



Maths With Zombies

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14. The Zombie Abundance Problem

You are an army general trying to work out how many soldiers you need to send in to clear a city of zombies. To have any chance of taking the city back, past experience has told you that you need to have at least one soldier for every 10 zombies – anything less than that and you will not succeed. However, if you send in too many, you will leave your base without enough soldiers to protect it if zombies attack. This means you need to send in exactly the right number of soldiers – no more, no less. To get a estimate of the number of zombies in the city, you've sent out a helicopter to count the number of zombies in five randomly-selected city blocks. It has counted 523 zombies in the first one, 632 in the second, 781 in the third, 421 in the fourth and 307 in the fifth one. Given that for every one zombie seen on the streets you know there's 4 hidden from sight in the buildings, and that there are 142 similar-sized blocks in the city, how many soldiers do you need to send in to guarantee that you'll be able to take back the city without jeopardizing the safety of your base?

- A. 2,738 soldiers
- B. 15,627 soldiers
- C. 37,829 soldiers
- D. 65,342 soldiers

What answer did you get?

- A:** With that many soldiers, there'd only be one for every 138 zombies and they'll get massacred in seconds!
- B:** That's closer to the right number, but it's still not enough since you'd only have one soldier for every 24 zombies. They'll last longer but your troops will still lose in the end.
- C:** Spot on. You'll have exactly one soldier for every 10 zombies, that that will be enough to clear the city without leaving your base unprotected.
- D:** Since you'll have one soldier for every six zombies, you'll be sure to win, but because you're sending in more than you need to, you'll risk losing your base if zombies attack – and that would be a disaster.

How to work it out: The first thing you need to do is estimate the total number of zombies in the city. To do this, you need to account for the zombies hidden in the buildings by multiplying the counts for each city block by five (which you get by adding one for the zombie you saw and four for the ones which remain hidden from sight). This gives 2,615, 3,160, 3,905, 2,105 and 1,535 as the estimated abundance in each block. Next, you need to work out the average number of zombies in a city block. This is done by adding up the counts in each block and dividing the total by the number of blocks sampled (in this case five). This gives an average of 2,664 per city block. You know that there are 142 similar-sized blocks in the city, so if you multiply the average number of zombies per block by this value (142) you will get the estimated abundance for the whole city. In this case, this is 378,288. Now you have the number of zombies, you can work out how many soldiers you need by dividing it by ten. This gives 37,828.8, or 37,829 if you round it up to the nearest whole number (since you can't send in a fraction of a soldier!).