

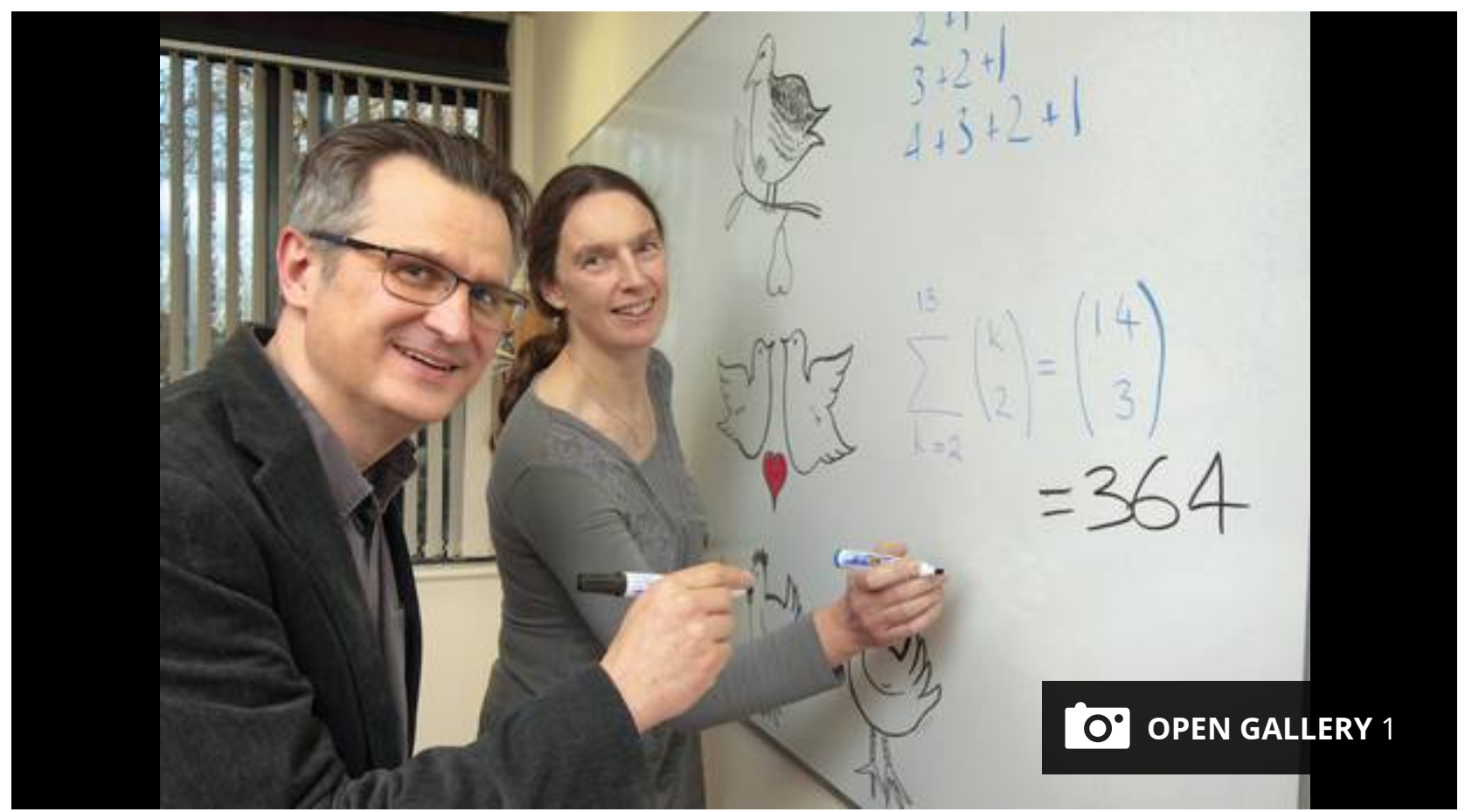
How many presents did my true love really send to me?

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Over the 12 days of Christmas, how many gifts did my true love send to me? The obvious answer might seem to be $1+2+3+4+5+6+7+8+9+10+11+12$, but inspection of the lyrics reveals that this vastly underestimates the true total. According to our calculations, I would need to give my true love a daily present for a whole year in order to surpass his generosity.

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On the first day of Christmas my true love sent to me a partridge in a pear tree - so that's one present for me. On the second day, this was followed by two turtle doves and another partridge. So that's $1+2=3$ presents that day and a total of $1+3=4$ presents so far. On each following day, all of the previous day's gifts were repeated and more added to the list, until Day 12.

Finding a neat way to calculate the number of presents received on a particular day is an interesting mathematical challenge. A famous story recounts its solution in 1784 by the great German mathematician Carl Friedrich Gauss. The 7-year-old Gauss reputedly amazed his teacher by adding up all the whole numbers from one to 100 in a matter of seconds.

Using the Gauss approach, the number of presents received on Day 6, or example, is calculated as one half of the sum $1+6+6-1$. So, to calculate my gift haul on Day 6, we need to add $1+2+3+4+5+6$. Let's write this sum twice, in reverse order the second time: $(1+2+3+4+5+6)+(6+5+4+3+2+1)$.

We find that by pairing numbers in each sequence, 1 and 6, 2 and 5, 3 and 4, etc, we end up with 6 pairs of numbers that add up to 7. So twice the sum is $6 \times 7 = 42$ and the sum itself is 21. That's exactly how Gauss astounded his teacher with the answer "5,050", which is half of 100×101 .

On the first day of Christmas my true love sent one present, which is half of 1×2 ; on the second day he sent 3 presents, which is half of 2×3 ; on the third day, he sent half of 3×4 , which is 6, etc.; until Day 12, when he sent half of 12×13 , which is 78 presents.

The total number of presents over the 12 days will thus be the sum of $1+3+6+10+15+21+28+36+45+55+66+78$, which is 364, one item short of one present per day for a whole (non-leap) year.

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