PHYSICS LAB.

(20147)

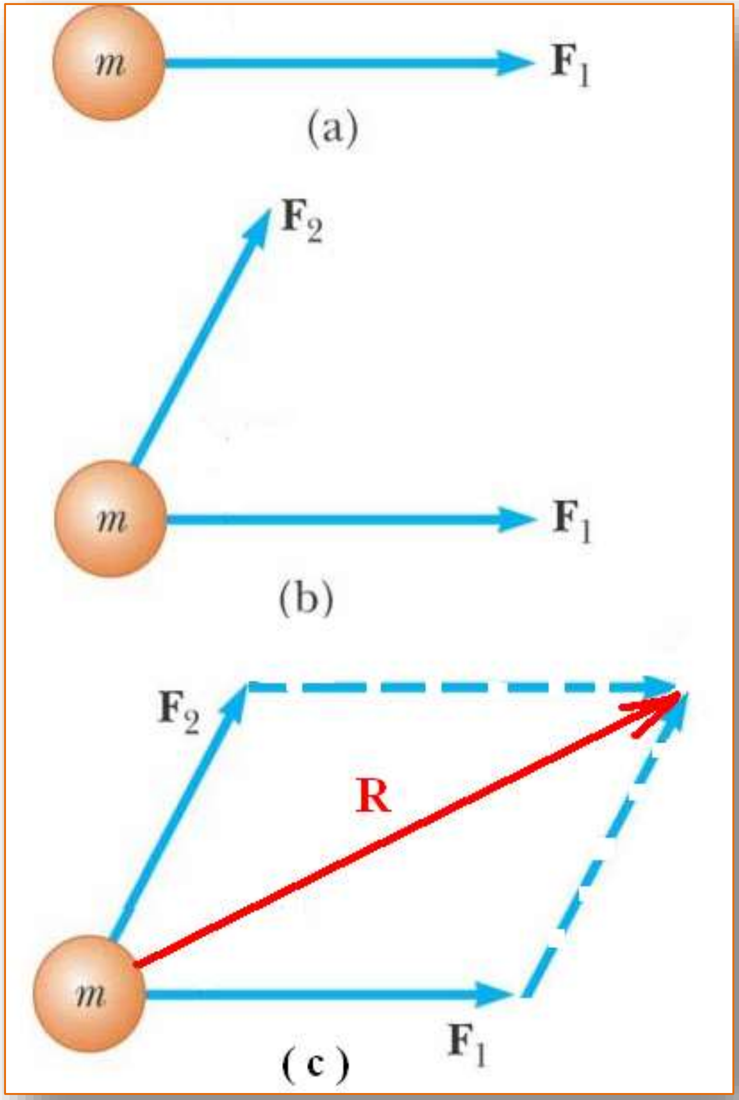
Experiment No. 4

Static Equilibrium

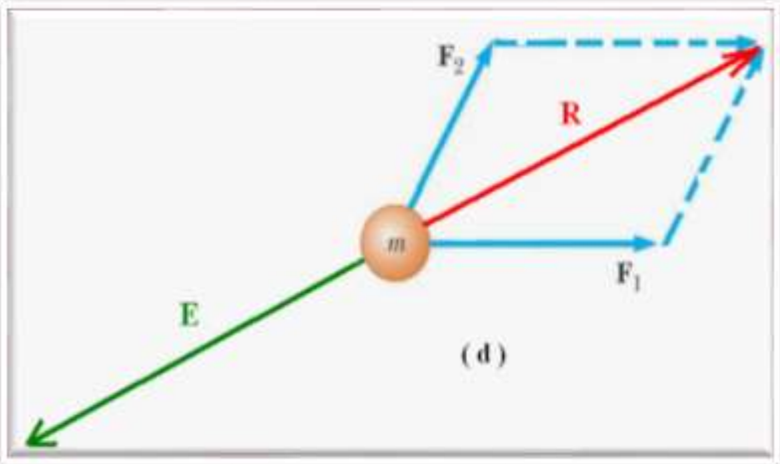
The resultant of Many Forces

Exp.no. 4 Static equilibrium
Composition of concurrent forces

- If a force F_1 is applied to an object of mass **m** as in fig. **(a)**, then the object will move in the direction of F_1.
- If two forces F_1 , F_2 are applied to the object as in fig. **(b)**, then the object will move in the direction of **resultant R** of the two forces F_1 , F_2 as shown in fig. **(c)**.
- The same rule are applied if many forces act on the object.



