EXPEDITION EXPLORER GUIDE
WHERE DOES **MATH** TAKE YOU?
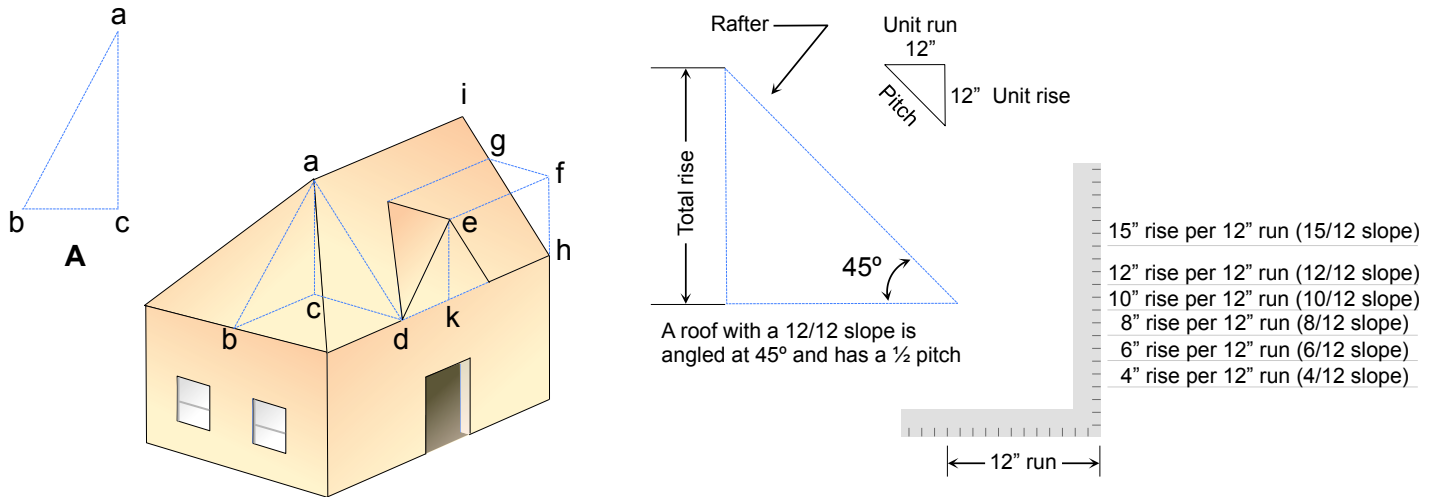
BODACIOUS *dream* **EXPEDITIONS**

Records from early cultures show mathematics arose from practical needs. Across the ancient world, it was used for surveying, agriculture, building, astronomy, and navigation. In fact, the word geometry comes from the Greek words *geo* and *metron*, which mean "earth & measure".

The Usefulness of Math

Mathematics continue to be an important part of our daily lives. Science and technology depend on it. So do our everyday tasks, like cooking or deciding how much gas we will need to drive to a destination. Before Dave was an ocean sailor, he was a carpenter and house builder. What he quickly learned is you have to constantly calculate costs and quantities when building. You also need to use geometry to figure out tasks like how to build square buildings and a slanted roof. Get your math wrong, and everyone's going to know it pretty quickly.

A roof with a 12/12 slope is angled at 45º and has a ½ pitch

15" rise per 12" run (15/12 slope)
12" rise per 12" run (12/12 slope)
10" rise per 12" run (10/12 slope)
8" rise per 12" run (8/12 slope)
6" rise per 12" run (6/12 slope)
4" rise per 12" run (4/12 slope)

Math is Essential to Sailing

Math informs sailing in many ways; how far away something is, what angle you need to steer to get there and if you can't make it on that angle, how much of a "tack" you're going to have to take to get there. (Tack is a change of direction to sail against the wind in the other direction using a zig-zagging motion.)


UNITED STATES - EAST COAST
VIRGINIA
CHESAPEAKE BAY ENTRANCE

BODACIOUS *dream* EXPEDITIONS
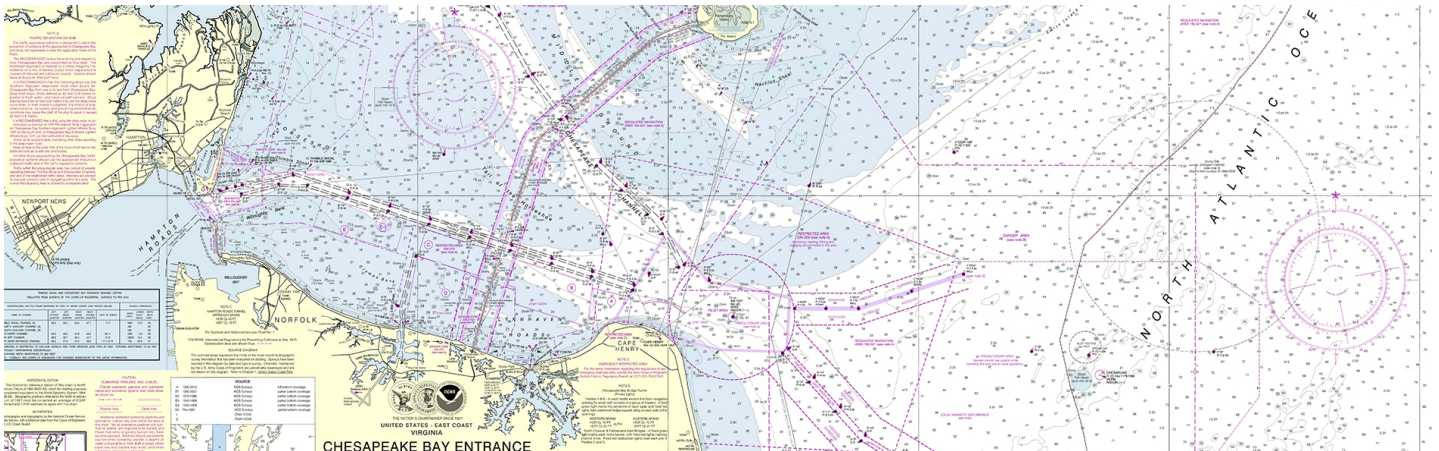
"The formulation of the problem is often more essential than its solution, which may be merely a matter of mathematical or experimental skill."

