

**Exam 4 Chm 205 (Dr Mattson) 25 April 2018**

**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.

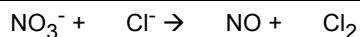
Signature: \_\_\_\_\_

Name: \_\_\_\_\_

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  $H^+$ .



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

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



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

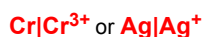
2a. (3 pts) Write the reaction in cell notation for this galvanic cell.

2b. (4 pts) What is  $E^0$  for the reaction?

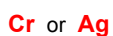
Show all work for credit.

Answer with units: \_\_\_\_\_

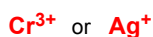
2c. (2 pts) The anode half cell is



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



2c. (2 pts) What solution increases in concentration as the reaction process?



3a. (4 pts) Determine  $E^0$  for  $Ni|Ni^{2+}||Ag^+|Ag$ .

Show all work for credit.

Answer with units: \_\_\_\_\_

3b. (4 pts) Calculate  $\Delta G^0$  for this reaction.

Show all work for credit.

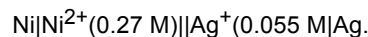
Answer with units: \_\_\_\_\_

3c. (4 pts) Calculate  $K_C$  for this reaction.

Show all work for credit.

Answer: \_\_\_\_\_

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



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: \_\_\_\_\_

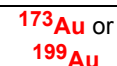
6a. (2 pts) Of the two radioactive isotopes  $^{173}Au$  and  $^{199}Au$ , one decays by  $\alpha$ -emission and the other by  $\beta$ -emission. Which is by  $\alpha$ -emission?



6b. (3 pts) Balance the reaction for the  $\alpha$ -emission.

6c. (3 pts) Balance the reaction for the  $\beta$ -emission.

6d. (2 pts) Of the two isotopes, which could possibly undergo electron capture?



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?



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

8a. (3 pts) The isotope  $^{222}\text{Rn}$  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  $^{222}\text{Rn}$  persists after 7.00 days?

Show all work.

Answer: \_\_\_\_\_

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

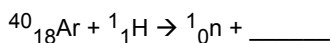
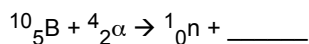
Show all work. Express in decimal format.

Answer: \_\_\_\_\_

8d. (4 pts)  $^{14}\text{C}$  has a half-life of 5715 years, giving it a decay rate constant of  $1.21 \times 10^{-4} \text{ yr}^{-1}$ . 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. (4 pts) How much energy, in kJ, is needed to heat 4.00 g ice at  $-11.0^\circ\text{C}$  to  $+30.0^\circ\text{C}$ ? Given  $\Delta H_f = 6.01 \text{ kJ/mol}$ , and the molar heat capacities of ice and water are  $36.6 \text{ J/mol deg}$  and  $75.4 \text{ J/mol deg}$ , respectively.

Answer: \_\_\_\_\_

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

a.  $\text{H}_2\text{O}$  or  $\text{CH}_4$

b.  $\text{C}_6\text{H}_6$ ,  $\Delta H_{\text{vap}}=31 \text{ kJ/mol}$  or  $\text{C}_2\text{H}_6\text{O}$ ,  $\Delta H_{\text{vap}}=39 \text{ kJ/mol}$

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

d.  $P_{\text{vap}}$ :  $\text{Br}_2$ , 228 mmHg or  $\text{C}_2\text{H}_6\text{O}$ , 55 mmHg

12a. (4 pts) Copper crystallizes 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  $\text{g/cm}^3$ ?

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  $5.0^\circ\text{C}$  and a boiling point of  $63.0^\circ\text{C}$ . It has a triple point of  $T_t = -7.0^\circ\text{C}$  and  $P_t = 200 \text{ mmHg}$  and its critical point is  $T_c = +315^\circ\text{C}$  and  $P_c = 102 \text{ atm}$ . What is the state of matter at...

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

b.  $T = 0^\circ\text{C}$ ,  $P = 100 \text{ mmHg}$  Circle: **Solid Liquid Gas**

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

d.  $T = 50^\circ\text{C}$ ,  $P = 1 \text{ atm}$  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



1b. 6

1c. (2 pts) Circle  $\text{NO}_3^-$ . Box  $\text{Cl}^-$



2b.  $E^\circ = 1.53 \text{ v}$

2c.  $\text{Cr}|\text{Cr}^{3+}$

2c. Ag

2c.  $\text{Cr}^{3+}$

3a.  $E^\circ = 1.06 \text{ v}$

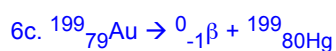
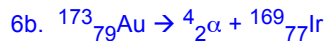
3b.  $\Delta G^\circ = -206 \text{ kJ}$

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

4.  $E^\circ = 1.002 \text{ v}$ ; ( $Q_c = [\text{Ni}^{2+}] / [\text{Ag}^+]^2$ )

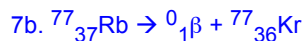
5. 660 g Co

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



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

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



8a.  $0.181 \text{ d}^{-1}$

8b. 28.1%

8c. 0.031

8d.  $1.22 \times 10^4 \text{ yr}$

9.  $^{13}_7\text{N}$ ;  $^{40}_{19}\text{K}$

10. 1.93 kJ

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

a.  $\text{H}_2\text{O}$

b.  $\text{C}_2\text{H}_6\text{O}$ ,  $\Delta H_{\text{vap}} = 39 \text{ kJ/mol}$

c.  $6.5 \times 10^{-3} \text{ N s/m}^2$

d.  $\text{C}_2\text{H}_6\text{O}$ , 55 mmHg

12a. 128 pm.

12b.  $8.90 \text{ g/cm}^3$

13. (a) 4 sulfides present in each unit cell (b) 4 metal ions present in each unit cell (c)  $\text{M}_1\text{S}_1$

14. (a) MCl (b) +1

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