- If we need to keep the object at rest or at Equilibrium , we must applied another force equal in magnitude but opposite in direction to the resultant force R, as shown in fig. (d).
- This force that keeps the object at Equilibrium under the action of two or more forces is called Equilibrium Force E .
- In our experiment, we shall determine the Equilibrium Force E experimentally for many different forces acting on a small object which has no mass and no dimensions, this object is called Point object. The forces acting on it is called Concurrent forces.



- The resultant force R, of many forces acting on a point object will be determined by two methods :

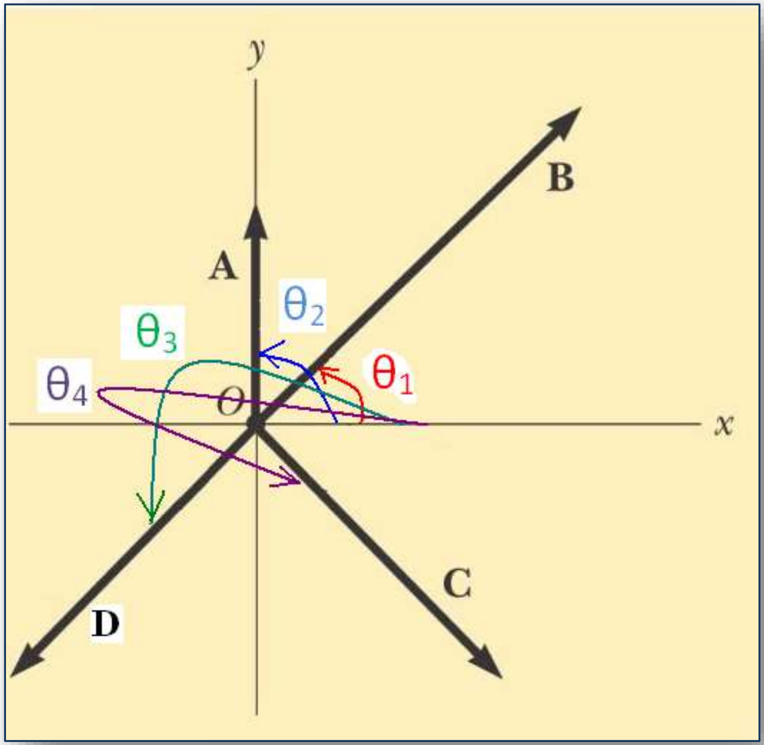
1. The analytical or the components method.

