Date of Lab 10/10/18

Date of Submission 10/15/18

Laboratory Report

Title 表題 Force of Equilibrium

Homeroom	Section	Name 氏名	
11 E			Ayano Chiba

Lab Partners 共同実験者 Anna Takaki

Summary

We ascertained that net force made from several forces in equilibrium is zero by using a force table in different angles and weights. After we wrote the results, we drew a diagrams using the parallelogram method and the head-to-tail method Even though there were some errors because of the rounding and our eyes weren't perfect, we learned that if the forces are balanced, then the net force will be zero and if the forces weren't balanced, then the net force won't be zero. We also showed these equations : $\vec{A}+\vec{B}+\vec{C}=0$, $\vec{A}+\vec{B}+\vec{C}+\vec{D}=0$

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

・締切り守って ・論理的に ・わかりやすく ・自分のことばで

Teacher Comments

Good results and beautiful drawings.

Add arrow heads for the net force in the head-to-tail method

1	2	3	4	5	6	7	8	9
Due 提出期限	Summary 要旨	Intro. 序	Method. 方法	Results 結果	Table/Fig. 表/図	Discussion 考察	Clearness わかりやすさ	General 全般

* Write your report in Japanese or in English * Use this form as a cover sheet.

* Submit your reports by the seventh day after your lab.

◆ Experiment

- Force table
- Pulley
- Cord
- Ring
- Mounting Pin
- Hanger
- Weight
- Notebook
- Graph paper
- Ruler
- Protractor
- Set Square

◆ Result

Table 1 - 3 hangers in equilibrium

Exp. 1	Weight (kg)	Force (N)	Arrow (cm)	Angle (°)
A	0.21	2.06	6.17	0
B	0.25	2.45	7.35	160
C	0.10	0.98	2.94	280

※ Length of an arrow : **1N = 3cm**

Exp. 1	F (N)	θ (°)	Fx = Fcosθ (N)	Fy = Fsinθ (N)
A	2.06	0	2.05	0
B	2.45	160	-2.30	0.94
C	0.98	280	0.17	-0.97
		Σ Fx, Σ Fy	-0.08	-0.03

OK

F = $\sqrt{(-0.08)^2 + (-0.03)^2}$ = **0.085 (N)**

θ = **20.56°** $180° + 20.56 = 200.56°$

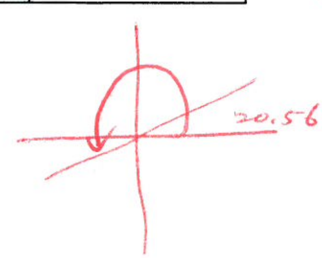


Table 2 - 4 hangers in equilibrium

Exp. 2	Weight (kg)	Force (N)	Arrow (cm)	Angle (°)
A	0.20	1.96	5.88	0
B	0.05	0.49	1.47	80
C	0.25	2.45	7.35	160
D	0.15	1.47	4.41	280

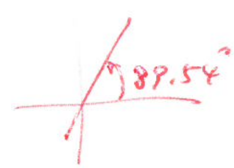
※ Length of an arrow : 1N = 3cm

※ Force = mass x gravitational acceleration
= mass x 9.80 m/s^2

Exp. 2	F (N)	θ (°)	Fx = Fcosθ (N)	Fy = Fsinθ (N)
A	1.96	0	1.96	0
B	0.49	80	0.085	0.483
C	2.45	160	-2.30	0.840
D	1.47	280	0.256	-1.448
		Σ Fx, Σ Fy	0.001	0.125

F = $\sqrt{(0.001)^2 + (0.125)^2}$ = **0.125 (N)**

θ = **89.54°**



OK

Table 3 - 4 hangers in slightly off balance

Exp. 3	Weight (kg)	Force (N)	Arrow (cm)	Angle (°)
A	0.20	1.96	5.88	0
B	0.08	0.784	2.352	80
C	0.25	2.45	7.35	160
D	0.15	1.47	4.41	280

