# Acceleration Due to gravity

pen falls

0 •
1 •
2 • $\downarrow \vec{v}$ $\vec{a} \downarrow$ A) ↑ (B) ↓
3 •
4 •

speeding up
$\vec{v}$ & $\vec{a}$ are same direction

Without air resistance, everything on Earth falls with acceleration $g = 9.8\ m/s^2 \downarrow$

$9.8 \frac{m/s}{s}$

After 1s, object moving at 9.8 m/s

After 2s, 19.6 m/s

After 3s, 29.4 m/s

$1\ m/s = 2.2\ mi/hr$

throw pen up in the air

3 •
2 •
1 • $\vec{v} \uparrow$ $\vec{a} \downarrow$ A) ↑ B) ↓
0 •

At top of flight,

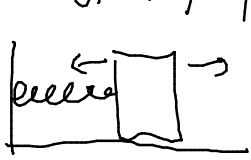
$\vec{v} = 0$

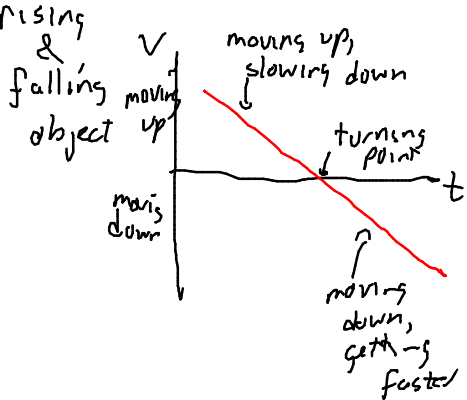
$\vec{a}$ at top: A) ↑ B) 0 (C) ↓

$\vec{a} = 9.8\ m/s^2 \downarrow$ even at top

You can have acceleration even if $\vec{v} = 0$

"turning point"

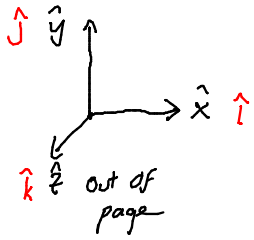



acceleration = slope of velocity vs time graph

$a = \frac{\Delta v}{\Delta t}$

To write vectors with numbers, we first need basis vectors

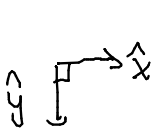


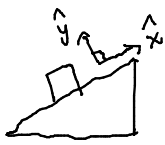

$\hat{x}$ is a unit vector which points in +x direction and has magnitude $|\hat{x}| = 1$.

A velocity of $5\ m/s$ in +x direction

$$\vec{V} = (5\ m/s)\,\hat{x}$$

We can choose other bases

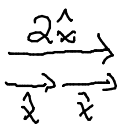


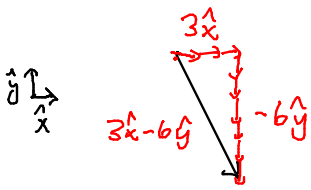

$\hat{x}$ & $\hat{y}$ & $\hat{z}$ must be perpendicular to each other

Write other vectors as sums of $\hat{x}, \hat{y}, \& \hat{z}$

e.g. $2\hat{x}$







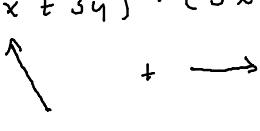

$-2\hat{x} + 3\hat{y}$

components of $\vec{A}$

$$\vec{A} = A_x\hat{x} + A_y\hat{y} + A_z\hat{z}$$

e.g. $\vec{A} = -2\hat{x} + 3\hat{y}$ $\quad A_x = -2$

$$(-2\hat{x} + 3\hat{y}) + (3\hat{x}) = (-2\hat{x} + 3\hat{x}) + 3\hat{y}$$




$= \hat{x} + 3\hat{y}$

$$3(-2\hat{x} + 3\hat{y}) = -6\hat{x} + 9\hat{y}$$

Magnitude

$\vec{F} = 1\hat{x} + 2\hat{y}\ N$ $\quad |\vec{F}| = ?$


$$|\vec{F}| = \sqrt{(1)^2 + (2)^2} = \sqrt{5}$$

Generally, $|\vec{A}| = \sqrt{A_x^2 + A_y^2 + A_z^2}$

e.g. $\vec{A} = -2\hat{x} + 3\hat{y} + 4\hat{z}$

$$|\vec{A}| = \sqrt{(-2)^2 + 3^2 + 4^2} = \sqrt{4 + 9 + 16}$$

$$= \sqrt{29} = 5.3!$$