

Second Semester Honors Chemistry Review

Gases

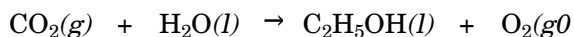
- A fixed quantity of gas at 23°C exhibits a pressure of 748 torr and occupies a volume of 10.3 L.
 - Use Boyle's law to calculate the volume the gas will occupy at 23°C if the pressure is increased to 1.55 atm.
 - Use Charles's law to calculate the volume the gas will occupy if the temperature is increased to 145°C while the pressure is held constant.
- 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.
- Calculate the absolute temperature of the gas at which 6.79×10^{-2} mole occupies 164 mL at 693 torr.
- Calculate the molar mass of a gas if 2.50 g occupies 0.875 L at 685 torr and 35°C.
- A mixture containing 2.50 g each of $\text{CH}_4(g)$, $\text{C}_2\text{H}_4(g)$, and $\text{C}_4\text{H}_{10}(g)$ is contained in a 1.50 L flask at a temperature of 15°C.
 - Calculate the partial pressure of each of the gases in the mixture.
 - Calculate the total pressure of the mixture.

Thermodynamics

- 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?
- How much heat is absorbed when 1.88×10^{24} molecules of ethanol ($\text{C}_2\text{H}_5\text{OH}$) is heated from 5.00°C to 74.0°C?
- Calculate the amount of heat added to raise the temperature of 14.5 g of solid mercury from 234 K to 603.0 K.
- Calculate the amount of heat needed to raise the temperature of 250.3 g of ice from -20°C to 120°C.
- 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.
- 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?
- Add and subtract each reaction to create the net reaction.

$2 \text{C}_2\text{H}_6(g) + 7 \text{O}_2(g) \rightarrow 4 \text{CO}_2(g) + 6 \text{H}_2\text{O}(l)$	$\Delta H = -3120 \text{ kJ}$
$\text{C}(s) + \text{O}_2(g) \rightarrow \text{CO}_2(g)$	$\Delta H = -394 \text{ kJ}$
$2 \text{H}_2(g) + \text{O}_2(g) \rightarrow 2 \text{H}_2\text{O}(l)$	$\Delta H = -572 \text{ kJ}$
<i>Net reaction:</i> $2 \text{C}(s) + 3 \text{H}_2(g) \rightarrow \text{C}_2\text{H}_6(g)$	$\Delta H =$

13. Determine the overall ΔH for the reaction.



14. $114 \text{ CO}_2(g) + 110 \text{ H}_2\text{O}(l) \rightarrow 2 \underline{\text{C}_{57}\text{H}_{110}\text{O}_6}(s) + 163 \text{ O}_2(g) \quad \Delta H = 75520 \text{ kJ}$

Solve for the underlined heat of formations.

15. $\text{SO}_4^{2-}(aq) + 4 \text{ H}^+(aq) + \text{Ni}(s) \rightarrow \text{Ni}^{2+}(aq) + \text{SO}_2(g) + 2 \text{ H}_2\text{O}(l) \quad @ 35^\circ\text{C}$

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

b. CCl_4 or CaCl_2

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

b. 18.0 grams of $\text{C}_{10}\text{H}_{22}$ 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 $2 \text{ NO}(g) + \text{O}_2(g) \rightarrow 2 \text{ NO}_2(g)$:

Experiment	$[\text{NO}]$ (M)	$[\text{O}_2]$ (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}

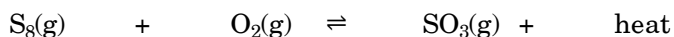
a. What is the rate law for the reaction?

b. What are the units of the rate constant?

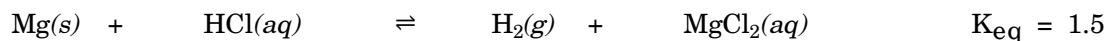
- c. What is the average value of the rate constant calculated from the three data sets?
20. For the reaction $2 \text{NO}_2(g) \rightarrow 2 \text{NO}(g) + \text{O}_2(g)$, the rate equation is
 $\text{Rate} = k [\text{NO}_2]^2$ at 25°C , $k = 1.4 \times 10^{-4} \text{ M}^{-1} \cdot \text{s}^{-1}$
- 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.



