FORMULA SHEET (tear off)

1A																	8A
1 H 1.01	2A											3A	4A	5A	6A	7A	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

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

$\Delta T_b = K_b m_B$ | $\Delta T_f = K_f m_B$ | $\Pi = [B]RT$

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

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

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

$K_a \cdot K_b = K_w = 1.0 \times 10^{-14}$ (at T = 25°C) | $pH = pK_a + \log_{10}\{[base]/[acid]\}$

GENERAL CHEMISTRY 2
THIRD HOUR EXAM

Name _____

Panthersoft ID _____

Signature _____

Part 1 _____ **(20 points)**

Part 2 _____ **(22 points)**

Part 3 _____ **(38 points)**

TOTAL _____ **(80 points)**

Do all of the following problems. Show your work.

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]

The following information will be of use in doing problems 1 and 2 below.

Weak acid	K_a	Weak acid	K_a
benzoic acid (C_6H_5COOH)	6.5×10^{-5}	nitrous acid (HNO_2)	4.5×10^{-4}
chloroacetic acid ($CH_2ClCOOH$)	1.4×10^{-3}	phenol (C_6H_5OH)	1.3×10^{-10}

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1) Which of the following 0.0100 M solutions of weak acid will have the lowest value for pH?

a) a 0.0100 M solution of benzoic acid
b) a 0.0100 M solution of chloroacetic acid
c) a 0.0100 M solution of nitrous acid
d) a 0.0100 M solution of phenol
e) All of the above solutions will have the same value for pH

2) Which of the following 0.0100 M solutions of the sodium salt of the conjugate base of a weak acid will have the highest value for pH?

a) a 0.0100 M solution of sodium benzoate (NaC_6H_5COO)
b) a 0.0100 M solution of sodium chloroacetate ($NaCH_2ClCOO$)
c) a 0.0100 M solution of sodium nitrite ($NaNO_2$)
d) a 0.0100 M solution of sodium phenolate (NaC_6H_5O)
e) All of the above solutions will have the same value for pH

3) Ammonium perchlorate (NH_4ClO_4) is a soluble salt formed by the reaction of a strong acid with a weak base. The pH of a 0.100 M solution of ammonium perchlorate, measured at T = 25. °C, is expected to be

a) exactly equal to 7.0
b) significantly larger than 7.0
c) approximately equal to 7.0
d) significantly smaller than 7.0
e) undefined, because the concept of pH does not apply to solutions of salts

4) Which of the following metal ions would be expected to be the strongest weak acid?

a) Al^{3+} ion
b) Ba^{2+} ion
c) Cs^{+} ion
d) Cu^{2+} ion
e) Pb^{2+} ion

5) Which of the following reactions is expected to go 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 strong base
d) Both a and b
e) Both a and b and c

Part 2. Short answer.

1) For each of the following circle the correct answer. There is one and only one correct answer per problem. [3 points each]

a) A polyprotic acid

HCl	HIO_2	HNO_3	H_2SO_4

b) The strongest acid fom the following acids

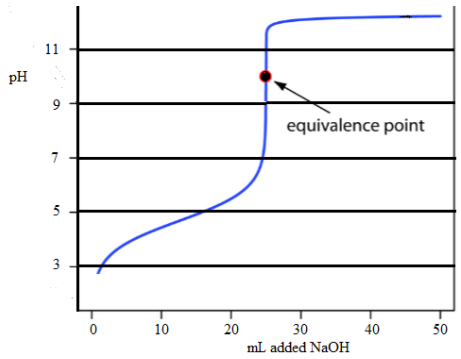
$HBrO_2$	$HBrO_3$	HIO_2	HIO_3

c) The strongest acid from the following acids

H_2S	H_2O	HBr	HF

2) What is the difference (if any) between the equivalence point and the end point of an acid/base titration? [5 points]

3) The figure below is for the titration of a 25.00 mL sample of nitrous acid (HNO_2, a weak acid) with a 0.2482 M solution of potassium hydroxide (KOH, a strong soluble base).



a) Give the balanced molecular equation corresponding to the neutralization reaction in the above titration. [4 points]

b) Which of the following indicators would be the best choice to use in the above titration (circle the correct answer). [4 points]

bromophenol blue	methyl red	bromothymol blue	phenolphthalein
$pK_a = 3.8$	$pK_a = 5.2$	$pK_a = 6.6$	$pK_a = 9.0$

Part 3. Problems.

1) Propanoic acid (CH_3CH_2COOH, MW = 74.08 g/mol) is a weak monoprotic acid, with $K_a = 1.34 \times 10^{-5}$.

a) A chemist prepares 1.000 L of a 0.0360 M aqueous solution of propanoic acid. What is the pH of the solution? [12 points]

b) 0.500 g of sodium hydroxide (NaOH, MW = 40.00 g/mol) is added to the above 1.000 L solution of propanoic acid. What is the new value for pH after the addition of the sodium hydroxide? You may assume that the addition of NaOH does not change the volume of the solution. [12 points]

2) A 25.00 mL sample of an aqueous stock solution of potassium hydroxide (KOH, MW = 56.11 g/mol) is titrated with a 0.2281 M aqueous solution of hydrochloric acid (HCl, MW = 36.46 g/mol) at T = 25. °C. After the addition of 23.04 mL of the HCl solution the equivalence point for the titration is reached.

a) What is the concentration of the stock solution of potassium hydroxide? [10 points]

b) What is the pH at the equivalence point of the titration (circle the correct answer)? [4 points]

greater than 7.0 equal to 7.0 less than 7.0