Var. A

## CHEM 1423 - Exam 4 - April 20, 2017

Name

The Gas Constant is:  $R = 8.31 \text{ J/mol-K} = 8.31 \text{x} 10^{-3} \text{ kJ/mol-K}$ 

## (76) PART I. MULTIPLE CHOICE (Circle the ONE correct answer)

1. The solubility of lead (II) arsenate, Pb<sub>3</sub>(AsO<sub>4</sub>)<sub>2</sub>, in pure water is 3.3x10<sup>-8</sup> M. The solublility product, K<sub>sp</sub>, of lead (II) arsenate is approximately:

- (A) 1.4x10<sup>-36</sup>
- (B) 3.9x10<sup>-38</sup>
- (C) 2.8x10<sup>-36</sup>

(D) 4.2x10<sup>-36</sup>

For #2 - #3: consider the slightly soluble compound, Pbl2(s). The solubility product (aka solubility constant) is  $K_{sp} = 1.4 \times 10^{-8}$ .

2. What is the lodide concentration, [I-], when Pbl2 is dissolved in water?

- (A) 3.0x10<sup>-3</sup> M
- (B) 1.2x10<sup>-4</sup> M
- (C) 4.8x10<sup>-3</sup> M
- (D) 1.5x10<sup>-3</sup> M

3. What is the solubility of Pbl<sub>2</sub>(s) in a 0.01 M solution of the strong electrolyte,  $Pb(NO_3)_2(aq)$ ?

- (A) 1.2x10<sup>-3</sup> M
- (B) 5.9x10<sup>-4</sup> M
- (C) 1.2x10<sup>-2</sup> M
- (D) 7.3x10<sup>-8</sup> M

4. The solubility products of two sparingly soluble Bromide (Br) salts are: AgBr -  $K_{sp} = 5.4x10^{-13}$ , HgBr<sub>2</sub> -  $K_{sp} = 6.2x10^{-20}$ .

Consider a solution which initially contains 5.0x10<sup>-5</sup> M Ag<sup>+</sup>(ag) and  $4.0x10^{-5}$  M Hg<sup>2+</sup>(aq). KBr (a strong electrolyte) is added until [Br] =  $5.0x10^{-8}$  M. Which of the above salts will form any solid precipitate?

- (A) AgBr only
- (B) HgBr<sub>2</sub> only
- (S)\_Both AgBr and HgB

- (D) Neither AgBr nor HgBr2
- 5. Which of the following statements is/are correct?
  - (1) The entropy change on condensing a gas is negative
  - 12) The entropy usually decreases when a gas is dissolved in a liquid
  - $\angle$ (3) The entropy of CaCO<sub>3</sub>(s) is higher than the entropy of CaO(s)
  - x(4) The entropy generally decreases when a solid-dissolves in a liquid
    - (A) 2 & 3 & 4
- (B) 1 & 3
- (C) 1 & 2 & 3
- (D) 1&2&4

6. The normal melting point of toluene is -95 °C. The Enthalpy of Fusion of toluene is 6.6 kJ/mol. What is the entropy change of the surroundings when one mole of liquid toluene crystallizes to solid toluene at -95 °C?

