

FORMULA SHEET (tear off)

1A										8A																																			
1 H 1.01	2A										3A	4A	5A	6A	7A	2 He 4.00																													
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																												
11 Na 22.99	12 Mg 24.31											13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.07	17 Cl 35.45	18 Ar 39.95																												
19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.87	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 65.41	31 Ga 69.72	32 Ge 72.64	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80																												
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																												
55 Cs 132.9	56 Ba 137.3	71 Lu 175.0	72 Hf 178.5	73 Ta 181.0	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]																												
87 Fr [223]	88 Ra [226]	103 Lr [262]	104 Rf [261]	105 Db [262]	106 Sg [266]																																								
<table border="1"> <tr> <td>57 La 138.9</td> <td>58 Ce 140.1</td> <td>59 Pr 140.9</td> <td>60 Nd 144.2</td> <td>61 Pm [145]</td> <td>62 Sm 150.4</td> <td>63 Eu 152.0</td> <td>64 Gd 157.2</td> <td>65 Tb 158.9</td> <td>66 Dy 162.5</td> <td>67 Ho 164.9</td> <td>68 Er 167.3</td> <td>69 Tm 168.9</td> <td>70 Yb 173.0</td> </tr> <tr> <td>89 Ac [227]</td> <td>90 Th 232.0</td> <td>91 Pa 231.0</td> <td>92 U 238.0</td> <td>93 Np [237]</td> <td>94 Pu [244]</td> <td>95 Am [243]</td> <td>96 Cm [247]</td> <td>97 Bk [247]</td> <td>98 Cf [251]</td> <td>99 Es [252]</td> <td>100 Fm [257]</td> <td>101 Md [258]</td> <td>102 No [259]</td> </tr> </table>																		57 La 138.9	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	89 Ac [227]	90 Th 232.0	91 Pa 231.0	92 U 238.0	93 Np [237]	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]
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$$N_A = 6.022 \times 10^{23}$$

$$1 \text{ amu} = 1.661 \times 10^{-27} \text{ kg}$$

$$1 \text{ atm} = 760 \text{ torr} = 760 \text{ mm Hg}$$

$$R = 0.08206 \text{ L}\cdot\text{atm/mol}\cdot\text{K}$$

$$R = 8.314 \text{ J/mol}\cdot\text{K}$$

$$^\circ\text{C} = (5/9) (^\circ\text{F} - 32)$$

$$^\circ\text{C} = \text{K} - 273.15$$

$$1 \text{ atm} = 1.013 \text{ bar}$$

$$1 \text{ L}\cdot\text{atm} = 101.3 \text{ J}$$

$$1 \text{ J} = 1 \text{ kg}\cdot\text{m}^2/\text{s}^2$$

$$^\circ\text{F} = (9/5)(^\circ\text{C}) + 32$$

$$\text{K} = ^\circ\text{C} + 273.15$$

$$pV = nRT$$

$$p_A = X_A p_A^\circ$$

$$\Delta T_b = K_b m_B$$

$$H = U + pV$$

$$[B] = k p_B$$

$$\Delta T_f = K_f m_B$$

$$G = H - TS$$

$$\Delta p_A = X_B p_A^\circ$$

$$\Pi = [B]RT$$

**GENERAL CHEMISTRY 2
FIRST EXAM**

Name _____

Panthersoft ID _____

Signature _____

Part 1 _____ (20 points)

Part 2 _____ (32 points)

Part 3 _____ (28 points)

TOTAL _____ (80 points)

Do all of the following problems. Show your work.

Part 1. Multiple choice. Circle the letter corresponding to the correct answer. There is one and only one correct answer per problem. [4 points each]

1) A solid compound is added to a liquid. Which of the following will favor formation of a solution from the solid and liquid?

- a) If randomness decreases when the solution forms
- b) If randomness increases when the solution forms
- c) If energy increases when the solution forms
- d) Both a and c
- e) Both b and c

2) Which of the following solutions is unstable?

- a) An unsaturated solution
- b) A saturated solution
- c) A supersaturated solution
- d) Both a and b
- e) Both a and b and c

3) For a chemical reaction to be spontaneous for standard conditions which of the following must be true?

- a) $\Delta H^\circ_{\text{rxn}} > 0$
- b) $\Delta S^\circ_{\text{rxn}} > 0$
- c) $\Delta G^\circ_{\text{rxn}} > 0$
- d) Both b and c
- e) None of the above

4) For which of the following pure chemical substances (in the form of a perfect crystal) will $S^\circ = 0.00 \text{ J/mol}\cdot\text{K}$ at absolute zero?

