Phys 221. Electromagnetics.

Lecture 1.

Assign. # 1. Due Friday.
May 8, @ 10:20 am
(assignment box)

1. page 44. # 2.5.
2. handout.

- Course Introduction.

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Course web page: ~mxchen/phys2210902/info221.htm.

Textbook & CD Rom.

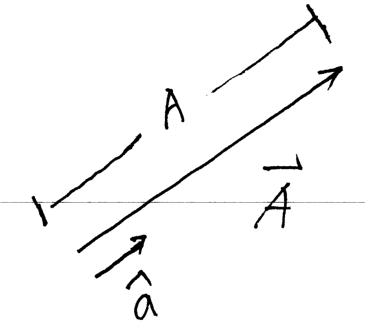
Grading: 5% attendence of tutorial.
10% homework.
15% midterm # 1. (May 29)
20% midterm # 2 (July 3)
Final Exam: 50% OR more.

- Suggestion: Review Math 251. on vectors.
($\vec{E}$, $\vec{B}$ are vectors!)

Review of Vector Algebra.

- Definition

vector $\vec{A}$

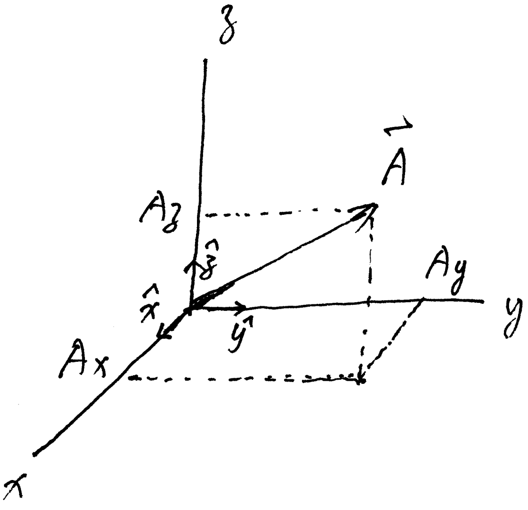


$\vec{A} = A\hat{a}$: magnitude : $A = |\vec{A}|$

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.

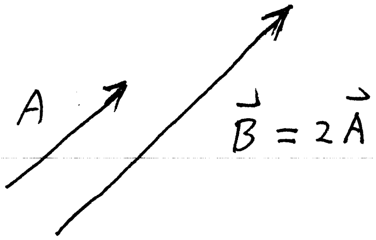
Method 1. Tip-to-tail.

Method 2. use components. — most useful.

- Multiplication

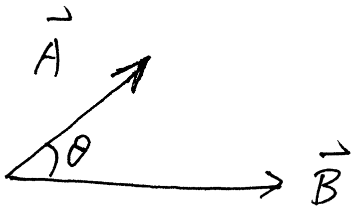
— Simple product.

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



— Dot product (scalar product)
The result is a scalar.

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



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).

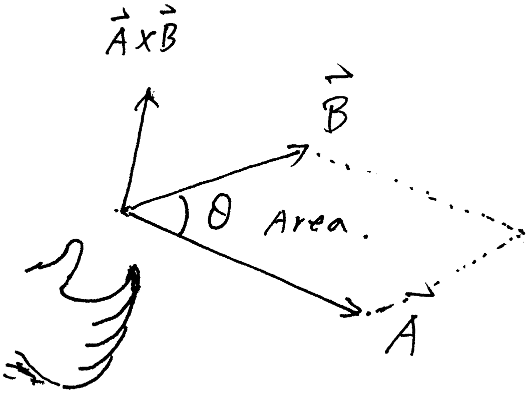
θ — angle between $\vec{A}$ and $\vec{B}$

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

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

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

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

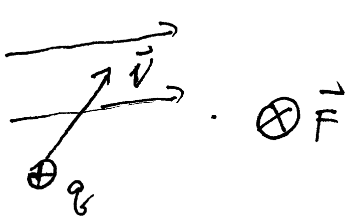


e.g. A charge q moving in a magnetic field $\vec{B}$

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:

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

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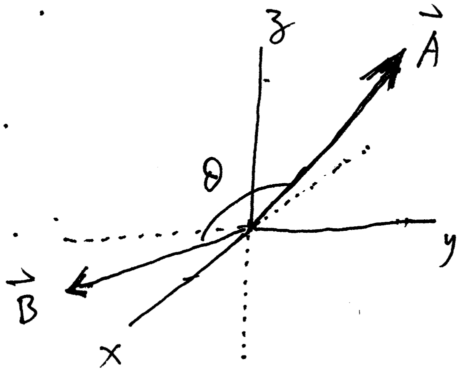
e.g. Given $\vec{A} = 2\hat{x} + 3\hat{y} + 3\hat{z}$.

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

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