- 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 [$\text{SO}_3(g) + \text{H}_2\text{O}(l) \rightleftharpoons \text{H}_2\text{SO}_4(aq)$]
22. $\text{CH}_4(l) + \text{O}_2(g) \rightleftharpoons \text{H}_2\text{O}(l) + \text{CO}_2(g)$ $K_{\text{eq}} = 2.883$
 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. $\text{H}_2(g) + \text{CO}_2(g) \rightleftharpoons \text{H}_2\text{O}(g) + \text{CO}(g)$ $K_{\text{eq}} = 4.40$
 Beginning with 0.702 M $\text{H}_2(g)$ and 0.665 M $\text{CO}_2(g)$, calculate the equilibrium of CO_2 .
24. $\text{C}(s) + \text{CO}_2(g) \rightleftharpoons \text{CO}(g)$ $K_{\text{eq}} = 14.1$
 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.



- a. $\text{HCl} = 0.30$ moles
 $\text{H}_2 = 0.50$ moles
 $\text{MgCl}_2 = 0.40$ moles
- b. $\text{HCl} = 0.50$ moles
 $\text{H}_2 = 0.30$ moles
 $\text{MgCl}_2 = 0.40$ 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 x 10 ⁻⁹ M				
b.				11.44	
c.			4.88 x 10 ⁻⁸ M		
d.		6.2			

27. Use titration principles to solve the following problems.

a. What volume of 0.50 M H₃PO₄ 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 | 16. a. CH ₃ CH ₂ OH | 23. [CO ₂] = 0.203 M |
| b. V ₂ = 14.5 L | b. CaCl ₂ | 24. [CO] = 2.4 M |
| 2. V = 39 L | 17. a. Tf = -64.9°C | 25. a. Q = 2.2, favors products |
| 3. T = 26.8 K | Tb = 62.3°C | b. Q = 0.48, favors reactants |
| 4. 80.2 g/mol | b. Tf = -3.47°C | 26. a. pH = 8.490 |
| 5. a. CH ₄ = 2.5 atm | Tb = 101°C | [OH ⁻] = 3.092 x 10 ⁻⁶ M |
| C ₂ H ₄ = 1.4 atm | 18. 183 g/mol | pOH = 5.510 |
| C ₄ H ₁₀ = 0.68 atm | 19. a. Rate = k [NO ₂] ² [O ₂] | b. [H ⁺] = 2.754 x 10 ⁻³ M |
| b. P _{total} = 4.5 atm | b. M ⁻² sec ⁻¹ | pH = 2.56 |
| 6. 270 g | c. k = 7.109 x 10 ³ M ⁻² sec ⁻¹ | [OH ⁻] = 3.631 x 10 ⁻¹² M |
| 7. q = 24,100 J | 20. a. t = 3.97 hours | c. [H ⁺] = 2.05 x 10 ⁻⁷ M |
| 8. q = 917 J | b. [NO ₂] = 7.19 x 10 ⁻⁴ M | pH = 7.31 |
| 9. q = 77,400 J | 21. a. right | pOH = 6.69 |
| 10. Tf = 79.6°C | b. right | d. [H ⁺] = 6.3 x 10 ⁻⁷ M |
| 11. C = 1.01 J/g°C | c. right | [OH ⁻] = 1.6 x 10 ⁻⁸ M |
| 12. ΔH = -86 J | d. left | pOH = 7.8 |
| 13. ΔH = +1366.8 kJ | e. right | 27. a. 1.2 L H ₃ PO ₄ |
| 14. ΔH _f = -388.5 kJ | f. left | b. 100.3 mL NaOH |
| 15. ΔH = +86.5 kJ, endothermic | g. right | c. 0.686 M HCl |
| ΔS = 1.9403 kJ/K | 22. [O ₂] = 0.24 M | |
| ΔG = -1413.35 kJ, spon. | [CO ₂] = 0.17 M | |