

Name _____

TA's Name _____

Section _____

INSTRUCTIONS:

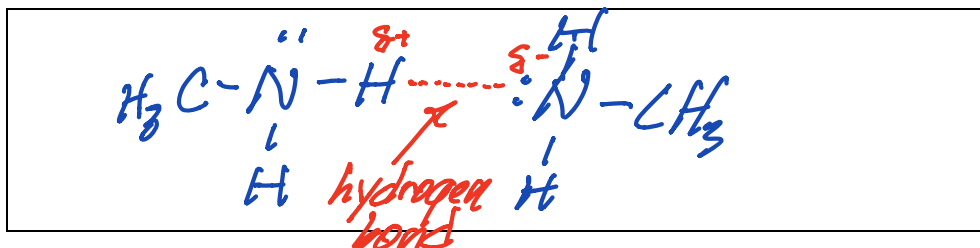
1. This examination consists of a total of 11 different pages. The last three pages include a periodic table, a table of vapor pressures for water, a solubility table and a table of thermodynamic values. All work should be done in this booklet.
2. PRINT your name, TA's name and your lab section number now in the space at the top of this sheet. DO NOT SEPARATE THESE PAGES.
3. Answer all questions that you can and whenever called for show your work clearly. Your method of solving problems should pattern the approach used in lecture. You do not have to show your work for the multiple choice or short answer questions.
4. No credit will be awarded if your work is not shown in 2c and 2e.
5. Point values are shown next to the problem number.
6. Budget your time for each of the questions. Some problems may have a low point value yet be very challenging. If you do not recognize the solution to a question quickly, skip it, and return to the question after completing the easier problems.
7. Look through the exam before beginning; plan your work; then begin.
8. **Relax** and do well.

	Page 2	Page 3	Page 4	Page 5	MC	TOTAL
SCORES	_____	_____	_____	_____	_____	_____
	(24)	(20)	(12)	(11)	(33)	(100)

(44) 1. Consider the following experimental data for the three compounds provided.

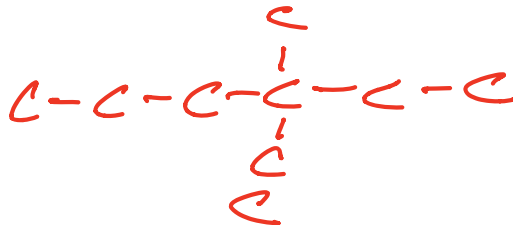
Compound	Boiling Point (°C)	Polarity
CH ₃ NH ₂ (l)	-6.6	
CH ₃ OH(l)	64.7	
CH ₃ CH ₃ (l)	-88.5	

- a) Complete the table above by indicating the polarity of each compound. (3 pts)
- b) Identify the intermolecular attractive forces that are present in liquid CH₃OH and liquid CH₃CH₃. Also in each compound identify the most important intermolecular attractive force. (6 pts)
- c) Using complete Lewis structures, draw at least two molecules of CH₃OH in the box below. Clearly show (with a dashed line) and label the most important intermolecular attractive force that occurs in the liquid phase of CH₃OH. (6 pts)



- d) Which compound has stronger intermolecular attractive forces: CH₃NH₂ or CH₃OH? What evidence do you have to support your prediction? (2 pts)
- e) Based on the types of intermolecular attractive forces present in each compound, explain your prediction in 1d. (7 pts)





1. Continued

f) Write a chemical equation that would represent the phase change from liquid to gas for CH_3CH_3 . (2 pts)



i. What is the sign of ΔH° for this phase change? (2 pts)

+

ii. What is the sign of ΔS° for this phase change? (2 pts)

+

iii. Is this phase change favored at high temperature or low temperature? Explain. (4 pts)

$$\longrightarrow \Delta G = \Delta H - T\Delta S$$

+
+

-
+

g) If liquid CH_3CH_3 is mixed with liquid CH_3OH , is the result going to be a homogeneous mixture or a heterogeneous mixture? Explain. (NOTE: Your explanation must be in terms of the solution process and include the thermodynamic quantities that are involved.) (10 pts)

$$\Delta H_{\text{soln}}^\circ \approx \Delta H_{\text{solute-solute}} + \Delta H_{\text{solvent-solvent}} +$$

IMAF
IMAF

$$\Delta S_{\text{soln}}^\circ +$$

↓ + or -

$$\Delta H_{\text{solute-solvent}}$$

IMAF

(23) 2. When methylamine, CH_3NH_2 is mixed with water a reaction occurs. A student obtains a 50.0 mL sample of an aqueous solution of methylamine and determines the pH of the solution to be 11.77. ($K_b(\text{CH}_3\text{NH}_2) = 6.4 \times 10^{-4}$)

