

Half-life calculations

Notes on General Chemistry

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Using coin flips to count people

Everyone in of a group of 202 people is initially standing. Each person flips a coin, and sits down if the coin lands heads up. Each person still standing flips again, and sits down if the coin lands heads up. After 5 coin flips, 7 people remain standing. How many people are in the large group?

The fundamental expression

$$N_n = (1/2)^n N_0.$$

becomes

$$7 = (1/2)^5 N_0.$$

We rearrange this for the number of people present, then the initial number of students—the class attendance—evaluates to

$$N_0 = 7 \times 2^5 = 7 \times 64 = 448.$$

This is different from the actual number of people, 202, but the result shows that, to within a factor of two, we can use “half life decay” to “count” an initial population size.

| Why is our result so different from the number of people present?

For such a small sample, this is definitely the hard and not very accurate way to count. But if we had a very large sample, say the people at a Boston Red Sox game in Fenway Park, it would be much quicker than counting each person individually.

Half-life

Half-life, t_{half} , is defined as the amount of time required for the amount of a substance to be reduced by 50%. Half-life a useful concept if its value does *not* depend on how much material is present. Such a decay process is called a *first order*. Nuclear decay is first order.

Let's say a substance undergoes first order decay with $t_{\text{half}} = 1$ hour, and that we begin with 60 units of the substance. This means

n / hours	units remaining
0	60
1	30 = 50% of 60
2	15 = 50% of 30
3	7.5 = 50% of 15

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