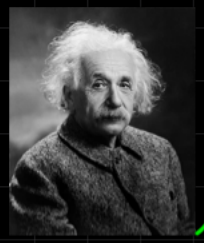
#Classical Relativity



- Albert Einstein consider as a Father of modern Physics

- A Theory of Relativity ← The Foundation of understanding space and Time provides the conceptual framework and mathematical tools called a Transformation that enables the two observers to transform a statement such as "Rock is at Rest" in one frame of reference to the statement "Rock is in motion" in another frame of reference

- The theory of Relativity ← its All About relative motion show that the space and Time are related but they are combined into a single system called space-time

- A Transformation is a way to measure what one observer, see into what another observer, see when they moving with different speeds (relative speed)

Associated with Newtonian mechanics
- Galilen Transformation
- Lorentz Transformation ← Associated with Relativity

} Types of Transformation

Table of differeneces

	Einstein (Relativity)	Newtonian (classical)
Time	Time is different for people moving at different speeds (speed ↑ Time passes ↓)	Time is the same for everyone (Time is absolute)
Mass & Energy	mass & energy are the same thing, in a way that you can turn mass → energy ($E=mc^2$)	mass & energy are seperate things
Length	moving fast, things gets shorter in the direction you're moving (compared to observer that not same fast)	The Length is the same no matter how fast you're moving

when things moves fast (close to the speed of Light) work for everyday speed and gravity

Galilean Transformation

- A Frame of Reference is a set of coordinates (إحداثيات) and a clock (stopwatch) that we use to measure quantites in "Newtonian mechanics" such as position and velocity (The motion of observer effect how they perceive (يشوف إن) the motion)

#An observer (المراقب) is always at rest in their frame of reference

- An inertial (NIL) frame of reference is a frame that is non-accelerate or rotate in "Newtonian mechanics", all inertia frames are equally valid

same (Physical Laws) ... Fundamental rules for the universe

- objects at rest stays at rest
- objects with constant velocity

} NIL

#Earth is not an example of inertial frame of reference (its rotating about its axis (Acceleration))

#Discussion



Axis rotating

#Is Earth an inertial frame? No its not since its orbiting the sun

- speed of earth around the sun = 3×10^4 m/s = 30 km/s (Hint: 2#)
- radius of rotation = 149.6 million km (Hint 2#)
- Acceleration = 0.006 m/s² (very small)

- Inertial Frames
  - objects subjected to no forces will experience no acceleration
  - Any Frame moving at constant velocity with respect to an inertial Frame must also be in an inertial Frame
- According to the Principle of Galilean Relativity, the laws of mechanics (≈ Newton's Laws of motion) are the same in all inertial Frame of reference (measurements can be different)

#Each car has its own Inertial Frame of reference

#Example 2.1 car A: 60 km/h; car B: 40 km/h; ground: 0 km/h

1# $V'_x = V_x - U$

$V'_x = 60 - 40$

$V'_x = 20$

The object is the (car A), and we want its Frame relative to the moving Frame, in this its (car B)

The Frame we measuring from is at rest in this case its (car B), relative to (car B) stationary Frame

we have to take the Frame of reference so we can compare between the Frames

- Two observers (O) and (O') are each at rest in their own Frames of reference but move relative to one another with constant velocity ($\vec{v}$)

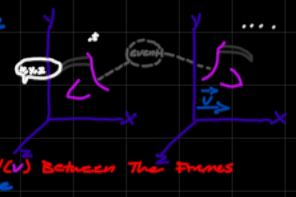
(O) (O')

- t = t' (time is the same for all observers)
- The origin of the coordinate systems coincide at t=0 (happen at the same time)

- Along the x-direction, (O) would observer the object using this Formula

$x' = x - vt$

(x' event in Frame (O'); x event in Frame (O); v relative velocity (v) between the Frames)



- According to (O), the (y) and (z) coordinates are the same as these in (O')

$y' = y \quad z' = z$

The coordinate of the motion is the one that changable

$z' = z - vt$ ← The motion in z-coordinate

$y' = y - vt$ ← The motion in y-coordinate

Velocity coordinates Transformation

- The velocity Formula depend on the changing variable (x, y, z)

$V'_x = V_x - S$

(V'_x → How fast an object (A) moving relative to a moving Frame; S → velocity of moving Frame relative to stationary Frame)

(V_x → How fast an object (A) moving relative to a stationary Frame (sure object) (LAB Frame))

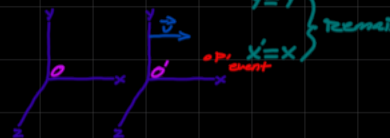
velocity of the moving Frame relative to the ground (with sign)

