Exam 4 Chm 205 (Dr Mattson) 25 April 2018

Name:

Academic Integrity Pledge: *In keeping with Creighton University's ideals and with the Academic Integrity Code, I pledge that this work is my own and that I have neither given nor received inappropriate assistance in preparing it.*

Signature:

Chemistry Student Number: ___________

Instructions: **Show all work whenever a calculation box is provided!** Write legibly. Include units whenever appropriate. You will receive credit for **how** you worked each problem as well as for the correct answer. If you need more space, you may use the back of the data sheet provided — Write: "See data sheet" in the answer box – then write your name on the data sheet. On your desk you are allowed only pencils (but no pencil pouch), an eraser, and a non-programmable calculator without a slipcover. Backpacks, bags, and purse-like items must be stored on the tables in the back of the room. Cell phones must be silent and placed in your backpack/bag/purse – not in your pocket.

1a. (4 pts) Balance this redox reaction in aqueous acidic solution. You may need to add H_2O and/or H^+.

NO_3^- + Cl^- → NO + Cl_2

1b. (1 pt) What is the value of n (the LCM)?

1c. (2 pts) **Circle** what is reduced. **Box** what is oxidized.

NO_3^- Cl^- NO Cl_2

2. Given: $Ag^+(aq) + Cr(s) \rightarrow Ag(s) + Cr^{3+}(aq)$ **(unbalanced)**

2a. (3 pts) Write the reaction in cell notation for this galvanic cell.

2b. (4 pts) What is E° for the reaction?

Show all work for credit.

Answer with units: ________________

2c. (2 pts) The anode half cell is **$Cr|Cr^{3+}$** or **$Ag|Ag^+$**

2d. (2 pts) Which electrode increases in mass as the reaction proceeds? **Cr** or **Ag**

2c. (2 pts) What solution increases in concentration as the reaction process? **Cr^{3+}** or **Ag^+**

3a. (4 pts) Determine E° for $Ni|Ni^{2+}||Ag^+|Ag$.

Show all work for credit.

Answer with units: ________________

3b. (4 pts) Calculate ΔG° for this reaction.

Show all work for credit.

Answer with units: ________________

3c. (4 pts) Calculate K_c for this reaction.

Show all work for credit.

Answer: ________________

4. (4 pts) Determine E for the following cell

$Ni|Ni^{2+}(0.27\ M)||Ag^+(0.055\ M|Ag$.

Show all work for credit.

Answer with units: ________________

5. (4 pts) What mass of cobalt can be produced from a molten Co^{2+} salt using a current of 25 amps for 24 hrs?

Show all work for credit.

Answer with units: ________________

6a. (2 pts) Of the two radioactive isotopes ^{173}Au and ^{199}Au, one decays by α-emission and the other by β-emission. Which is by α-emission? **^{173}Au** **^{199}Au**

6b. (3 pts) Balance the reaction for the α-emission.

6c. (3 pts) Balance the reaction for the β-emission.

6d. (2 pts) Of the two isotopes, which could possibly undergo electron capture? **^{173}Au** or **^{199}Au**

7a. (2 pts) Of the two isotopes ^{77}Rb and ^{85}Rb, one is stable and the other decays by positron-emission? Which isotope is stable? **^{77}Rb** **^{85}Rb**

7b. (3 pts) Balance the reaction for the radioactive isotope.

8a. (3 pts) The isotope ^{222}Rn has a half life of 3.82 days. What is the rate constant for this decay?

Show all work. Do not change the time units to minutes or seconds.

Answer with units: _______________

8b. (4 pts) What percentage of a sample of ^{222}Rn persists after 7.00 days?

Show all work.

Answer: _______________

8c. (4 pts) What fraction of the sample persists after exactly five half-lives?

Show all work. Express in decimal format.

Answer: _______________

8d. (4 pts) ^{14}C has a half-life of 5715 years, giving it a decay rate constant of 1.21×10^{-4} yr^{-1}. Currently living organisms exhibit a decay rate of 15.3 disintegrations per minute per gram carbon. How old is an ancient sample that has a decay rate of 3.5 dpm/g C?

Answer: _______________

9. (4 pts) Balance the following transmutation reactions.

