

Experiment No. : 1

Title of Experiment : Verification of Polygon Law of Coplanar Forces

Student's Name : Ayush Shailesh Jain

SAP No. : 60004200132

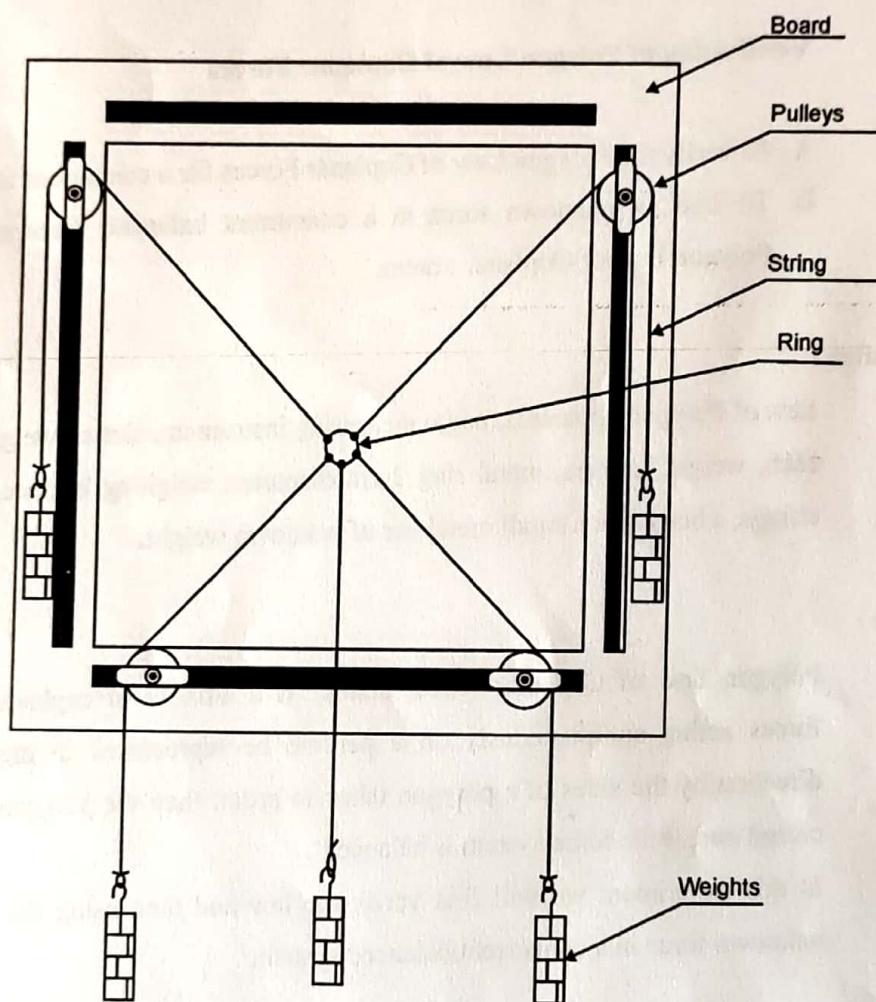
Semester : I

Academic Year : 2020 - 2021

Punctuality	Reading & Understanding	Application	Total	Signature & Date
02	04	04	10	

DJ19FEC104.01	Illustrate the effect of force and moment and apply the same along with the concept of equilibrium systems with the help of FBD.
DJ19FEC104.02	Demonstrate the understanding of Centroid and its significance and locate the same.
DJ19FEC104.03	Correlate real life application to specific type of friction and estimate required force to overcome friction.
DJ19FEC104.04	Establish relation between velocity and acceleration of a particle and analyze the motion by plotting the relation.
DJ19FEC104.05	Analyze general plane motion of rigid bodies using Instantaneous centre.
DJ19FEC104.06	Analyze particles in motion using force and acceleration, work-energy and impulse-momentum principles.

**Set-up Diagram**



**Polygon Law of Forces Apparatus**

Experiment No: \_\_\_\_\_

Date: 18/03/2021

**Title : Verification of Polygon Law of Coplanar Forces**

- Aim:**
- A. To verify the Polygon Law of Coplanar Forces for a concurrent force system.
  - B. To find an unknown force in a concurrent balanced force system using Polygon Law of Coplanar Forces.