- (A) -48.3 J/mol-K
- - +37 J/mol-K (C) +69 J/mol-K (D) -37 J/mol-K

					Vas. A	
7. Consid	der the reactio	n: 2 Ca(s) + (	$O_2(g) \rightarrow 2 M_0$	gO(s) , ∆Hº <	0. This reaction is	::
	eactant Favor					
(B) R	oduct Favore	d at all tempe	ratures			
C Pi	oduct Favore	d at low tempe	erature			
(D) Pr	oduct Favore	d at high temp	perature			
For #8 - #9: C	onsider the re	action: 2 SO:	$_3(g) \rightarrow 2 SO_2$	e(g) + O <sub>2</sub> (g) at	: 25 °C	
	SO <sub>2</sub> (g)	S	O <sub>3</sub> (g)	O <sub>2</sub> (g)	•	
S <sub>m</sub> °(25 °C)	248 J/mol-K	. 2	257 J/mol-K	205 J	I/mol-K	
$\Delta G_f^{\circ}(25  {}^{\circ}C)$	-297 kJ/mol	-:	396 kJ/mol			
8. What i	s ∆Gº for the a	above reaction	n [at 25 °C] ?	•		
(A) +1	98 kJ	(B)	+99 kJ	(C)	-198 kJ	
(D) In:	sufficient data	is available				
9. What is	s $\Delta H^o$ for the a	above reactior	n [at 25 ºC]?			
(A) -1	42 kJ	(B) +	-254 kJ	(C) +	·142 kJ	
(D) Ins	sufficient data	is available				
tempe	e hypothetical rature). The e s the entropy	quilibrium cor	nstant for the	reaction at 4	ependent of 00 °C is 1.0x10 <sup>-8</sup> .	
(A) -28	3 J/K	(B) +79 J/K	(C)	-42 J/K	(D) -79 J/K	
	action $A  o B$ can be conclude				change is +45 kJ. eaction?	
(A) ΔS	S < -70 J/K		(B) ∆S	> +150 J/K		
(C) ΔS	S < -150 J/K		(C) ΔS	$ > +150 \text{ J/R} $ $ = \frac{\Delta H}{T} $		

12. For the endergonic reaction,  $C \rightarrow D$ ,  $\Delta S = +50$  J/K For this reaction,

(A) ΔG>0 & ΔH>0

(B) ΔG>0 & ΔH<0

(C)  $\Delta$ G<0 &  $\Delta$ H>0

(D)  $\Delta G < 0 \& \Delta H < 0$ 

13. Consider the reaction, 2  $HI(g) \leftrightharpoons H_2(g) + I_2(s)$  at 25 °C. The Gibbs Free Energy of Formation of HI(g) is +1.70 kJ/mol. Therefore, the equilibrium constant for the above reaction at 25 °C is approximately:

(A) 0.25

(B) 2.0

(C) 3.9

(D) 2.4

Vas. A

14	$\Delta H^{c}$	the reaction, 2 P = -620 kJ. W ction, C <sub>2</sub> H <sub>6</sub> (g)	hat is the e	ntropy chan	ige of t	he <b>system</b>		
(	(A)	+235 J/K	(B) +10	)40 J/K	(C) -	+470 J/K	(D)	-1040 J/K
		<b>16:</b> The Entha (sol) is 19.6 J/r		on of I <sub>2</sub> (sol)	is 7.80	kJ/mol. T	he Entroր	by of
15		e Entropy chan ₂(sol) at 80 °C			ıniv, Wh	en one mo	le of I2(lic	ղ) crystallizes
	(A)	-2.5 J/mol-K		(B) +7.7 J	I/mol-K		(C) +2	2.5 J/mol-K
	(D)	None of the a	bove					
16		e Gibbs Energy ) °C is approxir		Gº, when 1	mole	of l <sub>2</sub> (liq) cry	ystallizes	to I <sub>2</sub> (sol) at
	(A)	-0.5 kJ/mol	(B) -4.9	kJ/mol	(C) +	4.9 kJ/mol	(D) +	-0.5 kJ/mol
17	the hyp α to ΔH <sup>o</sup>	class we discust Native and Ration of the β structure = -140 kJ/mone more stable	indom Coil in with two re, $\alpha \to \beta$ , I and $\Delta S^o =$	forms with v native form: the enthalp -420 J/mol-	/ariatio s, α ar y and -K. Fo	in in temper and $\beta$ . For the entropy characteristics in the second contracteristics and the second contracteristics are second contracteristics.	erature. ( the transi anges ar in, the	tion from the e:
(	(A)	α,60°C	(B) $\alpha$ ,	333 °C	(C)	$\beta$ , 47 °C	(D)	β , 60 °C
18	forr der as	class, we discumation of Doub naturation of a Cytosine-Guar $G \rightarrow C + G$ , the	ly-Coiled D DNA double nine (C-G).	NA from the coil. This For the bre	e indivi involve aking	dual DNA : es the brea of one of t	strands. king of b hese bas	Consider the ase pairs such e pairs, i.e.
	(A)	favored, favo	red		(B)	favored, d	lisfavored	i
	(C)	disfavored, fa	vored		(D)	disfavored	d, disfavo	red
19	. Re	garding the foll	owing reac	tion, which	of the s	statements	below is	/are correct?
		Fe <sub>2</sub> S	S3(s) + 3 G	$eS(g) \rightarrow 2$	Fe + 3	GeS <sub>2</sub> (g)		
V	∕(1) ×(3)	Fe <sub>2</sub> S <sub>3</sub> is the o	xidizing age	ent ·	(2) Go (4) Go	eS2 is oxid eS is reduc	ized ced	
,		2 & 4		}			(D)	1 only
)TII 7		(2) DDODLEN	AC. DEME	MDED TO	SHOW	I MODE E	OB CBEI	OIT.

