



ICE Tables Practice Worksheet

AP Chemistry - Unit 7 Equilibrium | K-Chemistry.com

Student Name: _____

Score: _____



Instructions

- **Critical Skill:** ICE tables are essential for Unit 7 (equilibrium) and Unit 8 (weak acids/bases)
- **Show all work** - Set up ICE table → Write equilibrium expression → Solve → Check units
- **Assumptions:** When x is small ($< 5\%$ of initial concentration), you can approximate
- **Check your work:** Does Q equal K at equilibrium? Are concentrations positive?
- **Target Time:** 90 minutes (9 min per problem average for Problems 1-10)

Section 1: Basic Equilibrium (Problems 1-5)

Problem 1

At 500 K, the equilibrium constant K_c for the reaction below is 0.040.



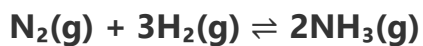
If you start with 2.00 M PCl_5 and no products, what are the equilibrium concentrations of all species?

	PCl_5	PCl_3	Cl_2
Initial (M)			
Change (M)			
Equilibrium (M)			

Work Space:

Problem 2

The equilibrium constant $K_p = 4.5 \times 10^{-3}$ at 720 K for the reaction:



A reaction vessel initially contains $P_{\text{N}_2} = 1.0 \text{ atm}$, $P_{\text{H}_2} = 3.0 \text{ atm}$, and $P_{\text{NH}_3} = 0 \text{ atm}$.

Calculate the equilibrium partial pressures.

	N_2	H_2	NH_3
Initial (atm)			
Change (atm)			
Equilibrium (atm)			

Work Space:

Problem 3

For the reaction $\text{H}_2(\text{g}) + \text{I}_2(\text{g}) \rightleftharpoons 2\text{HI}(\text{g})$, $K_c = 54.0$ at 425°C .

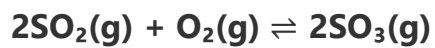
If a 1.0 L flask initially contains 0.80 mol H_2 , 0.80 mol I_2 , and 0 mol HI , what is the equilibrium concentration of HI ?

	H_2	I_2	HI
Initial (M)			
Change (M)			
Equilibrium (M)			

Work Space:

Problem 4

At 700 K, $K_p = 0.140$ for the reaction:



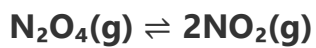
A mixture initially contains $P_{\text{SO}_2} = 0.50 \text{ atm}$, $P_{\text{O}_2} = 0.50 \text{ atm}$, and $P_{\text{SO}_3} = 0 \text{ atm}$. Find all equilibrium pressures.

	SO_2	O_2	SO_3
Initial (atm)			
Change (atm)			
Equilibrium (atm)			

Work Space:

Problem 5

The decomposition of N_2O_4 has $K_c = 0.36$ at 100°C :



If $[\text{N}_2\text{O}_4]_{\text{initial}} = 0.100 \text{ M}$ and $[\text{NO}_2]_{\text{initial}} = 0 \text{ M}$, calculate equilibrium concentrations.

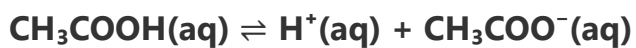
	N_2O_4	NO_2
Initial (M)		
Change (M)		
Equilibrium (M)		

Work Space:

Section 2: Weak Acids & Bases (Problems 6-10)

Problem 6

Calculate the pH of a 0.15 M solution of acetic acid (CH_3COOH). $K_a = 1.8 \times 10^{-5}$

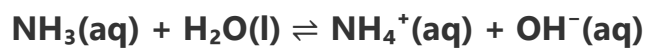


	CH_3COOH	H^+	CH_3COO^-
Initial (M)			
Change (M)			
Equilibrium (M)			

Work Space:

Problem 7

A 0.20 M solution of ammonia (NH_3) has $K_b = 1.8 \times 10^{-5}$. Calculate the pH.

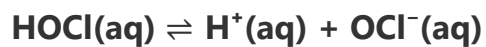


	NH_3	NH_4^+	OH^-
Initial (M)			
Change (M)			
Equilibrium (M)			

Work Space:

Problem 8

Hypochlorous acid (HOCl) has $K_a = 3.5 \times 10^{-8}$. What is the pH of a 0.050 M HOCl solution?

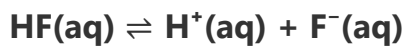


	HOCl	H ⁺	OCI ⁻
Initial (M)			
Change (M)			
Equilibrium (M)			

Work Space:

Problem 9

Calculate the percent ionization of 0.10 M hydrofluoric acid (HF). $K_a = 6.8 \times 10^{-4}$



Hint: Percent ionization = $([\text{H}^+]_{\text{eq}} / [\text{HF}]_{\text{initial}}) \times 100\%$

	HF	H ⁺	F ⁻
Initial (M)			
Change (M)			
Equilibrium (M)			

Work Space:

Problem 10

Pyridine ($\text{C}_5\text{H}_5\text{N}$) is a weak base with $K_b = 1.7 \times 10^{-9}$. Calculate the pH of a 0.25 M pyridine solution.