- a) Cu
- b) O₂
- c) Cu₂O
- d) Both a and b
- e) Both a and b and c

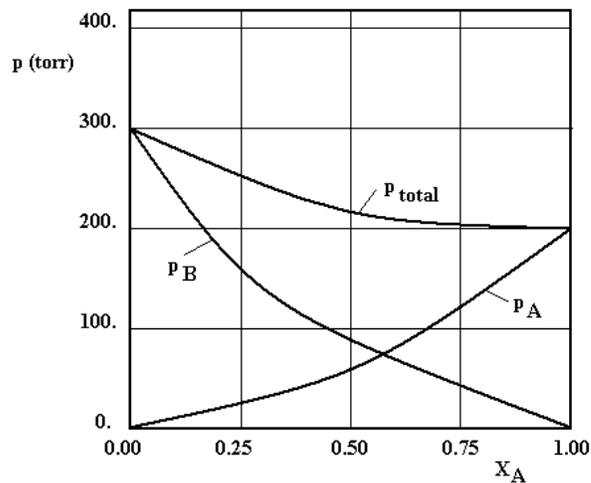
5) For which of the following pure chemical substances (at $T = 25.0 \text{ }^\circ\text{C}$) will ΔG°_f , the free energy of formation, be equal to 0.00 kJ/mol?

- a) O₂(g)
- b) O₃(g)
- c) SO₂(g)
- d) Both a and b
- e) Both a and b and c

Part 2. Short answer.

1) Define the Second Law of Thermodynamics [4 points]

2) A and B are volatile miscible liquids. The partial pressures of A and B and the total pressure above a solution of A and B are given in the diagram below as a function of X_A , the mole fraction of A, and at a temperature $T = 40.0\text{ }^\circ\text{C}$. Based on the diagram answer the following questions. [4 points each]



a) Do A and B form an ideal liquid solution (yes or no, and a brief justification for your answer)?

b) What is p_B° , the vapor pressure of pure B, at $T = 40.0\text{ }^\circ\text{C}$?

3) 2.09 g of copper II nitrate ($\text{Cu}(\text{NO}_3)_2$, $\text{MW} = 187.56\text{ g/mol}$) is dissolved in water, to form a solution with final volume $V = 250.0\text{ mL}$. What is the osmotic pressure of the solution relative to pure water? Assume $T = 25.0\text{ }^\circ\text{C}$ in your calculations, and give your final answer in units of atm. [12 points]

4) Complete the table below by filling in the missing information. Note that $T = 25.0\text{ }^{\circ}\text{C}$. [4 points each]

	$\Delta H^{\circ}_{\text{rxn}}$ (kJ/mol)	$\Delta G^{\circ}_{\text{rxn}}$ (kJ/mol)	$\Delta S^{\circ}_{\text{rxn}}$ (J/mol·K)	Is the reaction spontaneous?
Reaction 1	- 196.4	- 208.5	_____	yes
Reaction 2	+ 52.7	+ 45.0	+ 25.8	_____

Part 3. Problems.

1) A solution is prepared by mixing together cyclohexane (C_6H_{12} , MW = 84.16 g/mol) and p-xylene ($\text{C}_6\text{H}_4(\text{CH}_3)_2$, MW = 106.17 g/mol). The mole fraction of p-xylene in the solution is $X_p = 0.1664$. What are the molality and the percent by mass p-xylene in the solution? [12 points]

2) Thermodynamic data are given below (at $T = 25. \text{ }^\circ\text{C}$) and may be of use in doing this problem.

Substance	ΔH°_f (kJ/mol)	ΔG°_f (kJ/mol)	S° (J/mol \cdot K)
$\text{H}_2\text{O}(\ell)$	- 285.83	- 237.13	69.91
$\text{H}_3\text{PO}_4(\text{s})$	- 1279.0	- 1118.8	110.50
$\text{P}_4\text{O}_{10}(\text{s})$	- 2984.0	- 2697.0	228.86

Phosphoric acid (H_3PO_4) may be prepared by adding tetraphosphorus decaoxide (P_4O_{10}) to water (H_2O), by the process



a) What are $\Delta S^\circ_{\text{rxn}}$ and $\Delta G^\circ_{\text{rxn}}$ for the above reaction, at $T = 25.0 \text{ }^\circ\text{C}$? [12 points]

b) Give the correctly balanced formation reaction for $\text{H}_3\text{PO}_4(\text{s})$. [4 points]