Date of Lab 9/25/19 Date of Submission 10/02/19

Laboratory Report Cover for #12 Lab

Title Analyzing the Accelerating Motion with a Spark Timer

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Summary

To investigate how the acceleration changes when the mass of a Dynamic Cart and the steepness of the track changes, we used a Spark Timer to record the time of the Dynamic cart going down the track. When we changed the mass of the Dynamic cart by adding some weights, the accelera-tion did not change that much. However, when we changed the angle of the track, the acceleration changed. From this result, we found out that the change in the steepness is a big factor that affects the acceleration. Also, when we drew the Velocity-time graph, all 4 lines became straight lines. It means that the Dynamic Cart was constantly accelerated in all 4 cases. I conclude that the acceleration gets bigger as the slope gets steeper, and it will be smaller if the slope is more gentle and gradual.

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

* Use this form as a cover sheet.

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

❖ *Introduction*

<u>Objectives:</u> 1) Record the movement of a Dynamic Cart descending on a slope to obtain the acceleration.

2) Investigate the relations between acceleration and mass.

<u>Hypothesis:</u> The movement of a cart is constant-acceleration motion.

<u>Safety:</u> Do not drop a cart on your foot.

❖ *List of materials*

- Spark Timer (60Hz)
- Dynamic Cart (1.54kg)
- Weights (250g ×3)
- Track
- Scale
- Cramp
- Extension code
- Scissors
- Glue
- Graph papers
- Pencil
- Thermal Sensitive Tapes
- Wood board

❖ *Procedure*

1. Measure the height (h) and length (L) of the track to obtain the angle of the track; θ
2. Calculate the theta by using the formula: $\theta = \text{Tan}^{-1}(h/L)$
3. Insert the Thermal Sensitive Tape in the Spark Timer.
4. Connect it with the Dynamic Cart.

5. Place the Dynamic Cart at the top of the Track without weights, and let the Cart go down the track (make sure you turn the switch on.)
6. After the Cart hits the end of the track, turn the switch off and take out the Thermal Sensitive Tape.

7. Cut the Thermal Sensitive Tape by 6 dots and stick them to the graph paper.
8. Place 3 weights on the Dynamic Cart and repeat above steps.
9. Change the angle of the track and repeat above steps without the weights first, and with 3 weights the second.
10. Record the data on the table.

❖ *Results*

<u>Acceleration</u>: the acceleration is the slope of the velocity-time graph (Figure 2).

Ex 1. From Figure 2, the acceleration is: 1.000-0.500/0.75-0.35 = **1.25 m/s²**

Ex2. From Figure 2, the acceleration is: 1.596-0.552/0.85-0.25 = **1.74 m/s²**

Ex3. From Figure 2, the acceleration is: 0.679-0.169/0.650-0.05 = **0.85 m/s²**

Ex4. From Figure2, the acceleration is: 0.962-0.280/0.85-0.15= 0.9742...

→ **0.97 m/s²**

Table V. Summary of results

experimental	Mass of the Dynamic Cart (g)	Angle of θ (°)	Acceleration ($\Delta x/\Delta t$)
1	1540	14.0	1.25 m/s^2
2	2290	14.0	1.74 m/s^2
3	1540	9.56	0.85 m/s^2
4	2290	9.56	0.97 m/s^2

PhysicsLab-001	Analyzing the Accelerating Motion with a Spark Timer

Example

Time	t	[s]	0	0.100	0.200	0.300	0.400	0.500	0.600	0.700	0.800	0.900
Displacement	x	[x 10^{-2} m]	0	2.35	6.25	11.65	18.60	27.15	37.24	48.85	61.95	76.65
Displacement per 0.100 s	Δx	[x 10^{-2} m]	2.35	3.90	5.40	6.95	8.55	10.09	11.61	13.10	14.70	
Average velocity	v	[x 10^{-2} m/s]	23.5	39.0	54.0	69.5	85.5	100.9	116.1	131.0	147.0	
Time at central point	t	[s]	0.05	0.15	0.25	0.35	0.45	0.55	0.65	0.75	0.85	

Table I

Condition: (Ex 1) θ = 14.0° (steep slope) Mass = 1540 g (without the weights)