**Apparatus :**

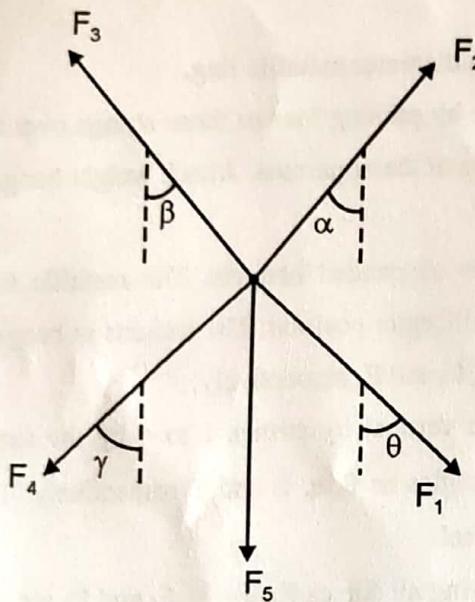
Law of Polygon apparatus, angle measuring instrument, slotted weights of 50 gm each, weight hangers, metal ring 2 cm diameter, weighing balance, thin strong strings, a body like a small metal bar of unknown weight.

**Theory :**

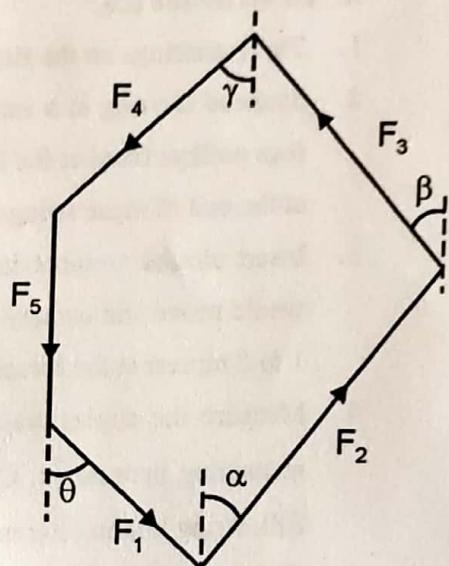
Polygon Law of Coplanar Forces states, 'If a number of coplanar concurrent forces acting simultaneously on a particle be represented in magnitude and direction by the sides of a polygon taken in order, then the polygon would be a closed one, if the force system is balanced'.

In this experiment we will first verify the law and then using the law find an unknown force in a concurrent balanced system.

A. To verify the law.



Free Body Diagram



Force Polygon

**Observation Table:**

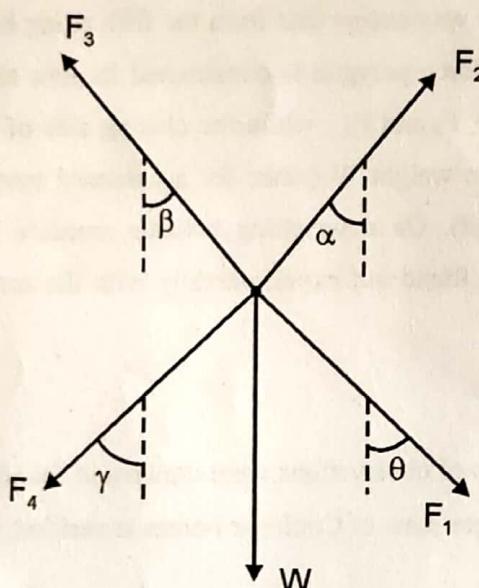
SR NO.	F <sub>1</sub> (N)	F <sub>2</sub> (N)	F <sub>3</sub> (N)	F <sub>4</sub> (N)	F <sub>5</sub> (N)	θ (deg.)	α (deg.)	β (deg.)	γ (deg.)
1	2.8	3.58	3.56	2.03	1.92	45	39	47	48
2	2.8	3.12	2.6	2.90	2.4	66	30	40	65
3	2.8	2.6	3.12	2.94	2.38	69	36	34	60