2. The geometrical or graphical method.

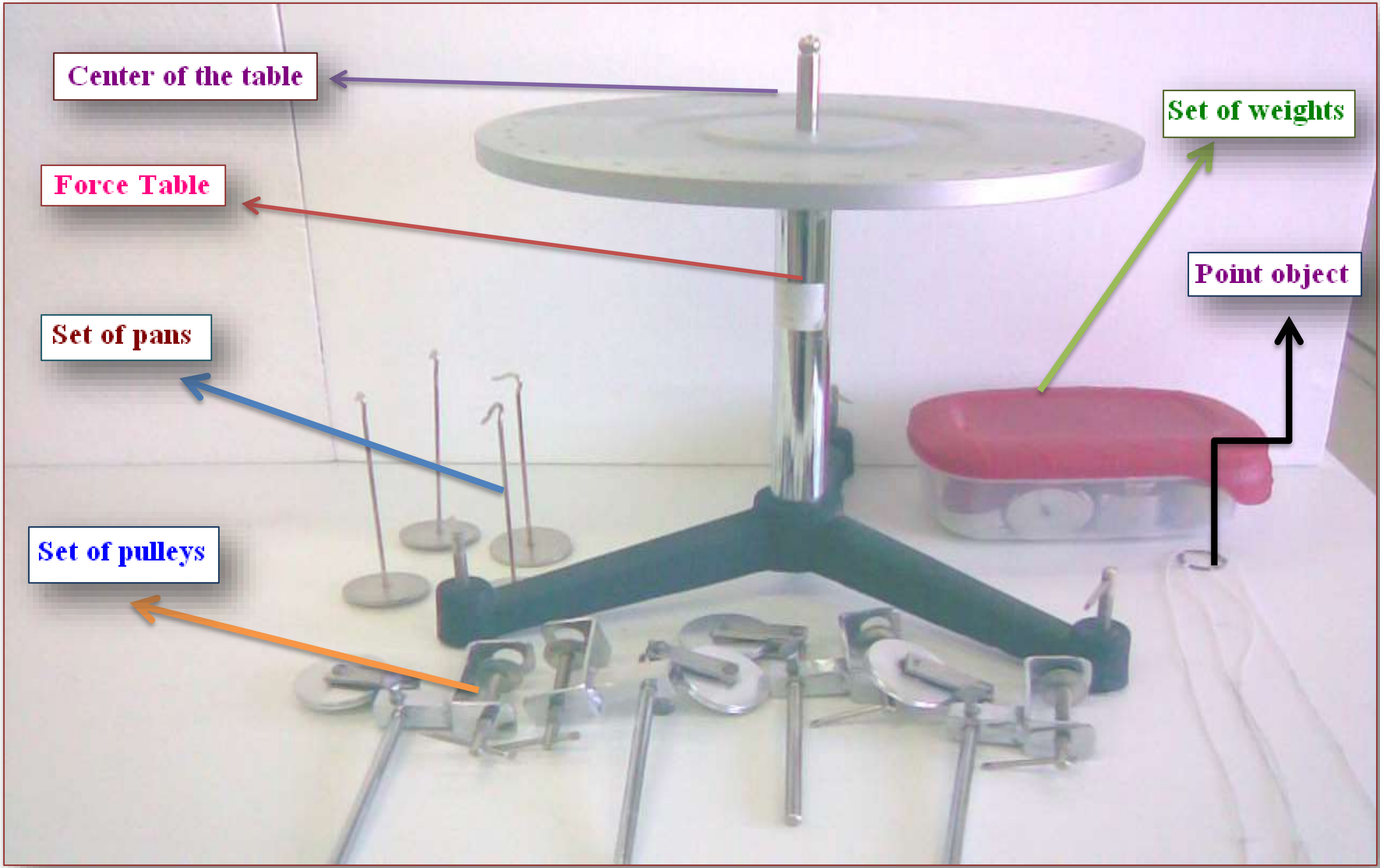
We shall explain the experimental method and both the analytical and geometrical methods.

Directions of the Applied Forces

All the directions of all forces acting on a point object is determined with respect to the positive X-axis and in the counter clock wise as shown in the figure.