PART II.

The Gas Constant is:  $R = 8.31 \text{ J/mol-K} = 8.31 \text{x} 10^{-3} \text{ kJ/mol-K}$ 

Vers. A

- (14) 1. For the reaction, 2 NH<sub>3</sub>(g)  $\rightleftharpoons$  N<sub>2</sub>(g) + 3 H<sub>2</sub>(g),  $\triangle$ H° = +92 kJ and  $\triangle$ S° = +360 J/K.
  - (6) (a) Calculate the equlibrium constant, K, for this reaction at 50 °C, in kJ.

$$26^{\circ 2} \times 10^{\circ} - 725^{\circ} = +92,000 \text{ } I - (323 \text{ } R) (3845 \text{ } R) = -24,280 \text{ } I$$

$$26^{\circ 2} - RThR \rightarrow hR = -\frac{-14,780}{RT} = -\frac{-14,780}{(823)(323)} = +9.65$$

$$R = e^{9.05} = 8.48 \times 10^{3}$$

(4) (b) Calculate the value of  $\Delta G$  for this reaction at 50 °C when the pressures are:  $P(N_2) = P(H_2) = 15.0$  bar,  $P(N_3) = 0.10$  bar.

$$= 5.013 \times 0^{6} = 17,160 = 17,2 \times 1$$

(4) (c) Calculate the temperature, in °C, at which reactants and products are in equilibrium under standard conditions. Is the reaction **Reactant favored** or **Product favored** at temperatures higher than this.

## Vast A&B

(10) 2. Balance the following oxidation-reduction reaction in aqueous Basic solution.  $Mo_2O_7^{2-} + SO_2 \rightarrow Mo^{3+} + SO_4^{2-}$ Oxid: SO -> SOy Rel. Mg Cs -> Mo 30 c mt mo my L ax: Add: 2the to left, 40t to right; 20 to right 502 + 21/20 -> 504° +411 +2e pel All 7 120th right, 14 W to left, be to bell Moz 07 + 14 11 + 60 - 2 M 36 + 711.0 3502 +6 MO+ Mo203 +14M+60 -> 3800 +12M+60 (3x Cx)6 (1x Res) Add 2 on to entend to concel the's [358 + Me207 + 420 -> 3584 + 2Mo +20A

CHEM 1423 - Exam 4 - April 20, 2017

The Gas Constant is:  $R = 8.31 \text{ J/mol-K} = 8.31 \text{x} 10^{-3} \text{ kJ/mol-K}$ 

## (76) PART I. MULTIPLE CHOICE (Circle the ONE correct answer)

For #1 - #2: consider the slightly soluble compound, Pbl<sub>2</sub>(s). The solubility product (aka solubility constant) is  $K_{sp} = 1.4 \times 10^{-8}$ 

חוווט	ly constant is resp —	1. <del>4</del> ×10 .					
1.	What is the lodide concentration, [l-], when Pbl2 is dissolved in water?						
	(A) 4.8x10 <sup>-3</sup> M	(B) 1.2x10 <sup>-4</sup> M	(C) 3.0x10 <sup>-3</sup> M	(D) 1.5x10 <sup>-3</sup> M			
2.	What is the solubilit Pb(NO <sub>3</sub> ) <sub>2</sub> (aq)?	ty of $Pbl_2(s)$ in a 0.	01 M solution of the str	rong electrolyte,			
	(A) 1.2x10 <sup>-3</sup> M	(B) 7.3x10 <sup>-8</sup> M	(C) 1.2x10 <sup>-2</sup> M	(D) 5.9x10 <sup>-4</sup> M			
3.			3(AsO <sub>4</sub> ) <sub>2</sub> , in pure wate enate is approximately:				
	(A) 4.2x10 <sup>-36</sup>	(B) 3.9x10 <sup>-38</sup>	(C) 2.8x10 <sup>-36</sup>	(D) 1.4x10 <sup>-36</sup>			
4.	The solubility produ AgBr - $K_{sp} = 5.4x10$		y soluble Bromide (Br) 6.2x10 <sup>-20</sup> .	) salts are:			
		-	tains 5.0x10 <sup>-5</sup> M Ag <sup>+</sup> (ad	• /			

Which of the above salts will form any solid precipitate?

