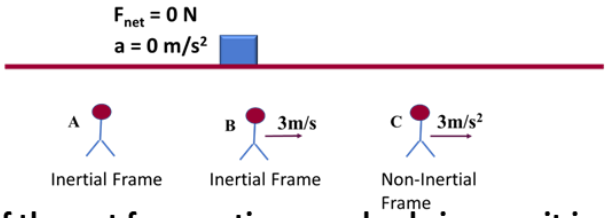
Newton's First Law of Motion (Law of Inertia)

Every body preserves its state of rest, or of uniform motion in a straight line, unless it is compelled to change that state by external forces impressed on it.

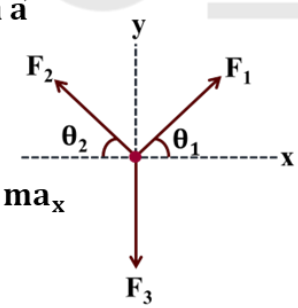
Inertial and Non-Inertial Reference Frame



If the net force acting on a body is zero, it is possible to find a reference frame in which that body has zero acceleration. Such reference frame is called Inertial Reference Frame.

Newton's Second Law of Motion

In Inertial Frame, $\sum\vec{F} = m\,\vec{a}$



2nd Law for x-axis

$$\sum \vec{F}_x = m\vec{a}_x$$

$$\Rightarrow F_1\cos\theta_1 - F_2\cos\theta_2 = ma_x$$

2nd Law for y-axis

$$\sum \vec{F}_y = m\vec{a}_y$$

$$\Rightarrow F_1\sin\theta_1 + F_2\sin\theta_2 - F_3 = ma_y$$

MIND MAP

NLM

Normal Contact Force

- It is an electromagnetic type of force.
- It always acts along the common normal of the two surfaces in contact i.e. perpendicular to the surfaces.
- It is always directed towards the system.

Linear Momentum

Linear Momentum is the product of Mass and Velocity

$\vec{P} = m\vec{v}$ (kg m/s) or (N-s)

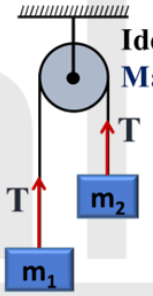
$$\vec{F}_{net} = \frac{d\vec{P}}{dt}$$

The rate of change of Linear Momentum of a body = net Force on a body.

Tension Force

- It is an electromagnetic type of force.
- This is a force applied by a string on an object or Force applied by one part of string on the remaining part of string.
- It acts along the string and away from the system on which it acts.

Tension in a massless string remains constant throughout the string if no tangential force acts along the string.



Ideal Pulley:
Massless and Frictionless

Ideal String:
Massless and Inextensible

Newton's Third Law of Motion

Every action has an equal and opposite reaction.

$\vec{F_1} = -\vec{F_2}$

Action and Reaction act on different bodies and not on the same body.

Action and Reaction forces are of same type.

MIND MAP

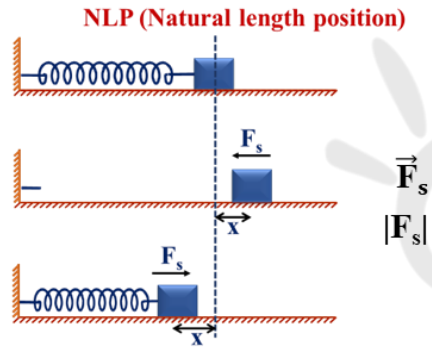
NLM

Translational Equilibrium

A system is said to be in Translational Equilibrium when net force on the system is zero.

$$\sum \vec{F} = 0$$

Spring Force:



$$\vec{F}_s = -K\vec{x}$$

$$|F_s| = K|x|$$

Variation of 'k' with natural length

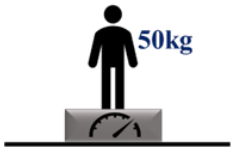
natural length $= \ell$

$k\ell$ = Constant

natural length $= \ell/2$

$k\ell = 2k\frac{\ell}{2}$

Reading of Weighing Machine



If an object is put on a weighing machine and 'N' is normal contact force b/w object & machine then reading of weighing machine will be given by

$$\text{Reading} = \frac{N}{g}$$

Constraint Motion

For a system,

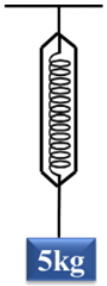
$$\sum \vec{T}.\vec{x} = 0 \qquad \sum \vec{T}.\vec{v} = 0$$

$$\sum \vec{T}.\vec{a} = 0$$

(if $\vec{a}$ are collinear with $\vec{v}$)

Reading of Spring Balance

Reading of spring balance $= \frac{kx}{g}$



Keypoint

Constraint relation in string will also hold for string having mass provided it is inextensible.