Math in Road Scholar

The required math skills for Road Scholar are pretty basic: the four arithmetic operations and the use of proportions. In addition, some basic measurements and conversions into distances are needed. Road Scholar math problems can be a simple as adding distances from information on a map. Many Road Scholar math problems involve setting up a simple proportion and finding the missing value. This discussion will focus on these proportion problems. Road Scholar uses three main proportions: latitude/longitude, distance/scale, and slope/gradient.

Latitude/Longitude

$$\frac{\text{measured mm to an object}}{\text{measured mm to a known distance (e.g., 150")}} = \frac{\text{seconds to an object}}{\text{seconds of a known distance (e.g., 150)}}$$

Distance/Scales

$$\frac{\text{measured mm of a distance}}{\text{measured mm to a known distance (scale, e.g., 2 mi)}} = \frac{\text{mi/ft/km/m}}{\text{known distance (scale, e.g., 2)}}$$

Slope/Gradient

$$\frac{\text{(end elevation – start elevation (ft/m))}}{\text{actual run distance (ft/m)}} = \frac{\text{elevation change (ft/m) per}}{\text{some standard distance (ft/m, e.g., 100)}}$$

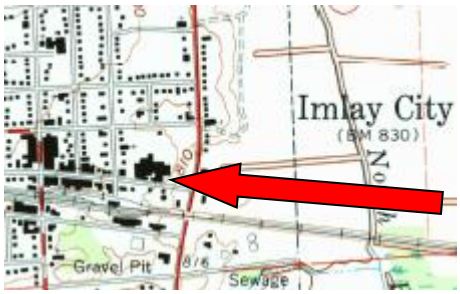
In each case, the left side of the proportion is the data from the map. The right side is the unknown in the numerator and a comparison value is in the denominator. Each of these proportions has one unknown, usually the right hand numerator. It is solved by cross multiplication; i.e. multiply the left hand numerator by the right hand denominator. This will isolate the unknown value on the right.

Slope/gradient requires a couple additional pieces of information. Mathematically, slope is always vertical change divided by horizontal change. The mnemonic for this is "Rise Over Run". But in Road Scholar and in the many real world applications of slope, the value is computed over some longer distance. In Road Scholar, slope is usually per 100 feet and gradient per 1000 feet. That is why you have a comparison value in the right hand denominator. Although the 100'/1000' values are default values, look at the question carefully to see what the comparison value being asked for is. In the real world, that comparison value can vary considerably depending on the application the slope is being used for.

It is important to make sure you have matched the units of measurement. This is especially the case with slope/gradient where the elevations are almost always in feet and distances are often in miles. In that case, make sure to convert the miles to feet first so that the units of measurement are correctly matched. Remember that slope is a signed value. Upslope is positive and downslope is negative. Stream gradients are almost always negative. Terrain slope can be positive or negative depending on where you are measuring from and to.

When you understand how these proportions are set up, then you can do the math to find an unknown value in any of the four positions. For example, if you are given a latitude and longitude and asked to find the location, then you can still use the proportion with the unknown in a different place. In this example, you have the seconds of the latitude and longitude and need to find the millimeters to measure on the map. Therefore, the unknown is in the left hand numerator instead of the right hand

numerator. That means you will multiply the right hand numerator by the left hand denominator to isolate the unknown on the left.



Here is an example of this process using the Imlay City topographic map. Locate the large building on the southeast side of Imlay City on the actual map. Using the proportion above, it is easy to compute the latitude and longitude. You should determine that it is 43° 01' 28.5" N 83° 04' 23" W. But suppose the question on the test asked you to determine what object or feature is located at 43° 01' 28.5" N 83° 04' 23" W. Here's how you work through that question.

The first step is to roughly locate the point on the map. You can look at geographic coordinates on each corner of the map and quickly determine the coordinates are closest to the southwest corner. The coordinates at the southwest corner are 43° 00' N and 83° 07' 30" W. We need to find the correct number of seconds to plug into the proportion. Subtract the minutes and seconds of the coordinates in the question from the appropriate value of the corner coordinates. You should obtain a value of 1' 28.5" for the latitude value and 3' 07" for the longitude value. These can be reduced to 88.5" and 187". We are now ready to plug those numbers into the proportion and solving. In the proportion, the seconds are the right hand numerator. The right hand denominator is still 150" for both the latitude and longitude values. We still measure the millimeters for 2.5' or 150": they are 191.5 for the latitude and 140.5 for the longitude. Those values become the left hand denominator. The unknown is the millimeters to the unknown object on the map which is the left hand numerator. We cross multiply by multiplying 88.5 times 191.5 for latitude or 187 times 140.5 for longitude. We take the result and divide by 150 in each case. The final result should be 113 mm for latitude and 175 mm for longitude. We measure those on the map and determine the large building is the object or feature at the specified latitude and longitude. Ta dah! You did it!

The kind of question where you are given the coordinates and asked to describe what is at those coordinates is very rare in Road Scholar, although it has a huge number of real world applications. It is within the rules and may to appear at very strong, competitive tournaments. In general, you want to understand the underlying principle for a formula and then you can use it when and how needed.

A General Note

For every Science Olympiad event, and especially Road Scholar, it is important to have your answers in the correct format as well as having the correct numbers. Any numeric answer needs to have the proper units included or correctly identify what the number is. For example, a 2 all by itself is at least incomplete and partially incorrect. Is it feet, meters, a US highway, a sector? For computations, numbers need units, such as 2 miles. For a highway number, it needs the type of highway, such as state highway 2. There are also standard abbreviations for most of the units and types. Miles is mi, state highway is SH 2 or SR 2 or M-2 in Michigan or WI-2 in Wisconsin. Latitude/longitude have very specific formats they need to be written with. For example, a latitude needs to be in the format of 43° 27' 39" N. Just getting it correctly computed is the major part of the answer, but expressing it correctly is a requirement. This general rule applies to all rectangular coordinate systems (Lat/Long, PLSS, UTM, SRS) and most other answers.

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