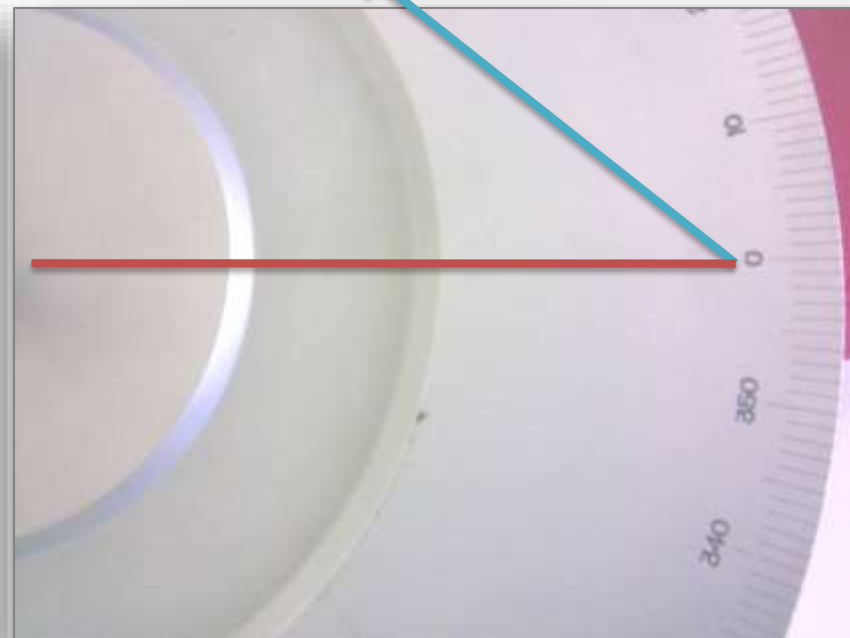
Experimental Method



Top view of the Force table

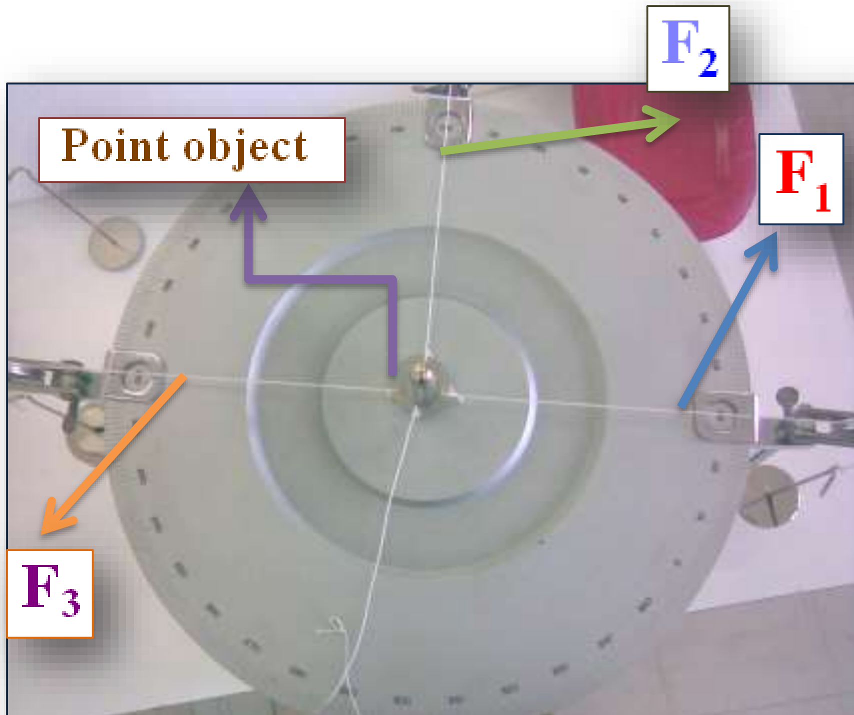
Center of the table

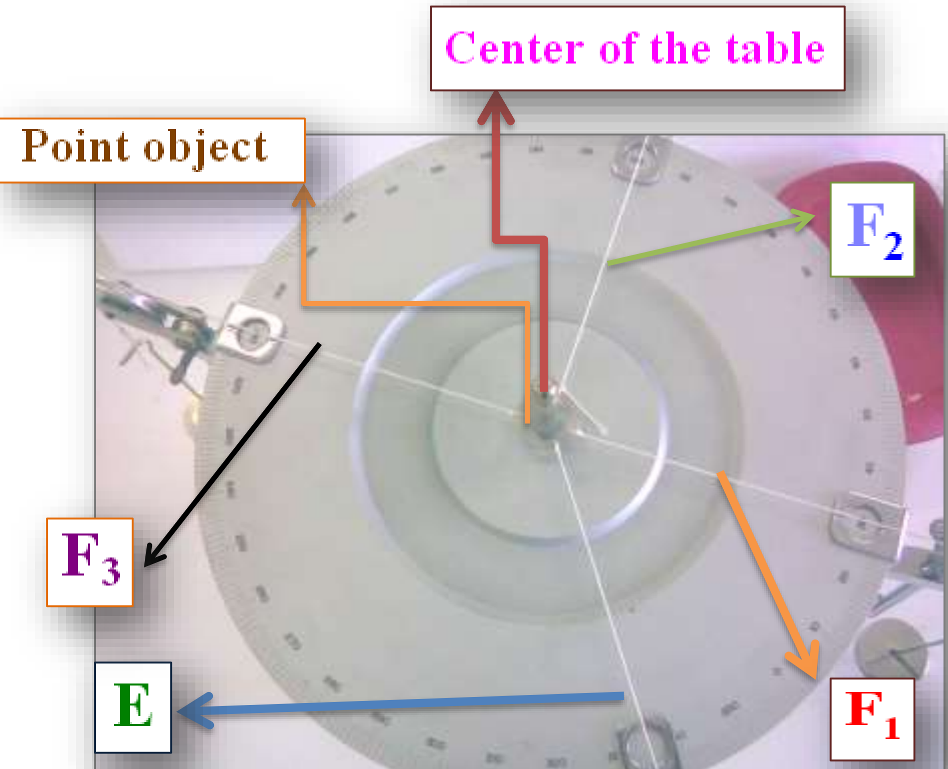
Positive X- axis

