		BLM 13.5.1
ASSESSMENT	**Chapter 13 Test**	

Multiple-Choice Questions

Circle the letter for the choice that best completes the statement or answers the question.

1. Spontaneous redox reactions occur in voltaic cells. Which one of the following combinations could make up a voltaic cell?
   a) $Cl^-(aq)$ and $H_2(g)$
   b) $Cr^{3+}(aq)$ and $Pb(s)$
   c) $Fe^{2+}(aq)$ and $Cu(s)$
   d) $I_2(s)$ and $Ca(s)$

2. What reaction occurs at the anode of a voltaic cell?
   a) oxidation of solid metals
   b) oxidation of cations
   c) reduction of solid metals
   d) reduction of cations

3. What reaction occurs at the cathode of a voltaic cell?
   a) oxidation of solid metals
   b) oxidation of cations
   c) reduction of solid metals
   d) reduction of cations

4. What is the function of the salt bridge or porous cup in a voltaic cell?
   a) allows electrons to flow from the anode to the cathode
   b) allows cations to flow from the cathode to the anode
   c) allows anions to flow from the anode to the cathode
   d) allows cations to flow from the anode to the cathode

5. Match the reactants to their proper electrode in the zinc–nickel dry cell:
   a) anode $Zn^{2+}(aq)$
   b) anode Zn
   c) cathode $Zn^{2+}(aq)$
   d) cathode Zn

6. A student attempts to makes a voltaic cell from the following half-reactions:

$$ClO_3^-(aq) + 6H^+(aq) + 5e^- \rightarrow \frac{1}{2}Cl_2(g) + 3H_2O(l) \qquad E_{cell} = 1.47 \text{ V}$$

$$2Cl^-(aq) \rightarrow Cl_2(g) + 2e^- \qquad\qquad\qquad E_{cell} = -1.36 \text{ V}$$
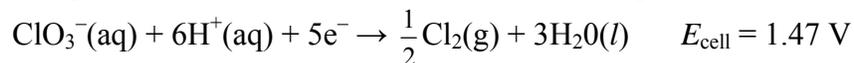
   Which one of the following statements regarding this reaction is **incorrect**?
   a) Chlorine gas is produced.
   b) A spontaneous reaction occurs.
   c) The pH of the mixture decreases.
   d) The concentrations of both $ClO_3^-(aq)$ and $Cl^-(aq)$ decrease.

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7. A shiny Cu(s) strip is placed in a blue $CuSO_4$(aq) solution in a porous cup, which is then placed in a beaker of $ZnSO_4$(aq) solution. A shiny Zn(s) strip is placed in the $ZnSO_4$(aq). The solution in the beaker starts turning blue immediately. When a voltmeter is connected between the Cu(s) and the Zn(s) electrodes, the reading is almost zero. Based on these observations, the most probable reason for such a low voltage is that
   a) the predicted net voltage for this reaction is 0 volts
   b) the copper and zinc strips were not clean and therefore did not react in the solution
   c) the porous cup was cracked, allowing the solutions to mix before a reading was possible
   d) the mixed solutions were too concentrated in SO_4^{2-}(aq) ions for a reaction to occur

8. The time required to produce 10.0 g of chromium metal from a 0.10 mol/L solution of chromium(III) nitrate in an electrolytic cell is dependent on the
   a) initial mass of the cathode in the cell
   b) voltage that is applied across the electrodes of the cell
   c) area of the anode in the cell
   d) charge of the nitrate ions in the solution

9. A new metal, M, has been isolated and it forms a soluble salt, $M(NO_3)_2$. A voltaic cell is made using the M rod dipped in $M(NO_3)_2$(aq) and a standard half-cell. The cell generates 1.24 V and the hydrogen half-cell is the anode. Which one of the following statements regarding this reaction is **correct**?
   a) The reduction half-reaction is M^{2+}(aq) $+ 2e^- \rightarrow$ M(s) and the reduction potential is $+1.24$ V.
   b) The oxidation half-reaction is $2H^+$(aq) $+ 2e^- \rightarrow H_2$(g) and the reduction potential is 0.00 V.
   c) The reduction half-reaction is M^{2+}(aq) $+ 2e^- \rightarrow$ M(s) and the reduction potential is -1.24 V.
   d) The reduction half-reaction is H_2(g) $\rightarrow 2H^+$(aq) $+ 2e^-$ and the reduction potential is 0.00 V.

