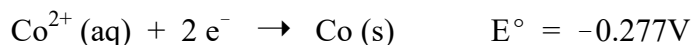
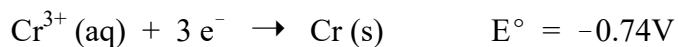


Name \_\_\_\_\_ Rec. TA/time \_\_\_\_\_

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Show **ALL** your work or **EXPLAIN** to receive full credit.  $R = 0.08206 \text{ L}\cdot\text{atm/mol}\cdot\text{K} = 8.314 \text{ J/mol}\cdot\text{K}$

1. (10 pts) A **voltaic** cell is made from the following half-cells.



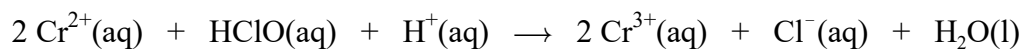
a) (2 pts) Write the half-reactions for the anode and cathode and label which is which. **Show all work.**

b) (3 pts) Write the overall balanced equation for the reaction and indicate the number of electrons transferred. **Show all work.**

c) (1 pts) What is the  $E^{\circ}_{\text{cell}}$ ? **Show all work.**

d) (4 pts) What is the  $E$  for the cell when the  $[\text{Co}^{2+}] = 3.00 \text{ M}$  and  $[\text{Cr}^{3+}] = 0.00100 \text{ M}$ ? **Show all work.**

2. (3 pts) Consider the cell reaction described by the following reaction. Which of the changes listed will cause an increase in the cell voltage? **Show all work and explain.**



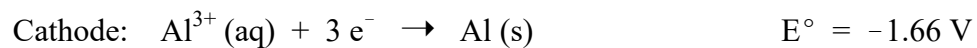
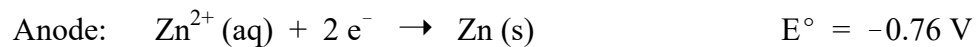
- I increase in  $[\text{HClO}]$
- II increase in size of inert electrodes
- III decrease in pH of cell solution

3. (2 pts) List two differences and two similarities between a voltaic cell and electrolytic cell?

4. (2 pts) Iron pipes can be protected via what's called cathodic protection. What does this mean?

**Not asked on Carmen quiz**

5. (8 pts) For the following 1/2-cells labeled as cathode and anode and the associated standard potentials at 25 °C answer the questions below.



a) (1 pt) What is the  $E^{\circ}$  for the cell? **Show all work and explain.**

b) (2 pts) Is the reaction spontaneous or nonspontaneous under standard state conditions? **(Explain!)**

c) (2 pts) Is this a voltaic cell or electrolytic cell? **(Explain!)**

d) (3 pts) What is the value of the equilibrium constant? **Show all work.**

6. (6 pts) Electrolysis of molten  $\text{CrCl}_3$  is performed. Answer the following. **Show all work and explain.**

**Not on Carmen quiz**

a) (1 pt) Write the reaction which takes place at the anode for this process?

b) (1 pt) Write the reaction which takes place at the cathode for this process?

c) (4 pts) Calculate the mass of Cr formed by a current of  $9.5 \times 10^4$  A flowing for 21 hours. Assume the electrolytic cell is 65% efficient.

7. (4 pts) Electrolysis of molten  $\text{FeCl}_3$  is performed. What amperage is required to plate out 15.6 g of Fe(s) in a period of 8.00 hr assuming the cell is only 75% efficient.

**Carmen quiz asked this for 100% efficiency**

8. (2 pts) Explain what is a ferromagnetic substance.
9. (2 pts) Which of the following is a characteristic property of paramagnetism?
- a) All electrons are paired.
  - b) The substance is repelled by a magnetic field.
  - c) magnetic moments are arranged in a regular array.
  - d) The interaction of a magnetic field with the substance is proportional to the number of unpaired electrons.
10. (4 pts) For the following metal ions write the ground-state electron configuration and whether they are paramagnetic or diamagnetic.
- a)  $\text{Cu}^+$
  - b)  $\text{Mn}^{4+}$

11. Which of the following coordination compounds will form a precipitate when treated with an aqueous solution of  $\text{AgNO}_3$ ?
- a)  $[\text{Cr}(\text{NH}_3)_3\text{Cl}_3]$                       b)  $[\text{Cr}(\text{NH}_3)_6]\text{Cl}_3$                       c)  $[\text{Cr}(\text{NH}_3)\text{Cl}]\text{ClO}_4$   
d)  $\text{Na}_3[\text{Cr}(\text{CN})_6]$                       e)  $\text{Na}_3[\text{CrCl}_6]$
12. (6 pts) For the following complex ion or coordination compound list the **oxidation number** and **coordination number** of the **metal** ion and **likely geometry** around the metal. (Show work or explain!)
- a)  $[\text{Cr}(\text{NH}_3)_4\text{Br}_2]\text{Cl}$
- b)  $\text{Na}_2[\text{Zn}(\text{CN})_2\text{Cl}_2]$

