Date of Lab 10/10 Date of Submission 10/~~10~~ 17

Laboratory Report

Title Force Table.

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Summary
We used a force table at various angles and weights to bring it into equilibrium. I put this results in the graph. Then using this result, I drew a diagram using the parallelogram method and the Head-to-tail method. There were some errors, but I found that the net force will be zero when the forces are balanced.

・Meet a deadline ・Write logically ・Write clearly ・Write with your own words

Teacher's Comments
Beautiful drawings and good analysis (only one wrong expressions ~~of~~ about angle on the math method) The table of comparison is very good.

1	2	3	4	5	6	7	8	9
Due	Summary	Intro.	Method.	Results	Table/Fig.	Discussion	Clearness	General

* Use this form as a cover sheet.
* Submit your reports by the seventh day after your lab.

2 Introduction

1) Objective: To conform that net force made from several force in equilibrium is zero by using a force table.

2) Hypothesis: The net force of all tensional force acting on three (or four) wires is zero.

3) Apparatus: Force Table, Cords, Pulleys, Hangers, Ring, Graph paper, Ruler

3 Procedure

1) Assemble a force table, in the figure.
2) Put different amount of weights in three hangers.
3) One cord is set on 0°.
4) Three force are balanced by trial and error.
5) Record the angles and the mass of weights.
6) Calculate force in N. obtain the length of an arrow expressing the magnitude of each force vector.
7) On graph paper, net force is obtained using the parallelogram method and using head-to-tail method.
8) Repeat the above using four hangers.
9) Repeat the above but the four force are slightly off the balance. Obtain the net force.
10) Perform the math method and compare the results with the graph method. (Exp.1~3)

4 Result

(1) Table1, three forces are balanced

Length of an arrow 1N = 3cm

Exp.1	Mass of Weight [kg]	Force [N]	Arrow [cm]	Angle [°]
A	0.2 kg	1.96N	5.88cm	0°
B	0.15kg	1.47N	4.41cm	85°
C	0.25kg	2.45N	7.35cm	212.5°

*Force = mass × gravitational acceleration = mass × $9.80m/s^2$

(2) Table 2, Four forces are balanced

Length of an arrow 1N = 3cm

Exp.2	Mass of Weight [kg]	Force [N]	Arrow [cm]	Angle [°]
A	0.3kg	2.94N	8.82cm	0°
B	0.2kg	1.96N	5.88cm	109°
C	0.25kg	2.45N	7.35cm	180°
D	0.2kg	1.96N	5.88cm	276°

*Force = mass × gravitational acceleration = mass × $9.80m/s^2$

(3) Table3, four forces are not balanced

Length of an arrow 1N = 3cm

Exp.3	Mass of Weight [kg]	Force [N]	Arrow [cm]	Angle [°]
A	0.3kg	2.94N	8.82cm	0°
B	0.2kg	1.96N	5.88cm	109°
C	0.3kg	2.94N	8.82cm	180°
D	0.2kg	1.96N	5.88cm	276°

*Force = mass × gravitational acceleration = mass × $9.80m/s^2$

(4) Table4, Math Method of Exp.1

Exp.1	F	θ	Fx = Fcos θ	Fy = Fsin θ
unit	[N]	[°]	[N]	[N]
A	1.96	0	1.96	0
B	1.47	85	0.128	1.464
C	2.45	212. 5	-2.066	-1.316
		ΣFx, ΣFy	0.022	0.148

$F= \sqrt{(\Sigma Fx)^2 + (\Sigma Fy)^2} = \sqrt{(0.022)^2 + (0.148)^2} = 0.149 \Rightarrow \underline{0.15\text{N}}$

$\theta = tan^{-1}\frac{\Sigma Fy}{\Sigma Fx} = tan^{-1}\frac{0.148}{0.022} = 81.54 \Rightarrow \underline{82°}$