$^{10}_{5}B + ^{4}_{2}\alpha \rightarrow ^{1}_{0}n +$ _______

$^{40}_{18}Ar + ^{1}_{1}H \rightarrow ^{1}_{0}n +$ _______

10. (4 pts) How much energy, in kJ, is needed to heat 4.00 g ice at -11.0 ^{o}C to +30.0 ^{o}C? Given ΔH_f = 6.01 kJ/mol, and the molar heat capacities of ice and water are 36.6 J/mol deg and 75.4 J/mol deg, respectively.

Answer: _______________

11. (4 pts) Which member of each series is expected to have the highest boiling point? Circle your choice.

a. H_2O or CH_4

b. C_6H_6, ΔH_{vap}=31 kJ/mol or C_2H_6O, ΔH_{vap}=39 kJ/mol

c. Viscosities of: 2.4×10^{-4} N s/m^2 or 6.5×10^{-3} N s/m^2

d. P_{vap}: Br_2, 228 mmHg or C_2H_6O, 55 mmHg

12a. (4 pts) Copper crystalizes in a face-centered unit cell with an edge length of 362 pm. What is the atomic radius of a copper atom?

Answer with units: _______________

12b. (4 pts) What is the density of copper in g/ cm^3?

Answer with units: _______________

13. (3 pts) A metal sulfide exists in a face-centered cubic lattice of sulfides with the metal ions in all of the edge-centered positions and the body centered position. (a) How many sulfides are present in each unit cell? (b) How many metal ions? (c) What is the **empirical** formula of the salt?

13a.	13b.	13c.

14. (2 pts) A metal chloride exists in a simple cubic lattice of chlorides with the metal ion in the body centered position. (a) What is the **empirical** formula of the metal chloride and (b) what is the charge on the metal ion?

14a.	14b.

15. (5 pts) A substance has a standard (at 1 atm) melting point of 5.0 ^{o}C and a boiling point of 63.0 ^{o}C. It has a triple point of T_t = -7.0 ^{o}C and P_t = 200 mmHg and its critical point is T_c = +315 ^{o}C and P_c = 102 atm. What is the state of matter at…

a. T = -10 ^{o}C, P = 1.0 atm **Circle: Solid Liquid Gas**

b. T = 0 ^{o}C, P = 100 mmHg **Circle: Solid Liquid Gas**

c. T = +320 ^{o}C, P = 102 atm **Circle: Solid Liquid Gas**

d. T = 50 ^{o}C, P = 1 atm **Circle: Solid Liquid Gas**

e. Is the density of the liquid less than that of the solid? Circle: **Yes** or **No**

Score _______________

A $\geq$ 90; B+ $\geq$ 85; B $\geq$ 80; C+ $\geq$ 75; C $\geq$ 70; D $\geq$ 60

Answers

1a. $8 H^+ + 2 NO_3^- + 6 Cl^- \rightarrow 2 NO + 3 Cl_2 + 4 H_2O$

1b. 6

1c. (2 pts) Circle NO_3^-. Box Cl^-

2a. $Cr|Cr^{3+}(aq)||Ag^+(aq)|Ag(s)$

2b. E^o 1.53 v

2c. $Cr|Cr^{3+}$
2c. Ag
2c. Cr^{3+}

3a. E^o = 1.06 v

3b. ΔG^o -206 kJ

3c. $K_c = 6.5 \times 10^{+35}$

4. E^o = 1.002 v; $(Qc = [Ni^{2+}] / [Ag^+]^2)$

5. 660 g Co

6a. ${}^{173}_{79}Au$

6b. ${}^{173}_{79}Au \rightarrow {}^{4}_{2}\alpha + {}^{169}_{77}Ir$

6c. ${}^{199}_{79}Au \rightarrow {}^{0}_{-1}\beta + {}^{199}_{80}Hg$

6d. ${}^{173}_{79}Au$

7a. ${}^{85}_{37}Rb$

7b. ${}^{77}_{37}Rb \rightarrow {}^{0}_{1}\beta + {}^{77}_{36}Kr$

8a. 0.181 d^{-1}

8b. 28.1%

8c. 0.031

8d. 1.22×10^4 yr

9. ${}^{13}_{7}N$; ${}^{40}_{19}K$

10. 1.93 kJ

11. (4 pts) Which member of each series is expected to have the highest boiling point? Circle your choice.

a. H_2O

b. C_2H_6O, ΔH_{vap}=39 kJ/mol

c. 6.5×10^{-3} N s/m^2

d. C_2H_6O, 55 mmHg

12a. 128 pm.

