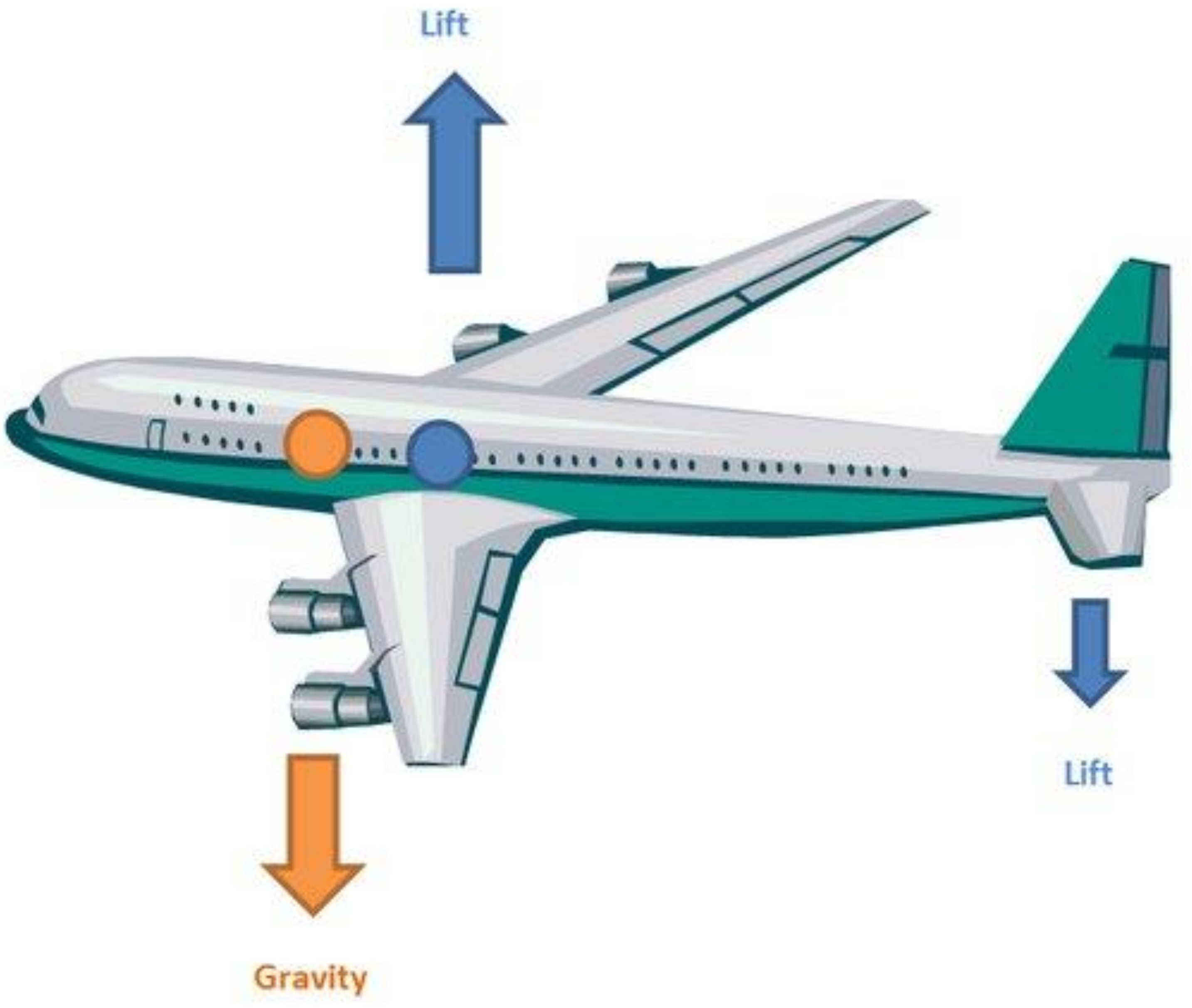


Aviation Department
First Grade- Spring Semester

Statics- General Principles (Lecture 1)

Lecturer: Ms. Jwan Khaleel M.

Lecture content:

- What is Engineering Mechanics?
- Fundamental Concepts
- Units of Measurement
- The International System of Units

Learning Outcomes:

At the end of this lecture, you will be able to:

- Introduce the concept of engineering mechanics and general applications.
- Analyze the classification of engineering mechanics.
- Evaluate a statement of Newton’s Laws of Motion and Gravitation.
- Solve related problems.

K-W-L Chart

Topic

Statics and Dynamics

Lecturer: Jwan Khaleel M.

What
is
Engineering
Mechanics ?

Elementary mechanics is sometimes partitioned into three courses named ‘statics’, ‘dynamics’, and “strength of materials”. These subjects all use, but vary in how much they emphasize, material properties, geometry, and Newton’s laws.

- **Statics** is mechanics with the idealization that the acceleration of mass is negligible in Newton’s laws.

- **Dynamics** concerns the non-negligible acceleration of mass.

- **Strength of materials** expands statics to include material properties and pays more attention to distributed forces (e.g., ‘traction’ and ‘stress’).

Engineering Mechanics

Mechanics is a branch of the physical sciences that is concerned with the state of rest or motion of bodies that are subjected to the action of forces.

Statics

Is concerned with the equilibrium of bodies that is either at rest or moves with constant velocity (no accelerated motion) under the action of force .

Dynamics

Is deal with the accelerated motion of a body

Kinematics

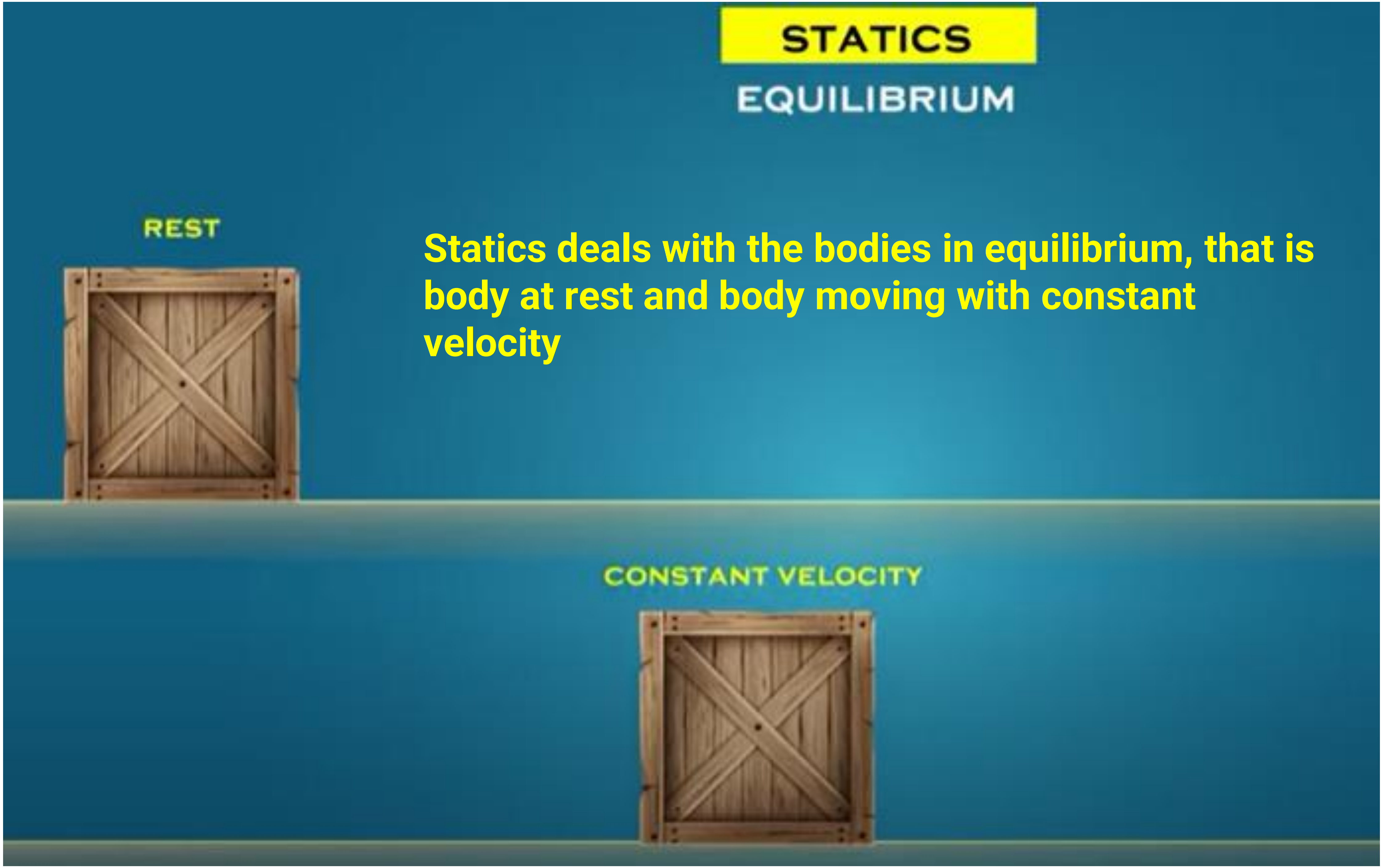
Study of motion without paying attention to the forces causing it.