Time	t	[s]	0	0.100	0.200	0.300	0.400	0.500	0.600	0.700	0.800	0.900
Displacement	x	[x 10^{-2} m]	0	0.97	2.46	5.01	8.89	14.32	21.37	29.97	40.27	52.17
Displacement per 0.100 s	Δx	[x 10^{-2} m]	0.97	1.49	2.55	3.88	5.43	7.05	8.60	10.30	11.90	
Average velocity	v	[x 10^{-2} m/s]	9.70	14.9	25.5	38.8	54.3	70.5	86.0	103.0	119.0	
Time at central point	t	[s]	0.05	0.15	0.25	0.35	0.45	0.55	0.65	0.75	0.85	

Table II

Condition: (Ex 2) θ = 14.0° (steep slope) Mass = 2290 g (with 3 weights)

Time	t	[s]	0	0.100	0.200	0.300	0.400	0.500	0.600	0.700	0.800	0.900
Displacement	x	[x 10^{-2} m]	0	2.38	6.47	11.99	19.49	28.59	39.40	52.01	66.21	82.17
Displacement per 0.100 s	Δx	[x 10^{-2} m]	2.38	4.09	5.52	7.50	9.10	10.81	12.61	14.20	15.96	
Average velocity	v	[x 10^{-2} m/s]	23.8	40.9	55.2	75.0	91.0	108.1	126.1	142.0	159.6	
Time at central point	t	[s]	0.05	0.15	0.25	0.35	0.45	0.55	0.65	0.75	0.85	

Table III

Condition: (Ex 3) θ = 9.56° (gentle slope) Mass = 1540 g (without the weights)

Time	t	[s]	0	0.100	0.200	0.300	0.400	0.500	0.600	0.700	0.800	0.900
Displacement	x	[x 10^{-2} m]	0	1.69	4.24	7.68	12.04	17.23	23.11	29.90	37.46	45.87
Displacement per 0.100 s	Δx	[x 10^{-2} m]	1.69	2.55	3.44	4.36	5.19	5.88	6.79	7.56	8.41	
Average velocity	v	[x 10^{-2} m/s]	16.9	25.5	34.4	43.6	51.9	58.8	67.9	75.6	84.1	
Time at central point	t	[s]	0.05	0.15	0.25	0.35	0.45	0.55	0.65	0.75	0.85	

Table IV

Condition: (Ex4) θ = 9.56° (gentle slope) Mass = 2290 g (with 3 weights)

Time	t	[s]	0	0.100	0.200	0.300	0.400	0.500	0.600	0.700	0.800	0.900
Displacement	x	[x 10^{-2} m]	0	1.81	4.61	8.33	13.13	18.92	25.72	33.44	42.16	51.78
Displacement per 0.100 s	Δx	[x 10^{-2} m]	1.81	2.80	3.72	4.80	5.79	6.80	7.72	8.72	9.62	
Average velocity	v	[x 10^{-2} m/s]	18.1	28.0	37.2	48.0	57.9	68.0	77.2	87.2	96.2	
Time at central point	t	[s]	0.05	0.15	0.25	0.35	0.45	0.55	0.65	0.75	0.85	

Condition:

Time	t	[s]										
Displacement	x	[x 10^{-2} m]										
Displacement per 0.100 s	Δx	[x 10^{-2} m]										
Average velocity	v	[x 10^{-2} m/s]										
Time at central point	t	[s]										

