Date of Lab_____ Date of Submission_____

Laboratory Report

Title
表題 Friction

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Summary

By pulling a wooden block with changing weight, contact surface area, and surface roughnesses, we measured its static and kinetic frictional force. We found that Fs max is larger than Fk, Fs max and Fk are proportional to the mass of an object, frictional force is smaller at the smooth surface, etc. There were some errors during the lab, such as, measuring the scale uncorrectly, not pulling the block in the constant speed, etc. I thought that these errors wouldn't happen if we pulled the block with motor, measured the scale with machine, etc.

・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

Beautiful tables and graphs with clear explanation.

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

- Spring scale
- Wooden block (430g)
- Board

  (The board that has a rough and smooth surface)
- Pulley
- String
- Weight (250g x 3)
- Notebook
- Graph paper
- Ruler
- Plastic bag

◆ Results

Table 1 - Rough surface, Larger contact area

Experiment	1	2	3	4
The surface of the board	Rough			
Contact Area [cm2]	35.75	35.75	35.75	35.75
The mass (wooden block+weights) [kg]	0.43	0.68	0.93	1.18
Normal force [N]	4.3	6.8	9.3	11.8
Maximum static frictional force [N]	1	1.4	2	2.4
Kinetic frictional force [N]	0.8	1.15	1.8	2.15
Coefficient of static friction-F	0.233	0206	0.215	0.203
Coefficient of kinetic friction	0.186	0.169	0.194	0.182
H / L	14 / 69.3 = 0.202	14.2 / 69.3 = 0.205	14.5 / 69.3 = 0.209	15.5 / 69.3 = 0.224
θ	11.65	11.83	12.08	12.93
Coefficient of static friction-θ	0.206	0.210	0.214	0.226

Type of surface = **Rough**, Contact Area = **35.75 cm2,**

Table 2 - Smooth surface, Larger contact area

Experiment	5	6	7	8
The surface of the board	Smooth			
Contact Area [cm2]	35.75	35.75	35.75	35.75
The mass (wooden block+weights) [kg]	0.43	0.68	0.93	1.18
Normal force [N]	4.3	6.8	9.3	11.8
Maximum static frictional force [N]	1.1	1.3	1.5	1.7
Kinetic frictional force [N]	0.75	1	1.3	1.5
Coefficient of static friction-F	0.256	0.191	0.161	0.144
Coefficient of kinetic friction	0.174	0.147	0.140	0.127
H/L	12 / 69.3 = 0.173	11 / 69.3 = 0.159	10.5 / 69.3 = 0.152	11.5 / 69.3 = 0.166
θ	9.97	9.13	8.71	9.55
Coefficient of static friction-θ	0.176	0.161	0.153	0.168

Type of surface = **Smooth,** Contact area = **35.75cm2**

Table 3 - Rough and Smooth surface, Smaller contact area

Experiment	9	10	11	12
The surface of the board	Rough		Smooth	
Contact Area [cm2]	9.75	9.75	9.75	9,75
The mass (wooden block+weights) [kg]	0.43	1.18	0.43	1.18
Normal force [N]	4.3	11.8	4.3	11.8
Maximum static frictional force [N]	0.8	2.2	0.9	2.3
Kinetic frictional force [N]	0.75	2	0.7	1.8
Coefficient of static friction-F	0.187	0.185	0.209	0.195
Coefficient of kinetic friction	0.174	0.170	0.163	0.153
H/L	14 / 69.3 = 0.202	13 / 69.3 = 0.188	11 / 69.3 = 0.159	10.5 / 69.3 = 0.152
θ	11.65	10.81	9.13	8.71
Coefficient of static friction-θ	0.206	0.191	0.161	0.153

Type of surface = **Smooth** and **Rough**, Contact area = **9.75 cm2**

◆ Discussion

1. From the Table 1, 2, and 3, I found that the maximum static friction force was always larger than the kinetic frictional force.

2. From the Figure 1, the maximum static frictional force (Fs max) increased as the normal force (N) increased, meaning that it increased as the mass increased. We can get the normal force by Normal Force = mass x gravity, so at this time, if the normal force changes, it means that the mass changed. Therefore, in this case, we can study that the maximum frictional force increased as the mass increased. This means that the static frictional forces are directly proportional to the mass of an object.

