

# Cartography & Trigonometry

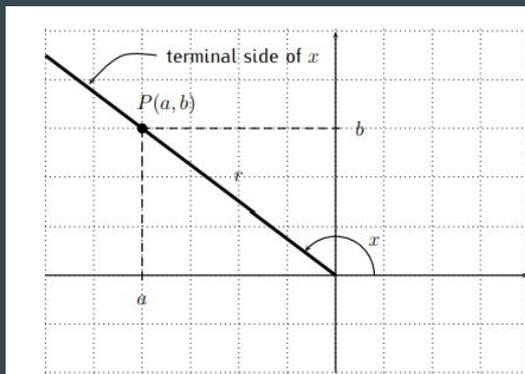
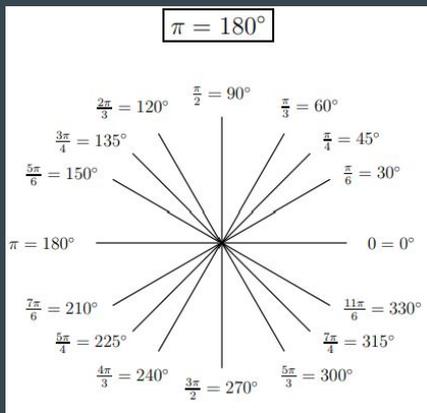


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# Trigonometry Basics

- Trigonometry is a branch of mathematics involving six functions that describe lengths and angles of triangles.



$$a^2 + b^2 = r^2$$
$$\Rightarrow r = \sqrt{a^2 + b^2}$$

$$\sin(x) = \frac{b}{r} \quad \csc(x) = \frac{r}{b}$$

$$\cos(x) = \frac{a}{r} \quad \sec(x) = \frac{r}{a}$$

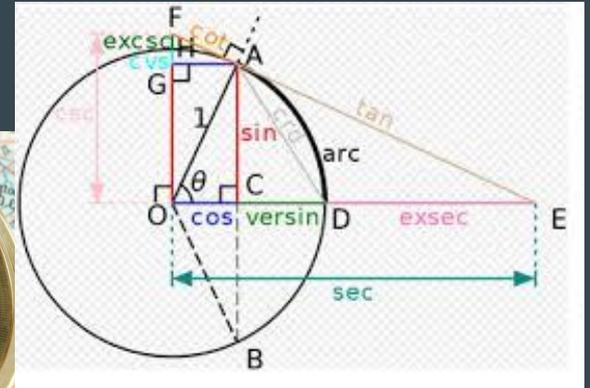
$$\tan(x) = \frac{b}{a} \quad \cot(x) = \frac{a}{b}$$

# What Is Cartography?

- Cartography is the use of arts and sciences, when combined produces a visualization of areas needed
- Cartographers allow three-dimensional images to be represented onto a two-dimensional image
- Using a variety of supplies and mathematics, cartographers are able to produce :
  - Atlases / Maps
  - Terrain Models
  - Geographical Visualizations
- The use of trigonometry is needed in order to form a representation of land/sea
  - Observation of the angles and /lengths of land/sea are measured which allow trigonometric functions to calculate the degree needed to pinpoint w=each area
  - Sine and cosine are most commonly used

# Tools/ Materials

- Telescopes
- Compasses
- Digital Scanners
- Scales
- Protractors
- Reference Guides
- Global Positioning System (GPS)
- Environment

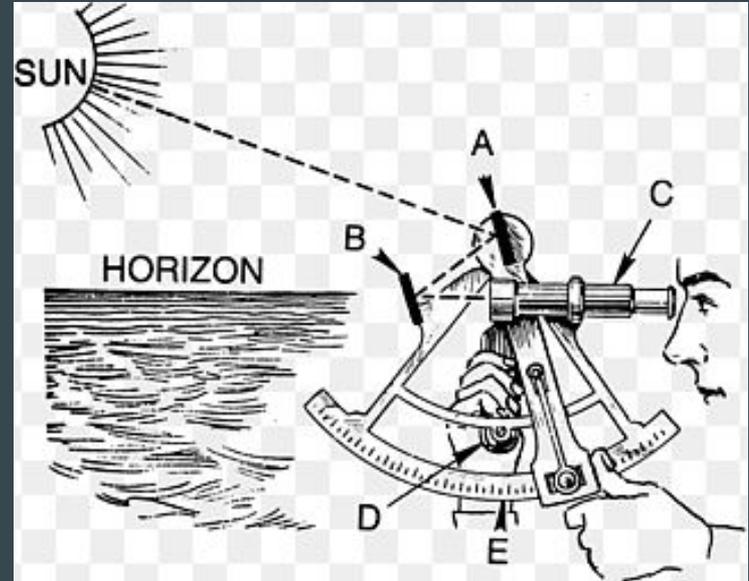


# Why Cartography is Necessary?

Before it existed:

