

Exam 4 Chm 205 (Dr Mattson) 5 April 2017

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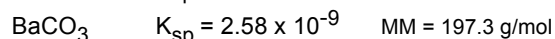
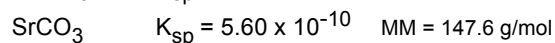
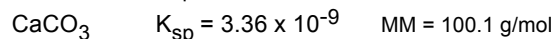
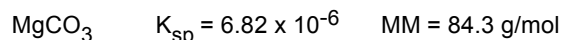
Signature:

Name:

Chemistry Student Number (1 bonus pt): _____

Instructions: Show all work whenever a calculation box is provided! Write legibly. Include units whenever appropriate. You will receive credit for how you worked each problem as well as for the correct answer. If you need more space, you may use the back of the data sheet provided — Write: "See data sheet" in the answer box — then write your name on the data sheet. On your desk you are allowed only pencils (but no pencil pouch), an eraser, and a non-programmable calculator without a slipcover. Backpacks, bags, and purse-like items must be stored in the rear section of the room. Cell phones must be silent and placed in your backpack/bag/purse — not in your pocket.

1. Carbonates are an important class of minerals. The Group II carbonates, and their K_{sp} values are:



1a, b. (4 pts) Write a balanced reaction for the dissolution of $SrCO_3$ in water and write a K_{sp} expression. Save most of the space -- Question 1c uses the same box.

1c. (4 pts) Showing your work in the box above (use a MICE table), determine the molar solubility of strontium carbonate. What is $[Sr^{+2}]$? Include units.

Molar solubility = _____ $[Sr^{+2}] =$ _____

1d. (1 pt) Which of these salts has the largest molar solubility? **$MgCO_3$ $CaCO_3$ $SrCO_3$ $BaCO_3$**

1e. (4 pts) What mass $SrCO_3$ dissolves in 400 mL H_2O ?

Answer with units: _____

1f. (4 pts) What is the molar solubility of calcium carbonate in a solution containing 0.072 M $Ca(NO_3)_2$?

Answer with units: _____

2a (4 pts). What is the molar solubility, x , of $Co(OH)_2$, given $K_{sp} = 5.9 \times 10^{-15}$

Answer with units: _____

2b. (2 pts) What is the pH of the above solution?

3. (4 pts) If a saturated solution of Ag_2CO_3 has $[Ag^+] = 2.56 \times 10^{-4} \text{ M}$, what is the value of K_{sp} ?

$K_{sp} =$ _____

4. (4 pts). Will a precipitate form if small amounts of $Mg(NO_3)_2$ and sodium carbonate are added to water so that $[Mg^{2+}] = 5.0 \times 10^{-4} \text{ M}$ and $[CO_3^{2-}] = 2.0 \times 10^{-4} \text{ M}$? You must show work (Q_{sp} calculation) for credit.

$Q_{sp} =$ _____ Precipitate? **Yes No**

5. (8 pts) **Alert!** Reactions A-D represent **one example of each** of the 4 combinations of ΔH and ΔS being + or -.

	ΔH	ΔS
A. $H_2O(g) \rightarrow OH(g) + H(g)$		
B. $3 O_2(g) \rightarrow 2 O_3(g)$		
C. $2 Cl(g) \rightarrow Cl_2(g)$		
D. $C_3H_8(g) + 5 O_2(g) \rightarrow 3 CO_2(g) + 4 H_2O(g)$		

5a. Which **two** reactions are exothermic?

A B C D

5b. Which **two** reactions are entropy-favored?

A B C D

5c. Which reaction is spontaneous only at high temperatures? (one answer)

A B C D

5d. Which reaction is never spontaneous? (one answer)

A B C D

6. (5 pts) Classify each of these as spontaneous or non-spontaneous at 1 atm.

$\Delta G < 0$ or $\Delta G > 0$ Cheese molding.

$\Delta G < 0$ or $\Delta G > 0$ Diffusion of perfume in a room.

$\Delta G < 0$ or $\Delta G > 0$ Ice melting in a freezer.

$\Delta G < 0$ or $\Delta G > 0$ Natural gas burning.

$\Delta G < 0$ or $\Delta G > 0$ More NaCl dissolving in a saturated solution.

7. (5 pts) Predict the sign of ΔS for each of these.

$\Delta S < 0$ or $\Delta S > 0$ Water vapor condensing.

$\Delta S < 0$ or $\Delta S > 0$ Crystals of CaCO_3 forming.

