

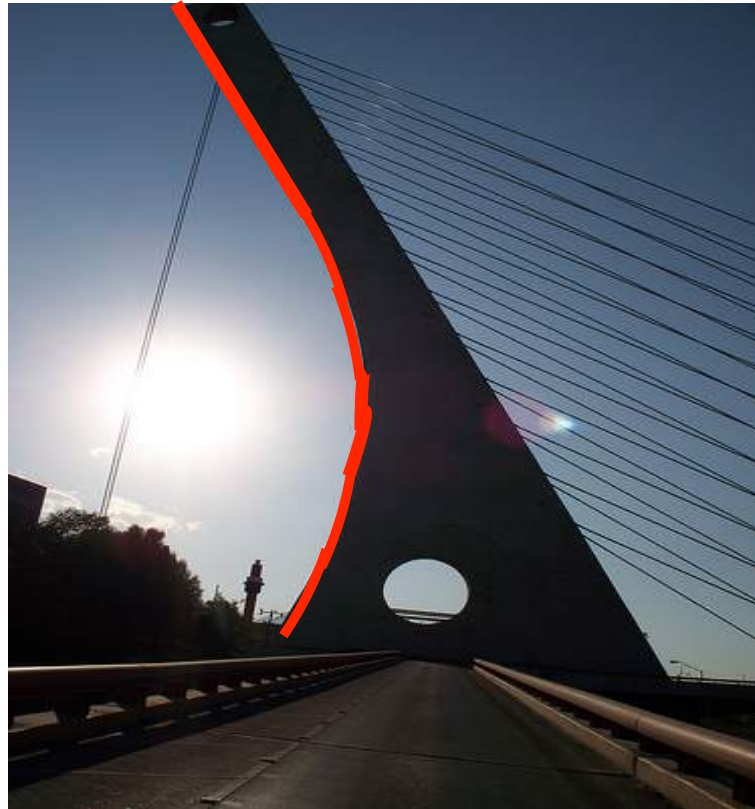


Successive Approximations as a tool to Measure Distances

Héctor Ochoa Grimaldo
Lorenza Illanes Díaz Rivera

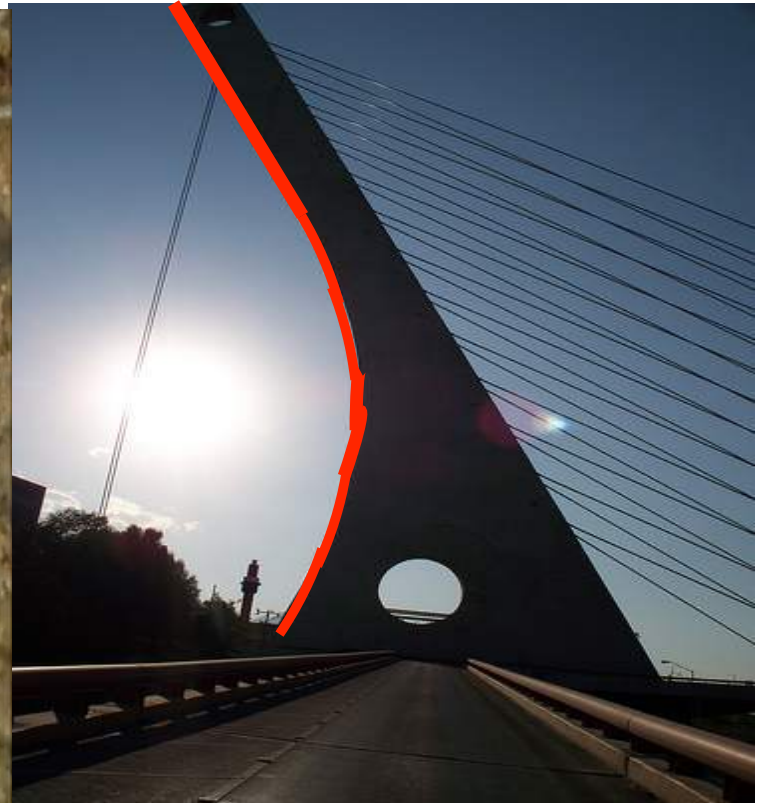
Video 1: Definition of the Problem

- › We see ants walking on the curved side of the Puente Atirantado.



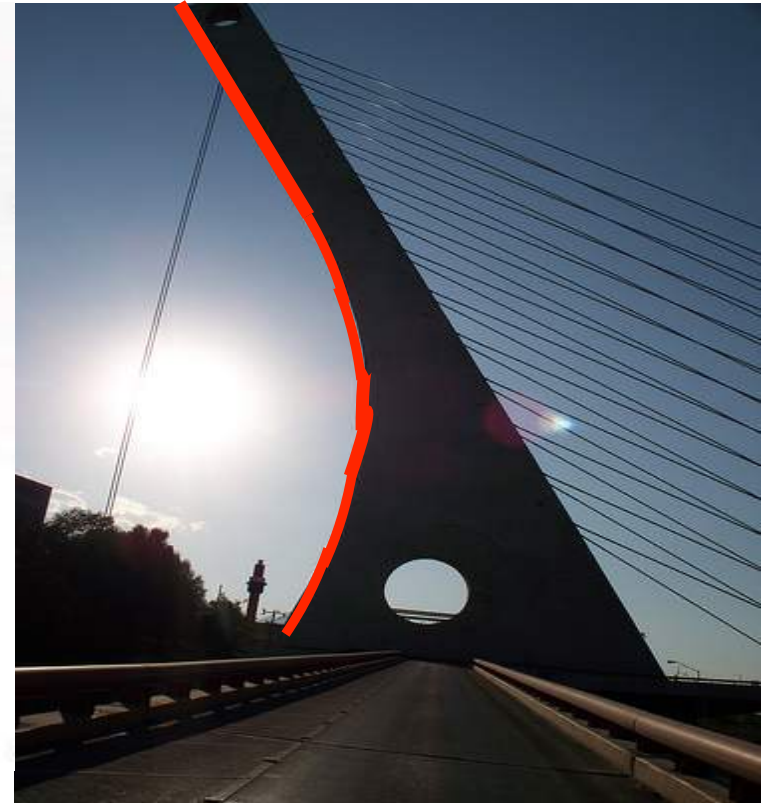
Video 1: Definition of the Problem

- › We see ants walking on the curved side of the Puente Atirantado.



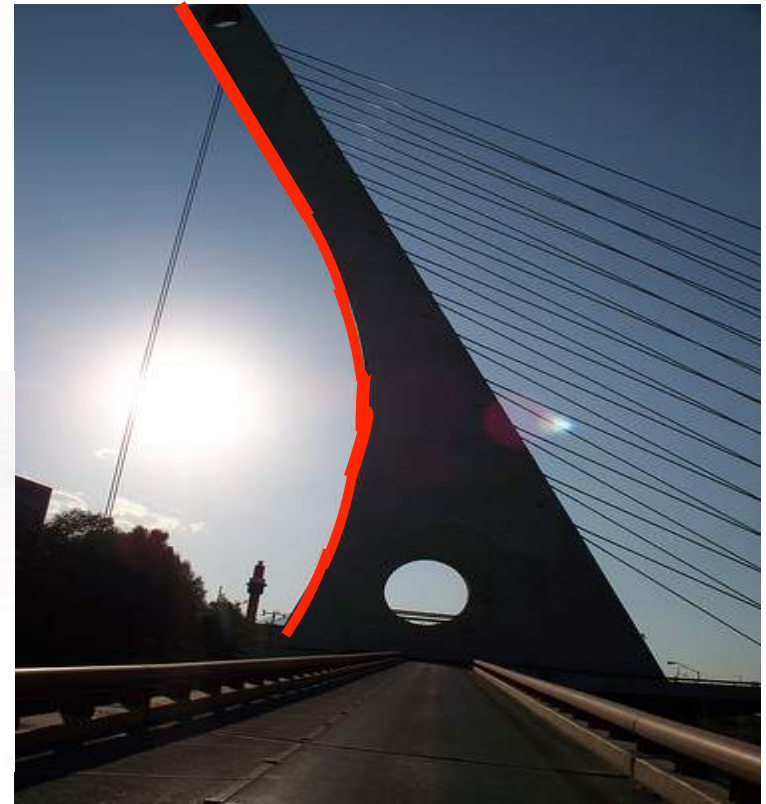
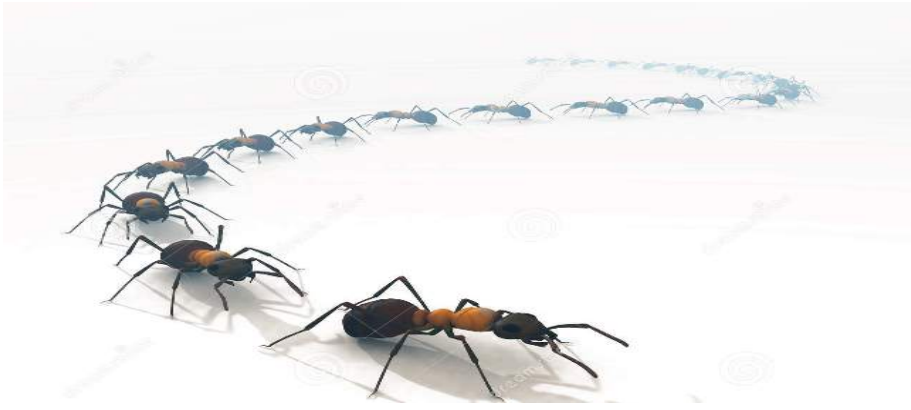
Video 1: Definition of the Problem

- › We notice that the ants that are walking are getting smaller and smaller.



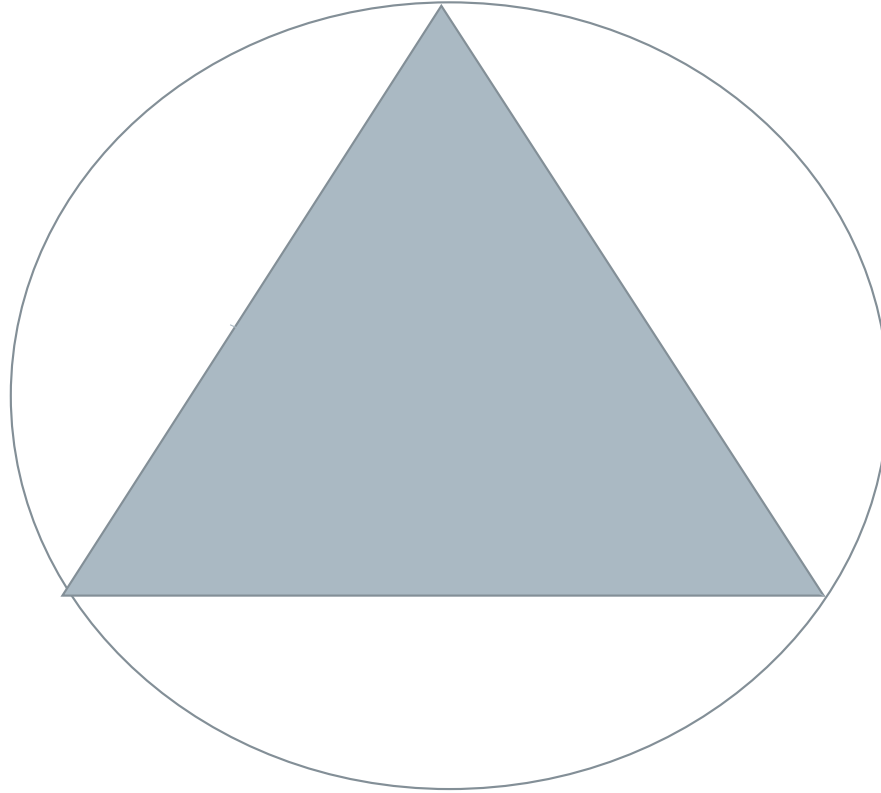
Video 1: Definition of the Problem

- › We want to know what you would do to find:
- › How much does the curved side measure?
- › How many ants would cover the curved side if they become increasingly smaller by 0.001 each time?

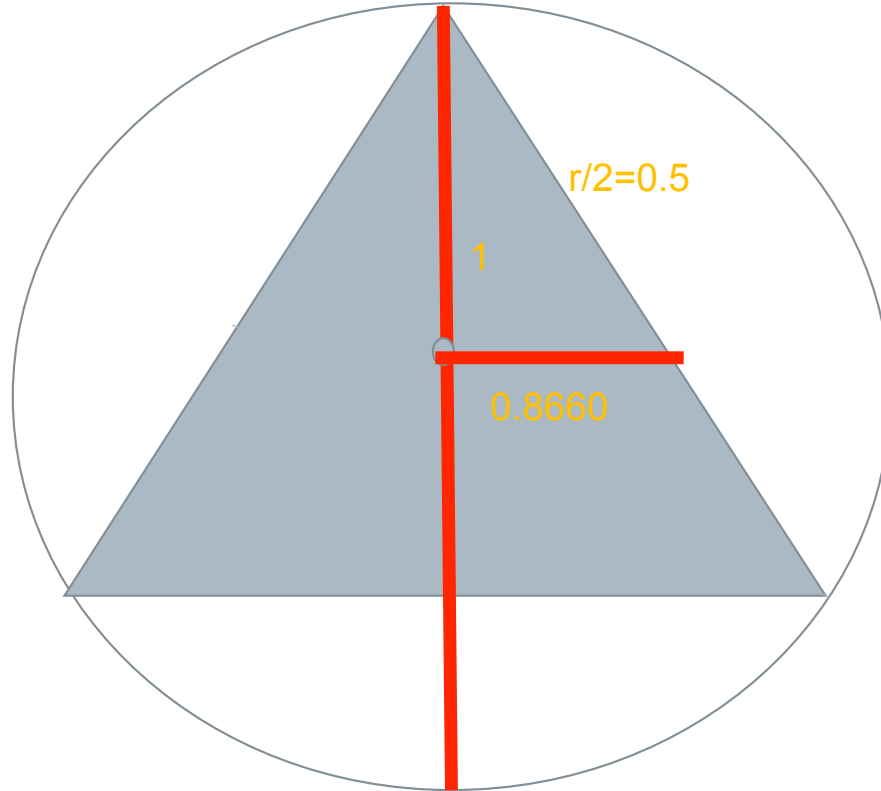


Video 2. Sheets of Paper Activity. Successive Approximations.