3. In the Figure 2, the kinetic frictional force (Fk) increases as the normal force (N) increases. As I said in the paragraph above, increasing of the normal force means that the mass has increased, so in this case, we can see that the kinetic force increased, as the mass increased. This means that the kinetic forces are directly proportional to the mass of an object.

4. In the Figure 3, it seems that the coefficient of static friction-F (μs (F)) didn't change as the normal force increased. There were some changes in some case, but it can be thought that it was because there were some errors during the lab. The errors could be: misreading the measurements, not pulling the board in constant speed, etc. Therefore, we can learn that the mass of an object doesn't affect on the coefficient of static friction-F by the Figure 3.

5. From the Figure 4, it seems that the coefficient of kinetic friction (μk) didn't change as the normal force increased. There were some changes in this case, too but we can say that this happened because of the errors that I stated on above. Thus, we can say that the mass of an object doesn't affect on the coefficient of kinetic friction from the Figure 4.

6. From the Figure 5, it seems that there were few differences between the coefficient of static friction-θ (μs (θ)) and the coefficient of static friction-F (μs(F)). I drew a linear line (linear line - a straight line that the slope of it is always one) and my results gathered around the line, so it means that there are almost no differences between two of them. Therefore, I can say that there are almost no differences between the coefficient of static friction-F and the coefficient of static friction-θ.

7. As I compare the Table 1 and 2, I can say that the frictional force is smaller at the smooth surface and larger at the rough surface.

8. By looking at all the tables, I can study that the contact area doesn't affect on the frictional force.

◆ Conclusion

The maximum static frictional force is larger than the kinetic frictional force.
The static frictional forces and the kinetic frictional forces are proportional to the mass of an object.
The mass of an object doesn't affect on the coefficient of static friction-F and the coefficient of kinetic friction.
There are almost no differences between the coefficient of static friction-F and the coefficient of static friction-θ.
The frictional force is smaller at the smooth surface and is larger at the rough surface.
The contact area doesn't affect on the frictional force.

❖ Opinions

Before this lab, I thought that the surface area of the object affects the frictional force, but it didn't, so I was surprised. I also learned that human errors greatly influences the results, so I thought there will be less amount of errors if we did this experience by using technology like pulling the string with motors.

