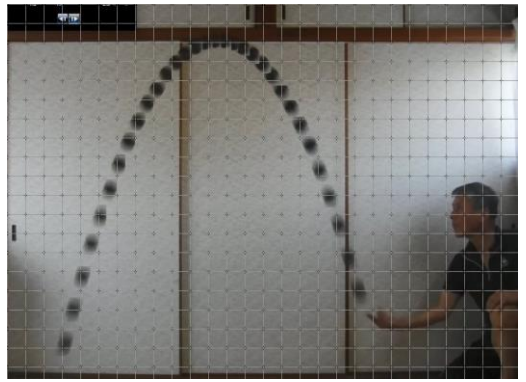
Science Activity Video





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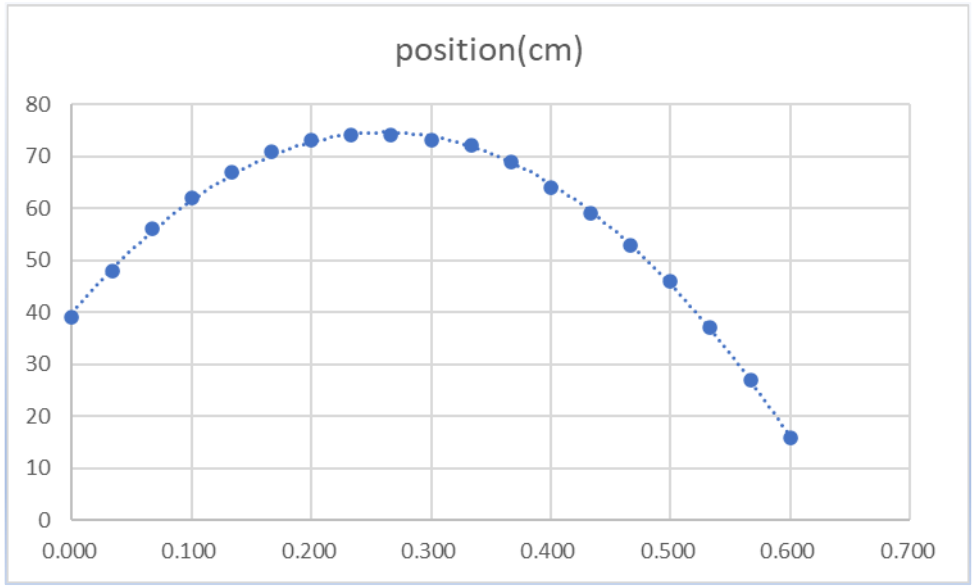
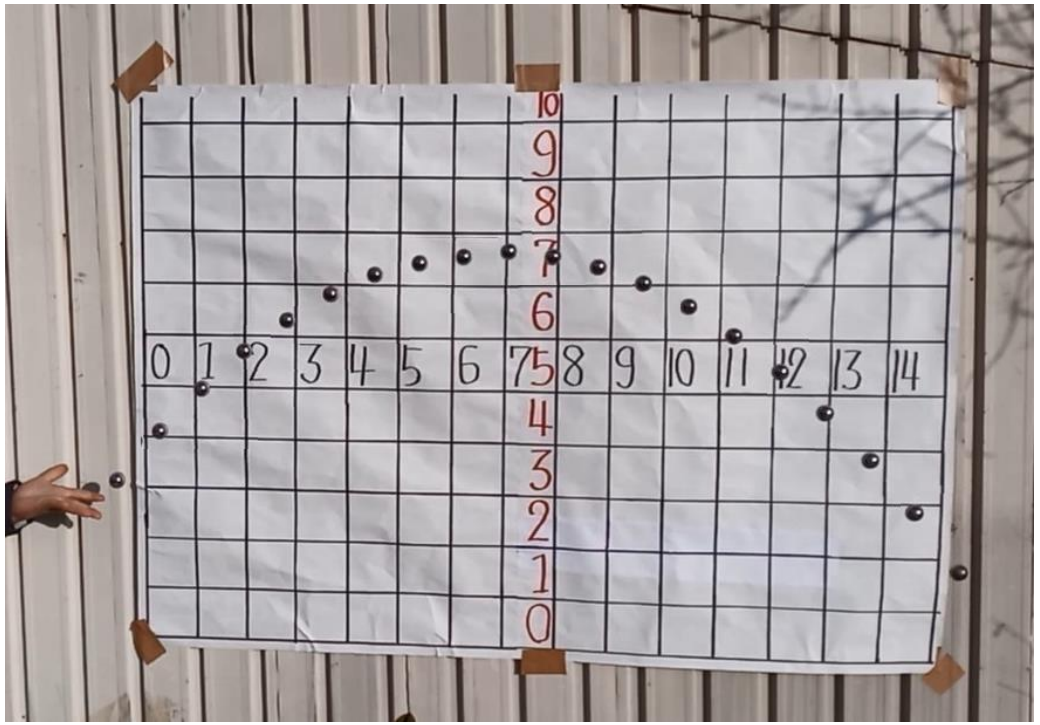
RECSAM Training Programme Division

JICA Senior Volunteer

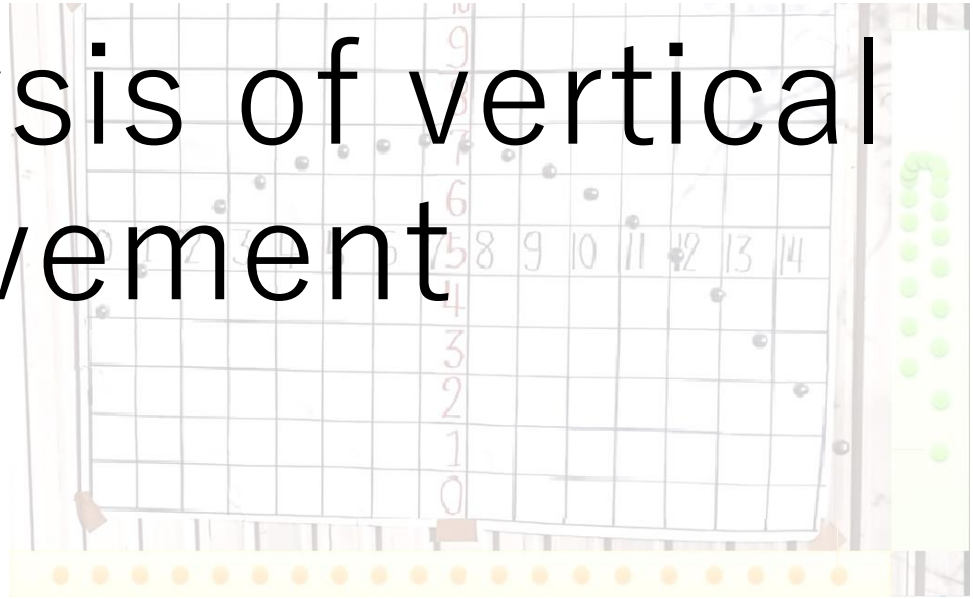
Measurement of Projectile motion by Smartphone Video





Objectives

- Measurement of projectile motion by smartphone video
- Independent analysis of vertical and horizontal movement



