Second Semester Honors Chemistry Review

Gases

1. A fixed quantity of gas at 23°C exhibits a pressure of 748 torr and occupies a volume of 10.3 L.

   a. Use Boyle's law to calculate the volume the gas will occupy at 23°C if the pressure is increased to 1.55 atm.

   b. Use Charles's law to calculate the volume the gas will occupy if the temperature is increased to 145°C while the pressure is held constant.

2. Calculate the volume of a gas, in liters, if 1.57 mol has a pressure of 0.86 atm at a temperature of –12°C.

3. Calculate the absolute temperature of the gas at which 6.79×10^{-2} mole occupies 164 mL at 693 torr.

4. Calculate the molar mass of a gas if 2.50 g occupies 0.875 L at 685 torr and 35°C.

5. A mixture containing 2.50 g each of $CH_4(g)$, $C_2H_4(g)$, and $C_4H_{10}(g)$ is contained in a 1.50 L flask at a temperature of 15°C.

   a. Calculate the partial pressure of each of the gases in the mixture.

   b. Calculate the total pressure of the mixture.

Thermodynamics

6. How much ice (in grams) is present if 10,304 J of energy is required to raise the temperature from -23.0°C to -4.5°C?

7. How much heat is absorbed when 1.88×10^{24} molecules of ethanol (C_2H_5OH) is heated from 5.00°C to 74.0°C?

8. Calculate the amount of heat added to raise the temperature of 14.5 g of solid mercury from 234 K to 603.0 K.

9. Calculate the amount of heat needed to raise the temperature of 250.3 g of ice from -20°C to 120°C.

10. Calculate the final temperature if 168.7 grams of iron at 323°C is added to 103.4 grams of water at 35.0°C.

11. Suppose 446.2 grams of mystery metal X at 122.2°C is added to 1.232 kg of 34°C water, causing the final temperature of the system to be 41.1°C. What is the specific heat of mystery metal X?

12. Add and subtract each reaction to create the net reaction.

$2\ C_2H_6(g) + 7\ O_2(g) \rightarrow 4\ CO_2(g) + 6\ H_2O(l)$	$\Delta H = -3120$ kJ
$C(s) + O_2(g) \rightarrow CO_2(g)$	$\Delta H = -394$ kJ
$2\ H_2(g) + O_2(g) \rightarrow 2\ H_2O(l)$	$\Delta H = -572$ kJ
Net reaction: $2\ C(s) + 3\ H_2(g) \rightarrow C_2H_6(g)$	$\Delta H =$

13. Determine the overall ΔH for the reaction.
$CO_2(g) + H_2O(l) \rightarrow C_2H_5OH(l) + O_2(g0$

14. $114\ CO_2(g) + 110\ H_2O(l) \rightarrow 2\ \underline{C_{57}H_{110}O_6}(s) + 163\ O_2(g)$ $\Delta H = 75520$ kJ
Solve for the underlined heat of formations.

15. $SO_4^{2-}(aq) + 4\ H^+(aq) + Ni(s) \rightarrow Ni^{2+}(aq) + SO_2(g) + 2\ H_2O(l)$ @ 35°C

ΔH: _____

Exo or Endo: _____

ΔS: _____

ΔG: _____

Spontaneity: _____

Solutions

16. On the basis of the rule "like dissolves like," explain which of the following in each pair is likely to be the more soluble in water:

a. $CH_3CH_2CH_2CH_2OH$ or CH_3CH_2OH

b. CCl_4 or $CaCl_2$

17. Calculate the freezing and boiling points of each solution.

b. 18.0 grams of $C_{10}H_{22}$ in 425 grams $CHCl_3$

c. 25.0 grams KBr in 225 grams H_2O

18. Lauryl alcohol is obtained from coconut oil and is used to make detergents. A solution of 5.00 g of lauryl alcohol in 0.100 kg of benzene freezes at 4.1°C. What is the molar mass of this substance?

Kinetics

19. The following data were collected for the rate of disappearance of NO in the reaction $2\ NO(g) + O_2(g) \rightarrow 2\ NO_2(g)$:

Experiment	[NO] (M)	[O_2] (M)	Initial Rate (M/s)
1	0.0126	0.0125	1.41×10^{-2}
2	0.0252	0.025	1.13×10^{-1}
3	0.0252	0.0125	5.64×10^{-2}

a. What is the rate law for the reaction?

b. What are the units of the rate constant?

c. What is the average value of the rate constant calculated from the three data sets?

20. For the reaction 2 $NO_2(g) \rightarrow 2\ NO(g) + O_2(g)$, the rate equation is
Rate = k $[NO_2]^2$ at 25°C, k = $1.4 \times 10^{-4}\ M^{-1} \bullet s^{-1}$

a. If 3.00 mol of NO_2 is initially presenting in a sealed 2.00 L flask at 25°C, how many hours pass for the concentration to be cut in one-fourth?

b. What concentration of NO_2 remains after 115 days?