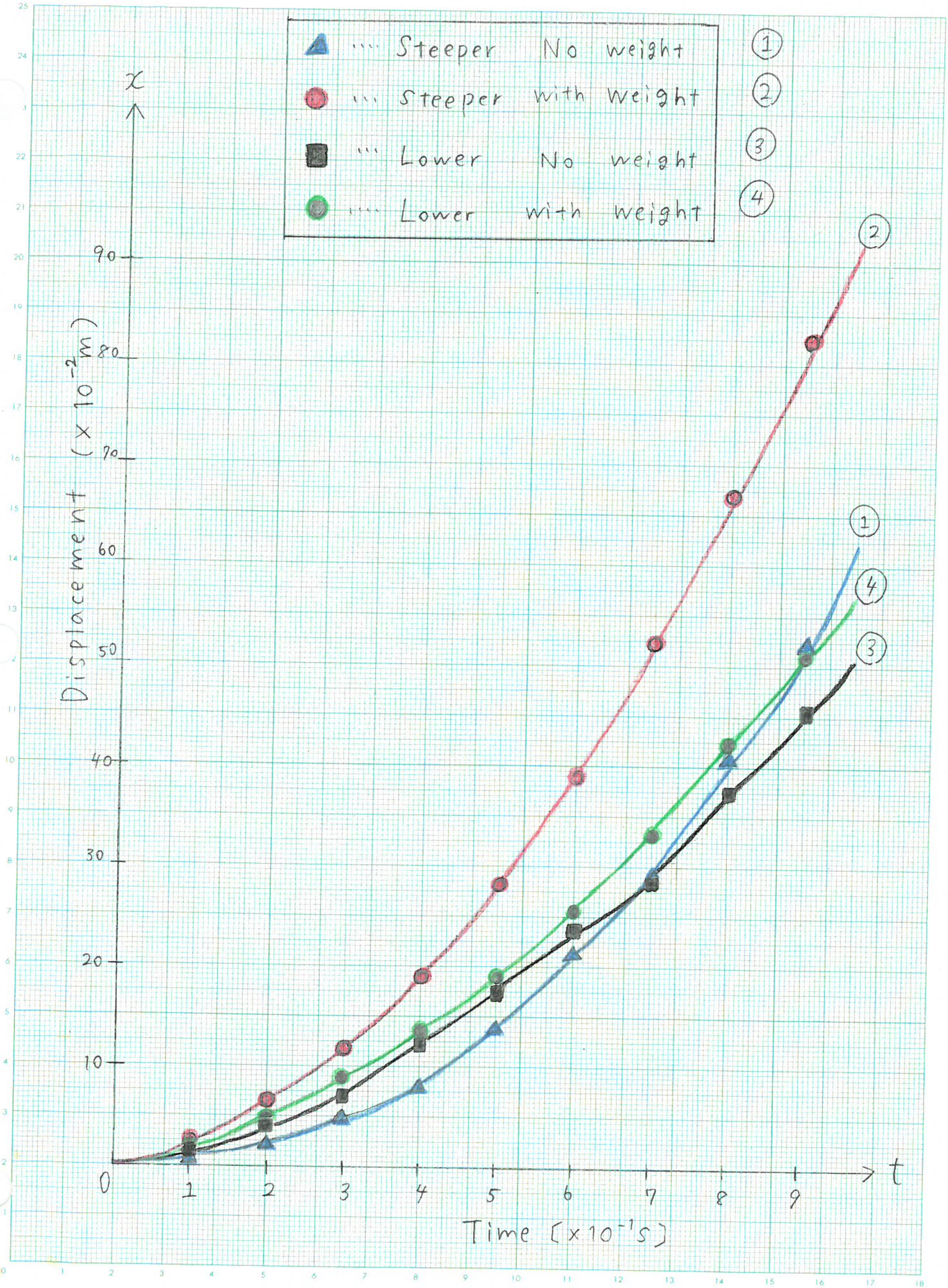

Figure 1. x-t Graph

JIS-A4 1mm (250×180) コクヨ ホ-19

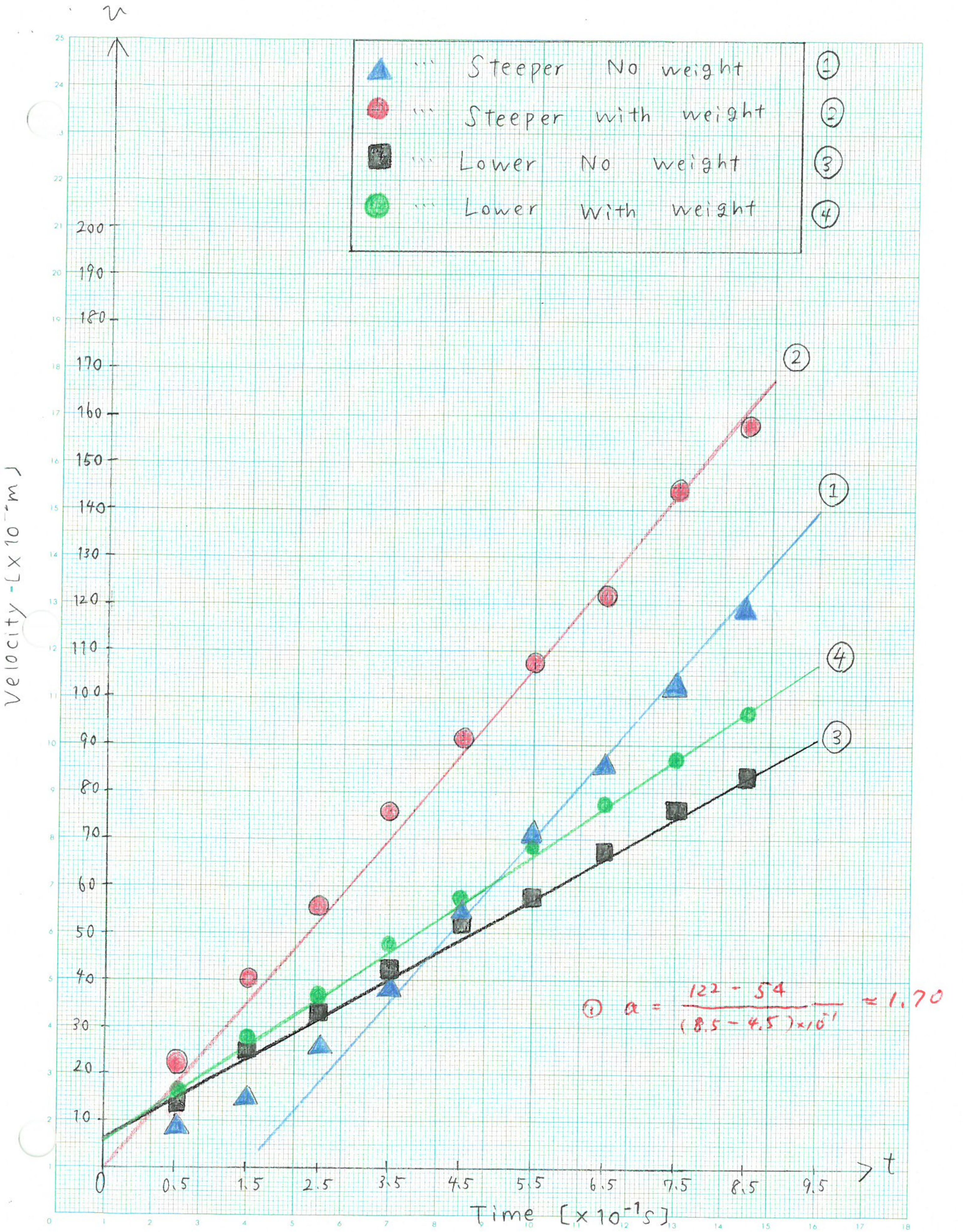

Figure 2. v - t Graph

❖ *Discussion*

As you can see from Table V, the acceleration of the Dynamic Cart on the steeper slope without additional weights is 1.25m/s^2 and the acceleration of the Dynamic Cart on the steeper slope with additional weights is 1.74m/s^2, and they are almost the same. In fact, when we look at Figure 2, we can see that these two graphs have roughly the same slope. I think we made some small mistakes when we did experiment 1, because there are several singular points that are deviated from the line. But overall, the acceleration of these two are in the same range.

Furthermore, the graph of the Cart on the lower slope without the weights the Cart on the lower slope with weights are almost parallel to each other; which means experimental 3 and 4 almost have the same slope, too. From this result, we can tell that the mass of the Dynamic Cart does not affect the acceleration of the movement of the Carts.

What affect the acceleration of the movement is the angle of the track. It is shown in the Table V that the accelerations of the Dynamic Carts are distinctly different between experimental 1 and 3, and between 2 and 4. In both cases, the mass of the Dynamic Carts are the same, but the angle is different; experimental 1 and 2 have the steeper slope, and experimental 3 and 4 have the lower, gentle slope. This difference in steepness affect the acceleration of the movement of the Dynamic Cart. We can say that the steeper the slope is, the greater the acceleration is.

Lastly, the Dynamic Carts were constantly accelerated in all 4 experiments because the velocity-time graph showed that they all have the straight lines. It means our hypothesis that the movement of the Dynamic Cart is constant-acceleration motion was correct.