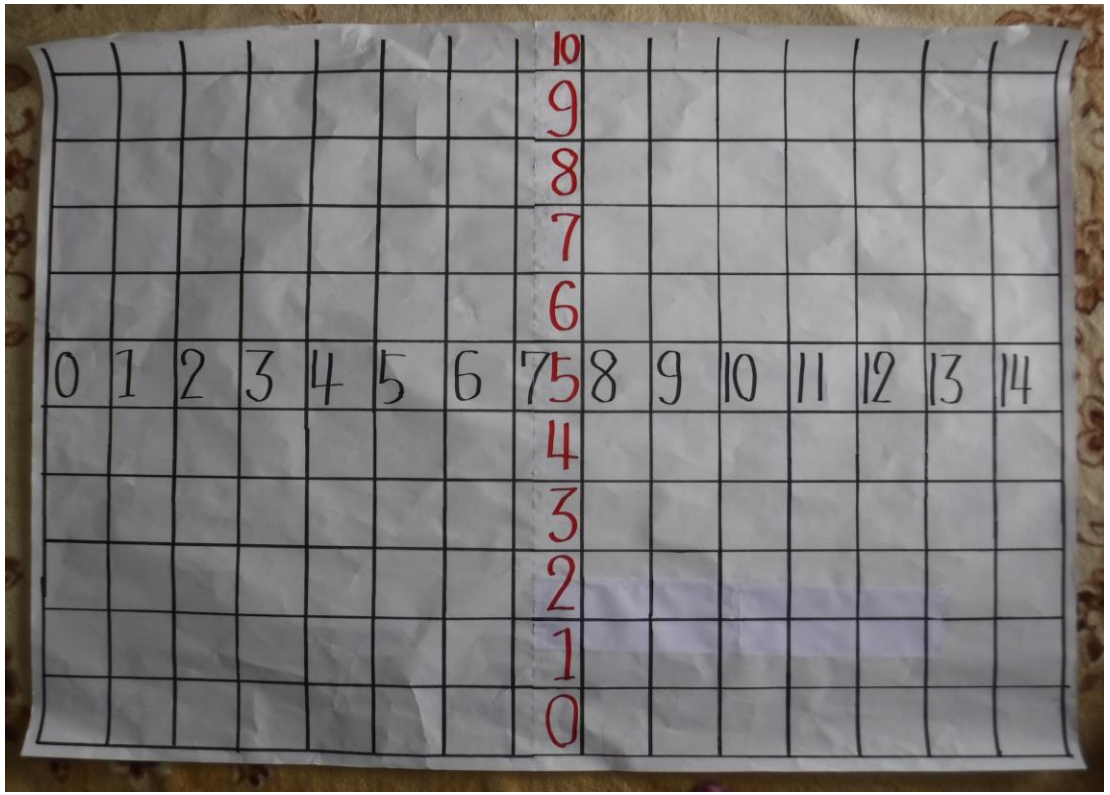
Experimental procedure

1. Take a video of projectile motion.
2. Read and record the ball position from each frame of the video.
3. Calculate periodical velocity and make a graph.

