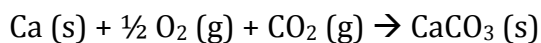


Chem 2B Final Exam Review – Winter 2011

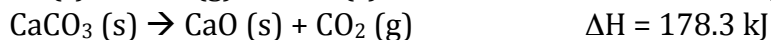
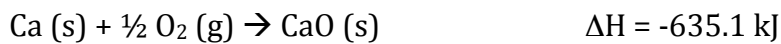
1. Calculate the heat transferred when a 5.5 g iron nail is cooled from 37°C to 25°C. Specific heat capacity of iron = 0.450 J/g K

2. A 25.64 g sample of a solid was heated in a test tube to 100.00°C in boiling water and carefully added to a coffee cup calorimeter containing 50.00 g water. The water temperature increased from 25.10°C to 28.49°C. What is the specific heat capacity of the solid? (Assume all heat is gained by the water.) Specific heat capacity of water = 4.184 J/g K

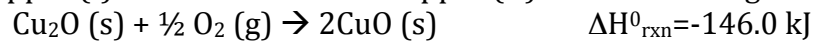
3. Calculate ΔH_{rxn} for



Given:



4. Copper (I) oxide is oxidized to copper (II) oxide according to the following:



Given that $\Delta H_{\text{f}}^{\circ}$ of $\text{Cu}_2\text{O (s)} = -168.6 \text{ kJ/mol}$, what is $\Delta H_{\text{f}}^{\circ}$ of CuO(s) ?

5. Why does water vapor at 100°C cause more severe burns than liquid water at 100°C ?

6. From the following data, calculate the total heat (in J) needed to convert 12.00 g ice at -5.00°C to liquid water at 0.500°C .

Melting point at 1 atm	0.0°C
c_{solid}	$2.09 \text{ J/g } ^{\circ}\text{C}$
c_{liquid}	$4.21 \text{ J/g } ^{\circ}\text{C}$
$\Delta H_{\text{fus}}^{\circ}$	6.02 kJ/mol

7. Use the following data to sketch a qualitative phase diagram for ethylene:

T_b at 1 atm	-103.7°C
T_m at 1 atm	-169.16°C
Critical point	9.9°C and 50.5 atm
Triple point	-169.17°C and 1.20×10^{-3} atm

8. Butane is a common fuel used in cigarette lighters and camping stoves. Normally supplied in metal containers under pressure, the fuel exists as a mixture of liquid and gas, so high temperatures may cause the container to explode. At 25.0°C, the vapor pressure is 2.3 atm. What is the pressure in the container at 150.0°C? ($\Delta H_{\text{vap}} = 24.3$ kJ/mol)

9. Which member in each pair has the higher vapor pressure at a given temperature? Explain.

a. C_2H_6 or C_4H_{10}

b. $\text{CH}_3\text{CH}_2\text{OH}$ or $\text{CH}_3\text{CH}_2\text{F}$

c. NH_3 or PH_3

10. For the metals listed, the number of atoms per unit cell is given in parentheses. What type of cubic lattice does each metal form?

a. Ni (4)

b. Cr (2)

c. Ca (4)

11. Zinc selenide (ZnSe) crystallizes in the zinc blende structure and has a density of 5.42 g/cm^3 .

a. How many Zn and Se particles are in each unit cell?

b. What is the mass of a unit cell?

c. What is the volume of a unit cell?

d. What is the unit cell edge length?

12. You are given a bottle of solid X and three aqueous solutions of X, one saturated, one unsaturated, and one supersaturated. How would you determine which solution is which?

13. A solution of isopropanol (C_3H_7OH) is made by dissolving 0.30 mol isopropanol in 0.80 mol water.

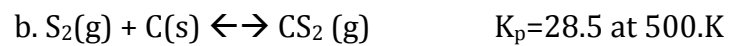
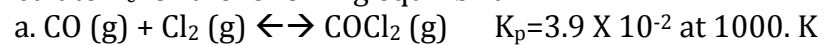
a. what is the mole fraction of isopropanol?

b. What is the mass percent of isopropanol?

c. What is the molality of isopropanol?

