BCI SCIENCE
SCH 4U

Electrochem Practice Test

Name: ANSWERS

/50

Multiple Choice
Identify the letter of the choice that best completes the statement or answers the question. (20 marks)

1. What is the purpose of a salt bridge in a galvanic cell?
B
a. to balance charge
b. to complete the circuit
c. to absorb electrons
d. to release electrons

2. Which is the correct net ionic equation for the following reaction $MgSO_4(aq) + Cu(s) \rightarrow Mg(s) + CuSO_4(aq)$
A
a. $Mg^{2+}(aq) + Cu(s) \rightarrow Cu^{2+}(aq) + Mg(s)$
b. $MgSO_4(aq) + Cu(s) \rightarrow Mg(s) + CuSO_4(aq)$
c. $Mg^{2+}(aq) \rightarrow Cu^{2+}(aq)$
d. $Mg^{2+}(aq) + SO_4^{2-}(aq) + Cu(s) \rightarrow Cu^{2+}(aq) + SO_4^{2-}(aq) + Mg(s)$

3. Identify the oxidizing agent in the reaction: $Sn^{2+}(aq) + Cl_2(g) \rightarrow Sn^{4+}(aq) + 2Cl^-(aq)$
B
a. $Sn^{2+}(aq)$
b. $Cl_2(g)$
c. $Sn^{2+}(aq)$
d. $Sn^{4+}(aq)$

4. Identify the reducing agent in the reaction: $2Fe(s) + O_2(g) + 2\,H_2O(el) \rightarrow 2Fe(OH)_2(s)$
C
a. $H_2O(el)$
b. Fe(s) and $O_2(g)$
c. Fe(s)
d. $O_2(g)$

5. In the reaction: $Al(s) + O_2(g) \rightarrow Al_2O_3(s)$, how many electrons does an atom of aluminum lose or gain?
C
a. aluminum loses 1 electron
b. aluminum gains 1 electron
c. aluminum loses 3 electrons
d. aluminum gains 3 electrons

6. Which of the following is a stronger reducing agent than Mg(s)?
A
a. Ca(s)
b. Pt(s)
c. Sn(s)
d. Fe(s)

7. Which of these reactions will proceed spontaneously, based on relative strength of reducing agents?
A
a. $Zn(s) + Cu^{2+}(aq) \rightarrow Zn^{2+}(aq) + Cu(s)$
b. $Sn(s) + Cr^{3+}(aq) \rightarrow Sn^{2+}(aq) + Cr(s)$
c. $Cd(s) + Al^{3+}(aq) \rightarrow Cd^{2+}(aq) + Al(s)$
d. $Ag(s) + Zn^{2+}(aq) \rightarrow Ag^{+}(aq) + Zn(s)$

8. What must be added to the following half-reaction for it to be balanced? $Al^{3+}(aq) \rightarrow Al(s)$ $3e^-$
C
a. 1 electron to the left side
b. 1 electron to the right side
c. 3 electrons to the left side
d. 3 electrons to the right side

9. What must be added to the following half-reaction for it to be balanced? $10H^+ + NO_3^-(aq) + 8e^- \rightarrow NH_4^+(aq)$ $+3H_2O$
C
a. 3 water molecules to the left side
b. 1 water molecule to the left side
c. 3 water molecules on the right side
d. 1 water molecule to the left side

10. How many hydrogen ions must be added to the half-reaction to balance the mass of hydrogen atoms?
H_2O D $+ CN^-(aq) \rightarrow CNO^-(s) + 2H^+$
a. 1 on the left side
b. 1 on the right side
c. 2 on the left side
d. 2 on the right side

11. Which of the following reactions is an example of a disproportionation reaction?
D
a. $PbCl_2(s) \rightarrow Pb(s) + Cl_2(g)$
b. $Fe(s) + CuSO_4(aq) \rightarrow FeSO_4(aq) + Cu(s)$
c. $NO_3^-(aq) + NH_3(g) \rightarrow 2NO_2^-(s)$
d. $3Cl_2(g) + 6OH^-(aq) \rightarrow 5Cl^-(aq) + ClO_3^-(aq) + 3H_2O(l)$

one reactant element is both oxidized + reduced.

12. Which electrode is the site of reduction?

D
a. the inert electrode
b. the salt bridge
c. the anode
d. the cathode

13. Which of the following statements is correct for an electrochemical cell?

D
a. the anode and cathode both increase in mass
b. the anode and cathode both decrease in mass
c. the anode increase in mass while the cathode decreases in mass
d. the anode decreases in mass while the cathode increases in mass

14. Why would sodium chloride not be a good choice for the electrolyte in the salt bridge if one of the half reactions involved solid silver and silver nitrate?

B
a. sodium chloride would not complete the circuit
b. solid silver chloride would precipitate out of solution
c. silver and sodium should not exist in the same solution together
d. sodium nitrate would interfere with the reaction

15. Aluminum is a stronger reducing agent than zinc. With this in mind, which metals would be used as the anode and cathode for a spontaneous galvanic cell involving aluminum and zinc?