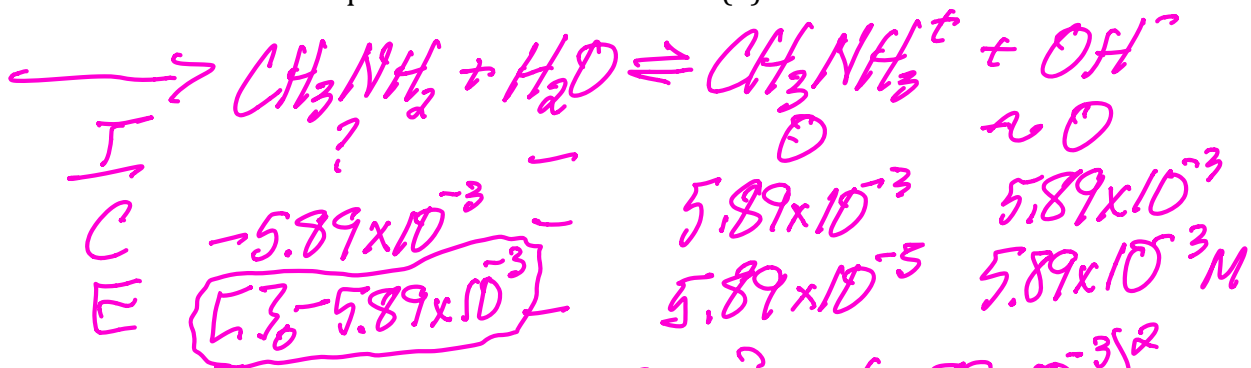
- a) Write the balanced chemical equation that describes what happens when methylamine is added to water. (3)



- b) Calculate the $[\text{OH}^-]$ in the 50.0 mL sample of methylamine. (3)

$$\begin{aligned} \text{pH} &= 11.77 \\ \text{pOH} &= 14 - 11.77 = 2.23 \\ \text{pOH} &= -\log[\text{OH}^-] = 2.23 = -\log[\text{OH}^-] \\ \rightarrow [\text{OH}^-] &= 10^{-2.23} = 5.89 \times 10^{-3} \text{ M} \end{aligned}$$

- c) Calculate the initial concentration of the CH_3NH_2 in the solution before it reacted with water and equilibrium was established. (6)



$$\left[6.4 \times 10^{-4} = K_b = \frac{[\text{CH}_3\text{NH}_3^+][\text{OH}^-]}{[\text{CH}_3\text{NH}_2]} = \frac{(5.89 \times 10^{-3})^2}{[]_0 - 5.89 \times 10^{-3}} \right]$$

$$6.4 \times 10^{-4} = \frac{3.47 \times 10^{-5}}{[]_0 - 5.89 \times 10^{-3}}$$

$$[]_0 - 5.89 \times 10^{-3} = \frac{3.47 \times 10^{-5}}{6.4 \times 10^{-4}} = 0.054$$