(A) AgBr only (B) HgBr₂ only (C) Neither AgBr and HgBr<sub>2</sub> (D) Both AgBr and HgBr

5. The normal melting point of toluene is -95 °C. The Enthalpy of Fusion of toluene is 6.6 kJ/mol. What is the entropy change of the surroundings when one mole of liquid toluene crystallizes to solid toluene at -95 °C?

(B) +37 J/mol-K (A) -48.3 J/mol-K (C) +69 J/mol-K (D) -37 J/mol-K

6. Which of the following statements is/are correct?

✓(1) The entropy change on condensing a gas is negative 代2) The entropy usually decreases when a gas is dissolved in a liquid ( 43) The entropy of CaCO<sub>3</sub>(s) is higher than the entropy of CaO(s)

X(4) The entropy generally decreases when a solid dissolves in a liquid

(A) 2 & 3 & 4

(B) 1&3

(C) 1&2&3

(D) 1 & 2 & 4

Vas. B

For #7 - #8: Consider the reaction: $2 SO_3(g) \rightarrow 2 SO_2(g) + O_2(g)$ at 25 °C						
	SO <sub>2</sub> (g)	SO₃(g)	O <sub>2</sub> (g	1)		
S <sub>m</sub> °(25 °C)	248 J/mol-K	257 J/mo	I-K 205	J/mol-K		
∆G <sub>f</sub> °(25 °C)	-297 kJ/mol	-396 kJ/n	nol			
7. What is	$_{ m S}$ $\Delta { m G}^{ m o}$ for the above reac	tion [at 25 <sup>c</sup>	PC] ?	_		
(A) -19	98 kJ (B	) +99 kJ	(C)	+198 kJ		
(D) Ins	sufficient data is available	е	_			
8. What is	s ΔHº for the above reac	tion [at 25 <sup>c</sup>	°C]?			
(A) +2	54 kJ (E	3) -142 kJ	(C)	+142 kJ		
(D) Ins	sufficient data is availabl	e				
9. Consid	er the reaction: 2 Ca(s)	$+ O_2(g) \rightarrow$	2 MgO(s) , ΔH°	< 0. This reaction is:		
(A) Re	actant Favored at all ter	nperatures				
(B) Pro	oduct Favored at all tem	peratures				
(C) Pro	oduct Favored at high te	mperature				
(D) Pro	oduct Favored at low ter	nperature				
of Forn	er the reaction, 2 HI(g) a nation of HI(g) is +1.70 k reaction at 25 °C is appr	J/mol. The				
(A) 0.2	25 (B) 3.9	•	(C) 2.4	(D) 2.0		
11. For the	e endergonic reaction,	$C \rightarrow D, \Delta S$	= +50 J/K For ti	nis reaction,		
(A) ΔG	G<0 & ∆H<0		(B) ΔG> <u>0 &amp; Δ</u> H	<0		
(C) ∆G	<0 & ∆H>0		(D) ΔG>0 & ΔH	>0		
	action A → B is <b>exergo</b> r an be concluded about		•			
(A) AS	> +150 J/K	•	B) ∆S < -150 J/ŀ	<		
(C) ΔS	S < -70 J/K	(C)	$\Delta S = \frac{\Delta H}{T}$			

13. For the hypothetical reaction, A  $\leftrightharpoons$  B,  $\Delta H^o$  = +50 kJ/mol (independent of temperature). The equilibrium constant for the reaction at 400 °C is 1.0x10<sup>-8</sup>. What is the entropy change,  $\Delta S^{o}$  for this reaction?