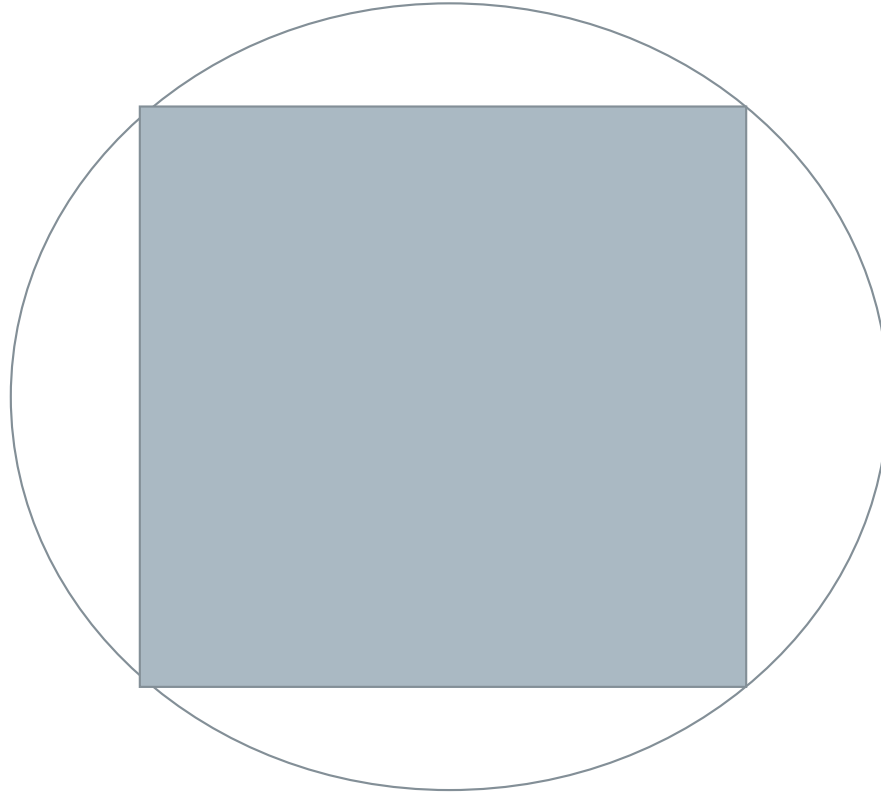
Successive Approximations



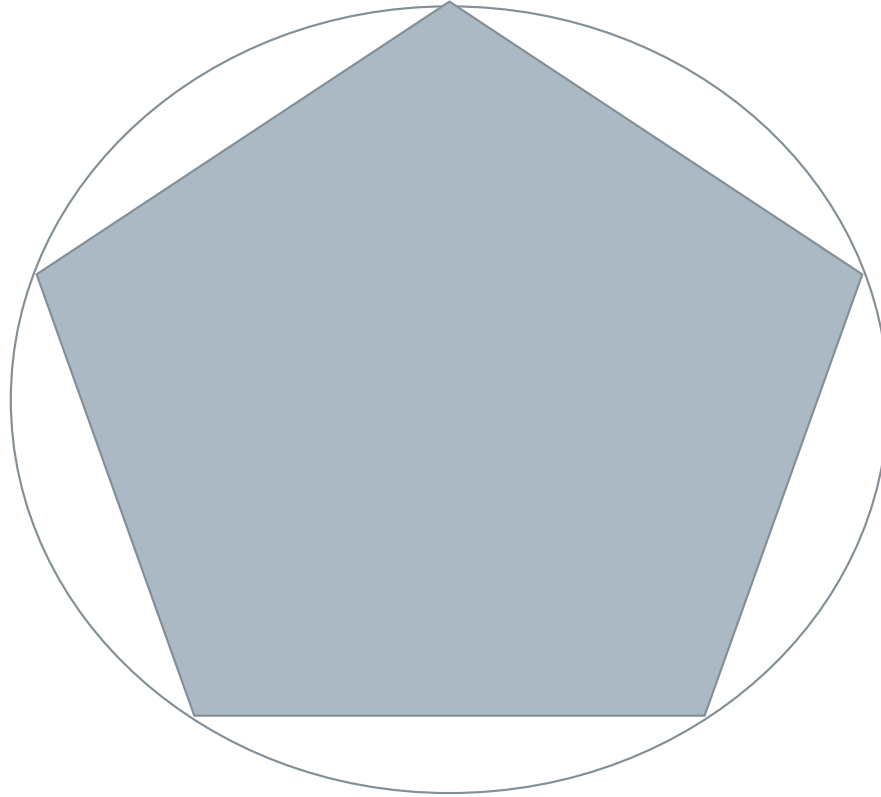
Successive Approximations



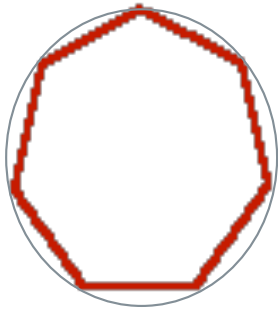
Successive Approximations



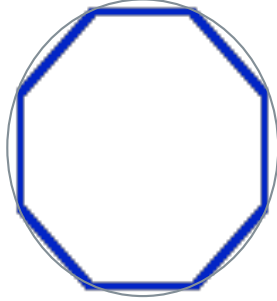
Successive Approximations



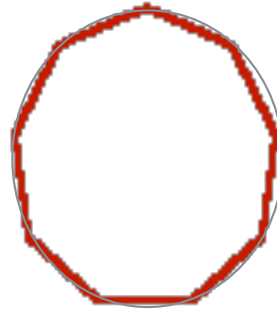
Successive Approximations



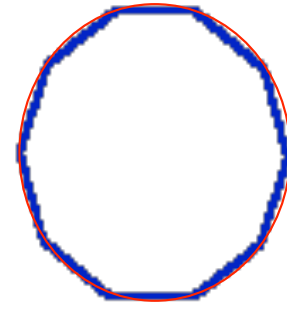
A



B



C



D

The video will be the answer (There needs to be an animation of this)

- › Select two squares and say they are the sheets



- › Leave one as is, and add halves made from the other square:

› + + + +... = 2 sheets



The video will be the answer (There needs to be an animation of this)

- › One of us continues to explain in the video::
- › that

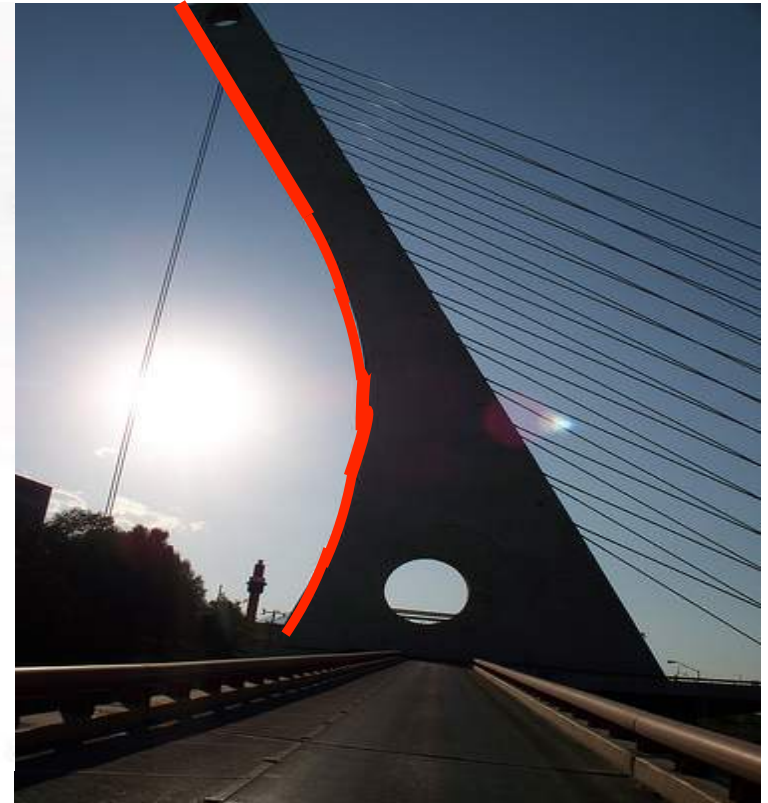
$$1 + \frac{1}{2} + \frac{1}{4} + \frac{1}{8} + \frac{1}{16} + \frac{1}{32} + \frac{1}{64} + \frac{1}{128} + \frac{1}{256} + \dots = 2$$

- › These fractions are known as successive approximations.
- › How could you use this to solve the problem?
- › Have them respond orally. Tell them we are going to work on a smaller problem.

Video 3. Rope Activity: Formula for Distance.

Video 1: Definition of the Problem

- › We notice that the ants that are walking are getting smaller and smaller.



π

How much does the longest rope measure?

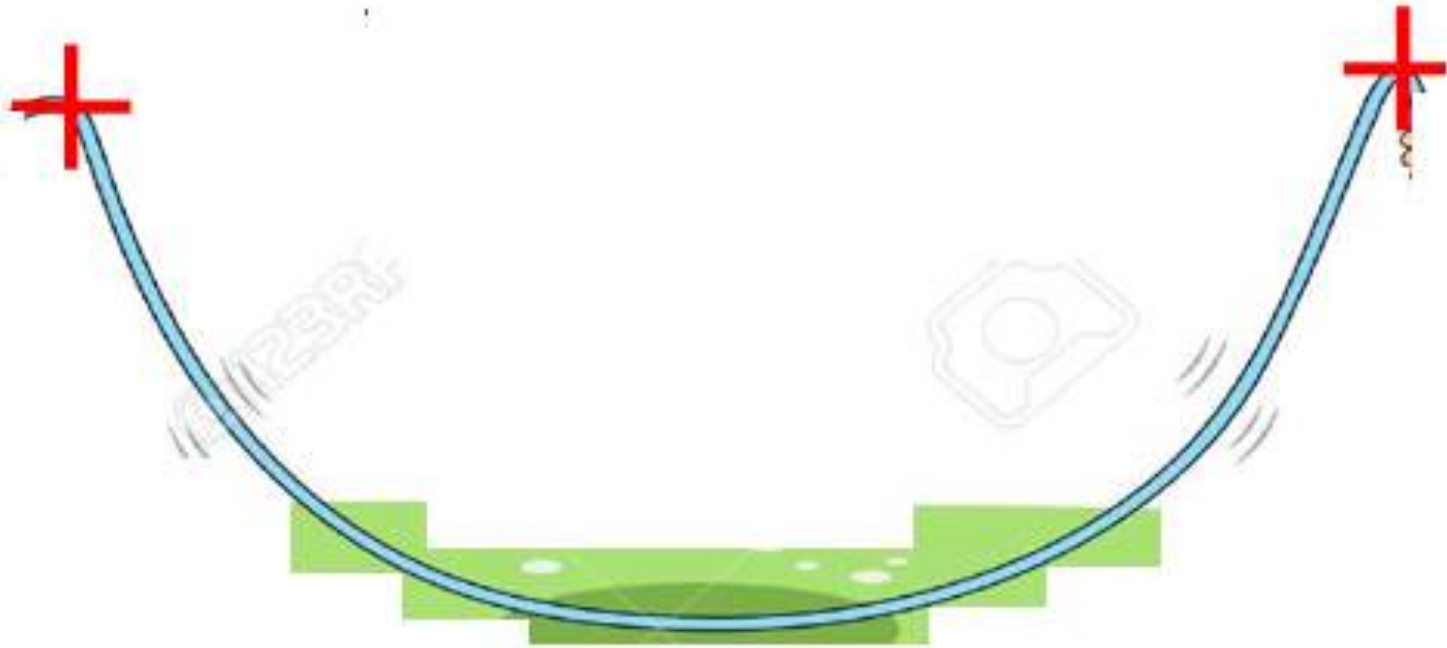


How much does the rope measure, from cross to cross?



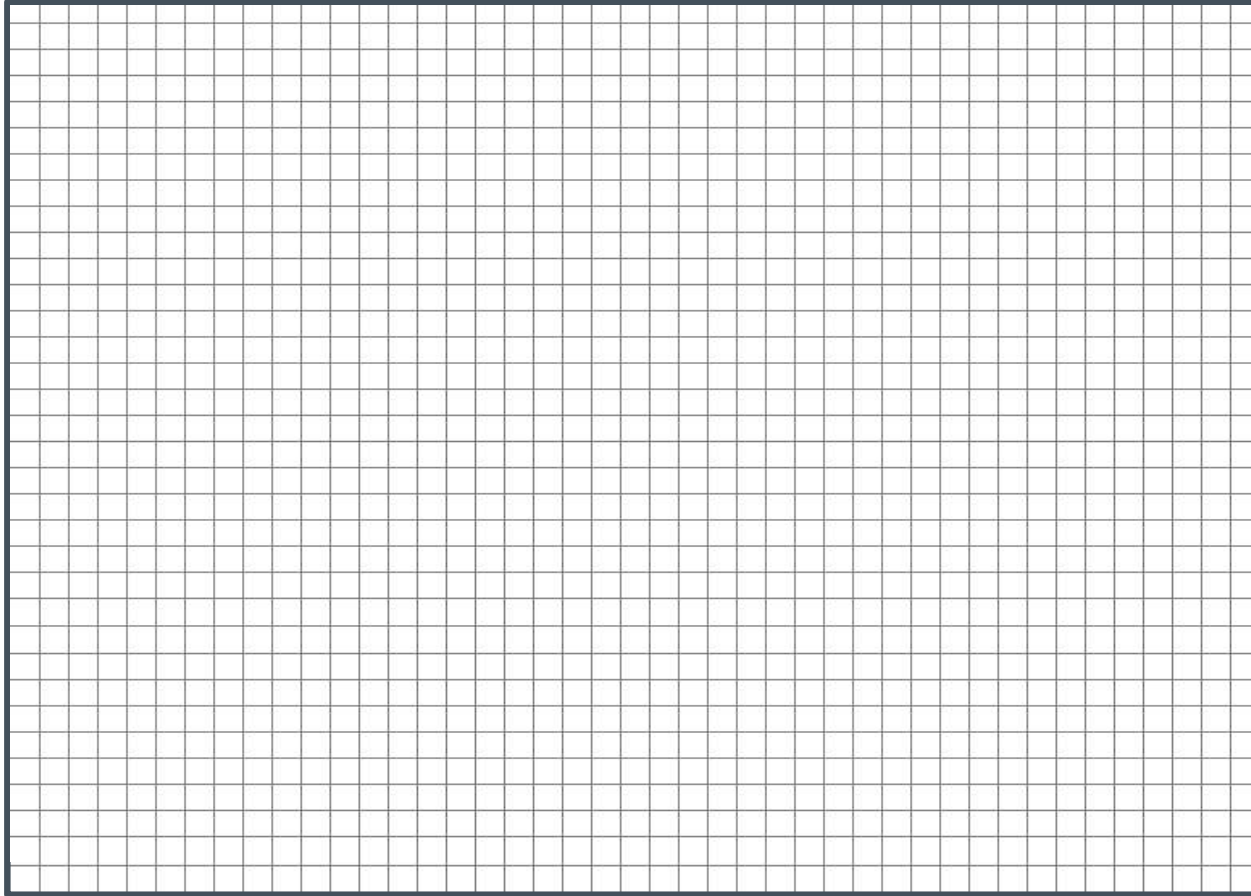
¿How much does the rope measure, from cross to cross?

The scale is 1 cm = 0.5m. Use successive approximations with the formula for distance.