❖ *Conclusion*

The acceleration is not affected by the mass of the Dynamic Cart, but it is affected by the steepness of the track. The movement of the Dynamic Cart was a constant-acceleration motion.

❖ *Opinion*

To me, the most exciting part of this lab was to look at the Spark Timer leaving the black tick marks on the Thermal Sensitive Tapes. Since it was my first time to use the Spark Timer, I made some mistake while using it. So I want to measure the data more accurately if I have a chance to use it again in a lab. Before doing this lab, I believed that the mass of an object is a factor that changes its acceleration. But it turned out to be different, so I was a little surprised by the result. I could learn a lot by doing this lab.

Writing a lab report is hard and time-consuming, and I struggled to gather up the information I got from the lab. Thanks to the teacher, who opened the website for us, I can learn how to write a lab report by looking at the former students' lab reports. I will work hard so that I can improve my lab report to make it more organized and clear.

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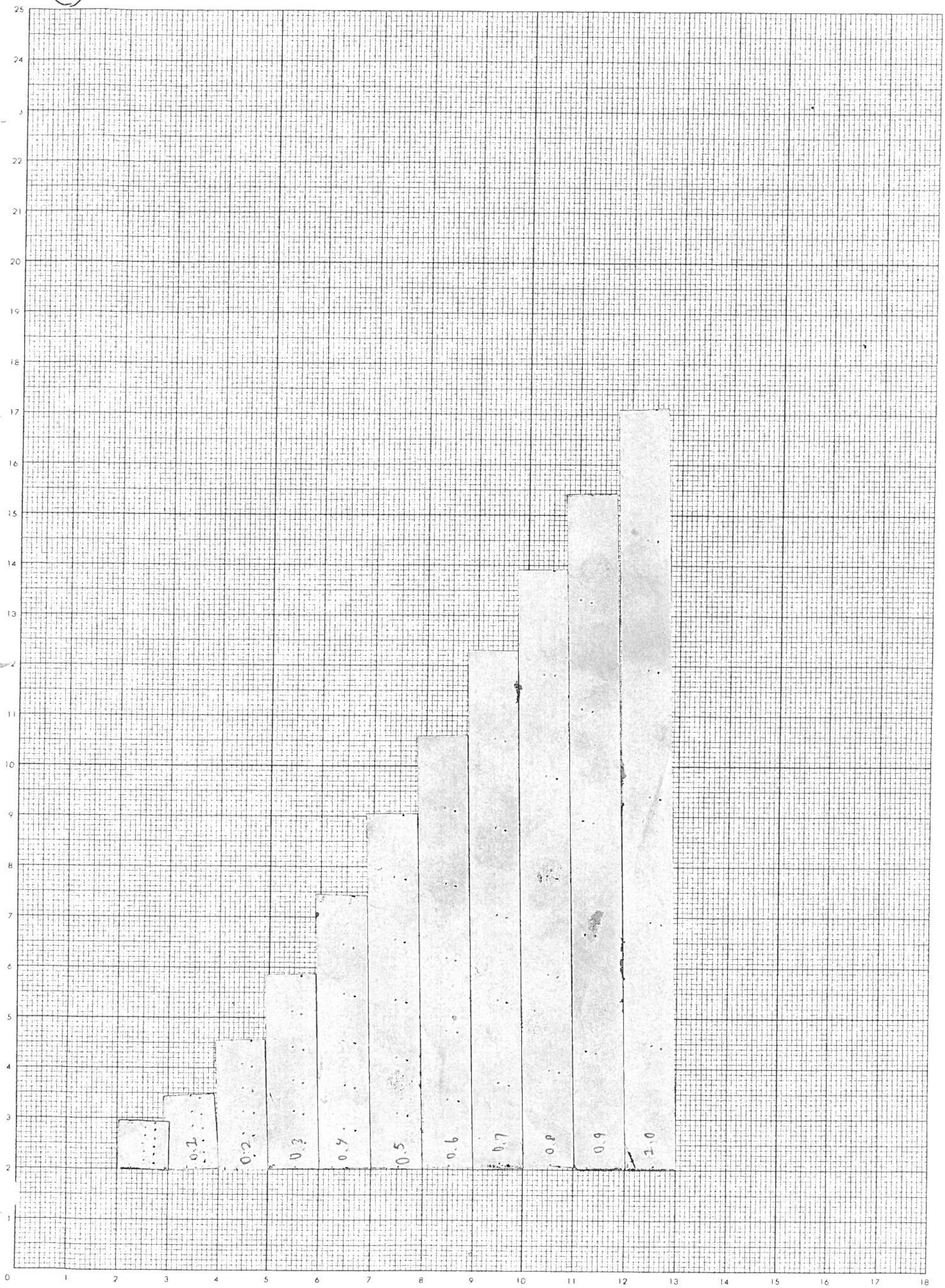

