

Unit 4 Test - Equilibrium Part

KU = 7/7	TI = 11/11	CO =
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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 ☺!

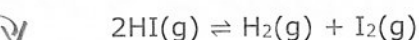
Part A: Knowledge and Understanding

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

Part B: Thinking and Investigation & Communication

1. 0.07 mol of HI(g), 0.020 mol H₂(g) and 0.0050 mol of I₂(g) are placed in a 500.0 mL container at 445°C and react according to the equation below. Is the system 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



$$K_{eq} = 0.020 \text{ at } 445^\circ\text{C}$$

$$0.07 \text{ mol HI} / 0.5 \text{ L} = 0.14 \text{ mol/L}$$

$$0.020 \text{ mol H}_2 / 0.5 \text{ L} = 0.04 \text{ mol/L}$$

$$0.005 \text{ mol I}_2 / 0.5 \text{ L} = 0.01 \text{ mol/L}$$

I₂

$$\frac{[\text{H}_2][\text{I}_2]}{[\text{HI}]^2} = Q_{eq} = \frac{(0.04 \text{ mol/L})(0.01 \text{ mol/L})}{(0.14 \text{ mol/L})^2}$$

$$= \frac{4 \times 10^{-4} \text{ mol}^2/\text{L}^2}{0.0196 \text{ mol}^2/\text{L}^2} = 0.02040816$$

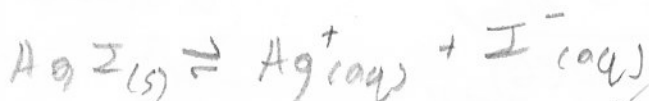
$$= 0.02041$$

$$Q_{eq} = 0.02041 \approx 0.0204 \text{ 1 sig dig}$$

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

2. Calculate the solubility product constant at 25°C for silver iodide, AgI(s), given that its solubility at this temperature is $5.02 \times 10^{-4} \text{ mol/L}$. (3 marks T, 1 mark C)

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



$$K_{sp} = x^2$$

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

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

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

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

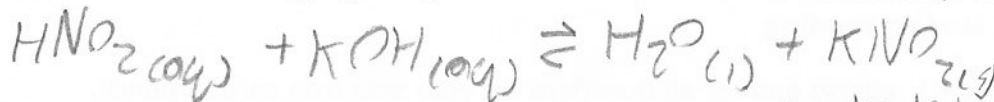
3 sig figs

3T + 1C

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 $\text{HNO}_2(\text{aq})$ analysed	10.00 mL
Volume of $\text{KOH}(\text{aq})$ titrated	9.69 mL
pH of $\text{HNO}_2(\text{aq})$ initially	1.92

Calculate the K_a of $\text{HNO}_2(\text{aq})$ using the data that the chemist collected. (5 marks T, 1 mark C)



calculate moles of KOH

$$C_{\text{KOH}} = 0.320 \text{ mol/L}$$

$$0.320 \text{ mol/L} = \frac{n}{4.69 \times 10^{-3} \text{ L}}$$

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

1:1 ratio

calculate moles of HNO_2

$$C_{\text{HNO}_2} = ?$$

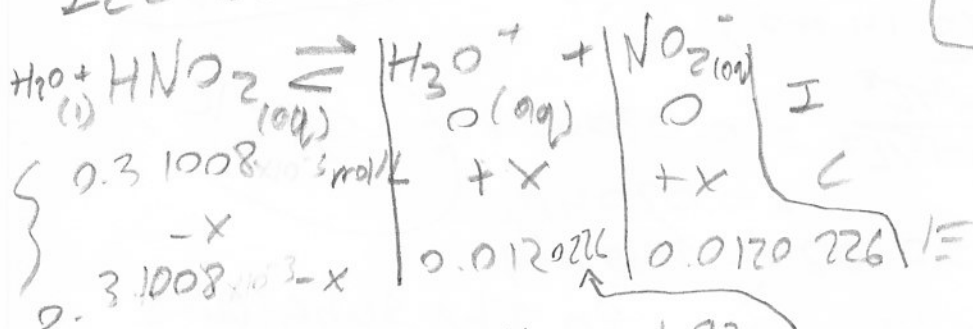
$$n_{\text{HNO}_2} = 3.1008 \times 10^{-3} \text{ mol}$$

$$V_{\text{HNO}_2} = 0.01 \text{ L}$$

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

$$= 0.31008 \text{ mol/L}$$

ICE Table



$$[\text{H}_3\text{O}^+] = 10^{-\text{pH}} = 10^{-1.92} = 0.0120226 = +x$$

$$K_a = \frac{(0.0120226)(0.0120226)}{(0.31008 - 0.0120226)}$$

$$= \frac{1.445 \times 10^{-4} \text{ mol}^2/\text{L}^2}{0.2980574 \text{ mol/L}}$$

$$= 4.85 \times 10^{-4}$$

3 sig figs

so the K_a of $\text{HNO}_2(\text{aq})$ is 4.85×10^{-4}

~~get the mark~~
but solution is still, ignore this

$$K_a = \frac{(x)(x)}{(0.31008 - x)} \frac{[\text{H}_3\text{O}^+]}{[\text{HNO}_2]}$$

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

5T + 1C