Materials

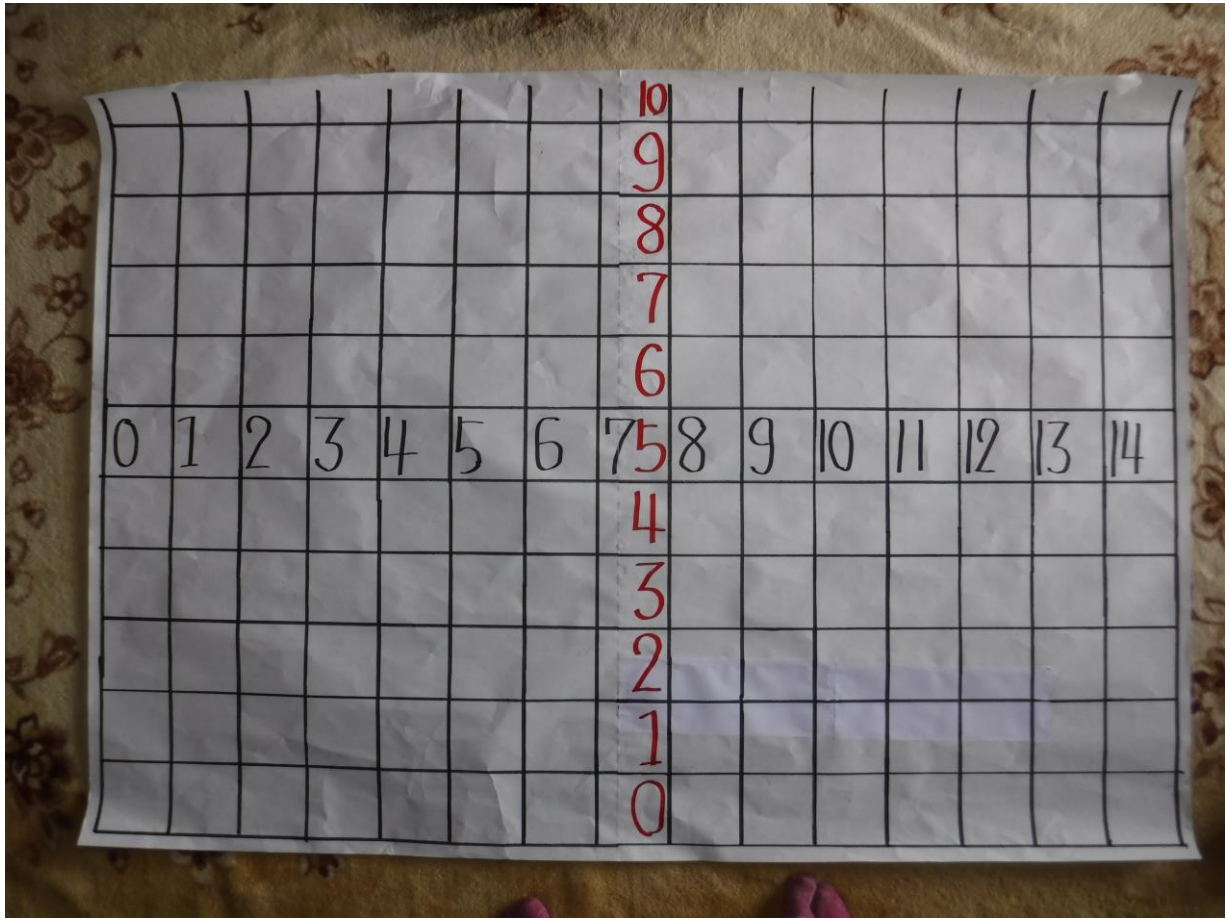
Ball

Smartphone



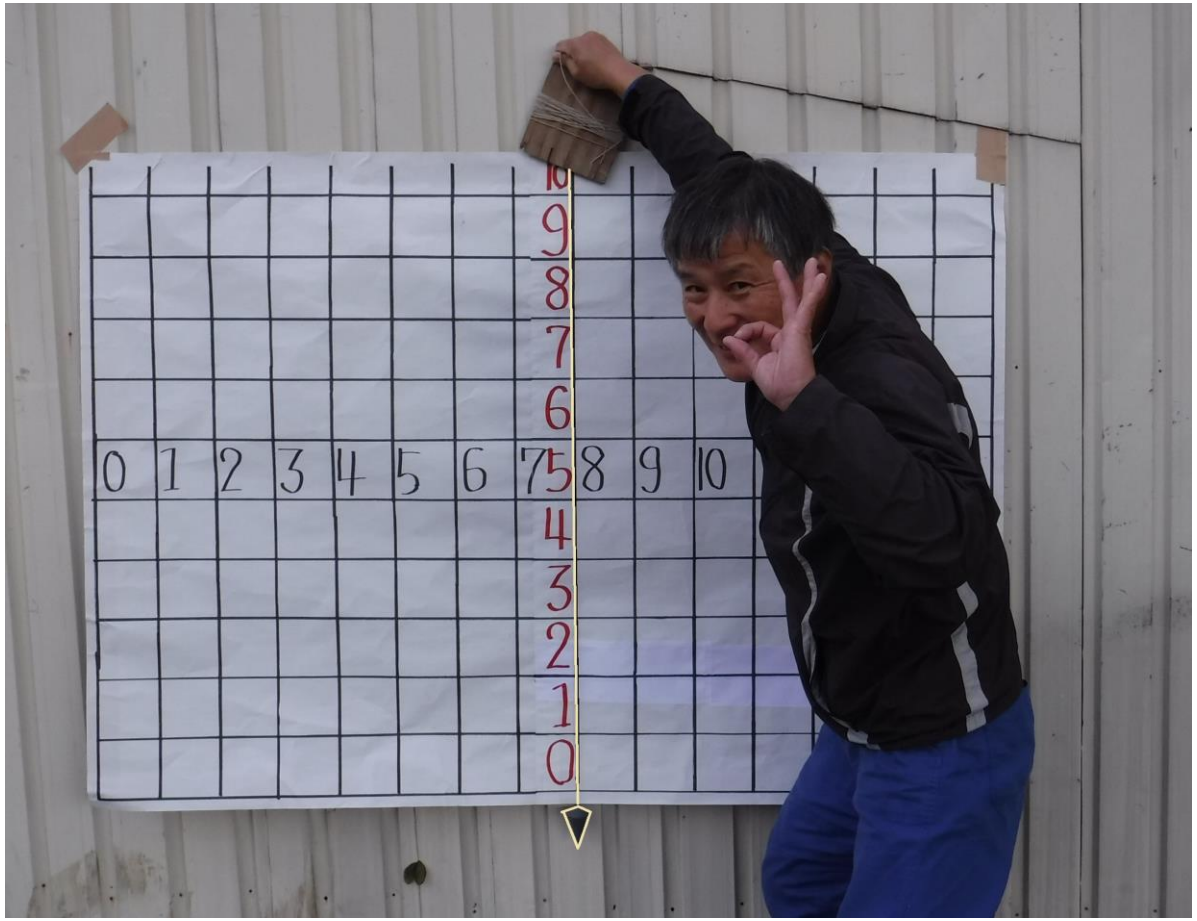
Large Scale

Preparation



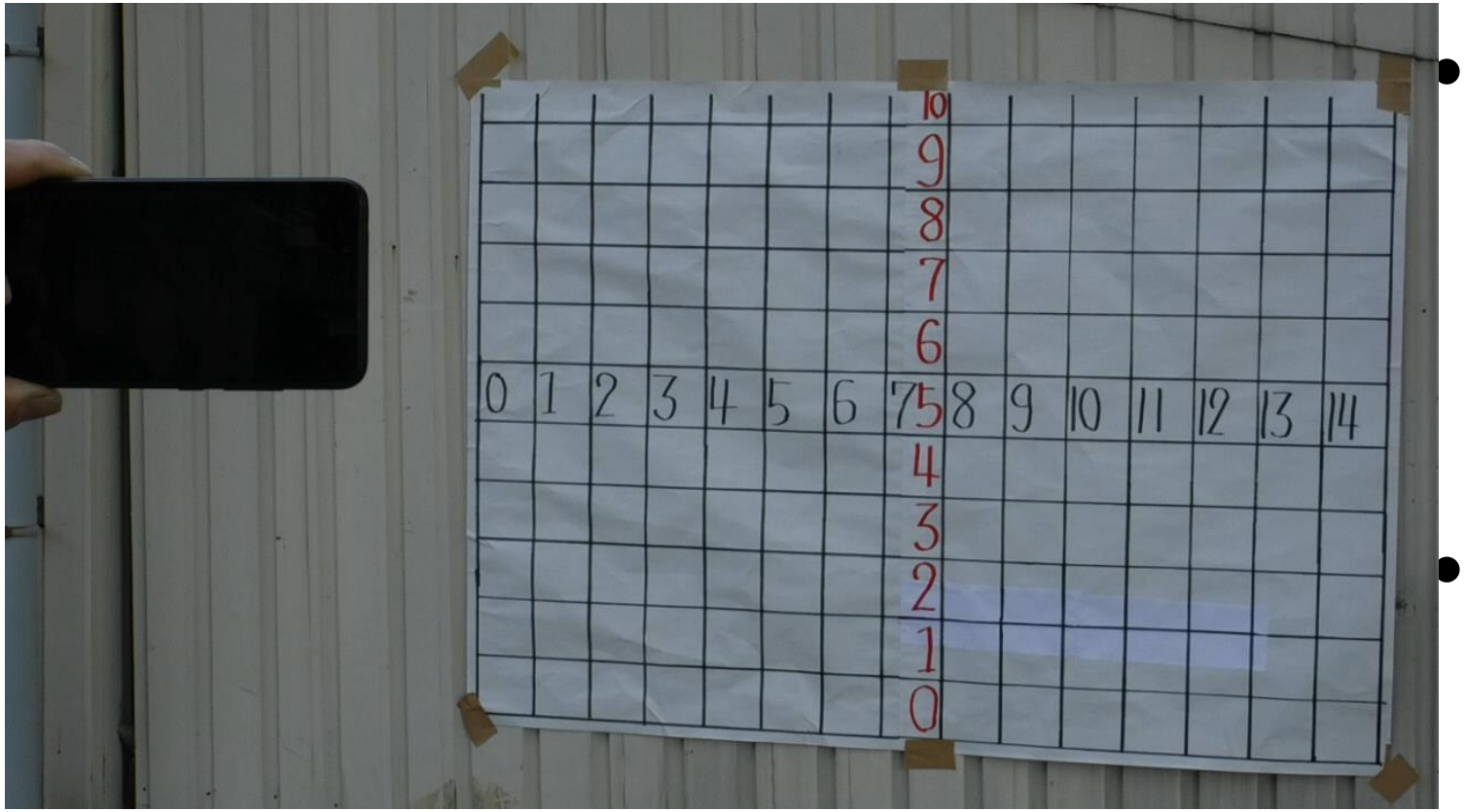
Draw a line every 10 cm in the vertical and horizontal directions on the paper.

Preparation



Use a weight to check the vertical direction and put this scale on the wall of the measurement place.

Video shooting



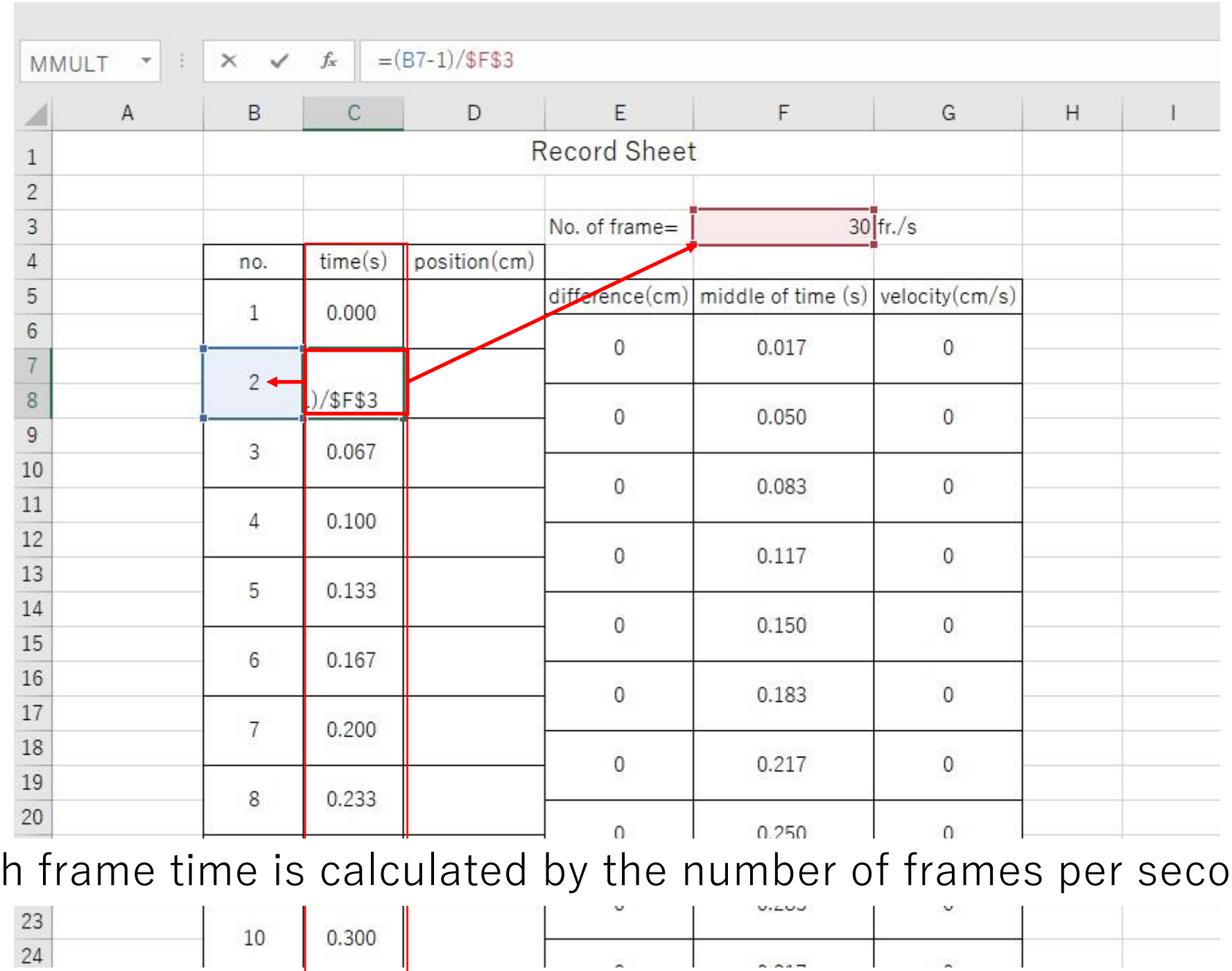
- One person throws the ball diagonally near a scale.
- Another person takes video by smartphone.

excel sheet for record, calculation and graph

Record Sheet

No. of frame= 30 fr./s

no.	time(s)	position(cm)	difference(cm)	middle of time (s)	velocity(cm/s)
1	0.000				
			0	0.017	0
2	0.033				
			0	0.050	0
3	0.067				
			0	0.083	0
4	0.100				
			0	0.117	0
5	0.133				
			0	0.150	0
6	0.167				
			0	0.183	0
7	0.200				
			0	0.217	0
8	0.233				
			0	0.250	0
9	0.267				
			0	0.283	0
10	0.300				



Each frame time is calculated by the number of frames per second.