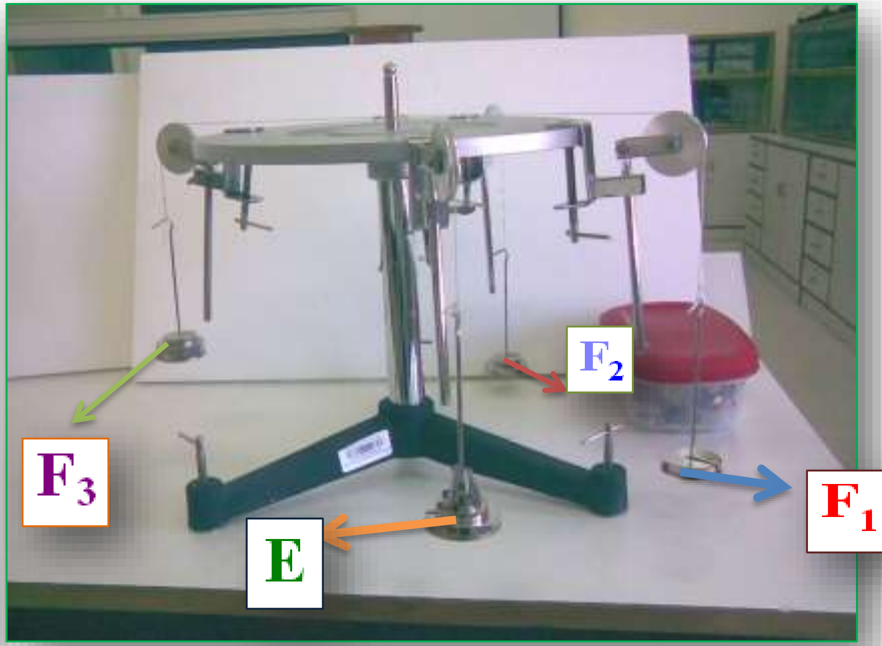


Example: Find the equilibrant for the following forces

$F_1 = 162\ g$, $\theta_1 = 30^\circ$, $F_2 = 212\ g$, $\theta_2 = 120^\circ$, $F_3 = 312g$, $\theta_3 = 210^\circ$



