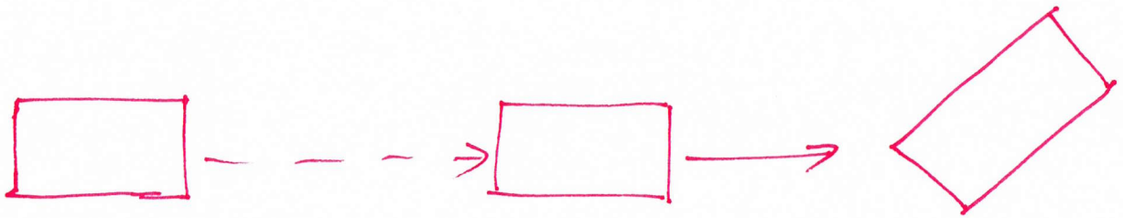
INTRODUCTION

Newtonian Mechanics --that science which describes and predicts the conditions of rest or motion of bodies under the action of forces. It is divided into three parts:

mechanics of rigid bodies--



mechanics of deformable bodies--

CVEN305

mechanics of fluids--

CVEN 221 and CVEN 363 are focused on mechanics of rigid bodies

221 **Statics** -- the study of bodies that are at rest with respect to a non-accelerating reference frame

Not accelerating

363 **Dynamics** -- the study of bodies that are in motion with respect to a non-accelerating reference frame

Accelerating

Basic Concepts of Newtonian Mechanics – These concepts cannot be truly defined – they must be accepted on the basis of our intuition and experience (faith) and used as a mental frame of reference (guide) for our study of mechanics.

Space –

right-handed

Time – seconds, minutes, hrs, days

Mass – property of matter – same everywhere

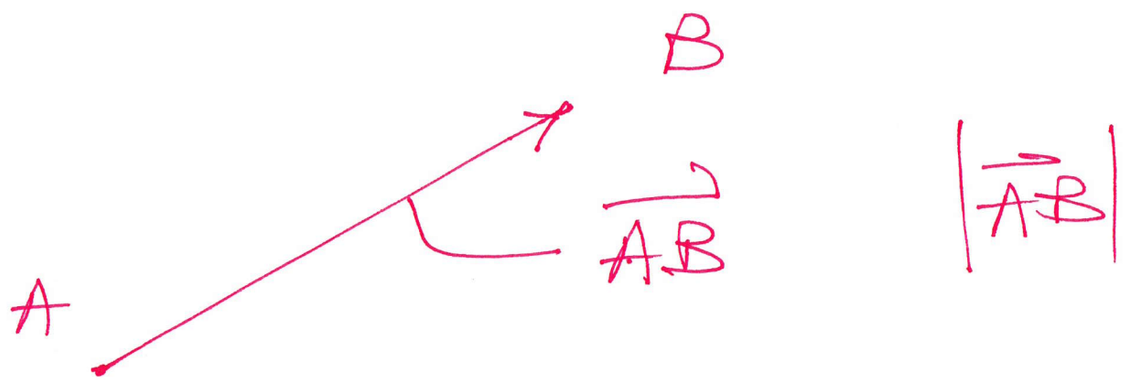
Force – action between two bodies in contact, gravity, magnetic

Important terms

Non-accelerating reference frame –

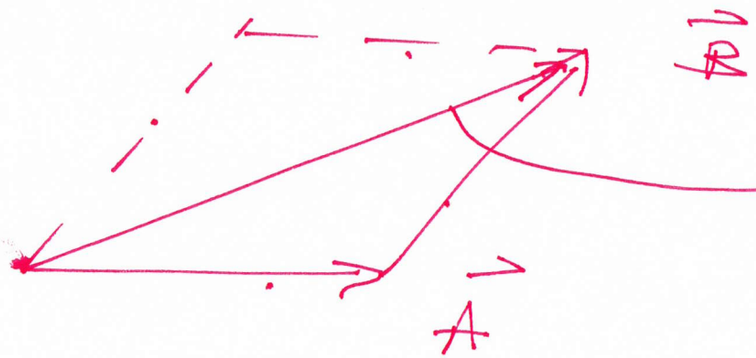
Scalar – magnitude only speed, time, mass, distance

