



Maths With Zombies

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22. The Big Freeze Problem

The zombie apocalypse has begun and a large group of you have sought refuge in the far North because you've heard that zombies can't move at low temperatures. This is because they seize up if they get too cold. However, at the northern latitudes where you're hiding out, it's not always sufficiently cold for this to happen, and for three months of the year (June, July and August) the temperatures are warm enough for the zombie to advance. This is quickly becoming known as the walking season and is dreaded by everyone since it's when almost all zombie attacks take place. Only 30% of the zombies survive their annual chill, and in each month when it's warm enough for them to move, they can stagger 100 miles. It's now the end of August and the temperatures have just started to drop so the zombies have frozen up for the winter meaning this year's walking season is over. You've estimated that 2 million zombies crossed the Canadian border, heading north, just before this happened. How long will it take for this zombie horde to reach you 1,300 miles to the North and how many will be left when they do?

- A.** It will take four years for them to reach us, and there will be 16,200 zombies left when they do.
- B.** They'll reach us in four years and ten months, and there will only be 4,860 left.
- C.** It will take the zombies five years and ten months to get here, and there will be 1,458 left.
- D.** All the zombies will die from the cold before they reach here so we're completely safe.

What answer did you get?

- A:** You're almost right, but the zombies will still be 100 miles away after four years and they will have to survive another winter before they can cover these last few miles. This will thin out their numbers even more meaning there will be many fewer for you to worry about.
- B:** Spot on! Now you know when the zombies will arrive and how many there will be, you can start preparing for their arrival.
- C:** I don't know what went wrong there, but you're a few months out, and there will be many more zombies than you're expecting. This means you'll be caught unaware and unprepared when they finally turn up on your door step.
- D:** I don't know how to worked that out, but your poor maths will give you a false sense of security. You'd better double-check your work before the first zombie lumbers over the horizon and descends on your unsuspecting encampment.

How to work it out: At the start of this problem, the 2 million zombies are frozen in place 1,300 miles to your south. This means they won't be able to start moving until the temperatures warm again next June. During this time, only 30% (or 0.3, if we express this as a decimal fraction) will survive. To work out how many this is, multiply the initial number (2 million) by the percentage expressed as a decimal fraction (0.3). This calculation tells you that at the start of the next summer there will only be 600,000 zombies left. Over the next three months, they'll stagger 100 miles each month, or 300 miles in total. So, in exactly one year's time, when the zombies freeze up again, there will be a horde of 600,000 zombies 1,000 miles away (the initial 1,300 minus the 300 they've been able to move in the summer months). If you repeat these calculations for the next year, starting with these new values, you'll find that at the end of the second year, the zombies will be 700 miles away and there will be 180,000 of them. At the end of the third year, there will be just 54,000 left and they'll be 400 miles away. At the end of the fourth year, they'll be only 100 miles away, but their numbers will have been whittled down to 16,200. During the next winter, 70% of these zombies will die, meaning there will only be 4,860 still alive to start walking nine months later at the beginning of the following June. Since they can cover 100 miles per month, this means these remaining zombies will reach you at the start of July. So in total, you've got four years and ten months to work out a way for you to be able to kill almost 5,000 zombies before any of them get you. Got any ideas?