Or in other words

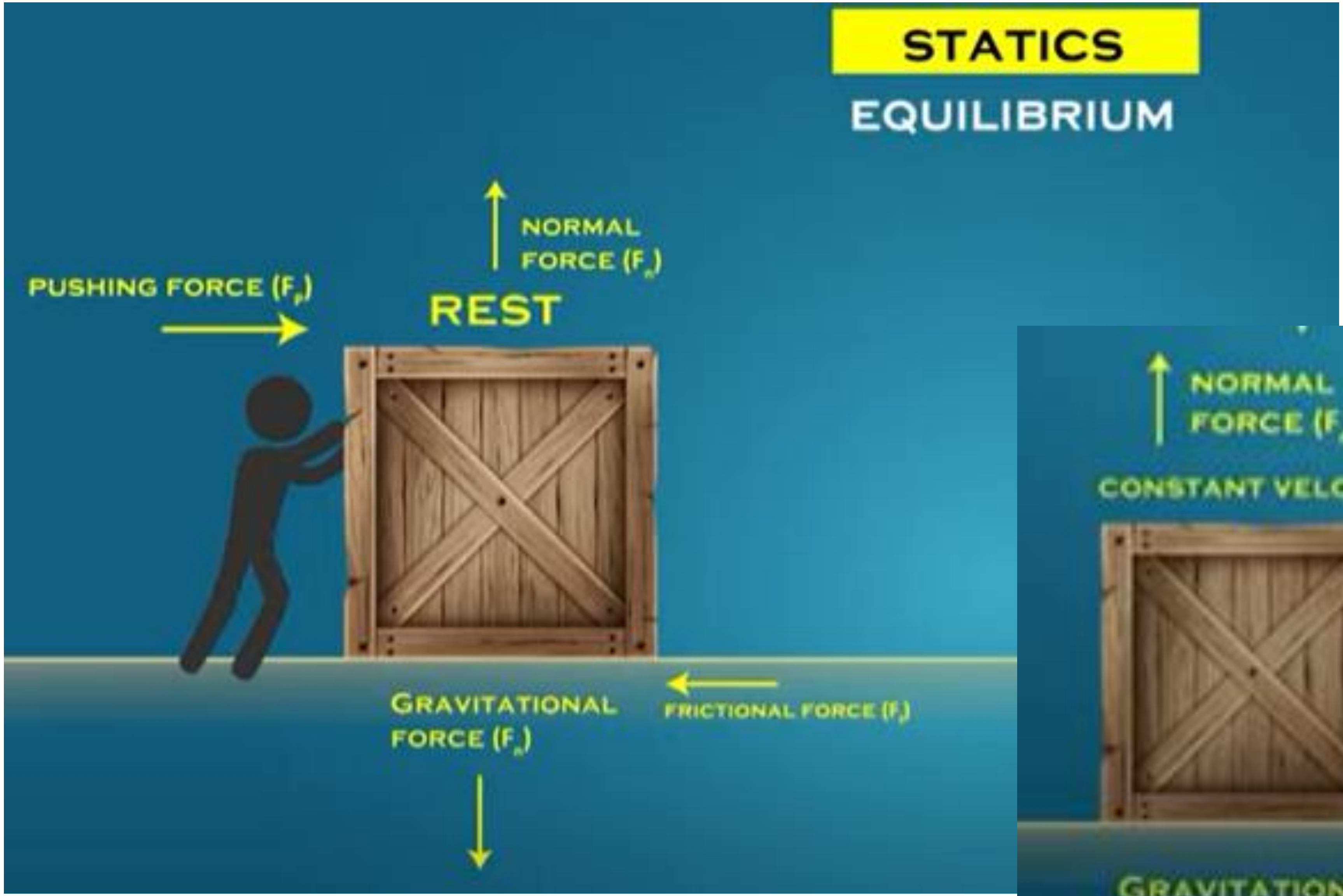
- Study of the geometry of motion.
- Relates displacement, velocity, acceleration, and time without reference to the cause of motion.

