THE "OFFICIAL" CHEMISTRY 12 REDOX &ELECTROCHEMISTRY STUDY GUIDE

1. **DO ALL THE QUESTIONS** in this booklet. These are actual Provincial Exam questions! Your own provincial exam and unit test will include questions similar to the ones in this booklet!
2. **RESIST THE URGE TO LOOK AT THE ANSWER KEY** until you have given all the questions in the section your best effort. Don't do one question, then look at the key, then do another and look at the key, and so on. Each time you look at one answer in the study guide, your eye will notice other answers around them, and this will reduce the effectiveness of those questions in helping you to learn.
3. **LEARN FROM YOUR MISTAKES**! If you get a question wrong, **figure out why**! If you are having difficulty, **talk to your study partner**, or maybe **phone someone in your Peer Tutoring group**. Get together with group members or other students from class and work on these questions together. Explain how you got your answers to tough questions to others. In explaining yourself to someone else, you will learn the material better yourself (try it!) Ask your teacher to explain the questions to you during tutorial or after school. **Your goal should be to get 100% on any Chemistry 12 multiple choice test**- learning from your mistakes in this booklet will really help you in your efforts to meet this goal!
4. **This is REALLY CRUCIAL**: **DO NOT mark the answer anywhere on the questions themselves**. For example, do not circle any of options A B C or D-instead use a different sheet of paper to place your answers on. By avoiding this urge, you can re-use this study guide effectively again, when preparing for your final exam. In the box to the left, put an asterisk or small note to yourself to indicate that you got the question wrong and need to come back to it. If you got the question correct initially, a check mark might be assurance that you understand this type of question and therefore can concentrate on other questions that present a challenge to you.
5. **Check Off the STATUS box on the PRESCRIBED LEARNING OUTCOMES sheet**. I have tried to organize the questions in the identical sequence to which they appear on your Redox/Electrochemistry Prescribed Learning Outcome sheet. By doing this, you can be confident that you know everything you need to know for both the UNIT EXAM and PROVINCIAL EXAM !

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INTRODUCTION

1. S01 **Which one of the following is the strongest reducing agent?**

A. I^- **B. F^-** **C. Cl^-** **D. Br^-**

2. S01 **In the reaction below:**

$$6H^+ + 6I^- + ClO_3^- \rightarrow 3I_2 + 3H_2O + Cl^-$$

the oxidizing agent is

A. I_2 **B. I^-** **C. H^+** **D. ClO_3^-**

3. S01 Which of the following is the **strongest** reducing agent?

A. cobalt
B. copper
C. calcium
D. chromium

4. S01 An oxidizing agent is

A. reduced as it loses electrons.
B. reduced as it gains electrons.
C. oxidized as it loses electrons.
D. oxidized as it gains electrons.

5. S01 Which of the following is the **strongest** oxidizing agent?

A. Mn
B. Mn^{2+}
C. acidified MnO_2
D. acidified MnO_4^-

6. S01 Referring to the Data Booklet, which of the following can act as an oxidizing agent but not as a reducing agent?

A. Zn
B. Cl^-
C. Sn^{2+}
D. Fe^{3+}

7. S01 **An oxidizing agent**

A. loses electrons.
B. decreases in oxidation number.
C. loses mass in an operating electrochemical cell.
D. acts as an anode in an operating electrochemical cell.

8. S01 Which of the following substances is the strongest reducing agent?

A. Hg
B. Zn
C. Sn
D. Ag

9. S01 Consider the following redox equation:

$$12\,H^+_{(aq)} + 2\,IO_3^-{}_{(aq)} + 10\,Fe^{2+}_{(aq)} \rightarrow 10\,Fe^{3+}_{(aq)} + I_{2(s)} + 6\,H_2O_{(\ell)}$$

The reducing agent is

A. I_2
B. H^+
C. Fe^{2+}
D. IO_3^-

10. S01 Which of the following represents a redox reaction?

A. $CaCO_3 \rightarrow CaO + CO_2$
B. $SiCl_4 + 2Mg \rightarrow Si + 2MgCl_2$
C. $2NaOH + H_2SO_4 \rightarrow 2H_2O + Na_2SO_4$
D. $AgBr + 2S_2O_3^{2-} \rightarrow Ag(S_2O_3)_2^{3-} + Br^-$

11. S01 **When NO_2 acts as a reducing agent, a possible product is**

A. NO B. N_2O C. N_2O_4 D. N_2O_5

12. S01 An oxidizing agent will cause which of the following changes?

A. $PtO_2 \rightarrow PtO$
B. $PtO_3 \rightarrow PtO_2$
C. $Pt(OH)_2 \rightarrow Pt$
D. $Pt(OH)_2^{2+} \rightarrow PtO_3$

13. S02 **The oxidation state of S in $S_2O_8^{2-}$ is:**

A. –2 B. +7 C. +8 D. +14

14. S02 **As SO_4^{2-} changes to SO_3^{2-}, it is said that sulphur is being reduced since its oxidation number:**

A. increases as electrons are lost.
B. decreases as electrons are lost.
C. increases as electrons are gained.
D. decreases as electrons are gained.

15. SO2 Consider the following:

$$3C_3H_8O + 2CrO_3 + 3H_2SO_4 \rightarrow 3C_3H_6O + 6H_2O + Cr_2(SO_4)_3$$

The oxidation number of the chromium

A. increases as it undergoes reduction.
B. increases as it undergoes oxidation.
C. decreases as it undergoes oxidation.
D. decreases as it undergoes reduction.

