

The Periodic Table

<i>IA</i> H 1 1.01																	<i>VIIIA</i> He 2 4.00		
<i>IIA</i> Li 3 6.94	Be 4 9.01											<i>IIIA</i> B 5 10.81	<i>IVA</i> C 6 12.01	<i>V A</i> N 7 14.01	<i>VIA</i> O 8 16.00	<i>VIIA</i> F 9 19.00	Ne 10 20.18		
Na 11 22.99	Mg 12 24.31			<i>IIIB</i> Sc 21 44.96	<i>IVB</i> Ti 22 47.88	<i>VB</i> V 23 50.94	<i>VIB</i> Cr 24 52.00	<i>VII B</i> Mn 25 54.94	<i>VIII B</i> Fe 26 55.85	<i>VIII B</i> Co 27 58.93	<i>VIII B</i> Ni 28 58.69	<i>IB</i> Cu 29 63.55	<i>IIB</i> Zn 30 65.39	<i>IIIA</i> Ga 31 69.72	<i>IVA</i> Ge 32 72.61	<i>V A</i> As 33 74.92	<i>VIA</i> Se 34 78.96	<i>VIIA</i> Br 35 79.90	Kr 36 83.80
Rb 37 85.47	Sr 38 87.62	Y 39 88.91	Zr 40 91.22	Nb 41 92.91	Mo 42 95.94	Tc 43 (97.9)	Ru 44 101.07	Rh 45 102.91	Pd 46 106.42	Ag 47 107.87	Cd 48 112.41	In 49 114.82	Sn 50 118.71	Sb 51 121.76	Te 52 127.60	I 53 126.90	Xe 54 131.29		
Cs 55 132.91	Ba 56 137.33	La 57 138.91	Hf 72 178.49	Ta 73 180.95	W 74 183.85	Re 75 186.21	Os 76 190.2	Ir 77 192.22	Pt 78 195.08	Au 79 197.97	Hg 80 200.59	Tl 81 204.38	Pb 82 207.2	Bi 83 208.98	Po 84 (209)	At 85 (210)	Rn 86 (222)		
Fr 87 223.02	Ra 88 226.03	Ac 89 227.03	Rf 104 (261)	Db 105 (262)	Sg 106 263	Bh 107 (262)	Hs 108 (265)	Mt 109 (266)	Ds 110 (271)	Rg 111 (272)	Uub 112 (285)	Uut 113 (284)	Uuq 114 (289)	Uup 115 (288)					
Ce 58 140.12	Pr 59 140.91	Nd 60 144.24	Pm 61 (145)	Sm 62 150.36	Eu 63 152.97	Gd 64 157.25	Tb 65 158.93	Dy 66 162.50	Ho 67 164.93	Er 68 167.26	Tm 69 168.93	Yb 70 173.04	Lu 71 174.97						
Th 90 232.04	Pa 91 231.04	U 92 238.03	Np 93 237.05	Pu 94 (240)	Am 95 243.06	Cm 96 (247)	Bk 97 (248)	Cf 98 (251)	Es 99 252.08	Fm 100 257.10	Md 101 (257)	No 102 259.10	Lr 103 262.11						

Some Useful Formulae and Constants:

$$\text{pH} = \text{pK}_a + \log_{10}\left\{\frac{[\text{A}^-]}{[\text{HA}]}\right\}$$

$$K_w = 1 \times 10^{-14} \text{ @ } 25^\circ\text{C}$$

SID

Last _____

First _____

Question 1

5 Points

Consider the following system at equilibrium at 298 K:

When some $\text{CCl}_4(\text{g})$ is removed from the equilibrium system at constant temperature:*(No partial credit)*

The reaction must:

- Run in the forward direction.
- Run in the reverse direction.
- Remain the same.

and

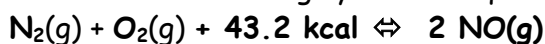
The concentration of CH_4 will:

- Remain the same.
- Increase.
- Decrease.

