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Opinion

An Alternate Form of the Integrated First-Order Rate Equation

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Abstract

Derivation of a first-order equation suitable for use in beginning energy science and chemistry courses is shown to be

$A = A_o / 2^{t/t_{1/2}}$

Where,

Ao is the original amount of the sample

A is the amount

T is time t and

t1/2 is the half-life

Ao is larger than A

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Derivation of the Alternate Form

Radioactive processes and many chemical processes follow first order kinetics. The usual equations

found in general chemistry textbooks are:

a. ln $Ao / A = kt$, Where, A_o is the original amount of the sample, A is the amount at time t and k is the rate constant.

b. Changing the rate constant to half-life, $ln2 = kt_{1/2}$, where $t_{1/2}$ is the half-life.

c. Solving equation 2 for k and substituting into equation 1 the result is $lnAo / A = (ln2)t / t_{1/2}$.

d. Rearranging equation 3 gives $A = A_o / e^{(ln2)t/t_{1/2}}$ as indicated in [1].

e. Since $e^{ln2} = 2$, substitution into equation 4 yields $A = A_o / 2^{t/t_{1/2}}$ the Alternate Form of the

Integrated first-order rate equation

Our students have found equation 5 to be relatively easier to use than equations 1 and 2. In equation 5, by dividing the time by the half-life, they get a number. On their calculators, they enter the number 2, y^x, the number and press=The result is divided into A_o, giving the value for A. For radioactive processes, the values of Ao and A may be in mass, such as grams, or activity in Becquerel's (counts/second). For chemical processes, units for A_o and A may be written as rates, such as molarity/second.

References

1. Kenneth AC (1991) Chemical kinetics, the study of reaction rates in solution. VCH Publishers, USA, p. 496.