C
a. a platinum anode and a zinc cathode
b. an aluminum anode and a platinum cathode
c. an aluminum anode and a zinc cathode
d. a zinc anode and an aluminum cathode

16. In the following:

D
$Fe^{2+}(aq) + 2e^- \rightarrow Fe(s)\ \ E° = -0.45\ V$

$F_2(g) + 2e^- \rightarrow 2F^-(aq)\ \ E° = +2.87\ V$

What is the standard cell potential for the corresponding galvanic cell?

a. +2.42 V
b. -2.42 V
c. -3.32 V
d. +3.32 V

17. Which of the following determines if a redox reaction is spontaneous?

D
a. a positive cell potential
b. a negative cell potential
c. the reducing agent on the left is stronger than the reducing agent on the right
d. two of the above are correct

18. What is the correct standard cell notation for a zinc-copper cell?

D
a. $Cu^{2+}(aq) \mid Cu(s) \parallel Zn(s) \mid Zn^{2+}(aq)$
b. $Cu(s) \mid Cu^{2+}(aq) \parallel Zn(s) \mid Zn^{2+}(aq)$
c. $Cu(s) \mid Cu^{2+}(aq) \parallel Zn^{2+}(aq) \mid Zn(s)$
d. $Zn(s) \mid Zn^{2+}(aq) \parallel Cu^{2+}(aq) \mid Cu(s)$

19. In standard cell notation, what does the symbol | represent?

A
a. the separation between the electrode and the aqueous solution
b. the salt bridge
c. the reaction arrow in the redox reaction
d. the separation between the two half cells

20. What is an electrolytic cell?

D
a. another name for any spontaneous cell
b. another name for a galvanic cell
c. another name for a battery
d. a cell that uses an external energy source to drive a non-spontaneous redox reaction

Short Answer and Calculations: ***For the following questions, show all your work if you want part marks. (30 marks).*** **Choose FIVE of the six questions!**

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21. For the following reaction, write the half-reactions and state which is the reduction and which is the oxidation half-reaction also identify the oxidizing agent and the reducing agent [/6]

$O_3(g) + Br^-(aq) \rightarrow BrO^-(aq) + O_2(g)$

$2e^- + O_3(g) \rightarrow O^{-2} + O_2(g)$ reduction, O_3 oxidizing agent

$Br^-(aq) \rightarrow Br^{+1}(aq) + 2e^-$ oxidation, Br^- reducing agent

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22. Balance the following redox reaction in acidic conditions using the half-reaction method.

$MnO_4^-(aq) + I^-(aq) \rightarrow IO_3^-(aq) + MnO_2(s)$

$2H^{+1}(aq) + 2MnO_4^{-1}(aq) + I^{-1}(aq) \rightarrow IO_3^{-1}(aq) + 2MnO_2(s) + H_2O(l)$

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23. Use the oxidation number method to balance the following redox reactions in basic conditions. [/6]

$S_2O_4^{2-}(aq) + Ag_2O \rightarrow SO_3^{2-}(aq) + Ag(s)$

$S_2O_4^{2-}(aq) + Ag_2O(s) + 2OH^{-1}(aq) \rightarrow 2SO_3^{2-}(aq) + 2Ag(s) + H_2O(l)$

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24. ***Use the following information to determine the galvanic cell potential of each indicated reaction.*** **[/6]**

$Br_2(l) + 2e^- \rightarrow 2Br^-(aq)$ $E^\circ = +1.07V$

$I_2(s) + 2e^- \rightarrow 2I^-(aq)$ $E^\circ = +0.54V$

$Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$ $E^\circ = +0.34V$

$Fe^{2+}(aq) + 2e^- \rightarrow Fe(s)$ $E^\circ = -0.45V$

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

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

a. aluminum/zinc = +0.9V d. aluminum/bromine = +2.73V

b. copper/bromine = +0.73V e. copper/aluminum = +2.0V

c. iron/iodine = +0.99V f. zinc/iron = +0.31V

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25. With the following half reactions, describe the galvanic cell that would generate the largest cell potential. Be sure to indicate such items as the anode, cathode, choice of electrolyte, overall cell potential calculation and the overall redox reaction for the cell. [/6]

$Br_2(l) + 2e^- \rightarrow 2Br^-(aq)$ $E^\circ = +1.07V$

$I_2(s) + 2e^- \rightarrow 2I^-(aq)$ $E^\circ = +0.54V$

$Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$ $E^\circ = +0.34V$

$Fe^{2+}(aq) + 2e^- \rightarrow Fe(s)$ $E^\circ = -0.45V$

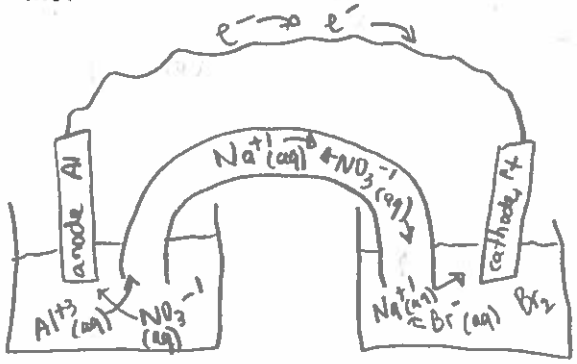
$Zn^{2+}(aq) + 2e^- \rightarrow Zn(s)$ $E^\circ = -0.76V$

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

$E^\circ_{cell} = E^\circ_{cathode} - E^\circ_{anode}$

$= +1.07V - (-1.66)$

$= +2.73V$



$Al(s) \rightarrow Al^{+3}(aq) + 3e^-$ $Br_2(l) + 2e^- \rightarrow 2Br^-(aq)$

$2Al(s) + 3Br_2(l) \rightarrow 2Al^{+3}(aq) + 6Br^{-1}(aq)$