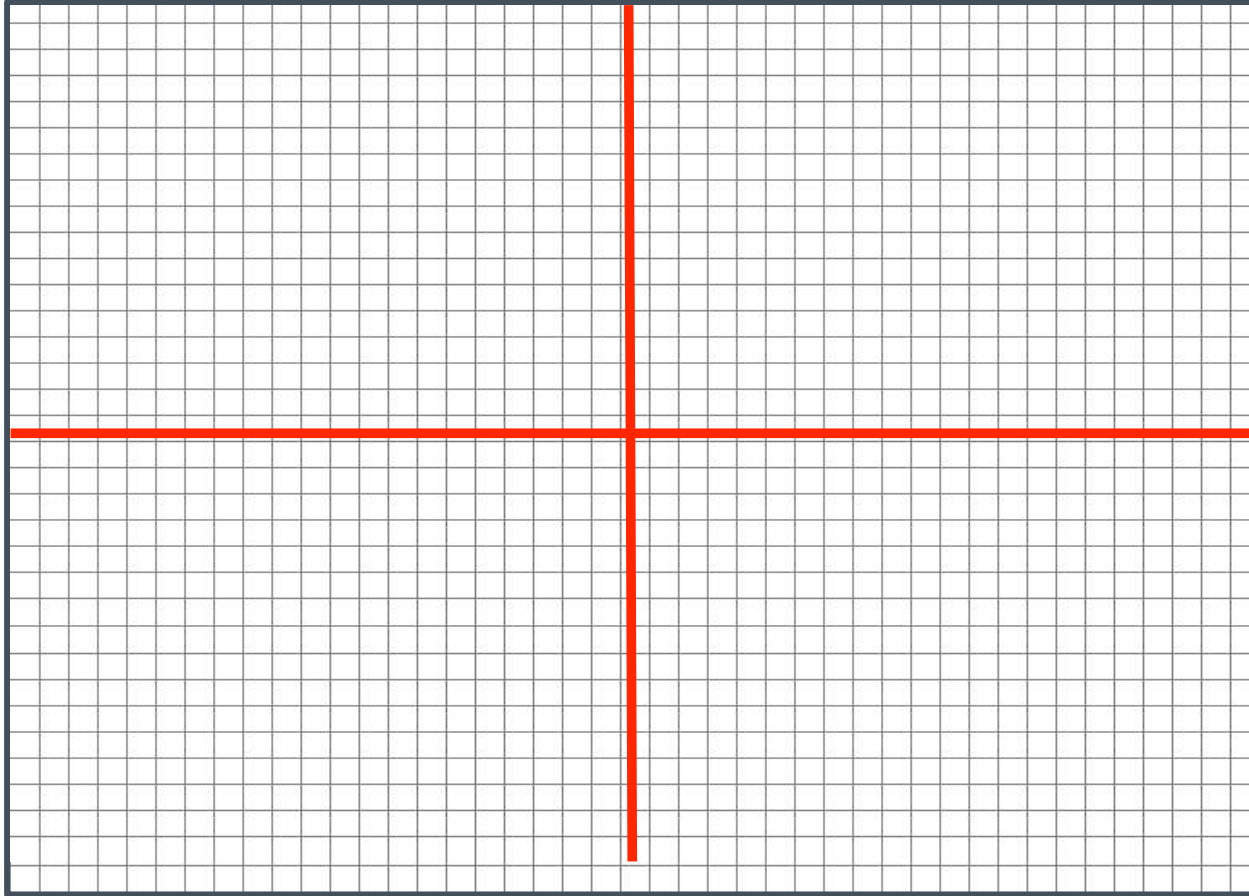


π

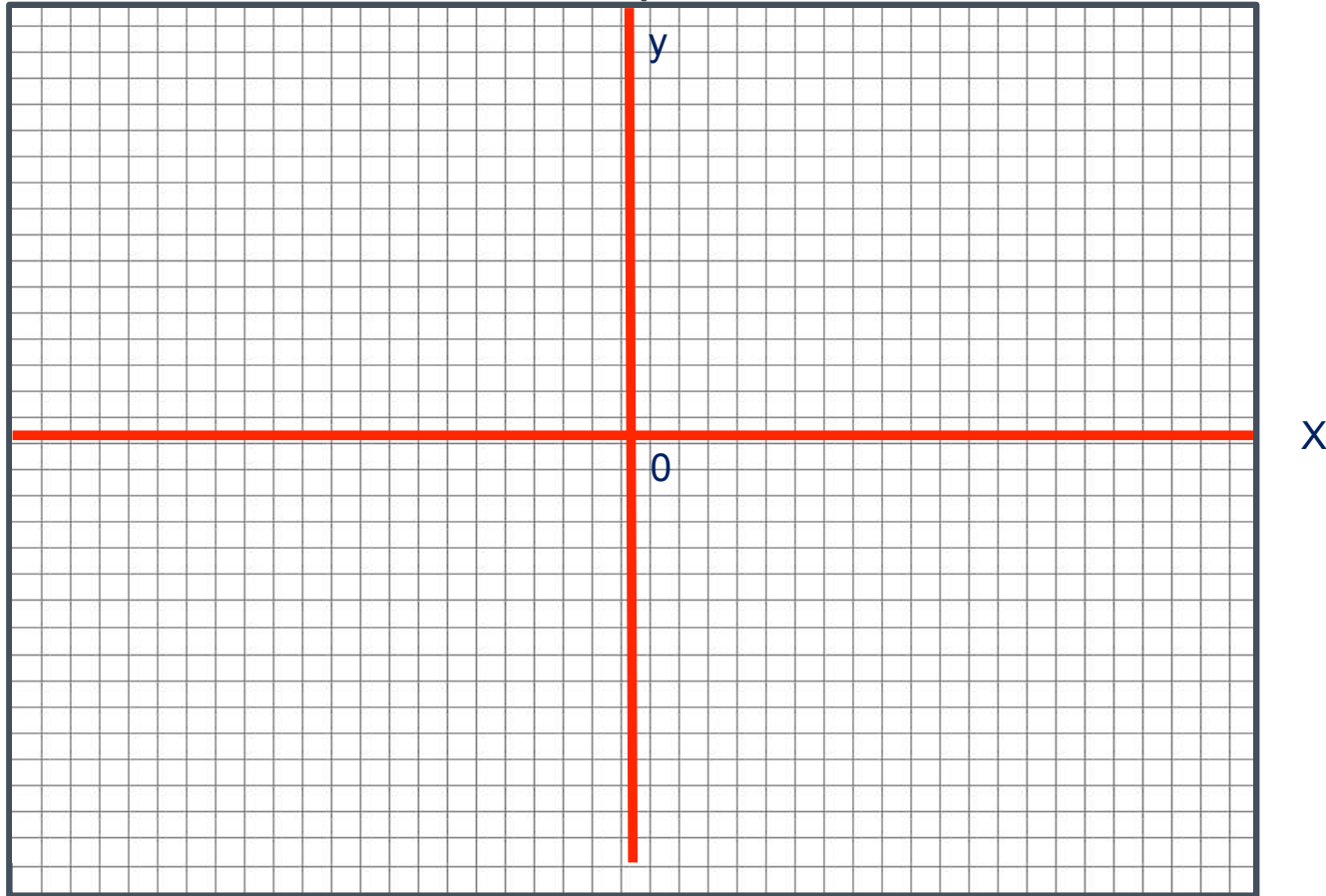
Formula for Distance (Video of its construction)



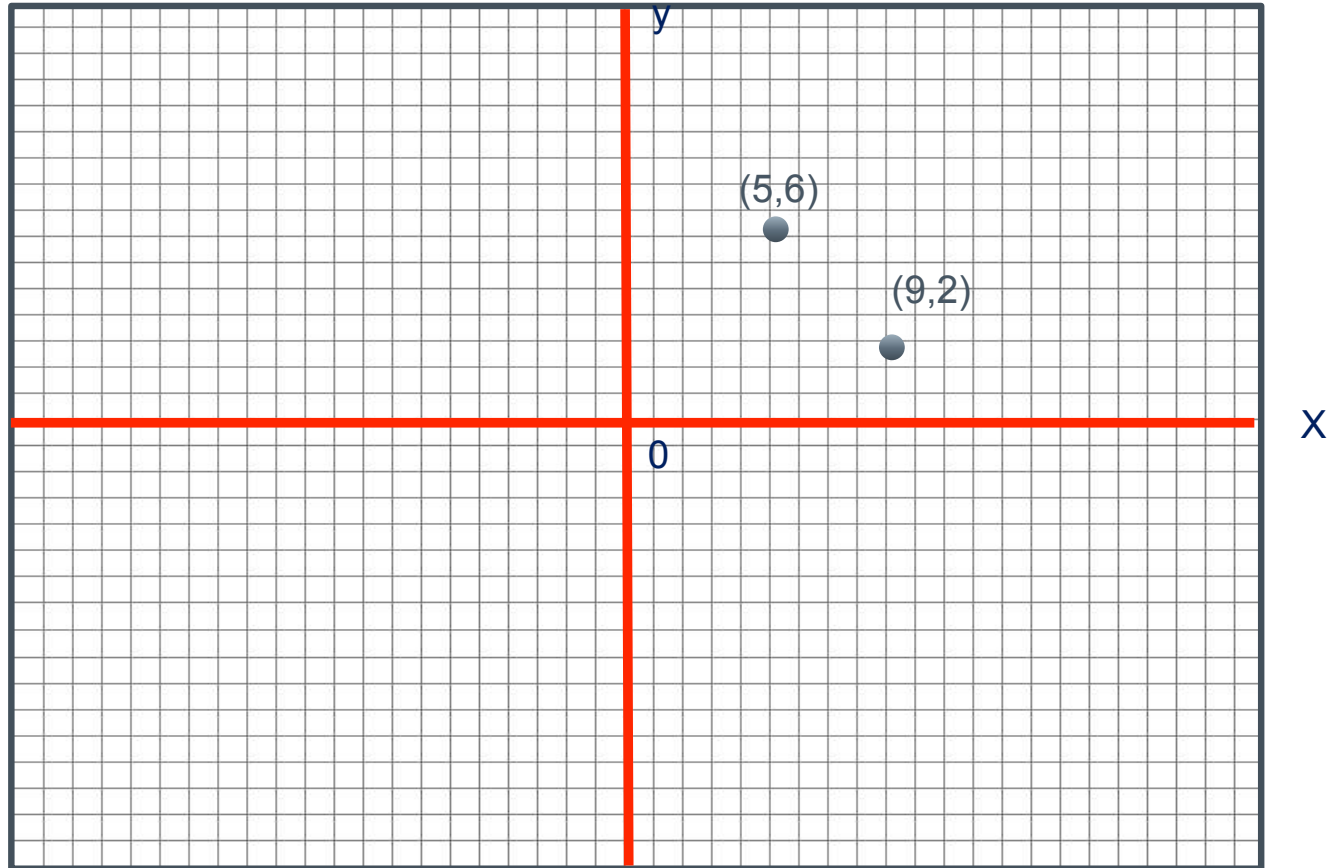
Formula for Distance (Video of its construction)



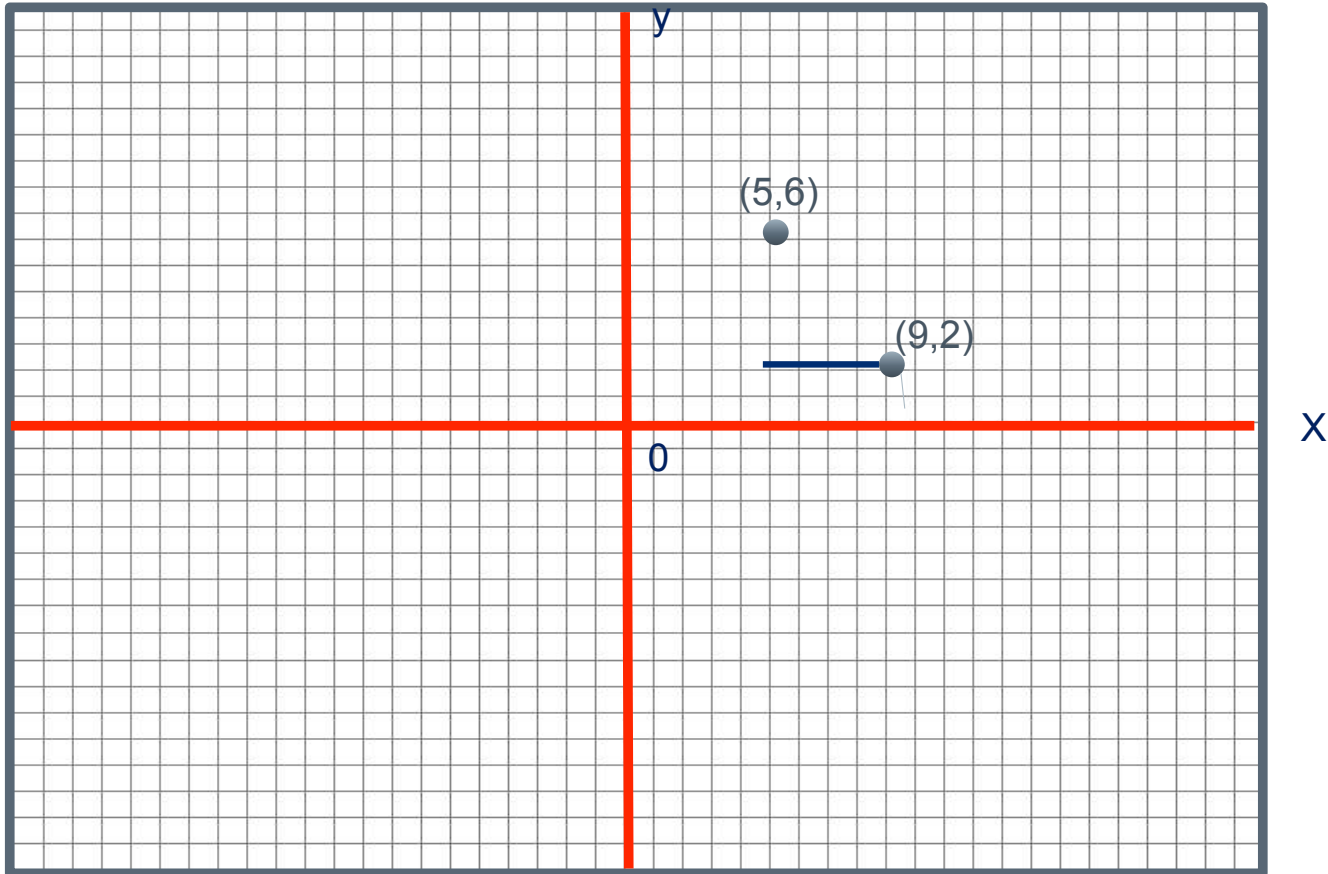
Formula for Distance (Video of its construction)



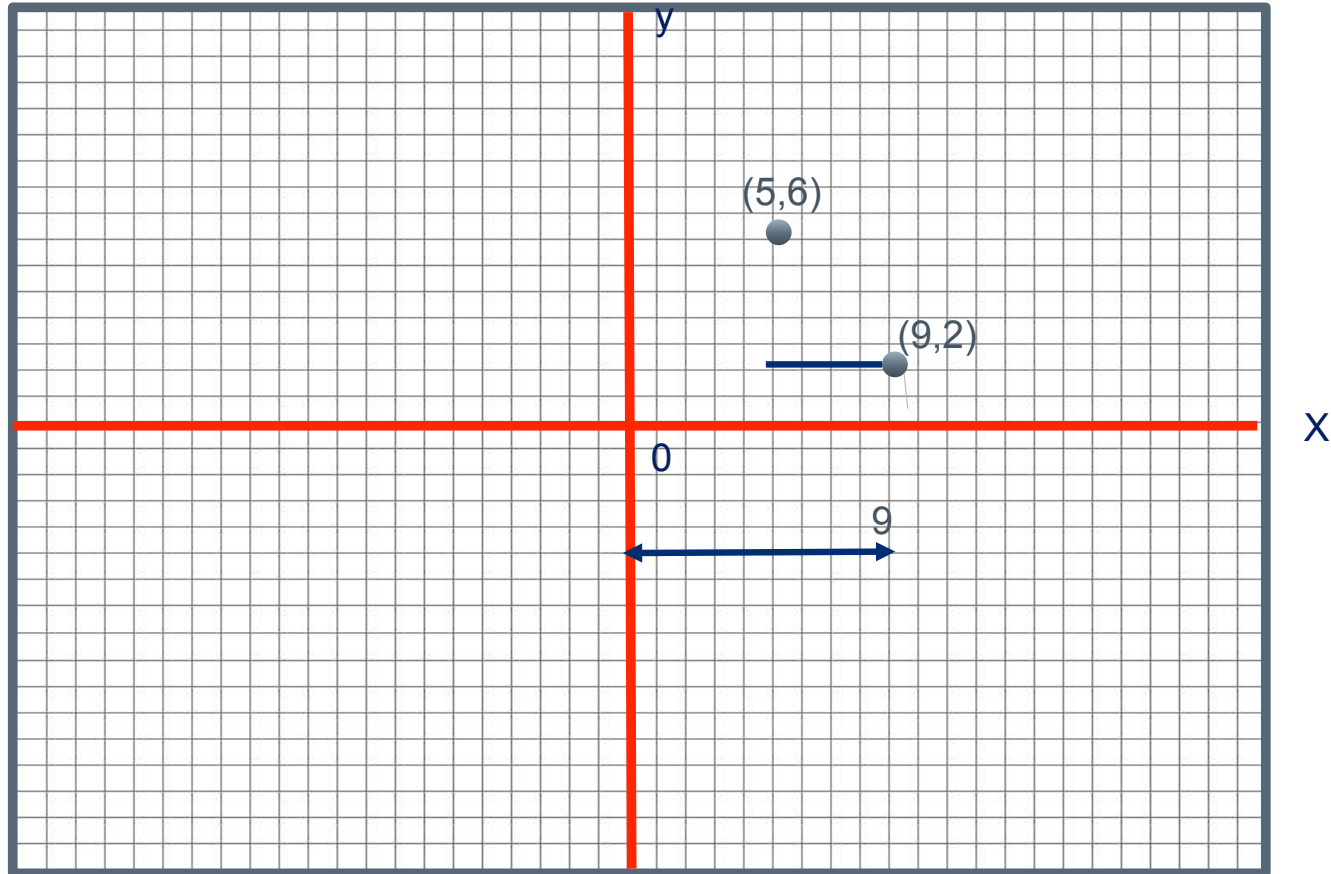
Formula for Distance (Video of its construction)



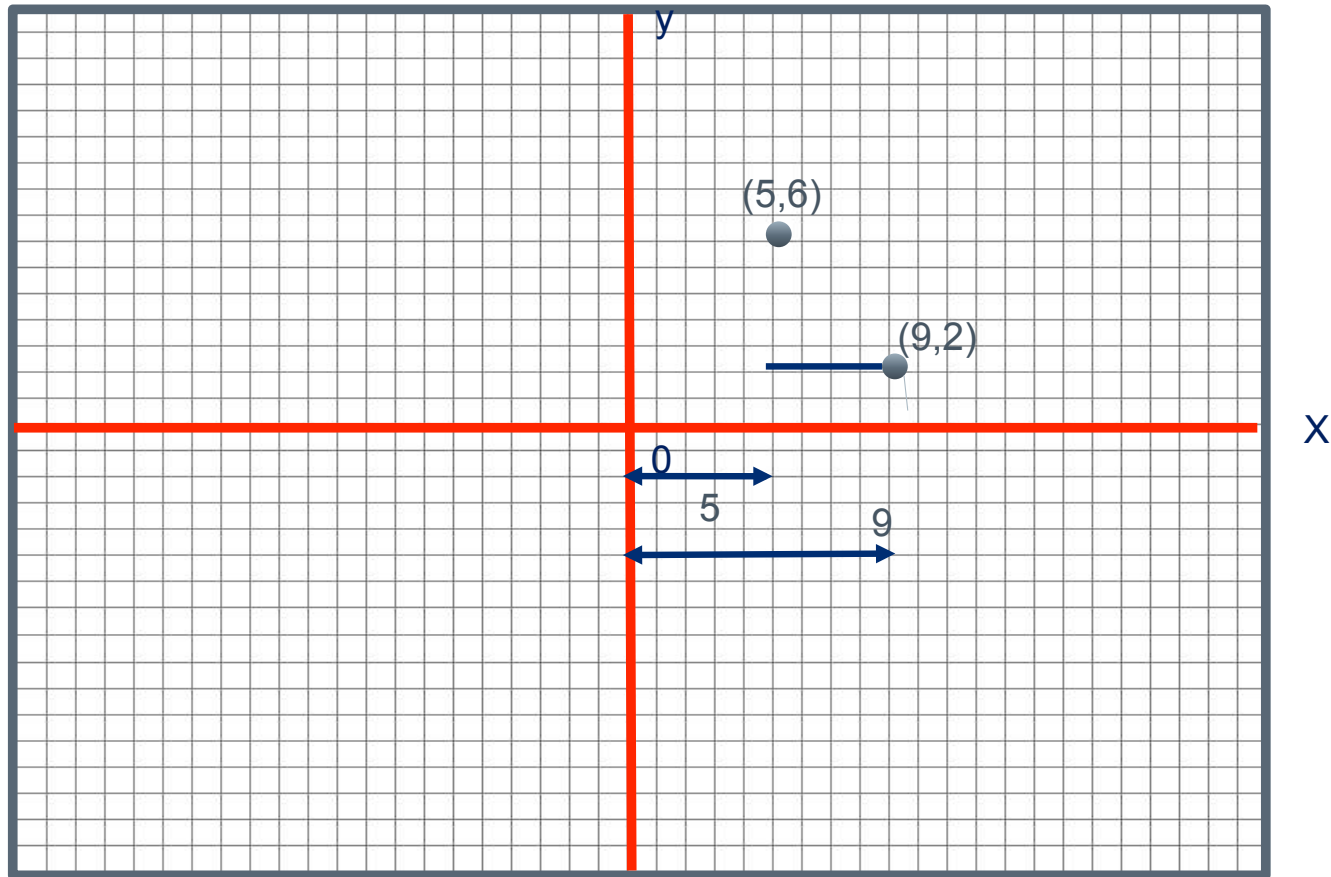
Formula for Distance (Video of its construction)