16. SO2 The oxidation number of sulphur in $Na_2S_2O_3$ is

A. -2
B. $+1$
C. $+2$
D. $+4$

17. SO2 Consider the following:

$$2MnO_4^- + 5H_2SO_3 \rightarrow 2Mn^{2+} + 3H_2O + 5SO_4^{2-} + 4H^+$$

The species that undergoes reduction is

A. S in H_2SO_3
B. H in H_2SO_3
C. O in MnO_4^-
D. Mn in MnO_4^-

18. SO2 In which of the following unbalanced equations does chromium undergo oxidation?

A. $Cr^{3+} \rightarrow Cr$
B. $Cr^{3+} \rightarrow Cr^{2+}$
C. $Cr^{3+} \rightarrow Cr_2O_7^{2-}$
D. $CrO_4^{2-} \rightarrow Cr_2O_7^{2-}$

19. SO2 The oxidation number of carbon in CaC_2O_4 is

A. +2
B. +3
C. +4
D. +6

20. SO2 When MnO_4^- reacts to form Mn^{2+}, the manganese in MnO_4^- is

A. reduced as its oxidation number increases.
B. reduced as its oxidation number decreases.
C. oxidized as its oxidation number increases.
D. oxidized as its oxidation number decreases.

21. SO2 The oxidation number of nitrogen increases in

A. $NO_3^- \rightarrow NO$
B. $N_2O_4 \rightarrow NI_3$
C. $NH_3 \rightarrow NH_4^+$
D. $NO_2 \rightarrow N_2O_5$

22. S02 In a redox reaction, the species which loses electrons

A. is oxidized.
B. is called the cathode.
C. gains mass at the electrode.
D. decreases in oxidation number.

23. S02 When NO_2 reacts to form N_2O_4 the oxidation number of nitrogen

A. increases by 2.
B. increases by 4.
C. increases by 8.
D. does not change.

24. S02 Consider the following half-reaction:

$$Sb_2O_3 + 6H^+ + 6e^- \rightleftarrows 2Sb + 3H_2O$$

The oxidation number of antimony in Sb_2O_3

A. increases by 3.
B. increases by 6.
C. decreases by 3.
D. decreases by 6.

25. S02 **Manganese has an oxidation number of +4 in**
A. MnO B. MnO_2 C. Mn_2O_3 D. Mn_2O_7

26. S02 In which reaction is nitrogen reduced?

A. $2NO + O_2 \rightarrow 2NO_2$
B. $4NH_3 + 5O_2 \rightarrow 4NO + 6H_2O$
C. $Cu^{2+} + 2NO_2 + 2H_2O \rightarrow Cu + 4H^+ + 2NO_3^-$
D. $4Zn + 10H^+ + NO_3^- \rightarrow 4Zn^{2+} + NH_4^+ + 3H_2O$

27. S03 Consider the following:

$$PbO_2 + Pb + 4H^+ + 2SO_4^{2-} \rightarrow 2PbSO_4 + 2H_2O$$

The substance which loses electrons is

A. Pb
B. PbO_2
C. H^+
D. SO_4^{2-}

28. S03 **Consider the following equation:**

$$2\ Fe + 3Cu(NO_3)_2 \longrightarrow 2Fe(NO_3)_3 + 3Cu$$

Electrons are lost in the reaction by

A. Fe B. Cu C. Fe^{+3} D. Cu^{+2}

29. S03 **Electrons are lost by the**
A. reducing agent as it undergoes oxidation.
B. reducing agent as it undergoes reduction.
C. oxidizing agent as it undergoes oxidation.
D. oxidizing agent as it undergoes reduction.

30. S03 Consider the following redox equation:

$$Br_2 + SO_2 + Na_2SO_4 + 2H_2O \rightarrow 2H_2SO_4 + 2NaBr$$

Which of the following is gaining electrons?

A. Br_2
B. SO_2
C. H_2O
D. Na_2SO_4

31. S03 Consider the following redox reaction:

$$As_2O_3 + 2NO_3^- + 2H_2O + 2H^+ \rightarrow 2H_3AsO_4 + N_2O_3$$

In this reaction, nitrogen

A. loses electrons and increases in oxidation number.
B. gains electrons and increases in oxidation number.
C. loses electrons and decreases in oxidation number.
D. gains electrons and decreases in oxidation number.

32. S03 Consider the following redox reaction:

$$2Cr^{3+}_{(aq)} + 3Cl_{2(aq)} + 7H_2O_{(\ell)} \rightarrow Cr_2O_7^{2-}{}_{(aq)} + 6Cl^-_{(aq)} + 14H^+_{(aq)}$$

The species which loses electrons is

A. Cl_2
B. Cr^{3+}
C. H_2O
D. $Cr_2O_7^{2-}$

33. S03 The species which gains electrons in a redox reaction

A. loses mass.
B. is oxidized.
C. is the oxidizing agent.
D. increases in oxidation number.

34. S03 **In an oxidation half-reaction there is a**

A. gain of protons. B. gain of electrons. C. loss of protons. D. loss of electrons.

35. S03 **As an element is oxidized, its oxidation number**

A. increases as electrons are lost. B. decreases as electrons are lost.
C. increases as electrons are gained. D. decreases as electrons are gained.

36. S03 Consider the following reaction:

$$TiCl_4 + O_2 \rightarrow TiO_2 + 2Cl_2$$

Each oxygen atom is

A. reduced and loses $2e^-$
B. reduced and gains $2e^-$
C. oxidized and loses $2e^-$
D. oxidized and gains $2e^-$

37. **S05** Samples of Uranium, Vanadium and Yttrium (U, V, Y) were placed in solutions containing one of the metallic ions U^{3+}, V^{2+}, Y^{3+}. The following observations were recorded.