OK

(5) Table5, Math Method of Exp.2

Exp.2	F	θ	Fx = Fcos θ	Fy = Fsin θ
unit	[N]	[°]	[N]	[N]
A	2.94	0	2.94	0
B	1.96	109	-0.638	1.853
C	2.45	180	-2.45	0
D	1.96	276	0.205	-1.949
		ΣFx, ΣFy	0.057	-0.096

$F= \sqrt{(\Sigma Fx)^2 + (\Sigma Fy)^2} = \sqrt{(0.057)^2 + (-0.096)^2} = 0.112 \Rightarrow \underline{0.11\text{N}}$

OK

$\theta = tan^{-1}\frac{\Sigma Fy}{\Sigma Fx} = tan^{-1}\frac{-0.096}{0.057} = -59.36 \Rightarrow \underline{300.7°}$

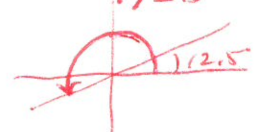
(6) Table6, Math Method of Exp.3

Exp.3	F	θ	Fx = Fcos θ	Fy = Fsin θ
unit	[N]	[°]	[N]	[N]
A	2.94	0	2.94	0
B	1.96	109	-0.638	1.853
C	2.95	180	-2.95	0
D	1.96	276	0.205	-1.949
		ΣFx, ΣFy	-0.443	-0.096

$F= \sqrt{(\Sigma Fx)^2 + (\Sigma Fy)^2} = \sqrt{(-0.443)^2 + (-0.096)^2} = 0.453 \Rightarrow \underline{0.45\text{N}}$

192.5°

$\theta = tan^{-1}\frac{\Sigma Fy}{\Sigma Fx} = tan^{-1}\frac{-0.096}{-0.433} = 12.50 \Rightarrow \underline{12.5°}$ ✗



192.5°

5 Discussion

1) Exp.1

- In Fig1, the length of $\vec{A}$ is almost same as length and force of $\vec{B}+\vec{C}$. And their arrows are almost opposite direction.
- In Fig2, the tail point of $\vec{C}$ almost reaches the head point of $\vec{A}$.
- In Fig2, net force is almost zero. (0.2N which is found by graph).
- In Table4, net force is almost zero. (0.149N which is found by calculation.)

⇨From these sentences, three forces are balanced. And the equation is made.

$$\vec{A}+\vec{B}+\vec{C}=0$$

⇨From calculation result of Table4, the ring is pulled by 0.15N to 82°

2) Exp.2

- In Fig3, the length of $\vec{A}+\vec{B}$ is almost same as length and force of $\vec{B}+\vec{C}$. And their arrows are almost opposite direction.
- In Fig4, the tail point of $\vec{D}$ almost reaches the head point of $\vec{A}$.
- In Fig4, net force is almost zero. (0.133N which is found by graph).
- In Table5, net force is almost zero. (0.112N which is found by calculation.)

⇨From these sentences, four forces are balanced. And the equation is made.

$$\vec{A}+\vec{B}+\vec{C}+\vec{D}=0$$

⇨From the calculation result of Table5, the ring is pulled by 0.11N to 300.7°

3) Exp.3

- In Fig5, the length of $\vec{A}+\vec{B}$ is **not** same as length and force of $\vec{B}+\vec{C}$.
- In Fig6, the tail point of $\vec{D}$ **does not** reach the head point of $\vec{A}$.
- In Fig6, net force is **not** zero. (0.5N which is found by graph).
- In Table5, net force is **not** zero. (0.453N which is found by calculation.)

⇨From these sentences, four forces are **not** balanced.

⇨From the calculation result of Table6, the ring is pulled by 0.45N to 12.5°

4) Error

Exp.1	Force (N)	Angle (°)
Calculation	0.15N	82°
Graph	0.2N	80°
Error	0.05N	2°

Exp.2	Force (N)	Angle (°)
Calculation	0.11N	300.7°
Graph	0.133N	302.0°
Error	0.023N	1.3°

Exp.3	Force (N)	Angle (°)
Calculation	0.45N	12.5° 192.5°
Graph	0.5N	11.5° 191.5°
Error	0.05N	0.5°

6 Conclusion

The net force made from several force is 0 at equilibrium

$$\vec{A}+\vec{B}+\vec{C}+\vec{D}=0$$

7 Opinion

In this experience, it was difficult to find the angles where the ring become the center. I learned how to drew parallelogram method and head-to-tail method, also I learned how to use math method. And I learned net force will be 0 when forces are balanced

8 Reference

Ryuki Shigeta & Chiaki Nagai's report.