Question 2

5 Points

Consider the following system at equilibrium at 298 K:



If the temperature is suddenly decreased:

(No partial credit)

The reaction must:

- Run in the forward direction.
- Run in the reverse direction.
- Remain the same.

and

The concentration of O_2 will:

- Remain the same.
- Increase.
- Decrease.

Question 3

5 Points

Consider the following system at equilibrium at 500 K:



If the pressure is suddenly decreased:

(No partial credit)

The reaction must:

- Run in the forward direction.
- Run in the reverse direction.
- Remain the same.

and

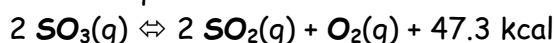
The concentration of Cl_2 will:

- Remain the same.
- Increase.
- Decrease.

Question 4

10 Points

Consider the following system at equilibrium at 1150 K:

The production of $\text{SO}_2(\text{g})$ is favored by

Indicate True (T) or False (F) for each of the following:

- | | | | |
|--------------------------------|---|--------------------------|---|
| a. Decreasing the temperature. | T | d. Adding SO_3 | T |
| b. Decreasing the pressure. | T | e. Adding O_2 . | F |
| c. Increasing the volume. | T | | |

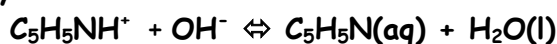
- Question 5
8 Points
- | | | |
|-------------------------------------|---|----------------|
| a. HCOOH | 2 | 1. Strong Acid |
| b. NH ₃ | 4 | 2. Weak Acid |
| c. C ₅ H ₁₁ N | 4 | 3. Strong Base |
| d. HBr | 1 | 4. Weak Base |

- Question 6
6 Points
- Circle the appropriate answers
- | Acid | K _a | | | | |
|------|----------------------|--|---|---|---|
| A | 7.9×10 ⁻⁷ | 1. The acid with the greatest [H ₃ O ⁺] in a 0.10 M aqueous solution is: | A | B | C |
| B | 1.8×10 ⁻⁵ | 2. The acid with the smallest pK _a : | A | B | C |
| C | 4.2×10 ⁻⁷ | 3. The acid with the smallest pOH in a 0.10 M aqueous solution is: | A | B | C |

- Question 7
6 Points
- The pK_a for HCN is 9.39 while the K_a for HClO is 3.5×10⁻⁸.
- | | |
|--|------|
| a. What is the pK _a for HClO? | 7.46 |
| b. Which is the stronger acid? | HClO |

- Question 8
9 Points
- The hydroxide concentration in an aqueous solution is 4.5×10⁻² M @ 25°C
- | | |
|--|-------------------------|
| a. The hydronium ion concentration is: | 2.2×10 ⁻¹³ M |
| b. The pH of this solution is: | 12.65 |
| c. The pOH is: | 1.35 |

- Question 9
12 Points
- In the following net ionic equation, identify each reactant as either a Bronsted-Lowry acid or a Bronsted-Lowry base.



- | | |
|--|-------------------------------|
| a. C ₅ H ₅ NH ⁺ | Bronsted- Lowry Acid . |
| b. OH ⁻ | Bronsted- Lowry Base . |

Give the formula for:

- | | |
|---|---|
| c. Conjugate acid of HPO ₄ ²⁻ | H ₂ PO ₄ ⁻ |
| d. Conjugate base of HPO ₄ ²⁻ | PO ₄ ³⁻ |

- Question 10
4 Points
- A buffer solution is 0.225 M in H₂C₂O₄ and 0.499 M in NaHC₂O₄. If pK_a for H₂C₂O₄ is 1.29, what is the pH of this buffer solution?
You must show work to obtain credit.

$$\text{pH} = 1.29 + \log_{10}\{0.499/0.225\}$$

pH = 1.64

Question 11 A small amount of **strong acid** is added to a **buffer** made from HNO_2 and NaNO_2 . What changes if any will occur to the solution?