– Albert Einstein

Here are some real world problems that Dave had to solve on Leg 1 of the Circumnavigation? See if you can solve them!

"*I'm in the middle of the South Atlantic right now, less than 2000 miles from Cape Town, South Africa – but the problems below could apply to any set of positions on the globe.*

See if you can answer them. I'll answer the first one for you. You do the rest!"
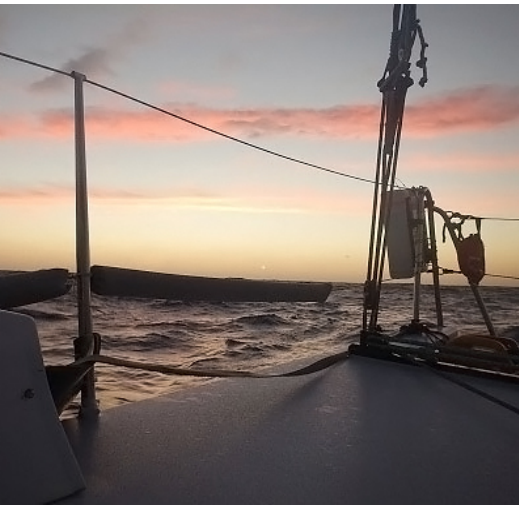
It's Monday, at 06:00 hours and I'm 300 miles from my next waypoint. The weather front is predicted to arrive on Tuesday evening at about 18:00 hours, so if I can arrive about that time, I can take advantage of the good winds to make additional distance toward Cape Town. I've been sailing at about 8.5 knots all night long, but once the sun rose, the winds died down and my speed dropped to 5.75 knots.

Q: How many hours will it take me to get to the waypoint?

Q: And can I make it before the weather front?

Answer - So, in this first one, the waypoint is 300 miles away – so just take the distance (300) and divide it by the speed (5.75) and that equals a bit more than 52 hours. Then time-wise, from Monday at 6:00 am until Tuesday at 18:00 (6:00 pm) that's 36 hours. So, 36 hours multiplied by 5.75 knots equals 207 miles, so you can see I won't make it.

Let's try some more!

Q: Now, if I use my engine some until the winds come back and can nudge the speed up to 6.5 knots until 12:00 hours and am then able to sail at 6.5 knots the rest of the way, how long will it take me? And then can I make it to the waypoint before the front?

Q: What speed would I have to average to make it to the waypoint on time?

Q: It's now later in the day, I just passed the 200 mark at 19:45 hours and I have 200 miles to go to the waypoint. The winds have increased nicely and with my biggest sail up, I am sailing along again at 8.5 knots. How close will I be to making the waypoint?

Mathematics is probably the most universal languages humans have invented. It can be used to describe the shape of a flower, determine distances to the stars, or measure the weight of an atom with a high degree of precision.

...Let's try some more!

Q: If I can make the waypoint by 18:00 hours on Tuesday and there are still 2150 miles from there to Cape Town, and if I average 150 miles a day, what day would I get there? And how many knots per hour do I have to go, to make 150 miles a day?

Q: Usually, after a front passes, the winds are pretty fresh and I can sail at pretty good speeds. So, here's a tougher problem for you. If I reach the waypoint and am able to sail for 60 hours at 8.5 knots before the winds ease back, and if I then sail for 5 days averaging 7 knots an hour, how many miles will be left to Cape Town? If I were able to sail them at 8 miles an hour, how would that change my arrival date in Cape Town?

The above are time and distance problems that apply to long distance sailing. Racing around buoys and markers raise other types of math problems. In the next problem you will need to apply math skills to plan your strategic maneuvers.

Q: If I know I'm going to need to change sails at a particular mark rounding and I know it will take me 4 minutes to set up the boat to make the sail change, I need to know at what distance we will be at with 4 minutes left to reach the mark. Let's say we are sailing at 6 knots. We know then that a mile takes 10 minutes to sail. What would my GPS tell me the distance is to the mark at four minutes before we reach it?

Well, there you have it – straight from the ocean. For so many things, where accuracy is important, math is a necessity to figure out how to do the things you need to do.

"Mathematical knowledge is unlike any other knowledge. While our perception of the physical world can always be distorted, our perception of mathematical truths can't be. They are objective, persistent, necessary truths. A mathematical formula or theorem means the same thing to anyone anywhere — no matter what gender, religion, or skin color; it will mean the same thing to anyone a thousand years from now. And what's also amazing is that we own all of them. No one can patent a mathematical formula, it's ours to share. There is nothing in this world that is so deep and exquisite and yet so readily available to all. That such a reservoir of knowledge really exists is nearly unbelievable. It's too precious to be given away to the "initiated few". It belongs to all of us."

- Edward Frenkel from his book, Love & Math