(A) -28 J/K

(B) +79 J/K

(C) -42 J/K

(D) -79 J/K

Uns. B

For #15 - #16: The Enthalpy of Fusion of  $I_2(sol)$  is 7.80 kJ/mol. The Entropy of Fusion of  $I_2(sol)$  is 19.6 J/mol-K.

	01 12(001) 10 10.0 0/11			
15.	The Entropy chang to l <sub>2</sub> (sol) at 80 °C is	ge of the universe, $\Delta S$ s approximately:	S <sub>univ</sub> , when one mole	of I <sub>2</sub> (liq) crystallizes
(	(A) +2.5 J/mol-K	) (B) +7.1	7 J/mol-K	(C) -2.5 J/mol-K
	(D) None of the all	oove		•
	(5) 110.10 01 010 01	,010		
16.	The Gibbs Energy 150 °C is approxim	Change, ∆Gº, when nately:	1 mole of I <sub>2</sub> (liq) crys	tallizes to I <sub>2</sub> (sol) at
	(A) -0.5 kJ/mol	(B) -4.9 kJ/mol	(C) +0.5 kJ/mol	(D) +4.9 kJ/mol
14.	$\Delta H^{\circ}$ = -620 kJ. Wh	$C_2H_2(g) + 4 H_2(g)$ - nat is the entropy cha $\rightarrow C_2H_2(g) + 2 H_2(g)$	ange of the <b>system</b> ,	$\Delta S_{ ext{sys}}$ , for the related
	(A) +1040 J/K	(B) +235 J/K	C) +470 J/K	(D) -1040 J/K
18.	formation of Doubl denaturation of a E as Cytosine-Guani		he individual DNA st is involves the break reaking of one of the	rands. Consider the ing of base pairs such ese base pairs, i.e.
	(A) favored, favore	∍d	(B) disfavored,	favored
	(C) favored, disfav	ored .	(D) disfavored,	disfavored
17.	the Native and Rai	ndom Coil forms with	variation in tempera	
	-nyoothetical brotei	n with two native forr	me (Yandin ⊨orth	a transition trans tha
	_	_	•	
	$\alpha$ to the $\beta$ structur $\Delta H^{o}$ = -140 kJ/mol	e, $lpha  ightarrow eta$ , the entha	llpy and entropy char ol-K. For this protein	nges are: , the form
	$\alpha$ to the $\beta$ structur $\Delta H^{\circ}$ = -140 kJ/mol is the more stable	re, $lpha  ightarrow eta$ , the entha and $\Delta S^o$ = -420 J/mo	nlpy and entropy char ol-K. For this protein res <b>above</b> º(	nges are: , the form
19.	$\alpha$ to the $\beta$ structur $\Delta H^{\circ}$ = -140 kJ/mol is the more stable (A) $\beta$ , 60 °C	re, $\alpha  ightarrow \beta$ , the entha and $\Delta S^o$ = -420 J/moone at all temperature	llpy and entropy char ol-K. For this protein res <b>above</b> ° (C) β, 47°C	nges are: , the form C. D α, 60 °C
19.	$\alpha$ to the $\beta$ structur $\Delta H^{\circ}$ = -140 kJ/mol is the more stable (A) $\beta$ , 60 °C Regarding the follows:	re, $\alpha \rightarrow \beta$ , the enthal and $\Delta S^{\circ}$ = -420 J/mc one at all temperature (B) $\alpha$ , 333 °C by wing reaction, which	llpy and entropy char ol-K. For this protein res <b>above</b> °( (C) β, 47 °C n of the statements b	nges are: , the form C. D α, 60 °C
	$\alpha$ to the $\beta$ structur $\Delta H^{\circ}$ = -140 kJ/mol is the more stable (A) $\beta$ , 60 °C Regarding the following Fe <sub>2</sub> S	re, $\alpha \rightarrow \beta$ , the enthal and $\Delta S^{\circ}$ = -420 J/mc one at all temperature (B) $\alpha$ , 333 °C owing reaction, which $\alpha(s) + 3 \text{ GeS}(g) \rightarrow 0$	alpy and entropy char ol-K. For this protein res <b>above</b> °( (C) β, 47 °C n of the statements b 2 Fe + 3 GeS <sub>2</sub> (g)	nges are:  t, the form  a.  D α, 60 °C  telow is/are correct?
Ŀ	$\alpha$ to the $\beta$ structur $\Delta H^{\circ} = -140 \text{ kJ/mol}$ is the more stable (A) $\beta$ , 60 °C Regarding the following	re, $\alpha \rightarrow \beta$ , the enthal and $\Delta S^{\circ} = -420$ J/mc one at all temperature (B) $\alpha$ , 333 °C owing reaction, which $\alpha(s) + 3$ GeS(g) $\alpha(s) + 3$ GeS(g) $\alpha(s) + 3$ GeS(g) $\alpha(s) + 3$	llpy and entropy char ol-K. For this protein res <b>above</b> °( (C) β, 47 °C n of the statements b 2 Fe + 3 GeS <sub>2</sub> (g) ★ (2) GeS <sub>2</sub> is oxidize	nges are:  , the form  C.  (D) α, 60 °C  relow is/are correct?
Ŀ	α to the β structur $\Delta H^{\circ} = -140 \text{ kJ/mol}$ is the more stable (A) β, 60 °C Regarding the following the	re, $\alpha \rightarrow \beta$ , the enthal and $\Delta S^{\circ}$ = -420 J/mc one at all temperature (B) $\alpha$ , 333 °C owing reaction, which $\alpha(s) + 3 \text{ GeS}(g) \rightarrow 0$	llpy and entropy char ol-K. For this protein res <b>above</b> °( (C) β, 47 °C n of the statements b 2 Fe + 3 GeS <sub>2</sub> (g) ★ (2) GeS <sub>2</sub> is oxidize	nges are:  , the form  C.  (D) α, 60 °C  relow is/are correct?