※ Length of an arrow : 1N = 3cm

※ Force = mass x gravitational acceleration
= mass x 9.80 m/s^2

Exp. 3	F (N)	θ (°)	Fx = Fcosθ	Fy = Fsinθ
A	1.96	0	1.96	0
B	0.784	80	0.136	0.772
C	2.45	160	-2.30	0.838
D	1.47	280	0.256	-1.448
		Σ Fx, Σ Fy	0.052	0.162

F = $\sqrt{(0.052)^2 + (0.162)^2}$ = **0.170(N)**

θ = **72.20°**

OK

◆ Discussion

(1) What can I learn from Experiment 1

- In Figure 1, the length of $\vec{A}$ was almost the same of the length of $\vec{B}+\vec{C}$.

(A⃗ : 6.17cm, $\vec{B}+\vec{C}$: 6.32cm)

- In Figure 1, the arrow of $\vec{A}$ and $\vec{B} + \vec{C}$ was almost pointing the opposite direction.
- In Figure 2, the tail point of $\vec{C}$ almost reached the origin of $\vec{A}$.
- In Table 1 and the calculation, sum of the Fx and Fy were almost zero.

(ΣFx = -0.08, ΣFy = -0.13)

⇒ From these results, we can say that these three forces (net force) are balanced, so these equations are made : $\vec{A} = \vec{B}+\vec{C}$, $\vec{A}+\vec{B}+\vec{C} = 0$

- From the calculation in Table 1, the ring is pulled by 0.085N to 20.56°.

(2) What can I learn from Experiment 2

- In Figure 3, the length of $\vec{A}$ was almost the same of the length of $\vec{B}+\vec{C}+\vec{D}$.

($\vec{A}$: 5.88cm, $\vec{B}+\vec{C}+\vec{D}$: 5.80cm)

- In Figure 3, the arrow of $\vec{A} + \vec{B}$ and $\vec{C} + \vec{D}$ was almost pointing the opposite direction.
- In Figure 4, the tail point of $\vec{D}$ reached the origin of $\vec{A}$.
- In Table 2 and the calculation, sum of the Fx and Fy were almost zero.

(ΣFx = 0.001, ΣFy = -0.125)

⇒ From the results on above, we can say that these three forces (net force) are balanced, so these equations are made : $\vec{A} = \vec{B}+\vec{C}+\vec{D}$, $\vec{A}+\vec{B}+\vec{C}+\vec{D} = 0$

- From the calculation in Table 1, the ring is pulled by 0.125N to 89.54°.

(3) What can I learn from Experiment 3

- In Figure 5, the length of $\vec{A}$ was NOT the same of the length of $\vec{B}+\vec{C}+\vec{D}$.
  ($\vec{A}$: 5.88cm, $\vec{B}+\vec{C}+\vec{D}$: 5.60cm)
- in Figure Figure 6, the tail point of $\vec{D}$ did NOT reach the origin of $\vec{A}$.
- In Table 3 and the calculation, sum of the Fx was near to the zero but Fy was the farest from zero of all the results.
  ($\Sigma Fx = 0.052$, $\Sigma Fy = 0.162$)

⇒ From these results, we can say that these forces (net force) are NOT balanced, so the equation can't be shown : $\vec{A} \neq \vec{B}+\vec{C}+\vec{D}$, $\vec{A}+\vec{B}+\vec{C}+\vec{D} \neq 0$

- From the calculation in Table 1, the ring is pulled by 0.170N to 72.20°.

(4) Comparing the net force from the calculation and from the graph

<Experiment 1>

- Calculation : 0.085N
- Graph : 0.083N

Percenet Error = (0.085-0.083) ÷ 0.083 x 100 = 0.241%

<Experiment 3>

- Calculation : 0.170N
- Graph : 0.180N

Percent Error = (0.180 - 0.170) ÷ 0.170 x 100 = 5.88%

⇒ From these, we can study that the experimental results are including errors. There errors occurred because ...