Trial	Ion	Metal	Observation
1	U^{3+}	Y	reaction
2	V^{2+}	U	reaction
3	V^{2+}	Y	reaction
4	Y^{3+}	V	no reaction

The oxidizing agents from the strongest to the weakest are

A. V^{2+}, U^{3+}, Y^{3+}
B. U^{3+}, V^{2+}, Y^{3+}
C. Y^{3+}, U^{3+}, V^{2+}
D. V^{2+}, Y^{3+}, U^{3+}

38. **S05** Consider the following redox reaction:

$$Hg^{2+} + Cu \rightarrow Hg + Cu^{2+}$$

In this reaction, Hg^{2+} is a

A. weaker reducing agent than Cu^{2+}
B. weaker oxidizing agent than Cu^{2+}
C. stronger reducing agent than Cu^{2+}
D. stronger oxidizing agent than Cu^{2+}

39. **S05** Which of the following is the strongest oxidizing agent?

A. Cu^{2+}
B. Pb^{2+}
C. Ni^{2+}
D. Sn^{2+}

40. **S05** Metallic platinum reacts spontaneously with $Au^{3+}_{(aq)}$ but does not react with $Ag^{+}_{(aq)}$. The metals, in order of increasing strength as reducing agents, are

A. Ag, Pt, Au
B. Pt, Au, Ag
C. Au, Ag, Pt
D. Au, Pt, Ag

41. **S06** **Which of the following reactions is spontaneous at standard conditions?**

A. $2H_2O \rightarrow 2H_2 + O_2$

B. $2Fe^{3+} + Fe \rightarrow 3Fe^{2+}$

C. $2Cl^- + Br_2 \rightarrow Cl_2 + 2Br^-$

D. $2Br^- + Sn^{4+} \rightarrow Sn^{2+} + Br_2$

42. **S06** Which of the following species will react with Cl_2 but not with Br_2 ?

A. Mn
B. acidified Mn^{2+}
C. acidified MnO_2
D. acidified MnO_4^-

43. SO6 Consider the following:

$$ClO_4^- + 4Mn^{2+} + 4H_2O \rightarrow Cl^- + 8H^+ + 4MnO_2$$

The forward reaction is

A. spontaneous and the E° is +0.16 V
B. spontaneous and the E° is −0.16 V
C. non-spontaneous and the E° is +0.16 V
D. non-spontaneous and the E° is −0.16 V

44. SO6 The reducing agents yttrium, uranium and vanadium, from the strongest to the weakest, are Y, U and V. Which of the following statements is true?

A. V will react with the Y^{3+} ion.
B. V will react with the U^{3+} ion.
C. V will react with both the U^{3+} and Y^{3+} ions.
D. V will not react with either U^{3+} or Y^{3+} ions.

45. SO6 Which of the following reactions is spontaneous?

A. $Fe + Cu^{2+} \rightarrow Fe^{2+} + Cu$
B. $Fe + Zn^{2+} \rightarrow Fe^{2+} + Zn$
C. $Fe + Mn^{2+} \rightarrow Fe^{2+} + Mn$
D. $Fe + Mg^{2+} \rightarrow Fe^{2+} + Mg$

46. SO6 Which of the following reactions is spontaneous?

A. $Fe^{2+} + Sn \rightarrow Fe + Sn^{2+}$
B. $Fe^{3+} + Sn \rightarrow Fe^{2+} + Sn^{2+}$
C. $Fe^{2+} + Sn^{2+} \rightarrow Fe + Sn^{4+}$
D. $Fe^{2+} + Sn^{4+} \rightarrow Fe^{3+} + Sn^{2+}$

47. SO6 The reaction that occurs when pieces of lead, zinc, copper and silver are placed in a solutior of $Ni(NO_3)_2$ is

A. $Pb + Ni^{2+} \rightarrow Pb^{2+} + Ni$
B. $Zn + Ni^{2+} \rightarrow Zn^{2+} + Ni$
C. $Cu + Ni^{2+} \rightarrow Cu^{2+} + Ni$
D. $2Ag + Ni^{2+} \rightarrow 2Ag^{+} + Ni$

48. SO6 Which of the following ions can be reduced from an aqueous solution?

A. Ba^{2+}
B. Al^{3+}
C. Sn^{2+}
D. Na^{+}

49. S06 Three beakers contain 1.0 M $CuCl_2$. A piece of metal is placed in each of the beakers.

BEAKER	SOLUTION	METAL
1	$CuCl_2$	Zn
2	$CuCl_2$	Ag
3	$CuCl_2$	Ni

Reactions occur in

A. beaker 2 only.
B. beakers 1, 2 and 3.
C. beakers 1 and 2 only.
D. beakers 1 and 3 only.

50. S06 Which of the following pairs of ions will react spontaneously in solution?

A. Cu^{2+} and Fe^{2+}
B. Pb^{2+} and Sn^{2+}
C. Co^{2+} and Cr^{2+}
D. Mn^{2+} and Cr^{2+}

51. S06 **Which of the following 1 0 . M solutions will react spontaneously with lead?**
A. KCl B. $CuCl_2$ C. $ZnCl_2$ D. $MgCl_2$

52. S06 Which of the following will oxidize Fe^{2+} ?

A. $I_{2(s)}$
B. $Ni_{(s)}$
C. $Zn_{(s)}$
D. $Br_{2(\ell)}$

BALANCING REDOX EQUATIONS

53. T01 Consider the following:

$$NO_3^- \rightarrow NH_4^+$$

The balanced half-reaction is

A. $NO_3^- + 10H^+ + 9e^- \rightarrow NH_4^+ + 3H_2O$
B. $NO_3^- + 7H^+ + 8e^- \rightarrow NH_4^+ + 3OH^-$
C. $NO_3^- + 6H^+ + 4e^- \rightarrow NH_4^+ + 3H_2O$
D. $NO_3^- + 10H^+ + 8e^- \rightarrow NH_4^+ + 3H_2O$

