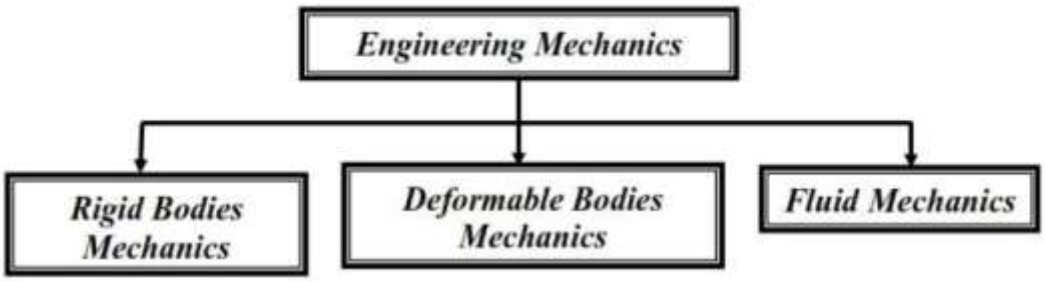
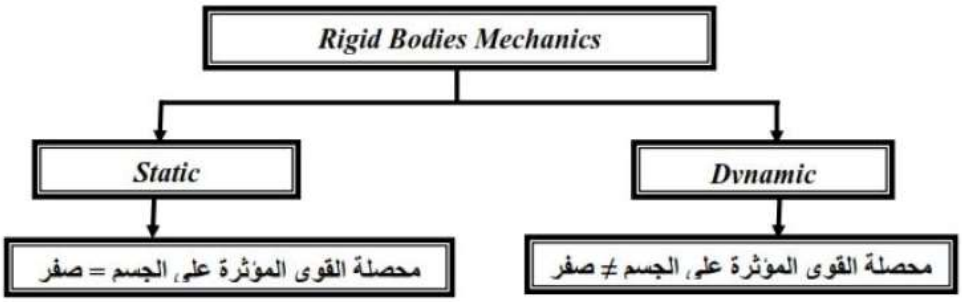
Introduction:

Mechanics: can be defined as that branch of the physical sciences concerned with the state of bodies that are subjected to the action of forces (in the state of motion or rest)

الميكانيك يعرف بأنه جزء من العلوم الفيزيائية التي تركز على حالة الاجسام تحت تأثير القوى الخارجية المسلطة على هذه الاجسام.



- *When the changes in shape of body are important, the problem becomes* ***Deformable Bodies Mechanics.***
- *Our study treats only with* ***Rigid Bodies Mechanics,*** *so that the body is stay in the same shape after applying the forces (No deformations are considered in the body).* دراستنا سوف تكون على الاجسام الغير قابلة للتشوه (الاجسام الجاسئة)



- **Static** deals with the equilibrium of bodies. That are either at rest or move with a constant velocity. الاجسام سوف تكون في حالة توازن اما ساكنة او متحركة بسرعة ثابتة
- **Dynamic** is concerned with the accelerated motion of bodies under effects of external forces. الاجسام سوف تكون في حالة حركة متغيرة

Vector & Scalar quantities :

Vector quantities : are the quantities which have magnitude and direction .such as: Force , weight , distance , speed , displacement , acceleration ,velocity .

Scalar quantities : are the quantities which have only magnitude , such as : Time , size , sound , density , light , volume .

