

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]		

$$N_A = 6.022 \times 10^{23}$$

$$1 \text{ amu} = 1.661 \times 10^{-27} \text{ kg}$$

$$1 \text{ atm} = 760 \text{ torr} = 760 \text{ mm Hg}$$

$$R = 0.08206 \text{ L}\cdot\text{atm}/\text{mol}\cdot\text{K}$$

$$R = 8.314 \text{ J}/\text{mol}\cdot\text{K}$$

$$F = 96485 \text{ C}/\text{mol}$$

$$^\circ\text{C} = (5/9)(^\circ\text{F} - 32)$$

$$^\circ\text{C} = \text{K} - 273.15$$

$$1 \text{ atm} = 1.013 \text{ bar}$$

$$1 \text{ L}\cdot\text{atm} = 101.3 \text{ J}$$

$$1 \text{ J} = 1 \text{ kg}\cdot\text{m}^2/\text{s}^2$$

$$(1 \text{ v})(1 \text{ C}) = 1 \text{ J}$$

$$^\circ\text{F} = (9/5)(^\circ\text{C}) + 32$$

$$\text{K} = ^\circ\text{C} + 273.15$$

$$pV = nRT$$

$$\ln(p) = -\frac{\Delta H^\circ_{\text{vap}}}{T} + C$$

$$\ln(p_2/p_1) = -(\Delta H^\circ_{\text{vap}}/R) \{ (1/T_2) - (1/T_1) \}$$

$$p_A = X_A p_A^\circ$$

$$\Delta T_b = K_b m_B$$

$$[B] = k p_B$$

$$\Delta T_f = K_f m_B$$

$$\Delta p_A = X_B p_A^\circ$$

$$\Pi = [B]RT$$

$$H = U + pV$$

$$\Delta G_{\text{rxn}} = \Delta G^\circ_{\text{rxn}} + RT \ln Q$$

$$G = H - TS$$

$$\ln K = -\Delta G^\circ_{\text{rxn}}/RT$$

$$K_p = K_C (RT)^{\Delta n}$$

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

$$K_a \cdot K_b = K_w = 1.0 \times 10^{-14} \text{ (at } T = 25^\circ\text{C)}$$

$$\Delta G = -nFE_{\text{cell}}$$

$$E_{\text{cell}} = E^\circ_{\text{cell}} - (RT/nF) \ln Q$$

$$\ln K = nFE^\circ_{\text{cell}}/RT$$

**GENERAL CHEMISTRY 2
THIRD EXAM (SAMPLE)**

Name _____

Panthersoft ID _____

Signature _____

Part 1 _____ (24 points)

Part 2 _____ (30 points)

Part 3 _____ (46 points)

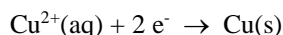
TOTAL _____ (100 points)

Do all of the following problems. Show your work.

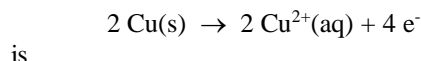
Part 1. Multiple choice. Circle the letter corresponding to the correct answer. There is one and only one correct answer per problem. [4 points each]