PART II. TWO (2) PROBLEMS: REMEMBER TO SHOW WORK FOR CREDIT

The Gas Constant is:  $R = 8.31 \text{ J/mol-K} = 8.31 \text{x} 10^{-3} \text{ kJ/mol-K}$ 

Vac. B

- (14) 1. For the reaction,  $2 \text{ NH}_3(g) \leftrightharpoons N_2(g) + 3 \text{ H}_2(g)$ ,  $\Delta H^o = +92 \text{ kJ}$  and  $\Delta S^o = +360 \text{ J/K}$ .
  - (6) (a) Calculate the equlibrium constant, K, for this reaction at 60 °C, in kJ.

$$26^{\circ} = 4^{\circ} - 125^{\circ} = + 92,000 - (333)/360) = -27,880$$

$$26^{\circ} = -176k \rightarrow 6k2 - 260 = -(-27880) = 610,0$$

$$k = e^{10,08} = 2.37810$$

(4) (b) Calculate the value of  $\Delta G$  for this reaction at 60 °C when the pressures are:  $P(N_2) = P(H_2) = 12.0$  bar,  $P(N_3) = 0.10$  bar.

$$Q = \frac{\Gamma_{12} \Gamma_{13}}{\Gamma_{143}}$$

$$= \frac{(2)/(12)^3}{(0,1)^2}$$

(4) (c) Calculate the temperature, in °C, at which reactants and products are in equilibrium under standard conditions. Is the reaction **Reactant favored** or **Product favored** at temperatures higher than this.

36° = 211-785° = 0 # = 93,000 \$\frac{7}{360 \frac{7}{R}}\$

= 257 R - 273 = [-17c]

Probab Lawred & high Ray.



Balance the following oxidation-reduction reaction in aqueous Basic solution. (10) $Mo_2O_7^{2-} + SO_2 \rightarrow Mo^{3+} + SO_4^{2-}$ Oxid: SO2 -> SOY

Rel. Mas Cr -> Mist emb me hy L Ox: Add: 21ho to left, 411t to right; 20 to right 502+2N20 -> 504 64N+2epel All 745t right, 14 W to left, be to bell Maz 07 + 14 11 + 60 -> 2 M, 36 + 711.0 3502 +6 NO+ Mo2 03 +144+60 -> 3504 +12 N +60 (3x Cx)6 (1x Rex).) 3502 + MO2 05 62N -> 3504 + 2M0 + N20 Eval At, RO, 8 Add 2 on to earlish & coral Mos. 1359 & May 07 & A20 -> 3504 & 2Mo 620A