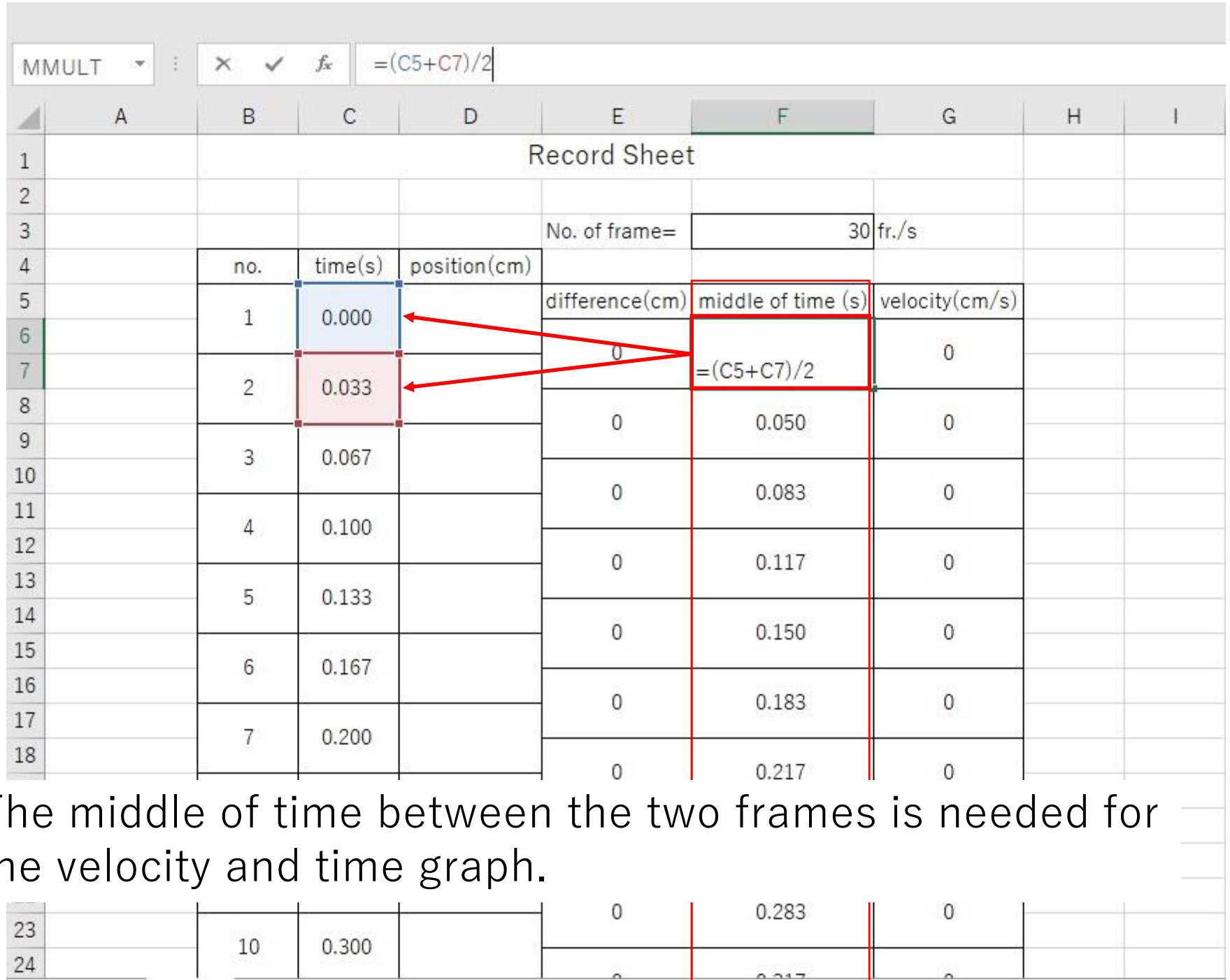
MMULT | =D7-D5

Record Sheet

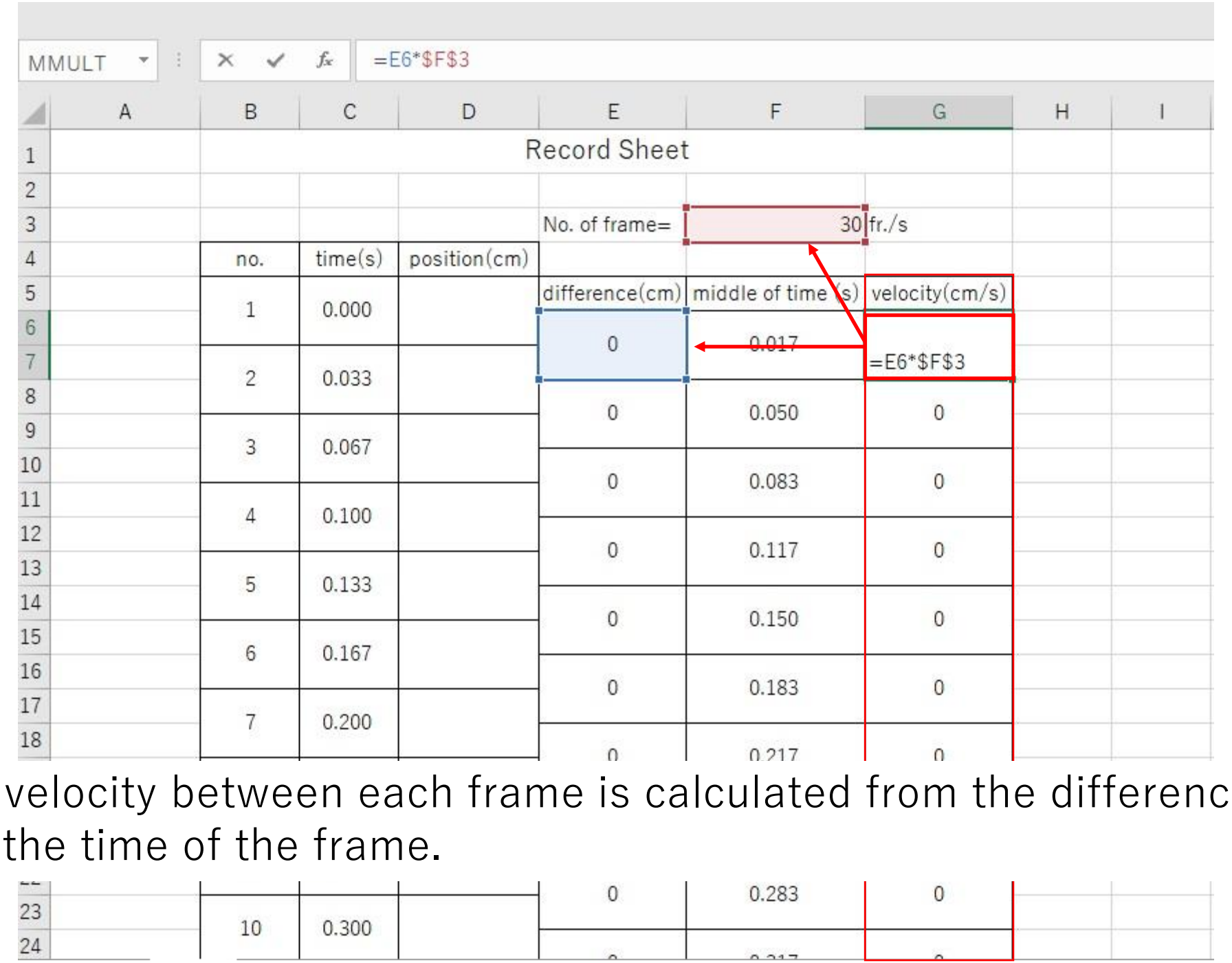
No. of frame= 30 fr./s

no.	time(s)	position(cm)	difference(cm)	middle of time (s)	velocity(cm/s)
1	0.000				
			=D7-D5	0.017	0
2	0.033		0	0.050	0
3	0.067		0	0.083	0
4	0.100		0	0.117	0
5	0.133		0	0.150	0
6	0.167		0	0.183	0
7	0.200		0	0.217	0
8	0.233		0	0.283	0
10	0.300				

The difference is the length from one flam to the next.