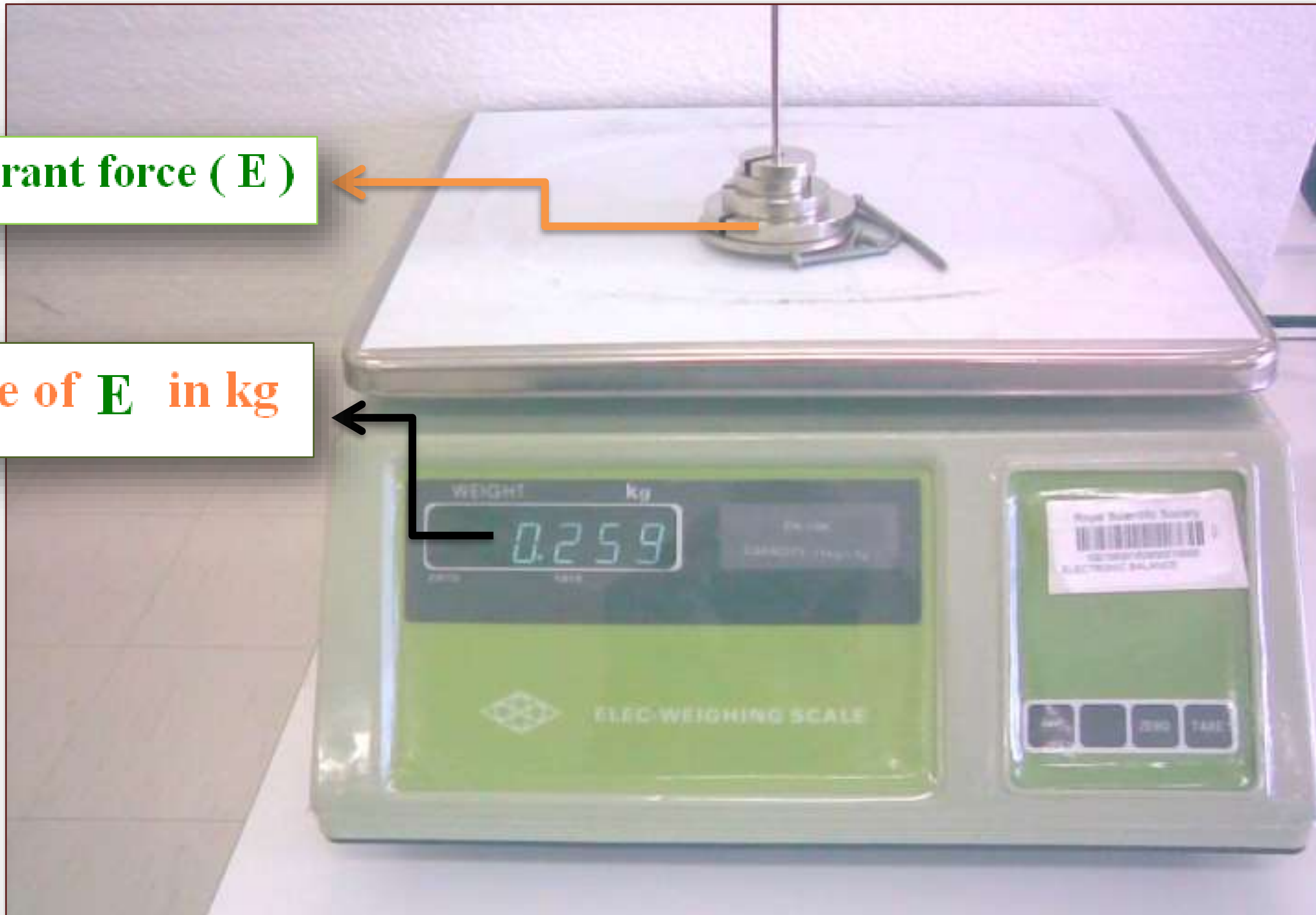

Center of the table
Point object
F_2
F_3
E
F_1


F_2
F_3
E
F_1

Using the electronic balance to determine the magnitude of the equilibrant force (E)

