Equation sheet Exam 1 PHY2048

Chapter 1: Measurements, Estimation, Vectors

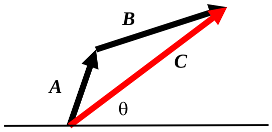
$\vec{A} - \vec{B} = \vec{C}$

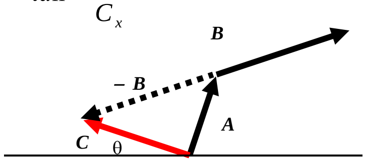
$A_x - B_x = C_x$

$A_y - B_y = C_y$

$|\vec{C}| = \sqrt{C_x^2 + C_y^2}$

$\theta = \tan^{-1}\dfrac{C_y}{C_x}$





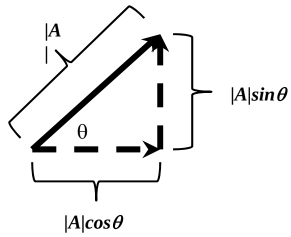
$\vec{A} + \vec{B} = \vec{C}$

$A_x + B_x = C_x$

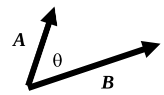
$A_y + B_y = C_y$

$|\vec{C}| = \sqrt{C_x^2 + C_y^2}$

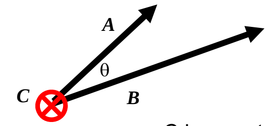
$\theta = \tan^{-1}\dfrac{C_y}{C_x}$



$\vec{A}\cdot\vec{B} = C = |\vec{A}||\vec{B}|\cos\theta = A_xB_x + A_yB_y + A_zB_z$



C is a scalar quantity that corresponds to the projection of A on B



C is a vector that is perpendicular to both vectors A and B

θ

$\vec{A}\times\vec{B} = \vec{D}$

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

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

Chapter 2&3: Motion in a Straight Line and in a Plane

Equations of motion that apply generally

$$\int_{x_0}^{x} d\vec{x} = \int_{t_0}^{t} \vec{v}(t)dt \rightarrow \vec{x} = \vec{x}_0 + \int_{t_0}^{t} \vec{v}(t)dt \qquad \int_{v_0}^{v} d\vec{v} = \int_{t_0}^{t} \vec{a}(t)dt \rightarrow \vec{v} = \vec{v}_0 + \int_{t_0}^{t} \vec{a}(t)dt$$

Displacement: A "vector" $\Delta\vec{r}$ that points between two locations. The vector begin at the initial location and ends at the final.

$$\text{displacement} = \Delta\vec{r} = \vec{r}_f - \vec{r}_i$$

Distance: A "scalar" quantity that describes the length of the path taken between

$$\text{distance} = |\Delta\vec{r}| = \sqrt{(x_f - x_i)^2 + (y_f - y_i)^2}$$

Definition of velocity and acceleration. note: velocity and acceleration are vector quantities

$$\vec{v}_{average} = \frac{\vec{x}_f - \vec{x}_i}{\Delta t}, \quad \vec{v}_{inst} = \lim_{\Delta t\to 0}\frac{\vec{x}_f - \vec{x}_i}{\Delta t} = \frac{d\vec{x}}{dt}$$

$$\vec{a}_{average} = \frac{\vec{v}_f - \vec{v}_i}{\Delta t}, \quad \vec{a}_{inst} = \lim_{\Delta t\to 0}\frac{\vec{v}_f - \vec{v}_i}{\Delta t} = \frac{d\vec{v}}{dt}$$

The equations of motion in 2 or 1 dimension when the acceleration is constant are given below. The time t is the quantity that is common to both dimensions for 2-D problems

$v_{2x} = v_{1x} + a_x t$

$x_2 = x_1 + v_{1x}t + \frac{1}{2}a_x t^2$

$v_{2x}^2 = v_{1x}^2 + 2a_x(x_2 - x_1)$

$v_{2y} = v_{1y} + a_y t$

$y_2 = y_1 + v_{1y}t + \frac{1}{2}a_y t^2$

$v_{2y}^2 = v_{1y}^2 + 2a_y(y_2 - y_1)$

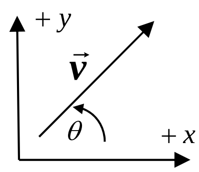
For projectile motion in the plane

$a_y = -g$

$a_x = 0$

$v_{(2/1)x} = v_{2/1}\cos\theta$

$v_{(2/1)y} = v_{2/1}\sin\theta$



For motion in a circle the acceleration vector points towards the center of the circle with a magnitude given by: $a_{rad} = \dfrac{v^2}{R}$

Chapter 4&5: Newton's Law and Applications

Newton's Laws of Motion

- 1st : A body at rest will remain at rest a body in motion will remain in motion unless acted upon by an external force

$$\sum \vec{F} = 0$$

- 2nd :The net sum of forces accelerates an object by an amount proportional to its mass and in the direction of the net forces.

$$\sum \vec{F} = m\vec{a}$$

- 3rd :For every action there is an opposite and equal reaction. Action reaction pairs never act on the same object

$$\vec{F}_{A\,on\,B} = -\vec{F}_{B\,on\,A}$$

Force of friction comes in two flavors. Static frictional forces apply when the object is at rest with respect to the surface. Kinetic frictional forces apply when the object is moving with respect to the surface. Both frictional forces always act parallel to the surface and are proportional to the normal force.

$\vec{F}_{friction} = \mu_k\vec{N}$

$\vec{F}_{friction} \le \mu_s\vec{N}$

Force due to spring is given by: $\vec{F}_{Spring} = -k\vec{x}$

Use FBD for spring problems, the sign of the force should be clear from the diagram