(V) moving away from (U) in the positive x-direction then u is positive

(V) moving toward (U) in the negative x-direction then u is negative

Important

- The velocity between the Frames (u) is constant
- other variables are the same for all Frames (in this case $V'_y = V_y$, $V'_z = V_z$)



$y' = y$, $x' = x$ remains the same

$z' = z$, $x' = x$ remains the same

#Acceleration

- The acceleration is the sure for all coordinates (will hold for both observers)

#ReFining Your understand

1# car A : 30 m/s

car B : 20 m/s

Find speed of A relative to B and B relative to A

$V'_x = V - S$	$V'_x = V - S$
$V'_x = 30 - 20$	$V'_x = 20 - 30$
$V'_x = 10$	$V'_x = -10$

- opposite 2# Train A : +25 m/s →
  direction
  Train B : -15 m/s ←

Find speed of A relative to B and B relative to A

$V'_x = V_x - S$	$V'_x = V_x - S$
$V'_x = 25 - (-15)$	$V'_x = -15 - (25)$
$V'_x = 40$ m/s	$V'_x = -40$ m/s

same magnitude

- Frame explicity given

relative To The Ground: A = 18 m/s, B = 12 m/s

$V'_x = V_x - S$
$V'_x = 18 - 12$
$V'_x = 6$ m/s

The car A is moving Forward relative To car B

- conceptual question

A Train is moving with constant.
Name Two different Frames in which:

1. Train is at rest ← (every Frame is at rest in Their own Frame (Assume someone inside The Train))
2. Train is moving ← (relative To The Ground/observer/Earth The Train is moving (Assume someone standing outside))

depend

The motion on The observer

- There's No absolute rest Frame in classical mechanics
  - when we say There's No absolute rest Frame, we Really means That There's No Fixed Frame That everything in The universe can Be compared To
- The Laws of mechanics are The same For A inertial Frames cause every experiment Yield To The same Result (Due To Physical Laws)

- same Direction

car A : 24 m/s

car B : 18 m/s

Find, 1 A relative To B; 2 B relative To A

I, $V'_x = V_x - u$	2, $V'_x = V_x - u$
$V'_x = 24 - 18$	$V'_x = 18 - 24$
$V'_x = 6$ m/s	$V'_x = -6$ m/s

- opposite Direction

car A : 20 m/s

car B : -10 m/s

Find, 1 A relative To B; 2 B relative To A

I, $V'_x = V_x - u$	2, $V'_x = V_x - u$
$V'_x = 20 - (-10)$	$V'_x = -10 - 20$
$V'_x = 30$ m/s	$V'_x = -30$ m/s

when The question Doesn't mention someone standing outside, imagine There's someone

- walking on a Train

A Train moves east at 30 m/s

A person walks west inside The Train at 5 m/s (Relative To The Train)

Find, 1 Person velocity Relative To The Ground; 2 Person velocity Relative To The Train

I, $V'_x = V_x - S$	2, $V'_x = V_x - S$
$V'_x = -5 + 30$	$V'_x = 25 - 30$
$V'_x = 25$ m/s	$V'_x = -5$ m/s

- conceptual

An object moves at constant speed

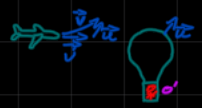
is it velocity The same in all inertial Frames? (No each measure different velocity)

Are The Laws of mechanics The same in all inertial Frames? (Yes The Physical Laws are The same)

- when The Frame is at Rest Then everything inside That Frame is also at rest, except if what inside The Frame is moving

Relativity In 2-Dimension

Examples, 2.2



x-Direction:

Find $U_{plane/o}$ $U'_x = U_{x\,(Target)} - u$

$U'_x = U_x + 65$

#Take x-axes To Be North — Wind Blows North (Person (O') Not moving and he in the same Frame as (u))

$U_x = 0 + 65$

$U_x = 65$

y-Direction:

#Take y-axes To Be East — Airplane velocity Doesn't change

$U'_y = V_y = 320$ km/h

Direction

$\theta = \tan^{-1} 65/320 = 11.5^\circ$ N of E — Angle Facing Direction

Speed

$|\vec{U}| = \sqrt{u_x^2 + v_y^2} = \sqrt{65^2 + 320^2} = 326.53$

Speed "c" Swimmer in The water swimming in a stream in which the current is "u" Assume it Less Than "c", suppose The swimmer swims upstream a Distance "L" and returns Downstream To The starting Point, Find The time To make The Trip