Experiment 1 JIS-A4 1mm (250×180) コクヨ ホ-19

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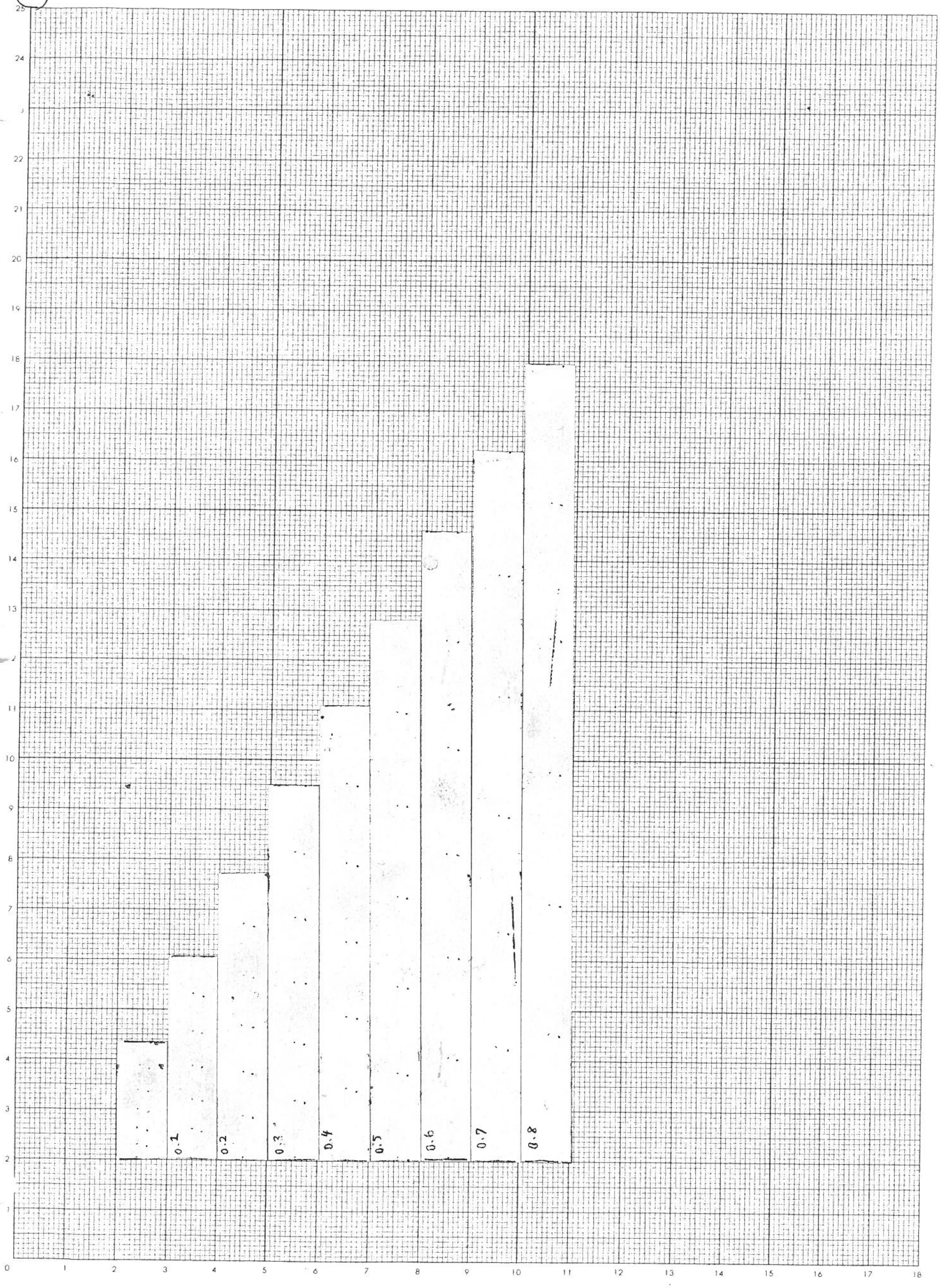

