Dr. Zellmer | Chemistry 1220 | All Sections
Time: 7 PM Sun. | Spring Semester 2023 | April 16, 2023
40 min | Quiz XI

Name _____ Rec. TA/time _____

Show **ALL** your work or **EXPLAIN** to receive full credit. R = 0.08206 L•atm/mol•K = 8.314 J/mol•K

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

$Cr^{3+}(aq) + 3\,e^- \rightarrow Cr(s)$ $\quad E° = -0.74V$

$Co^{2+}(aq) + 2\,e^- \rightarrow Co(s)$ $\quad E° = -0.277V$

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 $E°_{cell}$? **Show all work.**

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

Copyright R. J. Zellmer, April 16, 2023

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.**

$$2\ Cr^{2+}(aq) + HClO(aq) + H^{+}(aq) \longrightarrow 2\ Cr^{3+}(aq) + Cl^{-}(aq) + H_2O(l)$$

I increase in [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

Copyright R. J. Zellmer, April 16, 2023

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.

Anode: $Zn^{2+}(aq) + 2\,e^- \rightarrow Zn(s)$ $\quad E^\circ = -0.76$ V

Cathode: $Al^{3+}(aq) + 3\,e^- \rightarrow Al(s)$ $\quad E^\circ = -1.66$ V

a) (1 pt) What is the E° 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.**

Copyright R. J. Zellmer, April 16, 2023

6. (6 pts) Electrolysis of molten $CrCl_3$ 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 9.5×10^4 A flowing for 21 hours. Assume the electrolytic cell is 65% efficient.

7. (4 pts) Electrolysis of molten $FeCl_3$ 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

Copyright R. J. Zellmer, April 16, 2023

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) Cu^{+}

b) Mn^{4+}

Copyright R. J. Zellmer, April 16, 2023

11. Which of the following coordination compounds will form a precipitate when treated with an aqueous solution of $AgNO_3$?

a) $[Cr(NH_3)_3Cl_3]$ b) $[Cr(NH_3)_6]Cl_3$ c) $[Cr(NH_3)Cl]ClO_4$

d) $Na_3[Cr(CN)_6]$ e) $Na_3[CrCl_6]$

12. (6 pts) For the following complex ion or coordination compound list the **<u>oxidation</u> <u>number</u>** and **<u>coordination</u> <u>number</u>** of the **metal** ion and **<u>likely</u> geometry** around the metal. **(Show work or explain!**)

a) $[Cr(NH_3)_4Br_2]Cl$

b) $Na_2[Zn(CN)_2Cl_2]$

Copyright R. J. Zellmer, April 16, 2023

USEFUL INFORMATION

R = 0.08206 L-atm/mol-K = 8.3145 J/mol-K
k = 1.38 x 10^{-23} J/K
1 J = 1 C•V, 1 C = 1 A•s, F = 96,485 C/mol e−

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

$$\Delta G = \Delta G^\circ + RT \bullet \ln Q \qquad \Delta G^\circ = -RT \bullet \ln K$$

$$S = k \bullet \ln W$$

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

$$E = E^\circ - \frac{RT}{nF}\ln Q \qquad E = E^\circ - \frac{0.0592\,V}{n}\log Q \quad (at\ 25^\circ C)$$

$$E^\circ = \frac{RT}{nF}\ln Q \qquad E^\circ = \frac{0.0592\,V}{n}\log K \quad (at\ 25^\circ C)$$

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

A PERIODIC CHART OF THE ELEMENTS
(Based on ^{12}C)

Copyright R. J. Zellmer, April 16, 2023