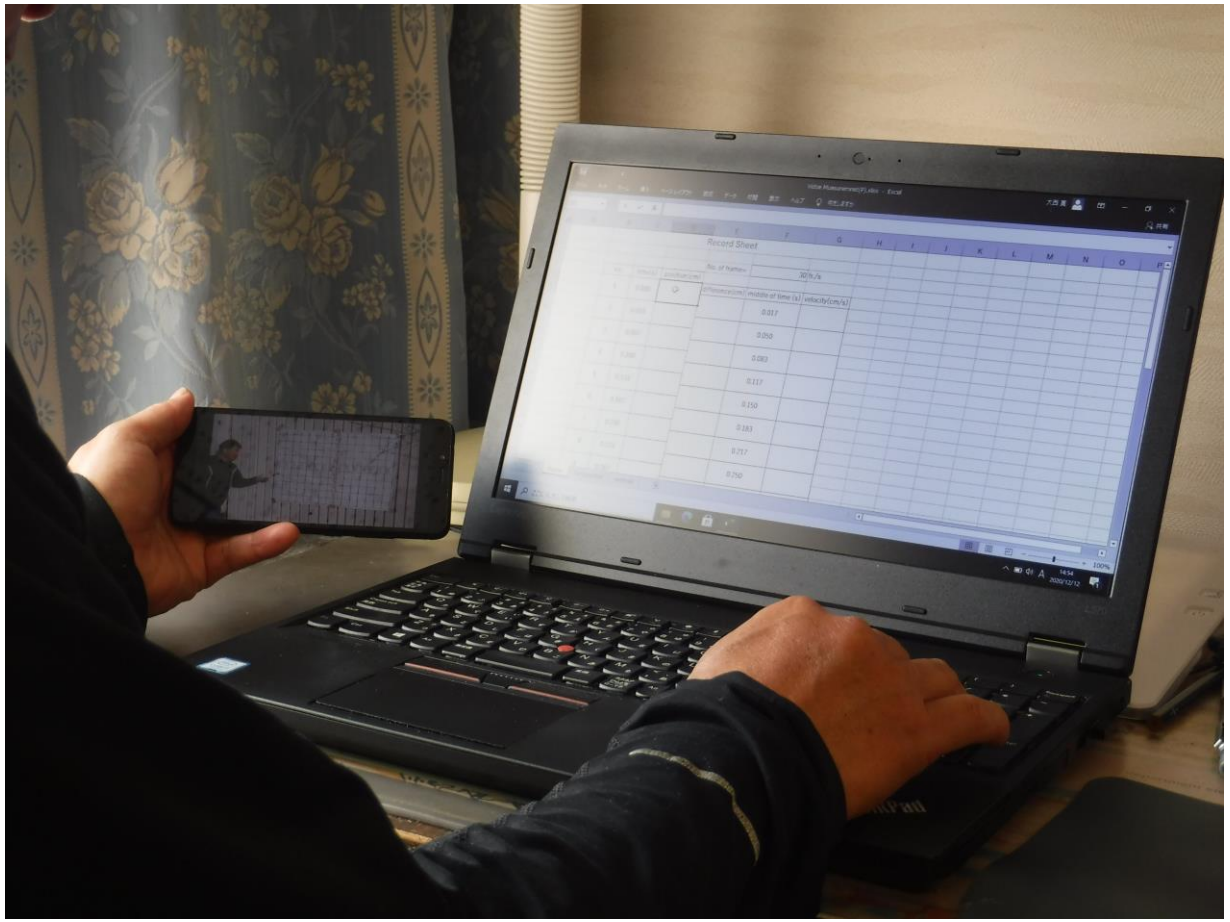


The middle of time between the two frames is needed for the velocity and time graph.



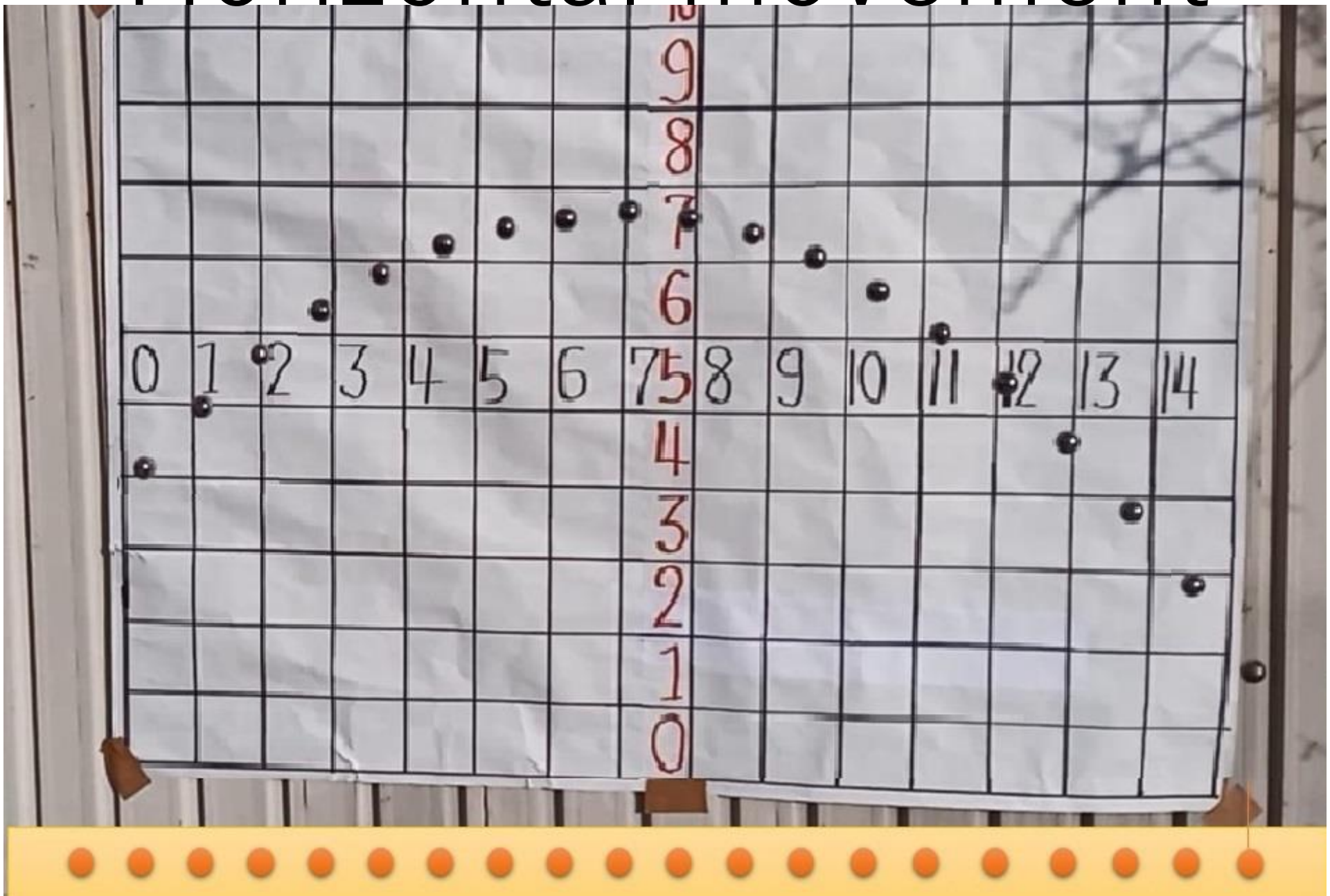
The velocity between each frame is calculated from the difference and the time of the frame.

Reading and Recording



- Read ball positions on each frame
- Record them in the sheet.

