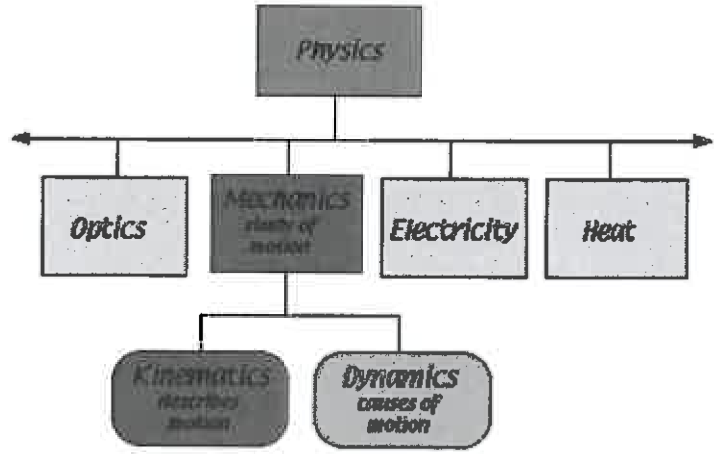
Introduction to Kinematics

Kinematics is the study of motion without regard for the cause.

- Uses position, velocity, and acceleration to explain what is happening.

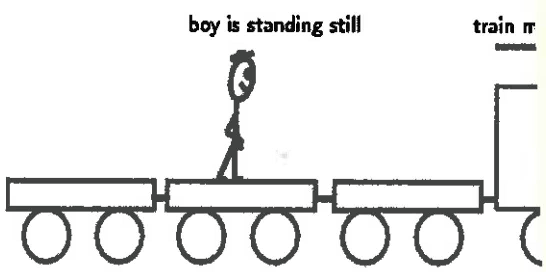
Dynamics is the study of the causes of motion.

- Considers initial conditions and laws of nature to explain why something is happening.



Motion is... the movement of an object relative to a reference point

A reference point (or frame of reference) is a random location from which the position of an object is being described.

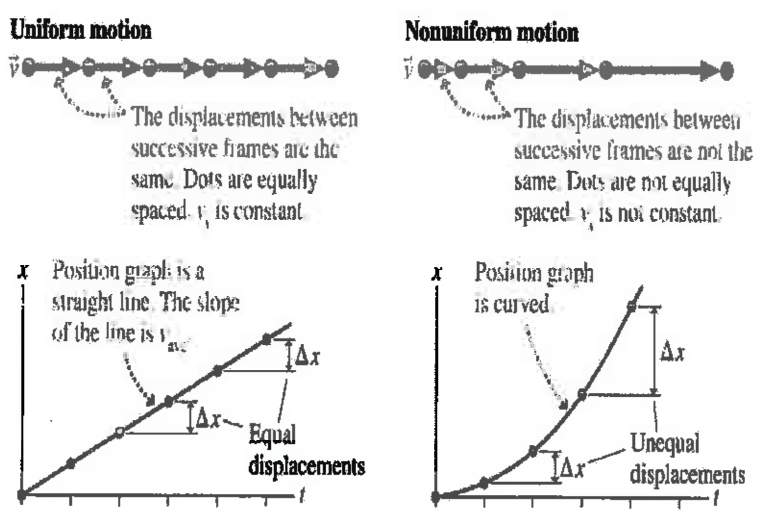


pop can on plane
video ~30s

From your frame of reference the boy is moving from left to right.

Uniform Motion is.... motion in one direction at a constant speed

Non-Uniform Motion is.... motion where speed and/or direction changes (ie velocity changes) called acceleration



where Δ = change in ; calculated as
$\Delta d = d_1 + d_2$ or $\Delta d = d_f - d_i$ depending on Q

Let's Review...

Distance, Δd		Displacement, $\vec{\Delta d}$
length of path travelled scalar (magnitude only)	vs.	change in position of an object $\vec{\Delta d} = \vec{d_f} - \vec{d_i}$ vector (needs direction)

Example: In a swimming race, Cynthia swam 2.5 km [E] followed by 7.0 km [S 21° E].
Calculate: a. the total **distance** traveled
b. Cynthia's resultant **displacement**

<u>Example Problem</u>:
In a swimming race, Cynthia swam 2.5 km [E] followed by 7.0 km [S 21° E].
Calculate:

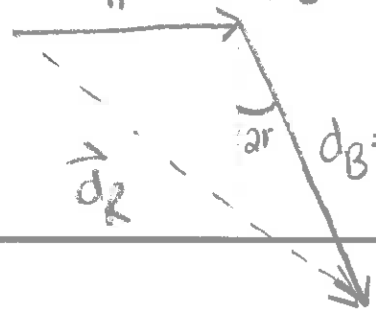
a. the total <u>distance</u> traveled
b. Cynthia's resultant <u>displacement</u>
c. Cynthia's final <u>position</u>

