FORMULA SHEET (tear off)

1A												3A	4A	5A	6A	7A	8A
1 H 1.01	2A																2 He 4.00
3 Li 6.94	4 Be 9.01											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18
11 Na 22.99	12 Mg 24.31											13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.07	17 Cl 35.45	18 Ar 39.95
19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.87	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.41	31 Ga 69.72	32 Ge 72.64	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80
37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc [98]	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	53 I 126.9	54 Xe 131.3
55 Cs 132.9	56 Ba 137.3	71 Lu 175.0	72 Hf 178.5	73 Ta 181.0	74 W 183.8	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.1	79 Au 197.0	80 Hg 200.6	81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	84 Po [209]	85 At [210]	86 Rn [222]
87 Fr [223]	88 Ra [226]	103 Lr [262]	104 Rf [261]	105 Db [262]	106 Sg [266]												

57 La 138.9	58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm [145]	62 Sm 150.4	63 Eu 152.0	64 Gd 157.2	65 Tb 158.9	66 Dy 162.5	67 Ho 164.9	68 Er 167.3	69 Tm 168.9	70 Yb 173.0
89 Ac [227]	90 Th 232.0	91 Pa 231.0	92 U 238.0	93 Np [237]	94 Pu [244]	95 Am [243]	96 Cm [247]	97 Bk [247]	98 Cf [251]	99 Es [252]	100 Fm [257]	101 Md [258]	102 No [259]

$N_A = 6.022 \times 10^{23}$ | $°C = (^5/_9)(°F - 32)$ | $°F = (^9/_5)(°C) + 32$

1 amu = 1.661×10^{-27} kg | $°C = K - 273.15$ | $K = °C + 273.15$

1 atm = 760 torr = 760 mm Hg | 1 atm = 1.013 bar | $pV = nRT$

$R = 0.08206$ L·atm/mol·K | 1 L·atm = 101.3 J

$R = 8.314$ J/mol·K | 1 J= 1 kg·m^2/s^2

$F = 96485.$ C/mol | (1 v) · (1 C) = 1 J

$p_A = X_A p_A°$ | $[B] = k p_B$ | $\Delta p_A = X_B p_A°$

$\Delta T_b = K_b m_B$ | $\Delta T_f = K_f m_B$ | $\Pi = M_B RT$

$H = U + pV$ | $G = H - TS$

$\Delta G_{rxn} = \Delta G°_{rxn} + RT \ln Q$ | $\ln K = -\frac{\Delta G°_{rxn}}{RT}$ | $K_p = K_C (RT)^{\Delta ng}$

If $ax^2 + bx + c = 0$, then $x = \left(\frac{-b \pm [b^2 - 4ac]^{1/2}}{2a} \right)$

$K_a \cdot K_b = K_w$ | $pH + pOH = pK_w$

$K_a \cdot K_b = 1.0 \times 10^{-14}$ (at T = 25. °C) | $pH + pOH = 14.00$ (at T = 25. °C)

$\Delta G = -nFE_{cell}$ | $E_{cell} = E°_{cell} - (RT/nF) \ln Q$ | $\ln K = \frac{nFE°_{cell}}{RT}$

GENERAL CHEMISTRY 2
THIRD HOUR EXAM
NOVEMBER 19, 2021

Name _____

Panthersoft ID _____

Signature _____

Part 1 _____ **(20 points)**

Part 2 _____ **(43 points)**

Part 3 _____ **(37 points)**

TOTAL _____ **(100 points)**

Do all of the following problems. Show your work.
Unless otherwise stated, you may assume T = 25. °C in all problems.

Part 1. Multiple choice. Circle the letter corresponding to the correct answer. There is one and only one correct answer per problem. [4 points each]

1) Which of the following reactions will go essentially to completion?
a) The reaction of a strong acid with a strong base
b) The reaction of a strong acid with a weak base
c) The reaction of a weak acid with a weak base
d) Both a and b
e) Both a and b and c

2) 0.0010 moles of KOH, a strong soluble base, is added to 500.0 mL of a pH = 6.80 buffer solution. After the addition of the KOH
a) The pH of the buffer solution will increase by a large amount (more than 0.1 pH unit)
b) The pH of the buffer solution will decrease by a large amount (more than 0.1 pH unit)
c) The pH of the buffer solution will increase by a small amount (less than 0.1 pH unit)
d) The pH of the buffer solution will decrease by a small amount (less than 0.1 pH unit)
e) Cannot tell from the information given

3) For which of the following titrations do we expect the pH at the equivalence point to be pH = 7.0?
a) Titration of a strong acid with a weak base
b) Titration of a strong acid with a strong base
c) Thtration of a weak acid with a strong base
d) Both a and c
e) Both a and b and c