Horizontal movement

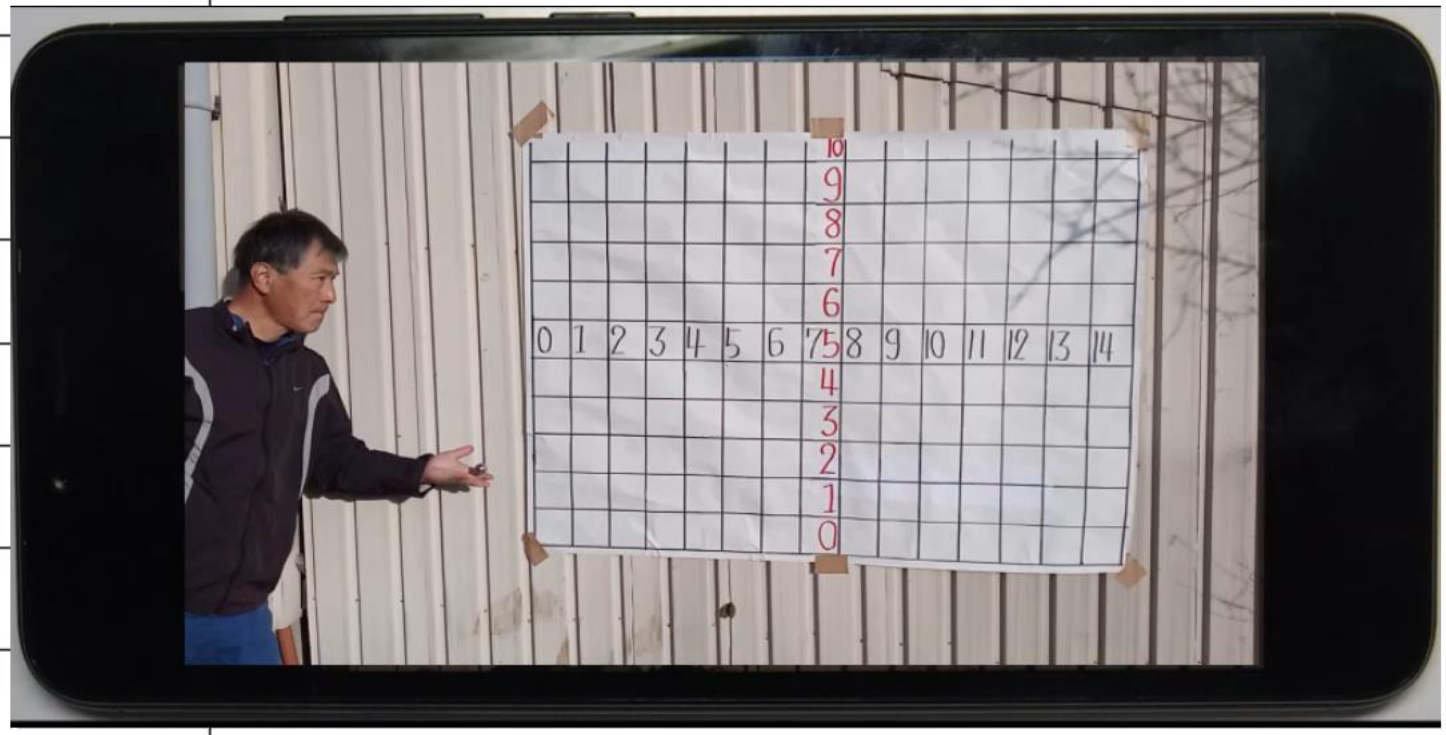


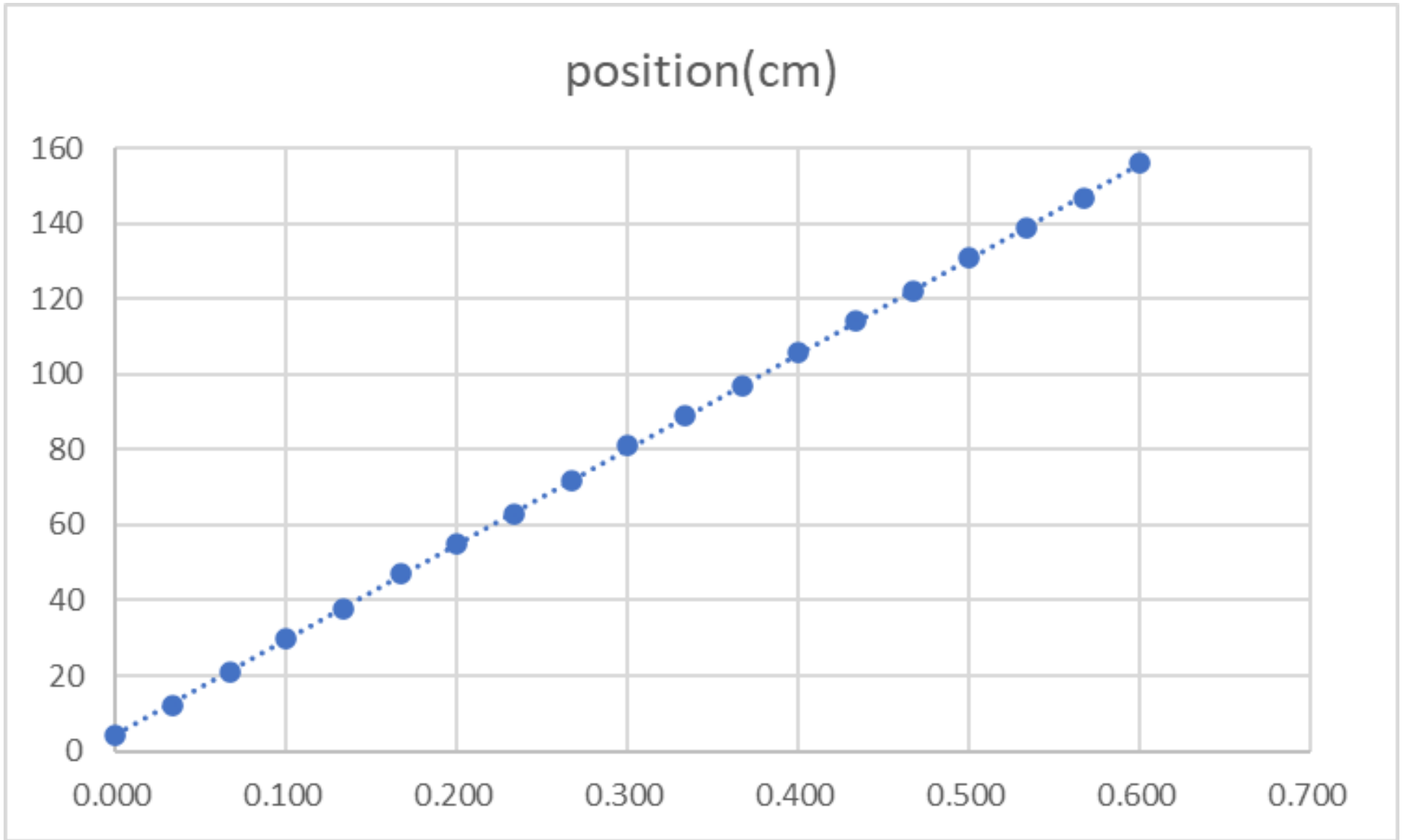
Record Sheet

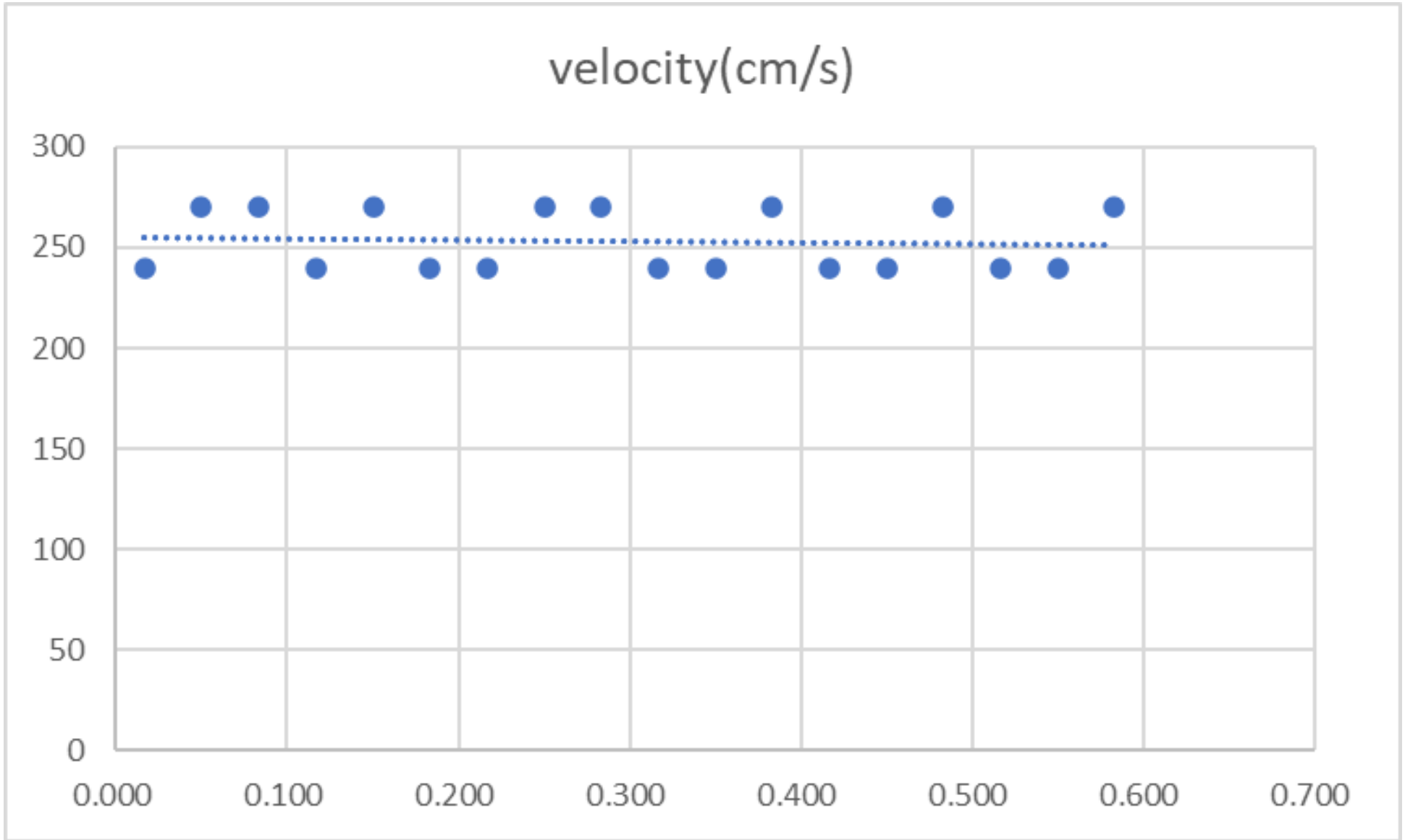
No. of frame= 30 fr./s

no.	time(s)	position(cm)	difference(cm)	middle of time (s)	velocity(cm/s)
1	0.000				
			0	0.017	0
2	0.033				
			0	0.050	0
3	0.067				
			0	0.083	0
4	0.100				
			0	0.117	
5	0.133				
			0	0.150	
6	0.167				
			0	0.183	
7	0.200				
			0	0.217	
8	0.233				
			0	0.250	
9	0.267				
			0	0.283	
10	0.300				
			0	0.317	
11	0.333				