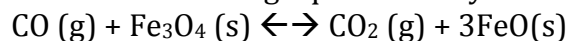
14. What is the minimum mass of ethylene glycol ($C_2H_6O_2$) that must be dissolved in 14.5 kg water to prevent the solution from freezing at $-10.0\text{ }^\circ\text{F}$? (Assume ideal behavior)

15. Calculate K_c for the following equilibria:



16. In an experiment to study the formation of HI (g), H₂ (g) and I₂ (g) were placed in a sealed container at a certain temperature. At equilibrium, [H₂] = 6.5 × 10⁻⁵ M, [I₂] = 1.60 × 10⁻³ M, and [HI] = 1.87 × 10⁻³ M. Calculate K_c for the reaction at this temperature.

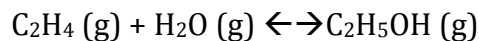
17. Consider the following equilibrium system



How does the equilibrium position shift as a result of each of the following disturbances?

- CO is added
- CO₂ is removed by adding solid NaOH
- Additional Fe₃O₄ (s) is added to the system
- Dry ice is added at constant T

18. One of the most important industrial sources of ethanol is the exothermic reaction of steam with ethene derived from crude oil



$$\Delta H^\circ_{\text{rxn}} = -47.8 \text{ kJ} \quad K_c = 9 \times 10^3 \text{ at } 600. \text{ K}$$

a. At equilibrium, P_{C₂H₅OH} = 200. Atm and P_{H₂O} = 400. Atm. Calculate P_{C₂H₄}

b. Is the highest yield of ethanol obtained at high or low pressures? High or low temperatures?

c. Calculate K_c at 450. K.

d. In the manufacture of ammonia, the yield of ammonia is increased by condensing it to a liquid and removing it from the vessel. Would condensing the C_2H_5OH work in this process? Explain.

19. Classify each of the following as a strong or weak acid or base:

a. $RbOH$

b. HBr

c. H_2Te

d. $HClO$

20. Which of the following solutions has the higher pH? Explain.

a. A 0.1 M solution of an acid with $K_a=1 \times 10^{-4}$ or one with $K_a=4 \times 10^{-5}$

b. A 0.1 M solution of an acid with $pK_a=3.0$ or one with $pK_a=3.5$

c. A 0.1 M solution of a weak acid or a 0.01 M solution of the same acid

d. A 0.1 M solution of a weak acid or a 0.1 M solution of a strong acid

e. A solution of $pOH\ 6.0$ or one of $pOH\ 8.0$

21. How many moles of H_3O^+ or OH^- must you add per liter of HA solution to adjust its pH from 3.25 to 3.65? Assume a negligible volume change.

22. Like any equilibrium constant, K_w changes with temperature. If autoionization is an endothermic process, does K_w increase or decrease at higher T? Explain with a reaction that includes heat as a reactant or product.

23. A 0.25 M solution of a weak acid is 3.0% dissociated.

a. Calculate the $[\text{H}_3\text{O}^+]$, pH, $[\text{OH}^-]$ and pOH of the solution.

b. Calculate K_a of the acid.

24. Calculate:

a. the pH of 0.175 M HY if $K_a = 1.00 \times 10^{-4}$

b. pOH of 0.175 M HX if $K_a = 1.00 \times 10^{-2}$

25. What is the pH of:

a. 0.53M potassium formate? K_a (formic acid) = 1.8×10^{-4}

b. 1.22 M NH_4Br ? K_b (ammonia) = 1.76×10^{-5}

26. Phenol, C_6H_5OH , is used as a disinfectant (known as carbolic acid). In water, its pK_a is 10.0, but in pure methanol it is 14.4.
- Why are the values different?
 - Use these two values to decide whether methanol is a stronger or weaker base than water.
 - Write the dissociation reaction of carbolic acid in methanol.
 - Write an expression that defines the autoionization constant of methanol.
27. Explain the increase or decrease in the pH and in the buffer-component concentration ratio, $[NaA]/[HA]$, of a buffer in each of the following cases:
- Addition of 0.1 M NaOH to the buffer
 - Addition of 0.1 M HCl to the buffer
 - Dissolving pure NaA in the buffer