Force :

A "force" is an action that changes, or tends to change, the state of motion of the body upon which it acts. It is a vector quantity that can be represented either mathematically or graphically

A complete description of a force MUST include its:

1. MAGNITUDE
2. DIRECTION and SENSE
3. POINT OF ACTION

هي الفعل الذي يغير او يحاول ان يغير من حالة الجسم الحركية او الشكلية، والقوة لها مقدار (Magnitude) واتجاه (Direction) ووجهة (Sense) ونقطة تأثير (Action point)

Classification of Forces

- ✓ Contact
  - 1 – Contacting or surface forces (mechanical)
  - 2 – Non-Contacting or body forces (gravitational, weight)
- ✓ Area
  - 1 – Distributed Force, uniform and non-uniform
  - 2 – Concentrated Force

Classification of Forces

- ✓ Force System
  - 1 – Concurrent : all forces pass through a point
  - 2 – Coplanar : in the same plane
  - 3 – Parallel : parallel line of action
  - 4 – Collinear : common line of action
- ✓ Three Types
  - 1 – Free (direction, magnitude and sense)
  - 2 – Sliding
  - 3 – Fixed

Unites and Their Relations:

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

1 m	100 cm
1 in	2.54 cm
1 m	1000 mm
1 ft	12 in
1 km	1000 m
1 mile	1609.1 m
1 yard	3 ft
1 kg	2.204 lb (pound)
1 kg	9.81 N
1 ton	1000 kg

SI Unites

The International System of Units, abbreviated SI (from the French, Système International d'Unités), is accepted in the United States and throughout the world, and is a modern version of the metric system. By international agreement, SI units will in time replace other systems. As shown in the table, in SI, the units kilogram (kg) for mass, meter (m) for length, and second (s) for time are selected as the base units, and the newton (N) for force is derived from the preceding three by Eq. 1/1. Thus, force (N) = mass (kg) × acceleration (m/s^2) or

$$N = kg \cdot m/s^2$$

Thus, 1 newton is the force required to give a mass of 1 kg an acceleration of 1 m/s^2.

Consider a body of mass m which is allowed to fall freely near the surface of the earth. With only the force of gravitation acting on the body, it falls with an acceleration g toward the center of the earth. This gravitational force is the *weight* W of the body, and is found from Eq. 1/1:

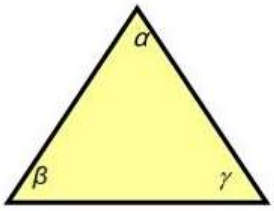
$$W(\mathrm{N}) = m(\mathrm{kg}) \times g(\mathrm{m/s^2})$$

Quantity Measurement Units:

Area	----------	m^2 , cm^2
Length	----------	m , cm
Volume	----------	m^3 , cm^3
Mass	----------	kg
Force	----------	N , KN
Moment	----------	$N.m$, $kN.m$
Time	----------	*sec, min, hr.*
Angle	----------	*degree, radian*

Symbols:

α	*ALPPHA*
β	*BETA*
γ	*GAMMA*
ϕ	*PHI*
π	*PI*
μ	*MU*



Trigonometric Relations for Right Angle's Triangles

$$\sin\beta = \frac{a}{c}$$

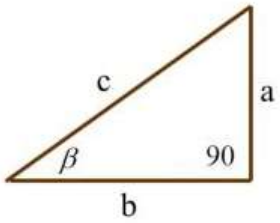
$$\cos\beta = \frac{b}{c}$$

$$\tan\beta = \frac{a}{b}$$

$$\sec\beta = \frac{c}{b} = 1/\cos\beta$$

$$\cot\beta = \frac{b}{a} = 1/\tan\beta$$

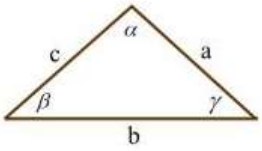
$$c\sec\beta = \frac{c}{a} = 1/\sin\beta$$



