CHEM 1412 Worksheet - Kinetics

1. The table presents data for the reaction: $2H_2(g) + 2NO(g) \rightarrow 2H_2O(g) + N_2(g)$
The temperature of the reaction is constant.

| | Initial Concentration (*M*) | | Initial Rate |
|---|---|---|---|
| Exp. | [NO] | $[H_2]$ | $-\Delta[NO]/\Delta t$ (*M/s*) |
| 1 | 0.60 | 0.10 | $1.8\times10^{-3}$ |
| 2 | 0.60 | 0.20 | $3.6\times10^{-3}$ |
| 3 | 0.10 | 0.60 | $3.0\times10^{-4}$ |
| 4 | 0.20 | 0.60 | $1.2\times10^{-3}$ |

Determine the rate law and the value of *k* for the above reaction system.

Calculate the necessary [NO] to achieve a rate of $8.0\times10^{-4}$ M/s when $[H_2] = 0.35$ M.

What is the rate of production of $N_2(g)$ in trial #3?

2. Initial rate data for the reaction: $2N_2O_5(g) \rightarrow 4NO_2(g) + O_2(g)$

| Exp. | $[N_2O_5]$ *M* | Rate (*M/s*) |
|---|---|---|
| 1 | 0.15 | 0.0046 |
| 2 | 0.20 | 0.0061 |

Write the rate law for the above reaction and determine k.

In experiment #2, what will $[N_2O_5]$ be after 1.0 min?

3. Rate = $k[NOCl]^2$ for the reaction $2NOCl \rightarrow 2NO + Cl_2$
Initially, 0.100 M NOCl is present, then after 12 minutes, 0.085 M remains.
Determine k for this reaction.

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4. Consider this reaction mechanism

$2CO + O_2 \rightarrow 2CO_2$ (slow)
$CO_2 + SO_2 \rightarrow CO + SO_3$ (fast)

Write the balanced equation for the overall reaction.

Write the rate law for the overall reaction.

5. Consider this reaction mechanism:

$H_2 \leftrightarrow 2H$ (fast)
$H + CO \rightarrow HCO$ (slow)
$H + HCO \rightarrow H_2CO$ (fast)

Write the balanced equation for the overall reaction.

Write the rate law for the overall reaction.

6. For each combination of sign for enthalpy and entropy (+ +, - -, + -, - +) determine whether the reaction is
   a) spontaneous at all temperatures
   b) non-spontaneous at all temperatures (spontaneous in the reverse direction
   c) spontaneous only at high temperatures
   d) spontaneous only at low temperatures

   Hint: use $\Delta G = \Delta H - T\Delta S$

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**Answers**

1. $k = 0.05\ M^{-2}s^{-1}$
   $[NO] = 0.214\ M$
   rate of $N_2 = 1.5\times10^{-4}\ M/s$

2. rate = $k[N_2O_5]$
   $k = 0.031\ s^{-1}$
   $[N_2O_5] = 0.005\ M$

3. $k = 0.0735\ M^{-1}min^{-1}$, or $0.00122\ M^{-1}s^{-1}$

4. $A + B \rightarrow C$, D is an intermediate
   rate = $k[A]^2[B]$

5. $H_2 + CO \rightarrow H_2CO_3$
   rate = $k[H_2]^{1/2}[CO]$

6. c, d, b, a