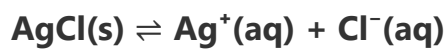
	$\text{C}_5\text{H}_5\text{N}$	$\text{C}_5\text{H}_5\text{NH}^+$	OH^-
Initial (M)			
Change (M)			
Equilibrium (M)			

Work Space:

Section 3: Solubility Equilibria - K_{sp} (Problems 11-15)

Problem 11

Calculate the molar solubility of AgCl in pure water. $K_{sp} = 1.8 \times 10^{-10}$

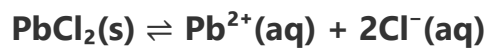


	AgCl(s)	Ag ⁺	Cl ⁻
Initial (M)	—		
Change (M)	—		
Equilibrium (M)	—		

Work Space:

Problem 12

What is the molar solubility of PbCl_2 in pure water? $K_{\text{sp}} = 1.7 \times 10^{-5}$



	Pb^{2+}	Cl^{-}
Initial (M)		
Change (M)		
Equilibrium (M)		

Work Space:

Problem 13

Calculate the solubility of $\text{Mg}(\text{OH})_2$ in grams per liter. $K_{\text{sp}} = 5.6 \times 10^{-12}$

Molar mass $\text{Mg}(\text{OH})_2 = 58.32 \text{ g/mol}$



	Mg^{2+}	OH^{-}
Initial (M)		
Change (M)		
Equilibrium (M)		

Work Space:

Problem 14 - Common Ion Effect

What is the molar solubility of AgCl in a 0.10 M NaCl solution? $K_{sp} = 1.8 \times 10^{-10}$



Challenge: NaCl provides Cl^- ions \rightarrow common ion effect!

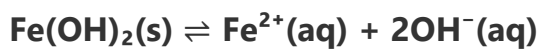
	Ag^+	Cl^-
Initial (M)		
Change (M)		
Equilibrium (M)		

Work Space:

Problem 15 - pH and Solubility

Calculate the molar solubility of $\text{Fe}(\text{OH})_2$ in a solution buffered at $\text{pH} = 9.0$.

$$K_{\text{sp}} = 4.9 \times 10^{-17}$$



Advanced: $\text{pH} = 9.0$ means $\text{pOH} = 5.0$, so $[\text{OH}^{-}] = 1.0 \times 10^{-5} \text{ M}$

	Fe^{2+}	OH^{-}
Initial (M)		
Change (M)		
Equilibrium (M)		

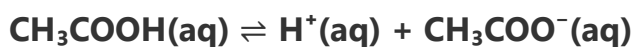
Work Space:

Section 4: Advanced - Buffers & Multiple Equilibria (Problems 16-20)

Problem 16 - Buffer Solution

A buffer contains 0.50 M CH_3COOH and 0.50 M CH_3COONa . Calculate the pH.

$$K_a = 1.8 \times 10^{-5}$$



Work Space:

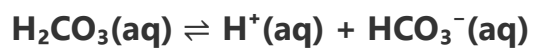
Problem 17

What is the pH after adding 0.10 mol HCl to 1.0 L of the buffer in Problem 16?

Work Space:

Problem 18

Calculate $[H^+]$ in a 0.10 M H_2CO_3 solution. $K_{a1} = 4.3 \times 10^{-7}$

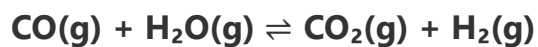


	H_2CO_3	H^+	HCO_3^-
Initial (M)			
Change (M)			
Equilibrium (M)			

Work Space:

Problem 19

A mixture initially contains 0.40 M CO and 0.40 M H₂O. At equilibrium, [CO₂] = 0.20 M. Calculate K_c.



	CO	H ₂ O	CO ₂	H ₂
Initial (M)				
Change (M)				
Equilibrium (M)				

Work Space:

Problem 20 - Challenge!

At 100°C, $K_p = 60.6$ for the reaction:



A 2.0 L flask initially contains 0.80 mol NOBr. Calculate equilibrium pressures (assume ideal gas, $R = 0.0821 \text{ L}\cdot\text{atm}/(\text{mol}\cdot\text{K})$, $T = 373 \text{ K}$).

Work Space:

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Teacher: Mr. Hisham Mahmoud

Unit 7: Equilibrium | **Connection:** Essential for Unit 8 (Acids & Bases)

 **Practice Daily** •  **Master ICE Tables** •  **You've Got This!**