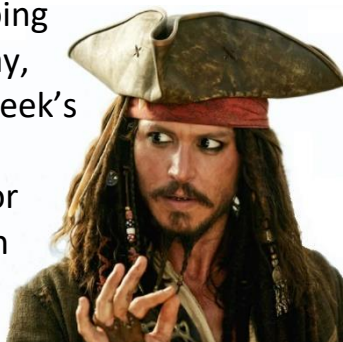




Every solvable version of the 15 puzzle can be solved in at most 80 moves

News

So it's the middle of January now and we're in lockdown again, working from home. I hope it's going well for you. Anyway, the theme of this week's maths newsletter is pirates¹. Believe it or not, there is enough vaguely related to pirates maths to fill at least one whole maths newsletter². We'll start with a famous puzzle.



5 pirates of different ages have 100 gold coins. On their ship, they decide to divide up the coins in the following way: The oldest pirate suggests a way of sharing out the coins, and ALL the pirates (including the oldest) then vote for or against it.

If 50% or more of the pirates vote for it, then the coins will be shared in that way. Otherwise, the pirate proposing the scheme will be thrown overboard, and the process is repeated with the pirates that remain.

As pirates tend to be a bloodthirsty bunch, if a pirate would get the same number of coins if he voted for or against a proposal, he will vote against it, so that the pirate who proposed the plan will be thrown overboard.

Assuming that all 5 pirates are intelligent, excellent at maths and logic, greedy, and do not wish to die, what will happen?³

1. Children's TV's favourite socially acceptable violent criminals from the past.
2. They have tried to rid the world of pirates during the coronavirus pandemic, but they've not been able to get the Arrrr value down low enough... (sorry about this joke... if you don't get it, just forget it.)
3. This is a complicated puzzle that belongs to the area of mathematics called Game Theory. You can find a solution here: <https://www.mathsisfun.com/puzzles/5-pirates-solution.html>

Maths Word

A **projection** is the transformation of all the points on one surface onto another surface. Good examples of this are flat maps of the world, which are made by taking all the points on the surface of something that is roughly spherical and projecting them onto a flat surface, which we call a map. The most famous of these is the Mercator map made by Flemish geographer and map maker Gerardus Mercator in 1569.



Ocean Statistics

71% of the surface of the earth is water. 50-80% of all life on earth is found under the ocean surface and the oceans contain 99% of the living space on the planet. Less than 10% of that space has been explored.

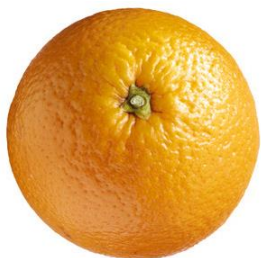
Sea Water Puzzle

3.5% of sea water is salt. River water is about 0.012% salt. If you have 1 litre of sea water, how many litres of pure water would you need to add to it to give it the salt content of river water?

Maps

If you were a pirate, it would probably be a good idea to have a good map of the world. I've already mentioned Mercator's map⁴, which is the one we are all used to seeing.

If you were to peel a roughly spherical orange and try to lay the peel out flat, you may notice a couple of things. One is



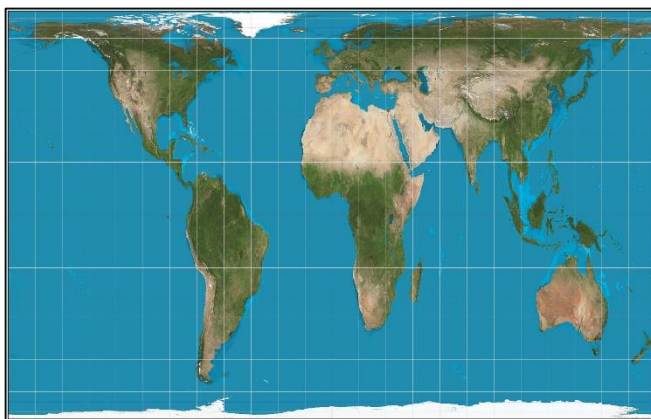
that the surface area of the orange seems to be equal the area of four circles with the same radius as the sphere⁵.

The other thing is that you can't lay down the surface of a sphere onto a flat surface with it having bumps in it. Because we don't want our maps to be bumpy, map-makers (actually called cartographers) have to stretch the map in some way, which can cause problems, particularly if you want the map to be a rectangle. Look at how much bigger than Australia Greenland seems to be on the Mercator map. In reality, Australia is about 3.6 times bigger than Greenland!

Whenever you make a map of the world, you have to choose which properties you want to keep accurate and which ones you don't mind losing. The Mercator map loses the property of accurate relative areas but – and this is the main reason it became the most popular world map – one of the things it kept accurate were the bearings you would need to travel on to get from one place to another. This is obviously very helpful if you are an explorer (or a pirate) and using the map to navigate your way around the world's oceans!

Some people don't like the Mercator map though because of the way that, for

example, it makes Africa look a lot smaller than it really is (because much of Africa is near the equator), so they have suggested other maps, such as the Gall-Peters map which preserves relative areas. This map, however, distorts the shapes of the countries and would be no good for navigating at sea.



Have a look at the famous clip from the TV show *The West Wing*, where they discuss this map⁶. And now, I think, let's end this newsletter with a joke...

Joke

What did the pirate say on his 80th birthday?



Aye Matey!

4. Don't confuse this with the Marauder's Map. That's from Harry Potter.

5. I'm joking obviously. You wouldn't notice this unless someone pointed it out to you, like I'm doing now.

Have a look at this YouTube video: <https://www.youtube.com/watch?v=jaL8Kuv6YHo>

6. Here's the clip from *The West Wing*: <https://www.youtube.com/watch?v=vVX-PrBRtTY>