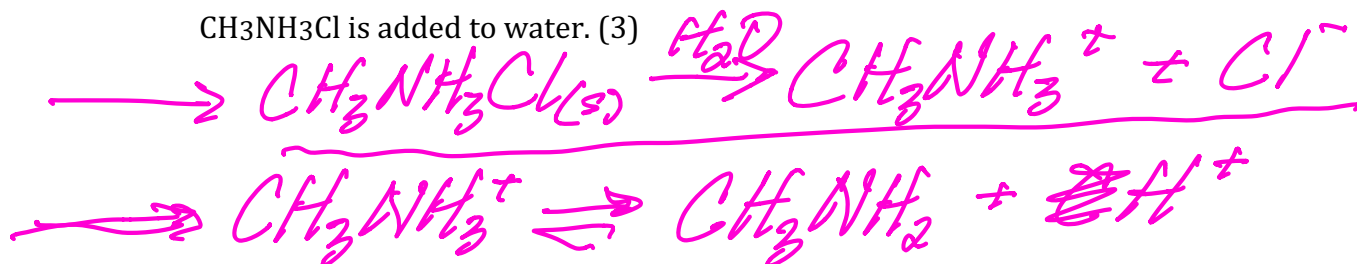
$$[]_0 - 5.89 \times 10^{-3} = 0.054$$

$$\begin{aligned} []_0 &= 0.054 + 0.00589 \\ &= 0.0601 \text{ M} \end{aligned}$$

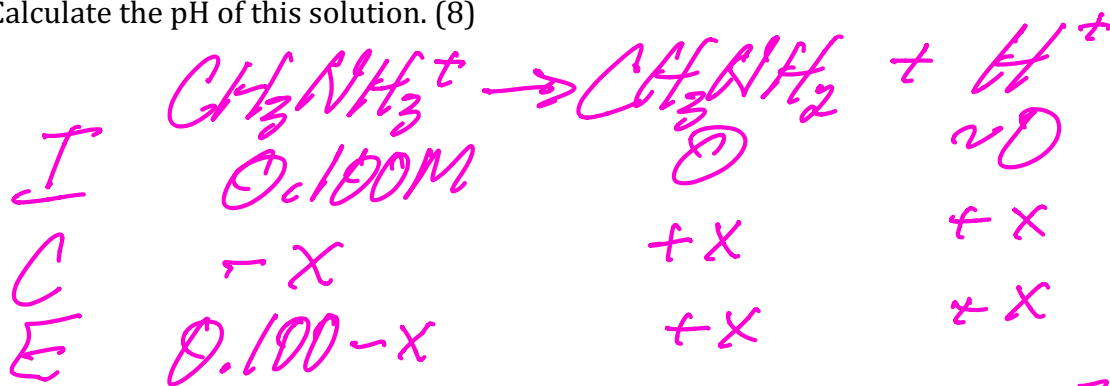
$$\frac{6.75 \text{ g}}{67.5 \text{ g/mol}} = 0.100 \text{ mol} = 1 \text{ M}$$

In another experiment 6.75 grams of $\text{CH}_3\text{NH}_3\text{Cl}$, the salt of a weak base and a strong acid, is added to enough water to prepare 100.0 mL of solution.

- d) Write the balanced chemical equation(s) that describes what happens when $\text{CH}_3\text{NH}_3\text{Cl}$ is added to water. (3)



- e) Calculate the pH of this solution. (8)



$$K_a = \frac{K_w}{K_b(\text{CH}_3\text{NH}_2)} = \frac{[\text{CH}_3\text{NH}_2][\text{H}^+]}{[\text{CH}_3\text{NH}_3^+]}$$

$$\frac{1 \times 10^{-14}}{6.4 \times 10^{-4}} = \frac{(x)^2}{0.100 - x}$$

$$1.56 \times 10^{-11} = \frac{x^2}{0.100 - x} \quad x \ll 0.1$$

$$1.36 \times 10^{-12} = x^2$$

$$1.25 \times 10^{-6} = x = [\text{H}^+]$$

$$\text{pH} = -\log(1.25 \times 10^{-6})$$

$$= 5.90$$

- (23) 4a. Calculate the pH of a 500. mL sample of a solution that is 0.325 M $\text{HC}_3\text{H}_5\text{O}_2$ and 0.300 M $\text{NaC}_3\text{H}_5\text{O}_2$. (10 pts)

$$0.500 \text{ L} \left(\frac{0.300 \text{ mol C}_3\text{H}_5\text{O}_2^-}{\text{L}} \right) = 0.150 \text{ mol C}_3\text{H}_5\text{O}_2^-$$



I	0.325 M	0	0.300 M
---	---------	---	---------

C	-x	+x	+x
---	----	----	----

E	0.325-x	+x	0.300+x
---	---------	----	---------

$$K_a = \frac{[\text{H}^+][\text{C}_3\text{H}_5\text{O}_2^-]}{[\text{HC}_3\text{H}_5\text{O}_2]} = \frac{x(0.300+x)}{0.325-x}$$

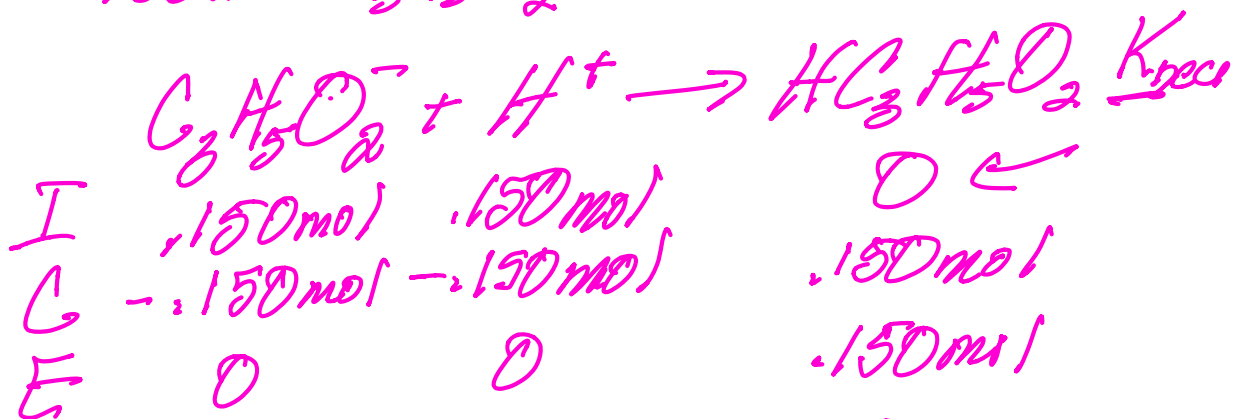
- b) Calculate the pH of the solution in Question 4a following the addition of 0.025 mol of $\text{HCl}(g)$. (12 pts)