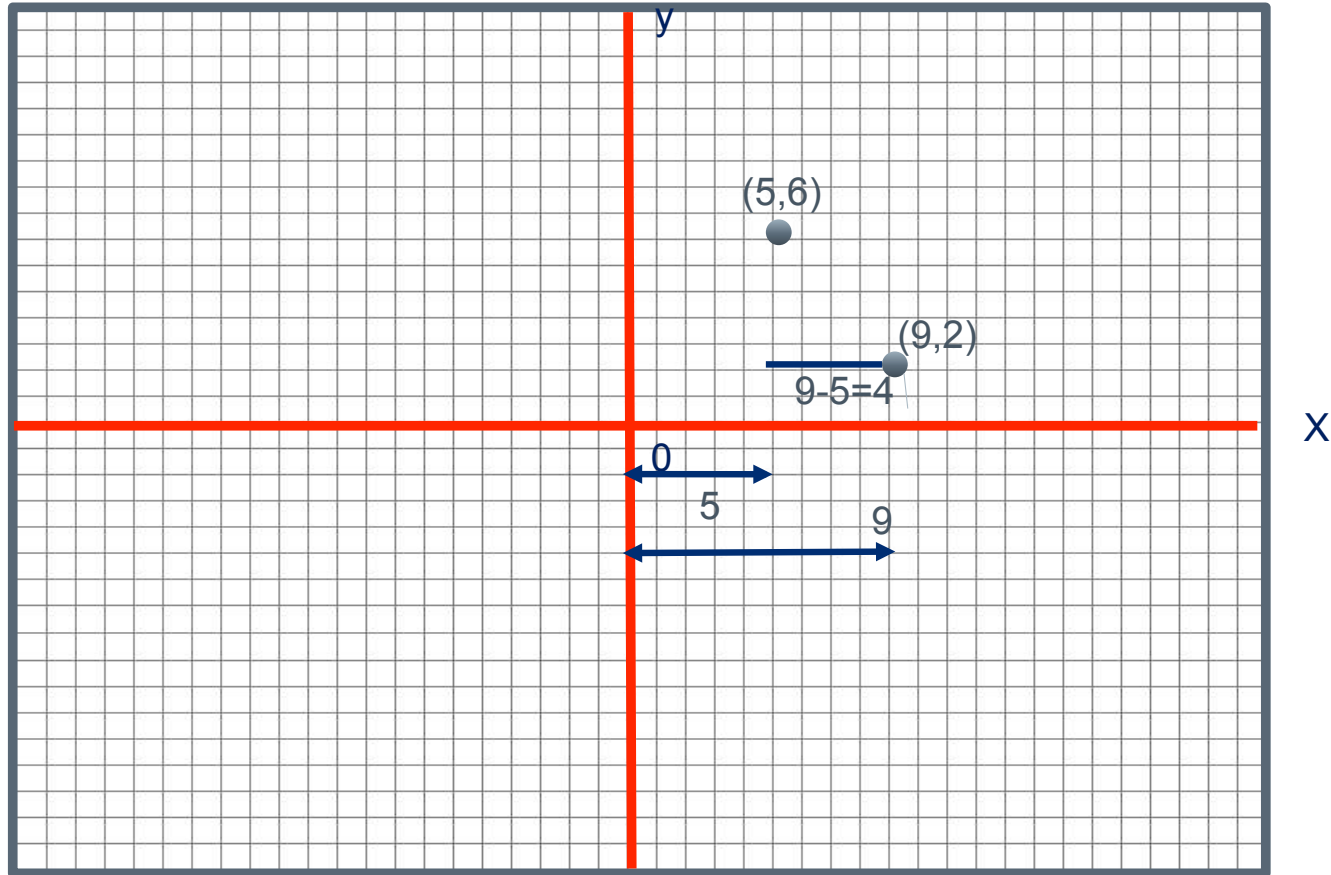
Formula for Distance (Video of its construction)



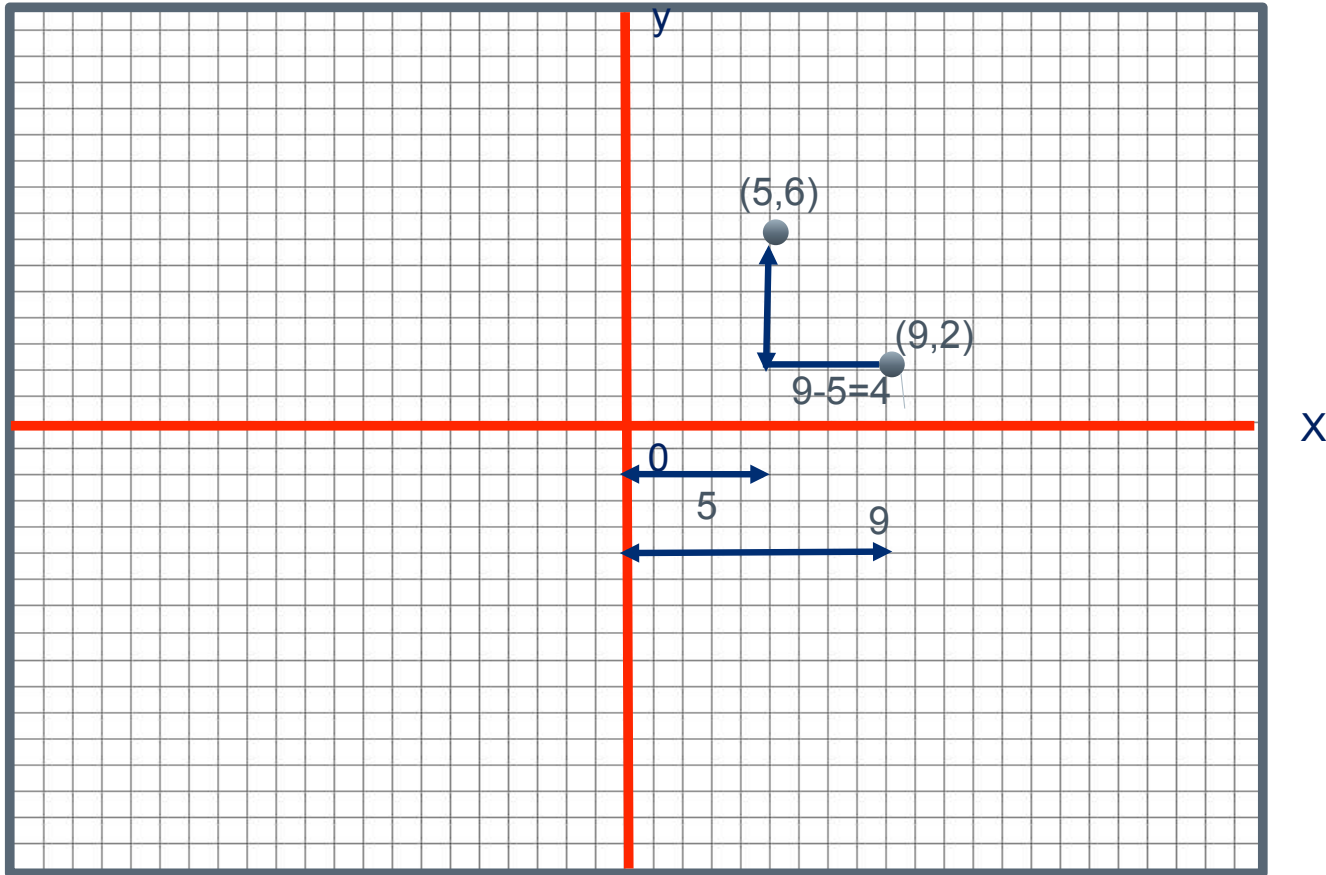
Formula for Distance (Video of its construction)



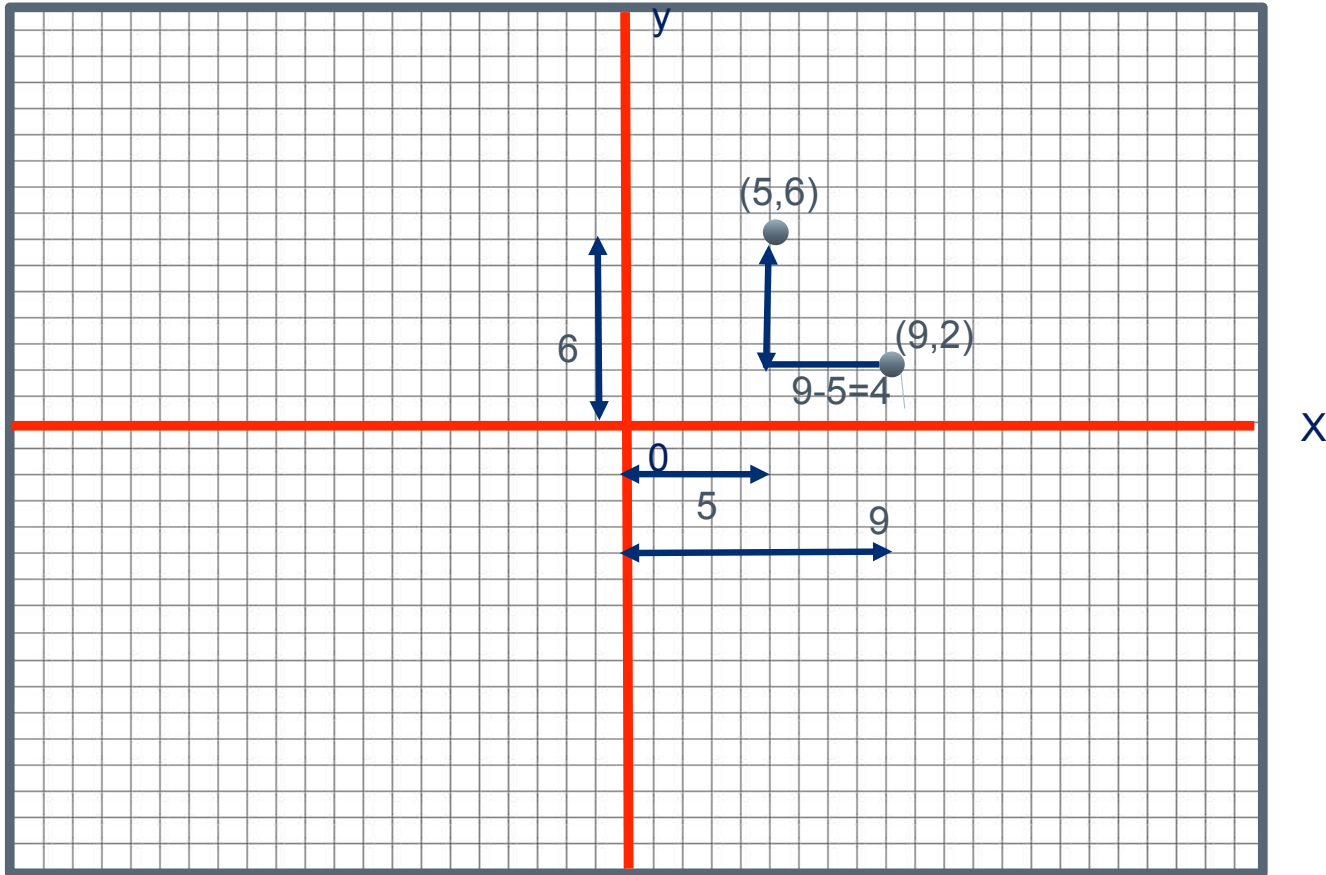
Formula for Distance (Video of its construction)



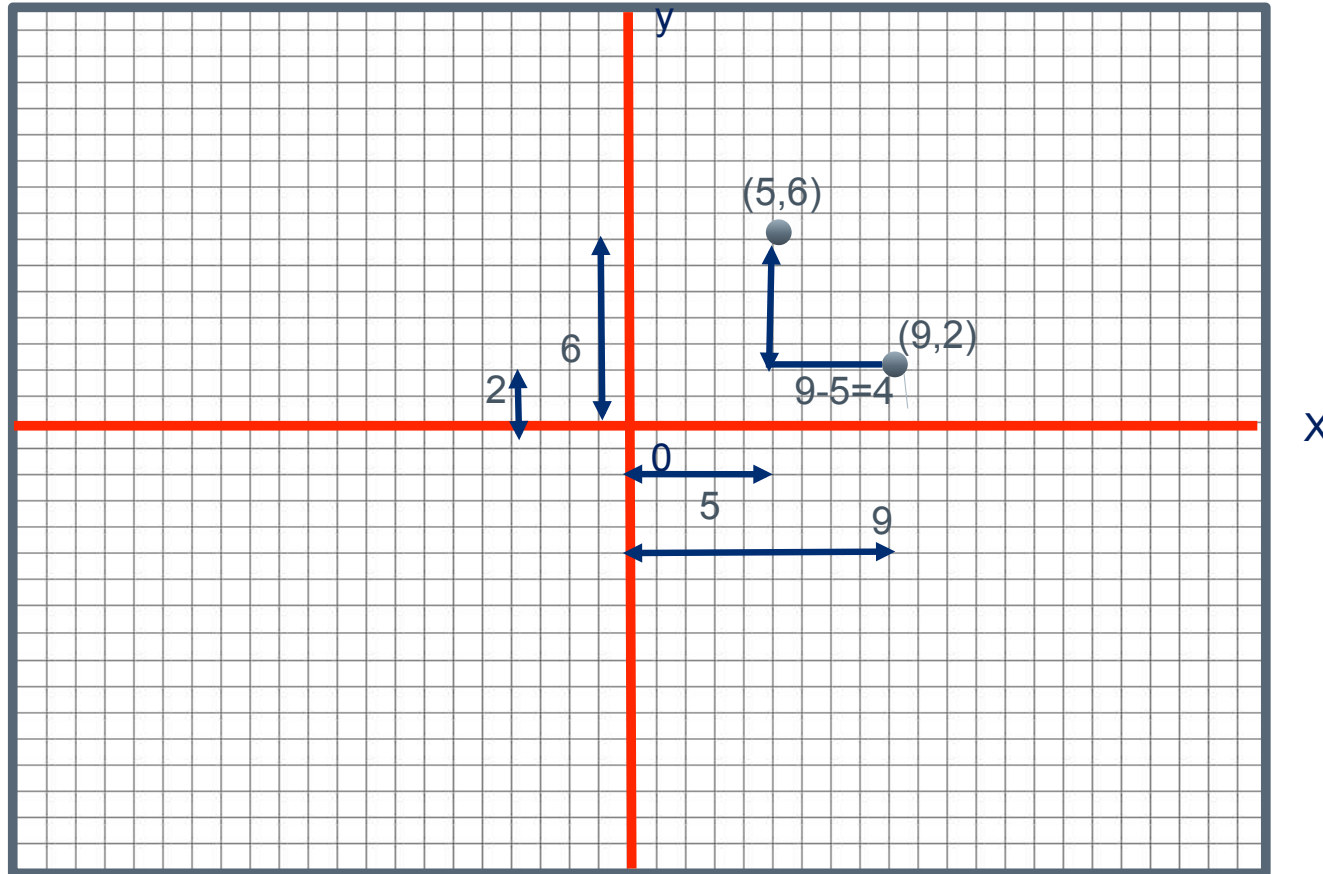
Formula for Distance (Video of its construction)