**Procedure:**

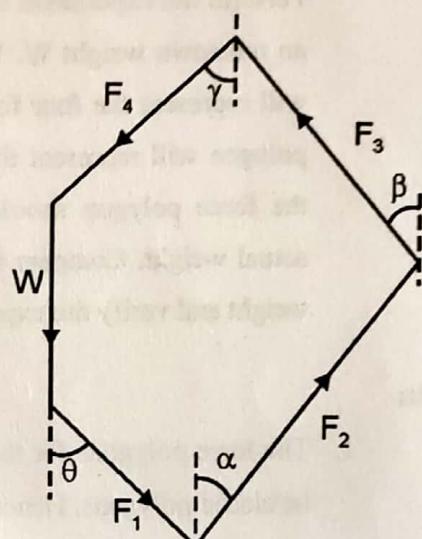
**A. To verify the law:**

1. Tie five strings on the rim of a 2 cm diameter metallic ring.
2. Suspend the ring in a vertical plane by passing four of these strings over the four pulleys fixed at the four corners of the apparatus. Attach weight hangers at the end of these strings.
3. Insert slotted weights in these five suspended hangers. The metallic ring would move and occupy a new equilibrium position. The weights in hangers 1 to 5 represent the forces  $F_1, F_2, F_3, F_4$  and  $F_5$  respectively.
4. Measure the angles made with the vertical by strings 1 to 4 by the angle measuring instrument. Call these angles as  $\theta, \alpha, \beta$  and  $\gamma$  respectively. The fifth string holding  $F_5$  remains vertical.
5. Construct a space diagram by drawing all forces  $F_1, F_2, F_3, F_4$  and  $F_5$  at their true orientation and location as shown.
6. Construct a force polygon ( a diagram which shows the forces represented to some force scale and connected to each other by a head and tail connection). The polygon here will be five sided since there are five forces. Draw the first side  $F_1$  parallel to its orientation in the space diagram and of a length equal to the magnitude of  $F_1$  and represented to some suitable scale. To the head of  $F_1$  connect the tail of force  $F_2$  drawn parallel to its orientation in the space diagram and of length equal to the magnitude of  $F_2$  converted by the force scale. Similarly construct sides  $F_3, F_4$  and  $F_5$  of the force polygon. The fifth side  $F_5$  is vertical since the force  $F_5$  is a vertical force.
7. The experiment will be verified if the force polygon is a closed polygon.
8. Repeat the above steps by changing the weights hanging from the five hangers for two more sets of observations.

B. To find an unknown force using the law.



Free Body Diagram



Force Polygon

**Observation Table:**

SR NO.	F <sub>1</sub> (N)	F <sub>2</sub> (N)	F <sub>3</sub> (N)	F <sub>4</sub> (N)	θ (deg.)	α (deg.)	β (deg.)	γ (deg.)	Unknown Weight W (N)
1	2.8	2.6	3.12	2.94	72	35	33	63 65	2.9
2	2.8	3.58	4.02	2.94	60	38	36	50	2.7
3	2.3	4.08	4.48	2.48	52	42	45	44	2.9
Mean W =									2.83

**B. To find an unknown force using the law:**

Perform the experiment in the same way except that from the fifth string hang an unknown weight W. When the force polygon is constructed its four sides will represent the four forces  $F_1$ ,  $F_2$ ,  $F_3$  and  $F_4$ , while the closing side of the polygon will represent the unknown weight W (since for a balanced system the force polygon should be closed). On a weighing balance measure the actual weight. Compare the weight found out experimentally with the actual weight and verify the experiment.

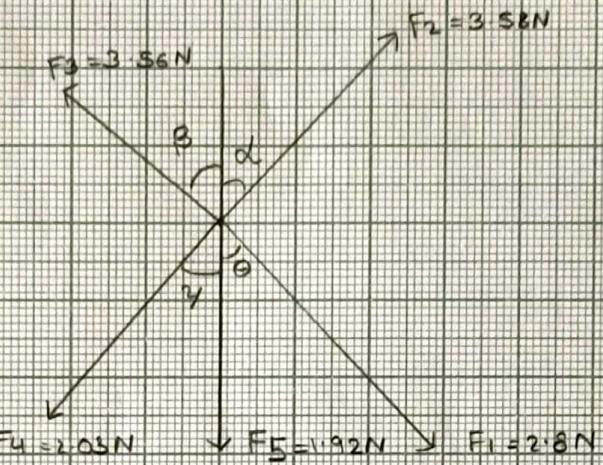
**Result:**

1. The force polygons for the three sets of observations were drawn and found to be closed polygons. Hence the Polygon Law of Coplanar Forces is verified.
2. The unknown weight found experimentally is 2.83 N and its actual weight on measurement was found to be 2.9 N. within the limits of experimental error, these values are found to be same and hence the experiment is verified.