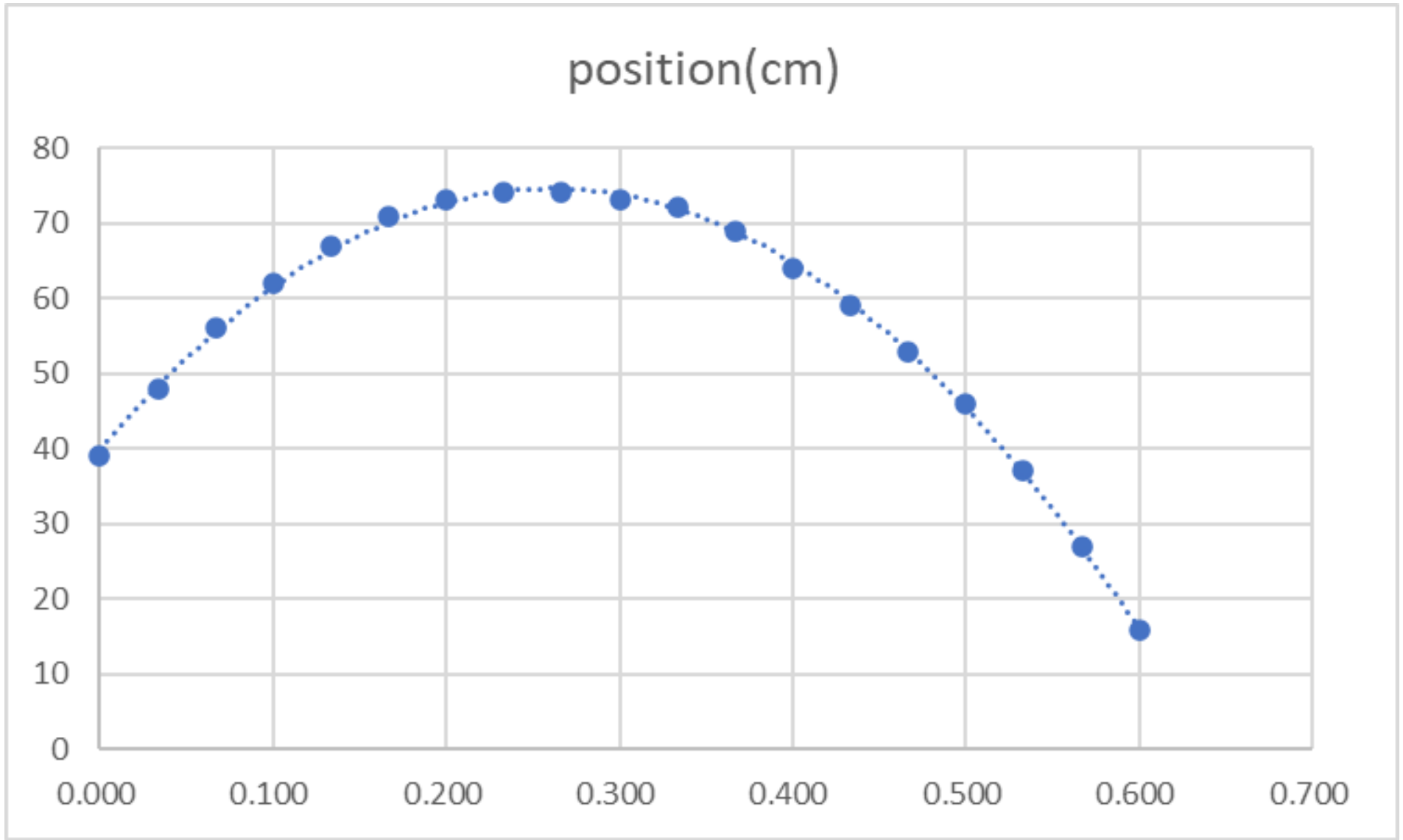
The position of the ball for each frame is read and recorded.
Calculations and graphs can be done at the same time.