- 1) Which of the following reactions goes essentially to completion in aqueous solution?
a) The reaction of a strong acid with a strong base
b) The reaction of a strong acid with a weak base
E c) The reaction of a weak acid with a strong base
d) Both a and b
e) Both a and b and c
- 2) A small amount of a strong base is added to a buffer solution. The pH of the buffer solution
a) will increase significantly
b) will increase by a small amount
B c) will be unchanged
d) will decrease by a small amount
e) will decrease significantly
- 3) 0.010 moles of HClO_2 (chlorous acid, a weak monoprotic acid) is added to 1.000 L of each of the following solutions. For which solution will the percent ionization of the chlorous acid be largest?
a) A 1.0×10^{-3} M solution of HNO_2 (nitrous acid, a weak acid)
b) A 1.0×10^{-3} M solution of HBr (hydrobromic acid, a strong acid)
D c) A 1.0×10^{-3} M solution of NH_3 (ammonia, a weak base)
d) A 1.0×10^{-3} M solution of KOH (potassium hydroxide, a strong base)
e) Pure water
- 4) Which of the following indicators would be the best to use in the titration of a strong acid by a strong base?
a) alizarin yellow ($\text{pK}_{\text{ind}} = 11.0$)
b) bromothymol blue ($\text{pK}_{\text{ind}} = 6.8$)
B c) bromophenol blue ($\text{pK}_{\text{ind}} = 3.8$)
d) thymol blue ($\text{pK}_{\text{ind}} = 2.0$)
e) All of the above would be suitable indicators for the titration
- 5) For a galvanic cell reaction to be spontaneous for standard conditions which of the following must be true?
a) $\Delta G^\circ_{\text{rxn}} > 0$ and $E^\circ_{\text{cell}} > 0$
b) $\Delta G^\circ_{\text{rxn}} > 0$ and $E^\circ_{\text{cell}} < 0$
C c) $\Delta G^\circ_{\text{rxn}} < 0$ and $E^\circ_{\text{cell}} > 0$
d) $\Delta G^\circ_{\text{rxn}} < 0$ and $E^\circ_{\text{cell}} < 0$
e) both c and d

6) The standard reduction potential for the process



is $E^\circ = + 0.34 \text{ v}$. Based on this, we can say that the half-cell oxidation potential for the process



- a) $E^\circ = + 0.68 \text{ v}$
b) $E^\circ = + 0.34 \text{ v}$
D c) $E^\circ = 0.00 \text{ v}$
d) $E^\circ = - 0.34 \text{ v}$
e) $E^\circ = - 0.68 \text{ v}$

Part 2. Short answer.

1) What is the pH of a saturated aqueous solution of manganese (II) hydroxide (Mn(OH)_2), at $T = 25.^\circ\text{C}$. The value for the solubility product of manganese (II) hydroxide at this temperature is $K_{\text{sp}} = 2.1 \times 10^{-13}$. [10 points]



	Initial	Change	Equilibrium	
Mn^{2+}	0	x	x	$(x)(2x)^2 = 4x^3 = 2.1 \times 10^{-13}$
OH^{-}	0	2x	2x	
				$x^3 = (2.1 \times 10^{-13})/4 = 5.25 \times 10^{-14}$
				$x = (5.25 \times 10^{-14})^{1/3} = 3.74 \times 10^{-5}$

$$[\text{OH}^{-}] = 2x = 2(3.74 \times 10^{-5}) = 7.49 \times 10^{-5}$$

$$\text{pOH} = -\log_{10}(7.49 \times 10^{-5}) = 4.13 \quad \text{pH} = 14.00 - \text{pOH} = 14.00 - 4.13 = 9.87$$

2) What is the oxidation number for phosphorus (P) in each of the following molecules? [3 points each]



3) Calcium metal can be obtained from the electrolysis of a molten solution of calcium chloride (CaCl_2). How many grams of calcium metal can be produced when a sample of molten CaCl_2 undergoes electrolysis for 4.00 hours using a current $i = 25.0$ amps (1 amp = 1 C/s)? [8 points]

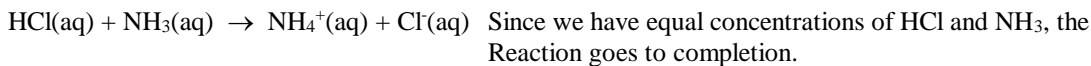


$$\text{grams calcium} = 4.00 \text{ hours} \frac{3600 \text{ s}}{1 \text{ hr}} \frac{25.0 \text{ C}}{1 \text{ s}} \frac{1 \text{ mol e}^{-}}{96485 \text{ C e}^{-}} \frac{1 \text{ mol Ca}}{2 \text{ mol e}^{-}} \frac{40.08 \text{ g Ca}}{1 \text{ mol Ca}} = 74.8 \text{ g Ca}$$

Part 3. Problems.