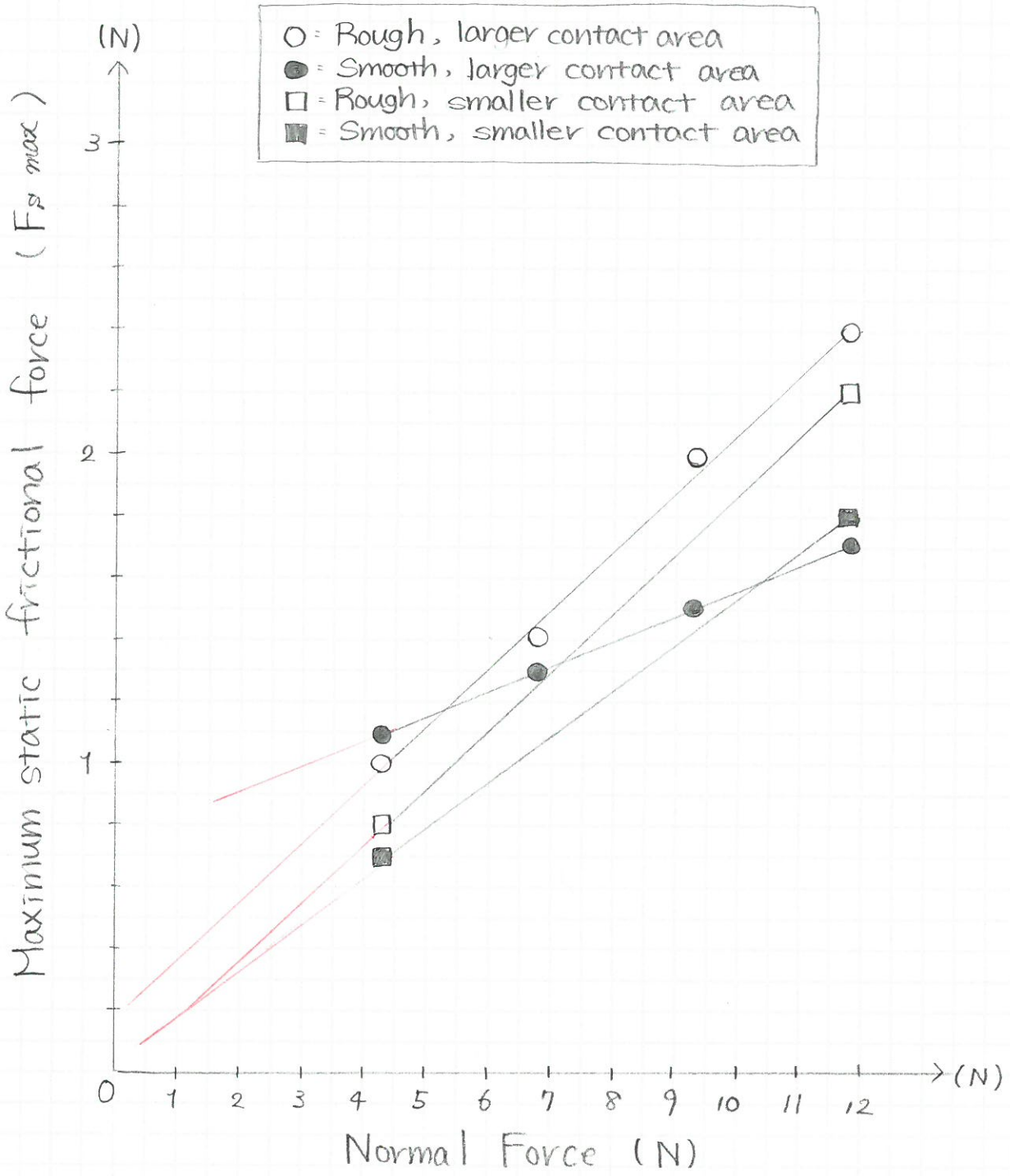

Figure 1 : $F_{s\,max}$ - N Graph