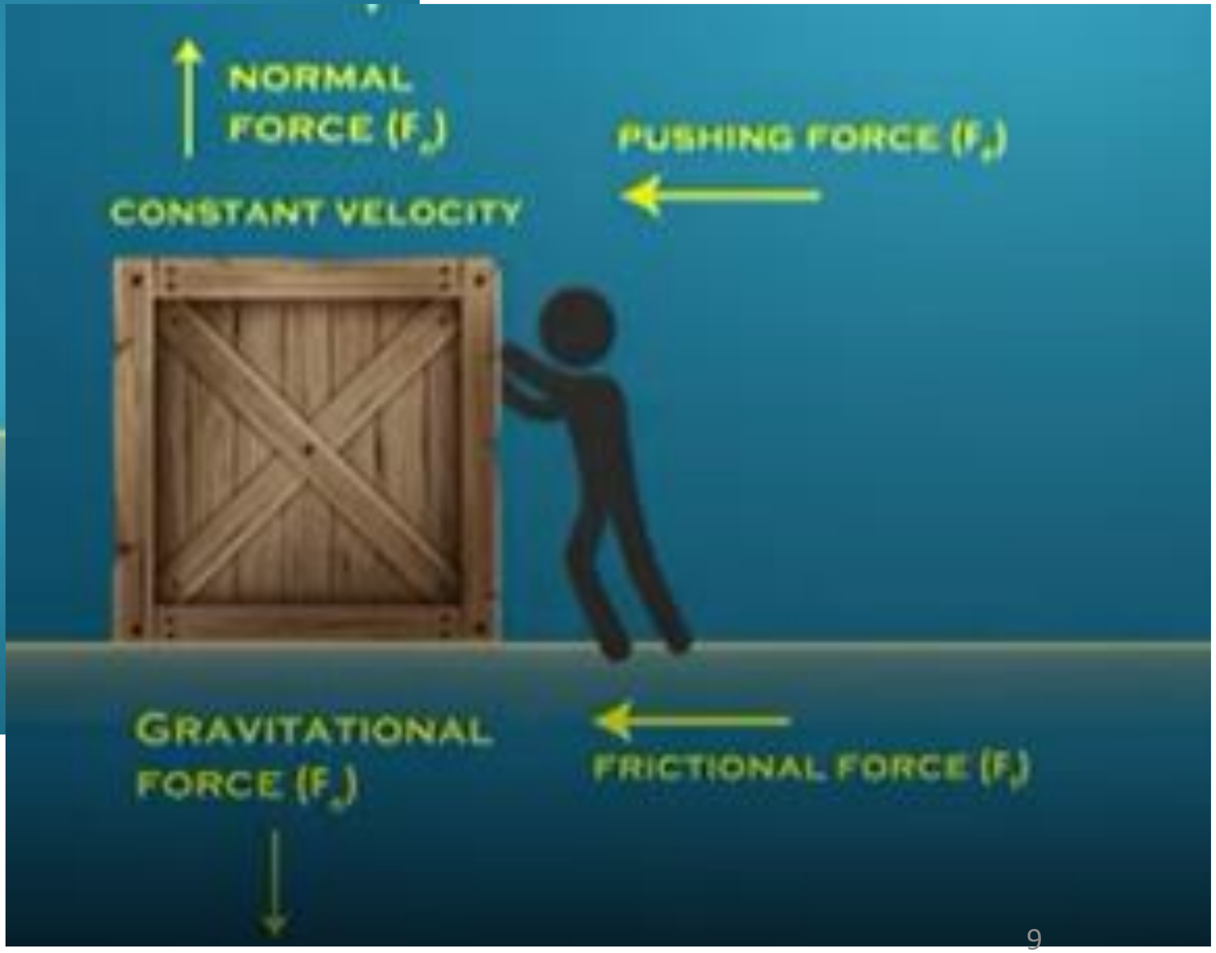
Kinetics

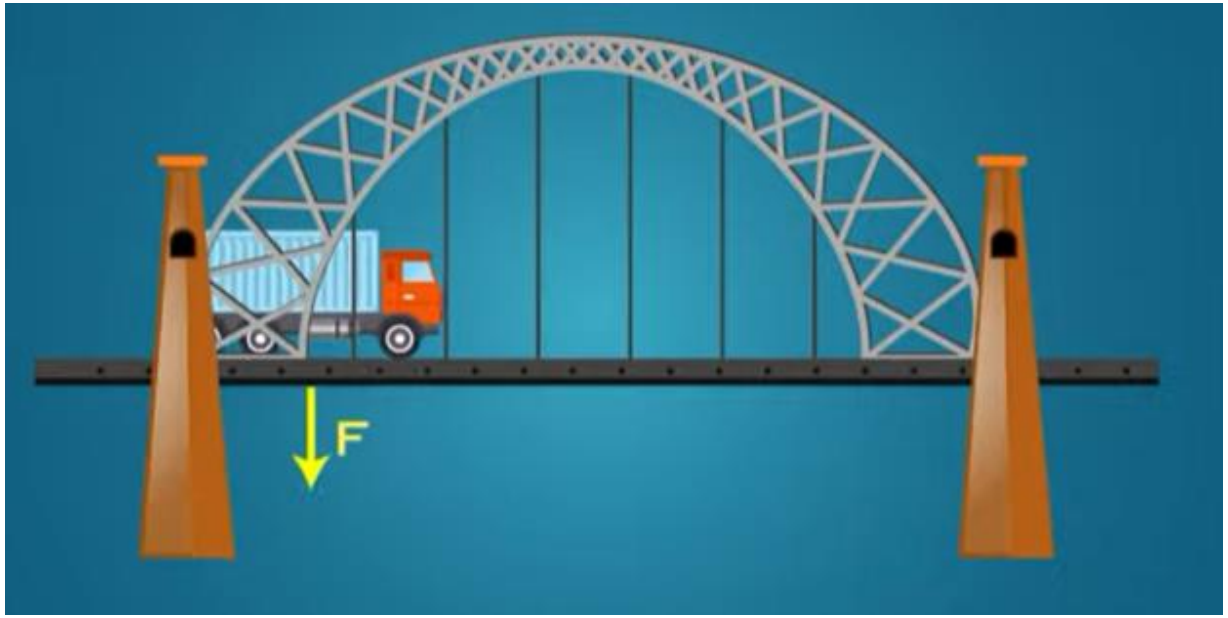
- Study of the relations existing between the forces acting on a body, the mass of the body, and the motion of the body.
- Kinetics is used to predict the motion caused by given forces or to determine the forces required to produce a given motion.



Statics deals with the bodies in equilibrium, that is body at rest and body moving with constant velocity


STATICS
EQUILIBRIUM
NORMAL FORCE (F)
PUSHING FORCE (F)
REST
GRAVITATIONAL FORCE (F)
FRICTIONAL FORCE (F)


NORMAL FORCE (F)
PUSHING FORCE (F)
CONSTANT VELOCITY
GRAVITATIONAL FORCE (F)
FRICTIONAL FORCE (F)

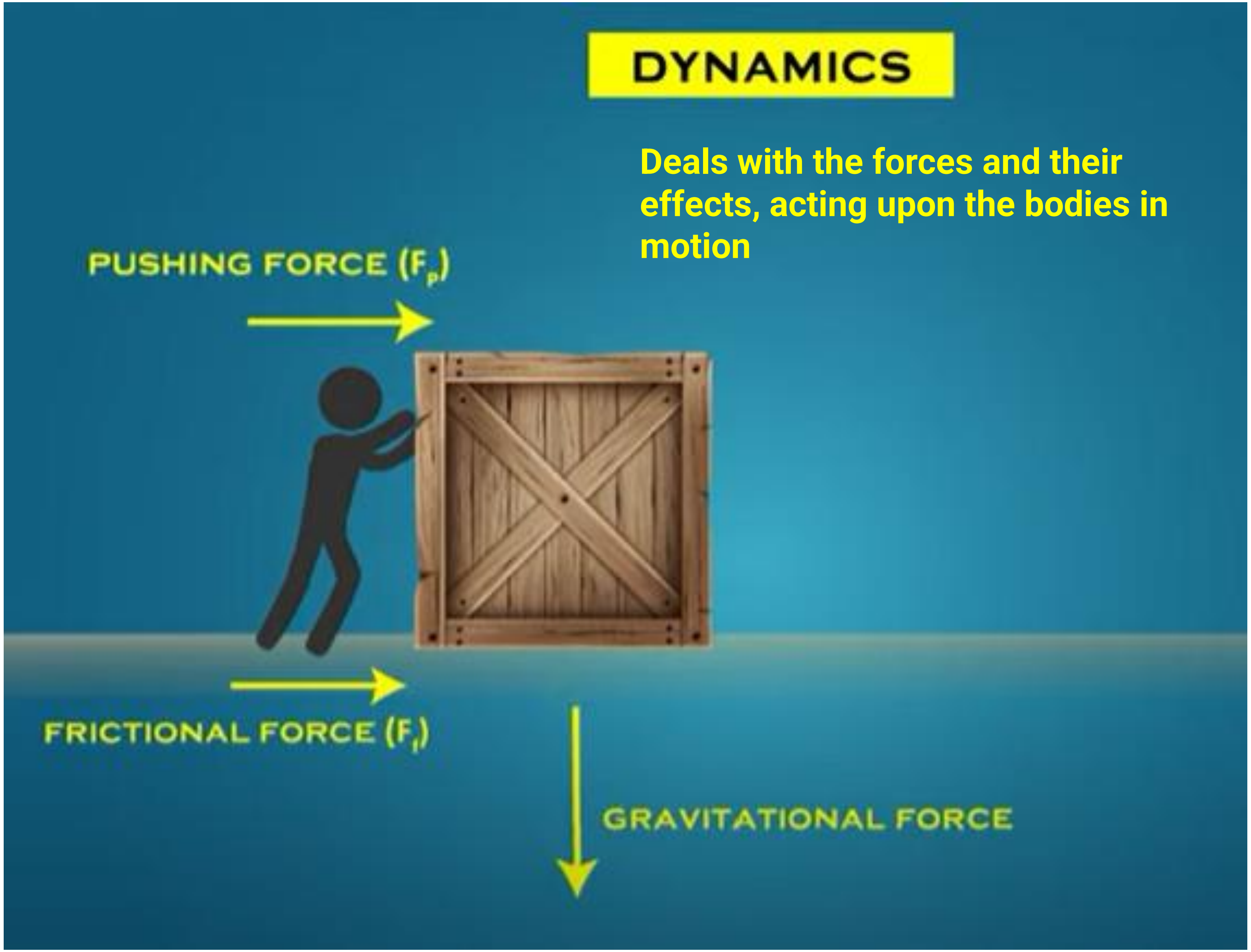


To determine how much force a bridge can withstand,

To calculate a force a dam needs to withstand from the water.

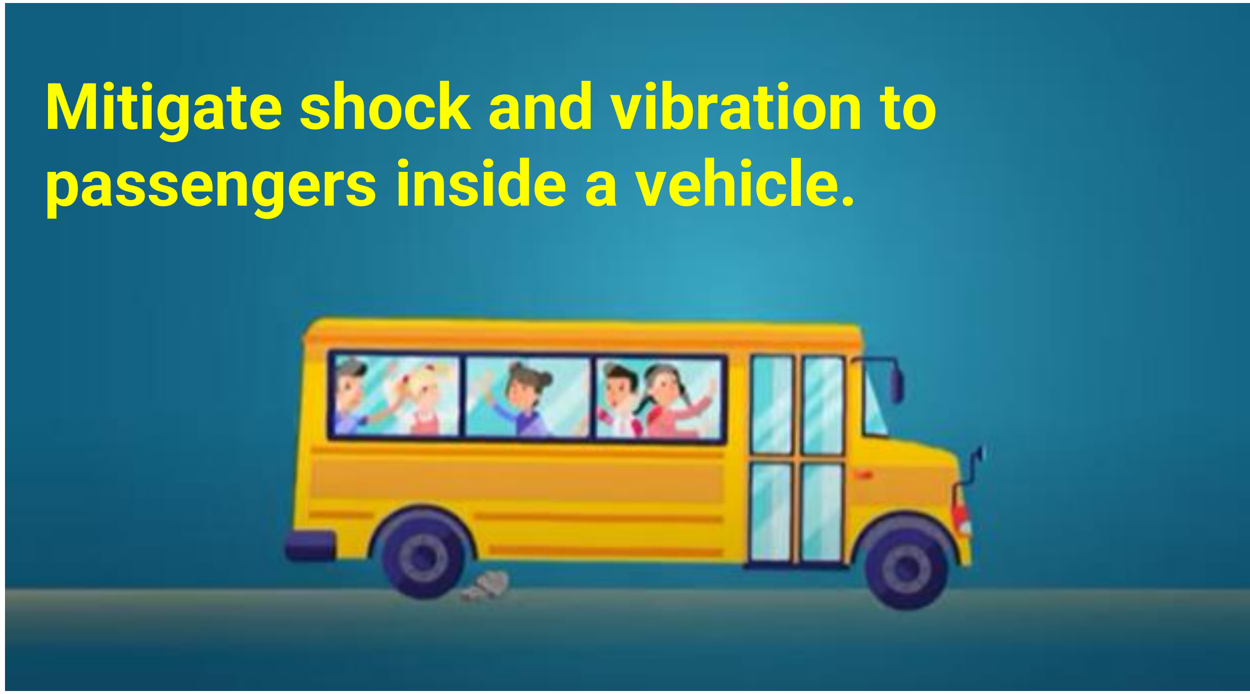
To calculate how much weight a crane can lift.

Cables and strings in stationary positions in mechanical systems also come under the statics.

