Chemistry 102

<div align="center">
REVIEW QUESTIONS
Chapter 14
</div>

1. Consider the reaction shown below:

$$A + 3B \rightarrow 2C + 2D$$
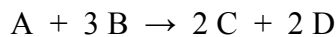
   a) Express the rate of this reaction in terms of concentrations of A, B, C and D.

   b) At some point in the reaction [B]=0.9986 M and 13.20 minutes later [B]=0.9746. Based on this data, what is the average rate of the reaction during this time in Ms^{-1}?

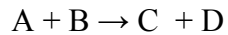2. The following data was collected for the reaction shown below:

$$2 HgCl_2 + C_2O_4^{2-} \rightarrow 2 Cl^- + 2 CO_2 + Hg_2Cl_2$$
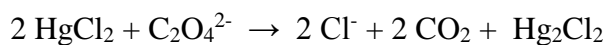
Expt.	$[HgCl_2]$ M	$[C_2O_4^{2-}]$ M	Initial Rate $M\ min^{-1}$
1	0.105	0.15	1.8×10^{-5}
2	0.105	0.30	7.1×10^{-5}
3	0.052	0.30	3.5×10^{-5}

   Determine the rate law for this reaction.

3. The following data was collected for the reaction shown below:

$$A + B \rightarrow C + D$$

Expt.	[A] M	[B] M	Initial Rate $M\ s^{-1}$
1	0.185	0.133	3.35×10^{-4}
2	0.185	0.266	1.35×10^{-3}
3	0.370	0.133	6.75×10^{-4}
4	0.370	0.266	????

a) Determine the rate law for this reaction.

b) Calculate the value of k for this reaction.

c) Calculate the rate of experiment 4.

4. The thermal decomposition of N_2O_5 to form NO_2 and O_2 is a first order reaction. The rate constant for the reaction is $5.1 \times 10^{-4} s^{-1}$ at 318 K. Calculate the half-life of this reaction.

5. The thermal decomposition of phosphine (PH_3) to phosphorus and hydrogen gas is a first order reaction, with a half-life of 35 s at 680°C.
   a) Calculate the rate constant for this reaction.

   b) Calculate the time required for 95% of phosphine to decompose.

6. The rate constant for the 2nd order reaction shown below is $0.54 M^{-1}$ at 300°C. How many seconds would it take for the concentration of NO_2 to decrease from 0.62 M to 0.28 M?

7. The gas phase decomposition of NO_2 to form NO and O_2 was studied at 383°C and the following data was collected:

| Time (s)	[NO_2], M
0.0	0.100
5.0	0.017
10.0	0.0090
15.0	0.0062
20.0	0.0047

Determine the order of this reaction with respect to [NO_2] and calculate the rate constant.

8. The reaction $2 N_2O_5 \rightarrow 4 NO_2 + O_2$ has an activation energy of 100 kJ/mol and an enthalpy of –23 kj/mol. Sketch a potential energy diagram for this reaction and determine the activation energy for the reverse reaction?
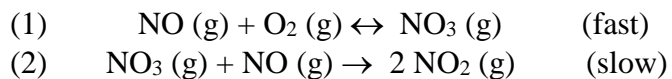
9. Shown below is an Arrhenius plot for the reaction:

$$CO\ (g) + NO_2\ (g) \rightarrow\ CO_2\ (g) + NO\ (g)$$
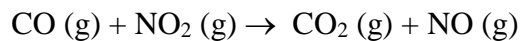
Based on this information, determine the activation energy (E_a) and the frequency factor (A) for this reaction. (Estimate your calculations to 3 sig figs.)
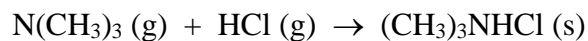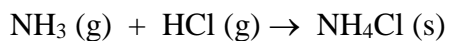

ln k vs. 1/T

$y = -16108x + 23.271$
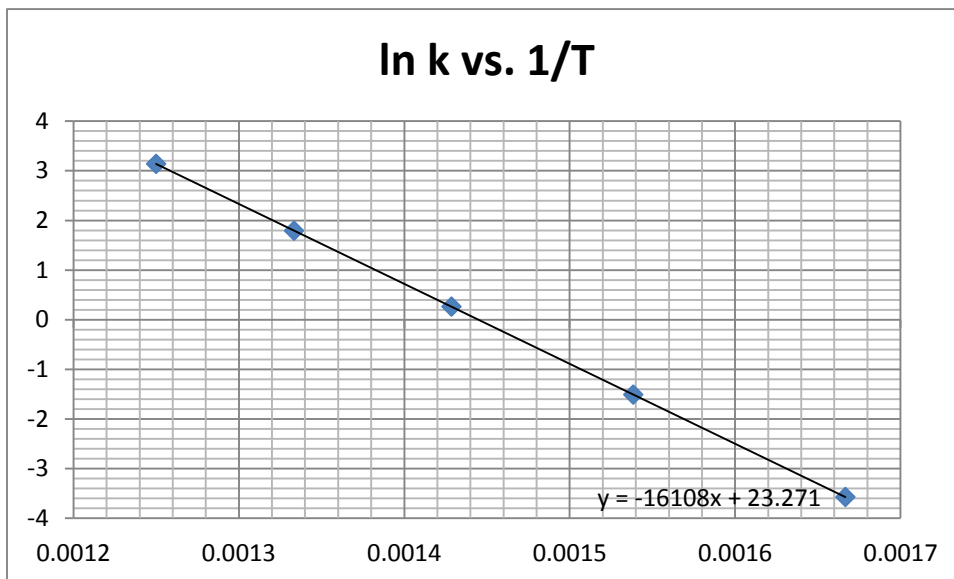
10. The reaction $2\ NO\ (g) + O_2\ (g) \rightarrow\ 2\ NO_2\ (g)$ was studied and the following mechanism was proposed:

(1) $NO\ (g) + O_2\ (g) \leftrightarrow\ NO_3\ (g)$ (fast)
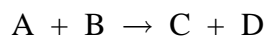(2) $NO_3\ (g) + NO\ (g) \rightarrow\ 2\ NO_2\ (g)$ (slow)

Determine the rate law based on this mechanism.

11. Assuming the activation energies are equal, which of the following reactions will occur at a higher rate at 50°C? (Hint: What factors affect the rate of a reaction)

$$NH_3 \text{ (g)} + HCl \text{ (g)} \rightarrow NH_4Cl \text{ (s)}$$

$$N(CH_3)_3 \text{ (g)} + HCl \text{ (g)} \rightarrow (CH_3)_3NHCl \text{ (s)}$$

12. The following rate data was collected for the reaction shown below:

$$A + B \rightarrow C + D$$

| Exp. #	[A] (M)	[B] (M)	Initial Rate (M/min)
1	0.50	1.50	4.2×10^{-3}
2	1.50	1.50	1.3×10^{-2}
3	3.00	3.00	5.2×10^{-2}

Determine the Rate Law and calculate the rate constant (k) for this reaction.

13. The following mechanism has been proposed for reaction of HBr with O_2 to form H_2O and Br_2

$$HBr + O_2 \rightarrow HOOBr$$

$$HOOBr + HBr \rightarrow 2\ HOBr$$

$$HOBr + HBr \rightarrow H_2O + Br_2$$
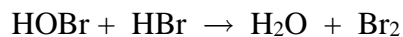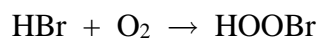
a) Identify all reaction intermediates in this reaction.

b) Write a balanced overall equation for this reaction. (Hint: you may have to multiply all the coefficients of an elementary reaction before adding)

14. The following mechanism has been proposed for the reaction of NO with H_2 to form N_2O and H_2O.

$$2\ NO\ (g) \rightarrow N_2O_2\ (g)$$

$$N_2O_2\ (g) + H_2\ (g) \rightarrow N_2O\ (g) + H_2O\ (g)$$
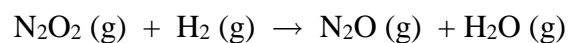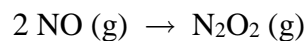
The observed rate law for this reaction is: Rate $= k\ [NO]^2\ [H_2]$. If the proposed mechanism is correct, what can we conclude about the relative speeds of the first and the second steps?

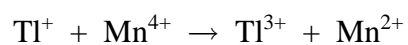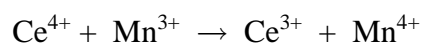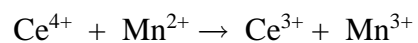15. The reaction below has been studied and the following experimental rate law determined:

$$H_2 + 2\ ICl \rightarrow 2\ HCl + I_2 \qquad Rate = k\ [H_2][ICl]$$
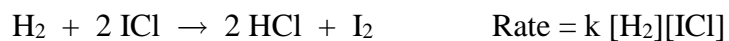
Three mechanisms have been proposed for this reaction. Predict the rate law based on each mechanism and determine which is consistent with the experimental rate law?

a) $2\ ICl + H_2 \rightarrow 2\ HCl + I_2$

b) $H_2 + ICl \rightarrow HI + HCl$ (slow)
       $HI + ICl \rightarrow HCl + I_2$ (fast)

c) $H_2 + ICl \rightarrow HI + HCl$ (fast)
       $HI + ICl \rightarrow HCl + I_2$ (slow)

16. The following mechanism has been proposed for the catalyzed oxidation of thallium (I) by cerium (IV):

$$Ce^{4+} + Mn^{2+} \rightarrow Ce^{3+} + Mn^{3+}$$

$$Ce^{4+} + Mn^{3+} \rightarrow Ce^{3+} + Mn^{4+}$$

$$Tl^{+} + Mn^{4+} \rightarrow Tl^{3+} + Mn^{2+}$$

a) Identify the catalyst and the intermediates in this mechanism.

b) Determine the overall equation for this reaction.

c) Explain why the reaction would be slow without the catalyst.