**Precautions**

1. The metal ring should be of a small diameter, less than 2 cm, so that a concurrent system is formed and its own weight becomes negligible.
2. Use thin and strong strings.
3. Oil the pulleys at their pins to make them close to being frictionless.
4. Hold the angle measuring instrument very close and parallel to the inclined strings. Note that the angle measuring instrument always gives the angle with the vertical.

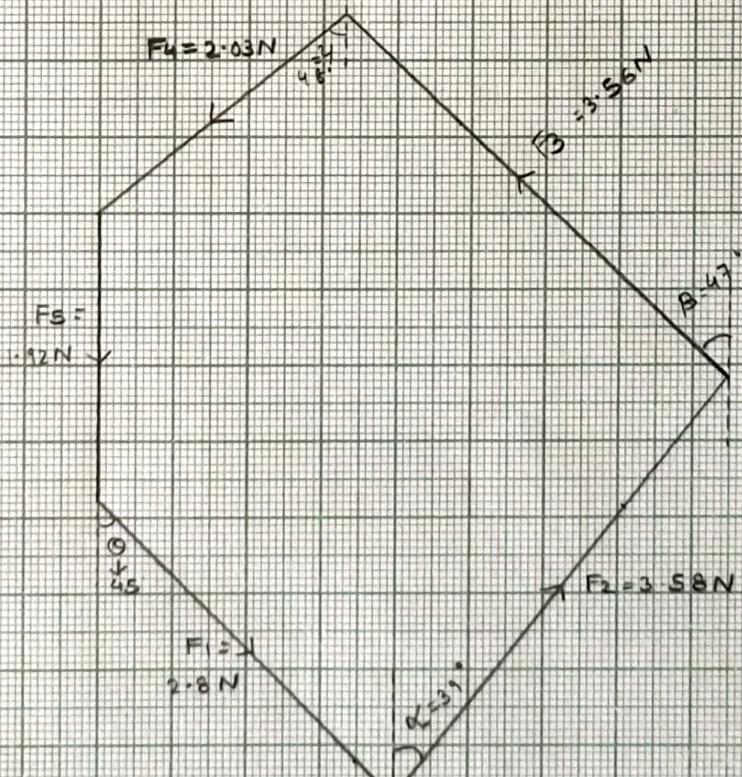
## Free Body Diagram



Scale

 $1 \text{ N} = 2 \text{ cm}$ 

## Force Polygon



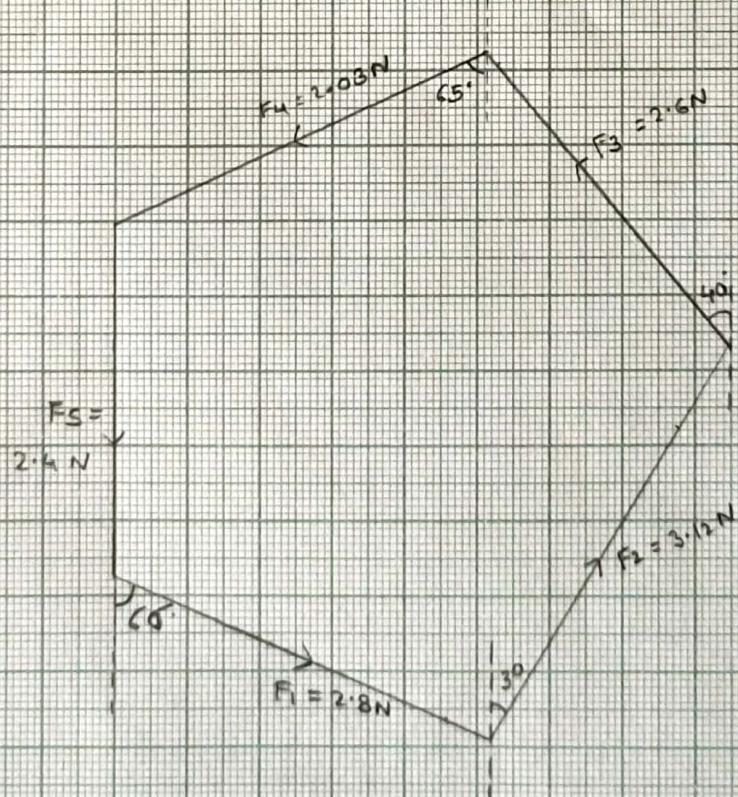
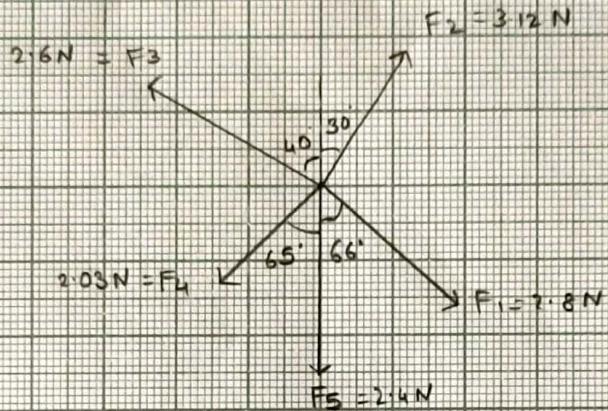