d. Dissolving pure HA in the buffer

28. What is the pH of a buffer that consists of 0.55 M HCOOH and 0.63 M HCOONa?
 pK_a (formic acid) = 3.74

29. Why is the center of the buffer region of a weak acid-strong base titration significant?

30. Calculate the pH during the titration of 20.00 mL of 0.1000 M butanoic acid, $CH_3CH_2CH_2COOH$ ($K_a = 1.54 \times 10^{-5}$), with 0.1000 M NaOH solution after the following additions of titrant:

a. 0 mL

b. 10.00 mL

c. 15.00 mL

d. 19.00 mL

e. 19.95 mL

f. 20.00 mL

g. 20.05 mL

h. 25.00 mL

31. The solubility of silver carbonate is 0.032 M at 20°C. Calculate the K_{sp} of silver carbonate.

32. Calculate the molar solubility of $\text{Ca}(\text{IO}_3)_2$ ($K_{sp} = 7.1 \times 10^{-7}$) in the following:

a. 0.060 M $\text{Ca}(\text{NO}_3)_2$

b. 0.060 M NaIO_3

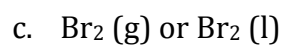
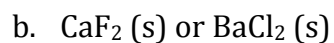
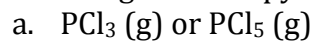
33. Predict the sign of ΔS_{sys} for each of the following processes:

a. Alcohol evaporating

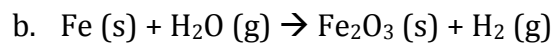
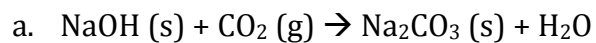
b. A solid explosive converting to a gas

c. Perfume vapors diffusing through a room

34. Assume 1 mol of substance for the following pairs. Choose the one in each pair with the higher entropy and explain why.



35. Balance the following equations, predict the sign of $\Delta S^\circ_{\text{rxn}}$, and calculate the value at 25°C .

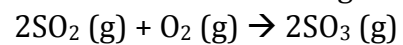


36. Does the oxidation of $\text{FeO} (\text{s})$ to $\text{Fe}_2\text{O}_3 (\text{s})$ occur spontaneously at 298 K?

37. Determine the standard free energy change at 298 K for the reaction
$$2\text{NO (g)} + \text{O}_2 \text{(g)} \rightarrow 2\text{NO}_2 \text{(g)}$$

38. Using ΔG_f^0 values, calculate the free energy change at 25°C for the reaction in problem 37

39. For the following reaction, determine if the process is spontaneous at 25°C, predict how ΔG will change with increasing T, and decide if the reaction is spontaneous at 900°C using the assumption that ΔH and ΔG are constant with T.



Useful Data:

<u>Substance or Ion</u>	<u>ΔH_f^0 (kJ/mol)</u>	<u>ΔG_f^0 (kJ/mol)</u>	<u>S^0 (J/mol K)</u>
CO ₂ (g)	-393.5	-394.4	213.7
H ₂ (g)	0	0	130.6
Fe (s)	0	0	27.3
FeO (s)	-272.0	-251.4	60.75
Fe ₂ O ₃ (s)	-825.5	-743.6	87.400
NO (g)	90.29	86.60	210.65
NO ₂ (g)	33.2	51	239.9
O ₂ (g)	0	0	205.0
H ₂ O (g)	-241.826	-228.60	188.72
H ₂ O (l)	-285.840	-237.192	69.940
NaOH (s)	-425.609	-397.53	64.454
Na ₂ CO ₃ (s)	-1130.8	-1048.1	139
SO ₂ (g)	-296.8	-300.2	248.1
SO ₃ (g)	-396	-371	256.66