

INFORMATION, SCRAP, AND COVER PAGE

This page contains information which may or may not be needed. This page can also be used for scrap paper or for cover paper. THIS PAGE WILL NOT BE COLLECTED. TEAR THIS PAGE OFF THE EXAM. DO NOT TURN IN THIS PAGE.

$$R = 0.08206 \text{ atm} \cdot \text{L}/(\text{mol} \cdot \text{K}) = 8.314 \text{ J}/(\text{mol} \cdot \text{K}) \text{ or } \text{J}/\text{K}$$

$$T(\text{K}) = T(^{\circ}\text{C}) + 273$$

Free energy $\Delta G^{\circ} = -RT \ln K$

Quadratic Equation
$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

Henderson-Hasselbalch
$$\text{pH} = \text{p}K_a + \log \frac{\text{base}}{\text{acid}}$$

Acid Dissociation constants, K_a

Name	Formula	Alternate	(Step)	K_a
acetic acid	$\text{CH}_3\text{CO}_2\text{H}$	$\text{CH}_3\text{C}(\text{O})\text{OH}$		1.8×10^{-5}
arsenic acid	H_3AsO_4	$\text{OAs}(\text{OH})_3$	(1)	4.9×10^{-3}
			(2)	8.9×10^{-8}
			(3)	3.2×10^{-12}
benzoic acid	$\text{C}_6\text{H}_5\text{CO}_2\text{H}$	$\text{C}_6\text{H}_5\text{C}(\text{O})\text{OH}$		6.3×10^{-5}
dichloroacetic acid	$\text{Cl}_2\text{CHCO}_2\text{H}$	$\text{Cl}_2\text{CHC}(\text{O})\text{OH}$		5.0×10^{-2}

Base Dissociation Constants, K_b

Name	Formula	Alternate	K_b
triethylamine	$(\text{C}_2\text{H}_5)_3\text{N}$	$(\text{CH}_3\text{CH}_2)_3\text{N}$	5.2×10^{-4}
pyridine	$\text{C}_5\text{H}_5\text{N}$		1.7×10^{-9}

Solubility Products, K_{sp}

Name	Formula	K_{sp}	Name	Formula	K_{sp}
barium chromate	BaCrO_4	1.2×10^{-10}	lead(II) chloride	PbCl_2	1.7×10^{-5}
calcium sulfate	CaSO_4	4.9×10^{-5}	magnesium fluoride	MgF_2	5.2×10^{-11}
iron(II) hydroxide	$\text{Fe}(\text{OH})_2$	4.9×10^{-17}	silver chloride	AgCl	1.8×10^{-10}

PRINT NAME _____

SIGN NAME _____

CIRCLE your recitation section in the list below.

A: M 9:00 NS 317

B: M 10:00 NS 317

C: T 11:00 NS 128

D: W 8:00 HM 207

E: W 12:00 DA 209A

F: Th 4:00 HM 210

SCORED GRADE: _____

All answers should be with the correct significant figures.

The Periodic Table and the Information Page will not be collected. They can be used as scratch paper or as cover paper. Do not turn them in.

Be certain your answers are clear. If an answer is not clear, it can be considered wrong.

Problems marked with ** in the margin are derived from the assigned homework. These total 40 points.

Place your name in the space provided at the top of each question page. This helps to identify the pages if they are accidentally separated during grading and processing.

Work promptly. Use your time effectively.

****KEEP YOUR WORK AND ANSWERS COVERED.****

1. (30 pts) Indicate whether each statement is true (T) or false (F). Be certain T or F is clearly indicated.

- _____ A basic solution has $\text{pOH} > 7$.
- _____ Hydrogen oxalate ion is amphoteric.
- _____ Bicarbonate ion is the conjugate base of carbonate ion.
- _____ Hypochlorous acid is polyprotic.
- _____ HPO_4^{2-} has a higher $\text{p}K_a$ than H_2PO_4^- .
- _____ 0.010 M KOH has a lower pH than 0.01 M NH_3 .
- _____ The basicity of ammonia arises from a lone pair in an sp^3 hybrid orbital which can pull H^+ from an acid, at least to some extent.
- _____ At standard conditions, dissociation of a weak acid is exergonic.
- _____ Nitrite ion is basic.
- _____ Lead(II) chloride has a significant base dissociation effect.