- c) Considering an original 500 mL sample of the solution in part 3a, how many moles of a strong acid would have to be added to destroy the buffer? Justify your claim with a calculation. (5)

4aC₃H₅O₂. (10 pts)

$$0.500 \text{ L} \left(\frac{.300 \text{ mol C}_3\text{H}_5\text{O}_2}{\text{L}} \right) = 0.150 \text{ mol C}_3\text{H}_5\text{O}_2^-$$

$$.150 \text{ mol C}_3\text{H}_5\text{O}_2^-$$



.150 mol strong acid are required to 'destroy' the buffer.

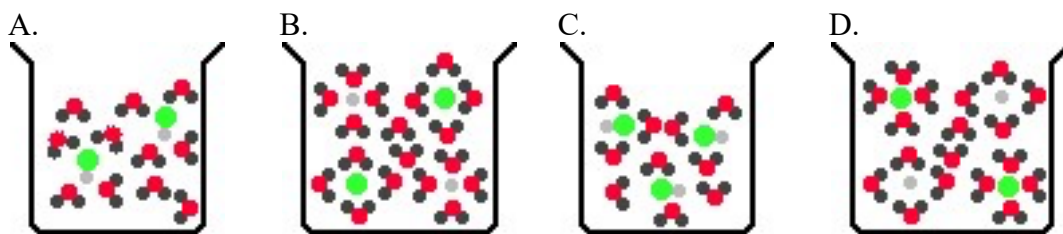
Multiple Choice: (33 points)

Print the letter (A, B, C, D, E) which corresponds to the answer selected.

3. _____ 4. _____ 5. _____ 6. _____
 7. _____ 8. _____ 9. _____ 10. _____
 11. _____ 12. _____ 13. _____

ONLY THE ANSWERS IN THE AREA ABOVE WILL BE GRADED. Select the most correct answer for each question. Each question is worth 3 points.

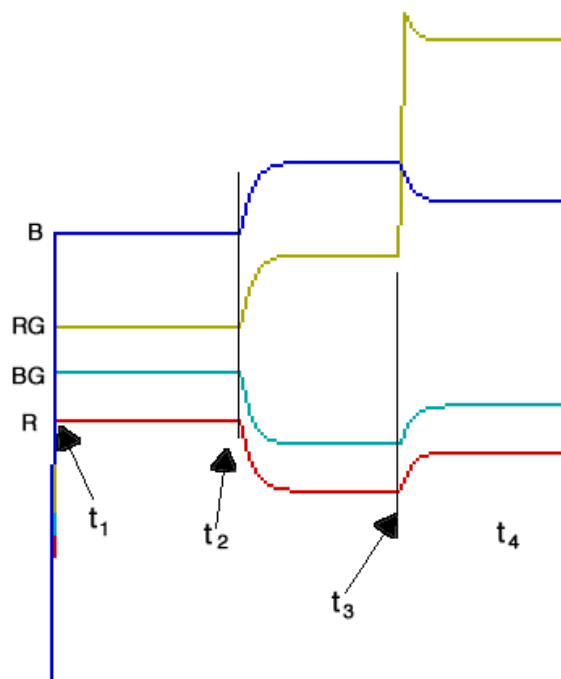
3. All of the following species can function as Bronsted-Lowry acids in solution EXCEPT
 A. H_2O
 B. CCl_3COOH
 C. CH_3NH_3^+
 D. HCO_3^-
 E. S^{2-}
4. Which of the images below best represents an ionic compound like NaCl dissolved in water?