- the weight of the hangers were not included.
- we rounded off (This made the result change slightly)
- we didn't read the angle of the force table correctly (Our eyes aren't perfect)
- we thought the ring was in the center, but actually it wasn't (Meaning that the force were not equal)

◆ Conclusion

In Experiment 1 and 2, the result was almost zero and the arrow of the force were almost pointing the opposite side. If these results were 0, it can show the equations below :

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

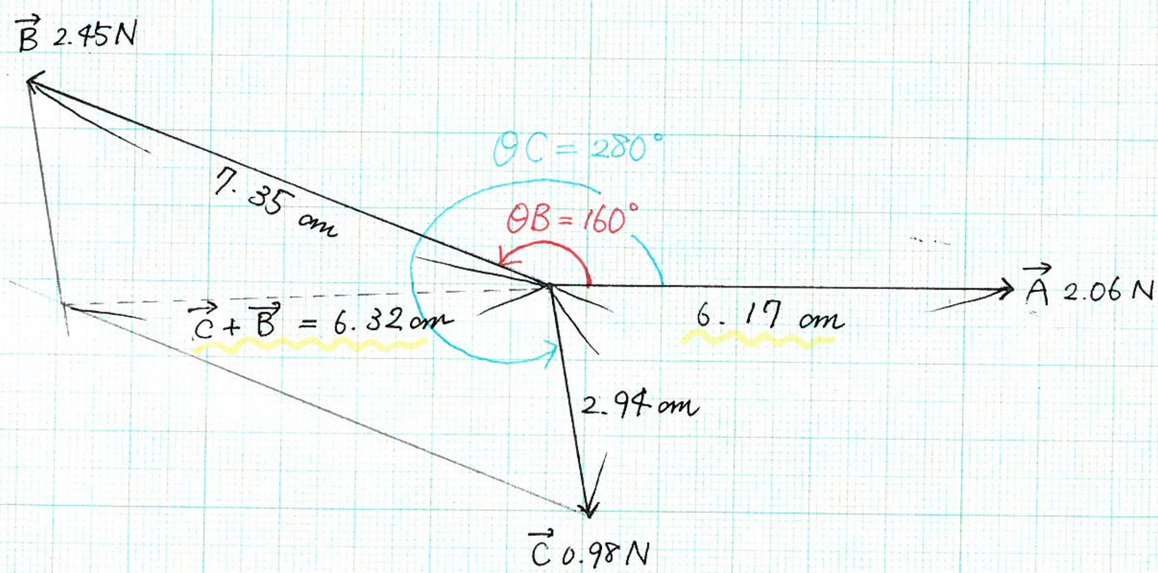
$$\vec{A}+\vec{B}+\vec{C}+\vec{D} = 0$$

◆ Opinions

After the lab and while I was writing this lab report, I finally understood how to draw the head-to-tail method and parallelogram method. I was also confused about how the head-to-tail method worked before the lab. I couldn't understand why $\vec{A} = \vec{B}+\vec{C}+\vec{D}$ worked during the class, but I understood that I have to get the force (N) to show the equation. I realized that I couldn't understand it, because I was adding the length of each arrows.