Fig 1

Exp.1 Parallelogram Method

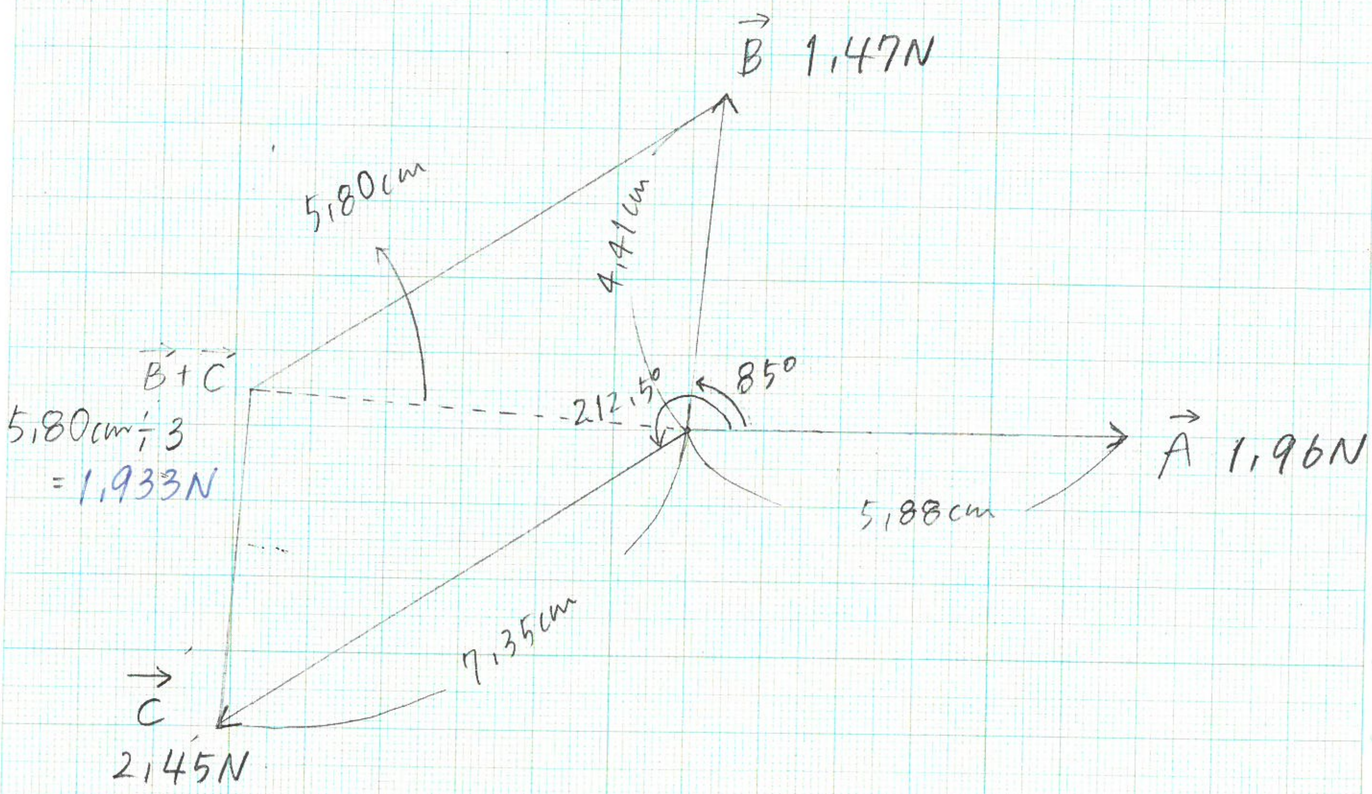
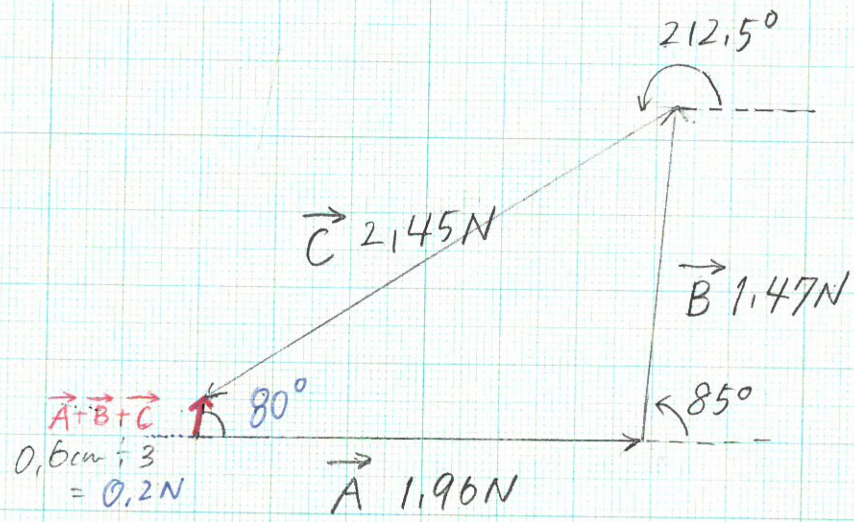