5. From the following list of aqueous solutions and water, select the one with the lowest ideal freezing point.
 A. 0.50 *m* NaCl
 B. 0.25 *m* Na_2SO_4
 C. 0.35 *m* NaClO_3
 D. 0.75 *m* $\text{C}_6\text{H}_{12}\text{O}_6$ (glucose)
 E. 0.50 *m* CH_3COOH
6. Select the strongest electrolyte from the following set.
 A. $\text{C}_2\text{H}_5\text{COOH}$ (propionic acid)
 B. $(\text{NH}_2)_2\text{CO}$, urea
 C. $\text{C}_6\text{H}_{12}\text{O}_6$, fructose
 D. CH_3NH_2 (methylamine)
 E. NaHSO_4 (sodium bisulfate)

7. Determine the concentration of ammonium ions, NH_4^+ , that are present when 50.0 mL of 3.00 M $(\text{NH}_4)_2\text{CO}_3$ are mixed with 100. mL of 2.00 M NH_4NO_3 ?
- A. 1.33 M
B. 2.33 M
C. 3.33 M
D. 4.33 M
E. 6.33 M
8. Which of the following statements describes the correct method of preparation of 1.00 kg of solution that is also a 5.0 molal sodium chloride solution? MM sodium chloride = 58.5 g mol^{-1}
- A. Dissolve 292 g of sodium chloride in 0.708 kg of distilled water
B. Dissolve 708 g of sodium chloride in 292 g of distilled water.
C. Dissolve 292 g of sodium chloride in 1.00 kg of distilled water.
D. Dissolve 226 g of sodium chloride in 774 g of distilled water.
9. A sample of water placed in an evacuated container exerts a pressure of 485 mmHg at 90.0°C . The container is cooled to 80.0°C . Which of the following is true at 80°C ;
- A. liquid and vapor exist and the vapor pressure is 472 mmHg
B. vapor only and the pressure is 355 mmHg.
C. vapor only and the pressure is 472 mmHg.
D. liquid and vapor exist and the vapor pressure is 355 mmHg
10. Which of the following solutions will have the lowest pH?
- A. 0.100 M H_2SO_4
B. 0.100 M NaOH
C. 0.100 M $\text{HC}_2\text{H}_3\text{O}_2$
D. 0.100 M $\text{HC}_2\text{H}_3\text{O}_2$ and 0.100 M $\text{NaC}_2\text{H}_3\text{O}_2$

Answer Questions 11 - 13 based on the chart recording below.



11. Above is a chart recording depicting the reaction
- $$R + BG \rightleftharpoons RG + B$$
- At t_1 some amounts of R, BG, RG and B have been added to the reaction vessel. At t_2 the reaction as described in the chemical equation above occurs.
- Based on the chart recording, which of the following statement is true?
- A) The reaction is at equilibrium at some time from t_1 to t_2 .
- B) The reaction is at equilibrium at some time from t_2 to t_3 .
- C) The temperature of the products was increased at t_2 .
- D) At t_2 some amounts of reactants were added and some amounts of products were removed from the container.
12. Based on the chart recording, which of the following statement is true?
- A) At t_3 some additional RG was added to the container.
- B) At t_3 a catalyst was added to the container.
- C) At t_3 the temperature of the reaction container was increased.
- D) At t_3 R and BG was added to the container and B was removed from the container.
13. Based on the chart recording, which of the following statement is true?
- A) During t_4 the temperature of the container is increased again.
- B) During t_4 the reaction is proceeding from right to left to establish equilibrium.
- C) During t_4 the reaction proceeds from left to right to establishes equilibrium, but it will require more time before equilibrium is established.
- D) During t_4 the reaction is slowing down.

Periodic Table of the Elements

	IA																VIII A	
1	1 H 1.008	IIA										III A	IVA	VA	VIA	VII A	2 He 4.00	
2	3 Li 6.94	4 Be 9.01										5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18	
3	11 Na 22.99	12 Mg 24.30	IIIB	IVB	VB	VIB	VII B	VIII		IB	IIB	13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.06	17 Cl 35.45	18 Ar 39.95	
4	19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.88	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.38	31 Ga 69.72	32 Ge 72.59	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80
5	37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc (98)	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	53 I 126.9	54 Xe 131.3
6	55 Cs 132.9	56 Ba 137.3	57 La 138.9	72 Hf 178.5	73 Ta 180.9	74 W 183.8	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.1	79 Au 197.0	80 Hg 200.6	81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	84 Po (209)	85 At (210)	86 Rn (222)
7	87 Fr (223)	88 Ra 226.0	89 Ac 227.0	104	105	106												

Lanthanides	58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm (145)	62 Sm 150.4	63 Eu 152.0	64 Gd 157.2	65 Tb 158.9	66 Dy 162.5	67 Ho 164.9	68 Er 167.3	69 Tm 168.9	70 Yb 173.0	71 Lu 175.0
Actinides	90 Th 232.0	91 Pa 231.0	92 U 238.0	93 Np 237.0	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (260)