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## Free Body diagram

Scale

1 N = 2 cm

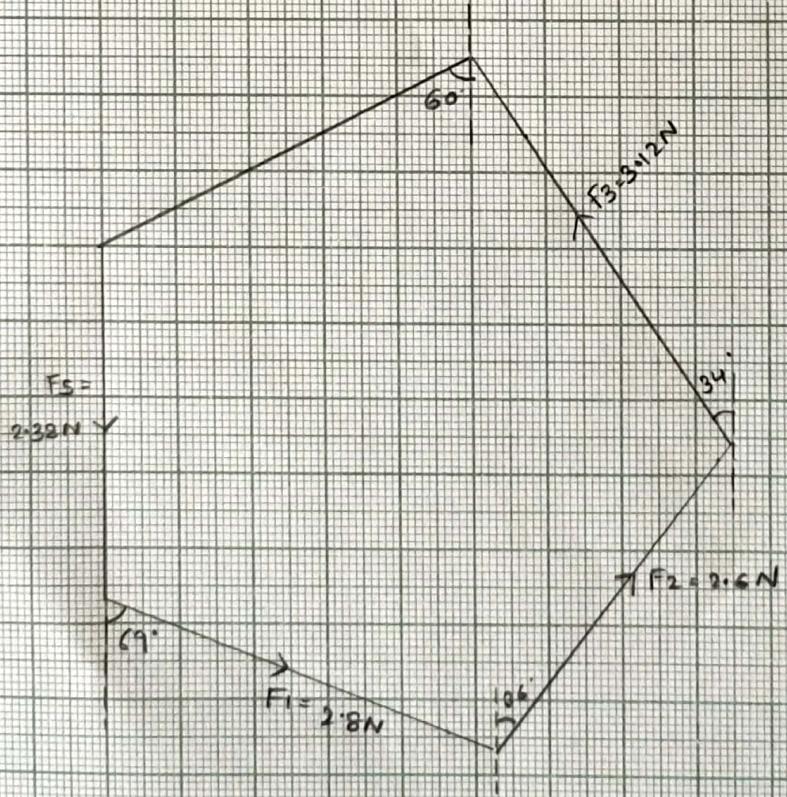
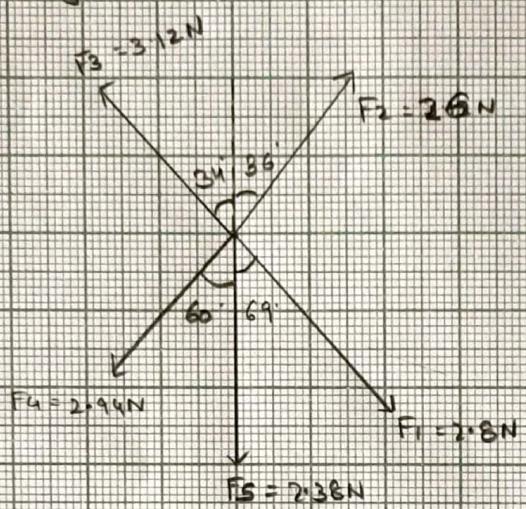


