

University of Bahrain, Department of Chemistry
Chemistry 102, First Semester 2013-2014, 3rd hour examination
Time : 75 min

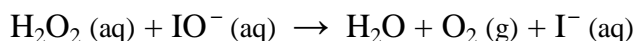
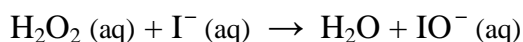
Instructors:

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Q1

(1 mark)

The reaction $2\text{H}_2\text{O}_2(\text{aq}) \rightarrow 2\text{H}_2\text{O} + \text{O}_2(\text{g})$ is believed to take place by a two-step path:



The catalyst in this reaction is I^-

Q2

(1 mark)

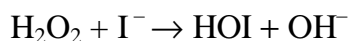
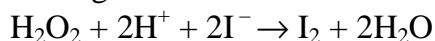
The rate law for the reaction $2\text{NO}_2 + \text{O}_3 \rightarrow \text{N}_2\text{O}_5 + \text{O}_2$ is $\text{rate} = k[\text{NO}_2][\text{O}_3]$. Which one of the following mechanisms is consistent with this rate law?

- A) $\text{NO}_2 + \text{NO}_2 \rightarrow \text{N}_2\text{O}_4$ (fast)
 $\text{N}_2\text{O}_4 + \text{O}_3 \rightarrow \text{N}_2\text{O}_5 + \text{O}_2$ (slow)
- B) $\text{NO}_2 + \text{O}_3 \rightarrow \text{NO}_5$ (fast)
 $\text{NO}_5 + \text{NO}_2 \rightarrow \text{N}_2\text{O}_5 + \frac{5}{2}\text{O}_2$ (slow)
- C) $\text{NO}_2 + \text{O}_3 \rightarrow \text{NO}_3 + \text{O}_2$ (slow)
 $\text{NO}_3 + \text{NO}_2 \rightarrow \text{N}_2\text{O}_5$ (fast)
- D) $\text{NO}_2 + \text{NO}_2 \rightarrow \text{N}_2\text{O}_2 + \text{O}_2$ (slow)
 $\text{N}_2\text{O}_2 + \text{O}_3 \rightarrow \text{N}_2\text{O}_5$ (fast)

Q3

(1 mark)

The following mechanism has been suggested for the reaction



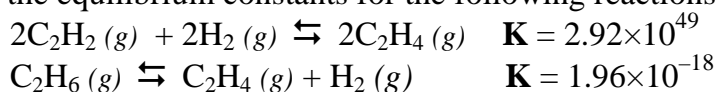
Identify all intermediates included in this mechanism.

- A) H^+ and I^-
- B) H^+ and HOI
- C) HOI and OH^-
- D) HOI only
- E) H_2O and OH^-

Q4

(2 marks)

Given the equilibrium constants for the following reactions

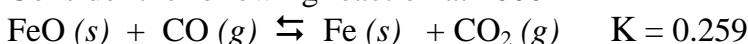
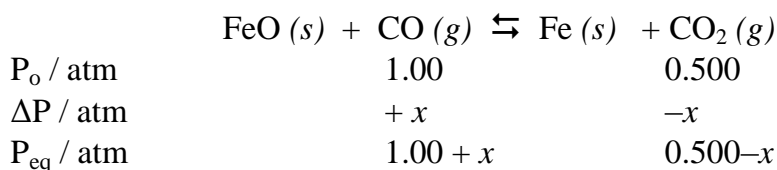
What is **K** for the reaction $\text{C}_2\text{H}_2(g) + 2\text{H}_2(g) \rightleftharpoons \text{C}_2\text{H}_6(g)$?

- a) 3.6×10^{53} b) 1.66×10^{21} c) 2.8×10^{42} d) 9.4×10^{-8} e) 1.1×10^7

Q5

(2.5 marks)

Consider the following reaction at 1000 K

What is the equilibrium partial pressure of CO_2 at 1000 K if the initial partial pressures are $P_{\text{CO}} = 1.000$ atm and $P_{\text{CO}_2} = 0.500$ atm ? *Show your work*Since $Q = 0.5 > K$, then reaction goes backward to achieve equilibrium.

$$(0.500 - x) / (1.00 + x) = 0.259 \Rightarrow x = 0.191 \text{ atm}$$

$$\therefore P_{\text{CO}_2} = 0.500 - x = 0.309 \text{ atm}$$

Q6

(1 mark)

Consider the equilibrium $\text{COCl}_2(g) \rightleftharpoons \text{CO}(g) + \text{Cl}_2(g)$ $\Delta H > 0$

Which of the following effects will shift the equilibrium to the right?

- I- The amount of CO is decreased.
- II- The amount of Cl_2 is increased.
- III- The temperature is increased.
- IV- The volume is decreased.

- a) II and IV b) I, III and IV c) II only d) IV only e) I and III

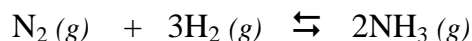
Q7

(2.5 marks)

A mixture consists initially of only N_2 and H_2 was allowed to come to equilibrium

at a given temperature $\text{N}_2(g) + 3\text{H}_2(g) \rightleftharpoons 2\text{NH}_3(g)$.

The mixture at equilibrium contains 2.0 atm of N_2 , 3.0 atm of H_2 , and 1.5 atm of NH_3 . What was the initial pressure of H_2 ? *Show your work*



P_o / atm	$P_o(\text{N}_2)$	$P_o(\text{H}_2)$	0
$\Delta P / \text{atm}$	$-x$	$-3x$	$+2x$
$P_{\text{eq}} / \text{atm}$	2.0	3.0	1.5

$$P_{\text{eq}}(\text{NH}_3) = 1.5 = 2x \Rightarrow x = 0.75 \text{ atm}$$

$$P_o(\text{H}_2) - 3x = 3.0 \Rightarrow P_o(\text{H}_2) = 5.25 \text{ atm}$$

Q8

(2 marks)

Arrange the following 0.1M aqueous solutions in order of increasing pH

FeCl_3 , LiClO_4 , $\text{Ba}(\text{OH})_2$, HNO_3 , NH_4CN [$K_a \text{NH}_4^+ = 5.6 \times 10^{-10}$,

$K_b \text{CN}^- = 1.7 \times 10^{-5}$]



Q9

(1 mark)

What is the pOH of 0.501 M HBr?

- a) 14.82 b) -0.823 c) 12.2 d) 0.823 e)
- 13.7

Q10

(2.5 marks)

The pH of 0.400 M NaNO₂ is 8.42, what is K_b for NO₂⁻? *Show your work*

$$\text{pH} = 8.42 \Rightarrow [\text{H}^+] = 3.80 \times 10^{-9} \text{ M} \ \& \ [\text{OH}^-] = 2.63 \times 10^{-6} \text{ M}$$



[] _o / M	0.400	0	0
Δ [] / M	-x	+x	+x
[] _{eq} / M	0.400-x	x	x

$$K_b = [x^2 / (0.400 - x)] \approx x^2 / 0.400 = (2.63 \times 10^{-6})^2 / 0.400$$

$$\therefore K_b = 1.73 \times 10^{-11}$$

Q11

(2 marks)

Classify each salt of the following as acidic, basic, or neutral in an aqueous solution.

Ba(CN)₂ basicNiBr₂ acidicNH₄NO₃ acidic

KI neutral