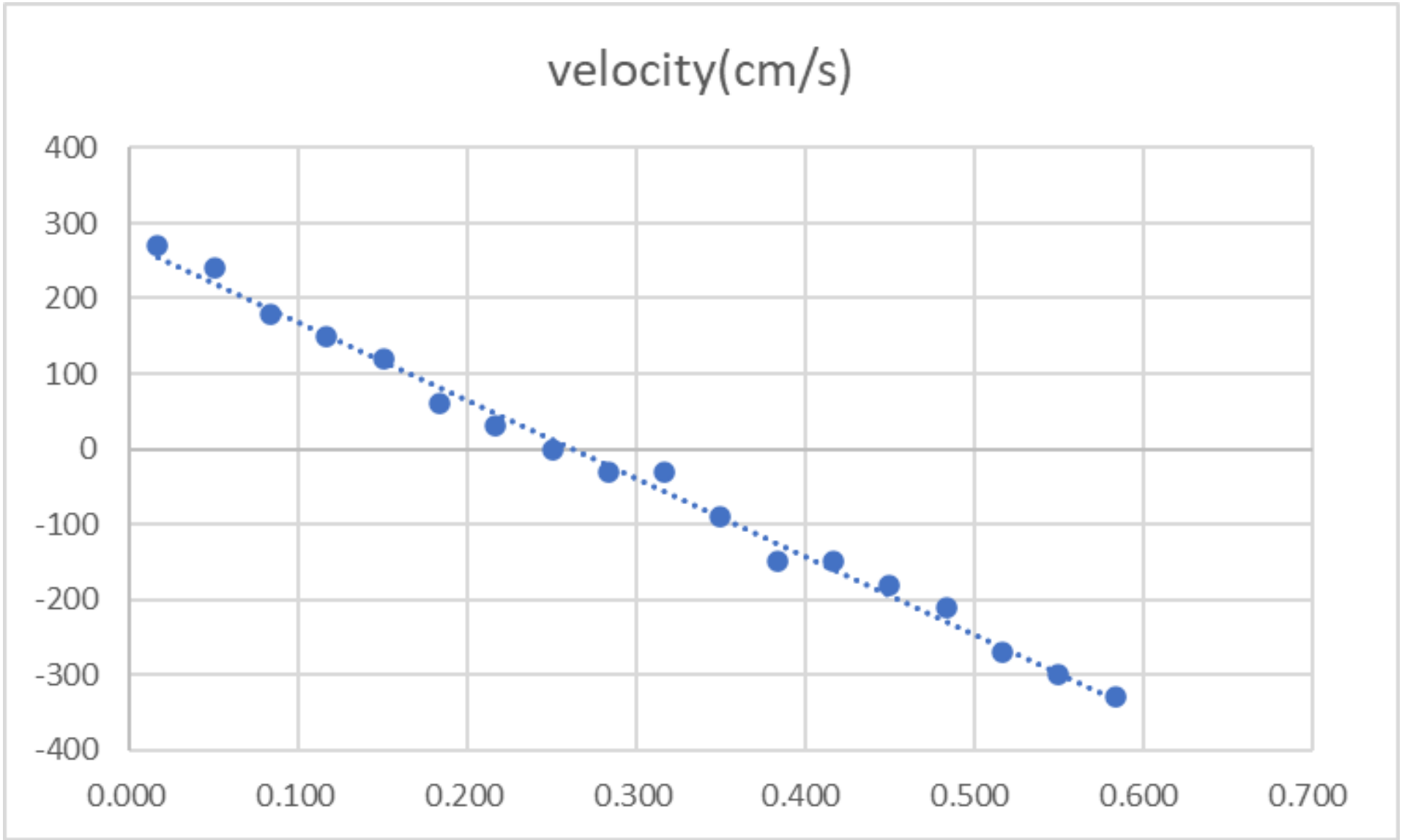


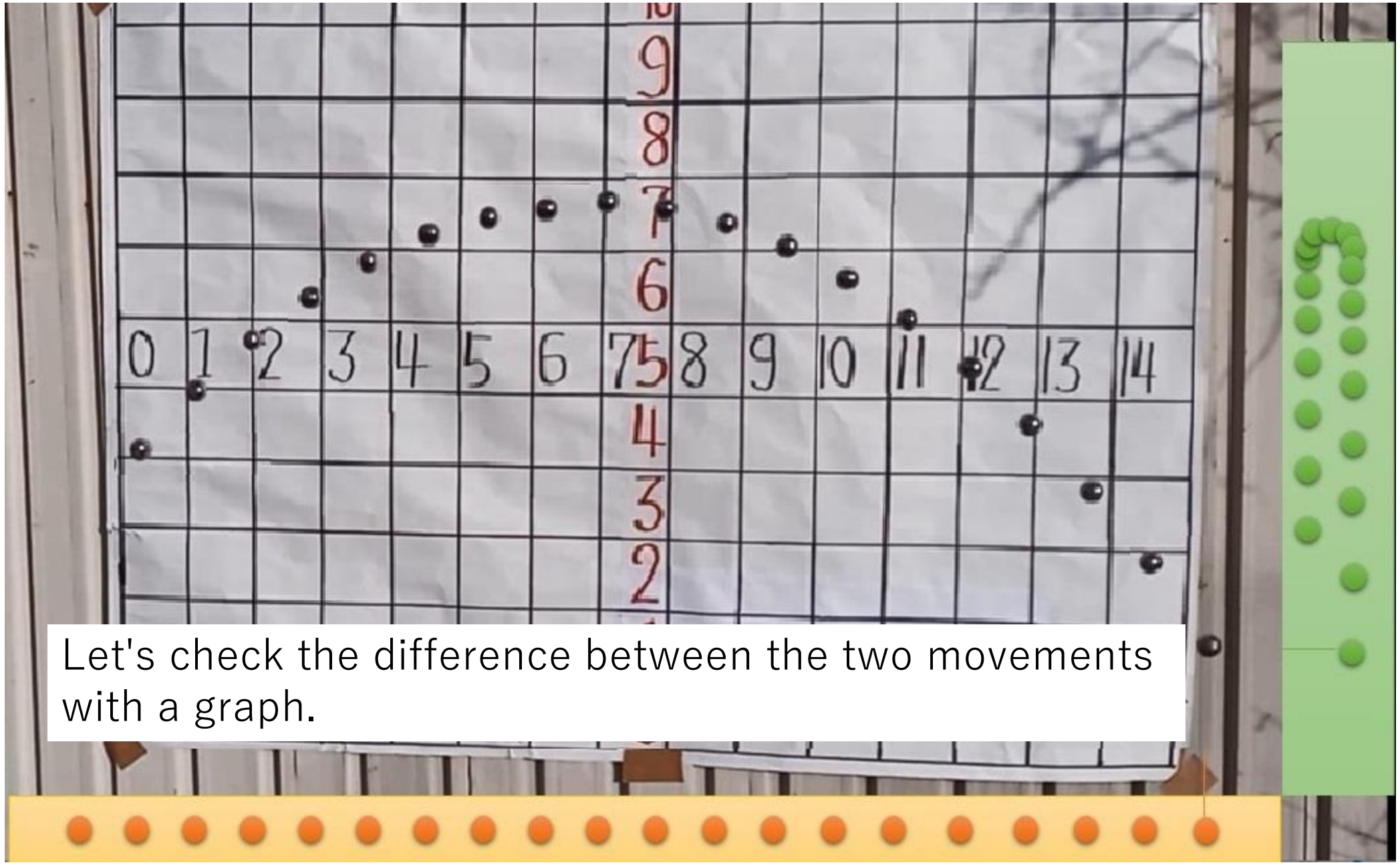

position(cm)
160
140
120
100
80
60
40
20
0
0.000
0.100
0.200
0.300
0.400
0.500
0.600
0.700


velocity(cm/s)
300
250
200
150
100
50
0
0.000
0.100
0.200
0.300
0.400
0.500
0.600
0.700

Vertical movement

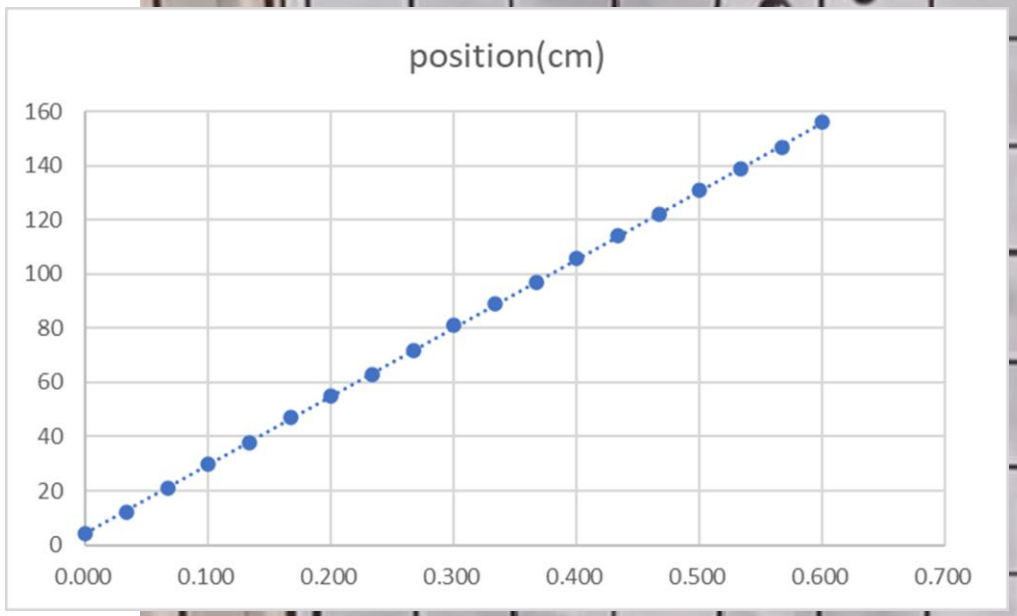

position(cm)
80
70
60
50
40
30
20
10
0
0.000
0.100
0.200
0.300
0.400
0.500
0.600
0.700

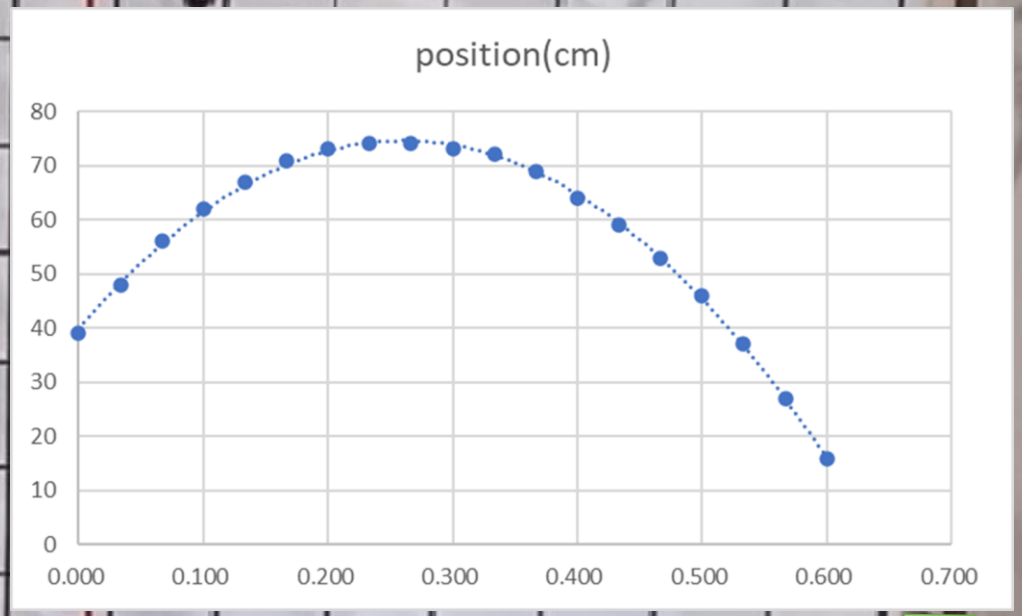

velocity(cm/s)
400
300
200
100
0
-100
-200
-300
-400
0.000
0.100
0.200
0.300
0.400
0.500
0.600
0.700



Let's check the difference between the two movements with a graph.

The position changes in direct proportion in the horizontal direction, and it changes in the vertical direction with a quadratic curve.





No force works in the horizontal direction, it moves at a constant velocity.
Gravity works in the vertical direction, the velocity changes at a constant rate.