Equilibrium

21. Predict the direction of shift and explain why.
$S_8(g) + O_2(g) \rightleftharpoons SO_3(g) +$ heat

a. Add more S_8.

b. Add more O_2.

c. Increase the pressure on the system by adding an unreactive gas such as argon.

d. Increase the temperature.

e. Decrease the temperature.

f. Add H_2 gas to the chamber.

g. Add water [$SO_3(g) + H_2O(l) \rightleftharpoons H_2SO_4(aq)$]

22. $CH_4(l) + O_2(g) \rightleftharpoons H_2O(l) + CO_2(g)$ Keq = 2.883
Predict the equilibrium concentrations for the reactants and products when beginning with 0.88 moles of O_2 in a 1.5 L flask.

23. $H_2(g) + CO_2(g) \rightleftharpoons H_2O(g) + CO(g)$ Keq = 4.40
Beginning with 0.702 M $H_2(g)$ and 0.665 M $CO_2(g)$, calculate the equilibrium of CO_2.

24. $C(s) + CO_2(g) \rightleftharpoons CO(g)$ Keq = 14.1
Beginning with 32.22 grams of CO_2 in a 450 mL flask, calculate the equilibrium concentration of CO.

25. Predict whether the system is at equilibrium by using the Q-test. Assume the reaction occurs in a 1 L container.
$Mg(s) + HCl(aq) \rightleftharpoons H_2(g) + MgCl_2(aq)$ $K_{eq} = 1.5$

a. HCl = 0.30 moles
H_2 = 0.50 moles
$MgCl_2$ = 0.40 moles

b. HCl = 0.50 moles
H_2 = 0.30 moles
$MgCl_2$ = 0.40 moles

Acids and Bases

26. Fill in the missing pieces of the following chart.

	$[H^+]$	[pH]	$[OH^-]$	pOH	Acid, Base, or Neutral
a.	3.234×10^{-9} M				
b.				11.44	
c.			4.88×10^{-8} M		
d.		6.2			

27. Use titration principles to solve the following problems.

a. What volume of 0.50 M H_3PO_4 would be needed to titrate 65 g of $Ca(OH)_2$?

b. How many milliliters of 0.02800 M of NaOH would be required to titrate 18.73 mL of 0.1500 M HCl?

c. A 13.0 gram tablet of $Mg(OH)_2$ neutralizes 650.0 mL of stomach acid. What is the molarity of the HCl in the stomach?

ANSWERS:

1. a. V_2 = 6.54 L
   b. V_2 = 14.5 L
2. V = 39 L
3. T = 26.8 K
4. 80.2 g/mol
5. a. CH_4 = 2.5 atm
   C_2H_4 = 1.4 atm
   C_4H_{10} = 0.68 atm
   b. Ptotal = 4.5 atm
6. 270 g
7. q = 24,100 J
8. q = 917 J
9. q = 77,400 J
10. Tf = 79.6°C
11. C = 1.01 J/g°C
12. ΔH = -86 J
13. ΔH = +1366.8 kJ
14. ΔHf = -388.5 kJ
15. ΔH = +86.5 kJ, endothermic
    ΔS = 1.9403 kJ/K
    ΔG = -1413.35 kJ, spon.
16. a. CH_3CH_2OH
    b. $CaCl_2$
17. a. Tf = -64.9°C
    Tb = 62.3°C
    b. Tf = -3.47°C
    Tb = 101°C
18. 183 g/mol
19. a. Rate = k $[NO_2]^2$ $[O_2]$
    b. M^{-2} sec^{-1}
    c. k = 7.109×10^3 M^{-2} sec^{-1}
20. a. t = 3.97 hours
    b. $[NO_2] = 7.19 \times 10^{-4}$ M
21. a. right
    b. right
    c. right
    d. left
    e. right
    f. left
    g. right
22. $[O_2]$ = 0.24 M
    $[CO_2]$ = 0.17 M
23. $[CO_2]$ = 0.203 M
24. [CO] = 2.4 M
25. a. Q = 2.2, favors products
    b. Q = 0.48, favors reactants
26. a. pH = 8.490
    $[OH^-] = 3.092 \times 10^{-6}$ M
    pOH = 5.510
    b. $[H^+] = 2.754 \times 10^{-3}$ M
    pH = 2.56
    $[OH^-] = 3.631 \times 10^{-12}$ M
    c. $[H^+] = 2.05 \times 10^{-7}$ M
    pH = 7.31
    pOH = 6.69
    d. $[H^+] = 6.3 \times 10^{-7}$ M
    $[OH^-] = 1.6 \times 10^{-8}$ M
    pOH = 7.8
27. a. 1.2 L H_3PO_4
    b. 100.3 mL NaOH
    c. 0.686 M HCl