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AP Chemistry – Rates and Mechanisms – 56

Name _____Per ___

1. (a) From the following data for the first-order gas-phase isomerization of CH_3NC at 215°C, use a graphing calculator to determine the first-order rate constant:

Time(s)	0	2000	5000	8000	12000	15000
Pressure(torr)	502	335	180	95.5	41.7	22.4

(b) What is the half-life for the reaction?

2. (a) The activation energy for the isomerization of methyl isonitrile is 160.0 kJ/mole. Calculate the fraction of methyl isonitrile that have an energy of 160.0 kJ or greater at 500.0 K.

(b) Calculate this fraction for a temperature of 510.0 K. What is the ratio of the fraction at 510.0 K to that at 500.0 K?

3. The gas-phase reaction, $Cl_{(g)} + HBr_{(g)} \rightarrow HCl_{(g)} + Br_{2(g)}$, has an overall enthalpy change of -66 kJ. 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?

4. What is the molecularity of each of the following elementary processes? Write the rate law for each.
(a) $2NO_{(g)} \rightarrow N_2O_{2(g)}$

(b) $CH_2CH_2CH_{2(g)} \rightarrow CH_2CHCH_{3(g)}$

(c) $SO_{3(g)} \rightarrow SO_{2(g)} + O_{(g)}$

5. The following mechanism has been proposed for the reaction of NO with H_2 to form N_2O and H_2O:
$NO_{(g)} + NO_{(g)} \rightarrow N_2O_{2(g)}$ $\quad\quad$ $N_2O_{2(g)} + H_{2(g)} \rightarrow N_2O_{(g)} + H_2O_{(g)}$

(a) Show that the elementary steps of the proposed mechanism add to provide a balanced chemical equation for the reaction.

(b) Write a rate law for each elementary step in the mechanism.

(c) Identify any intermediates in the mechanism.

(d) The observed rate law is rate = $k[NO]^2[H_2]$. If the proposed mechanism is correct, what can we conclude about the relative speeds of the first and second steps?

6. The following data were measured for the reaction $BF_{3(g)} + NH_{3(g)} \rightarrow F_3BNH_{3(g)}$:

Experiment	$[BF_3]$ M	$[NH_3]$ M	Initial Rate (M/s)
1	0.250	0.250	0.2130
2	0.250	0.125	0.1065
3	0.200	0.100	0.0682
4	0.350	0.100	0.1193
5	0.175	0.100	0.0596

(a) What is the rate law for the reaction?

(b) What is the overall order of the reaction?

(c) What is the value of the rate constant for the reaction?

7. The reaction of nitrogen monoxide and bromine gas proceeds by the following reaction: $2NO_{(g)} + Br_{2(g)} \rightarrow 2NOBr_{(g)}$. The data that were collected for this experiment at $25^{\circ C}$ are below:

Experiment	Initial [NO] M	Initial [Br_2] M	Initial Rate of Appearance of NOBr M/s
1	0.0160	0.0120	3.24×10^{-4}
2	0.0160	0.0240	6.38×10^{-4}
3	0.0320	0.0060	6.42×10^{-4}

(a) Determine the initial rate of disappearance of $Br_{2(g)}$ for experiment 1.

(b) What is the order of each of the reactants? Explain.

(c) Write the rate law.

(d) Calculate the rate law constant. Don't forget the units.

(e) A chemist writes a proposed mechanism for the reaction indicating that $Br_{2(g)} + NO_{(g)} \rightarrow NOBr_{2(g)}$ is the rate limiting step, where the second step $NOBr_{2(g)} + NO_{(g)} \rightarrow 2\ NOBr_{(g)}$ is a fast process. Is this proposed mechanism supported by the experimentally derived rate law? Explain.