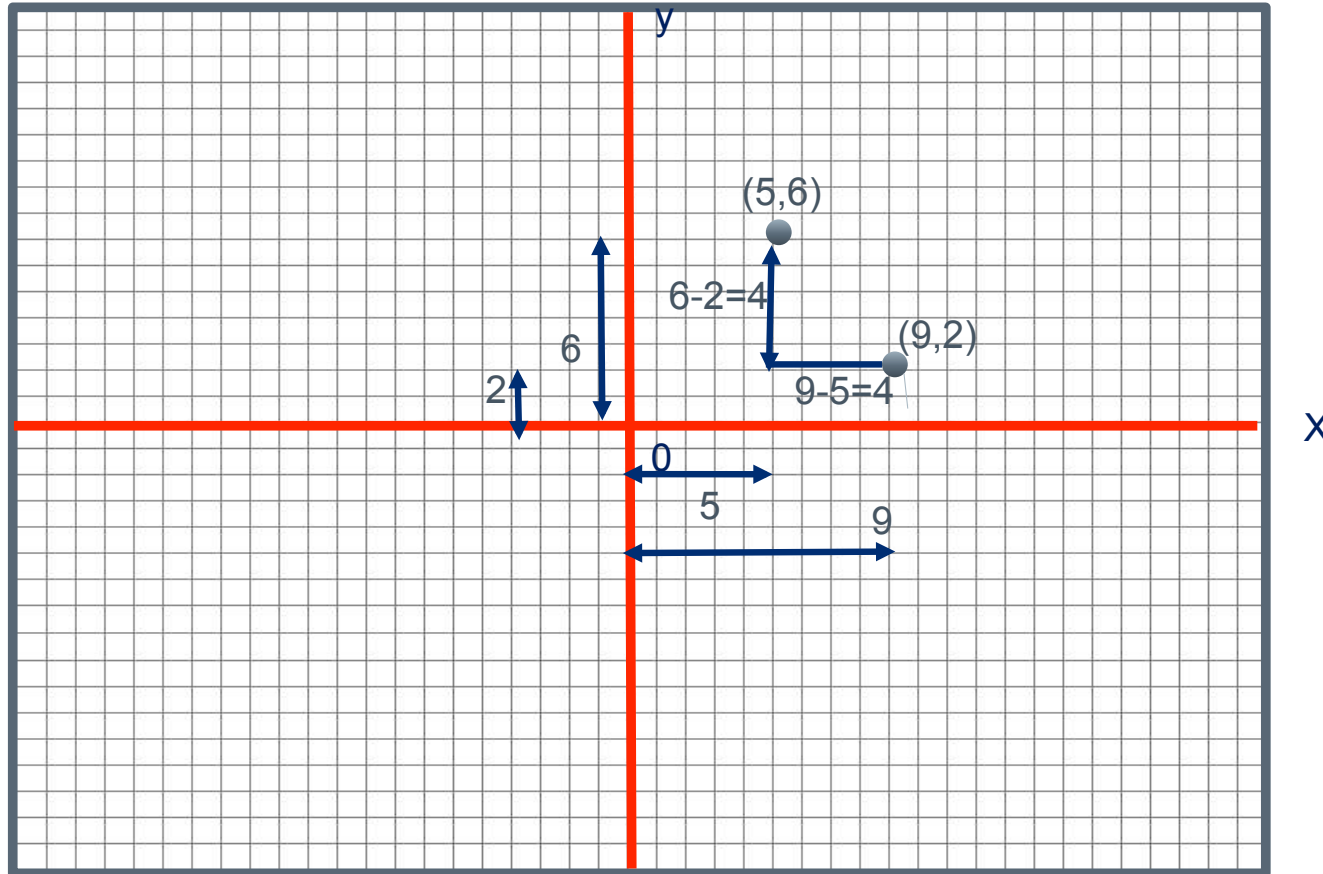
Formula for Distance (Video of its construction)



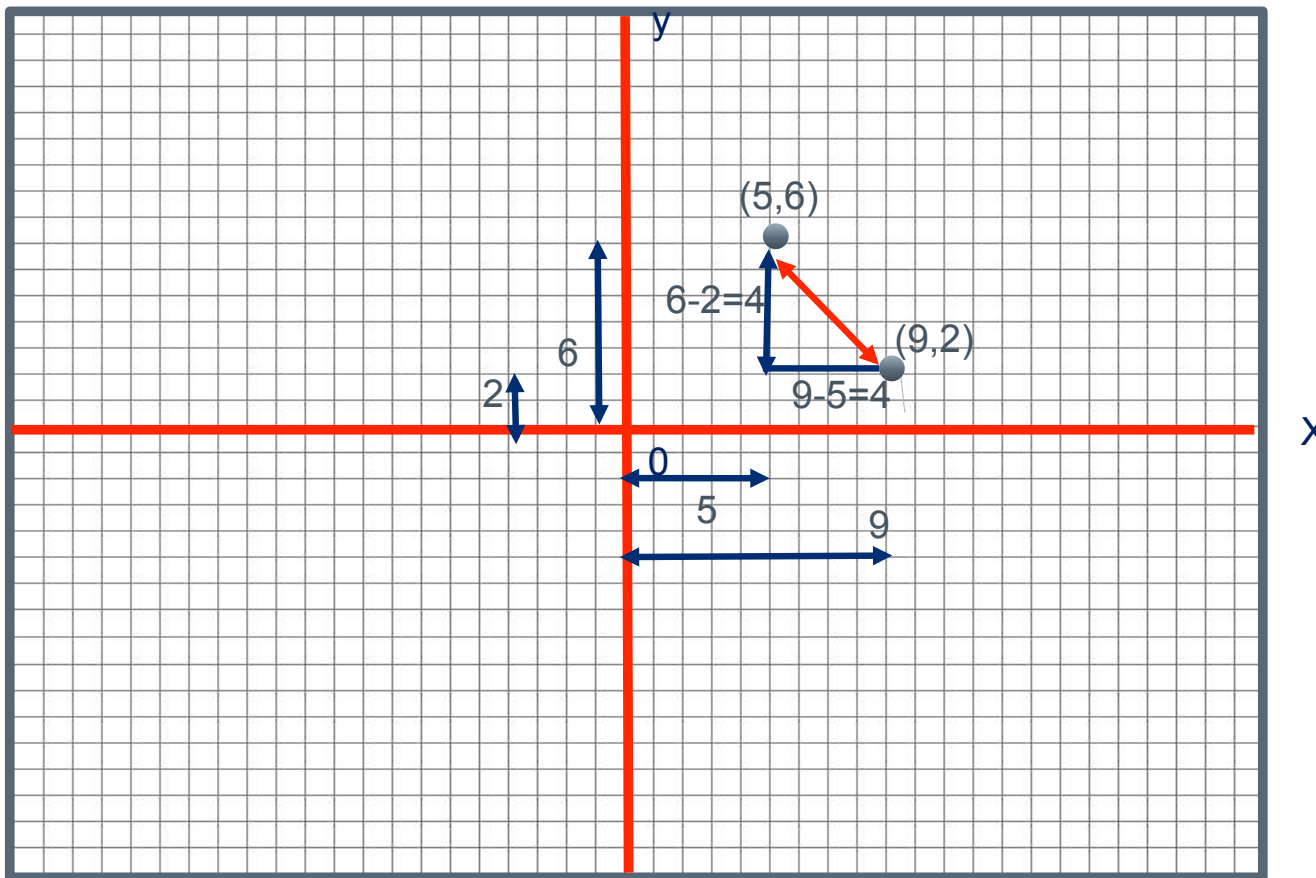
Formula for Distance (Video of its construction)



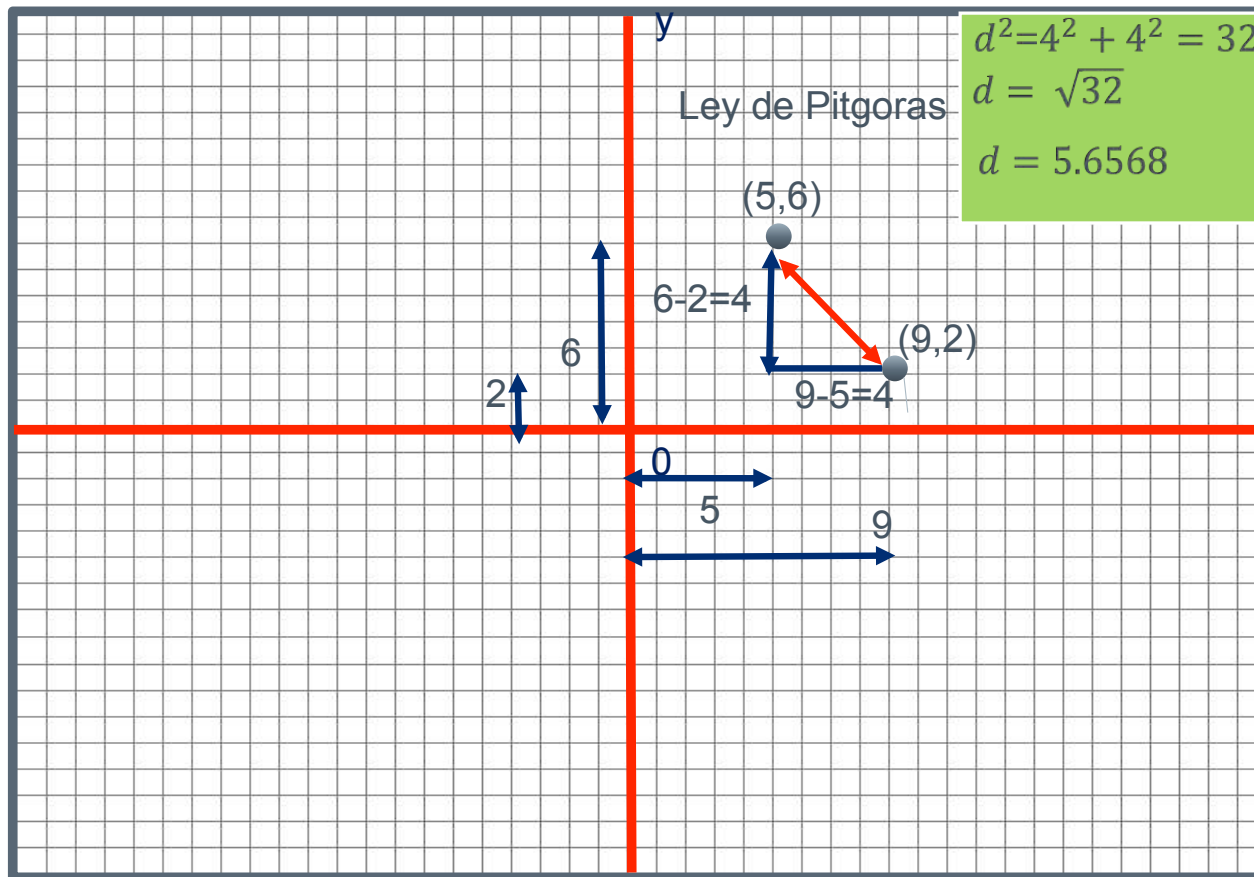
Formula for Distance (Video of its construction)



Formula for Distance (Video of its construction) Let's apply the Pythagorean Theorem

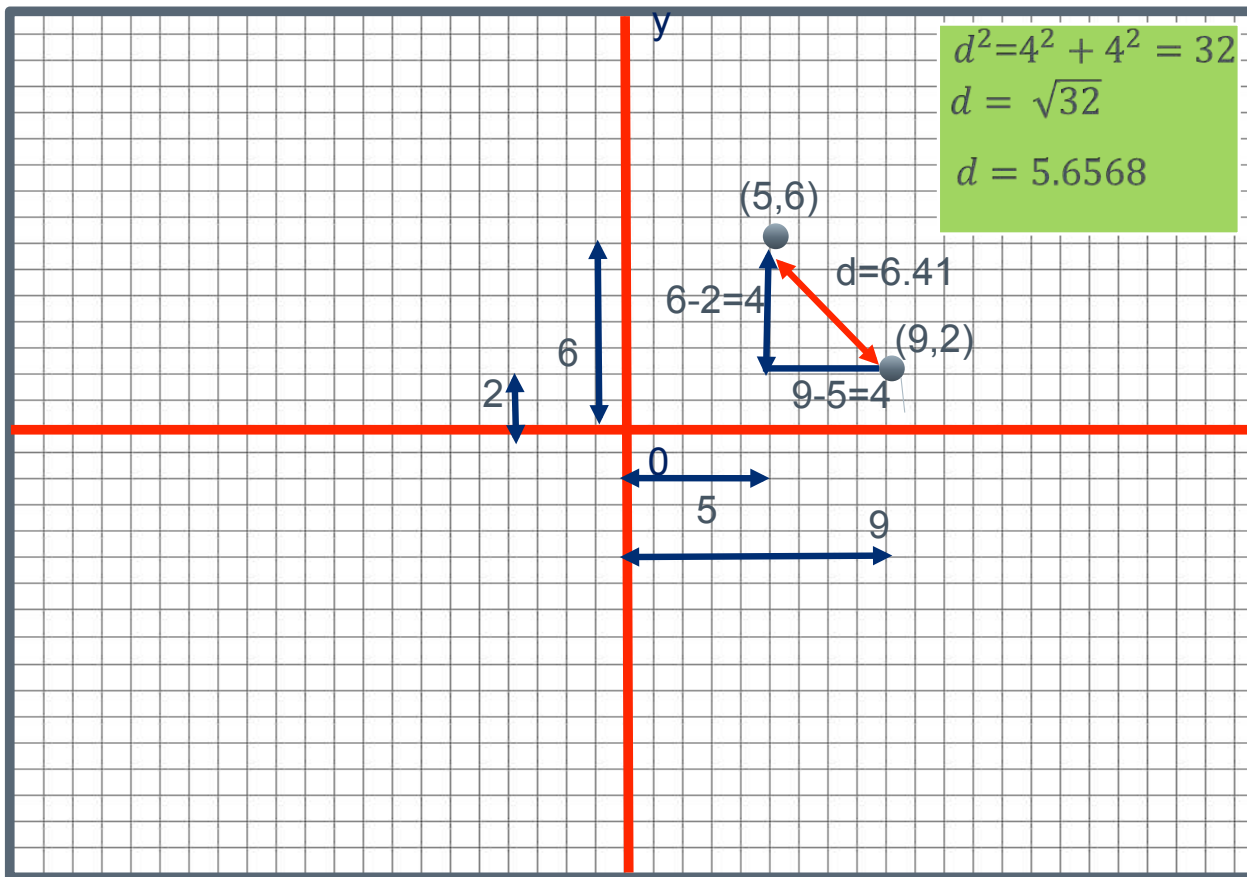


Formula for Distance (Video of its construction) Let's apply the Pythagorean Theorem

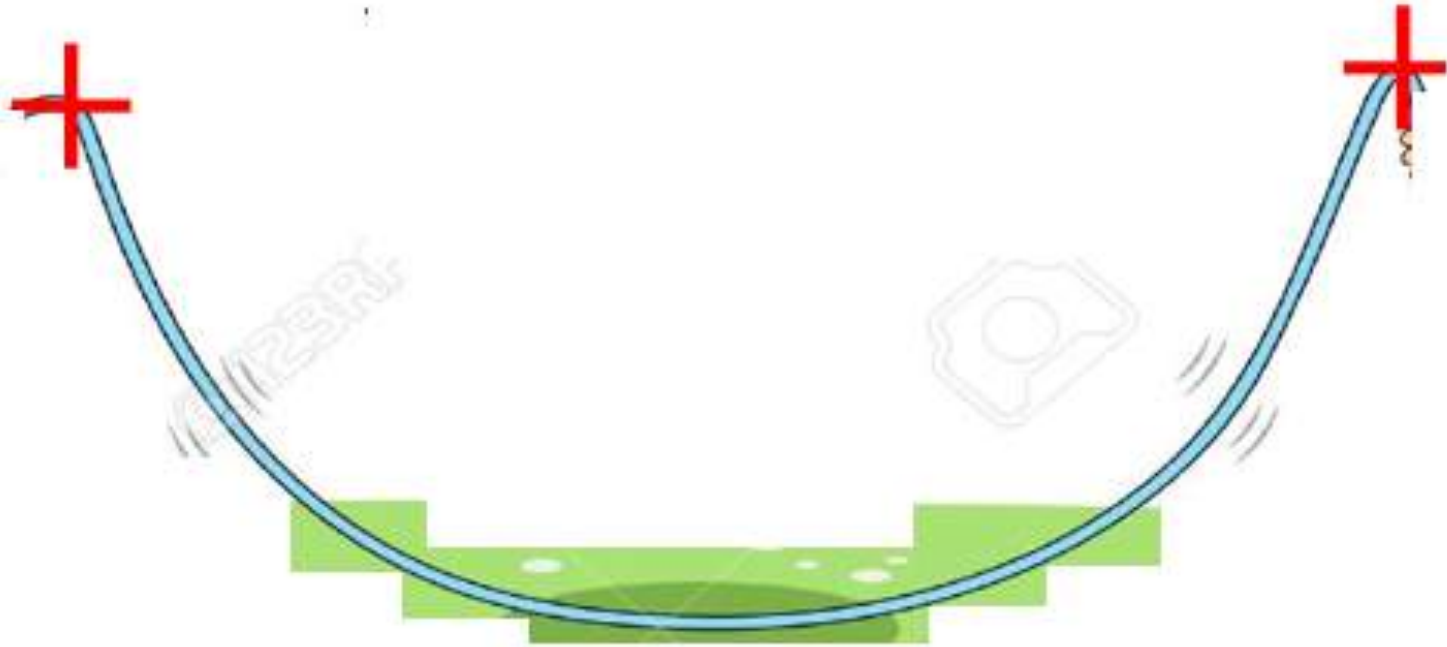


Formula for Distance (Video of its construction)

