

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]														
		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]				

$$N_A = 6.022 \times 10^{23}$$

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

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

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

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

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

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

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

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

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

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

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

$$pV = nRT$$

$$p_A = X_A p_A^\circ$$

$$\Delta T_b = K_b m_B$$

$$H = U + pV$$

$$[B] = k p_B$$

$$\Delta T_f = K_f m_B$$

$$G = H - TS$$

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

$$\Pi = M_B RT$$

**GENERAL CHEMISTRY 2  
FIRST HOUR EXAM  
SEPTEMBER 21, 2018**

**Name** \_\_\_\_\_

**Panthersoft ID** \_\_\_\_\_

**Signature** \_\_\_\_\_

**Part 1** \_\_\_\_\_ (20 points)

**Part 2** \_\_\_\_\_ (44 points)

**Part 3** \_\_\_\_\_ (36 points)

**TOTAL** \_\_\_\_\_ (100 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) Which of the following combinations of enthalpy and entropy changes is most likely to lead to the formation of a solution?

- a) If  $\Delta H^\circ_{\text{soln}}$  is greater than zero and  $\Delta S^\circ_{\text{soln}}$  is greater than zero
- b) If  $\Delta H^\circ_{\text{soln}}$  is greater than zero and  $\Delta S^\circ_{\text{soln}}$  is less than zero
- c) If  $\Delta H^\circ_{\text{soln}}$  is less than zero and  $\Delta S^\circ_{\text{soln}}$  is greater than zero
- d) If  $\Delta H^\circ_{\text{soln}}$  is less than zero and  $\Delta S^\circ_{\text{soln}}$  is less than zero
- e) Solution formation is equally likely for all of the above combinations of enthalpy and entropy change

2) A metal alloy is 0.085 % by mass chromium. The concentration of chromium in the alloy is also

- a) 0.085 ppm by mass chromium
- b) 8.5 ppm by mass chromium
- c) 850 ppm by mass chromium
- d) 85000 ppm by mass chromium
- e) None of the above

3) Which of the following aqueous solutions is expected to have the highest value for normal boiling point?

- a) A 0.200 M solution of sodium chloride (NaCl)
- b) A 0.200 M solution of iron III nitrate ( $\text{Fe}(\text{NO}_3)_3$ )
- c) A 0.300 M solution of glucose ( $\text{C}_6\text{H}_{12}\text{O}_6$ )
- d) A 0.300 M solution of potassium iodide (KI)
- e) Pure water

4) For a process to be spontaneous for standard conditions which of the following must be true?

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

5) For a particular chemical reaction both  $\Delta H^\circ_{\text{rxn}}$  and  $\Delta S^\circ_{\text{rxn}}$  are positive. Which of the following statements concerning the reaction is correct?

- a) The reaction is expected to always be spontaneous
- b) The reaction is expected to never be spontaneous
- c) The reaction is expected to be spontaneous at low temperatures, but not at high temperatures
- d) The reaction is expected to be spontaneous at high temperatures, but not at low temperatures
- e) No prediction can be made about when the reaction is or is not spontaneous

**Part 2. Short answer.**

1) A solution is formed by dissolving 18.7 g of sodium bromide (NaBr, MW = 102.9 g/mol) in water. The final volume of the solution is  $V = 400.0$  mL. What is the molarity of NaBr in the solution? [6 points]

2) Define the following terms [5 points each]

solvent

state function

3) The molality of carbon disulfide ( $\text{CS}_2$ , MW = 76.14 g/mol) in a liquid solution of carbon disulfide and toluene ( $\text{C}_6\text{H}_5\text{CH}_3$ , MW = 92.13 g/mol) is  $m = 1.748$  mol/kg. What is the mole fraction of carbon disulfide in the solution? [10 points]

4) Give the correctly balanced formation reaction for iron pentacarbonyl ( $\text{Fe}(\text{CO})_5(\ell)$ ). [5 points]

5) The absolute entropy ( $S^\circ$ ) of any pure chemical substance at  $T = 25.^\circ\text{C}$  is always positive. Explain this observation. [5 points]

6) Complete the chart below by providing the missing information. [4 points each]

$\Delta S_{\text{sys}}$ (J/mol·K)	$\Delta S_{\text{surr}}$ (J/mol·K)	$\Delta S_{\text{univ}}$ (J/mol·K)	Is the process spontaneous? (yes or no)
+ 91.7	_____	- 14.3	_____

**Part 3. Problems.**

1) A solution is prepared by dissolving 4.48 g of a nonvolatile solute in 160.00 g of liquid benzene ( $C_6H_6$ , MW = 78.11 g/mol).

a) Will the vapor pressure of benzene in the above solution be higher than, equal to, or lower than the vapor pressure of pure benzene at the same temperature? [5 points]

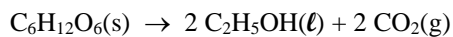
b) The normal boiling point for the above solution is 0.44 °C higher than the boiling point of pure benzene. What is the molality of solute in the solution? Note that for benzene  $K_b = 2.62 \text{ kg}\cdot^\circ\text{C} / \text{mol}$ . [8 points]

c) Based on the above information, what is the molecular weight of the solute? [8 points]

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

Substance	$\Delta H^\circ_f$ (kJ/mol)	$\Delta G^\circ_f$ (kJ/mol)	$S^\circ$ (J/mol $\cdot$ K)
$\text{CO}_2(\text{g})$	- 393.5	- 394.4	213.7
$\text{C}_2\text{H}_5\text{OH}(\ell)$	- 277.2	- 174.9	160.7
$\text{C}_6\text{H}_{12}\text{O}_6(\text{s})$	- 1273.3	- 910.4	212.1

The fermentation of glucose ( $\text{C}_6\text{H}_{12}\text{O}_6$ , MW = 180.2 g/mol) can produce ethyl alcohol by the process



a) What are  $\Delta S^\circ_{\text{rxn}}$  and  $\Delta G^\circ_{\text{rxn}}$  for the above reaction at  $T = 25. \text{ }^\circ\text{C}$  (including units)? [10 points]

b) Is the above reaction spontaneous for standard conditions and  $T = 25. \text{ }^\circ\text{C}$ ? Briefly justify your answer. [5 points]