Oblique Triangle

a-Sine Low

$$\frac{\mathbf{a}}{\sin\beta} = \frac{\mathbf{b}}{\sin\alpha} = \frac{\mathbf{c}}{\sin\gamma}$$



b-Cosine Low

$$\mathbf{a}^2 = \mathbf{b}^2 + \mathbf{c}^2 - 2\mathbf{bc}\cos\beta$$

$$\mathbf{b}^2 = \mathbf{a}^2 + \mathbf{c}^2 - 2\mathbf{ac}\cos\alpha$$

$$\mathbf{c}^2 = \mathbf{a}^2 + \mathbf{b}^2 - 2\mathbf{ab}\cos\gamma$$

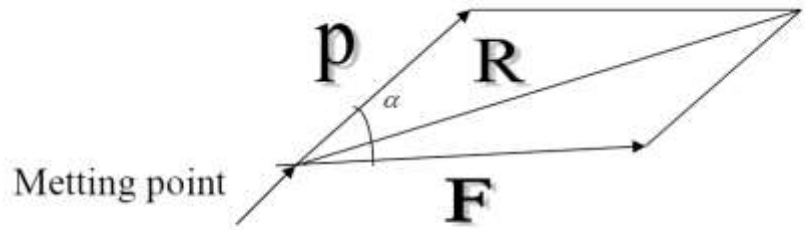
Resultaut: المحصلـة

The resultant of a force system is the force which can replace تحل محل the original system with out changing بدون تغيير its external effects التأثير الخارجي on rigid bodies .

PARAIIE LOGRAM LAW قانون متوازي الاضلاع

IF two forces acting تؤثر on appoint and two side of(parallel log ram) متوازي أضلاع representing them meeting تلتقي in the same point نقطة . then the resultant المحصلة represent تتمثل of these two

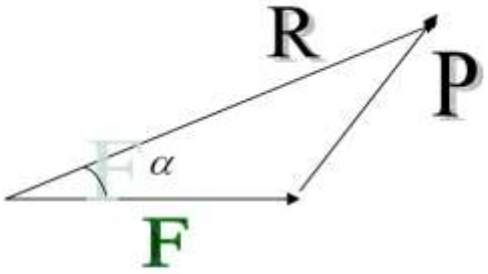
forces represents exactly بالضبط the diagonal قطر of the parallelogram from the same point نفس النقطة .



$$R=\sqrt{P^2+F^2-2PF\cos\alpha}$$

Triangle Law قانون مثلث القوى

IF two forces are repented by their vectors placed Tip رأس to tail ذيل , their resultant vector is the third side الضلع الثالث of the triangle the Direction of resultant المحصلة being from the tail of the force to the tip of the last vector .



$$\frac{R}{\text{Sin } \beta} = \frac{P}{\text{sin } \alpha} = \frac{F}{\text{sin } \theta}$$

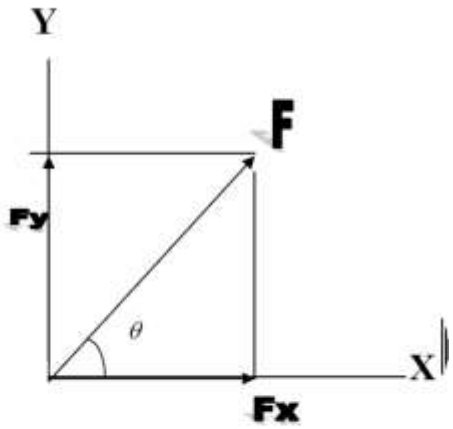
Force and Components : القوى ومركباتها

IF we want to find the components of the force we must know نعلم
The magnitude مقدار and Direction اتجاه of the force .
(F_x) , (F_y) are the components of (F)

$$\text{Cos } \theta = \theta \text{ جتا} = \frac{\text{المجاور}}{\text{الوتر}}$$

$$\text{Cos } \theta = \frac{Fx}{F}$$

$$Fx = F \cos \theta$$



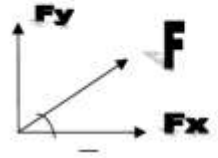
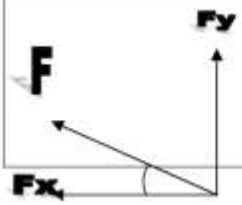
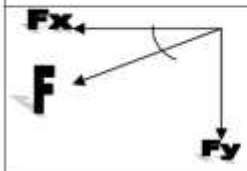
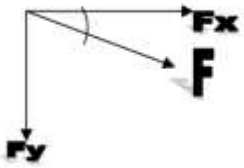
$$\text{Sin } \theta = \theta \text{ جا} = \frac{\text{المقابل}}{\text{الوتر}}$$

$$\text{Sin } \theta = \frac{F\ y}{F}$$

$$Fy = F \sin \theta$$

The direction of Component fiade from هذا عندما تكون الزاوية بين القوة ومحور السينات

