Note Title 2/8/2012

- Textbook, chapters, exam schedule, grading etc..
  physics website.
- Contact info: Emre Kahya, 285-6993

iti email: next week

- Might have to start at $8^{45} \rightarrow 9^{00}$
- I will post my office hr. next week with proper email.
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Ch1. Units, Physical Quantities and Vectors

Physics: mathem. description of the universe.

- Units: without units numbers have no meaning

12 cm = Length

$1k = 10^3$ $1n = 10^{-9}$ $1.2\,ns = 1.2 \times 10^{-9}\,s$

$1M = 10^6$

$1G = 10^9 \rightarrow 1Gm = 10^9\,m$

M, L, T

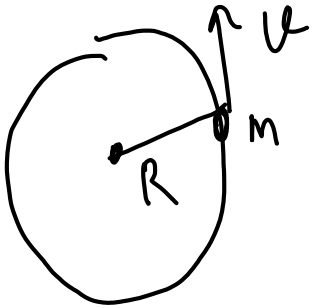
mass length time

Conversion of units:

- ounce

$$\text{Velocity} = \frac{L}{T}$$

, $\text{Momentum} = \vec{P} = m\vec{v} = M * \frac{L}{T}$



$F \propto m$

$F \propto \frac{1}{R}$

$F \propto v$

$F = ma = \frac{mv}{T}$

$$F = \frac{Mv^2}{R}$$

$$\vec{F} = m\vec{a} = \frac{mv}{T} = \frac{mL}{T^2} = \frac{kgm}{s^2} = (mass)^N (Radius)^L (vel)^K$$

dimension of force

$$M^N L^L \left(\frac{L}{T}\right)^K = M^1 L^1 T^{-2}$$

$$M^N = M^1 \Rightarrow N = 1$$

$$T^{-K} = T^{-2} \Rightarrow K = 2$$

$$L^{L+K} = L^1 \Rightarrow L+K = 1 \Rightarrow L+2 = 1 \Rightarrow L = -1$$

Conversion of units $\Rightarrow$ $u = \frac{\text{Length}}{\text{Time}} \Rightarrow \frac{m}{s}, \frac{km}{h}, \frac{cm}{h}$

$\frac{m}{s} \rightarrow \frac{km}{h} \Rightarrow$ $\frac{1m \rightarrow 1km}{1s \rightarrow 1hr.}$ $\quad 1m = 10^{-3}\,km \Rightarrow 1km = 10^{3}\,m$

$1s = \frac{1hr}{60 \times 60s} \Rightarrow 3600\,s = 1hr$

$1\frac{m}{s} = \frac{10^{-3}\,km}{hr/3600} = \frac{3600}{10^{3}}\frac{km}{h} = \boxed{3.6\frac{km}{h}}$

- Uncertainty and significant figures

Sig fig $\Rightarrow$ $\underline{2.91} \Rightarrow$ $2.9100 =$ 0.00291

↑↑ sig ↑↑↑

Measure something : mass of this desk ⇒ 2 kg ⇒ not exactly

2.05 ± 0.02 kg

Multiplication ⇒ least sig. figs. after dec.
Division

$0.745 \times 2.2 / 3.885 = \underline{0.42}$

$(1.32578 \times 10^{7}) \times (4.11 \times 10^{-3}) = 5.45 \times 10^{4}$

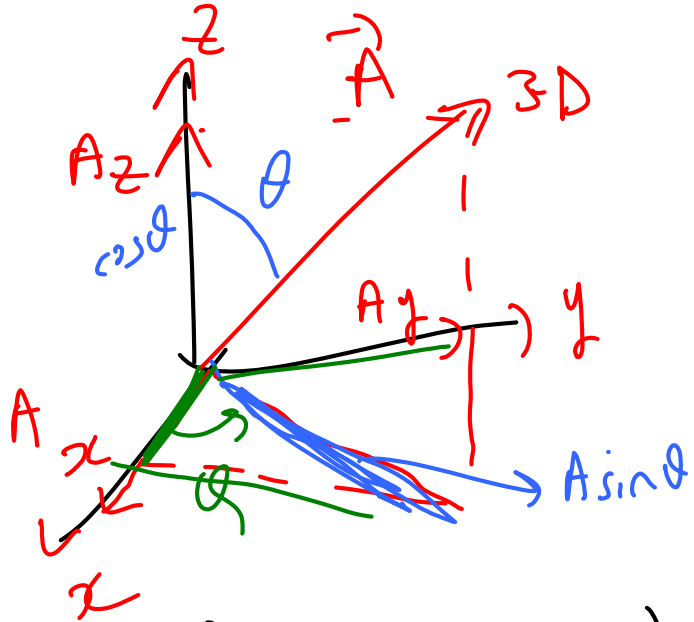
Addition
Sub

$27.153 + 138.2 - 11.74 = 153.6$

↑ 1 fig after dec. ↑ should have 1 also

- vectors : first fundamental thing in math is scalars.

