

Kinetics Worksheet #1.5 (2011)

Determine the rate law expression and the value for the rate constant (k) including units.



Experiment	Initial [A]	Initial [B]	Initial Rate of Formation of C (M min ⁻¹)
1	0.10	0.10	1.70×10^{-5}
2	0.20	0.10	1.71×10^{-5}
3	0.10	0.20	3.41×10^{-5}

$RATE = k[A]^0[B]^1$
 $RATE = k[B]$

$1.70 \times 10^{-5} = k[.10]$
 $k = 1.7 \times 10^{-4}$
 $k = 1.7 \times 10^{-4} \text{ min}^{-1}$

units
 $\frac{M}{\text{min}} = \frac{k \cdot M}{M}$
 $\frac{1}{\text{min}} = k$



Trial	Initial [X]	Initial [Y]	Initial Rate of Formation of Z (M min ⁻¹)
1	1.00×10^{-3}	0.25×10^{-3}	0.26×10^{-9}
2	1.00×10^{-3}	0.50×10^{-3}	0.52×10^{-9}
3	1.00×10^{-3}	1.00×10^{-3}	1.04×10^{-9}
4	2.00×10^{-3}	1.00×10^{-3}	4.16×10^{-9}
5	3.00×10^{-3}	1.00×10^{-3}	9.36×10^{-9}

$RATE = k[X]^2[Y]^1$
 $RATE = k[X]^2[Y]$

$.26 \times 10^{-9} = k[1.00 \times 10^{-3}]^2[.25 \times 10^{-3}]$
 $k = 1.04$
 $k = 1.04 \text{ M}^{-2} \text{ min}^{-1}$

units
 $\frac{M}{\text{min}} = k \text{ M}^2 \cdot M$
 $k = \frac{1}{\text{M}^2 \text{ min}} = \text{M}^{-2} \text{ min}^{-1}$



Experiment	Initial [A]	Initial [B]	Initial Rate of Formation of C (M min ⁻¹)
1	1.00×10^{-2}	4.00×10^{-4}	6.00×10^{-3}
2	2.00×10^{-2}	4.00×10^{-4}	1.20×10^{-2}
3	4.00×10^{-2}	4.00×10^{-4}	2.40×10^{-2}
4	1.00×10^{-2}	8.00×10^{-4}	6.00×10^{-3}

$RATE = k[A]^1[B]^0$
 $RATE = k[A]$

$6.00 \times 10^{-3} = k[1.00 \times 10^{-2}]$
 $k = .600$
 $k = .600 \text{ min}^{-1}$

units
 $\frac{M}{\text{min}} = \frac{k \cdot M}{M}$
 $k = \frac{1}{\text{min}} = \text{min}^{-1}$

4. Consider the hypothetical chemical reaction where $5X + Y \rightarrow 2Z$

How fast does X disappear compared to Y? 5x's faster

How fast does X disappear compared to the formation of Z? 2.5x's faster

How fast does Z appear compared to the disappearance of Y? 2x's faster

5. Consider the following chemical reaction: $2A + B \rightarrow 2C$

Experiment	Initial [A]	Initial [B]	Initial Rate of Formation of C (M min ⁻¹)
1	3.0	1.0	4.6×10^{-3}

It states in the data table shown above that C forms at a rate of 4.6×10^{-3} M/min.

Based on that number, how fast did A disappear? BASED ON COEFFICIENTS FOR A + C
A DISAPPEARS AT SAME RATE
SO 4.6×10^{-3} M/min

How fast did B disappear?

COMPARING COEFFICIENTS OF B AND C,
 $\frac{4.6 \times 10^{-3}}{2} = 2.3 \times 10^{-3} \frac{M}{min}$

6. Consider the combustion of H₂ in the following chemical reaction.



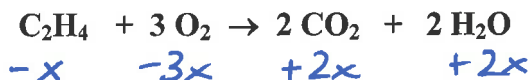
(a) If H₂ is burning at a rate of 0.82 mol/s, what is the rate of consumption of oxygen?

.41 mol/sec (compare coefficients of H₂ and O₂)

(b) If H₂ is burning at a rate of 0.82 mol/s, what would be the rate of formation of water vapor?

.82 mol/sec (compare coefficients of H₂ and H₂O)

7. Consider the combustion of ethylene in the following chemical reaction.



If the concentration of C₂H₄ is decreasing at a rate of 0.24 M/s, what are the rates of change in the concentrations of: oxygen, carbon dioxide, and water vapor?

$x = .24$ M/sec

O₂ $(.24)(3) = .72$ M/sec

CO₂ $(.24)(2) = .48$ M/sec
 H₂O $(.24)(2) = .48$ M/sec