Vector – magnitude and direction



Vector addition

Parallelogram law –

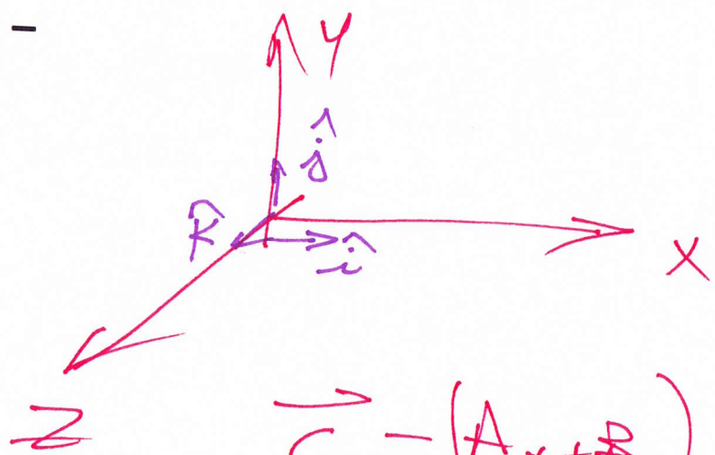


$\vec{C} = \vec{A} + \vec{B}$

Law of Sines

Law of Cosines

Orthogonal Coordinates –

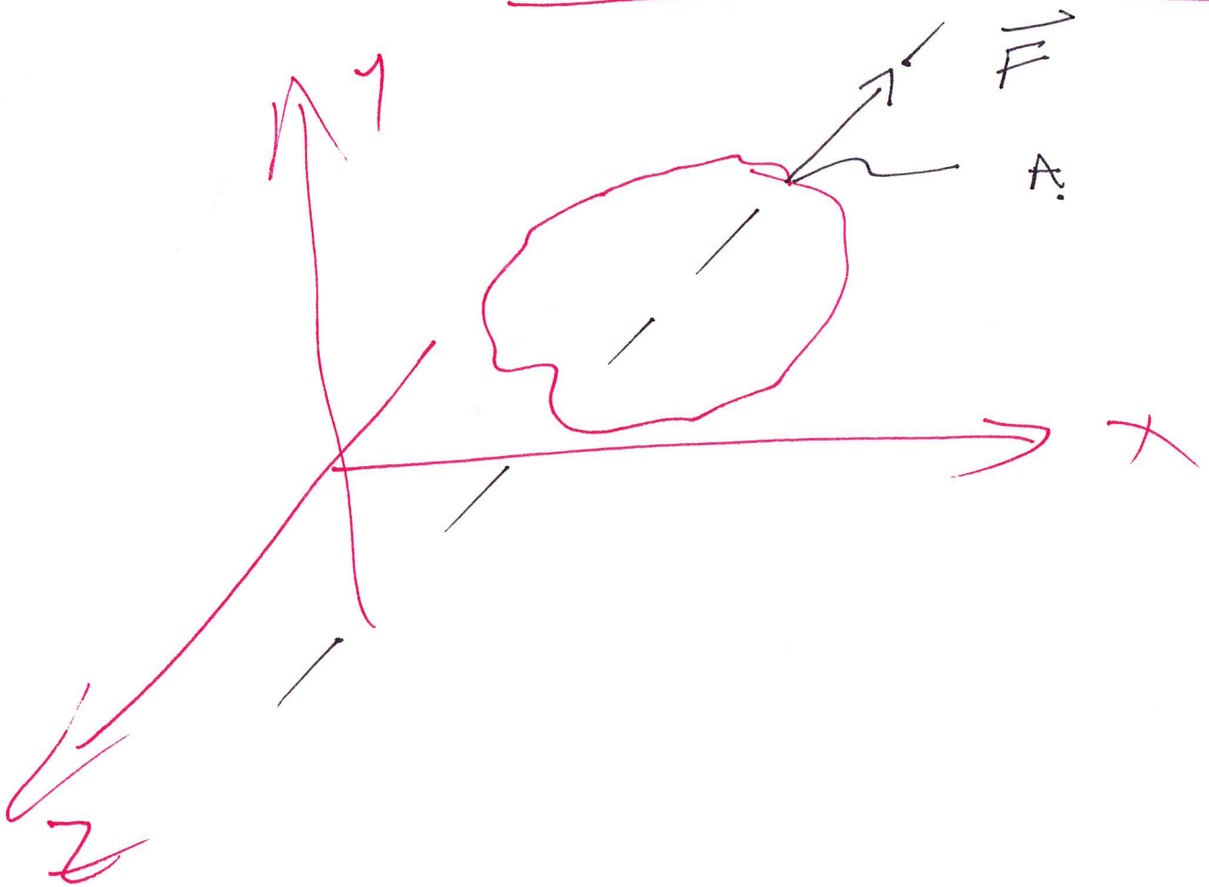


$\vec{A} = A_x \hat{i} + A_y \hat{j} + A_z \hat{k}$

$\vec{B} = B_x \hat{i} + B_y \hat{j} + B_z \hat{k}$

$\vec{C} = (A_x + B_x)\hat{i} + (A_y + B_y)\hat{j} + (A_z + B_z)\hat{k}$

Principle of transmissibility



Newton's Four Laws

Newton's First Law – If the resultant force acting on a particle is zero, the particle will remain at rest (if originally at rest) or will move with constant speed in a straight line (if originally in motion).

Newton's Second Law -- If the resultant force acting on a particle (of constant mass) is not zero, the particle will have an acceleration proportional to the magnitude of the resultant force and in the direction of this resultant force.

