Find the angle between $\vec{A}$ and $\vec{B}$.



[solution]: $\vec{A} \cdot \vec{B} = A B \cos\theta$.

$$\cos\theta = \frac{\vec{A} \cdot \vec{B}}{A B}$$

$$= \frac{A_x B_x + A_y B_y + A_z B_z}{\sqrt{A_x^2 + A_y^2 + A_z^2}\sqrt{B_x^2 + B_y^2 + B_z^2}}$$

$$= \frac{-2 - 15 - 3}{\sqrt{2^2 + 3^2 + 3^2}\sqrt{1 + 5^2 + 1}}$$

$$= \frac{-20}{\sqrt{22}\sqrt{27}}. \qquad \theta = 145.1^\circ.$$

- Scalar triple product

$$\vec{A}\cdot(\vec{B}\times\vec{C}) = \vec{B}\cdot(\vec{C}\times\vec{A}) = \vec{C}\cdot(\vec{A}\times\vec{B})$$

$$\vec{A}\cdot(\vec{B}\times\vec{C}) = \begin{vmatrix} A_x & A_y & A_z \\ B_x & B_y & B_z \\ C_x & C_y & C_z \end{vmatrix}$$

- Vector triple product.

$$\vec{A}\times(\vec{B}\times\vec{C}) = \vec{B}(\vec{A}\cdot\vec{C}) - \vec{C}(\vec{A}\cdot\vec{B})$$

Note: $\vec{A}\times(\vec{B}\times\vec{C}) \neq (\vec{A}\times\vec{B})\times\vec{C}$

(Doesn't obey the associative law).

i.e, $\vec{B}\times\vec{C}$ first.

Then $\vec{A}\times(\vec{B}\times\vec{C})$