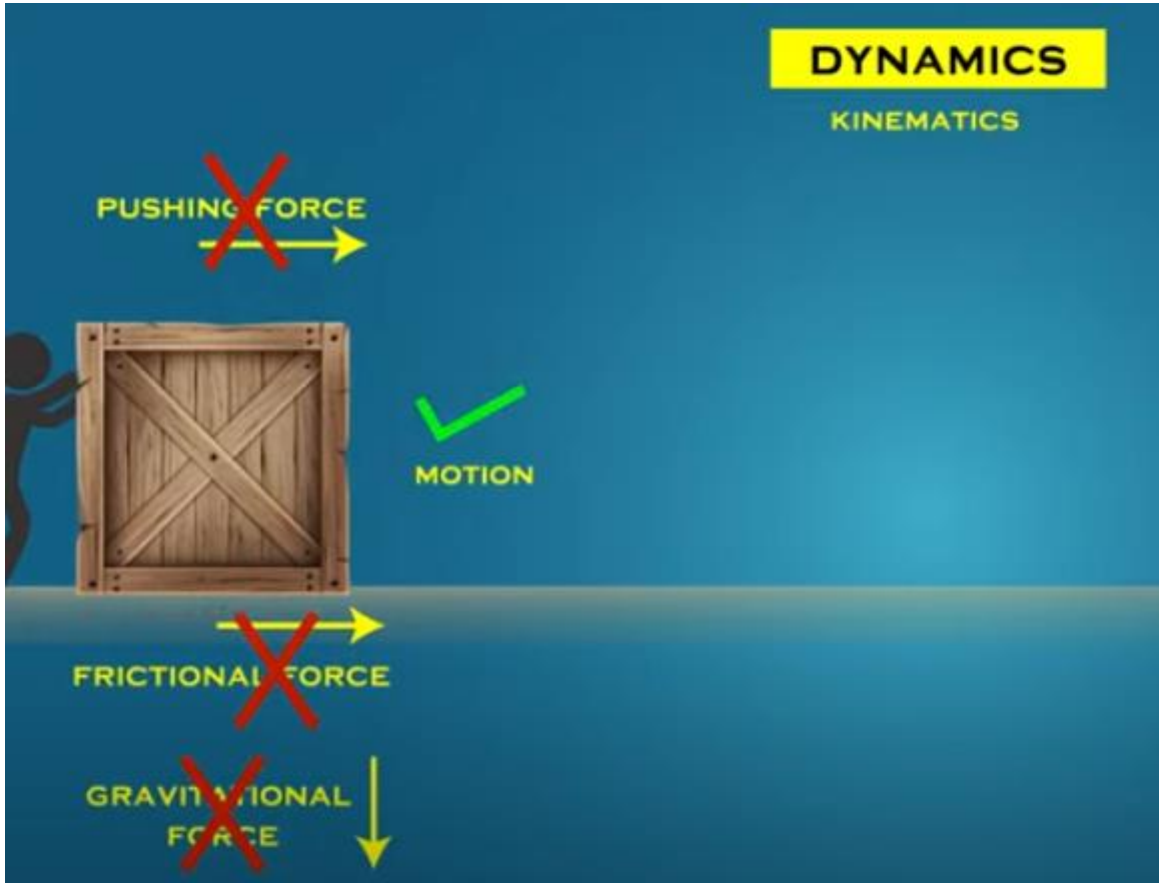

DYNAMICS
Deals with the forces and their effects, acting upon the bodies in motion
PUSHING FORCE (F_p)
FRICTIONAL FORCE (F_f)
GRAVITATIONAL FORCE

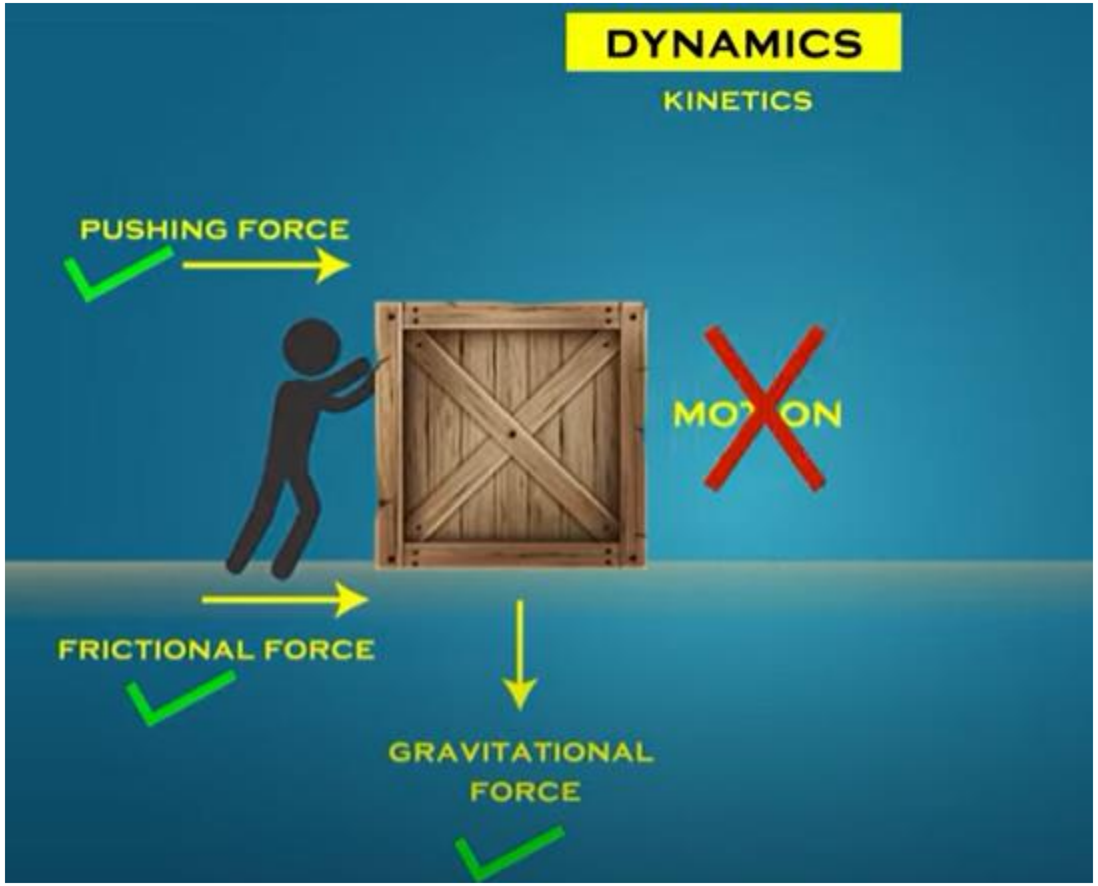
Moves in a parabolic path under the influence of person’s force and gravitational force

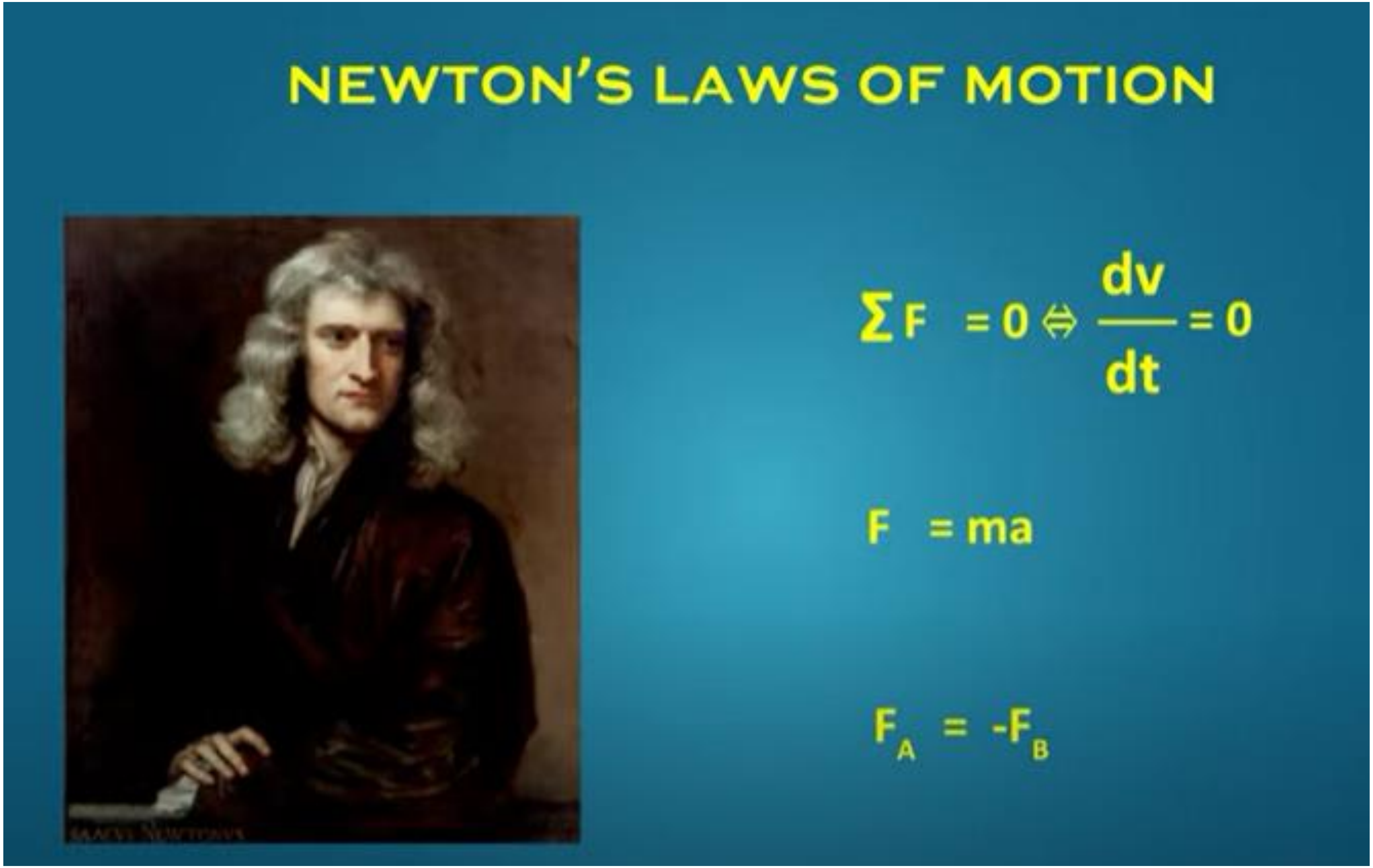
Analyze the flight characteristics of a jet,