54. T01 Consider the following:

$$Cl_2 \rightarrow ClO_3^-$$

The balanced half-reaction is

A. $Cl_2 + 3H_2O \rightarrow ClO_3^- + 6H^+ + 5e^-$
B. $Cl_2 + 3H_2O \rightarrow 2ClO_3^- + 6H^+ + 4e^-$
C. $Cl_2 + 6H_2O + 2e^- \rightarrow 2ClO_3^- + 6H_2$
D. $Cl_2 + 6H_2O \rightarrow 2ClO_3^- + 12H^+ + 10e^-$

55. T01 In a redox reaction, ClO^- was converted to Cl^- in a basic solution. The balanced half-reaction for this process is

A. $ClO^- + H_2O + 2e^- \rightarrow Cl^- + 2OH^-$
B. $ClO^- + 2OH^- \rightarrow Cl^- + 2e^- + H_2O$
C. $ClO^- + H_2O \rightarrow Cl^- + 2e^- + 2OH^-$
D. $ClO^- + 2OH^- + 2e^- \rightarrow Cl^- + H_2O$

56. T01 Which of the following represents a balanced reduction half-reaction?

A. $VO_2^+ + H^+ + 2e^- \rightarrow VO^{2+} + H_2O$
B. $VO_2^+ + H_2 \rightarrow VO^{2+} + H_2O + 1e^-$
C. $VO_2^+ + 2H^+ + 1e^- \rightarrow VO^{2+} + H_2O$
D. $VO_2^+ + 4H^+ + 3e^- \rightarrow VO^{2+} + 2H_2O$

57. T01 Consider the following half-reaction in a basic solution:

$Ag_2O_3 \rightarrow AgO$ (basic)

The balanced half-reaction is

A. $Ag_2O_3 + 4H^+ + 4e^- \rightarrow AgO + 2H_2O$
B. $Ag_2O_3 + 2H^+ + 2e^- \rightarrow 2AgO + H_2O$
C. $Ag_2O_3 + H_2O + 2e^- \rightarrow 2AgO + 2OH^-$
D. $Ag_2O_3 + 2H_2O + 4e^- \rightarrow AgO + 4OH^-$

58. T02 Which of the following is a balanced half-reaction in base?

A. $Cl_2 + 3H_2O \rightarrow ClO_3^- + 6H^+ + 5e^-$
B. $Cl_2 + 6OH^- \rightarrow ClO_3^- + 5e^- + 3H_2O$
C. $Cl_2 + 6H_2O \rightarrow 2ClO_3^- + 12H^+ + 10e^-$
D. $Cl_2 + 12OH^- \rightarrow 2ClO_3^- + 6H_2O + 10e^-$

59. T04 What two substances are produced when Cr and 1.0 M MnO_4^- react in **basic** solution?

A. Mn^{2+} and Cr^{3+}
B. MnO_2 and Cr^{3+}
C. Mn^{2+} and Cr^{2+}
D. MnO_2 and CrO_4^{2-}

60. T05 Which of the following chemicals could be used in a titration in which Br^- is changed to Br_2 ?

A. I_2
B. Cl^-
C. NO_3^- (acidified)
D. H_2O_2 (acidified)

61. T05 **The concentration of $Fe^{2+}_{(aq)}$ can be determined by a redox titration using**
A. KBr B. SnCl 2 C. $KmnO_4$ (basic) D. $KBrO_3$ (acidic)

62. T06 Consider the following reaction:

$$Zn_{(s)} + 2Ag^{+}_{(aq)} \rightarrow Zn^{2+}_{(aq)} + 2Ag_{(s)}$$

What volume of 0.500 M $AgNO_3$ is required to react completely with 6.54 g of zinc?

A. 0.0131 L
B. 0.0262 L
C. 0.200 L
D. 0.400 L

63. T06 Consider the following redox reaction:

$$I_2 + 2S_2O_3^{2-} \rightarrow S_4O_6^{2-} + 2I^-$$

In a titration, 40.00 mL of $Na_2S_2O_3$ is needed to react completely with 4.0×10^{-3} mol I_2.
What is the concentration of $Na_2S_2O_3$?

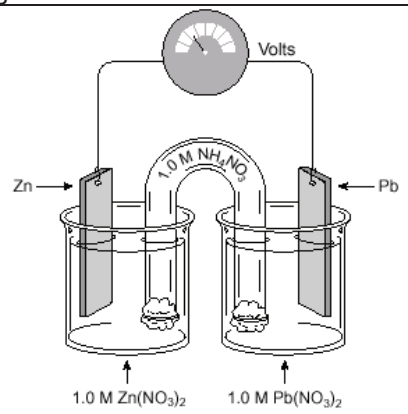
A. 0.10 M
B. 0.16 M
C. 0.20 M
D. 0.32 M

ELECTROCHEMICAL CELLS

64. U01 **In an electrochemical cell, the cathode**
A. is reduced. B. loses mass. C. is the reducing agent. D. is the site of reduction.

65. U01 **In an operating electrochemical cell the function of a salt bridge is to**
A. allow hydrolysis to occur. B. allow a non-spontaneous reaction to occur.
C. permit the migration of ions within the cell. D. transfer electrons from the cathode to the anode.

