Date:

VECTORS

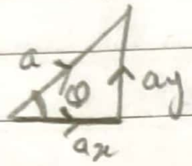
A vector is a quantity that has both magnitude and direction.

eg: velocity, displacement, acceleration and force

AC is the vector sum of AB and BC

- Components of vectors

Resolving vectors : $\boxed{a_x = a\cos\theta}$ $\boxed{a_y = a\sin\theta}$



$$\boxed{\begin{array}{c}\text{magnitude of } a = \sqrt{a_x^2 + a_y^2} \\ \tan\theta = a_y/a_x\end{array}}$$

- Unit vector

① $\vec{r} = xi + yj + zk$ ② $|r| = \sqrt{x^2 + y^2 + z^2}$

③ unit v. $\hat{r} = \dfrac{xi + yj + zk}{|r|}$

$\vec{a} = a_x\hat{i} + a_y\hat{j}$ $\vec{b} = b_x\hat{i} + b_y\hat{j}$

For, $r_x = a_x + b_x$

$r_y = a_y + b_y$

$r_z = a_z + b_z$

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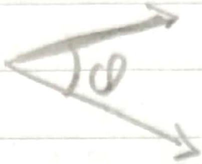
- Multiplying vectors.

$\vec{a} \cdot \vec{b} = |a||b| \cos\theta$

- for non-zero vectors
- if $\cos\theta = 0$, vectors are perpendicular.



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- Dot product.

$A \cdot B = AB \cos\theta$

$A \cdot \hat{i} = A \cos\theta = A_x$

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

- Vector Product.

$a \times b = ab \sin\theta$

$i \times j = k \qquad i \times k = j \qquad j \times k = i$

$A \times B = (A_y B_z - A_z B_y)i + (A_z B_x - A_x B_z)j + (A_x B_y - A_y B_x)k$

Date:

MOTION

- Displacement

$\Delta x = x_f(t_f) - x_i(t_i)$

vector quantity, unit = meters (m)

Has +ve and -ve direction

Displacement $\neq$ Distance

- Speed

scalar quantity, unit m/s or km/h

$$\boxed{\text{Avg. speed} = \frac{\text{T. dist}}{\text{T. time}}}$$

- Instantaneous speed : At a given instant in time
- Avg speed : Avg of all inst. speeds

- Velocity

vector quantity, m/s

$$\boxed{\text{Avg. velocity} = \Delta x / \Delta t} \qquad \boxed{\text{Inst. velocity} = dx/dt = \lim_{\Delta t \to 0} \Delta x/\Delta t}$$

~~Velocity is slope of position time graph.~~

- Inst. velocity : at a given istant
- Uniform velocity : const. velocity, inst. velocities are always same.

Date:

- Acceleration

$$\boxed{a_x = \frac{\Delta v_x}{\Delta t} = \frac{v_{xf} - v_{xi}}{t_f - t_i}}$$

- Inst. acc = $a_x = \lim_{\Delta t \to 0} \Delta v_x / \Delta t = dv_x/dt$
- Avg. acc : • non-uniform acceleration

Vector quantity, Rate of change of velocity,

units = m/s^2

- Equations:

(1) $v = u + at$

(2) $\cancel{s}\ \Delta x = \frac{1}{2}(u+v)t$

(3) $s = ut + \frac{1}{2}at^2$

(4) $v^2 = u^2 + 2as$

MOTION IN 2D

Position vector: $r = xi + yj + zk$

Displacement vector: $\Delta r = r_2 - r_1 = (x_2 - x_1)i + (y_2 - y_1)j + (z_2 - z_1)k$

- Avg velocity: $V_{avg} = \vec{\Delta r}/\Delta t = \frac{\Delta x}{\Delta t} i + \frac{\Delta y}{\Delta t} j + \frac{\Delta z}{\Delta t} k$

- Inst. velocity: $\vec{v} = d\vec{r}/dt$

Date:

- Average acceleration: $A_{avg} = \frac{\text{change in velocity}}{\text{time interval}}$

$$a_{avg} = \frac{v_2 - v_1}{\Delta t} = \frac{\Delta v}{\Delta t}$$

- Inst. acc = $dv/dt = \frac{dv_x}{dt} i + \frac{dv_y}{dt} j + \frac{dv_z}{dt} k$

FREE FALL / G. ACC

Terminal velocity, when the force of gravity on a falling object equals the force of air resistance going against gravity the obj stops accelerating

Circular Motion

- centripedal acc = v^2/r

$$T = 2\pi r/v$$

- Tangential and Radial acc:

$$\boxed{\text{Radial } (a_t) = \frac{d|v|}{dt}} \qquad \boxed{\text{Tangential } (a_r) = v^2/r}$$

Total $= a_r + a_t$

Date:

Projectile Motion

- Types:

Horizontal:

- velocity = const

Vertical:

- Force due to gravity
- Vertical comp changes with time

$V_{xf} = V \cos\theta$

$V_{yf} = V \sin\theta - gt$

- Equations:

X-compt:

$x_f = x_i + V_{xi} t$

Y-compt:

$y_f = y_i + V_{yi} - \frac{1}{2}gt^2$

$V_{yf}^2 = V_{yi}^2 - 2g\Delta y$

$V_{yf} = V_{yi} - gt$

Vectors:

$V_{xi} = V_i \cos\theta$ $\quad$ $V_{yi} = V_i \sin\theta$

Equation path: $y = (\tan\theta_0)x - \frac{gx^2}{2(V_0 \cos\theta_0)^2}$

Horizontal Range: $R = V_0^2/g \sin 2\theta_0$

Max height: $h = \frac{V_i^2 \sin^2\theta_i}{2g}$