$\Delta S < 0$ or $\Delta S > 0$ A drop of ink dissipating in water

$\Delta S < 0$ or $\Delta S > 0$ $2 \text{C(s)} + \text{O}_2(\text{g}) \rightarrow 2 \text{CO(g)}$

$\Delta S < 0$ or $\Delta S > 0$ $2 \text{CO(g)} + \text{O}_2(\text{g}) \rightarrow 2 \text{CO}_2(\text{g})$

8. Nitrogen monoxide readily reacts with oxygen to produce nitrogen dioxide, a reddish gas. The reaction is:



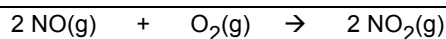
Thermodynamic data: ΔH_f° kJ/mol ΔS° J/mol K

NO(g) +91 211

O₂(g) 0 205

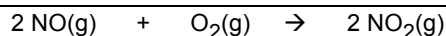
NO₂(g) +33 240

8a. (4 pts) Calculate ΔS° for this reaction.



Answer with units: _____

8b. (4 pts) Calculate ΔH° for this reaction.



Answer with units: _____

8c. (4 pts) Calculate ΔG° for this reaction.

Answer with units: _____

8d. (3 pts) At what temperature does this reaction switch from spontaneous to non-spontaneous or visa versa?

Answer with units: _____

8e. (4 pts) Estimate the equilibrium constant at 298 K

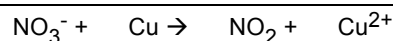
Answer: _____

8f. (4 pts) Calculate ΔG at 298 K for this reaction if the initial pressures of NO(g), O₂(g), and NO₂(g) are 2.0 atm, 2.0 atm and 0.20 atm, respectively? Is the reaction spontaneous? [Show work for credit!](#)

Answer with units: _____ Is reaction spontaneous? **Yes** or **No**

9a. (4 pts) Balance this redox reaction in aqueous acidic solution. [You may need to add H₂O and/or H⁺.](#)

9b. (1 pt) What is the value of n (the LCM)?



n = _____ e⁻

9c. (2 pts) **Circle** what is reduced.

Box what is oxidized.



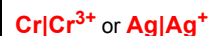
10. Given: $\text{Ag}^+(\text{aq}) + \text{Cr(s)} \rightarrow \text{Ag(s)} + \text{Cr}^{3+}(\text{aq})$ **unbalanced**

10a. (3 pts) Write the reaction in cell notation for this galvanic cell.

10b. (4 pts) What is E⁰ for the reaction?

Answer with units: _____

10c. (2 pts) What is the anode half cell?



10d. (2 pts) As reaction proceeds, the cathode **increases** or **decreases** in mass.

11a. (4 pts) Determine E⁰ for $\text{Pb}|\text{Pb}^{2+}||\text{H}^+|\text{H}_2|\text{Pt}$.

Answer with units: _____

11b. (4 pts) Calculate ΔG° for this reaction.

Answer with units: _____

Score _____ + _____ + _____ = _____

A \geq 90; B+ \geq 85; B \geq 80; C+ \geq 75; C \geq 70; D \geq 60

Answers



1c. Molar solubility = $2.37 \times 10^{-5} \text{ M}$ $[\text{Sr}^{2+}] = 2.37 \times 10^{-5} \text{ M}$



1e. $1.40 \times 10^{-3} \text{ g}$

1f. $4.7 \times 10^{-8} \text{ M}$

2a. $1.14 \times 10^{-5} \text{ M}$

2b. 9.36

3. 8.4×10^{-12}

4. $Q_{\text{sp}} = 1.0 \times 10^{-7}$, therefore $Q_{\text{sp}} < K_{\text{sp}}$ and no precipitate forms

5.

	ΔH	ΔS
A. $\text{H}_2\text{O}(\text{g}) \rightarrow \text{OH}(\text{g}) + \text{H}(\text{g})$	+	+
B. $3 \text{O}_2(\text{g}) \rightarrow 2 \text{O}_3(\text{g})$	+	-
C. $2 \text{Cl}(\text{g}) \rightarrow \text{Cl}_2(\text{g})$	-	-
D. $\text{C}_3\text{H}_8(\text{g}) + 5 \text{O}_2(\text{g}) \rightarrow 3 \text{CO}_2(\text{g}) + 4 \text{H}_2\text{O}(\text{g})$	-	+

5a. C, D

5b. A, D

5c. A

5d. B

6. $\Delta G < 0$, $\Delta G < 0$, $\Delta G > 0$, $\Delta G < 0$, $\Delta G > 0$

7. $\Delta S < 0$, $\Delta S < 0$, $\Delta S > 0$, $\Delta S > 0$, $\Delta S < 0$

8a. $\Delta S^\circ = -147 \text{ J/K}$

8b. $\Delta H^\circ = -116 \text{ kJ}$

8c. $\Delta G^\circ = -72 \text{ kJ}$

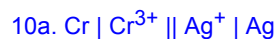
8d. 789 K

8e. $K = 4.5 \times 10^{+12} \text{ M}$

8f. $\Delta G = -85 \text{ kJ}$, so Yes, spontaneous



9c. Circle NO_3^- ; Box Cu



10b. $E^\circ = 1.53 \text{ V}$



10d. increases

11a. $E^\circ = +0.13 \text{ v}$

11b. $\Delta G^\circ = -25 \text{ kJ}$