The equilibrant force (E)

Magnitude of E in kg



Analytical Or Components (Theoretical) Method

$F_1 = 162$ g , $\theta_1 = 30^\circ$, $F_2 = 212$ g , $\theta_2 = 120^\circ$, $F_3 = 312$g , $\theta_3 = 210^\circ$

$F_{1x} = 162 \cos 30 = 140.3$ g , $F_{1y} = 162 \sin 30 = 81$

$F_{2x} = 212 \cos 120 = -106$ g , $F_{2y} = 212 \sin 120 = 183.4$ g.

$F_{3x} = 312 \cos 210 = -270.2$ g , $F_{3y} = 312 \sin 210 = -156$ g

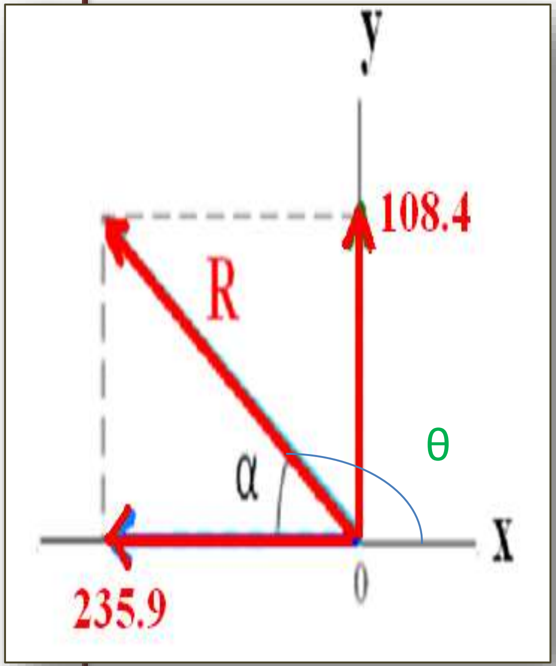
$R_x = 140.3 - 106 - 270.2 = -235.9$ g .

$R_y = 81 + 183.4 - 156 = 108.4$ g .

$R = \sqrt{(235.9)^2 + (108.4)^2} = 259$ g.

$\tan \alpha = 108.4 / 235.9$, $\alpha = 25^\circ$

$\theta = 180 - 25 = 155^\circ$



Geometrical or Graphical Method

Scale : 1 cm = 25 g.