Fig 2

Exp. 1 Head-to-tail Method



Exp, 2

Fig 3

Exp, 2 Parallelogram Method

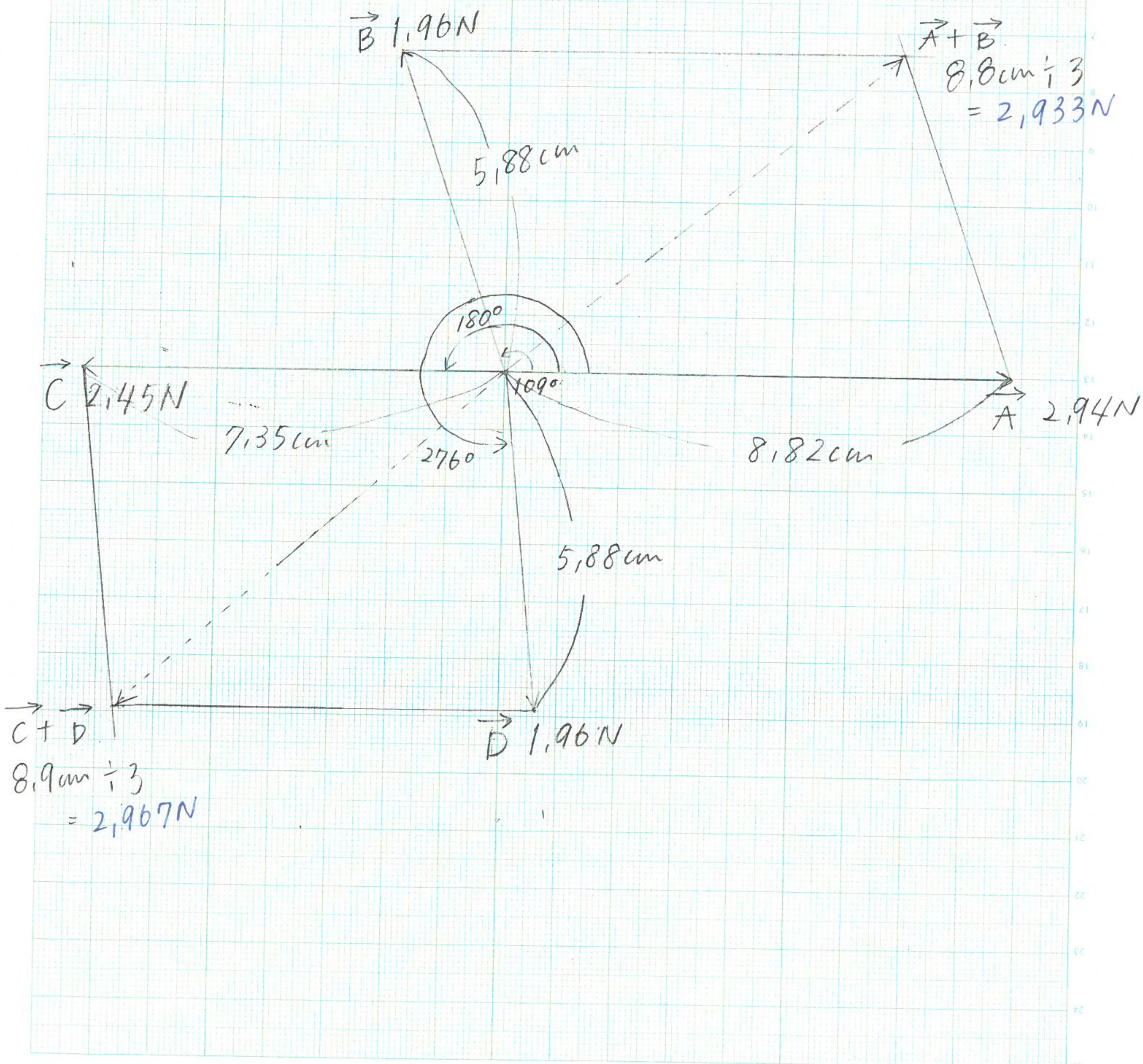