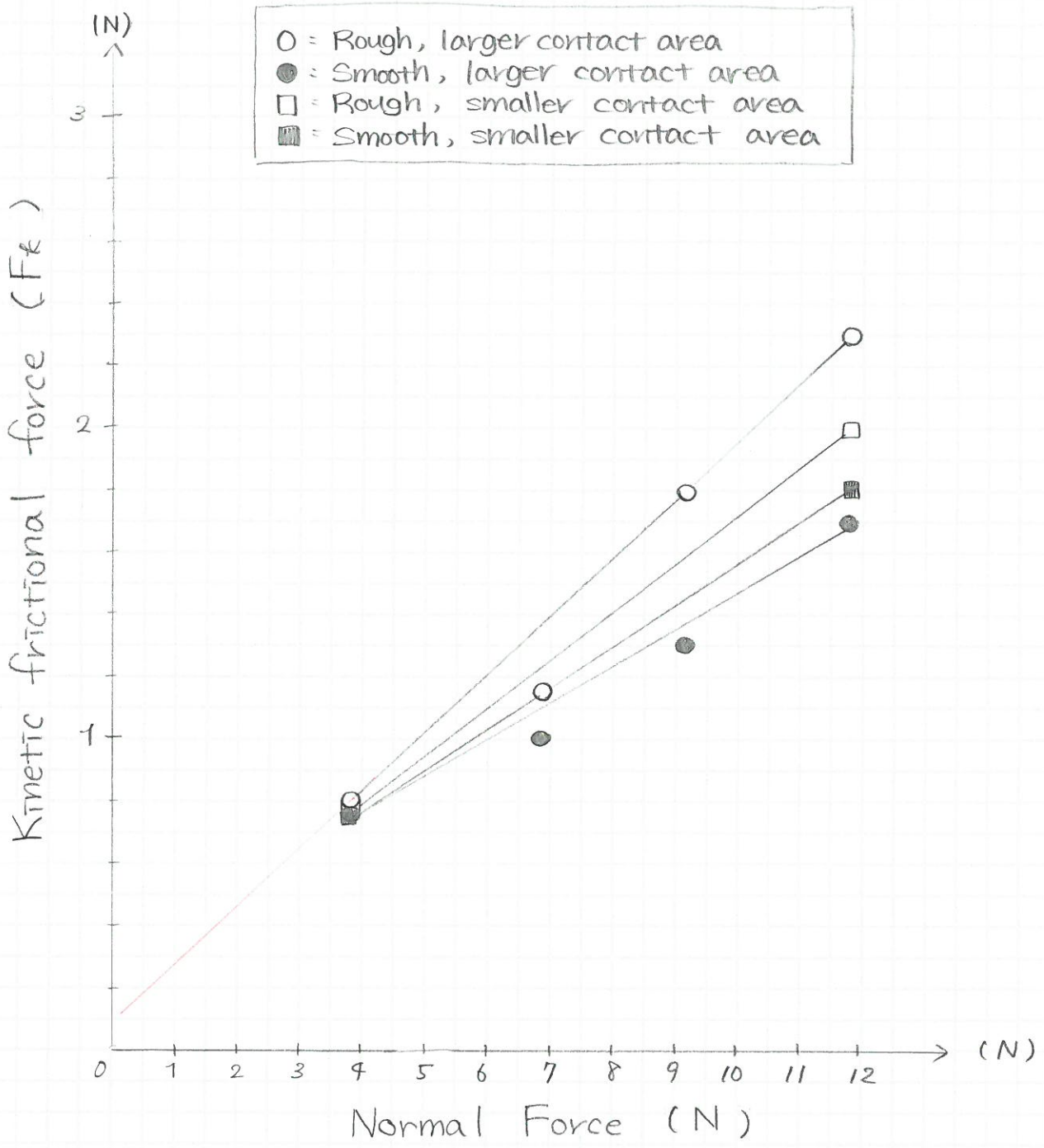

Figure 2 : Fk - N Graph

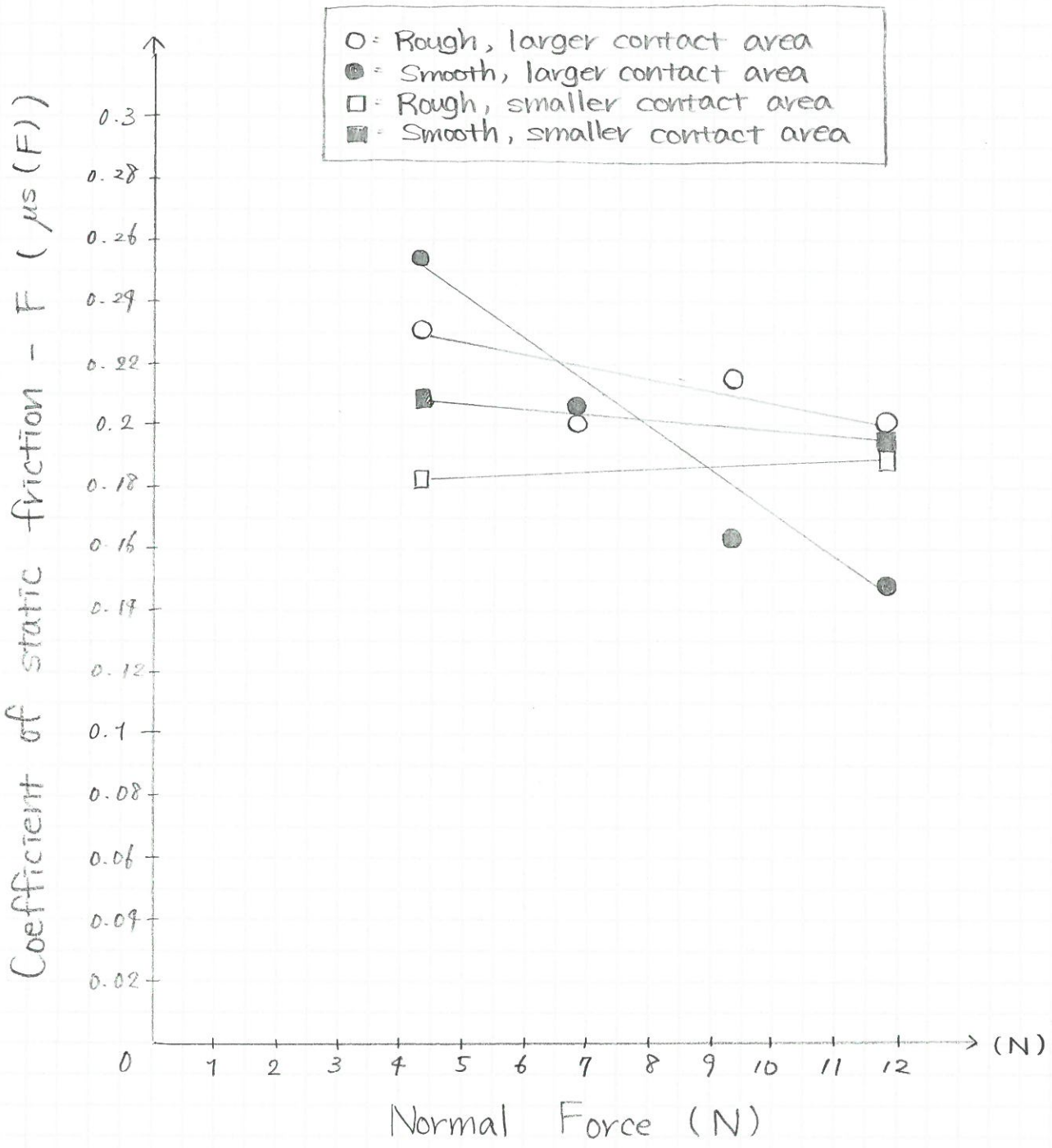