66. U02



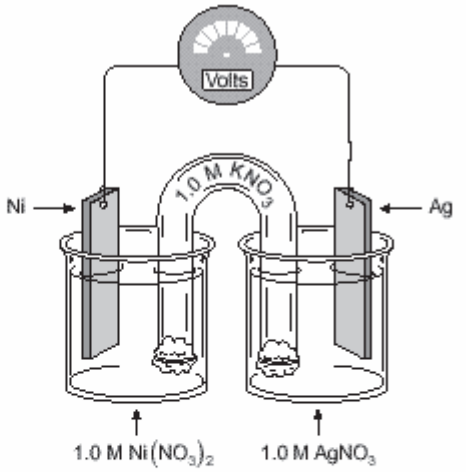
The reaction at the anode is

A. $Pb \rightarrow Pb^{2+} + 2e^-$
B. $Pb^{2+} + 2e^- \rightarrow Pb$
C. $Zn^{2+} + 2e^- \rightarrow Zn$
D. $Zn \rightarrow Zn^{2+} + 2e^-$

67. U02 The electrons move from the

A. zinc to the lead through the wire.
B. lead to the zinc through the wire.
C. zinc to the lead through the salt bridge.
D. lead to the zinc through the salt bridge.

68. UO 2



. The balanced equation for the overall reaction is

A. $Ni^{+}_{(aq)} + Ag_{(s)} \rightarrow Ag^{+}_{(aq)} + Ni_{(s)}$

B. $Ni_{(s)} + Ag^{+}_{(aq)} \rightarrow Ag_{(s)} + Ni^{+}_{(aq)}$

C. $Ni^{2+}_{(aq)} + 2Ag_{(s)} \rightarrow 2Ag^{+}_{(aq)} + Ni_{(s)}$

D. $Ni_{(s)} + 2Ag^{+}_{(aq)} \rightarrow 2Ag_{(s)} + Ni^{2+}_{(aq)}$

69. UO 2

This redox reaction occurs because

A. $Ag_{(s)}$ is a stronger oxidizing agent than $Ni_{(s)}$

B. $Ag_{(s)}$ is a weaker reducing agent than $Ni_{(s)}$

C. $Ag^{+}_{(aq)}$ is a stronger reducing agent than $Ni^{2+}_{(aq)}$

D. $Ag^{+}_{(aq)}$ is a weaker oxidizing agent than $Ni^{2+}_{(aq)}$

70. UO 2

The initial cell voltage at 25°C is

A. −1.06 V

B. −0.54 V

C. +0.54 V

D. +1.06 V

71. UO 2

Consider the overall reaction of the rechargeable nickel-cadmium battery:

$$NiO_{2(s)} + Cd_{(s)} + 2H_2O_{(\ell)} \rightarrow Ni(OH)_{2(s)} + Cd(OH)_{2(s)}$$

Which of the following occurs at the **anode** as the reaction proceeds?

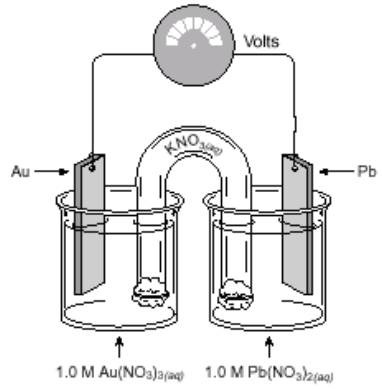
A. Cd loses $2e^-$ and forms $Cd(OH)_{2(s)}$

B. Cd gains $2e^-$ and forms $Cd(OH)_{2(s)}$

C. NiO_2 loses $2e^-$ and forms $Ni(OH)_{2(s)}$

D. NiO_2 gains $2e^-$ and forms $Ni(OH)_{2(s)}$

72. UO 3



As the cell operates,

A. NO_3^- and K^+ will migrate toward the Pb half-cell.
B. NO_3^- and K^+ will migrate toward the Au half-cell.
C. NO_3^- will migrate toward the Pb half-cell and K^+ will migrate toward the Au half-cell.
D. NO_3^- will migrate toward the Au half-cell and K^+ will migrate toward the Pb half-cell.

73. UO 3

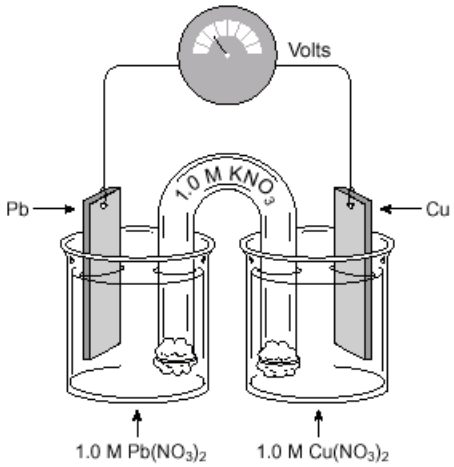
The initial voltage is

A. –1.37 V
B. 0.00 V
C. 1.37 V
D. 1.63 V

74. UO 3

The direction of the electron flow is
A. from Au to Pb through the wire.
B. from Pb to Au through the wire.
C. from Au to Pb through the salt bridge.
D. from Pb to Au through the salt bridge.

75. UO 4



In the electrochemical cell above, the electrons flow from

A. copper to lead through the wire.
B. lead to copper through the wire.
C. copper to lead through the salt bridge.
D. lead to copper through the salt bridge.

76. UO 4

In the electrochemical cell above, the initial E° value is

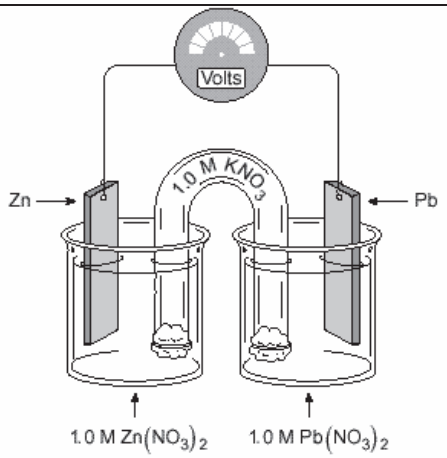
A. 0.03 V
B. 0.21 V
C. 0.29 V
D. 0.47 V

77. UO 4

In an operating zinc-copper electrochemical cell, the oxidizing agent

A. loses electrons at the anode. B. loses electrons to the cations. C. gains electrons at the cathode. D. gains electrons from the anions.