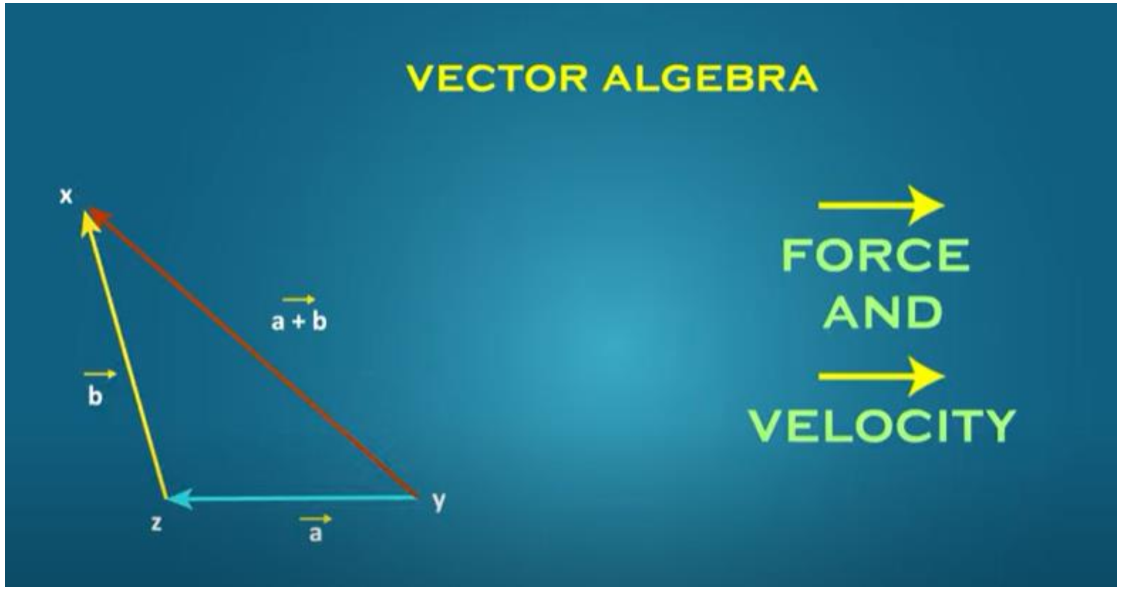


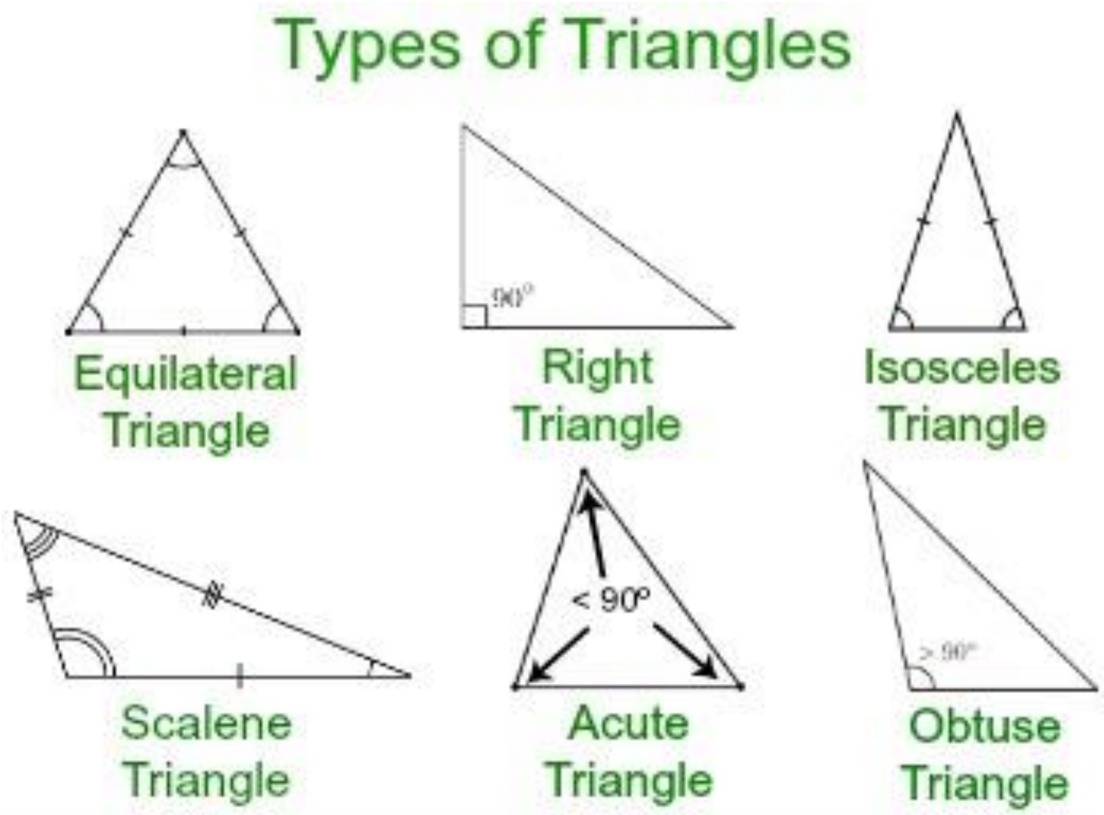
To calculate with how much force we need to send a satellite into orbit


DYNAMICS
KINEMATICS
PUSHING FORCE
MOTION
FRICTIONAL FORCE


DYNAMICS
KINETICS
PUSHING FORCE
FRICTIONAL FORCE
GRAVITATIONAL
FORCE

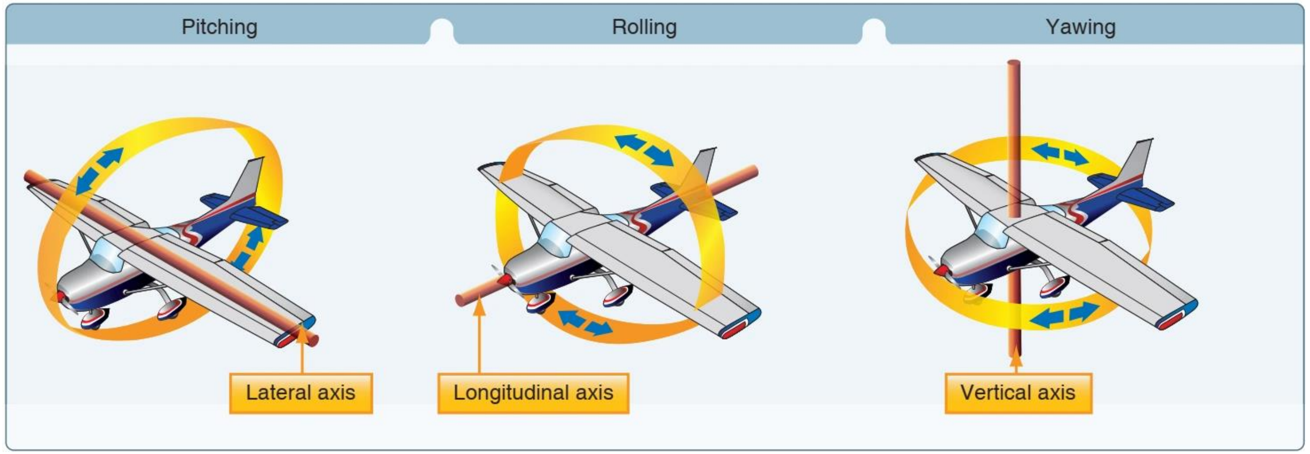

NEWTON'S LAWS OF MOTION
$\sum F = 0 \Leftrightarrow \frac{dv}{dt} = 0$
$F = ma$
$F_A = -F_B$