2. (6 pts) A solution contains 0.010 M Ag^+ and you want to recover the majority of the Ag^+ ion from this. The silver ion can be precipitated using Cl^- to form AgCl . Circle the concentration (in M) of Cl^- which must be present at equilibrium in order to have $[\text{Ag}^+] = 1.2 \mu\text{M}$.

- | | | | | | |
|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|
| 1.9×10^{-6} | 3.5×10^{-6} | 5.3×10^{-6} | 7.1×10^{-6} | 8.6×10^{-6} | 2.1×10^{-5} |
| 4.8×10^{-5} | 6.4×10^{-5} | 7.5×10^{-5} | 9.0×10^{-5} | 1.5×10^{-4} | 3.7×10^{-4} |

- ** 3. (6 pts) A solution contains 0.256 g perchloric acid in 800. mL of solution. Circle the pH.

- | | | | | | |
|------|------|------|------|------|------|
| 1.06 | 1.32 | 1.60 | 2.31 | 2.50 | 2.78 |
| 3.26 | 3.40 | 3.61 | 4.12 | 4.38 | 4.53 |

last name: _____

- ** 4. (8 pts) 0.0126 mol triethylamine, $(C_2H_5)_3N$, was dissolved into water to produce 300.0 mL of solution. Circle the concentration (in M) of $(C_2H_5)_3NH^+$ at equilibrium.

0.0032 0.0035 0.0038 0.0041 0.0044 0.0047
0.0050 0.0053 0.0056 0.0059 0.0062 0.0065

Circle the percent dissociation. Above answer must be correct for credit here.

2.7% 3.6% 4.8% 5.0% 6.3% 7.6%
8.3% 9.0% 10.% 12% 13% 14%

5. (5 pts) Consider the metal complex formed by a cobalt(II) cation, four ammonia ligands, and two fluoride ligands.

What is the charge of the complex? _____

What is the shape of the complex? _____

- ** 6. (6 pts) Of the following acids, CIRCLE the one which is the strongest. UNDERLINE the one which is the weakest.

HIO HBrO₃ HBrO₂ HClO₃ HClO₂ HClO

7. (5 pts) 0.00200 mol of the weak base imidazole, $C_3H_4N_2$, is dissolved in 250. mL solution. The pH at equilibrium is measured to be 9.45. Circle the value of K_b .

3.2×10^{-9} 8.7×10^{-9} 4.9×10^{-8} 9.8×10^{-8} 2.4×10^{-7} 7.1×10^{-7}
 3.6×10^{-6} 8.3×10^{-6} 2.3×10^{-5} 6.4×10^{-5} 3.5×10^{-4} 7.9×10^{-4}

last name: _____

- ** 8. (3 pts) Give the formula of the conjugate base of ammonium ion. _____
(3 pts) Give the formula of the product of the
deprotonation of hydrofluoric acid. _____

- ** 9. (8 pts) A buffer solution is prepared from 0.0608 mol $\text{CH}_3\text{CO}_2\text{H}$ and 0.0163 mol NaCH_3CO_2 in 1.00 L total volume. Circle the initial pH.

3.82	3.98	4.17	4.36	4.52	4.66
4.81	5.02	5.13	5.31	5.53	5.60

Circle the pH after adding 1.6 mmol HNO_3 . (Above answer must be correct for credit here.)

3.81	3.88	3.92	4.11	4.40	4.53
4.63	4.76	4.96	5.21	5.30	5.55

10. (8 pts) Indicate whether separate solutions of each of the following are acidic (A), basic (B) or neutral (N).

K_2HAsO_4 _____ piperidinium chloride _____ $\text{Bi}(\text{ClO}_4)_3$ _____ $\text{Ba}(\text{CN})_2$ _____

- ** 11. (6 pts) Derive the equation for solubility with complex formation for copper(I) chloride using cyanide as the ligand, to form the complex $\text{Cu}(\text{CN})_4^{3-}$. Put only the final answer on the line below; only that will be graded. Phases are not needed.
- _____

12. (6 pts) Circle the solubility (in M) of $\text{Fe}(\text{OH})_2$ in a solution of KOH which is initially at pH 9.84.

4.9×10^{-9}	8.3×10^{-9}	1.0×10^{-8}	3.1×10^{-8}	4.6×10^{-8}	7.3×10^{-8}
9.8×10^{-8}	1.4×10^{-7}	3.5×10^{-7}	4.1×10^{-7}	6.5×10^{-7}	7.8×10^{-7}