$$\vec{F} = m\,\vec{a}$$

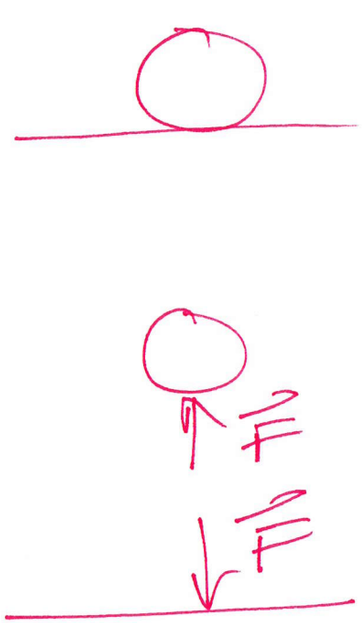
where

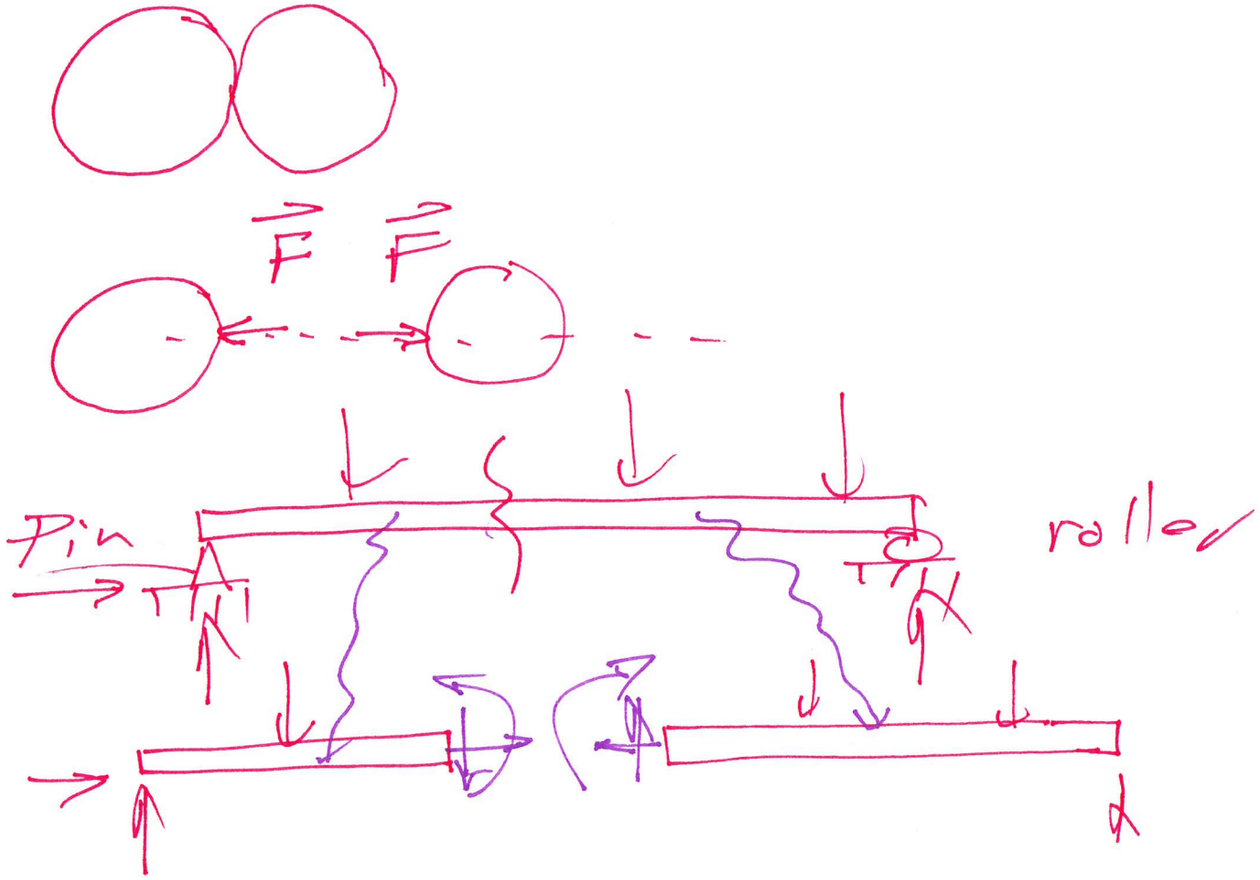
$\vec{F}$ is the resultant external force vector acting on the particle,

m is the mass of the particle, and

$\vec{a}$ is the acceleration vector of the particle in the direction of the same direction as the force vector.

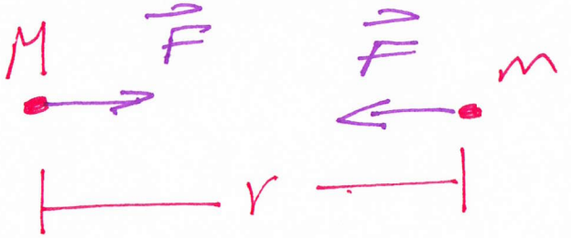
Newton's Third Law -- The forces of action and reaction between bodies in contact have the same magnitude, same line of action, and opposite sense.





Newton's Fourth Law or Newton's Law of Gravitation – Two particles of mass M and m are mutually attracted with equal and opposite forces $\vec{F}$ and $-\vec{F}$ according to the following relationship:

$$\vec{F} = G\frac{Mm}{r^2}$$



where

r is the distance between the two particles

G is the universal constant of gravitation

L – Length
T – time
m – mass
F – Force

mass

$G = 6.67 \times 10^{-11}\ m^3/(kg\ s^2)$ [SI] — metric

or

$G = 3.44 \times 10^{-8}\ ft^4/(lb\ s^4)$ [US Customary] — US

lbf or lbm

Force

WARNING: NEWTON'S LAW OF GRAVITATION IS **NOT** DERIVED FROM NEWTON'S SECOND LAW -- FAILURE TO INTERNALIZE THIS SIMPLE **TRUTH** WILL RESULT IN A COMPLETE LACK OF UNDERSTANDING OF FUNDAMENTAL NEWTONIAN MECHANICS.

GRAVITY MANIFESTS ITSELF AS FORCE –
NOT ACCELERATON.