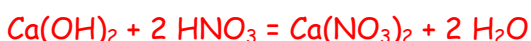
8 Points

- Circle the appropriate answer

- | | | | |
|----------------------|----------|----------|-----------|
| a. pH | Increase | Decrease | Unchanged |
| b. $[\text{NO}_2^-]$ | Increase | Decrease | Unchanged |
| c. $[\text{HNO}_2]$ | Increase | Decrease | Unchanged |
| d. $[\text{OH}^-]$ | Increase | Decrease | Unchanged |

Question 12 Calcium hydroxide is standardized by titration with 0.320 M solution of nitric acid. If 38.5 mL of base are required to neutralize 23.4 mL of acid, what is the molarity of the calcium hydroxide solution?

6 Points



$$0.320 \times 0.0234 = 7.48 \times 10^{-3} \text{ mol HNO}_3$$

$$\frac{7.48 \times 10^{-3} \text{ mol HNO}_3}{2 \text{ HNO}_3} \left| \frac{1 \text{ Ca(OH)}_2}{2 \text{ HNO}_3} \right. = 3.74 \times 10^{-3} \text{ mol Ca(OH)}_2$$

$$M = 3.74 \times 10^{-3} / 0.0385$$

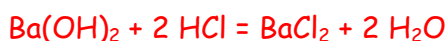
0.0972

M

Question 13 How many grams of solid barium hydroxide are needed to exactly neutralize 25.4 mL of a 1.49 M hydrochloric acid solution?

5 Points

Assume that the volume remains constant.



$$1.49 \times 0.0254 = 3.78 \times 10^{-2} \text{ mol HCl}$$

$$\frac{3.78 \times 10^{-2} \text{ mol HCl}}{2 \text{ HCl}} \left| \frac{1 \text{ Ba(OH)}_2}{2 \text{ HCl}} \right. = 1.89 \times 10^{-2} \text{ mol Ba(OH)}_2$$

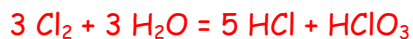
$$\frac{1.89 \times 10^{-2} \text{ mol Ba(OH)}_2}{1 \text{ mol}} \left| \frac{171.35 \text{ g}}{1 \text{ mol}} \right. =$$

3.24

g

Question 14 How many grams of chloric acid will be formed upon the complete reaction of 29.0 grams of water with excess chlorine gas?

6 Points



$$\frac{29 \text{ g H}_2\text{O}}{18.02 \text{ g}} \times \frac{1 \text{ mol}}{18.02 \text{ g}} = 1.61 \text{ mol H}_2\text{O}$$

$$\frac{1.61 \text{ mol H}_2\text{O}}{3 \text{ H}_2\text{O}} \times \frac{1 \text{ HClO}_3}{3 \text{ H}_2\text{O}} = 0.536 \text{ mol HClO}_3$$

$$\frac{0.536 \text{ mol HClO}_3}{1 \text{ mol}} \times \frac{84.46 \text{ g}}{1 \text{ mol}} =$$

45.3

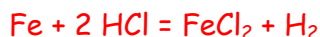
g

Question 15 What mass of iron in grams would produce 27.7 L of hydrogen gas (P = 1 atm, T = 25°C) when it reacts completely with excess hydrochloric acid?

5 Points



$$R = 0.08205 \text{ L}\cdot\text{atm}\cdot\text{K}^{-1}\cdot\text{mol}^{-1}$$



$$n = \frac{PV}{RT} = \frac{1 \times 27.2}{0.08205 \times 298} = 1.13 \text{ mol H}_2$$

$$\frac{1.13 \text{ mol H}_2}{1 \text{ H}_2} \times \frac{1 \text{ Fe}}{1 \text{ H}_2} = 1.13 \text{ mol Fe}$$

$$\frac{1.13 \text{ mol Fe}}{1 \text{ mol}} \times \frac{55.85 \text{ g}}{1 \text{ mol}} =$$

63.3

g

Exam III Score