Figure 3 : μs (F) - N Graph

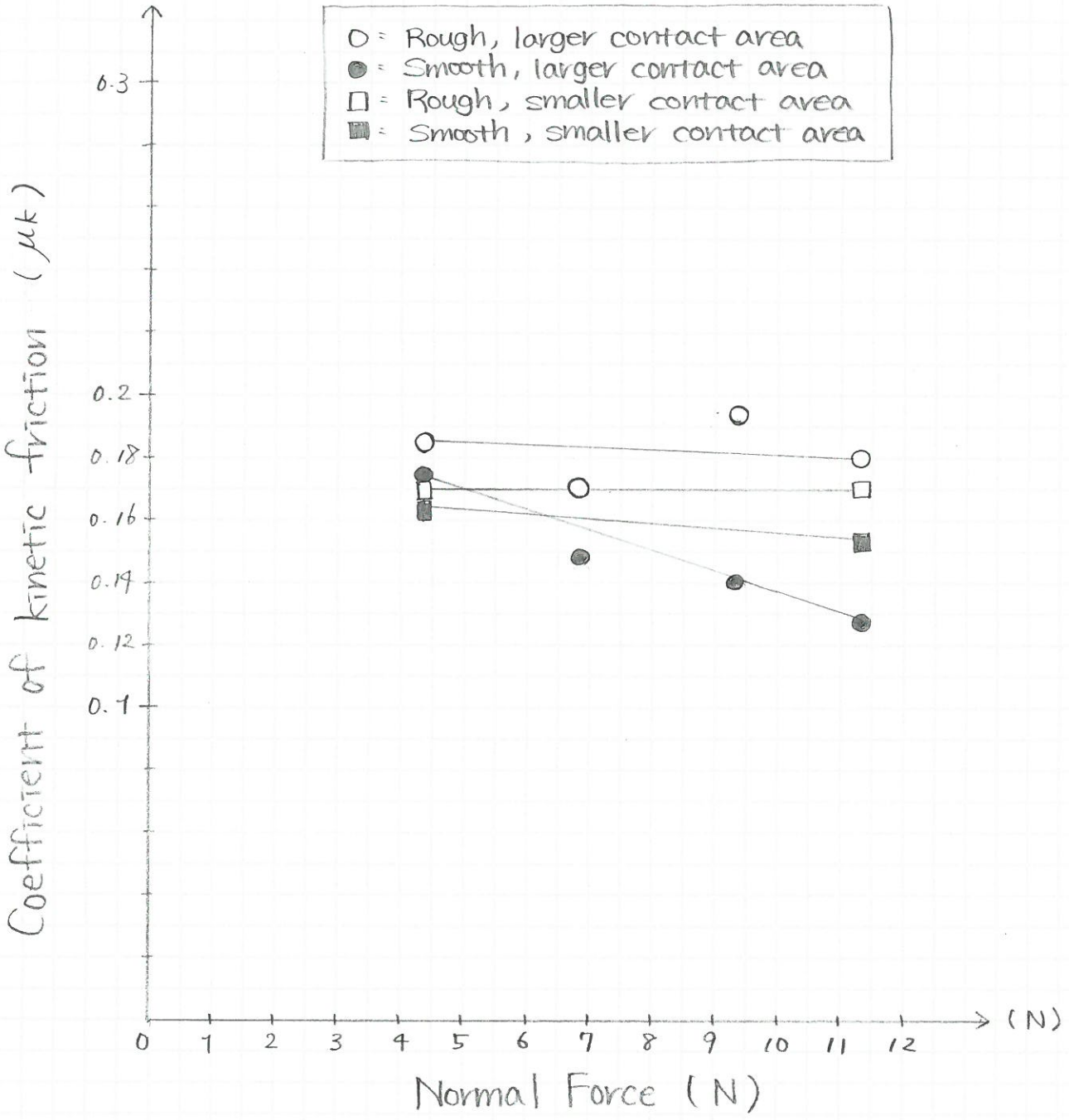