Useful Information

$$PV = nRT \quad R = 0.0821 \frac{\text{L}\cdot\text{atm}}{\text{mol}\cdot\text{K}} = 8.314 \frac{\text{J}}{\text{mol}\cdot\text{K}} \quad \text{density of H}_2\text{O} = 1.00 \frac{\text{g}}{\text{cm}^3}$$

$$\ln\left(\frac{vp_2}{vp_1}\right) = -\frac{\Delta H^\circ_{\text{vap}}}{R} \left(\frac{1}{T_2} - \frac{1}{T_1}\right)$$

$$\Delta H^\circ_{\text{rxn}} = \sum m(\Delta H_f^\circ(\text{products})) - \sum n(\Delta H_f^\circ(\text{reactants}))$$

$$\Delta S^\circ_{\text{rxn}} = \sum m(S^\circ(\text{products})) - \sum n(S^\circ(\text{reactants}))$$

$$\Delta G^\circ_{\text{rxn}} = \sum m(\Delta G_f^\circ(\text{products})) - \sum n(\Delta G_f^\circ(\text{reactants}))$$

$$\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ \quad \Delta G^\circ = -RT \ln K$$

$$K_a \cdot K_b = K_w$$

$$P_{\text{solution}} = \chi_{\text{solvent}} P^\circ_{\text{solvent}} \quad \Delta T = i k m \quad k_f(\text{H}_2\text{O}) = 1.86 \frac{^\circ\text{C}}{\text{m}} \quad k_b(\text{H}_2\text{O}) = 0.52 \frac{^\circ\text{C}}{\text{m}}$$

$$\text{pH} = -\log[\text{H}^+] \quad \text{pOH} = -\log[\text{OH}^-] \quad \text{pH} + \text{pOH} = 14$$

$$K_w = 1.00 \times 10^{-14} \quad K_p = K_c(RT)^{\Delta n}$$

$$x_{1,2} = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} \quad \text{for } ax^2 + bx + c = 0$$

Equilibrium Vapor Pressure for Water			
Temperature (°C)	Vapor Pressure(mmHg)	Temperature (°C)	Vapor Pressure(mmHg)
-5	3.2	50	92.5
0	4.6	55	118.0
5	6.52	60	149.4
10	9.20	65	187.5
15	12.8	70	233.7
20	17.5	75	289.1
25	23.8	80	355.1
30	31.8	85	433.6
35	42.1	90	525.8
40	55.3	95	633.9
45	71.9	100	760

Solubility Table

<u>Ion</u>	<u>Solubility</u>	<u>Exceptions</u>
NO ₃ ⁻	soluble	none
ClO ₄ ⁻	soluble	none
Cl ⁻	soluble	except Ag ⁺ , Hg ₂ ²⁺ , *Pb ²⁺
I ⁻	soluble	except Ag ⁺ , Hg ₂ ²⁺ , Pb ²⁺
SO ₄ ²⁻	soluble	except Ca ²⁺ , Ba ²⁺ , Sr ²⁺ , Hg ²⁺ , Pb ²⁺ , Ag ⁺
CO ₃ ²⁻	insoluble	except Group IA and NH ₄ ⁺
PO ₄ ³⁻	insoluble	except Group IA and NH ₄ ⁺
-OH	insoluble	except Group IA, *Ca ²⁺ , Ba ²⁺ , Sr ²⁺
S ²⁻	insoluble	except Group IA, IIA and NH ₄ ⁺
Na ⁺	soluble	none
NH ₄ ⁺	soluble	none
K ⁺	soluble	none

*slightly soluble

Thermodynamic Values (25 °C)