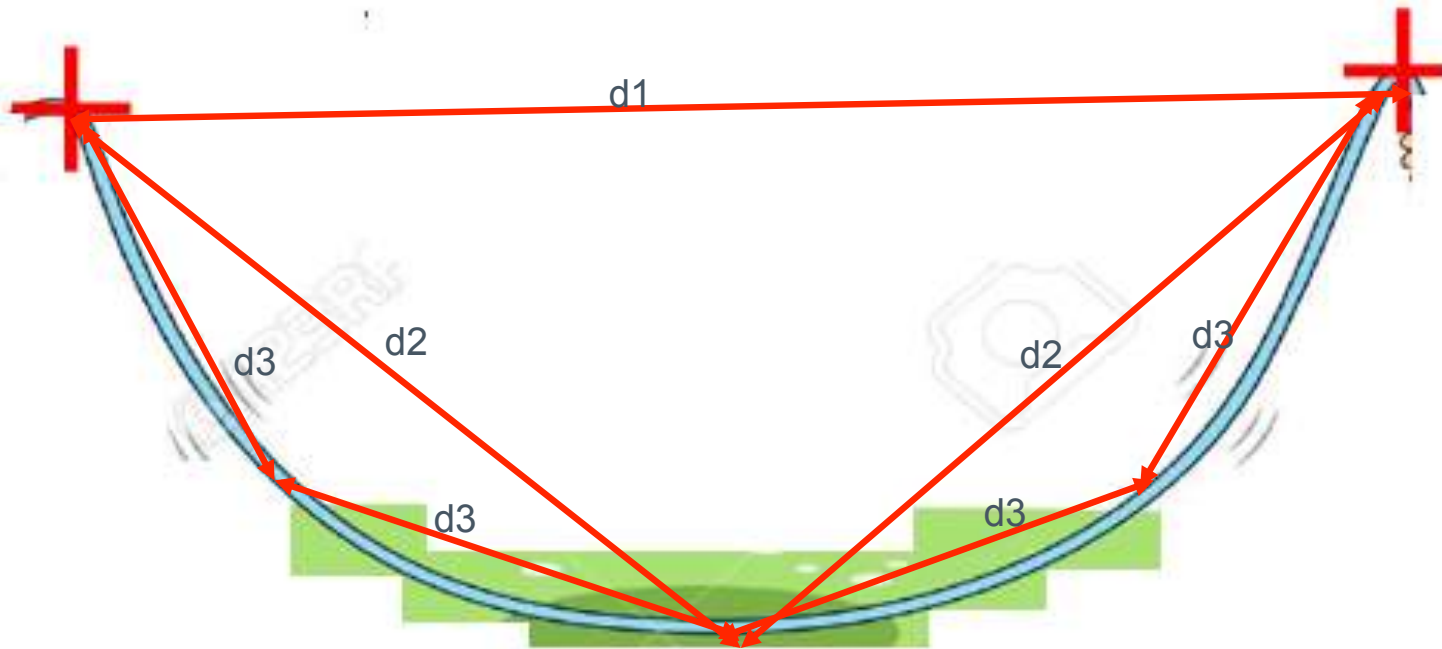
Let's apply the Pythagorean Theorem



How much does the rope measure, from cross to cross? The scale is 1 cm = 0.5m. Use successive approximations with the formula for distance.



Video - Doing successive approximations of the rope, using the distance.

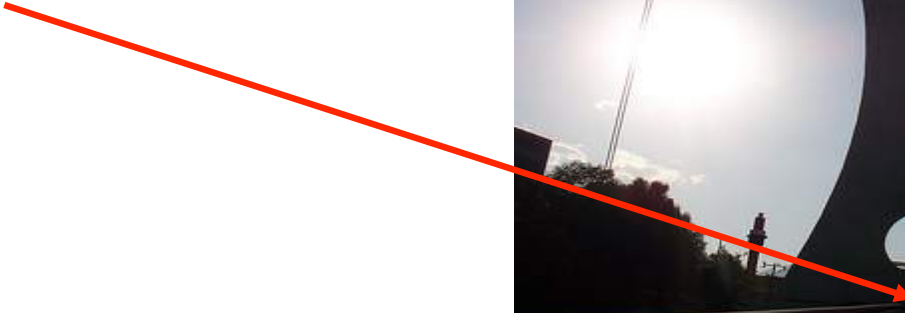


Video 4. The Scale

Summarizing the video

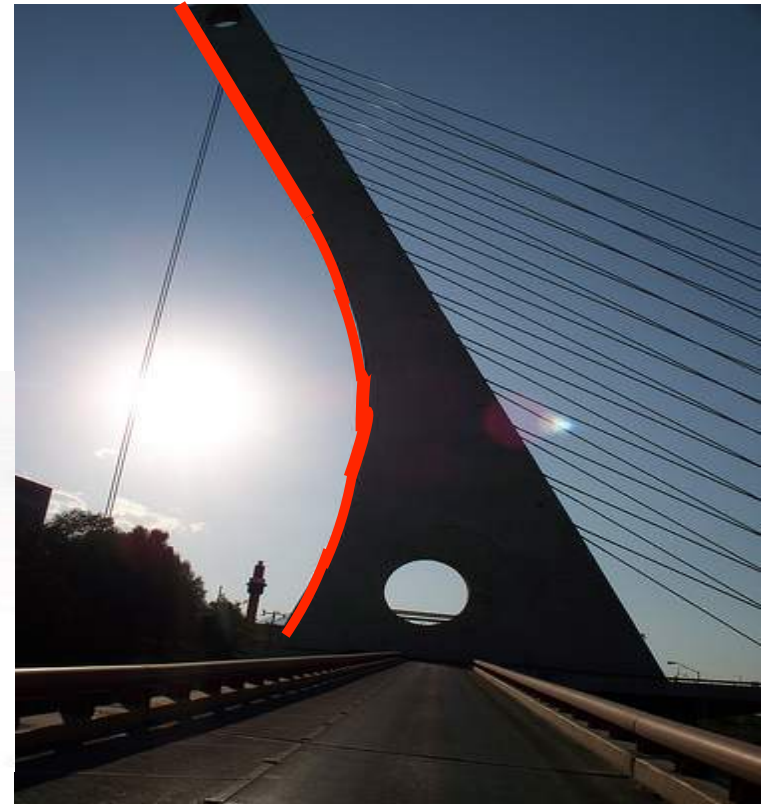
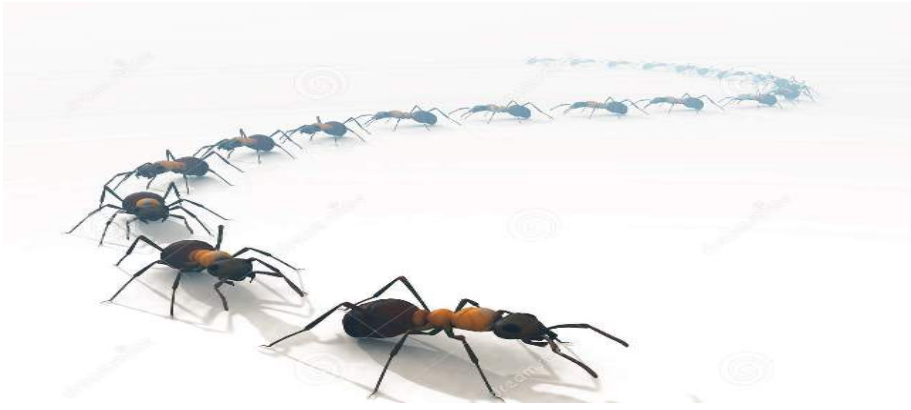
- › We know what successive approximations are
- › We know the formula for distance
- › We know how to use successive approximations to measure a curved surface
- › Now we only need to find the scale

Héctor in the Puente Atirantado
We know that Héctor is ??? tall. (Héctor, what is your height?)



Problem

- › We want to know what you would do to find:
- › How much does the curved side measure?
- › How many ants would cover the curved side if they become increasingly smaller by 0.001 each time?

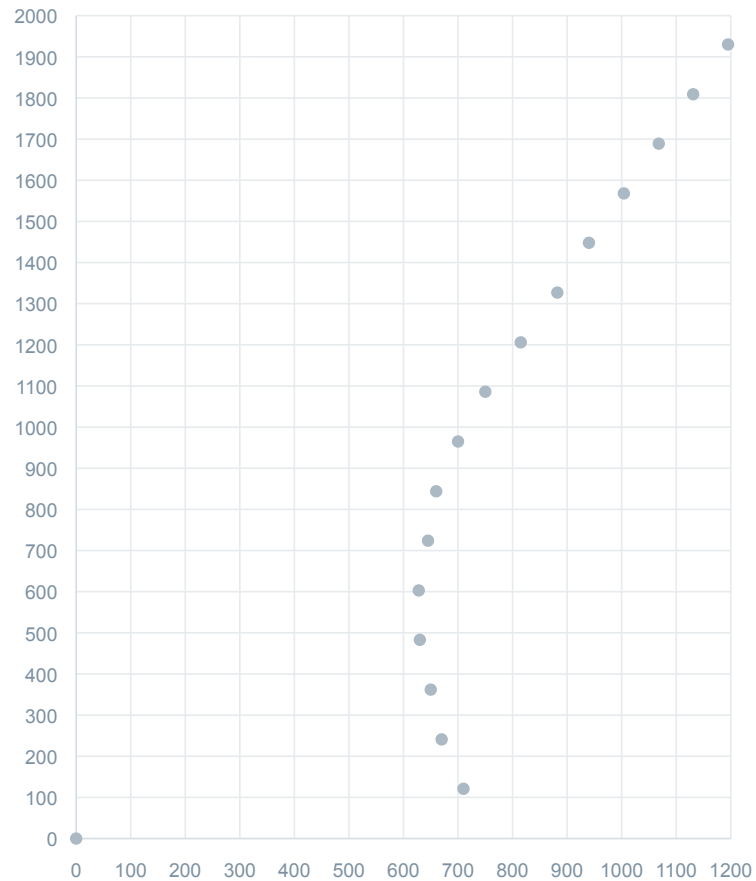


Video 5. The Solution

The solution includes:

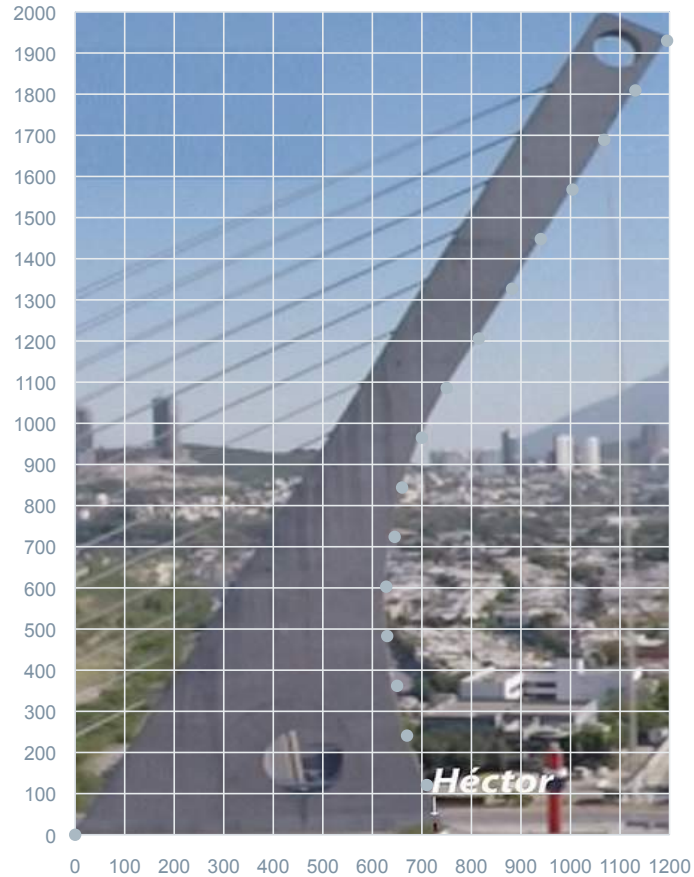
- › Turn the Punte Atirantado around
- › Apply Successive Approximations with the distance formula (Excel, Mathematica)
- › Apply the scale
- › Calculate the number of ants (Excel)

Puente Atirantado

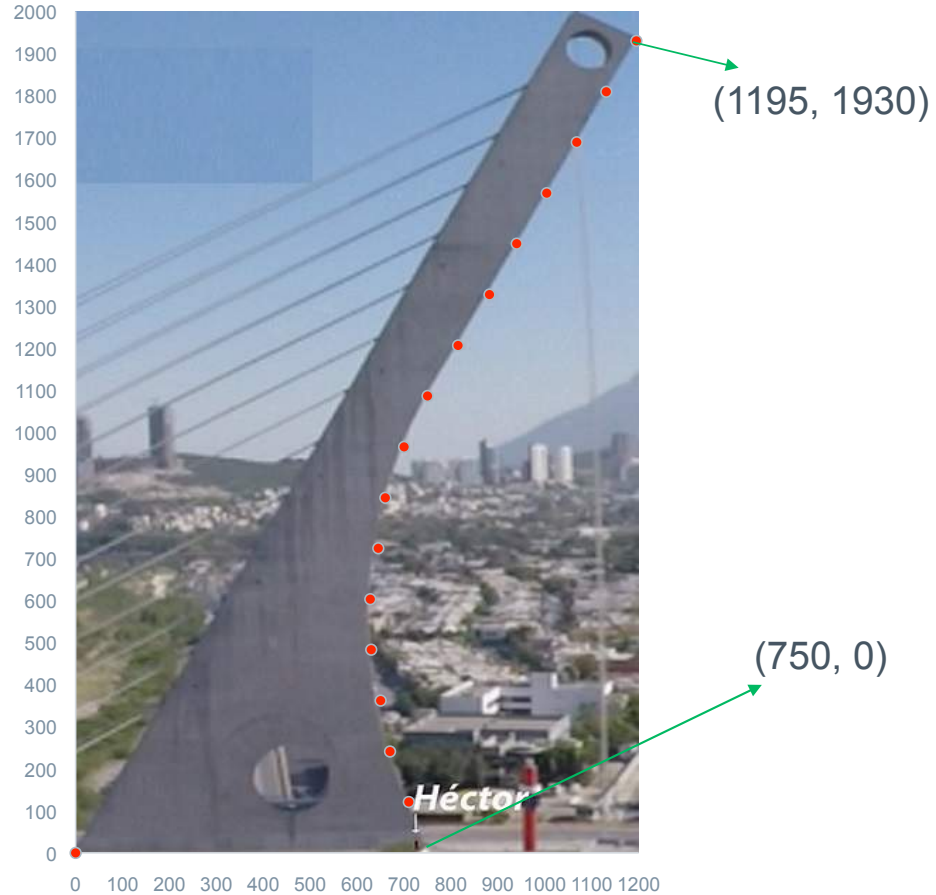




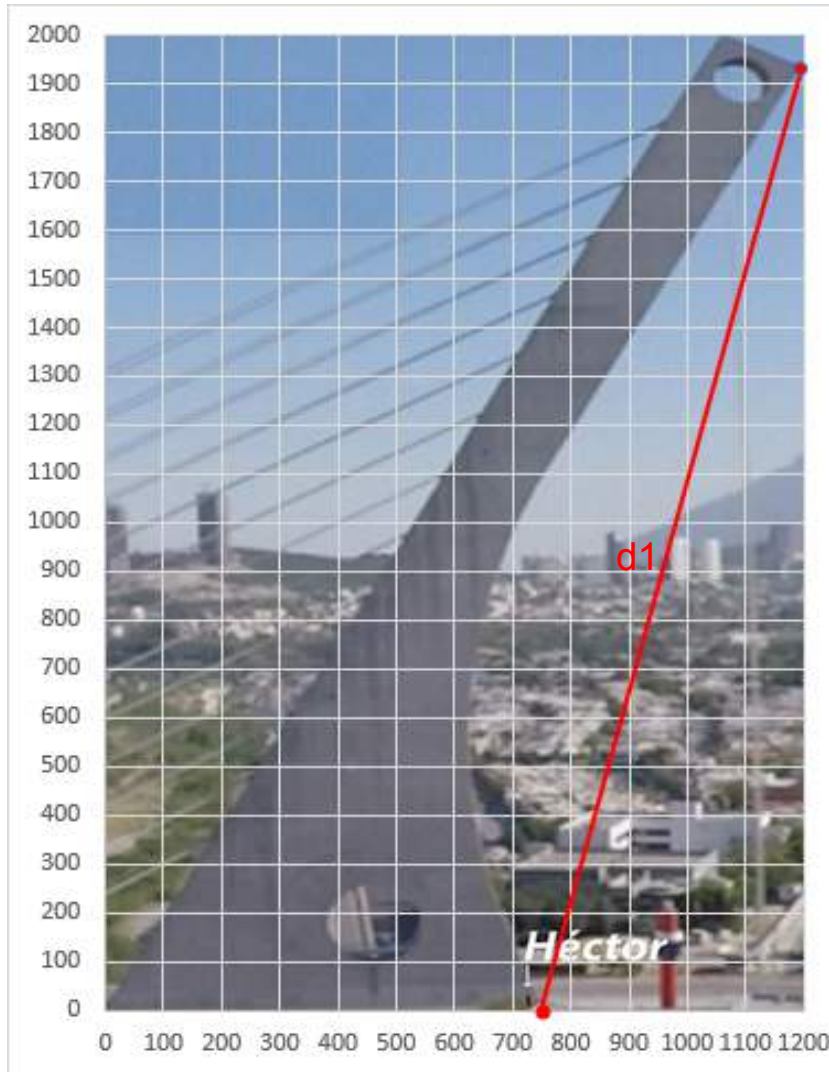
Puente Atirantado



Puente Atirantado



Puente Atirantado



Formula for distance in EXCEL =
 $SQRT((B2-B3)^2+(C2-C3)^2)$

No.	X	Y	Distancia
1	1195	1930	
2	750	0	1980.638

Puente Atirantado

No.	X	Y	PMX	PMY	Distancia
1	1195	1930			
2	750	0	707	965	1980.638

(707, 965)