JIS-A4 1mm (250×180) コクヨ ホ-19

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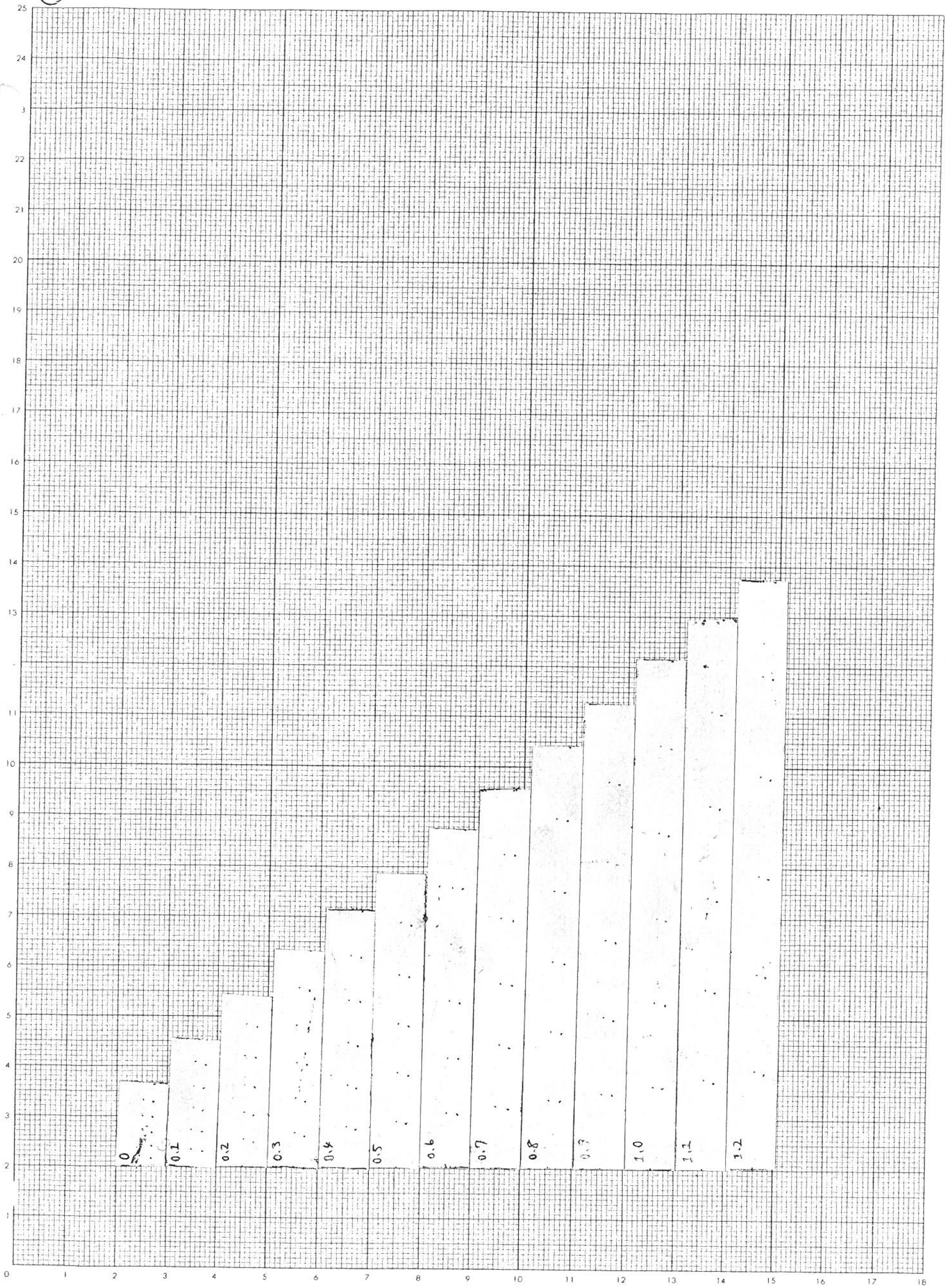