78. UO 4



In the electrochemical cell above, the electrons flow from

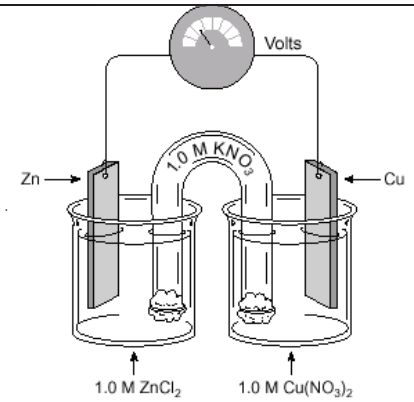
A. zinc to lead and the mass of zinc increases.
B. zinc to lead and the mass of lead increases.
C. lead to zinc and the mass of zinc increases.
D. lead to zinc and the mass of lead increases.

79. UO 9

The initial cell voltage is

A. −0.89 V
B. −0.63 V
C. +0.63 V
D. +0.89 V

80. UO 5



In the above electrochemical cell,

A. the mass of the anode increases and the mass of the cathode increases.
B. the mass of the anode decreases and the mass of the cathode decreases.
C. the mass of the anode decreases and the mass of the cathode increases.
D. the mass of the anode increases and the mass of the cathode decreases.

81. UO 5

In the electrochemical cell above,

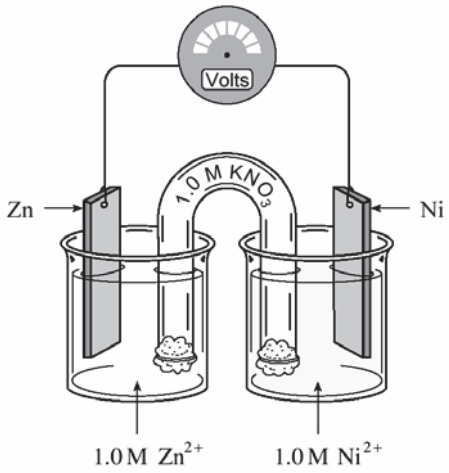
A. electrons migrate into the salt bridge.
B. the zinc ions migrate into the salt bridge.
C. the chloride ions migrate into the salt bridge.
D. the copper(II) ions migrate into the salt bridge.

82. UO 5

In the operating electrochemical cell above, the initial voltage is

A. −1.10 V
B. −0.42 V
C. 0.00 V
D. +1.10 V

83. UO 5



Which of the following occurs as the cell operates?

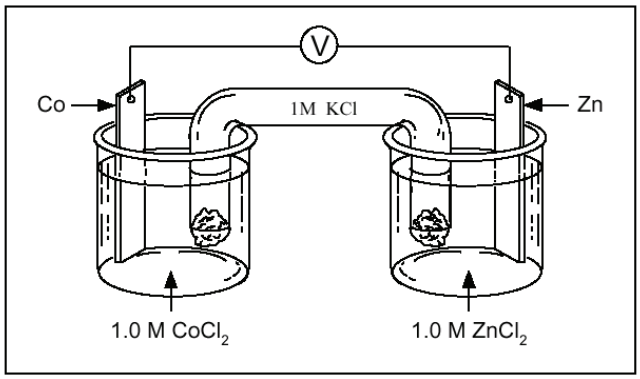
A. Zinc electrode is reduced and increases in mass.
B. Zinc electrode is reduced and decreases in mass.
C. Zinc electrode is oxidized and increases in mass.
D. Zinc electrode is oxidized and decreases in mass.

84. UO 6

When the cell establishes equilibrium, the voltage will be

A. −0.63 V
B. 0.00 V
C. +0.63 V
D. +0.89 V

85. U0 7



The initial voltage of the cell in the above diagram is

A. 0.48 V
B. −0.48 V
C. 0.00 V
D. 1.04 V

86. U0 7 **Which of the following statements would be correct if the zinc half-cell had been chosen as the standard instead of the hydrogen half-cell?**

A. The reduction potentials of all half-cells would remain unchanged.
B. The reduction potentials of all half-cells would increase by 0.76 V.
C. The reduction potentials of all-half-cells would have positive values.
D. The reduction potential of the hydrogen half-cell would decrease by 0.76 V.

87. U0 8 The E° of the hydrogen half-cell is

A. arbitrarily set.
B. determined by experiment.
C. independent of temperature.
D. found by comparison with the oxygen half-cell.

88. U0 9 A student attempted to determine the E° (volts) of the following half-reaction:

$$Pd^{2+} + 2e^- \rightarrow Pd$$

She recorded the following:

1. $Pd^{2+} + Cu \rightarrow Pd + Cu^{2+}$
2. $Pd^{2+} + Au \rightarrow$ no reaction
3. $Pd^{2+} + Hg \rightarrow$ no reaction

Based on the above, the E° (volts) of a Pd half-cell is

A. less than 0.34 V.
B. greater than 1.50 V.
C. greater than 0.85 V but less than 1.50 V.
D. greater than 0.34 V but less than 0.85 V.

