

# Form S

Chemistry 1442/1302

Test #4

Zumdahl, Chapter 17 and Section 4.9-4.10

November 24, 2004

Name (please print) \_\_\_\_\_

Last Name

First Name

IA																	VIII A
1 H 1.01															2 He 4.00		
IIA												III A	IV A	V A	VIA	VII A	
3 Li 6.94	4 Be 9.01											5 B 10.81	6 C 12.01	7 N 14.01	8 O 15.999	9 F 18.998	10 Ne 20.18
11 Na 22.99	12 Mg 24.31											13 Al 26.98	14 Si 28.086	15 P 30.97	16 S 32.06	17 Cl 35.45	18 Ar 39.95
		IIIB	IVB	VB	VIB	VII B	VIII B		IB	IIB							
19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.90	23 V 50.94	24 Cr 51.996	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 (98)	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	58 Ce 140.12	59 Pr 140.91	60 Nd 144.24	61 Pm (145)	62 Sm 150.4	63 Eu 151.96	64 Gd 157.25	65 Tb 158.93	66 Dy 162.50	67 Ho 164.93	68 Er 167.26	69 Tm 168.93	70 Yb 173.04	71 Lu 174.97	
87 Fr (223)	88 Ra 226.03	89 Ac 227.03	90 Unq (261)	91 Unp (262)	92 Unh (263)												

58 Ce 140.12	59 Pr 140.91	60 Nd 144.24	61 Pm (145)	62 Sm 150.4	63 Eu 151.96	64 Gd 157.25	65 Tb 158.93	66 Dy 162.50	67 Ho 164.93	68 Er 167.26	69 Tm 168.93	70 Yb 173.04	71 Lu 174.97
90 Th 232.04	91 Pa 231.04	92 U 238.03	93 Np 237.05	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)	103 Lr (260)

## Reduction Potentials at 25°C

E° (V)

E° (V)

$F_2(g) + 2e^- \rightarrow 2F^-(aq)$	2.87	$Sn^{4+}(aq) + 2e^- \rightarrow Sn^{2+}(aq)$	0.15
$H_2O_2(aq) + 2H^+(aq) + 2e^- \rightarrow 2H_2O(l)$	1.78	$2H^+(aq) + 2e^- \rightarrow H_2(g)$	0.00
$MnO_4^-(aq) + 8H^+(aq) + 5e^- \rightarrow Mn^{2+}(aq) + 4H_2O(l)$	1.51	$Pb^{2+}(aq) + 2e^- \rightarrow Pb(s)$	-0.13
$Cl_2(g) + 2e^- \rightarrow 2Cl^-(aq)$	1.36	$Ni^{2+}(aq) + 2e^- \rightarrow Ni(s)$	-0.26
$Cr_2O_7^{2-}(aq) + 14H^+(aq) + 6e^- \rightarrow 2Cr^{3+}(aq) + 7H_2O(l)$	1.33	$Cd^{2+}(aq) + 2e^- \rightarrow Cd(s)$	-0.40
$O_2(g) + 4H^+(aq) + 4e^- \rightarrow 2H_2O(l)$	1.23	$Fe^{2+}(aq) + 2e^- \rightarrow Fe(s)$	-0.45
$Br_2(l) + 2e^- \rightarrow 2Br^-(aq)$	1.09	$Zn^{2+}(aq) + 2e^- \rightarrow Zn(s)$	-0.76
$Ag^+(aq) + e^- \rightarrow Ag(s)$	0.80	$2H_2O(l) + 2e^- \rightarrow H_2(g) + 2OH^-(aq)$	-0.83
$Fe^{3+}(aq) + e^- \rightarrow Fe^{2+}(aq)$	0.77	$Al^{3+}(aq) + 3e^- \rightarrow Al(s)$	-1.66
$O_2(g) + 2H^+(aq) + 2e^- \rightarrow H_2O_2(aq)$	0.70	$Mg^{2+}(aq) + 2e^- \rightarrow Mg(s)$	-2.37
$I_2(s) + 2e^- \rightarrow 2I^-(aq)$	0.54	$Na^+(aq) + e^- \rightarrow Na(s)$	-2.71
$O_2(g) + 2H_2O(l) + 4e^- \rightarrow 4OH^-(aq)$	0.40	$Li^+(aq) + e^- \rightarrow Li(s)$	-3.04
$Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$	0.34		

## Useful Information:

$R = 0.08206 \text{ L}\cdot\text{atm/mol}\cdot\text{K} = 8.314 \text{ J/mol}\cdot\text{K}$

$1 F = 96,485 \text{ C/mol } e^-$

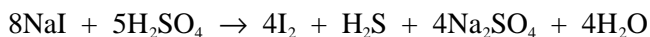
## Instructions:

- This exam consists of **20** questions.
- No scratch paper is allowed.** You may do the work in the test margins and on the backs of the test pages.
- Mark the answers you choose on the test itself for your own information and also on the standard answer sheet you provided.  
Scoring will be based on the answer sheet.
- When you finish, turn in both the test form and the answer form. The test form and your personal report will be returned to you at the next class. Write your name on both forms.