- We used Dead Reckoning:
  - *“The combined use of physical landmarks and the estimation of direction and distance traveled based on first-person experience.”*
- Astronomical Navigation was used for navigational purposes.
  - *Using the layout of celestial objects to determine location*

- The Earth is spherical and cannot be flattened for calculation.
- The Earth’s surface at time has objects that obstruct the horizon’s view making it impossible always calculate with physical points.



# Why Cartography?

Cartography is used in many modern navigational applications such as those created by Google: Maps, Earth, etc. as well as the global positioning system (GPS) that is also used to locate satellites. This modern technology is one we use on the daily and can often go unappreciated. Trigonometry can be used in many different applications but it's rarely linked to cartography. As one of the most influential aspects of discovery and also one of the most underappreciated ones, we are going to consider the mathematical theory behind this application.

# Example Question 1

Let us assume that a surveyor is trying to measure the height of a mountain. The elevation angle between the ground and the top of the mountain is found to be 73 degrees. If the surveyor is standing 300 feet away from the base of the mountain, how we can find the height of the mountain ?

# Solution and Explanation

Here, we can calculate the height of the mountain by using basic trigonometric function.

We know,  $\tan \alpha = \text{opposite} / \text{adjacent}$

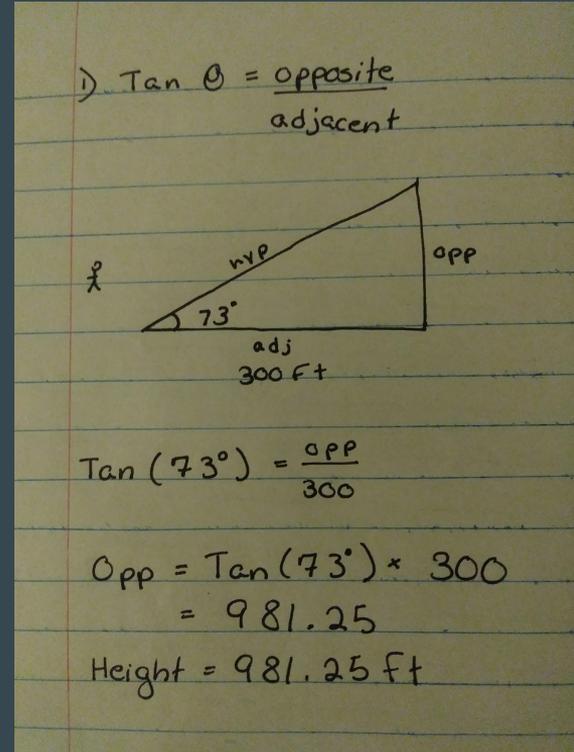
Here, The elevation angle,  $\alpha = 73$  degrees,

The adjacent = 300 feet

Therefore, we get,  $\tan 73 = \text{Opposite}/300$

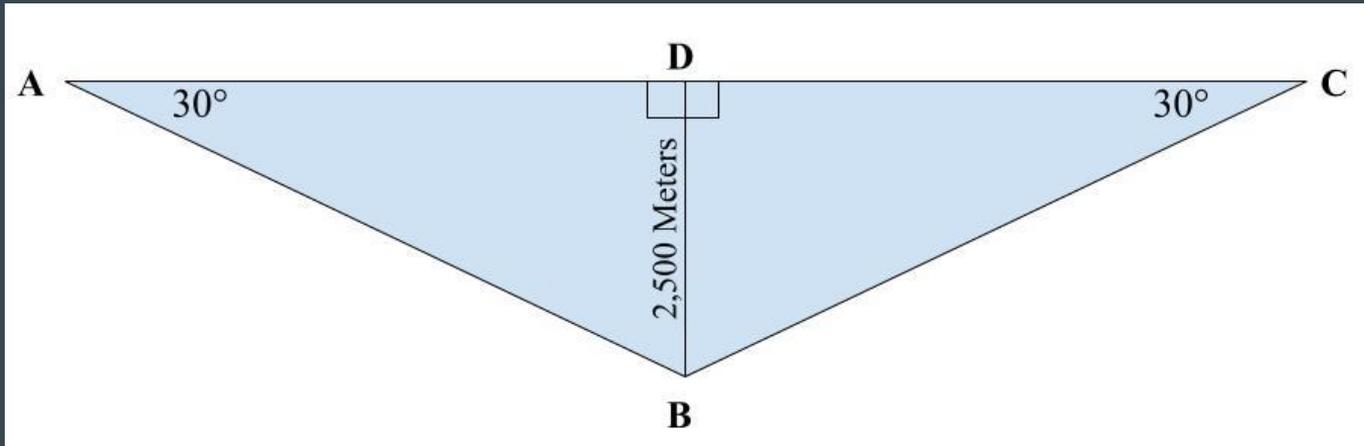
$$\Rightarrow \text{Opposite} = \tan 73 * 300 = 981.25$$