((الجدول Table))

Drawingالرسم	Location موقع	Sine of Fx اشارة	Sine of Fy اشارة
	الربع الاول	+	+
	الربع الثاني	–	+
	الربع الثالث	–	–
	الربع الرابع	+	–

ملاحظة : لاتوجد قوة سالبة وإنما السالب والموجب يمثل اتجاه المركبة .

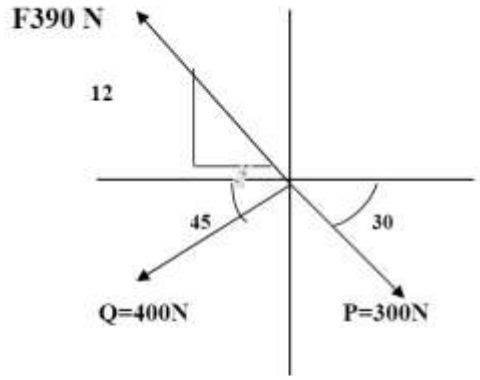
IF we want the force (F) from the components (Fx) , (Fy).

$$F=\sqrt{Fx^2+Fy^2}$$ المقدار

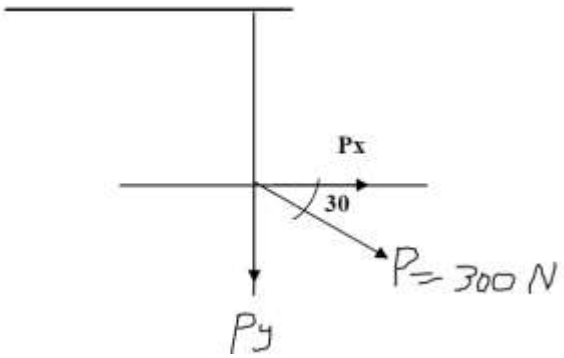
$$\tan\theta=\frac{Fy}{Fx}$$ الاتجاه

Tan θ = θ ظا = المقابل / المجاور

Q/ Find the Components المركبات of forces shown in Fig الموضحات في الرسم.



For the force (P)



$P_X = P \cos \theta = 300 \cos 30 = 300 * 0.866$

$P_{X=+} 250.8\ N$

$PX = 259.8\ N \longrightarrow$

$P_{y=} P \sin \theta = 300 \sin 30 = -300 * 0.5$

$P_y = -150\ N$

$P_y = 150\ N \downarrow$

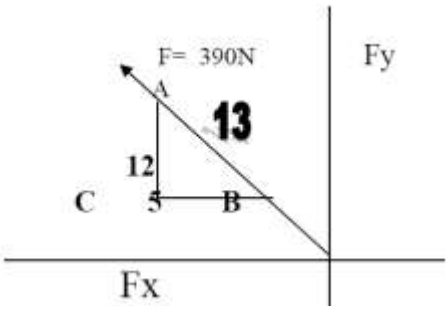
For the force (F)

$$AB = \sqrt{Bc^2 + cA^2}$$ حسب نظرية فيثاغورس

$$AB = \sqrt{5^2 + 12^2}$$

$$AB = \sqrt{25 + 144} = \sqrt{169}$$

AB= 13



$$F_X = F \cos\theta = -390 * \frac{5}{13}$$

$F_X = -145$ N

$F_X = 145$ N ←

$$F_y = F \sin\theta = +390 * \frac{12}{13}$$

$F_y = 375$ N ↑