The Periodic Table

IA												IIIA	IVA	VA	VIA	VIIA	VIIIA
H 1 1.01	IIA																He 2 4.00
Li 3 6.94	Be 4 9.01											B 5 10.81	C 6 12.01	N 7 14.01	O 8 16.00	F 9 19.00	Ne 10 20.18
Na 11 22.99	Mg 12 24.31	IIIB	IVB	VB	VIB	VIIB	VIIIB	VIIIB	VIIIB	IB	IIB	Al 13 26.98	Si 14 28.09	P 15 30.97	S 16 32.07	Cl 17 35.45	Ar 18 39.95
K 19 39.10	Ca 20 40.08	Sc 21 44.96	Ti 22 47.88	V 23 50.94	Cr 24 52.00	Mn 25 54.94	Fe 26 55.85	Co 27 58.93	Ni 28 58.69	Cu 29 63.55	Zn 30 65.39	Ga 31 69.72	Ge 32 72.61	As 33 74.92	Se 34 78.96	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:

$$pH = pK_a + \log_{10}\{[A^-]/[HA]\}$$

$$K_w = 1\times10^{-14} \text{ @ } 25^\circ C$$

SID | | | | | | | | | Last _____ First _____

Question 1 (5 Points)

Consider the following system at equilibrium at 298 K:

2 CH_2Cl_2(g) ⇔ CH_4(g) + CCl_4(g)

When some **CCl_4(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:

N_2(g) + O_2(g) + 43.2 kcal ⇔ 2 NO(g)

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:

PCl_5(g) ⇔ PCl_3(g) + Cl_2(g)

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:

2 **SO_3**(g) ⇔ 2 **SO_2**(g) + **O_2**(g) + 47.3 kcal

The production of **SO_2**(g) is **favored by**

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

a. **Decreasing** the temperature. **T**

b. **Decreasing** the pressure. **T**

c. **Increasing** the volume. **T**

d. **Adding SO_3** **T**

e. **Adding O_2.** **F**

Question 5 (8 Points)

a. **HCOOH**	2	**1.** Strong Acid
b. NH_3	4	**2.** Weak Acid
c. $C_5H_{11}N$	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}
B	1.8×10^{-5}
C	4.2×10^{-7}

1. The acid with the **greatest** $[H_3O^+]$ in a **0.10** M aqueous solution is: **A** **B** **C**
2. The acid with the **smallest pKa**: **A** **B** **C**
3. The acid with the **smallest pOH** in a 0.10 M aqueous solution is: **A** **B** **C**

Question 7 (6 Points) The **pKa** for **HCN** is **9.39** while the **Ka** for **HClO** is 3.5×10^{-8}.

a. What is the pKa 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**.

$$C_5H_5NH^+ + OH^- \Leftrightarrow C_5H_5N(aq) + H_2O(l)$$

a. $C_5H_5NH^+$ Bronsted- Lowry **Acid**.

b. OH^- Bronsted- Lowry **Base**.

Give the **formula** for:

c. Conjugate **acid** of HPO_4^{2-} $H_2PO_4^-$

d. Conjugate **base** of HPO_4^{2-} PO_43^-

Question 10 (4 Points) A buffer solution is **0.225** M in $H_2C_2O_4$ and **0.499** M in $NaHC_2O_4$. If **pKa** for $H_2C_2O_4$ is **1.29**, what is the pH of this buffer solution?

You must show work to obtain credit.

$$pH = 1.29 + \log10\{0.499/0.225\}$$

pH = 1.64

Question 11
8 Points

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?

- Circle the appropriate answer

a.	**pH**	Increase	**Decrease**	Unchanged
b.	**$[NO_2^-]$**	Increase	**Decrease**	Unchanged
c.	**$[HNO_2]$**	**Increase**	Decrease	Unchanged
d.	**$[OH^-]$**	Increase	**Decrease**	Unchanged

Question 12
6 Points

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?

$$Ca(OH)_2 + 2\ HNO_3 = Ca(NO_3)_2 + 2\ H_2O$$

$$0.320 \times 0.0234 = 7.48\times10^{-3}\ \text{mol } HNO_3$$

$$\frac{7.48\times10^{-3}\ \text{mol } HNO_3 \mid 1\ Ca(OH)_2}{2\ HNO_3} = 3.74\times10^{-3}\ \text{mol } Ca(OH)_2$$

$$M = 3.74\times10^{-3}/0.0385$$

0.0972 M

Question 13
5 Points

How many **grams** of solid **barium hydroxide** are needed to exactly neutralize **25.4 mL** of a **1.49 M hydrochloric acid** solution?
Assume that the volume remains constant.

$$Ba(OH)_2 + 2\ HCl = BaCl_2 + 2\ H_2O$$

$$1.49 \times 0.0254 = 3.78\times10^{-2}\ \text{mol } HCl$$

$$\frac{3.78\times10^{-2}\ \text{mol } HCl \mid 1\ Ba(OH)_2}{2\ HCl} = 1.89\times10^{-2}\ \text{mol } Ba(OH)_2$$

$$\frac{1.89\times10^{-2}\ \text{mol } Ba(OH)_2 \mid 171.35\ g}{1\ \text{mol}} =$$

3.24 g

Question 14
6 Points

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

Chlorine (g) + water (l) = hydrochloric acid (aq) + chloric acid ($HClO_3$)

$$3\ Cl_2 + 3\ H_2O = 5\ HCl + HClO_3$$

$$\frac{29\ g\ H_2O \mid 1\ mol}{18.02\ g} = 1.61\ mol\ H_2O$$

$$\frac{1.61\ mol\ H_2O \mid 1\ HClO_3}{3\ H_2O} = 0.536\ mol\ HClO_3$$

$$\frac{0.536\ mol\ HClO_3 \mid 84.46\ g}{1\ mol} =$$

45.3 g

Question 15
5 Points

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**?

Iron (s) + hydrochloric acid (aq) = iron(II) chloride (aq) + hydrogen (g)

R = 0.08205 L.atm.K^{-1}.mol^{-1}

$$Fe + 2\ HCl = FeCl_2 + H_2$$

$$PV = nRT \qquad n = PV/RT$$

$$n = \frac{1 \times 27.2}{0.08205 \times 198} = 1.13\ mol\ H_2$$

$$\frac{1.13\ mol\ H_2 \mid 1\ Fe}{1\ H_2} = 1.13\ mol\ Fe$$

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

63.3 g

Exam III Score