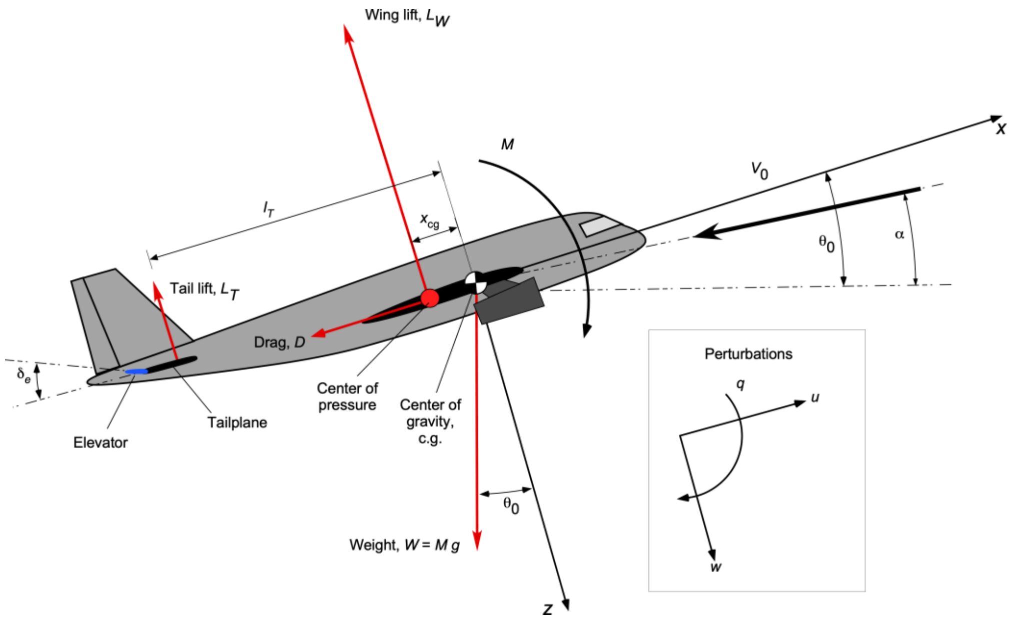

VECTOR ALGEBRA
x
a + b
b
z
a
y
FORCE
AND
VELOCITY

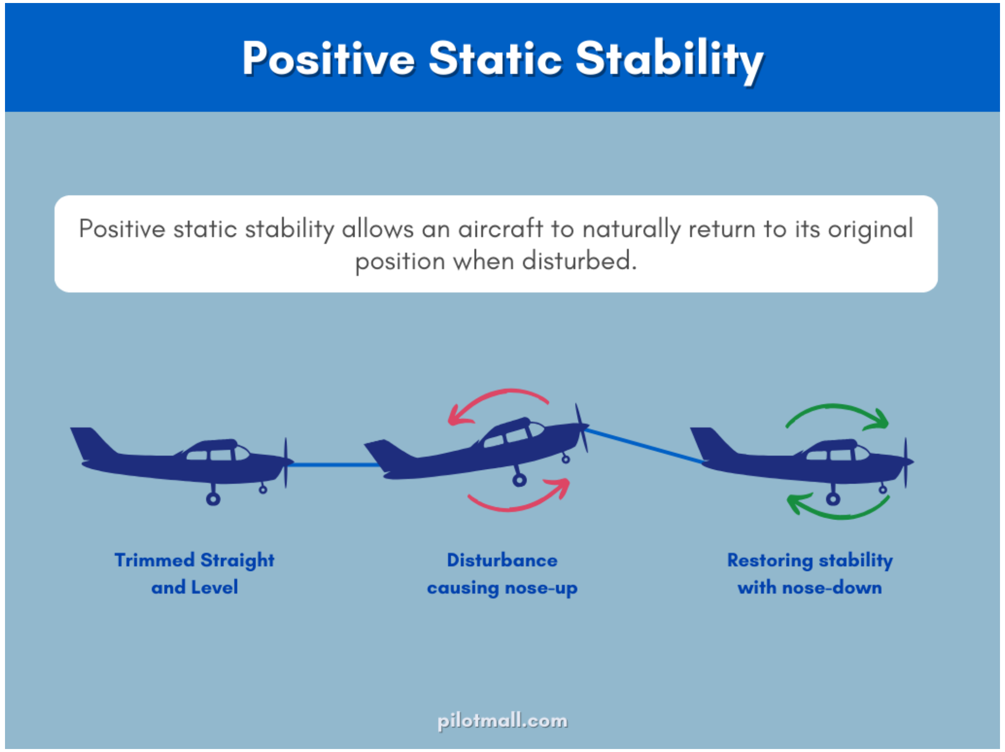

Types of Triangles
Equilateral Triangle
90°
Right Triangle
Isosceles Triangle
Scalene Triangle
< 90°
Acute Triangle
> 90°
Obtuse Triangle

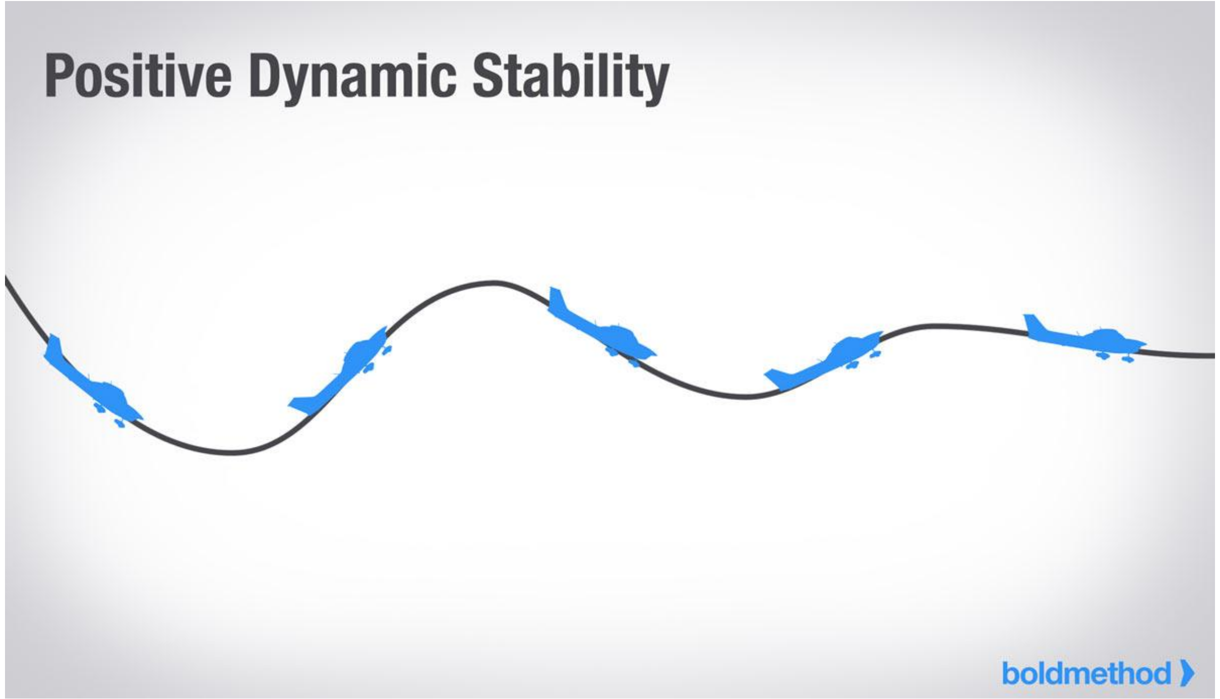
Applications To Mechanics:

1. Analysis and design of moving structures.
2. Fixed structures subject to shock loads
3. Robotic devices.
4. Machining of turbines and pumps.
5. Automatic control system
6. Rockets.
7. Missiles and spacecraft.
8. Ground and air transportation vehicles. And others.