- Vectors are defined by two prop:
  1) direction
  2) Magnitude



$A_y = A \sin\theta \sin\varphi$

$A_x = A \sin\theta \cos\varphi$

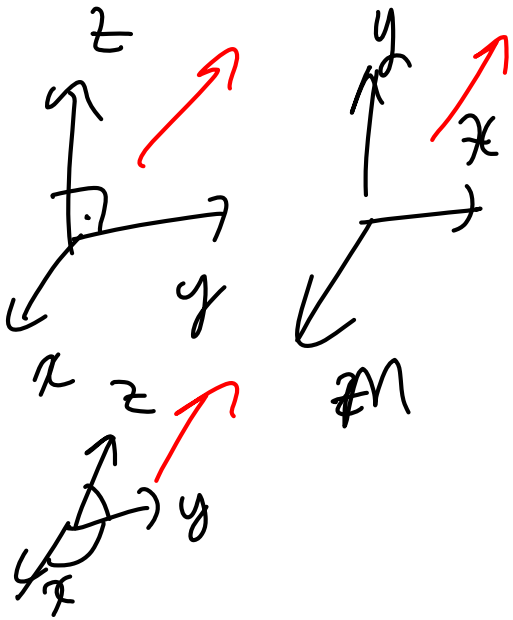
$A_z = A \cos\theta$

Vector	$\vec{A}$	$\vec{B}$	scalar
(x, y, z)	$(1, 3, -6)$	$(-1, 2, -3)$	= a number
			used
$(a, b, c) \longleftarrow$			(vector)

• Vectors : Add them, (Subtract them), Multiply, Nodiv.

Scalar multiplication (scalar product)

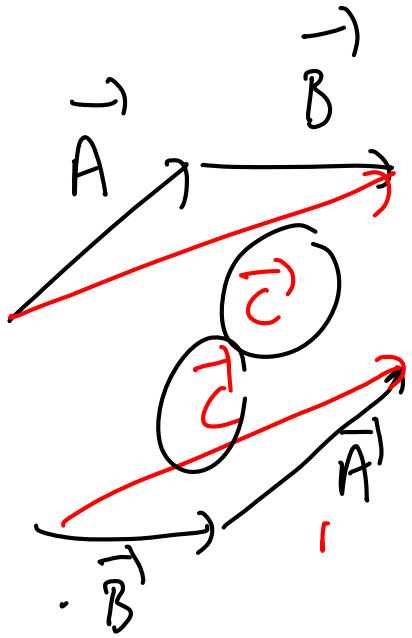
vector multiplication



Add vectors

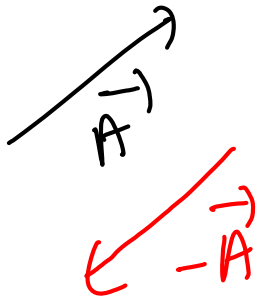
$\vec{A}+\vec{B}=C$

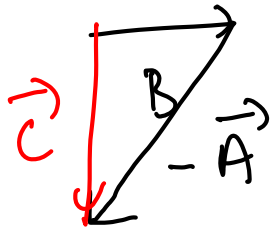
$\vec{B}+\vec{A}=C$



Subtracting vectors $\vec{B} - \vec{A} = \vec{B} + (-\vec{A})$

$\rightarrow \vec{B}$





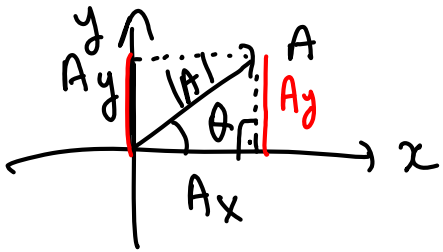
Inverse: $\vec{A} + \text{Inverse}\,\vec{A} = 0$

$\Rightarrow$ Inv. $\vec{A} = -\vec{A}$

Components of a vector: $\vec{A} = (A_x, A_y, A_z)$ (x, y, z)

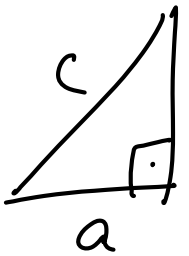
$|\vec{A}| = \sqrt{A_x^2 + A_y^2}$ ← magnitude

2-D $\Rightarrow$



$\Rightarrow A_y = |\vec{A}| \sin\theta$

$A_x = |\vec{A}| \cos\theta$



$a^2 + b^2 = c^2$

3D $|\vec{A}| = \sqrt{A_x^2 + A_y^2 + A_z^2}$

along y

Unit vectors : $\hat{i}$, $\hat{j}$, $\hat{k}$ — a vector with mag. of 1.

along x, along z axis

$\vec{A} = A_x \hat{i} + A_y \hat{j} + A_z \hat{k} \Rightarrow (A_x, A_y, A_z)$

$\vec{A} \pm \vec{B} = (A_x, A_y, A_z) \pm (B_x, B_y, B_z)$

$\vec{C} = (A_x \pm B_x, A_y \pm B_y, A_z \pm B_z)$

$\vec{C} = (A_x \pm B_x)\hat{i} + (A_y \pm B_y)\hat{j} + (A_z \pm B_z)\hat{k}$

x, y, z

$$\vec{A} = 3\hat{i} + 4\hat{j} - 2\hat{k}$$
$$\vec{B} = -2\hat{i} + 2\hat{j} - 3\hat{k}$$

