Vectors in 3 Dimensions

$$\vec{A} = \hat{\imath}A_x + \hat{\jmath}A_y + \hat{k}A_z$$

- Addition

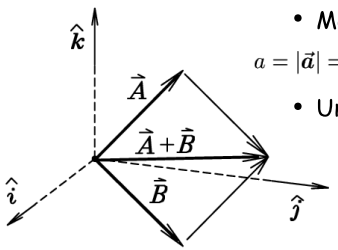
$$\vec{A} + \vec{B} = \hat{\imath}(A_x + B_x) + \hat{\jmath}(A_y + B_y) + \hat{k}(A_z + B_z)$$

- Scalar ("Dot") Product

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

- Vector ("Cross") Product

$$\vec{A} \times \vec{B} = \hat{\imath}(A_y B_z - a_z B_y) + \hat{\jmath}(A_z B_x - A_x B_z) + \hat{k}(A_x B_y - A_y B_x)$$

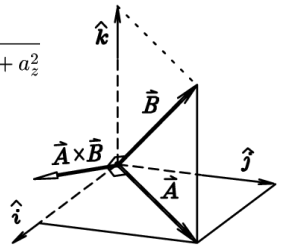


- Magnitude

$$a = |\vec{a}| = \sqrt{a_x^2 + a_y^2 + a_z^2}$$

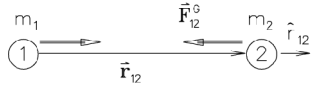
- Unit Vector

$$\hat{a} = \frac{\vec{a}}{a}$$



CHARGE!

Gravitational force:

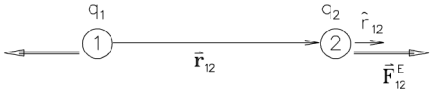


$$\vec{F}_{12}^{G} = -G\frac{m_1 m_2}{r_{12}^2}\hat{r}_{12}$$

$G = 6.67259\times10^{-11}\ \mathrm{m^3\,kg^{-1}\,s^{-2}}$

$m_e = 9.10939\times10^{-31}\ \mathrm{kg}$

Electrostatic force:



$$\vec{F}_{12}^{E} = k_E\frac{q_1 q_2}{r_{12}^2}\hat{r}_{12}$$

$k_E = 8.98755\times10^{9}\ \mathrm{V\,m\,C^{-1}}$

$q_e = 1.60217733\times10^{-19}\ \mathrm{C}$

Between 2 electrons, $F^G/F^E = 2.4\times10^{-43}$

Fundamental Constants

$c \equiv 2.99792458 \times 10^8$ m/s

$k_E \equiv 1/4\pi\epsilon_0 = c^2 \times 10^{-7} = 8.9875518 \times 10^9\ \mathrm{V\,m\,C^{-1}}$

$\epsilon_0 = 10^7 / 4\pi c^2 = 8.8542 \times 10^{-12}\ \mathrm{C^2\,N^{-1}\,m^{-2}}$