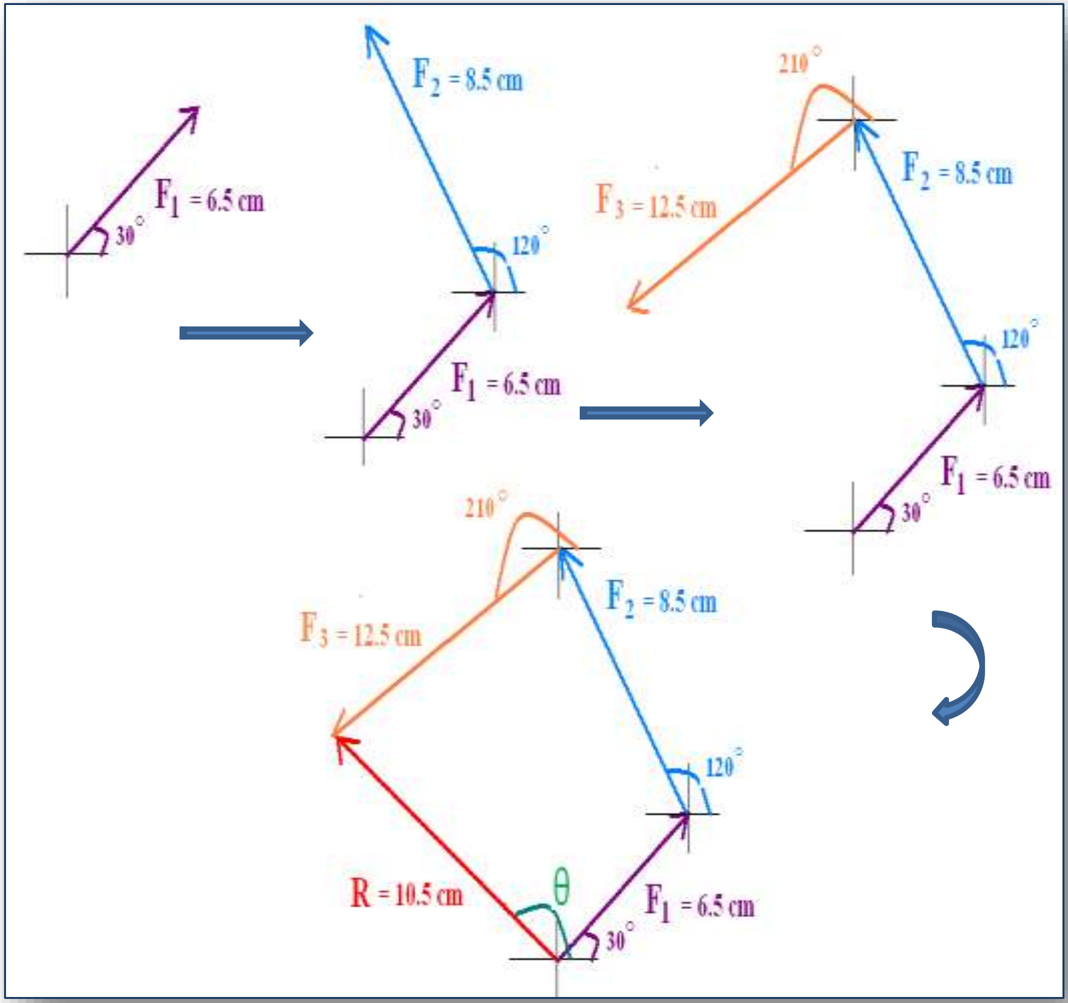
F_1 = 162/ 25 = 6.5 cm
$\theta_1 = 30^\circ$

F_2 = 212/25 = 8.5 cm.
$\theta_2 = 120^\circ$

F_3 = 312/ 25 = 12.5 cm
$\theta_3 = 210^\circ$

R = 10.5 x 25 = 255 g.

$\theta = 155^\circ$



3. Data :

a) Complete the following table:

Sample:

No.	F_1		F_2		F_3		E		R From calculation	
	Value g	Angle θ_1	Value g	Angle θ_2	Value g	Angle θ_2	Value g	Angle α	Value g	Angle θ
1										
2										
3										

3. Data :

a) Complete the following table: 1

No.	F_1		F_2		F_3		E		R	
	Value g	Angle θ_1	Value g	Angle θ_2	Value g	Angle θ_2	Value g	Angle α	Value g	Angle θ
1	262	0	162	45	212	110				
2	162	300	262	90	362	210				
3	162	0	262	30	362	270				

b. Calculate the resultant R for each case in the above table by using components method. Write your results in the table.

Theoretical Calculations:

NO.1

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No. 2

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No. 3

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C. Find the result ant force (R) for problem no.1 only using the graphical method.

Solution:

Scale : 1 cm = gm.

F_1 = cm

F_2 = cm.

F_3 = cm.

Draw the graph below.

The results:

R = cm, R = gm.

Θ =