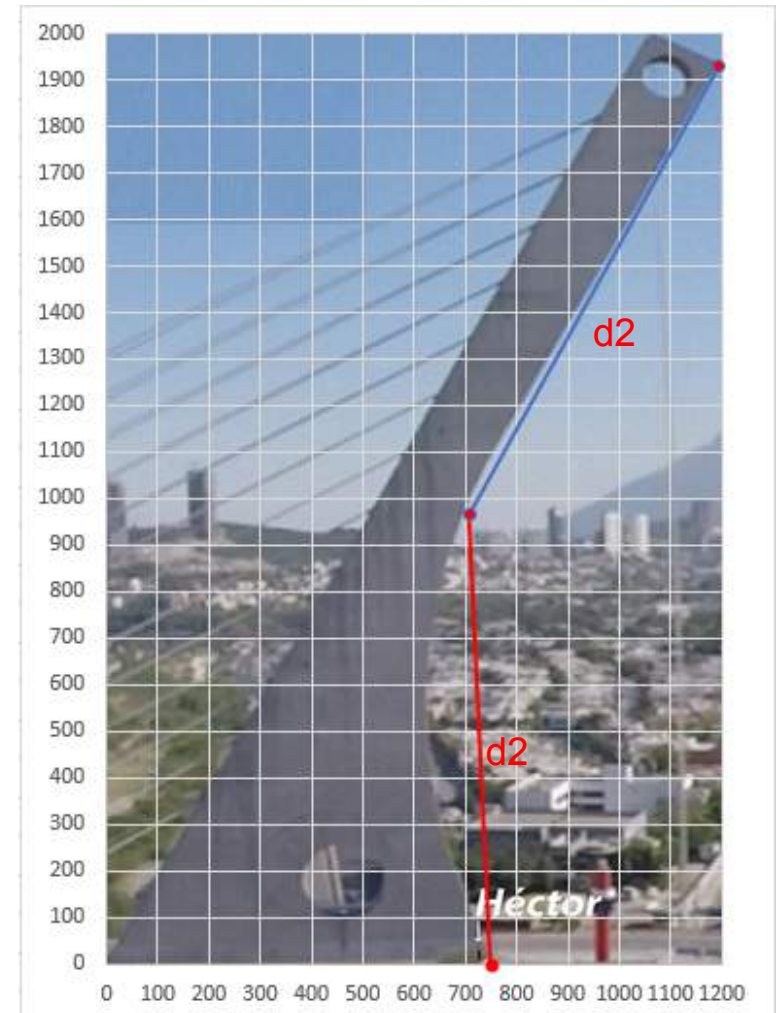


Puente Atirantado

No.	X	Y	Distancia	Dtotal
1	1195	1930		
2	707	965	1081.374	
3	750	0	1980.638	3062.011

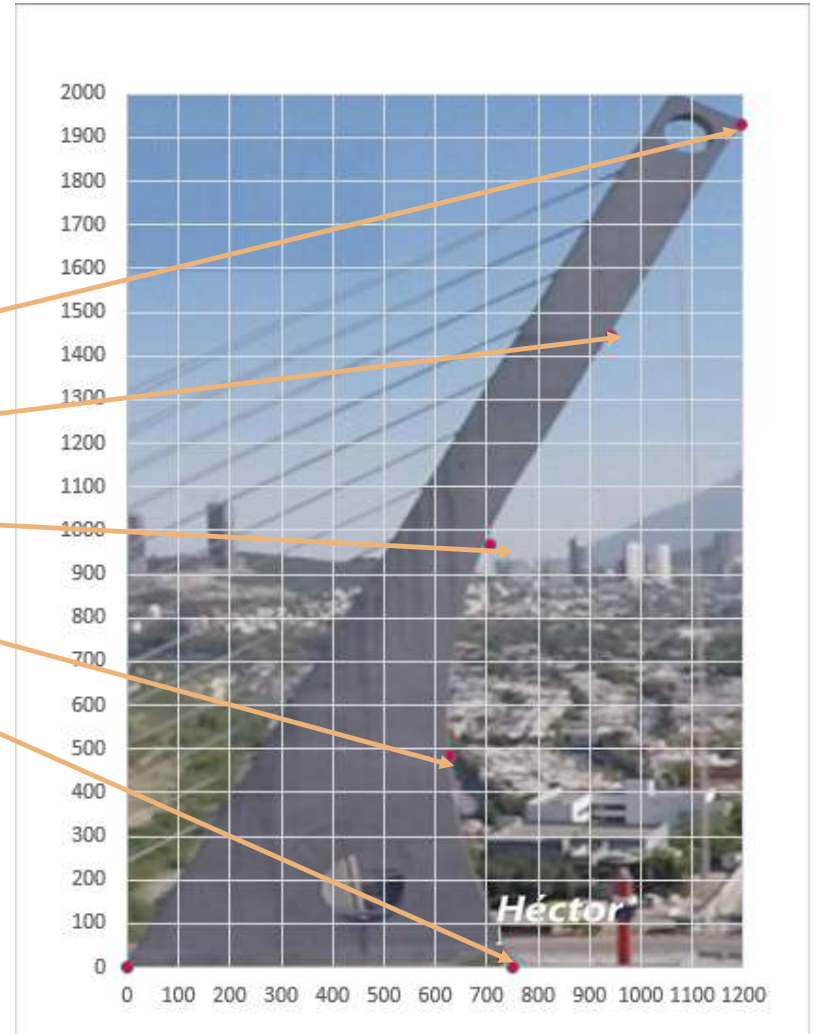
$D_{total} = d_1 + d_2$

The formula in EXCEL is
`=SUM(D2:d5)`



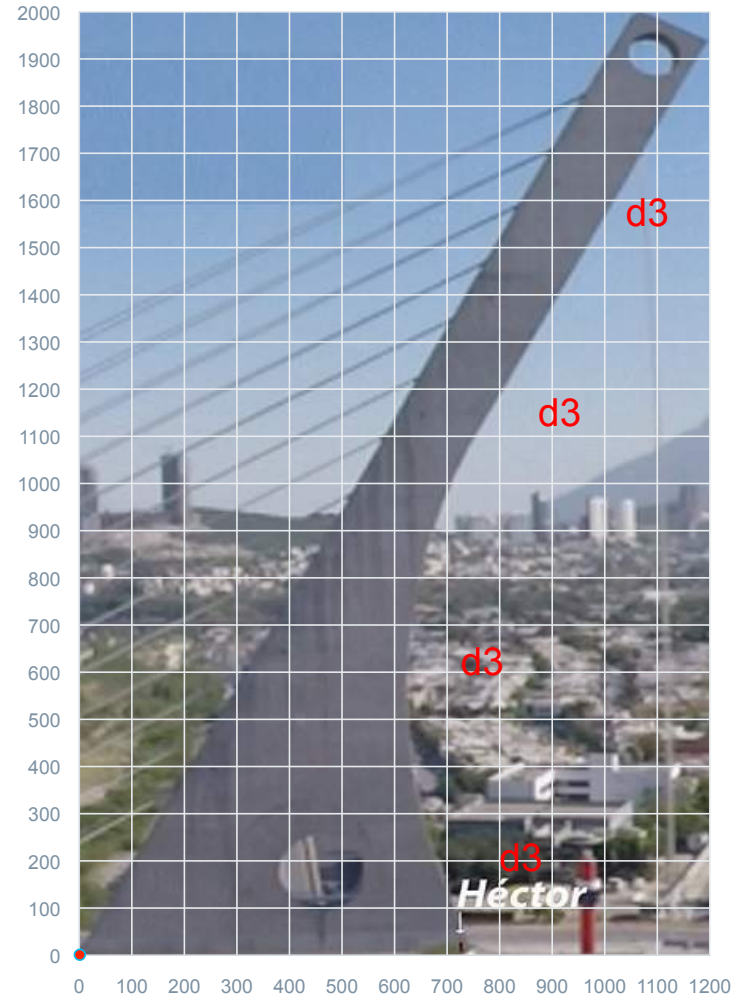
Puente Atirantado

No.	X	Y
1	1195	1930
2	940	1448
3	700	965
4	630	483
5	750	0



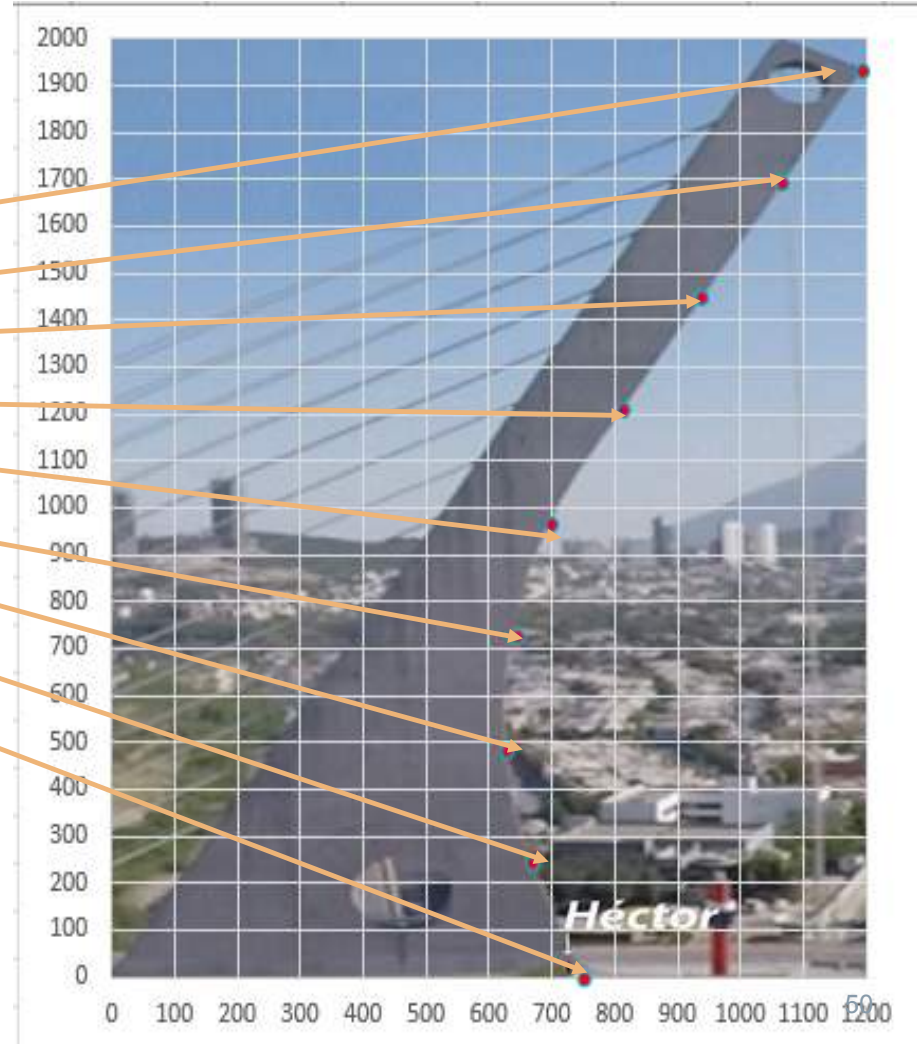
No.	X	Y	Distancia	Dtotal
1	1195	1930		
2	940	1448	545.7392	
3	700	965	538.8935	
4	630	483	487.5513	
5	750	0	497.1984	2069.382

Puente Atirantado



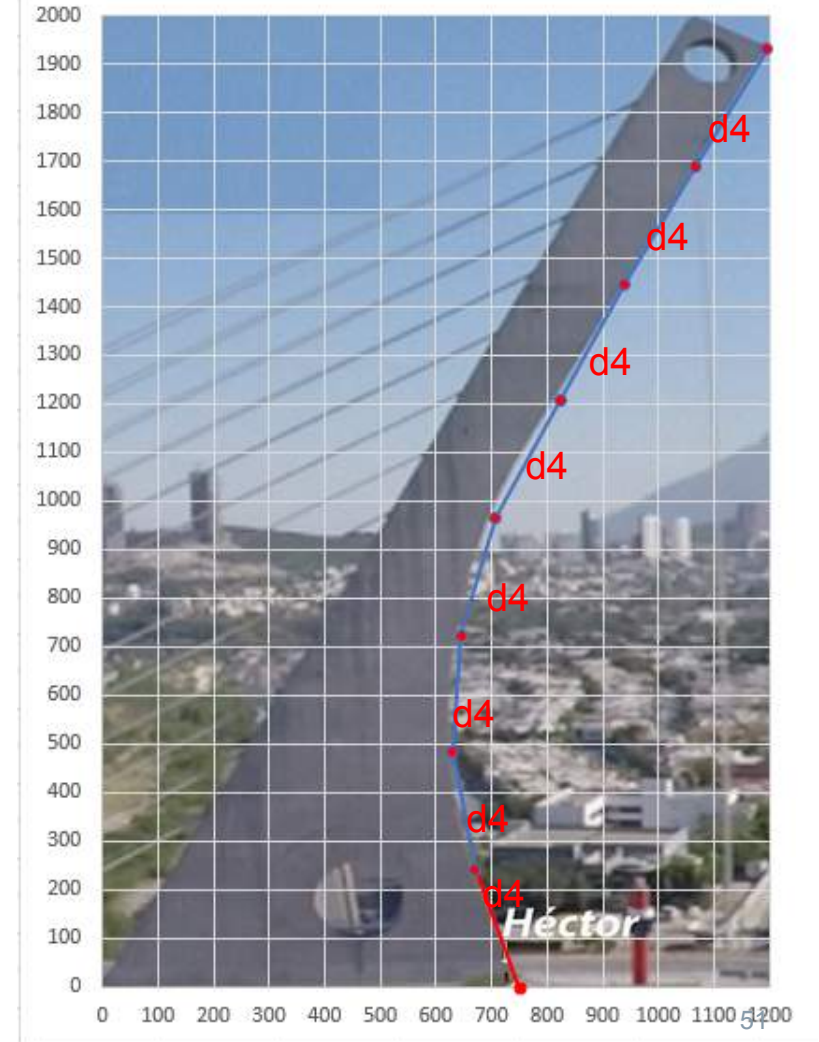
Puente Atirantado

No.	X	Y
1	1195	1930
2	1068	1689
3	940	1448
4	815	1206
5	700	965
6	645	724
7	630	483
8	670	241
9	750	0



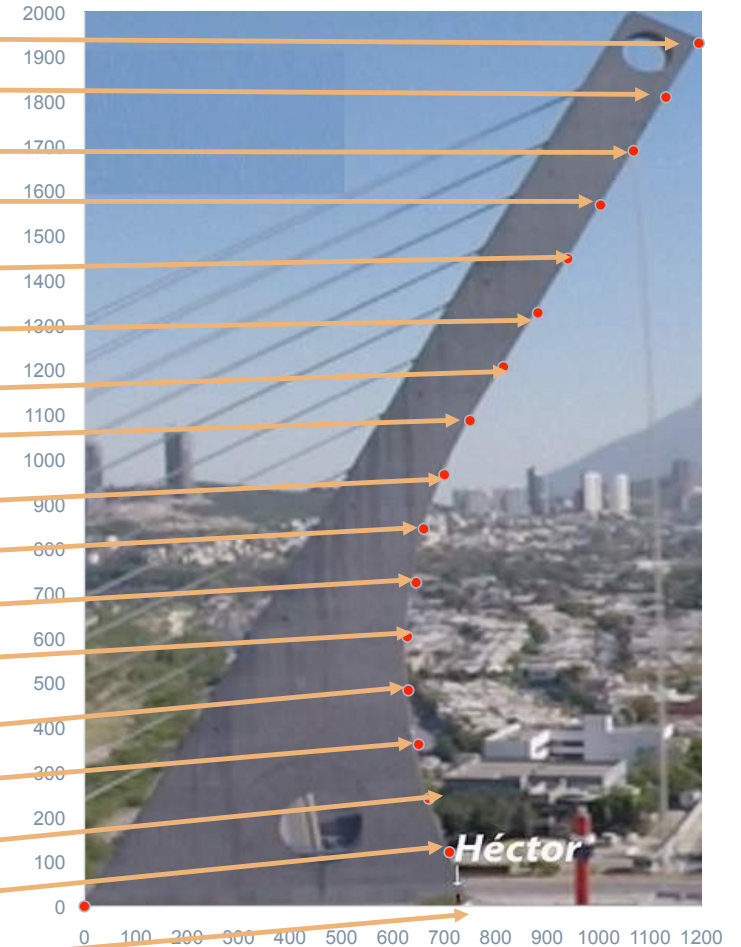
Puente Atirantado

No.	X	Y	Distancia	Dtotal
1	1195	1930		
2	1068	1689	272.8696	
3	940	1448	272.8696	
4	815	1206	271.7104	
5	700	965	267.2575	
6	645	724	247.44	
7	630	483	241.7159	
8	670	241	244.7902	
9	750	0	253.9311	2072.584