So, the height of the mountain is 981.25 feet.



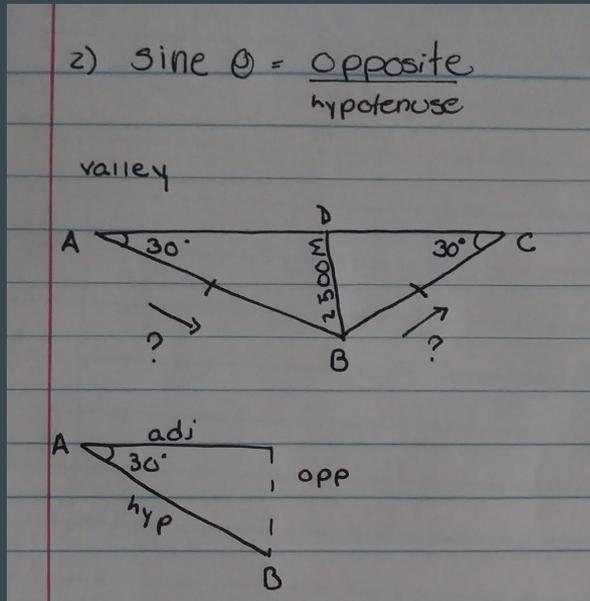
## Example Question 2

A cartographer wishes to walk across an unnaturally symmetrical valley. Knowing the angles A and C are 30 degrees and the depth of the valley (B to D) is 2,500 meters, how would the cartographer know the distance between points A, B, C, without traveling?



# Solution and Explanation

Besides physically measuring the distance while traveling, the use of trigonometry allows the cartographer to calculate the distance.



$$\overline{AB} \rightarrow \sin(30^\circ) = \frac{2500}{\text{hyp}}$$
$$\text{hyp} = \frac{2500}{\sin(30^\circ)}$$
$$\text{hyp} = 5000 \text{ M}$$

From A to B, the distance is 5,000 M

if  $\overline{AB}$  is equal to  $\overline{BC}$ , we can multiply  $\overline{AB}$  times 2, to find  $\overline{ABC}$ :  $5,000 \times 2 = 10,000$

$$\overline{ABC} = 10,000 \text{ meters}$$

# Conclusion

Trigonometry is a branch of mathematics everyone typically ignores and takes for granted. Cartography is one of the many examples where math is used, making the process of creating maps possible. Whether it's charting a new found land or some one just trying to make it home after a long party, cartography allows humanity to progress in its exploration on Earth.

# References

(n.d.). About Civil Engineering Tools. Career Trend.

<https://careertrend.com/facts-4843632-civil-engineering-tools.html>

(n.d.). Cartography. Geography. <https://geography.name/cartography/>

(n.d.). Chapter 13 : Trigonometric Ratios and Functions Cartographer. Class Zone McDougal Littel. [http://classzone.com/books/algebra\\_2/page\\_build.cfm?content=links\\_car1\\_ch13&ch=13](http://classzone.com/books/algebra_2/page_build.cfm?content=links_car1_ch13&ch=13)

(n.d.). How Does a Compass Work? Wonderopolis.

<https://wonderopolis.org/wonder/how-does-a-compass-work>

(n.d.). Mathematical explanation: Trigonometric functions. Steemit.

<https://steemit.com/mathematics/@joseferrer/mathematical-explanation-trigonometric-functions>