1) Consider the following solution, which contains initial amounts of both HCl and NH₃.

a) Find the pH of the a solution initially containing 0.0100 M hydrochloric acid (HCl), a strong acid, and 0.0100 M ammonia (NH₃), a weak base, with K_b = 1.8 x 10⁻⁵. Assume T = 25. °C. [12 points]



NH₄⁺(aq) + H₂O(ℓ) ⇌ H₃O⁺(aq) + NH₃(aq) K_a = (1.0 x 10⁻¹⁴)/K_b =
 (1.0 x 10⁻¹⁴)/(1.8 x 10⁻⁵) = 5.56 x 10⁻¹⁰

K_a = $\frac{[\text{H}_3\text{O}^+][\text{NH}_3]}{[\text{NH}_4^+]}$ = 5.56 x 10⁻¹⁰

$\frac{(x)(x)}{(0.0100 - x)} = 5.56 \times 10^{-10}$ Assume x << 0.010

	Initial	Change	Equilibrium
NH ₄ ⁺	0.0100	-x	0.0100 - x
NH ₃	0	x	x
H ₃ O ⁺	0	x	x

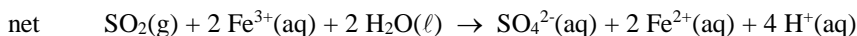
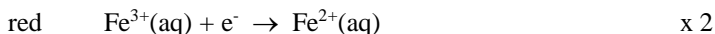
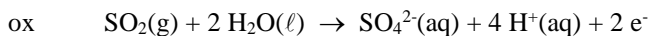
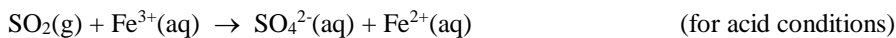
$x^2 = 5.56 \times 10^{-10}$ $x^2 = (0.0100)(5.56 \times 10^{-10}) = 5.56 \times 10^{-12}$
 (0.0100) $x = (5.56 \times 10^{-12})^{1/2} = 2.36 \times 10^{-6}$ (so x is small)

[H₃O⁺] = 2.36 x 10⁻⁶ pH = -log₁₀[H₃O⁺] = -log₁₀(2.36 x 10⁻⁶) = 5.63

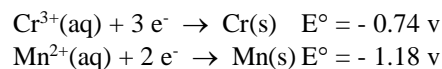
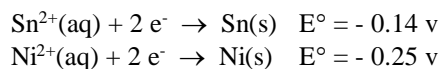
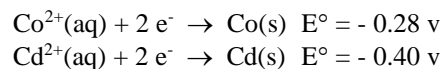
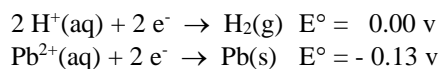
b) Is the above solution a buffer solution (yes/no and a brief justification of your answer)? [4 points]

No. After the reaction takes place there is a weak conjugate acid present (NH₄⁺), but there is no significant concentration of weak base ([NH₃] = 2.4 x 10⁻⁶).

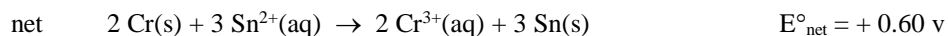
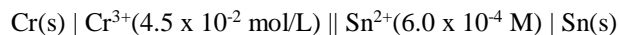
2) Balance the following unbalanced oxidation-reduction reaction [10 points each]



3) A portion of the electrochemical series is given below and may be of use in doing the following problem.



Give the half cell oxidation reaction, the half cell reduction reaction, the net cell reaction, and the value for E°_{cell} and E_{cell} for the galvanic cell whose cell diagram is given below. [20 points]



From Nernst,

$$E_{\text{cell}} = E^\circ_{\text{cell}} - (RT/nF) \ln Q$$

$$Q = \frac{[\text{Cr}^{3+}]^2}{[\text{Sn}^{2+}]^3} = \frac{(4.5 \times 10^{-2})^2}{(6.0 \times 10^{-4})^3} = 9.4 \times 10^6$$

$$\text{So} \quad E_{\text{cell}} = 0.60 \text{ v} - \frac{(8.314 \text{ J/mol}\cdot\text{K})(298. \text{ K})}{(6)(96485. \text{ C/mol})} \ln(9.4 \times 10^6)$$

$$= 0.60 \text{ v} - 0.07 \text{ v} = 0.53 \text{ v}$$