Fig4

Exp.2 Head-to-tail Method

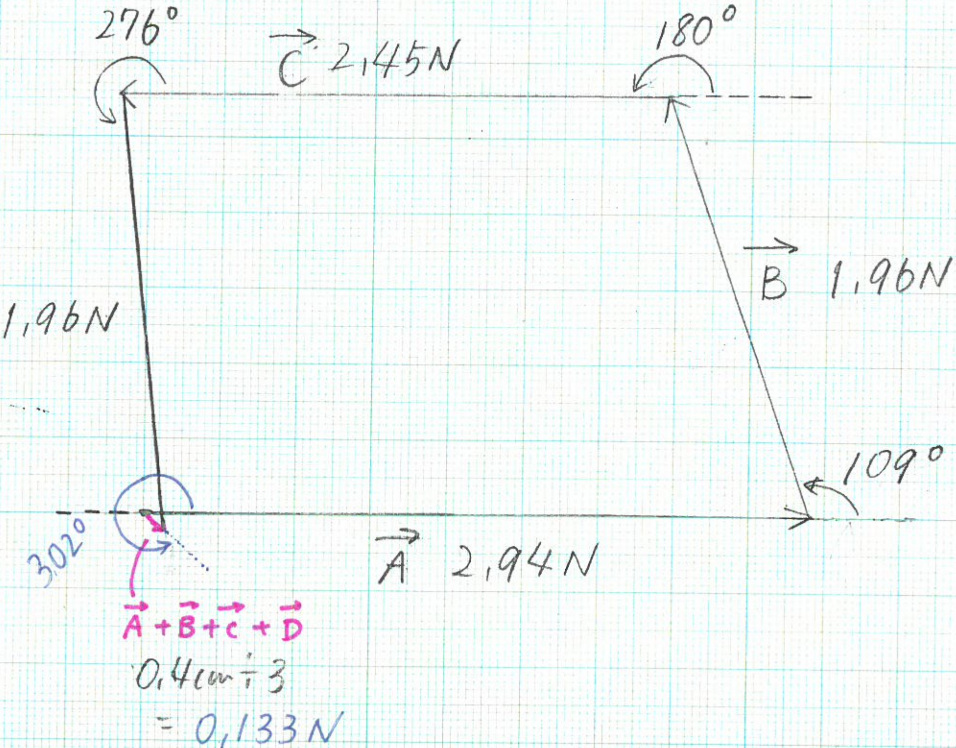


Fig 5