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## Free Body Diagram

Scale

$$1 \text{ N} = 2 \text{ cm}$$

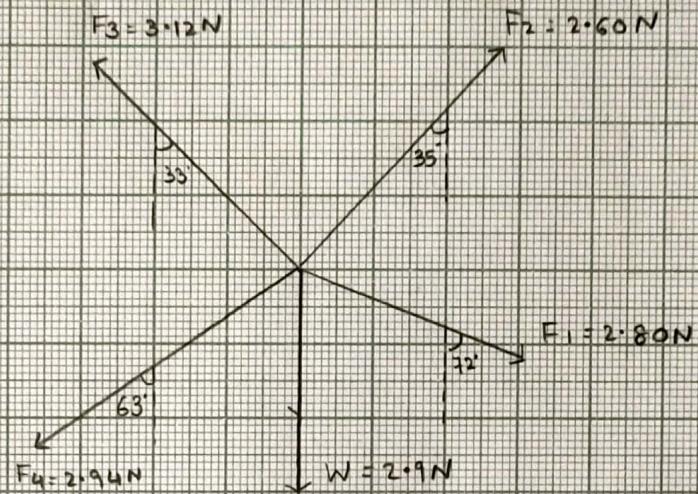




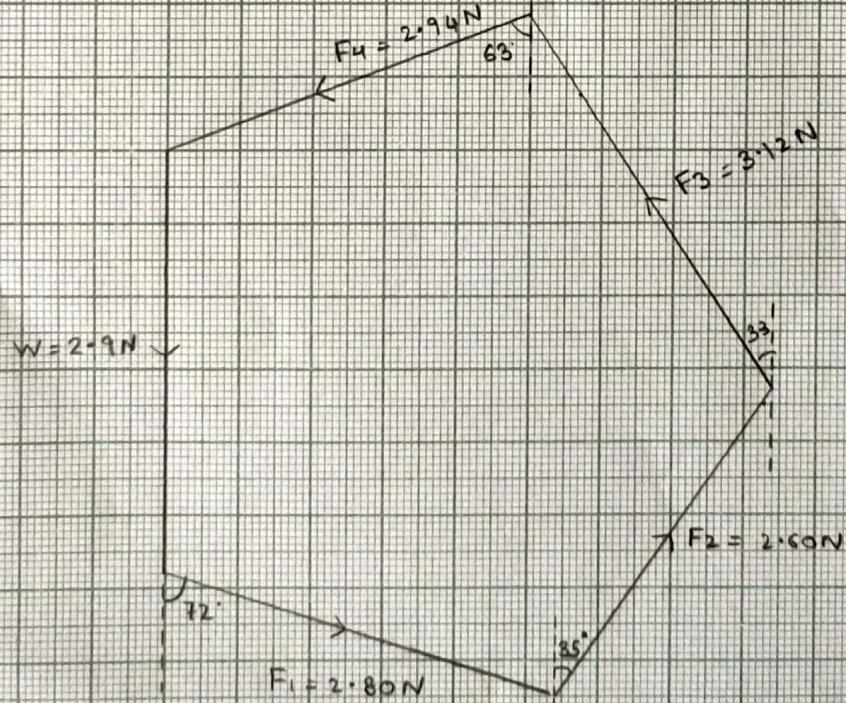
## Free Body Diagram

Scale

1 N = 2 cm



## Force Polygon



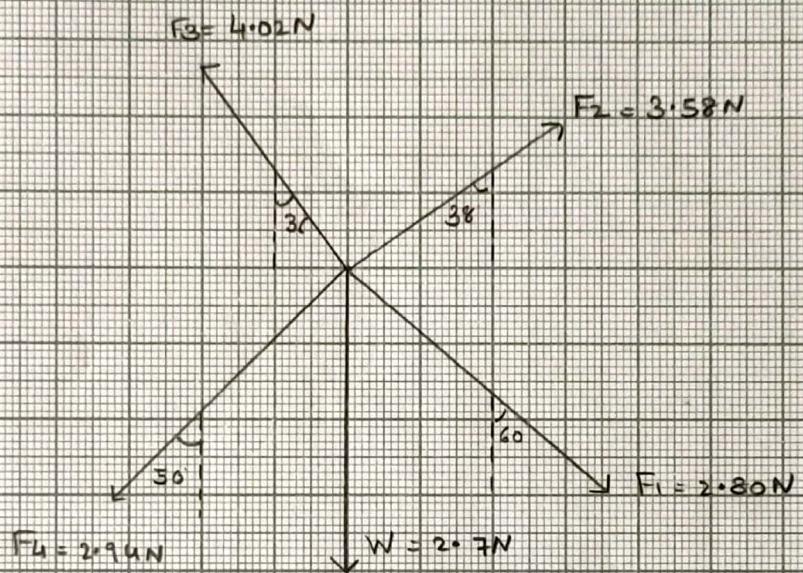
Part b) - 2)