Figure 4 : μk - N Graph

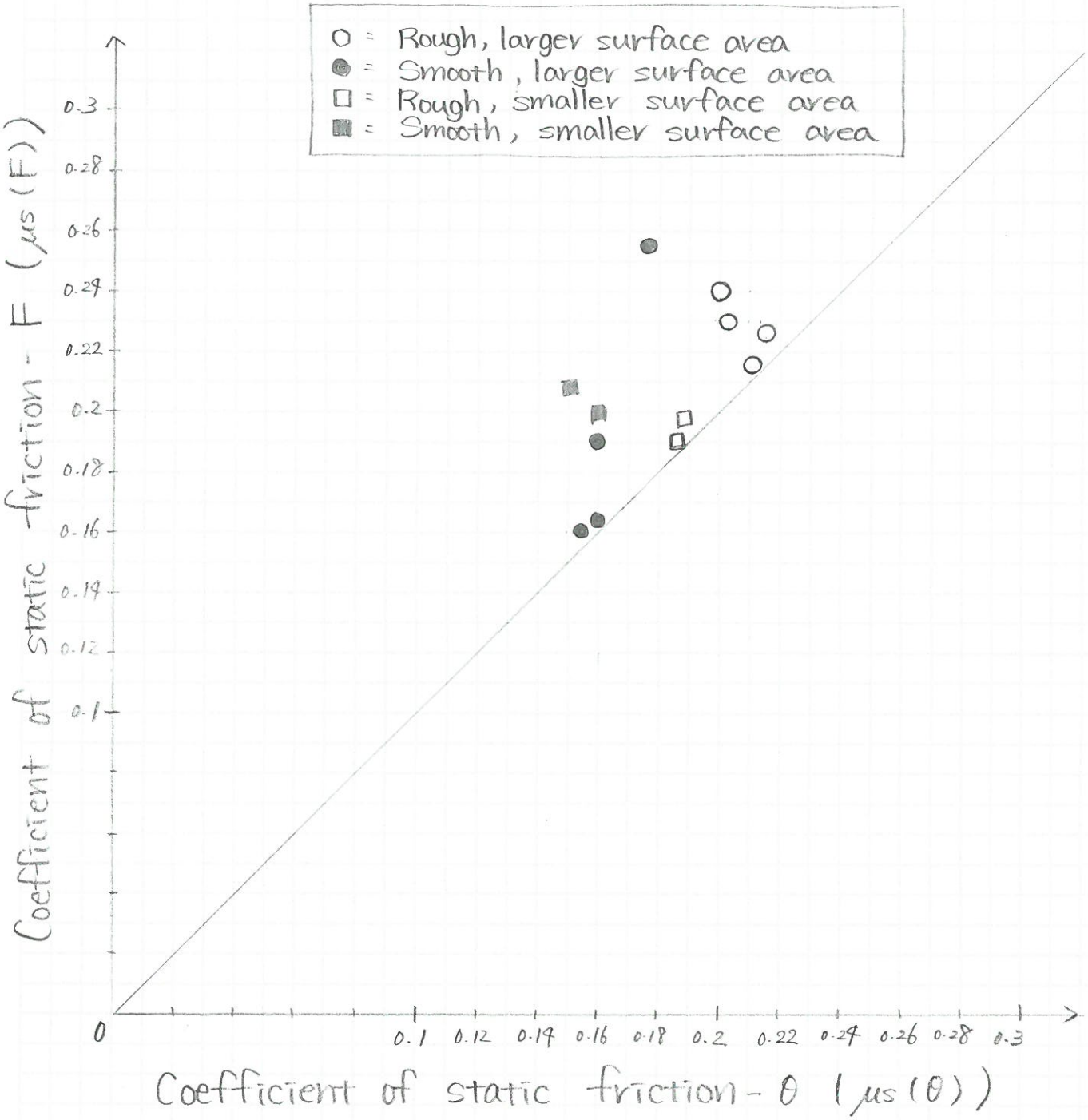

Figure 5 : μs (F) - μs (θ) Graph.