Exp. 3 Parallelogram Method

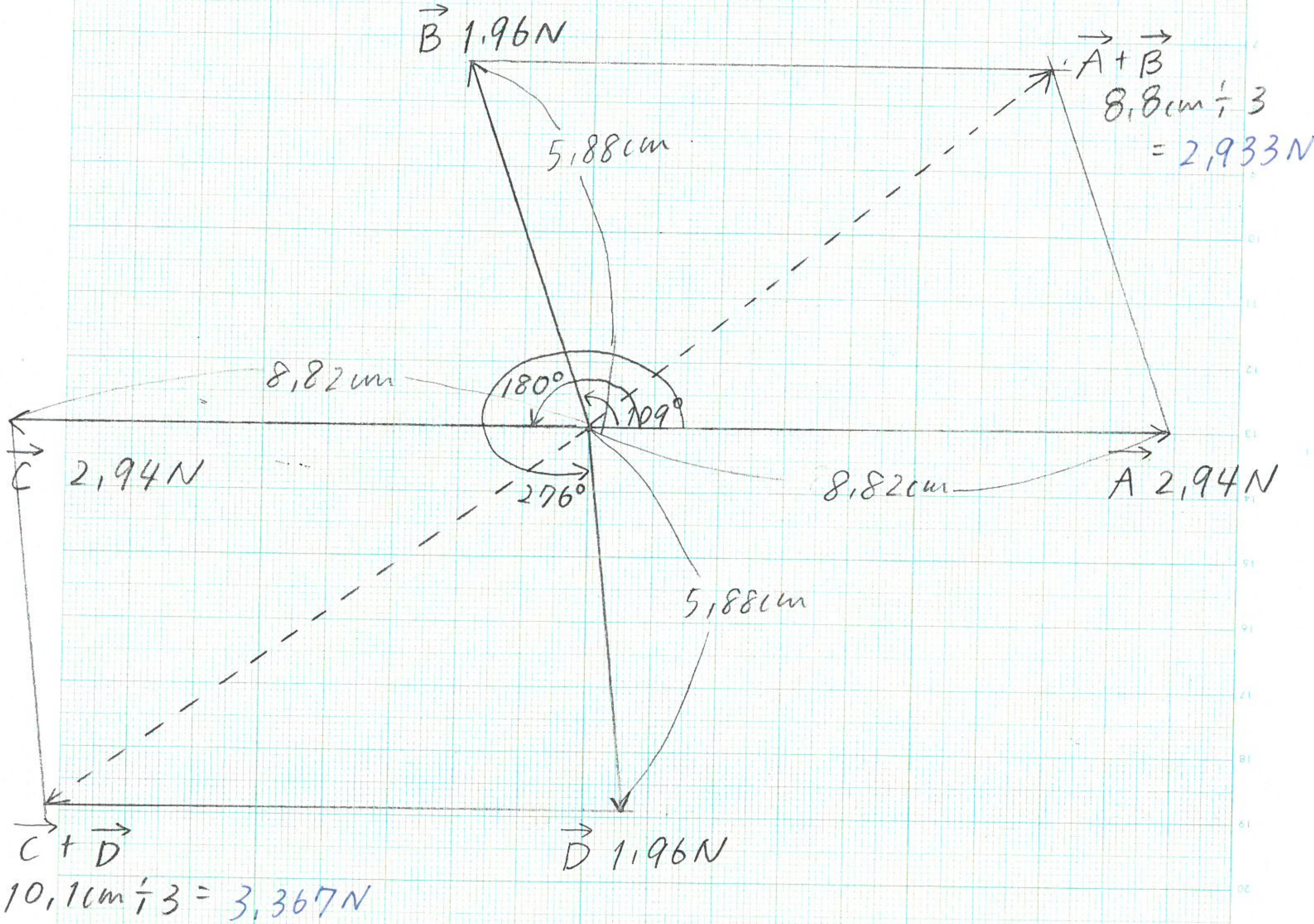


Fig6

Exp.3 Head-to-tail Method