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SCH 4U0/R – F2018A – P. 1 Saxena

Unit 4 Test - Equilibrium Part

Excellent

KU = 7/7	TI = 11/11	CO...

Excellent

Please read all questions carefully before answering. In order to receive **full marks**, make sure to include complete and logical solutions to all problems, including units and significant digits where appropriate. Good luck ☺!

Part A: Knowledge and Understanding

1. Multiple choice (7 marks K): please answer all questions on your scantron card in pencil.

Part B: Thinking and Investigation & Communication

1 sig dig

* 1. 0.07 mol of HI(g), 0.020 mol $H_2(g)$ and 0.0050 mol of $I_2(g)$ are placed in a 500.0mL container at 445°C and react according to the equation below. Is the system is at equilibrium? If not, predict the direction in which the reaction will proceed to reach equilibrium. (3 marks T, 1 mark C)

unnecessary but cleaner

$2HI(g) \rightleftharpoons H_2(g) + I_2(g)$ $K_{eq} = 0.020$ at 445°C

$0.07 mol\ HI / 0.5L = 0.14 mol/L$

$0.020 mol\ H_2 / 0.5L = 0.04 mol/L$

$0.005 mol / 0.5L = 0.01 mol/L$ (I_2)

$Q_{eq} = 0.02$

$K_{eq} = 0.020$

$Q_{eq} = K_{eq}$

$$\frac{[H_2][I_2]}{[HI]^2} = Q_{eq} = \frac{(0.04\ mol/L)(0.01\ mol/L)}{(0.14\ mol/L)^2}$$

$$= \frac{4 \times 10^{-4}\ mol^2/L^2}{0.0196\ mol^2/L^2} = 0.020408163$$

$= 0.02041$

$Q_{eq} = 0.02041 = 0.02$ ← 1 sig dig

Q_{eq} is equal to K_{eq} so The substances are at equilibrium

3T + 1C

2. Calculate the solubility product constant at 25°C for silver iodide, AgI(s), given that its solubility at this temperature is 5.02x10^{-4} mol/L. (3 marks T, 1 mark C)

$X = 5.02 \times 10^{-4}\ mol/L$

$AgI_{(s)} \rightleftharpoons Ag^+_{(aq)} + I^-_{(aq)}$

$K_{sp} = X^2$

$K_{sp} = [Ag^+][I^-]$

$K_{sp} = (5.02 \times 10^{-4}\ mol/L)^2$

$= 2.52004 \times 10^{-7}$

3 sig figs

$= 2.52 \times 10^{-7}$

3T + ½C

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3. A chemist performs a titration between nitrous acid (HNO_2) and a 0.320 mol/L solution of potassium hydroxide (KOH), and records her results in the table below.

Volume of HNO_2(aq) analysed	10.00mL
Volume of KOH(aq) titrated	9.69mL
pH of HNO_2(aq) initially	1.92

Calculate the Ka of HNO_2(aq) using the data that the chemist collected. (5 marks T, 1 mark C)

$HNO_{2(aq)} + KOH_{(aq)} \rightleftharpoons H_2O_{(l)} + KNO_{2(s)}$

Calculate moles of KOH

$C_{KOH} = 0.320$ mol/L

$0.320 \text{ mol/L} = \frac{n}{9.69 \times 10^{-3} L}$

$n = 3.1008 \times 10^{-3}$ mol

1:1 ratio

Calculate moles of HNO_2

$C_{HNO_2} = ?$

$n_{HNO_2} = 3.1008 \times 10^{-3}$ mol

$V_{HNO_2} = 0.01 L$

$C = \frac{3.1008 \times 10^{-3}}{0.01 L}$

$= 0.31008$ mol/L

ICE Table

$H_2O_{(l)} + HNO_{2(aq)}$	$\rightleftharpoons H_3O^+_{(aq)}$	$+ NO^-_{2(aq)}$	
0.31008 mol/L	0	0	I
−x	+x	+x	C
0.31008 − x	0.0120226	0.0120226	E

~~I got the mark but solution is still, ignore this~~

$[H_3O^+] = 10^{-pH} = 10^{-1.92} = 0.0120226 = +x$

$Ka = \frac{(x)(x)}{(0.31008 - x)} = \frac{[H_3O^+][NO_2^-]}{[HNO_2]}$

$= \frac{x^2}{(0.31008 - x)}$

$Ka = \frac{(0.0120226)(0.0120226)}{(0.31008 \text{ mol/L} - 0.0120226) \text{ mol/L}}$

$= \frac{1.445 \times 10^{-4} \cancel{mol^2/L^2}}{0.298057}$ ← no units for Ka

$Al(OH)_3$

$= 4.85 \times 10^{-4}$ ← 3 sig digs

∴ The Ka of $HNO_{2(aq)}$ is 4.85×10^{-4}

5T + 1C