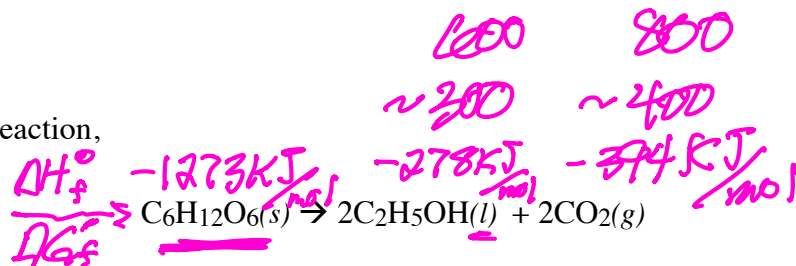
Substance and State	ΔH_f° ($\frac{\text{kJ}}{\text{mol}}$)	ΔG_f° ($\frac{\text{kJ}}{\text{mol}}$)	S° ($\frac{\text{J}}{\text{K}\cdot\text{mol}}$)	Substance and State	ΔH_f° ($\frac{\text{kJ}}{\text{mol}}$)	ΔG_f° ($\frac{\text{kJ}}{\text{mol}}$)	S° ($\frac{\text{J}}{\text{K}\cdot\text{mol}}$)
Carbon				Oxygen			
C(s) (graphite)	0	0	6	O ₂ (g)	0	0	205
CO(g)	-110.5	-137	198	O(g)	249	232	161
CO ₂ (g)	-393.5	?	214	O ₃ (g)	143	163	239
CH ₄ (g)	-75	-51	186	Nitrogen			
CH ₃ OH(l)	-239	?	127	N ₂ (g)	0	0	192
CH ₃ Cl(g)	-80.8	-57.4	234	NCl ₃ (g)	230	271	-137
CHCl ₃ (l)	-131.8	-71.5	203	NF ₃ (g)	-125	-83.6	-139
CCl ₄ (l)	-139	-68.6	214.4	NH ₃ (g)	-46.2	-17	193
H ₂ CO(g)	-116	-110	219	NH ₃ (aq)	?	-27	111
HCOOH(g)	-363	-351	249	CH ₃ NH ₂ (l)	-47.3	?	150
HCN(g)	135.1	125	202	NO(g)	90	87	211
C ₂ H ₂ (g)	227	209	201	NO ₂ (g)	32	52	?
C ₂ H ₄ (g)	52	68	219	N ₂ O(g)	82	104	?
CH ₃ CHO(g)	-166	-129	250	N ₂ O ₄ (g)	10	98	?
C ₂ H ₅ OH(l)	-278	-175	161	N ₂ O ₅ (g)	-42	134	?
C ₂ H ₆ (g)	-84.7	-32.9	229.5	HNO ₃ (aq)	-207	-111	146
C ₄ H ₁₀ (g)	-125	-16.7	310	HNO ₃ (l)	-174	-81	156
C ₆ H ₁₂ O ₆ (s)	-1273		212	NH ₄ Cl(s)	-314	-201	95
Bromine				Silver			
Br ₂ (l)	0	0	152.	Ag(s)	0	0	42.6
Br ₂ (g)	30.91	3.13	245.	Ag ⁺ (aq)	105.6	77.1	72.7
BrCl(g)	14.64	-0.96	240	Ag(S ₂ O ₃) ³⁻ (aq)	-1285.7	--	--
Chlorine				Sulfur			
Cl ₂ (g)	0	0	223	S(rhombic)	0	0	31.8
Cl ₂ (aq)	-23	7	121	SO ₂ (g)	-296.8	-300.2	248.8
Cl ⁻ (aq)	-167	-131	57	SO ₃ (g)	-395.7	-371.1	256.3
HCl(g)	-92	-95	187	H ₂ S(g)	-20.17	-33.0	205.6
Fluorine				Phosphorus			
F ₂ (g)	0	0	203	P ₄ (s)	0	0	41.1
F ⁻ (aq)	-333	-279	-14	PCl ₅ (g)	-375	-305	---
HF(g)	-271	-273	174	PCl ₃ (g)	-287	-272	---
Hydrogen				Aluminum			
H ₂ (g)	0	0	131	AlCl ₃ (s)	-526	-505	?
H(g)	217	203	115	Barium			
H ⁺ (aq)	0	0	0	BaCl ₂ (aq)	-872	-823	123
OH ⁻ (aq)	-230	-157	-11	Ba(OH) ₂ ·8H ₂ O(s)	-3342	-2793	427
H ₂ O(l)	-286	?	70	Iodine			
H ₂ O(g)	-242	-229	189	I ₂ (s)	0	0	116.7
Magnesium				HI(g)			
Mg(s)	0	0	33		25.94	1.30	206.3
Mg ²⁺ (aq)	-492	-456	-118				
MgO(s)	-601	-569	26.9				