$\vec{A} + \vec{B}$ =

$$\begin{array}{r} 3 \quad 4 \quad -2 \\ -2 \quad 2 \quad -3 \\ \hline 1 \quad 6 \quad -5 \end{array}$$

$\vec{A} + \vec{B} = \vec{C}$

$\vec{C} = \hat{i} + 6\hat{j} - 5\hat{k}$

$\vec{A} - \vec{B} = \vec{D}$ ⇒

$\vec{A} - \vec{B}$ =

$$\begin{array}{r} 3 \quad 4 \quad -2 \\ -2 \quad 2 \quad -3 \\ \hline 5 \quad 2 \quad 1 \end{array}$$

$\vec{D} = 5\hat{i} + 2\hat{j} + \hat{k}$

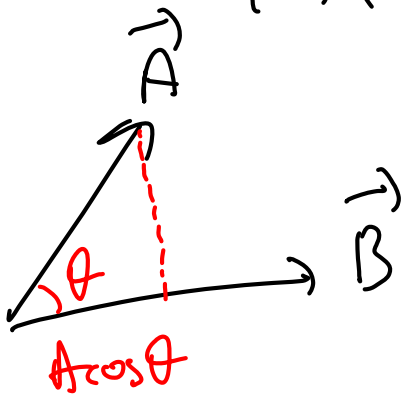
- Scalar Multiplication (dot/scalar product)

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

$\vec{A} \cdot \vec{B}$

$\vec{A}$ (A_x, A_y, A_z)

$\vec{B}$ (B_x, B_y, B_z)



$\vec{A} \cdot \vec{B} = (A_x B_x + A_y B_y + A_z B_z) \Rightarrow$ $A_x B_x + A_y B_y + A_z B_z$ = number

$|A||B|\cos\theta$

$\vec{A} = 3\hat{i} + 4\hat{j} - 2\hat{k}$

$\vec{B} = -2\hat{i} + 2\hat{j} - 3\hat{k}$

$\Rightarrow \begin{pmatrix} 3 & 4 & -2 \\ -2 & 2 & -3 \end{pmatrix}$

$-6 + 8 + 6 \rightarrow 8$

$\rightarrow (\sqrt{29})(\sqrt{17})\cos\theta = 8$

$\theta = \cos^{-1}\left[\frac{8}{\sqrt{29}\sqrt{17}}\right]$

$= 67°$

- Vector Product : $\vec{A} \times \vec{B} = \vec{C}$ $\quad |\vec{A}|\,|\vec{B}|\sin\theta = |\vec{C}|$

$\vec{A} = A_x\hat{i} + A_y\hat{j} + A_z\hat{k}$

$\vec{B} = B_x\hat{i} + B_y\hat{j} + B_z\hat{k}$

(A_x, A_y, A_z)

$\times \quad (B_x, B_y, B_z)$

$\hat{i}\times\hat{j} = \hat{k}$

$\hat{j}\times\hat{i} = -\hat{k}$

$\hat{i}\times\hat{i} = 0 = \hat{j}\times\hat{j} = \hat{k}\times\hat{k}$

$(A_yB_z \;,\; -A_xB_z \;,\; A_xB_y)$

$(-A_zB_y \;,\; A_zB_x \;,\; -A_yB_x)$

$$\vec{A}\times\vec{B} = \vec{C} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ A_x & A_y & A_z \\ B_x & B_y & B_z \end{vmatrix}$$

$$\vec{C} = (A_yB_z - A_zB_y)\hat{i} + (-A_xB_z + A_zB_x)\hat{j} + (A_xB_y - A_yB_x)\hat{k}$$

$$\vec{A} = 3\hat{i} + 4\hat{j} - 2\hat{k}$$
$$\vec{B} = -2\hat{i} + 2\hat{j} - 3\hat{k}$$

$$\vec{A} \times \vec{B} = \vec{C} = |\vec{A}||\vec{B}| \sin\theta$$

$$\sqrt{29} \quad \sqrt{17}$$

$$\left[(4)(-3) - (-2)(2)\right]\hat{i}$$

$$\left[-(3)(-3) + (-2)(-2)\right]\hat{j}$$

$$\left[(3)(2) - (4)(-2)\right]\hat{k}$$

$$\vec{C} = -8\hat{i} + 13\hat{j} + 14\hat{k}$$

$$|\vec{C}| = \sqrt{(-8)^2 + (13)^2 + (14)^2}$$

$$\sqrt{64 + 169 + 196} = \sqrt{429} = 20.71$$

$$\sin\theta = \frac{|\vec{A} \times \vec{B}|}{|A||B|} = \frac{20.71}{\sqrt{29 \times 17}} \simeq 68^\circ \Rightarrow$$