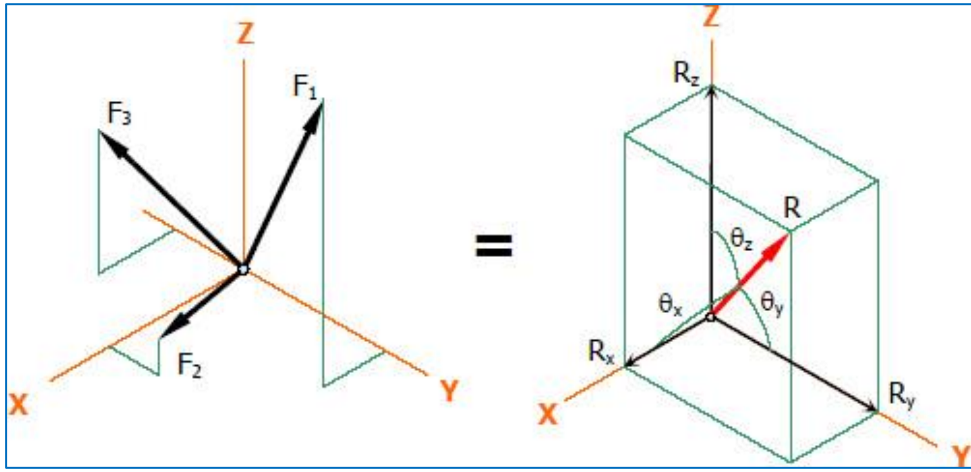




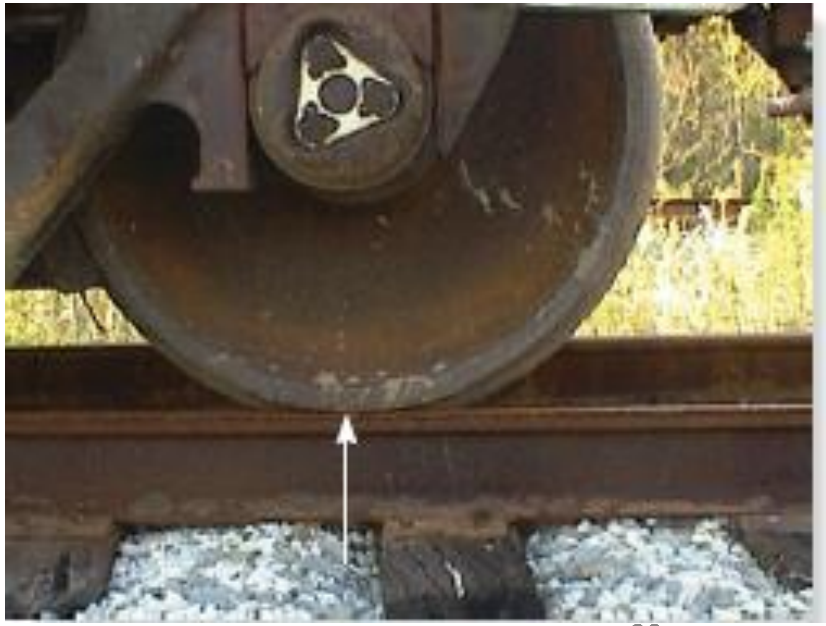


https://www.youtube.com/watch?v=2ezQghYO1bA

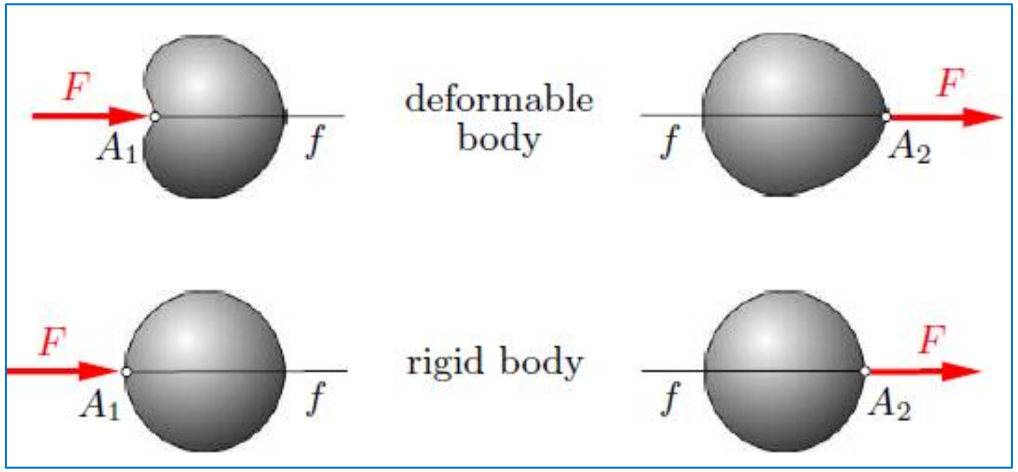
Basic Concept of Mechanics:



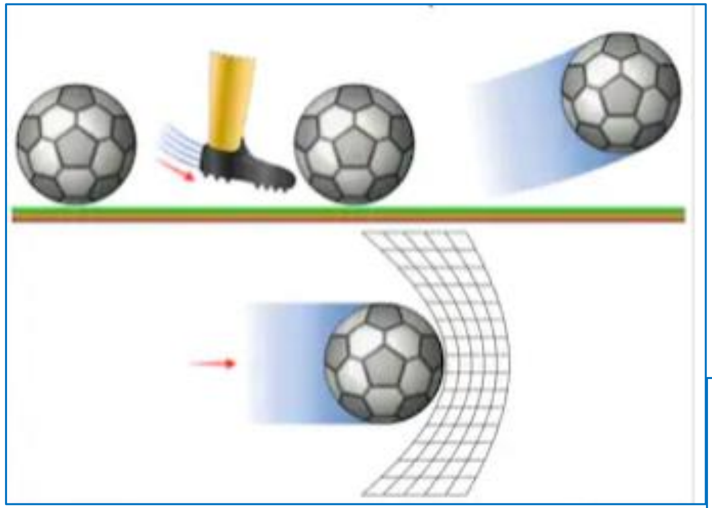
- ***Space:*** is a geometric region occupied by bodies whose positions are describes by linear and angular measurement relative to a coordinate system two or three dimensions
- ***Time:*** is a basic quantity in dynamics.
- ***Mass:*** is a quantity of matter in a body (***statics***) measure of the inertia of a body, which its resistance to a change of velocity (***dynamics***).
- ***Force:***

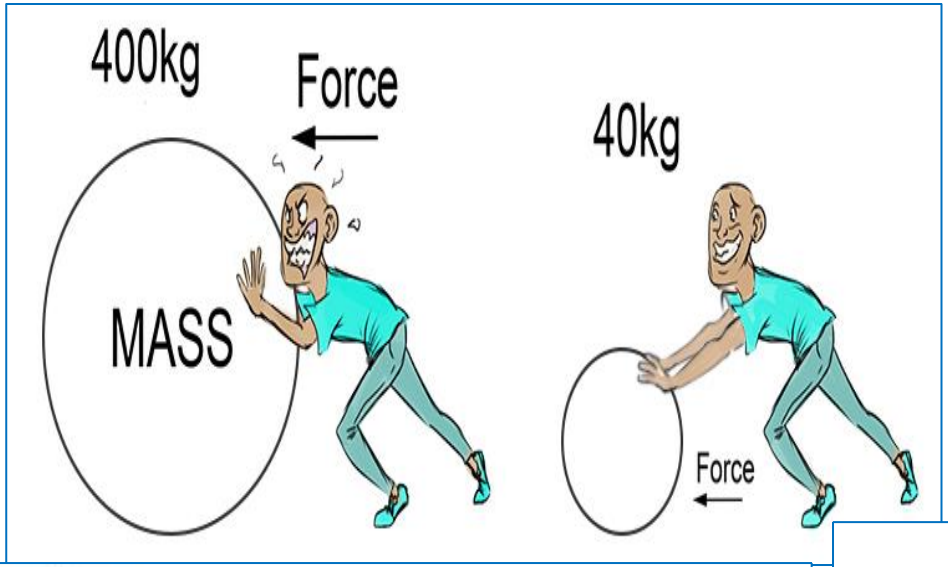


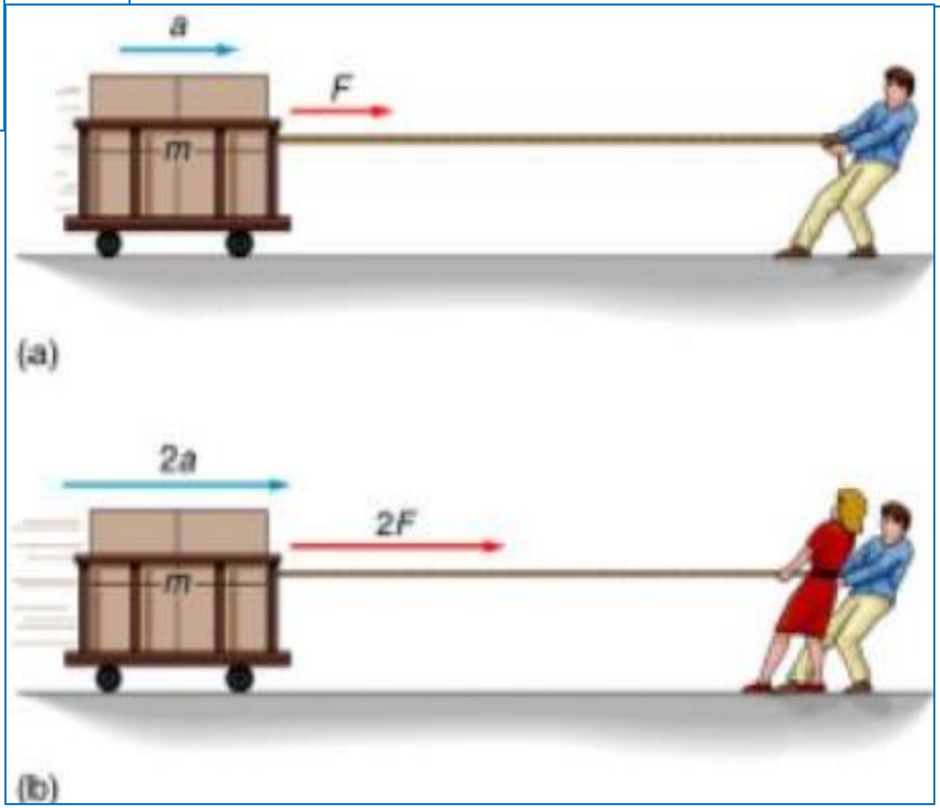
- ***Particle:*** is a body of negligible dimensions.
- ***Rigid body:***
- ***Deformable body:***