Figure 1 : Experiment 1

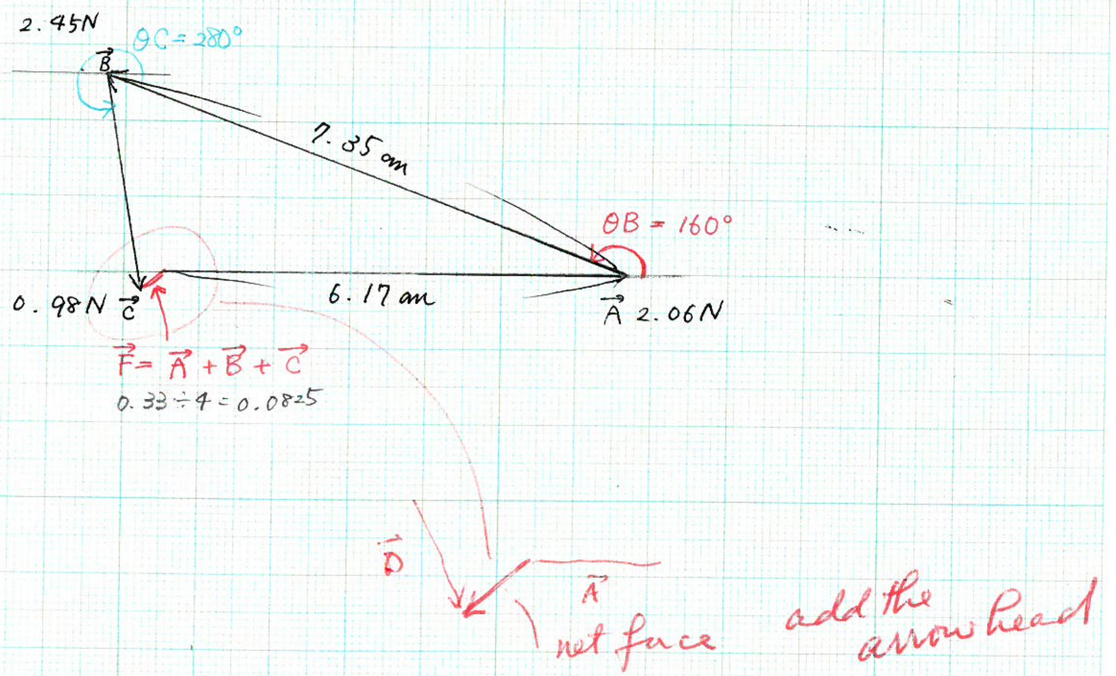
3 hangers in equiliburium



Parallelogram Method

Figure 2: Experiment 1

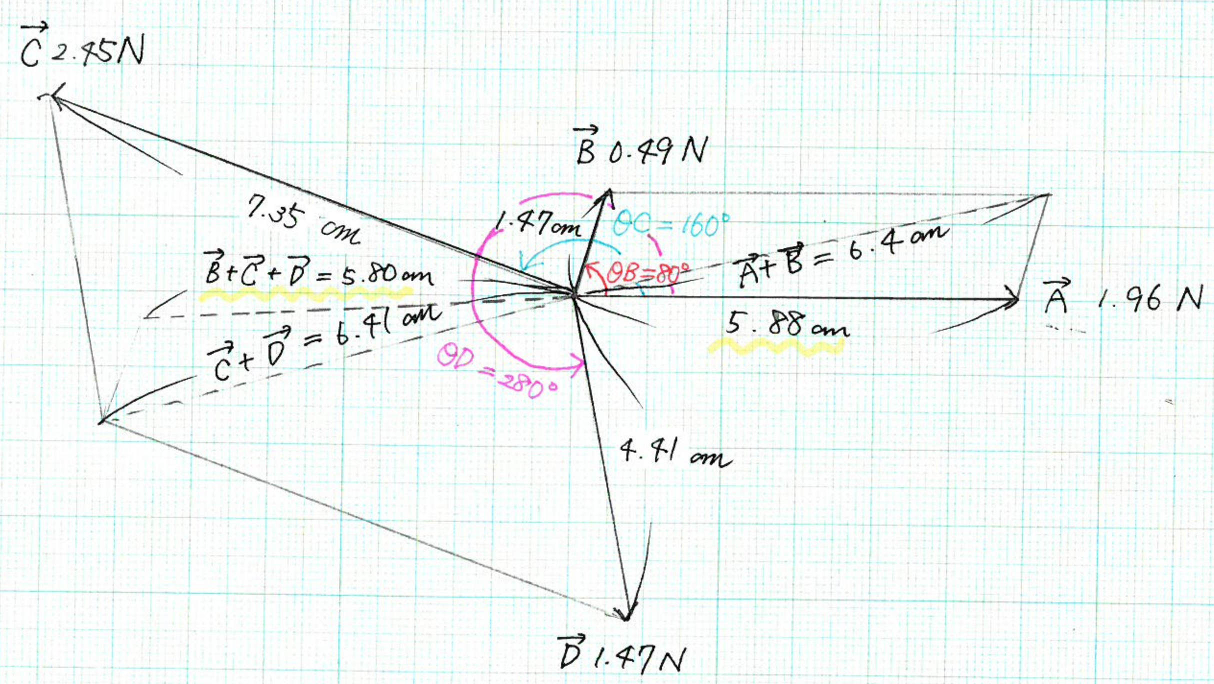
3 hangers in equilibrium



Head-to-tail Method