10. In a voltaic cell, the mass of the
   a) anode decreases
   b) anode stays the same
   c) cathode decreases
   d) cathode stays the same

11. A chemical explanation for using copper pipes in plumbing, rather than iron, is that
   a) copper has a greater ability to transmit heat energy than iron does
   b) iron will react with dissolved minerals such as calcium
   c) iron has a greater tendency to be oxidized than copper does
   d) commercial drain cleaners like sodium hydroxide will react with iron

12. A student constructed an electrochemical cell composed of an Fe^{3+}(aq)/Fe(s) half-cell connected to an unknown half-cell. With Fe as the anode, the E net for the cell was 0.58 V. The same unknown half-cell was connected to an Ag^+(aq)/Ag(s) half-cell, and the silver electrode was the cathode. If the unknown half-cell contained M(s) as the metal electrode and M^{2+}(aq) ions in solution, then the metals M(s), Ag(s), and Fe(s) in order of decreasing reducing agent strength were
   a) Fe(s), M(s), Ag(s)
   b) Fe(s), Ag(s), M(s)
   c) M(s), Ag(s), Fe(s)
   d) Ag(s), M(s), Fe(s)

13. Identify the statement that distinguishes voltaic cells from electrolytic cells.
   a) Electrolytic cells require an electrolyte.
   b) Voltaic cells require a cathode and an anode.
   c) Electrolytic cells require an external power source.
   d) Voltaic cells have electron-flow from the anode to cathode.

14. Four cells containing $CuSO_4$(aq), $AgNO_3$(aq), $Pb(NO_3)_2$(aq), and $Au(NO_3)_3$(aq) are connected to power supplies that operate at 12.0 A for 1.00 h. At the end of this time, which cell will deposit the greatest mass of metal?
   a) $CuSO_4$(aq)
   b) $AgNO_3$(aq)
   c) $Pb(NO_3)_2$(aq)
   d) $Au(NO_3)_3$(aq)

15. In order to prevent an iron object from rusting, the object is often connected to another metal that can offer cathodic protection. In this case, a good choice of metal would be
   a) aluminium
   b) copper
   c) silver
   d) gold

Numerical Response Questions

For each numerical response question, record the answer in the following response box.

16.
17.
18.
19.
20.
21.
22.
23.
24.

16. Use the *Alberta Chemistry Data Booklet* to calculate the cell potential of the following reaction.

$$Pb(s) + 2SO_4^{2-}(aq) + 4H^+(aq) \rightarrow H_2SO_3(aq) + PbSO_4(s) + H_2O(l)$$
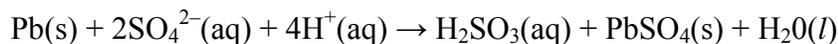
17. A technician wants to electroplate 10.0 g of gold onto a ring by immersing it in a solution of $AuCl_3(aq)$ and using a power source that supplies 4.00 A of current. For what length of time, in minutes, should the cell be allowed to operate?

18. What is the volume of 0.0250 mol/L $Ag^+(aq)$ necessary to react exactly with 2.18 g of Zn(s)?

19. Silver plating of ornaments or utensils is done by electrolysis of a soluble silver compound. The object to be plated is placed at one of the electrodes. If 10.8 g of silver is to be deposited, how long, in minutes, will it take to plate the object using a current of 0.500 A?

20. How long, in minutes, must a cell run to produce 1.00 g of Na(l) in a molten NaCl(l) electrolytic cell that is operating at 10.0 A?

21. A voltaic cell is made of $Fe^{2+}(aq)/Fe$ and $Mg/Mg^{2+}(aq)$. If the iron electrode undergoes a mass change of 0.50 g, what will be the change in mass of the magnesium electrode?

22. An unknown metal chloride with the formula MCl_3 undergoes electrolysis using a current of 6.50 A for 1000 s and deposits 1.56 g. What is the molar mass of the metal?

23. A salt of an aqueous solution of copper is electrolyzed by a current of 3.50 A running for 50.0 min. If 3.457 g Cu is produced at the cathode, what is the charge of the copper ions in solution?

24. What is the cell potential of an electrolytic cell made of Al^{3+}(Aq) and Cd(s)?

Written Response Questions

Answer each question in the space provided. Use complete sentences and diagrams when necessary.

25. A student constructs an electrochemical cell using a Zn/Zn^{2+} half-cell and a Cu/Cu^{2+} half-cell. The zinc electrode is immersed in a zinc sulfate solution and the copper electrode is immersed in a copper(II) sulfate solution.

   a) Sketch a diagram of the functioning cell, labelling its various parts. Be sure to include the substance at the anode and the substance at the cathode.

   b) If each 50.0 mL solution has a concentration of 1.00 mol/L, calculate the mass change at each electrode (assume the cell is able to use all of one solution).

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26. A student wants to plate a clasp on a school lanyard with nickel.
    a) Suggest a substance that the student could use as an anode.

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    b) The student wants to plate 5.0 g of nickel using a nickel sulfate solution, but has only 10 min to do so. What current is required to achieve this?

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