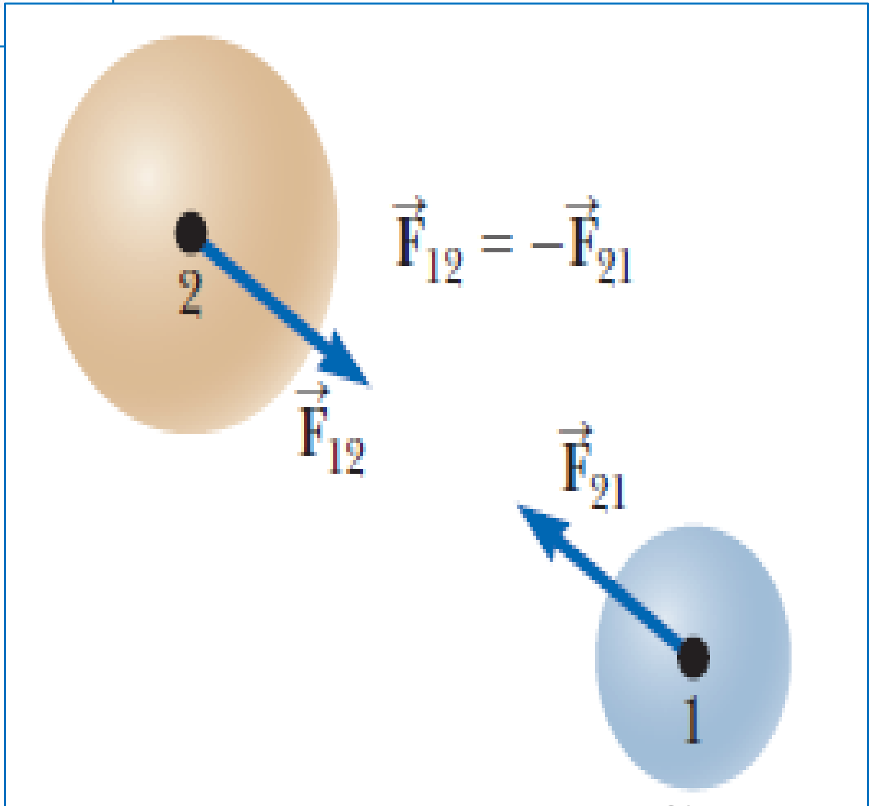


Newton's laws:









$$\mathbf{F} = ma$$

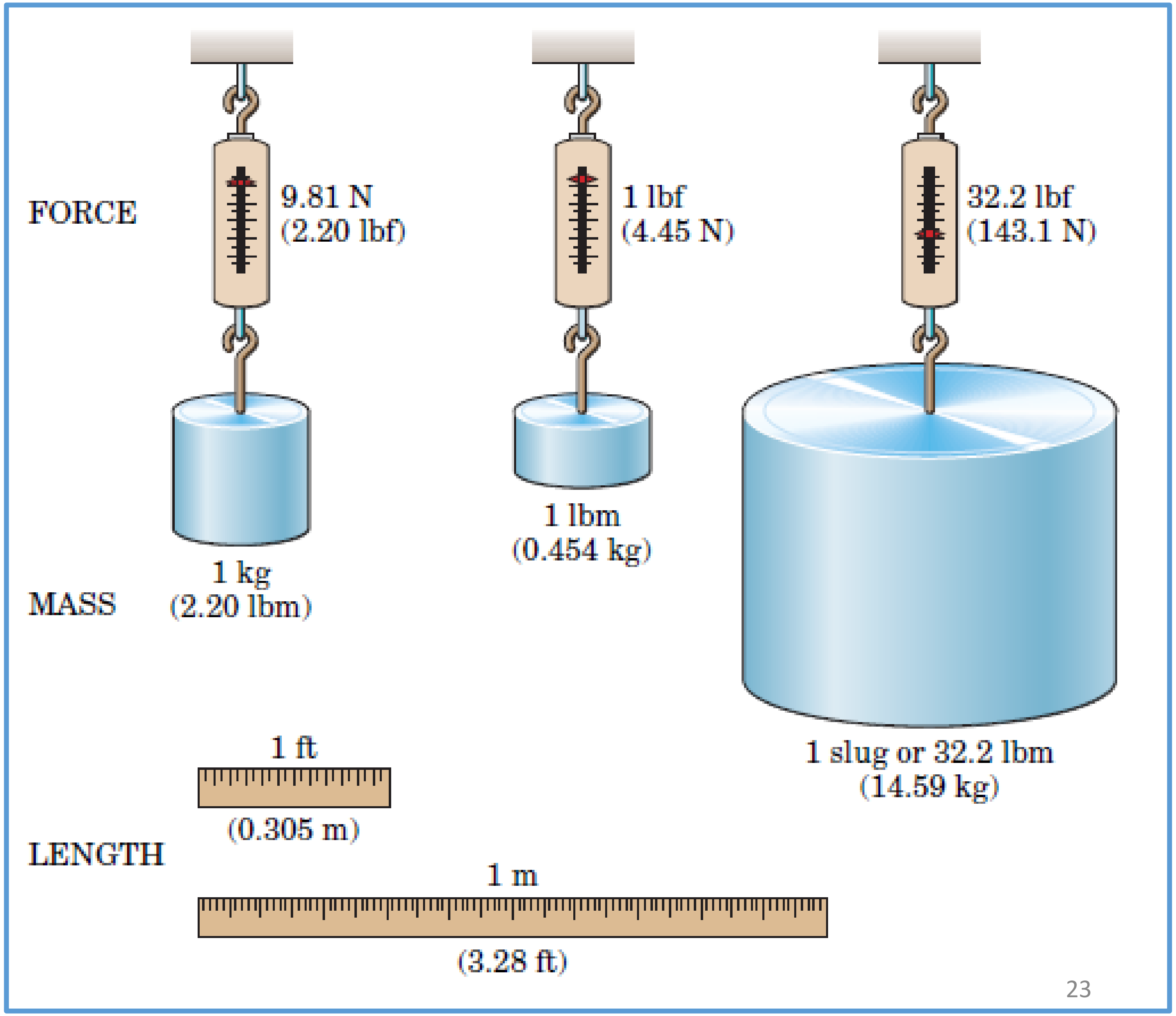
Units of Measurements:

QUANTITY	DIMENSIONAL SYMBOL	SI UNITS: UNIT	SI UNITS: SYMBOL	U.S. CUSTOMARY UNITS: UNIT	U.S. CUSTOMARY UNITS: SYMBOL
Mass	M	kilogram (Base unit)	kg	slug	—
Length	L	meter* (Base unit)	m	foot (Base unit)	ft
Time	T	second (Base unit)	s	second (Base unit)	sec
Force	F	newton	N	pound (Base unit)	lb

SI UNITS	U.S. CUSTOMARY UNITS
$(1\ \text{N}) = (1\ \text{kg})(1\ \text{m/s}^2)$	$(1\ \text{lb}) = (1\ \text{slug})(1\ \text{ft/sec}^2)$
$\text{N} = \text{kg}\cdot\text{m/s}^2$	$\text{slug} = \text{lb}\cdot\text{sec}^2/\text{ft}$

- # Units Conversion:

SI units	$g = 9.806\ 65\ m/s^2$
U.S. units	$g = 32.1740\ ft/sec^2$



- ***Prefixes:***

	Exponential Form	Prefix	SI Symbol
Multiple			
1 000 000 000	10^9	giga	G
1 000 000	10^6	mega	M
1 000	10^3	kilo	k
Submultiple			
0.001	10^{-3}	milli	m
0.000 001	10^{-6}	micro	μ
0.000 000 001	10^{-9}	nano	n

Example 1//

What is the weight in both **newton** and **pounds** for 1500 kg beam?

$$W = mg = (1500\,kg) \times 9.81\,\frac{m}{s^2} = 14{,}720\,N$$

$$m = (1500)\left(\frac{1\,slug}{14.594\,kg}\right) = 102.8\,slugs$$

$$W = mg = (102.8\,slugs)(32.2\,\frac{ft}{sec^2})$$

$$= 3310\,Ib$$

Example 2// Convert 2 km/h to m/s, How many ft/s is this?

SOLUTION

Since 1 km = 1000 m and 1 h = 3600 s, the factors of conversion are arranged in the following order, so that a cancellation of the units can be applied:

$$2\ \text{km/h} = \frac{2\ \text{km}}{\text{h}}\left(\frac{1000\ \text{m}}{\text{km}}\right)\left(\frac{1\ \text{h}}{3600\ \text{s}}\right)$$

$$= \frac{2000\ \text{m}}{3600\ \text{s}} = 0.556\ \text{m/s} \qquad \textit{Ans.}$$

We know that;. 1 ft = 0.3048 m. Thus,

$$0.556\ \text{m/s} = \left(\frac{0.556\ \text{m}}{\text{s}}\right)\left(\frac{1\ \text{ft}}{0.3048\ \text{m}}\right)$$

$$= 1.82\ \text{ft/s} \qquad \textit{Ans.}$$

Next Lecture :

- Scalars and Vectors
- Vector Operations
- Vector Addition of Forces
- Addition of a System of Coplanar
- Forces

References:

Engineering Mechanics R.C. Hibbeler 13^{th} edition (Statics).

Engineering Mechanics, Mariam13th edition (Statics).

The end of the lecture
Enjoy your time