Experiment 3

JIS-A4 1mm (250×180) コクヨ ホ-19

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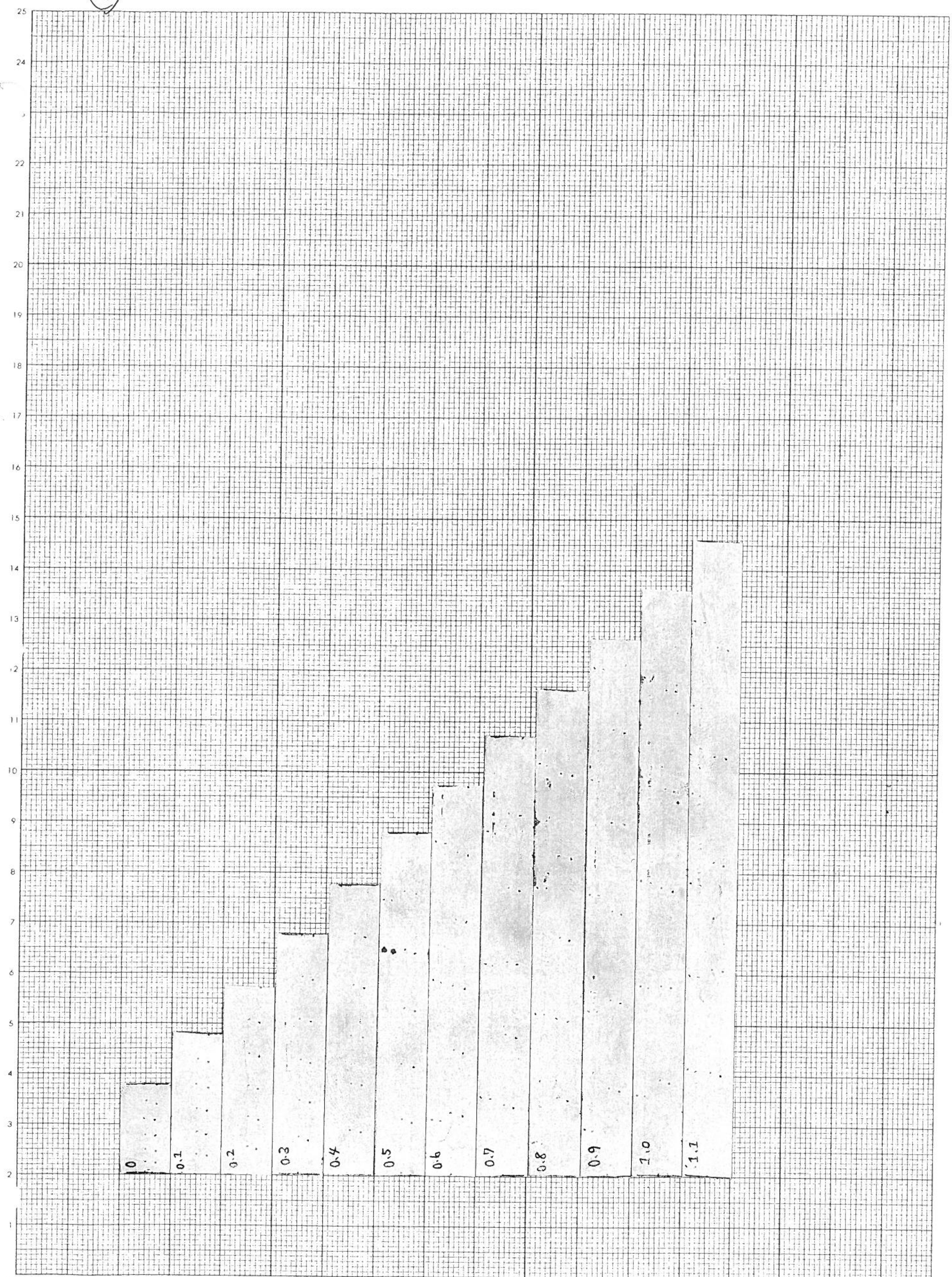

Experiment 4

JIS-A4 1mm (250×180) コクヨ ホ-19

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