## USEFUL INFORMATION

$$R = 0.08206 \text{ L-atm/mol-K} = 8.3145 \text{ J/mol-K}$$

$$k = 1.38 \times 10^{-23} \text{ J/K}$$

$$1 \text{ J} = 1 \text{ C} \cdot \text{V}, 1 \text{ C} = 1 \text{ A} \cdot \text{s}, F = 96,485 \text{ C/mol e}^-$$

$$\Delta G = \Delta H - T\Delta S$$

$$\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ$$

$$\Delta G = \Delta G^\circ + RT \cdot \ln Q$$

$$\Delta G^\circ = -RT \cdot \ln K$$

$$S = k \cdot \ln W$$

$$\Delta G = -nFE$$

$$\Delta G^\circ = -nFE^\circ$$

$$E = E^\circ - \frac{RT}{nF} \ln Q$$

$$E = E^\circ - \frac{0.0592 \text{ V}}{n} \log Q \quad (\text{at } 25^\circ \text{C})$$

$$E^\circ = \frac{RT}{nF} \ln Q$$

$$E^\circ = \frac{0.0592 \text{ V}}{n} \log K \quad (\text{at } 25^\circ \text{C})$$

	IA	IIA	IIIB	IVB	VB	VIB	VII B	VIII B				IB	IIB	IIIA	IVA	VA	VIA	VIIA	VIIIA
1	1.008 H 1																	4.003 He 2	
2	6.941 Li 3	9.012 Be 4											10.811 B 5	12.011 C 6	14.007 N 7	15.999 O 8	18.998 F 9	20.179 Ne 10	
3	22.990 Na 11	24.305 Mg 12											26.98 Al 13	28.09 Si 14	30.974 P 15	32.06 S 16	35.453 Cl 17	39.948 Ar 18	
4	39.098 K 19	40.08 Ca 20	44.96 Sc 21	47.88 Ti 22	50.94 V 23	52.00 Cr 24	54.94 Mn 25	55.85 Fe 26	58.93 Co 27	58.69 Ni 28	63.546 Cu 29	65.38 Zn 30	69.72 Ga 31	72.59 Ge 32	74.92 As 33	78.96 Se 34	79.904 Br 35	83.80 Kr 36	
5	85.47 Rb 37	87.62 Sr 38	88.91 Y 39	91.22 Zr 40	92.91 Nb 41	95.94 Mo 42	98 Tc 43	101.07 Ru 44	102.91 Rh 45	106.42 Pd 46	107.87 Ag 47	112.41 Cd 48	114.82 In 49	118.69 Sn 50	121.75 Sb 51	127.60 Te 52	126.90 I 53	131.39 Xe 54	
6	132.91 Cs 55	137.33 Ba 56	138.91 La 57	178.39 Hf 72	180.95 Ta 73	183.85 W 74	186.21 Re 75	190.23 Os 76	192.22 Ir 77	195.08 Pt 78	196.97 Au 79	200.59 Hg 80	204.38 Tl 81	207.2 Pb 82	208.98 Bi 83	209 Po 84	210 At 85	222 Rn 86	
7	223 Fr 87	226.03 Ra 88	227.03 Ac 89	261 Rf 104	262 Ha 105	263 Sg 106	262 Ns 107	265 Hs 108	266 Mt 109	269  110	272  111	277  112							

Lanthanide Series	140.12 <b>Ce</b> 58	140.91 <b>Pr</b> 59	144.24 <b>Nd</b> 60	145 <b>Pm</b> 61	150.36 <b>Sm</b> 62	151.96 <b>Eu</b> 63	157.25 <b>Gd</b> 64	158.93 <b>Tb</b> 65	162.50 <b>Dy</b> 66	164.93 <b>Ho</b> 67	167.26 <b>Er</b> 68	168.93 <b>Tm</b> 69	173.04 <b>Yb</b> 70	173.04 <b>Lu</b> 71
Actinide Series	232.04 <b>Th</b> 90	231.04 <b>Pa</b> 91	238.03 <b>U</b> 92	237.05 <b>Np</b> 93	<b>Pu</b> 94	<b>Am</b> 95	<b>Cm</b> 96	<b>Bk</b> 97	<b>Cf</b> 98	<b>Es</b> 99	<b>Fm</b> 100	<b>Md</b> 101	<b>No</b> 102	<b>Lr</b> 103

A PERIODIC CHART OF THE ELEMENTS  
(Based on <sup>12</sup>C)