12b. 8.90 g/ cm^3

13. (a) 4 sulfides present in each unit cell (b) 4 metal ions present in each unit cell (c) M_1S_1

14. (a) MCl (b) +1

15. a. Solid; b. Gas; c. Gas; d. Liquid; e. Yes

Table of Standard Reduction Potentials

	E^o (V)
$Cl_2 + 2\,e^- \rightarrow 2Cl^-$	1.36
$O_2 + 4\,H^+ + 4\,e^- \rightarrow 2\,H_2O$	1.23
$Br_2 + 2\,e- \rightarrow 2\,Br^-$	1.09
$Ag^+ + e^- \rightarrow Ag$	0.80
$I_2 + 2\,e^- \rightarrow 2\,I^-$	0.54
$O_2 + 2\,H_2O + 4\,e^- \rightarrow 4\,OH^-$	0.40
$Cu^{2+} + 2\,e^- \rightarrow Cu$	0.34
$2H^+ + 2\,e^- \rightarrow H_2$	0.00
$Fe^{3+} + 3\,e^- \rightarrow Fe$	-0.036
$Pb^{2+} + 2\,e^- \rightarrow Pb$	-0.13
$Ni^{2+} + 2\,e^- \rightarrow Ni$	-0.26
$Co^{2+} + 2\,e^- \rightarrow Co$	-0.28
$PbSO_4 + 2\,e^- \rightarrow Pb + SO_4^{2-}$	-0.35
$Cd^{2+} + 2\,e^- \rightarrow Cd$	-0.40
$Fe^{2+} + 2\,e^- \rightarrow Fe$	-0.44
$Cr^{3+} + e^- \rightarrow Cr^{2+}$	-0.50
$Cr^{3+} + 3\,e^- \rightarrow Cr$	-0.73
$Zn^{2+} + 2\,e^- \rightarrow Zn$	-0.76
$2\,H_2O + 2\,e^- \rightarrow H_2 + 2\,OH^-$	-0.83
$Al^{3+} + 3\,e^- \rightarrow Al$	-1.66
$Mg^{+2} + 2\,e^- \rightarrow Mg$	-1.66
$Na^+ + e^- \rightarrow Na$	-2.71
$Ca^{2+} + 2\,e^- \rightarrow Ca$	-2.76
$Ba^{2+} + 2\,e^- \rightarrow Ba$	-2.90
$K^+ + e^- \rightarrow K$	-2.92
$Li^+ + e^- \rightarrow Li$	-3.05

Useful equations for Electrochemistry:

$E = E^o - {}^{0.0592}/_{n} \log Q = E^o - {}^{R\,T}/_{n\,F} \log Q$

$E^o = {}^{0.0592}/_{n} \log K = {}^{R\,T}/_{n\,F} \ln K$

$\Delta G = -nFE \qquad \Delta G^o = -nFE^o$

1 F = 96500 coul = 1 mol e^- = 96500 J/mol V

Charge (coul) = current (amps) x time(s)

Useful equations for Nuclear Chemistry:

$\ln({}^{N_o}/_{N_t}) = kt \qquad t_{1/2} = 0.693/k$

Miscellaneous useful values:

$N_A = 6.02 \times 10^{23}$

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1 H 1.01																1 H 1.01	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 32.06	17 Cl 35.45	18 Ar 39.95
19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.90	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.70	29 Cu 63.55	30 Zn 65.38	31 Ga 69.72	32 Ge 72.59	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 97	44 Ru 101.07	45 Rh 102.91	46 Pd 106.4	47 Ag 107.87	48 Cd 112.41	49 In 114.82	50 Sn 118.69	51 Sb 121.75	52 Te 127.60	53 I 126.90	54 Xe 131.30
55 Cs 132.91	56 Ba 137.33	57 La 138.91	72 Hf 178.49	73 Ta 180.95	74 W 183.85	75 Re 186.21	76 Os 190.2	77 Ir 192.22	78 Pt 195.09	79 Au 196.97	80 Hg 200.59	81 Ti 204.37	82 Pb 207.2	83 Bi 208.98	84 Po 209	85 At 210	86 Rn 222
87 Fr 223	88 Ra 226.03	89 Ac 227															