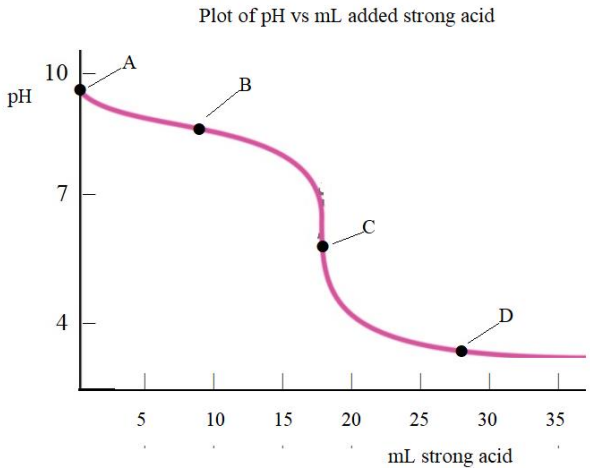
4) For which of the following substances does Mn have the smallest oxidation number?
a) Mn(s)
b) $Mn^{2+}(aq)$
c) $MnO_2(s)$
d) $Mn(OH)_2(s)$
e) $MnO_4^-(aq)$

5) Which of the following will be true for a spontaneous reaction in a galvanic cell at a constant temperature and pressure?
a) $E_{cell} < 0$ and $\Delta G_{rxn} > 0$
b) $E_{cell} < 0$ and $\Delta G_{rxn} < 0$
c) $E_{cell} > 0$ and $\Delta G_{rxn} > 0$
d) $E_{cell} > 0$ and $\Delta G_{rxn} < 0$
e) $E_{cell} = 0$ and $\Delta G_{rxn} = 0$

Part 2. Short answer.

1) A solution is prepared by mixing 0.0561 moles hypobromous acid (HOBr, K_a = 2.0 x 10^{-9}) and 0.0138 moles hypobromite ion (OBr^-). The final volume of the solution is V = 500.0 mL, What is the pH of the solution?
[8 points]

2) A plot of pH vs mL added acid is given below for the titration of a weak base with a strong monoprotic acid. Based on this plot, circle the correct answer for each of the questions below [3 points each]



a) The point corresponding to the equivalence point of the titration

point A point B point C point D

b) The point corresponding to the buffer region of the titration

point A point B point C point D

c) The indicator that would be the best choice to use in the titration

thymol blue	chlorophenol red	phenolphthalein	alizarin yellow
pK_{Ind} = 2.0	pK_{Ind} = 6.0	pK_{Ind} = 8.8	pK_{Ind} = 10.6

3) Radium iodate ($Ra(IO_3)_2$, MW = 576.0 g/mol) is a slightly soluble ionic compound, with $K_{sp} = 1.2 \times 10^{-9}$.

a) Give the oxidation number of each type of atom in $Ra(IO_3)_2$. [2 points each]

$Ra(IO_3)_2$ Ra _____ I _____ O _____

b) What is the molar solubility (in units of mol/L) and solubility by mass (in units of g/L) for $Ra(IO_3)_2$ in water? [10 points]

4) Balance the following unbalanced net ionic reaction for acid conditions [10 points]

$Fe^{2+}(aq) + Cr_2O_7^{2-}(aq) \rightarrow Fe^{3+}(aq) + Cr^{3+}(aq)$ (acid conditions)

Part 3. Problems.

1) The concentration of Cu^{2+} ion in an aqueous solution can be determined from an oxidation-reduction titration. The reaction taking place is the following

$$2\ Cu^{2+}(aq) + 4\ I^{-}(aq) \rightarrow 2\ CuI(s) + I_2(aq)$$

a) What is the oxidizing agent in the above titration reaction? [3 points]

_____

b) A 25.00 mL sample of an aqueous stock solution containing Cu^{2+} ion is titrated with a 0.1389 M solution of I^{-} ion. After the addition of 39.82 mL of the I^{-} solution the equivalence point for the titration is reached. What is the concentration of Cu^{2+} ion in the stock solution? [12 points]

2) The half-cell data given below (for T = 25.0 °C) may be of use in doing the following problem.

Half reaction	E° (v)	Half reaction	E° (v)
$Pb^{2+}(aq) + 2\ e^- \rightarrow Pb(s)$	– 0.13	$Cd^{2+}(aq) + 2\ e^- \rightarrow Cd(s)$	– 0.40
$Sn^{2+}(aq) + 2\ e^- \rightarrow Sn(s)$	– 0.14	$Fe^{2+}(aq) + 2\ e^- \rightarrow Fe(s)$	– 0.45
$Ni^{2+}(aq) + 2\ e^- \rightarrow Ni(s)$	– 0.26	$Zn^{2+}(aq) + 2\ e^- \rightarrow Zn(s)$	– 0.76
$Co^{2+}(aq) + 2\ e^- \rightarrow Co(s)$	– 0.28	$Zn(OH)_2(s) + 2\ e^- \rightarrow Zn(s) + 2\ OH^-(aq)$	– 1.25

a) Give the half-cell oxidation reaction, the half-cell reduction reaction, the net cell reaction, and the cell potential for standard conditions ($E°_{cell}$) for the galvanic cell given below. [14 points]

$$Cd(s) \mid Cd^{2+}(aq) \parallel Pb^{2+}(aq) \mid Pb(s)$$

b) Find the numerical value for K_{sp} for the following solubility reaction [8 points]

$$Zn(OH)_2(s) \leftrightarrows Zn^{2+}(aq) + 2\ OH^-(aq)$$