(a) $\Sigma d = d_A + d_B$
$= 2.5\ km + 7.0\ km$
$= 9.5\ km$

(b) use vector component method to solve for $\vec{d}_R$

$d_A = 2.5\ km\ [E]$ $\theta_A = 0°$

step 1



$d_B = 7.0\ km\ [S\ 21°\ E]$ $\theta_B = 291°$

<u>Example Problem</u>:
In a swimming race, Cynthia swam 2.5 km [E] followed by 7.0 km [S 21° E].
Calculate:

a. the total <u>distance</u> traveled
b. Cynthia's resultant <u>displacement</u>
c. Cynthia's final <u>position</u>

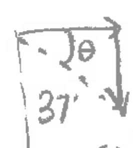
next
$d_{Rx} = 2.5 \cos 0 + 7.0 \cos 291$
$= 5.01\ km$

$d_{Ry} = 2.5 \sin 0 + 7.0 \sin 291$
$= -6.54\ km$

then
$d_R = \sqrt{5.01^2 + (6.54)^2}$
$= 8.24\ km$
$= 8.2\ km$

$\theta = \tan^{-1} \left| \frac{6.54}{5.01} \right|$
$= 52.5$
$= 53°$

last
$+d_{Rx}, -d_{Ry}$
means quad 4



(b) + (c)
$\vec{d}_R = 8.2\ km\ [S\ 37°\ E]$

Speed, v

distance travelled per time

$v = \frac{d}{t}$ (distance)

Scalar (no direction included)

VS.

Velocity, $\vec{v}$

Change in position with time

$\vec{v} = \frac{\Delta \vec{d}}{\Delta t}$ (displacement)

Vector (needs + is direction aware)

$\vec{v}_{ave}$ vs $\vec{v}_{inst}$

Example: A student travels 11 m north and then turns around and travels 25 m south. If the total time of travel is 12 s, find:

a. The student's average speed

b. The student's average velocity

a) $v = \frac{d}{t} = \frac{11m + 25m}{12s} = \boxed{3.0\ m/s}$

b) $\vec{v} = \frac{\Delta \vec{d}}{\Delta t} = \frac{11m\,[N] + (-25m\,[N])}{12s} = \frac{-14m}{12s} = \boxed{-1.2\ m/s\,[N] \text{ or } 1.2\ m/s\,[S]}$

Introduction to Kinematics

1. If an off-road vehicle traveled 10.6 km [N 13°W], changed direction to [S 29°W] for 8.8 km and then traveled 13.7 km [W], calculate:

   a. the total distance traveled

   b. the resultant displacement of the vehicle

p. 10
#1, 2, 4

3. **If an off-road vehicle traveled 10.6 km [N 13°W], changed direction to [S 29°W] for 8.8 km and then traveled 13.7 km [W], calculate:**

a. **the total distance traveled**

$\Delta d = 10.6 km + 8.8 km + 13.7 km$
$= 33.1 km$ *s.d. adding goes to decimal

b. **the resultant displacement of the vehicle**

$\Delta \vec{d}_1 = 10.6 km$ [N 13°W], $\theta_1 = 103°$ $\Delta \vec{d}_{x_1} = 10.6 \cos 103$ $\Delta \vec{d}_{y_1} = 10.6 \sin 103$

$\Delta \vec{d}_2 = 8.8 km$ [S29°W], $\theta_2 = 241°$ $\Delta \vec{d}_{x_2} = 8.8 \cos 241$ $\Delta \vec{d}_{y_2} = 8.8 \cos 241$

$\Delta \vec{d}_3 = 13.7 km$ [W], $\theta_3 = 180°$ $\Delta \vec{d}_{x_3} = 13.7 \cos 180$ $\Delta \vec{d}_{y_3} = 13.7 \cos 180$

$\Delta \vec{d}_R = \sqrt{(20.351)^2 + (2.632)^2}$ $\Sigma \vec{d}_x = -20.351$ $\Sigma \vec{d}_y = 2.632$

$= 20.52$ Since $\vec{d}_x$ is −, $\vec{d}_y$ is + we are in quad 2.

$\theta_R = \tan^{-1}\left(\frac{2.632}{20.351}\right)$ $\theta = 180 - 7 = 173°$ or [N 83°W]

$= 7.37°$

c. **the vehicle's final position**

$\therefore \Delta \vec{d}_R = 20.5 km$ [N 83°W]

$= 21 km$ [N 83°W]

$\Delta \vec{d}_R = 20.5 km$ [N 83°W]