1. Which of the following reactions does not involve oxidation-reduction?

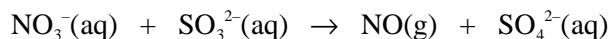
- a)  $\text{CH}_4 + 3\text{O}_2 \rightarrow 2\text{H}_2\text{O} + \text{CO}_2$
- b)  $\text{Zn} + 2\text{HCl} \rightarrow \text{ZnCl}_2 + \text{H}_2$
- c)  $2\text{Na} + 2\text{H}_2\text{O} \rightarrow 2\text{NaOH} + \text{H}_2$
- d)  $\text{MnO}_2 + 4\text{HCl} \rightarrow \text{Cl}_2 + 2\text{H}_2\text{O} + \text{MnCl}_2$
- e) All are oxidation-reduction reactions.

2. Which element is oxidized in the reaction below?



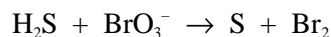
- a) Na
- b) I
- c) S
- d) H
- e) O

3. Balance the reaction below, which occurs in *basic* solution. When this equation is balanced using the smallest whole-number coefficients, what is the coefficient on  $\text{H}_2\text{O}$ , and on which side of the equation does  $\text{H}_2\text{O}$  appear?



- a) 1, on the reactant side
- b) 1, on the product side
- c) 3, on the product side
- d) 6, on the product side
- e) 6, on the reactant side

4. Balance the reaction below, which occurs in *acidic* solution. When this equation is balanced using the smallest whole-number coefficients, what is the coefficient on  $\text{H}_2\text{O}$ , and on which side of the equation does  $\text{H}_2\text{O}$  appear?



- a) 3, on the product side
- b) 6, on the product side
- c) 9, on the product side
- d) 4, on the reactant side
- e) 5, on the reactant side

5. Which energy conversion shown below takes place in a galvanic cell?

- a) electrical to chemical
- b) chemical to electrical
- c) mechanical to chemical
- d) chemical to mechanical
- e) mechanical to electrical

6. Which of the species below cannot function as an oxidizing agent?
- S(s)
  - $\text{NO}_3^-(\text{aq})$
  - $\text{Cr}_2\text{O}_7^{2-}(\text{aq})$
  - $\text{I}^-(\text{aq})$
  - $\text{MnO}_4^-(\text{aq})$
7. Solid copper will spontaneously reduce which of the following?
- $\text{Fe}^{2+}$  and  $\text{Ag}^+$
  - $\text{Fe}^{2+}$
  - $\text{Ag}^+$
  - $\text{Al}^{3+}$
  - $\text{Fe}^{2+}$  and  $\text{Al}^{3+}$
8. Which of the following is the best oxidizing agent under standard conditions at 25°C?
- Cd(s)
  - $\text{Cu}^{2+}(\text{aq})$
  - $\text{Mg}^{2+}(\text{aq})$
  - $\text{Cl}^-(\text{aq})$
  - $\text{I}_2(\text{s})$
9. Which of the following is the best reducing agent under standard conditions at 25°C?
- Cd(s)
  - $\text{Cu}^{2+}(\text{aq})$
  - $\text{Mg}^{2+}(\text{aq})$
  - $\text{Cl}^-(\text{aq})$
  - $\text{I}_2(\text{s})$
10. A voltaic cell is constructed using a  $\text{Cu}(\text{s})/\text{Cu}^{2+}(\text{aq})$  half cell and a  $\text{Fe}(\text{s})/\text{Fe}^{2+}(\text{aq})$  half cell. Both half cells are at standard conditions and at 25°C. The two solutions are connected with a salt bridge, and the  $\text{Cu}(\text{s})$  electrode is connected to the  $\text{Fe}(\text{s})$  electrode with a wire. Which statement below is correct?
- Electrons will not move through the wire, because this is not a spontaneous reaction.
  - Electrons move through the wire towards the iron electrode, which is the anode.
  - Electrons move through the wire towards the iron electrode, which is the cathode.
  - Electrons move through the wire towards the copper electrode, which is the anode.
  - Electrons move through the wire towards the copper electrode, which is the cathode.
11. What is the cell potential of the following cell under standard conditions at 25°C?
- $$\text{Al}(\text{s}) \mid \text{Al}^{3+}(1 \text{ M}) \parallel \text{Zn}^{2+}(1 \text{ M}) \mid \text{Zn}(\text{s})$$
- 3.46 V
  - 0.45 V
  - 1.04 V
  - 0.90 V
  - 2.42 V

12. For a certain reaction in a galvanic cell, both  $\Delta H^\circ$  and  $\Delta S^\circ$  are positive. Which of the following statements is true?