Figure 3: Experiment 2

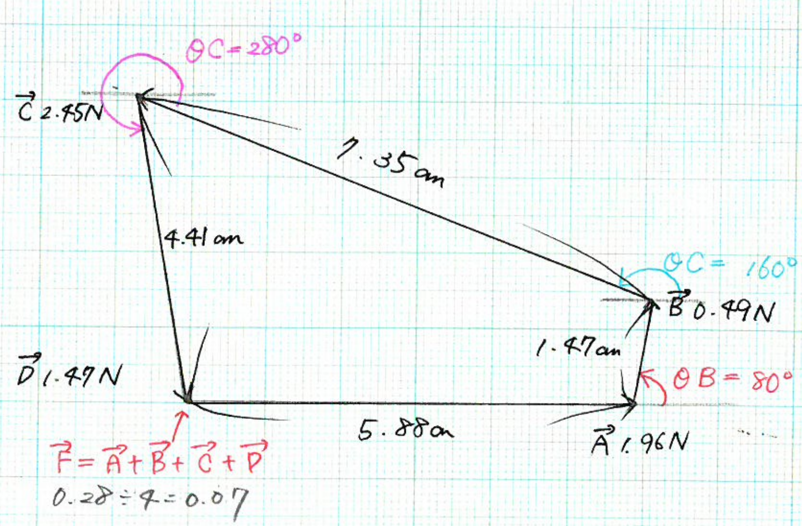
4 hangers in equliburium



Parallelogram Method

Figure 4: Experiment 2

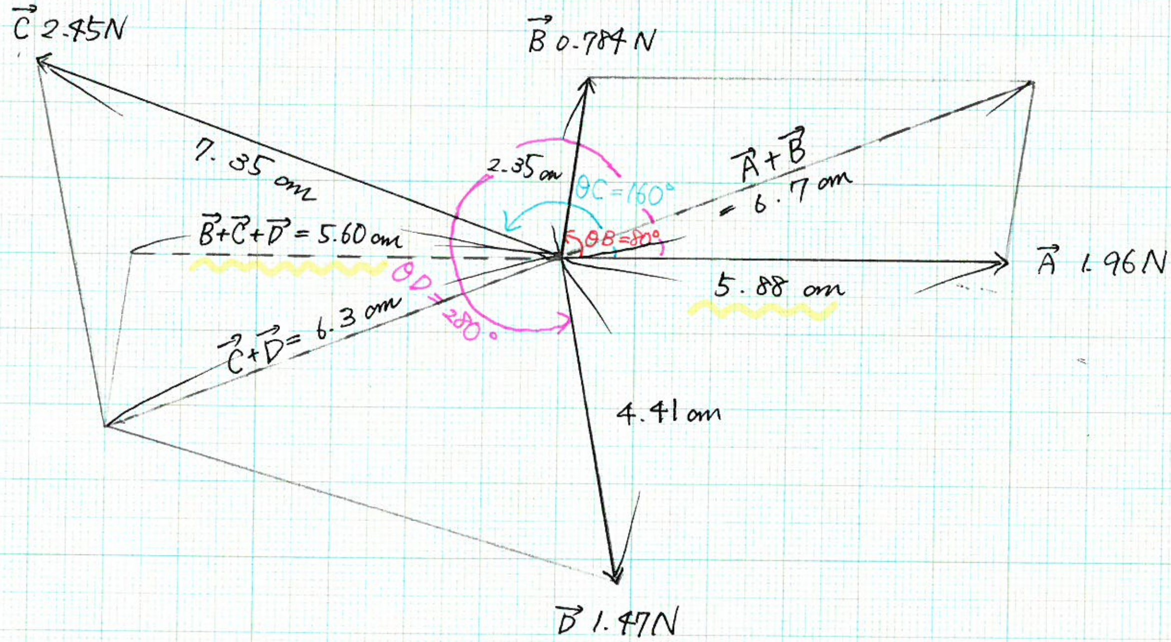
4 hangers in equiliburium