Name	Formula	K_{a1}	K_{a2}	K_{a3}
Acetic	$\text{HC}_2\text{H}_3\text{O}_2$	1.8×10^{-5}		
Ascorbic	$\text{HC}_6\text{H}_7\text{O}_6$	8.0×10^{-3}		
Arsenic	H_3AsO_4	5.6×10^{-3}	1.0×10^{-7}	3.0×10^{-12}
Arsenous	H_3AsO_3	6.0×10^{-10}		
Benzoic	$\text{HC}_7\text{H}_5\text{O}_2$	6.5×10^{-5}		
Boric	H_3BO_3	5.8×10^{-10}		
Butyric acid	$\text{HC}_4\text{H}_7\text{O}_2$	1.5×10^{-5}		
Carbonic	H_2CO_3	4.3×10^{-7}	5.6×10^{-11}	
Cyanic	HCNO	3.5×10^{-4}		
Citric	$\text{H}_3\text{C}_6\text{H}_5\text{O}_7$	7.4×10^{-4}	1.7×10^{-5}	4.0×10^{-7}
Formic	HCHO_2	1.8×10^{-4}		
Hydroazoic	HN_3	1.9×10^{-5}		
Hydrocyanic	HCN	4.9×10^{-10}		
Hydrofluoric	HF	7.2×10^{-4}		
Hydrogen chromate ion	HCrO_4^-	3.0×10^{-7}		
Hydrogen peroxide	H_2O_2	2.4×10^{-12}		
Hydrogen selenate ion	HSeO_4^-	2.2×10^{-2}		
Hydrogen sulfate ion	HSO_4^-	1.2×10^{-2}		
Hydrogen sulfide	H_2S	5.7×10^{-8}	1.3×10^{-13}	
Hypobromous	HBrO	2.0×10^{-9}		
Hypochlorous	HClO	3.0×10^{-8}		
Hypoiodous	HIO	2.0×10^{-11}		
Iodic	HIO_3	1.7×10^{-1}		
Lactic	$\text{HC}_3\text{H}_5\text{O}_3$	1.4×10^{-4}		
Malonic	$\text{H}_2\text{C}_3\text{H}_2\text{O}_4$	1.5×10^{-3}	2.0×10^{-6}	
Oxalic	$\text{H}_2\text{C}_2\text{O}_4$	5.9×10^{-2}	6.4×10^{-5}	
Nitrous	HNO_2	4.5×10^{-4}		
Phenol	$\text{HC}_6\text{H}_5\text{O}$	1.3×10^{-10}		
Phosphoric	H_3PO_4	7.5×10^{-3}	6.2×10^{-8}	4.2×10^{-13}
Paraperiodic	H_5IO_6	2.8×10^{-2}	5.3×10^{-9}	
Propionic	$\text{HC}_3\text{H}_5\text{O}_2$	1.3×10^{-5}		
Pyrophosphoric	$\text{H}_4\text{P}_2\text{O}_7$	3.0×10^{-2}	4.4×10^{-3}	
Selenous	H_2SeO_3	2.3×10^{-3}	5.3×10^{-9}	
Sulfuric	H_2SO_4	strong acid	1.2×10^{-2}	
Sulfurous	H_2SO_3	1.7×10^{-2}	6.4×10^{-8}	
Tartaric	$\text{H}_2\text{C}_4\text{H}_4\text{O}_6$	1.0×10^{-3}	4.6×10^{-5}	

E.2 DISSOCIATION CONSTANTS FOR BASES AT 25°C

Name	Formula	K_b	Name	Formula	K_b
Ammonia	NH_3	1.8×10^{-5}	Hydroxylamine	HONH_2	1.1×10^{-8}
Aniline	$\text{C}_6\text{H}_5\text{NH}_2$	4.3×10^{-10}	Methylamine	CH_3NH_2	4.4×10^{-4}
Dimethylamine	$(\text{CH}_3)_2\text{NH}$	5.4×10^{-4}	Pyridine	$\text{C}_5\text{H}_5\text{N}$	1.7×10^{-9}
Ethylamine	$\text{C}_2\text{H}_5\text{NH}_2$	6.4×10^{-4}			
Hydrazine	H_2NNH_2	1.3×10^{-6}			

(29) 1. For the reaction,



a) Calculate the $\Delta H^\circ_{\text{rxn}}$, $\Delta S^\circ_{\text{rxn}}$, and $\Delta G^\circ_{\text{rxn}}$ at 25 °C. (20)

$$\begin{aligned}
 + \Delta H^\circ_{\text{rxn}} &= 2\Delta H_f^\circ(\text{CO}_2) + 2\Delta H_f^\circ(\text{C}_2\text{H}_5\text{OH}) - \Delta H_f^\circ(\text{C}_6\text{H}_{12}\text{O}_6) \\
 + \Delta S^\circ_{\text{rxn}} &= 2 \cdot S^\circ(\text{CO}_2(g)) + 2S^\circ(\text{C}_2\text{H}_5\text{OH}) - S^\circ(\text{C}_6\text{H}_{12}\text{O}_6(s)) \\
 \Delta G^\circ_{\text{rxn}} &= 2 \cdot \Delta G_f^\circ(\text{CO}_2) + 2\Delta G_f^\circ(\text{C}_2\text{H}_5\text{OH}) - \Delta G_f^\circ(\text{C}_6\text{H}_{12}\text{O}_6)
 \end{aligned}$$

b) Does the thermodynamic favorability of this reaction depend on temperature? Explain. (6)

$\Delta G^\circ = -71 \text{ kJ/mol}$ yes $\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ$

+ +

high T the more thermodynamically favored

c) Is the decomposition of $\text{C}_6\text{H}_{12}\text{O}_6(s)$ thermodynamically favored (spontaneous) at 25 °C? Explain. (3)

$$\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ$$

TF @ all T