Puente Atirantado

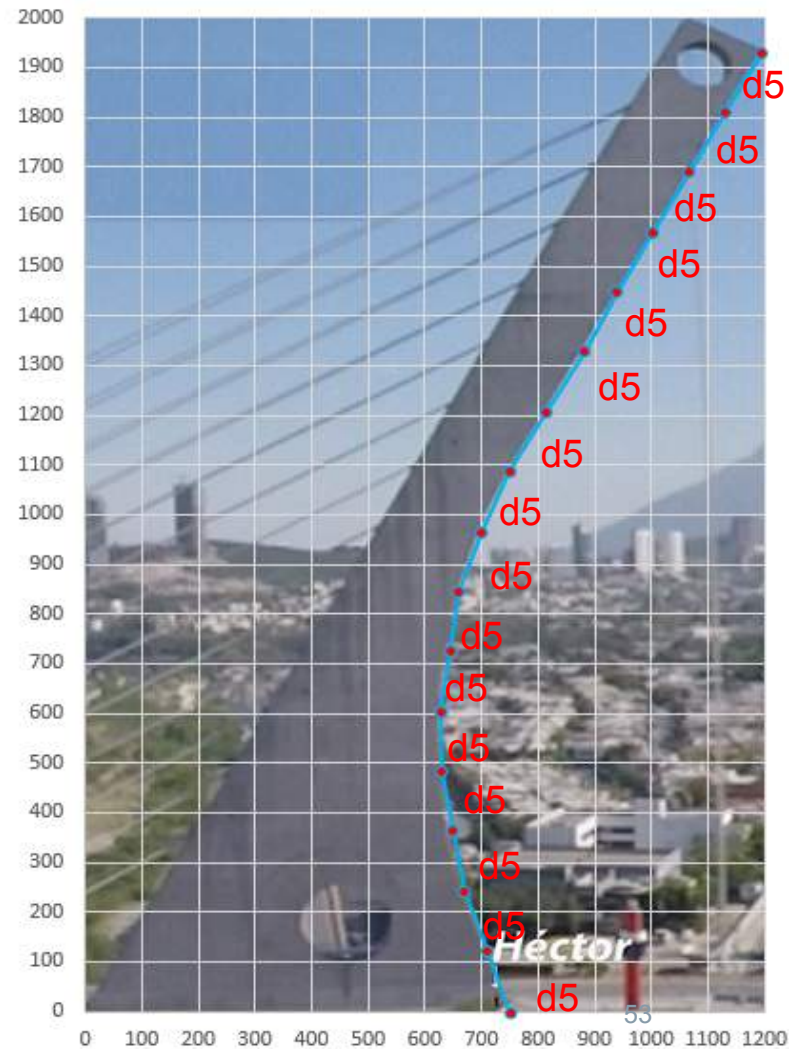
No.	X	Y
1	1195	1930
2	1131	1809
3	1068	1689
4	1004	1568
5	940	1448
6	882	1327
7	815	1206
8	750	1086
9	700	965
10	660	844
11	645	724
12	628	603
13	630	483
14	650	362
15	670	241
16	710	121
17	750	0



π

No.	X	Y	Distancia	Dtotal
1	1195	1930		
2	1131	1809	136.4348	
3	1068	1689	136.4348	
4	1004	1568	136.4348	
5	940	1448	136.4348	
6	882	1327	133.9532	
7	815	1206	137.8621	
8	750	1086	137.0233	
9	700	965	130.5771	
10	660	844	127.0842	
11	645	724	121.5541	
12	628	603	121.817	
13	630	483	120.6416	
14	650	362	122.3951	
15	670	241	122.3951	
16	710	121	126.9655	
17	750	0	126.9655	2074.973

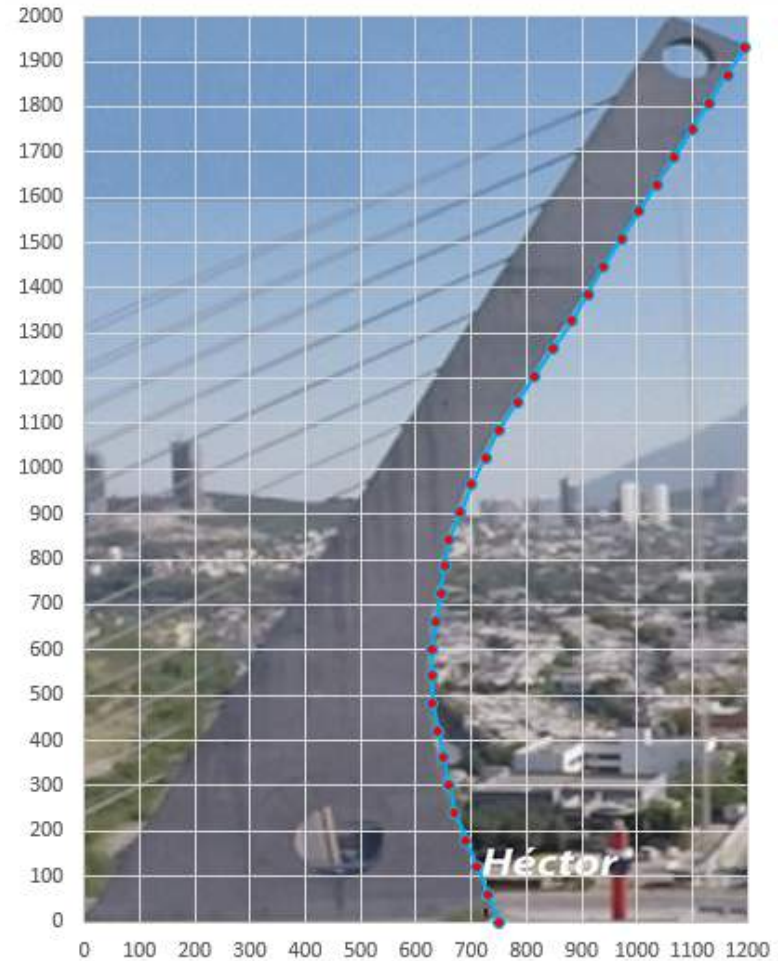
Puente Atirantado





Note for Roberto: See steps 0-6 to see the algorithm that generates the successive approximations in the Excel document. The next chart is the last graph generated.

The Excel calculation for the measurement of the curved side of the Puente Atirantado is 2075 Units.

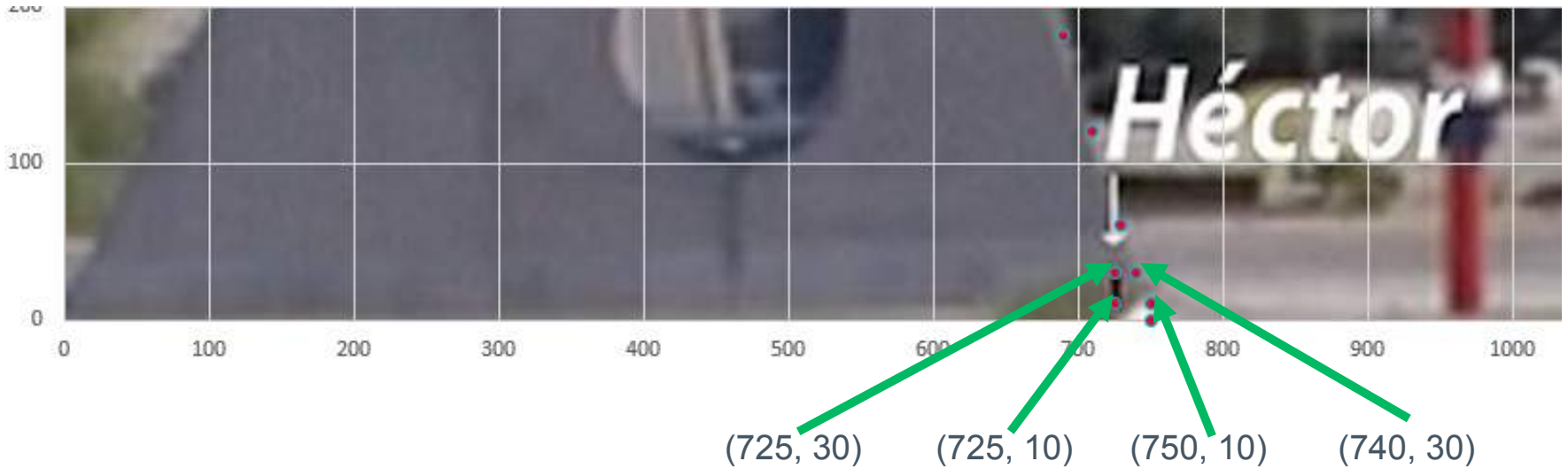


π

Now let's apply the scale.



Scale: Héctor is 1.70 meters tall

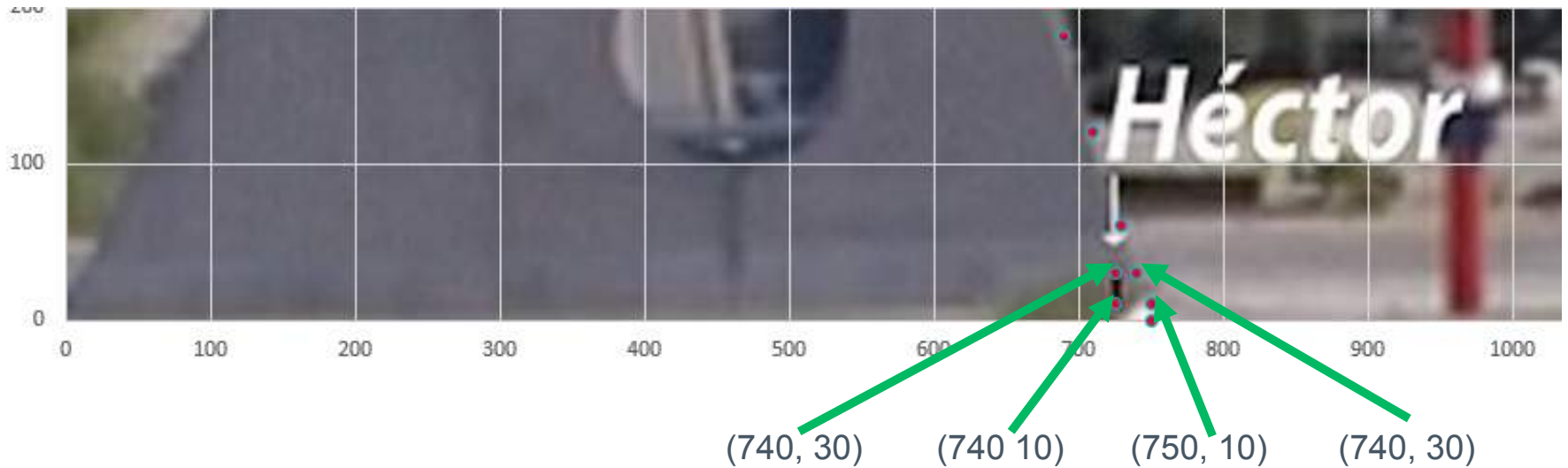


Scale: Héctor is 1.70 meters tall



When we move Professor Héctor horizontally, the points change and we can apply the Pythagorean Theorem.

Scale: Professor Héctor is 1.70 meters tall



$$c_1 = \sqrt{(740 - 740)^2 + (30 - 10)^2} = \sqrt{400} = 20$$

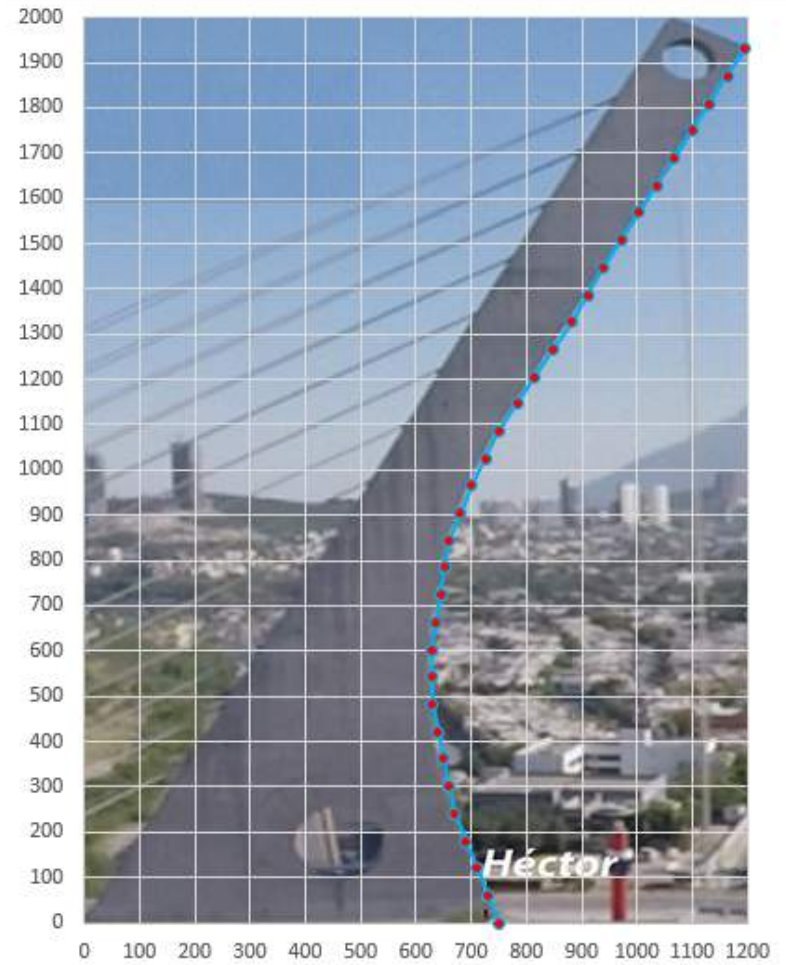
$$h = \sqrt{(750 - 740)^2 + (10 - 30)^2} = \sqrt{100 + 400} = 22.36$$

$$c_2 = \sqrt{h^2 - c_1^2} = \sqrt{22.36^2 - 20^2} = \sqrt{99.96} = 9.99$$

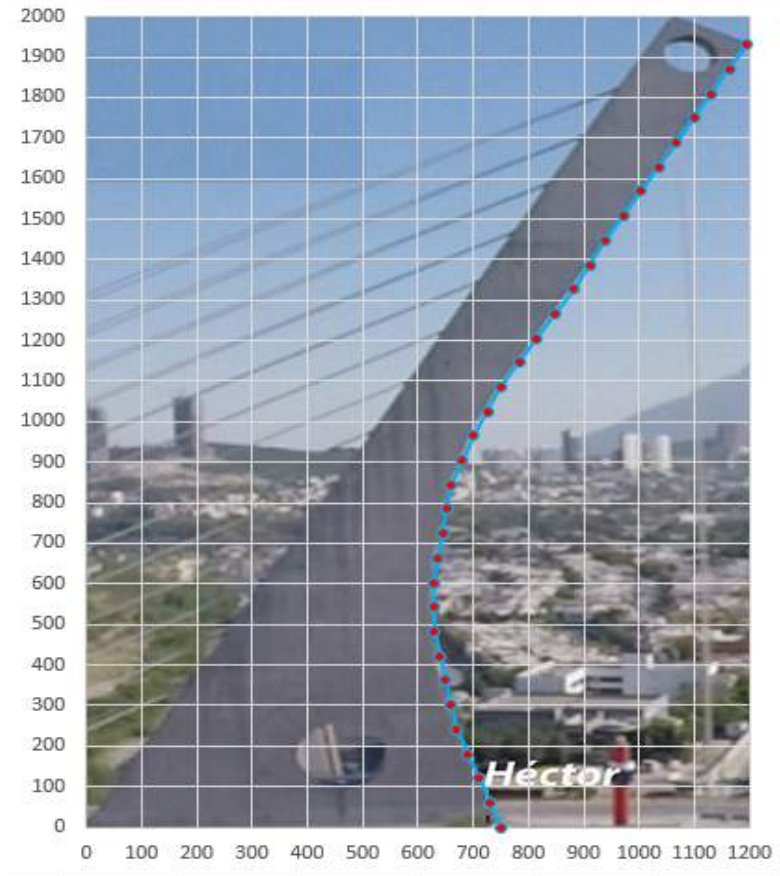
La escala de EXCEL20 = 1.70m

*2075 / 20 = 103.75 * 1.70 = 176m*

According to Excel calculations, the curved side of the Puente Atirantado measures 176 meters.



According to Excel calculations, the curved side of the Puente Atirantado measures 176 meters and 17600 ants are needed.





Teacher Guide Segment

π

Puente Atirantado



Approximate Length of Arch (Excel)

	A	B	C	Δ		
1	x	f(x) =x^3	distance	1		
2	0	0				
3	1	1	=SQRT(POWER ((A3-A2), 2)+POWER((B3- B2),2))		L=	=SUM M (C2: C5)



Successive Approximations as a Tool to Measure Distances

END

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