Using Line Equations to Find Information

1. For the first order reaction: $2\ N_2O_5 \rightarrow 2\ N_2O_4 + O_2$ at 45°C, $k = 6.22 \times 10^{-4}\ s^{-1}$. If $[N_2O_5] = 0.100M$:

a.) How long does it take for the concentration to drop to 0.010M?

A: $3.70 \times 10^3 s$

b.) What is the concentration after one hour?

A: 0.0107M

2. The decomposition of sulfuryl chloride (SO_2Cl_2) is first order in SO_2Cl_2. The rate constant for the decomposition at 660K is $4.5 \times 10^{-2}\ s^{-1}$.

a.) If we begin with an initial SO_2Cl_2 pressure or 450 torr, what is the pressure of this substance after 60.s? A: 30. torr

b.) At what time will the pressure of SO_2Cl_2 decline to 1/10 its initial value? A: 51s

Half-life Examples

1. For a 1st order reaction, determine the time it will take for only 1/8 of a material to be left if $t_{½} = 3.47 \times 10^2 s$

A: $1.04 \times 10^3 s$

2. The reaction below is first order in $[H_2O_2]$:

$$2H_2O_2\ (l) \rightarrow 2\ H_2O\ (l) + O_2\ (g)$$

A solution originally at 0.600M is found to be 0.075M after 54min. Determine the half-life.

A: 18 min

3. The thermal decomposition of phosphine (PH_3) into phosphorus and molecular hydrogen is a first order reaction:

$$4PH_3\ (g) \rightarrow P_4\ (g) + 6\ H_2\ (g)$$

The half-life of the reaction is 35.0s at 680°C. Calculate (a) the first order rate constant for the reaction and (b) the time required for 95% of the phosphine to decompose.

A: (a) $0.0198 s^{-1}$ (b) 151s

4. The rate constant for the second-order reaction

$$2\ NO_2\ (g) \rightarrow 2\ NO\ (g) + O_2\ (g)$$

is 0.54 $M^{-1}s^{-1}$ at 300°C.

(a) How long, in seconds, would it take for the concentration of NO_2 to decrease from 0.62M to 0.28M?

A: 3.6s

(b) Calculate the half-lives at these two concentrations.

A: 3.0s, 6.6s

More uses of the Arrhenius Equation

1. The activation energy of a certain reaction is 31.5 kJ/mol. At 30°C, the rate constant is 0.0190 s^{-1}. At what temperature in degrees Celsius would this reaction go twice as fast?

A: 48°C

2. The gas-phase reaction Cl(g) + HBr(g) → HCl(g) + Br(g) has an overall enthalpy change of -66kJ. The activation energy for the reaction is 7 kJ.

(a) Sketch the energy profile for the reaction, and label E_a and ΔE.

(b) What is the activation energy for the reverse reaction?

A: 73 kJ

3. On the basis of the frequency factors and activation energy values of the following two reactions, determine which one will have the larger rate constant at room temperature (298K).

A: second reaction

$$O_3\ (g) + O\ (g) \rightarrow O_2\ (g) + O_2\ (g)$$

$A = 8.0 \times 10^{-12}$ mL/mol-s $\qquad E_a = 17.1$ kJ/mol

$$O_3\ (g) + Cl\ (g) \rightarrow ClO\ (g) + O_2\ (g)$$

$A = 2.9 \times 10^{-11}$ mL/mol-s $\qquad E_a = 2.16$ kJ/mol