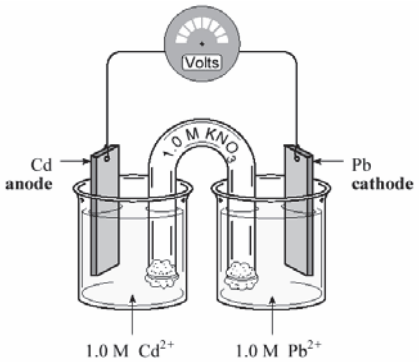
89. U09 Consider the following overall reaction:

$$2Rh^{+}_{(aq)} + Pb_{(s)} \rightarrow 2Rh_{(s)} + Pb^{2+}_{(aq)} \qquad E^{\circ} = +0.73\ V$$

The E° for the half-reaction $Rh^{+}_{(aq)} + e^{-} \rightleftarrows Rh$ is

A. -0.86 V
B. -0.60 V
C. $+0.60$ V
D. $+0.86$ V

90. U09
91. U09



As the cell operates, electrons flow toward

A. the Pb electrode, where Pb is oxidized.
B. the Cd electrode, where Cd is oxidized.
C. the Pb electrode, where Pb^{2+} is reduced.
D. the Cd electrode, where Cd^{2+} is reduced.

The E° value for the reduction of Cd^{2+} is

A. -0 40 .V
B. -0 27 V
C. +0.14 V
D. +0.40 V

92. U09 **The following reaction occurs in an electrochemical cell:**

$$3Cu^{2+} + 2Cr \rightarrow 2Cr^{3+} + 3Cu$$

The E° for the cell is

A. 0.40V B. 0.75V C. 1 .08V D. 2.50V

93. U09 Which of the following reactants would produce an E° of $+0.63$ V?

A. $Ag^{+} + I_2$
B. $Pb^{2+} + Zn$
C. $Mg^{2+} + Ca$
D. $Zn^{2+} + Mn$

94. U10 Consider the following redox reaction:

$$Co^{2+}_{(aq)} + 2Ag_{(s)} \rightarrow 2Ag^{+}_{(aq)} + Co_{(s)}$$

The reaction is

A. spontaneous and E° is positive.
B. spontaneous and E° is negative.
C. non-spontaneous and E° is positive.
D. non-spontaneous and E° is negative.

95. U11 **The principal function of a fuel cell is to**

A. produce fuel. B. electrolyze fuel. C. produce hydrogen. D. produce electricity.

96. U11 Hydrogen and oxygen react to provide energy in a(n)

A. dry cell.
B. fuel cell.
C. alkaline cell.
D. lead-acid storage cell.

97. U11 Hydrogen and oxygen react to provide energy in a(n)

A. dry cell.
B. fuel cell.
C. alkaline cell.
D. lead-acid storage cell.

CORROSION

98. V01 E A reaction that occurs during the corrosion of iron is

A. $Fe + 3e^- \rightarrow Fe^{3+}$
B. $Fe \rightarrow Fe^{2+} + 2e^-$
C. $Fe^{2+} + 2e^- \rightarrow Fe$
D. $Fe^{3+} + e^- \rightarrow Fe^{2+}$

99. V02 During the corrosion of magnesium, the anode reaction is

A. $Mg \rightarrow Mg^{2+} + 2e^-$
B. $Mg^{2+} + 2e^- \rightarrow Mg$
C. $4OH^- \rightarrow O_2 + 2H_2O + 4e^-$
D. $O_2 + 2H_2O + 4e^- \rightarrow 4OH^-$

100. V03 Which of the following should be used to cathodically protect an iron sculpture?

A. lead
B. nickel
C. copper
D. magnesium

101. V03 Corrosion of iron can be prevented by attaching a piece of

A. Mn
B. Cu
C. Pb
D. Sn

102. V04 Which of the following metals can be used to cathodically protect iron?

A. tin
B. zinc
C. nickel
D. copper

103. V04 **Which of the following metals could be used to cathodically protect a sample of lead?**
A. iron B. gold C. silver D. copper

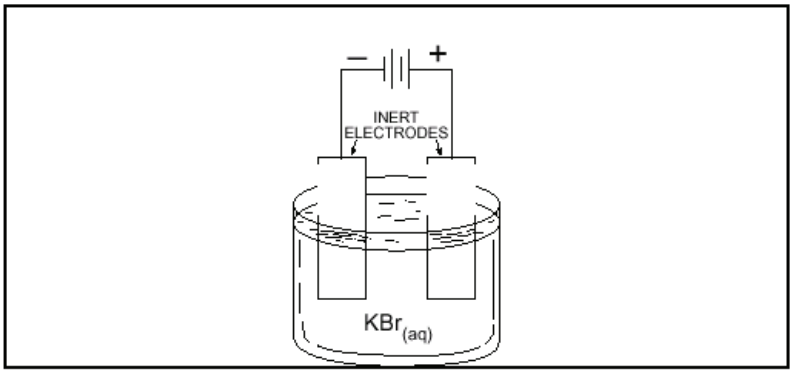
104. V04 A solution of 1.0 M $Pb(NO_3)_2$ will not react with a container made of

A. Cu
B. Fe
C. Sn
D. Zn

ELECTROLYTIC CELLS

105. WO 1 [**The process of applying an electric current through a cell to produce a chemical change is called:**
A. corrosion. B. ionization. C. hydrolysis. D. electrolysis.

106. WO 4



The product at the cathode is

A. K
B. O_2
C. H_2
D. Br_2

107. WO 4 In the above cell,

A. K^+ ions move to cathode and Br^- ions move to anode.
B. Br^- ions move to cathode and K^+ ions move to anode.
C. Br^- ions move to cathode and H^+ ions move to anode.
D. OH^- ions move to cathode and Br^- ions move to anode.