Head-to-tail Method

Figure 5 : Experiment 3

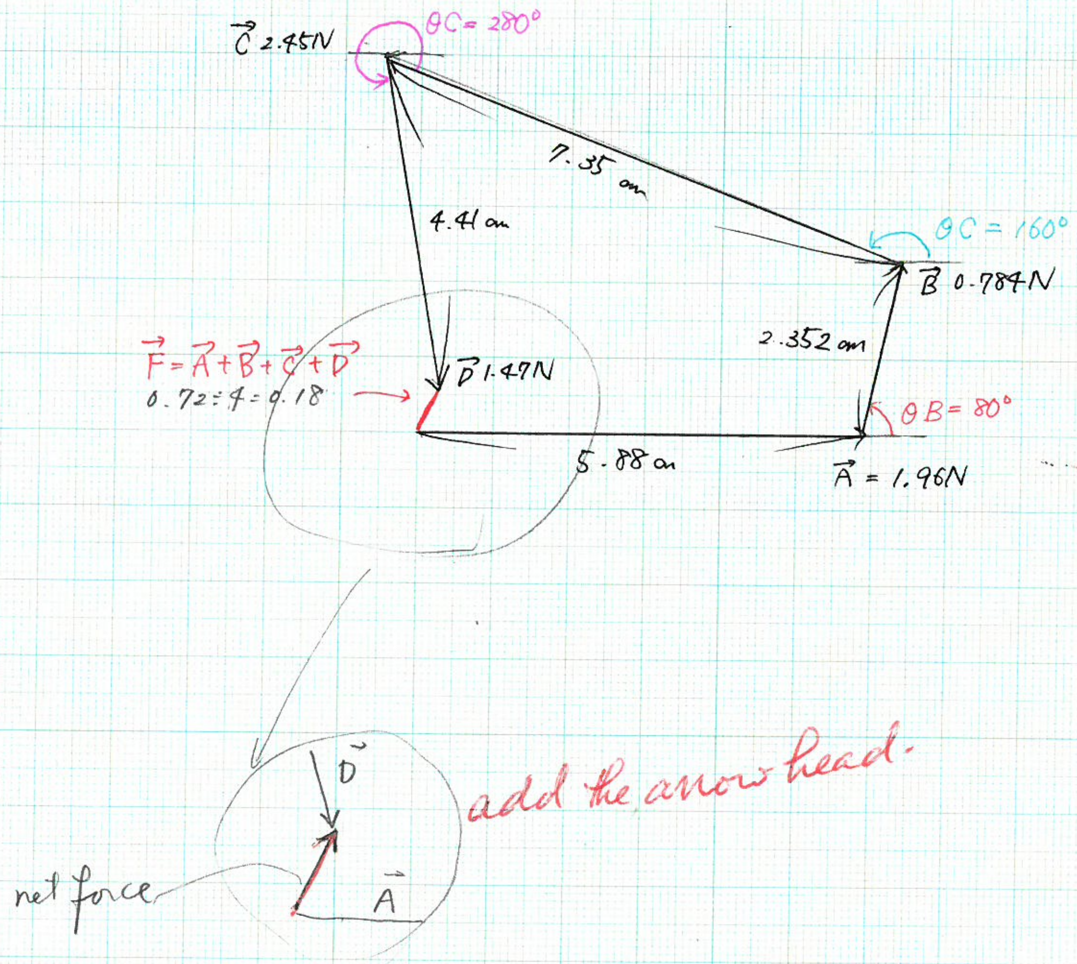
4 hangers in slightly off balance



Parallelogram Method

Figure 6 : Experiment 3

4 hangers in slightly off balance



Head-to-tail Method