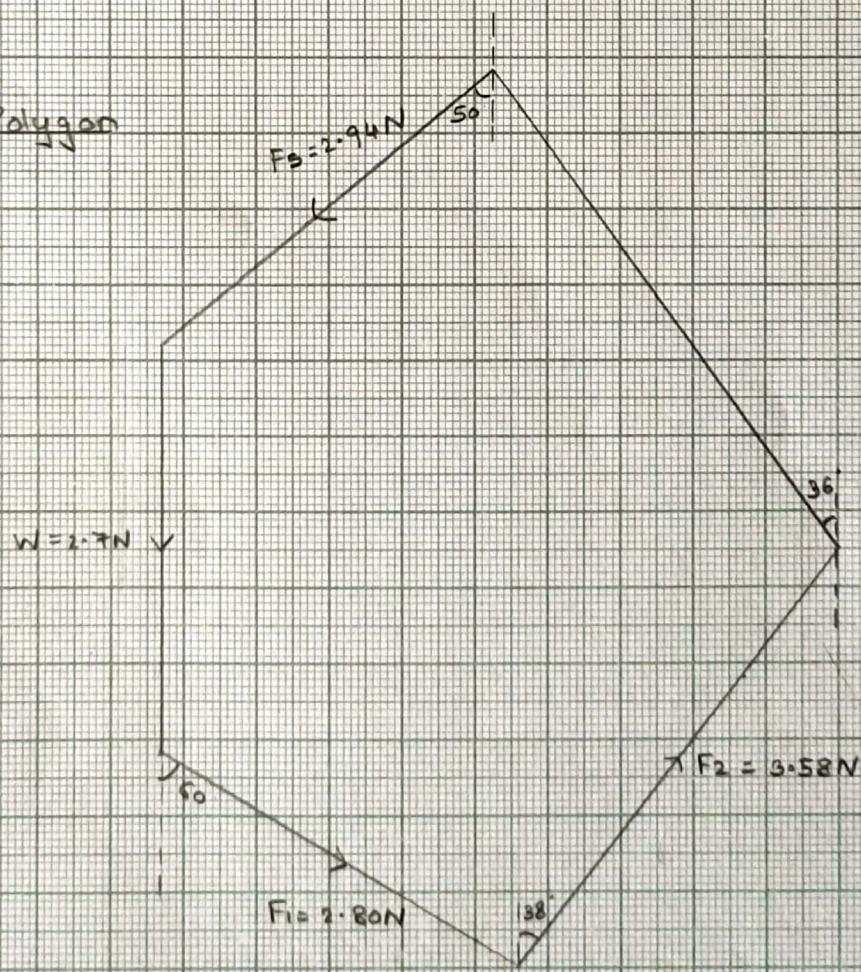
Free Body diagram

Scale

1 N = 2 CM



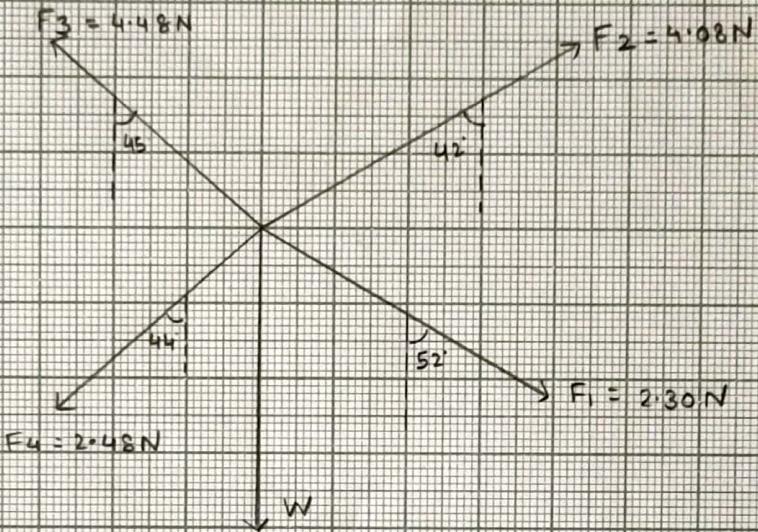
Force Polygon



Free Body Diagram

Scale

1 N = 2 cm

Force Polygon