108. WO 4 The substance formed at the anode during the electrolysis of 1.0 M NaI is

A. iodine.
B. oxygen.
C. sodium.
D. hydrogen.

109. WO 4 When molten aluminum oxide is electrolyzed, the cathode reaction is

A. $Al \rightarrow Al^{3+} + 3e^-$
B. $Al^{3+} + 3e^- \rightarrow Al$
C. $O_2 + 4e^- \rightarrow 2O^{2-}$
D. $2O^{2-} \rightarrow O_2 + 4e^-$

110. WO 4 When 1.0 M NaI is electrolyzed, bubbles of gas form on one electrode and a reddish-brown substance forms on the other. The half-reaction at the cathode is

A. $2I^- \rightarrow I_2 + 2e^-$
B. $Na^+ + e^- \rightarrow Na$
C. $H_2O \rightarrow \frac{1}{2}O_2 + 2H^+ + 2e^-$
D. $2H_2O + 2e^- \rightarrow H_2 + 2OH^-$

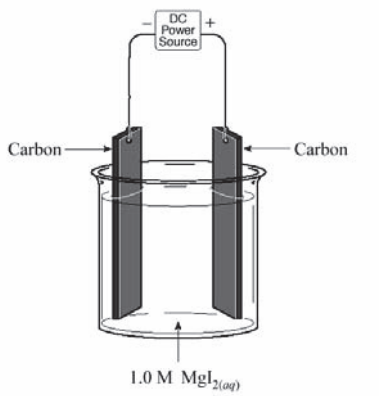
111. WO 4 Which of the following is formed at the anode during the electrolysis of 1.0 M NaI ?

A. I_2
B. O_2
C. H_2
D. Na

112. WO 4 An iron spoon is electroplated with copper. The equation representing the reduction reaction is

A. $Cu^{2+}_{(aq)} + 2e^- \rightarrow Cu_{(s)}$
B. $Cu_{(s)} \rightarrow Cu^{2+}_{(aq)} + 2e^-$
C. $Fe^{2+}_{(aq)} + 2e^- \rightarrow Fe_{(s)}$
D. $Fe_{(s)} \rightarrow Fe^{2+}_{(aq)} + 2e^-$

113. WO 4



The cathode reaction is

A. $2I^- \rightarrow I_2 + 2e^-$
B. $Mg^{2+} + 2e^- \rightarrow Mg$
C. $H_2O \rightarrow \frac{1}{2}O_2 + 2H^+ + 2e^-$
D. $2H_2O + 2e^- \rightarrow H_2 + 2OH^-$

114. WO 6 If a piece of nickel is to be gold-plated using an electrolytic process, which half-reaction occurs at the cathode?

A. $Ni \rightarrow Ni^{2+} + 2e^-$
B. $Ni^{2+} + 2e^- \rightarrow Ni$
C. $Au \rightarrow Au^{3+} + 3e^-$
D. $Au^{3+} + 3e^- \rightarrow Au$

115. WO 6 **To plate a nickel coin with copper,**

A. the nickel coin must be the cathode.
B. the cathode must be made of copper.
C. the electrons must flow to the anode.
D. the solution must contain nickel ions.

116. WO 7 In electrorefining lead, pure lead is deposited on the cathode from an impure lead anode. In this process, lead is

A. reduced at the anode.
B. oxidized at the anode.
C. reduced at the anode and the cathode.
D. oxidized at the anode and the cathode.

117. WO 7 An example of electrorefining is the

A. extraction of aluminum from bauxite.
B. purification of lead from an impure anode.
C. recovery of zinc from a zinc sulphate solution.
D. production of chlorine from a sodium chloride solution.

118. WO 8 The substance formed at the cathode during the electrolysis of molten $ZnCl_2$ is

A. zinc.
B. oxygen.
C. chlorine.
D. hydrogen.

119. WO 8 In the electrolysis of molten zinc chloride, the half-reaction at the anode is

A. $Cl_2 + 2e^- \rightarrow 2Cl^-$
B. $2Cl^- \rightarrow Cl_2 + 2e^-$
C. $Zn^{2+} + 2e^- \rightarrow Zn$
D. $Zn \rightarrow Zn^{2+} + 2e^-$

120. WO 8 A molten binary salt, $ZnCl_2$, undergoes electrolysis. The cathode reaction is

A. $Zn \rightarrow Zn^{2+} + 2e^-$
B. $2Cl^- \rightarrow Cl_2 + 2e^-$
C. $Cl_2 + 2e^- \rightarrow 2Cl^-$
D. $Zn^{2+} + 2e^- \rightarrow Zn$

ANSWER KEY:

Introduction:

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

20.	B
21.	D
22.	A
23.	D
24.	C
25.	B
26.	D
27.	A
28.	A
29.	A
30.	A
31.	D
32.	B
33.	C
34.	D
35.	A
36.	B
37.	A
38.	D

39.	A
40.	D
41.	B
42.	B
43.	A
44.	D
45.	A
46.	B
47.	B
48.	C
49.	D
50.	C
51.	B
52.	D

Balancing Redox Equations:

53.	D
54.	D
55.	A
56.	C
57.	C
58.	D
59.	B
60.	D
61.	D
62.	D
63.	C

Electrochemical Cells

64.	D
65.	C
66.	D
67.	A
68.	D
69.	B
70.	D
71.	A
72.	C
73.	D
74.	B
75.	B

76.	D
77.	C
78.	B
79.	C
80.	C
81.	B
82.	D
83.	D
84.	B
85.	A
86.	B
87.	A

88.	D
89.	C
90.	C
91.	A
92.	C
93.	B
94.	D
95.	D
96.	B
97.	C

Corrosion:

98.	B
99.	A

100.	**D**
101.	**A**
102.	**B**
103.	**A**
104.	**A**

Electrolytic Cells:

105.	**D**
106.	**C**
107.	**A**
108.	**A**
109.	**B**
110.	**D**
111.	**A**
112.	**A**

113.	**D**
114.	**D**
115.	**A**
116.	**B**
117.	**B**
118.	**A**
119.	**B**
120.	**D**