- a)  $E^\circ_{\text{cell}}$  will increase with an increase in temperature.
- b)  $E^\circ_{\text{cell}}$  will decrease with an increase in temperature.
- c)  $E^\circ_{\text{cell}}$  will not change when the temperature increases.
- d)  $\Delta G^\circ > 0$  for all temperatures.
- e) None of these statements is true.

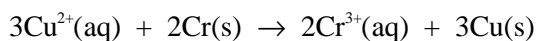
13. A zinc-silver voltaic cell can be constructed by attaching a  $\text{Zn}/\text{Zn}^{2+}$  half-cell to a  $\text{Ag}/\text{Ag}^+$  half-cell. What is the cell potential at  $25^\circ\text{C}$  for this voltaic cell, given the following ion concentrations:

$$[\text{Zn}^{2+}] = 0.0200 \text{ M}$$

$$[\text{Ag}^+] = 0.0020 \text{ M}$$

- a) 1.78 V
- b) 1.34 V
- c) 1.45 V
- d) 1.62 V
- e) 1.53 V

14. What is the standard free energy change for the reaction shown if the cell potential  $E^\circ$  is 1.08 V at  $25^\circ\text{C}$ ?



- a) -104 kJ
- b) -208 kJ
- c) -417 kJ
- d) -827 kJ
- e) -625 kJ

15. Based on the table of reduction potentials, what substances are expected to be produced by the electrolysis of an aqueous solution of  $\text{MgI}_2$ ?

- a)  $\text{I}_2$  at the cathode and Mg at the anode.
- b) Mg at the cathode and  $\text{I}_2$  at the anode.
- c)  $\text{H}_2$  at the cathode and  $\text{I}_2$  at the anode.
- d)  $\text{H}_2$  at the cathode and  $\text{O}_2$  at the anode.
- e) Mg at the cathode and  $\text{O}_2$  at the anode.

16. Gold is plated from a solution of chlorauric acid,  $\text{HAuCl}_4$ ; it deposits on the cathode. Calculate the time (in minutes) it takes to deposit 0.50 g of Au under a constant current of 0.10 A. (The molar mass of Au is 197.0 g/mol.)

- a) 120 min
- b) 41 min
- c) 82 min
- d) 360 min
- e) 14 min

17. Electrolysis of a molten salt with the formula  $MCl$ , using a current of 3.86 A for 972 s, deposits 1.52 g of the metal. Identify the metal.
- Li
  - Na
  - K
  - Rb
  - Cs
18. Use the table of standard reduction potentials to determine the equilibrium constant at 25° C for the reaction below:
- $$2I_2(s) + 4OH^-(aq) \rightarrow 4I^-(aq) + O_2(g) + 2H_2O(l)$$
- $3.0 \times 10^9$
  - $5.5 \times 10^4$
  - $1.0 \times 10^{67}$
  - $8.2 \times 10^{12}$
  - $9.3 \times 10^{27}$
19. A concentration cell is constructed using two Ni electrodes with  $Ni^{2+}$  concentrations of 1.00 M and  $1.00 \times 10^{-4}$  M in the two half-cells. Determine the potential of this cell at 25°C.
- 0.368 V
  - +0.132 V
  - 0.132 V
  - +0.118 V
  - +0.0591 V
20. Which of the statements below is/are true?
- Oxidation and reduction cannot occur independently of each other.
  - Oxidation and reduction describe the loss and gain of electrons, respectively.
  - Oxidation and reduction result in a change in the oxidation states of the species involved.
  - Only statements (a) and (c) are true.
  - Statements (a), (b), and (c) are true.

**Answers**

- |      |       |       |       |
|------|-------|-------|-------|
| 1. E | 6. D  | 11. D | 16. A |
| 2. B | 7. C  | 12. A | 17. C |
| 3. A | 8. E  | 13. C | 18. A |
| 4. B | 9. A  | 14. E | 19. D |
| 5. B | 10. E | 15. C | 20. E |