**Name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

 **Electrochem Quiz (121 points)**

 1) What is the oxidation number of nitrogen in the HNO3?

|  |  |
| --- | --- |
| A) | -1 |
| B) | +1 |
| C) | +3 |
| D) | +5 |
| E) | +7 |

 2) Which element is oxidized in the reaction below?

Fe(CO)5 (l) + 2HI (g)  Fe(CO)4I2 (s) + CO (g) + H2 (g)

|  |  |
| --- | --- |
| A) | Fe |
| B) | C |
| C) | O |
| D) | H |
| E) | I |

 3) Which element is reduced in the reaction below?

Fe+2 + H+ + Cr2O7-2  Fe+3 + Cr+3 + H2O

|  |  |
| --- | --- |
| A) | Fe |
| B) | Cr |
| C) | O |
| D) | H |

 4) Which of the following reactions is a redox reaction?

(a) K2CrO4 + BaCl2  BaCrO4 + 2KCl

(b) Pb22+ + 2Br-  2PbBr

(c) Cu + S  CuS

|  |  |
| --- | --- |
| A) | (a) only |
| B) | (b) only |
| C) | (c) only |
| D) | (a) and (c) |
| E) | (b) and (c) |

 5) Which substance is the reducing agent in the following reaction?

Fe2S3 + 12HNO3  2Fe(NO3)3 + 3S + 6NO2 + 6H2O

|  |  |
| --- | --- |
| A) | HNO3 |
| B) | S |
| C) | NO2 |
| D) | Fe2S3 |
| E) | H2O |

 6) What is the coefficient of the dichromate ion when the following equation is balanced?

Fe2+ + Cr2O72-  Fe3+ + Cr3+ (acidic solution)

|  |  |
| --- | --- |
| A) | 1 |
| B) | 2 |
| C) | 3 |
| D) | 5 |
| E) | 6 |

 7) The purpose of the salt bridge in an electrochemical cell is to \_\_\_\_\_\_\_\_\_\_.

|  |  |
| --- | --- |
| A) | maintain electrical neutrality in the half-cells via migration of ions. |
| B) | provide a source of ions to react at the anode and cathode. |
| C) | provide oxygen to facilitate oxidation at the anode. |
| D) | provide a means for electrons to travel from the anode to the cathode. |
| E) | provide a means for electrons to travel from the cathode to the anode. |

 8) Which transformation could take place at the anode of an electrochemical cell?

|  |  |
| --- | --- |
| A) | NO  NO3- |
| B) | CrO42-  Cr2O42- |
| C) | VO2+  VO2+ |
| D) | H2AsO4  H3AsO3 |
| E) | O2  H2O2 |

 9) Which one of the following is the best oxidizing agent?

|  |  |
| --- | --- |
| A) | H2 |
| B) | Na |
| C) | O2 |
| D) | Li |
| E) | Ca |



 10) Which of the following reactions will occur spontaneously as written?

|  |  |
| --- | --- |
| A) | Sn4+ (aq) + Fe3+ (aq)  Sn2+ (aq) + Fe2+ (aq) |
| B) | 3Fe (s) + 2Cr3+ (aq)  2Cr (s) + 3Fe2+ (aq) |
| C) | Sn4+ (aq) + Fe2+ (aq)  Sn2+ (aq) + Fe (s) |
| D) | 3Sn4+ (aq) + 2Cr (s)  2Cr3+ (aq) + 3Sn2+ (aq) |
| E) | 3Fe2+ (aq)  Fe (s) + 2Fe3+ (aq) |

 11) Consider an electrochemical cell based on the reaction:

2H+ (aq) + Sn (s)  Sn2+ (aq) + H2 (g)

Which of the following actions would change the measured cell potential?

|  |  |
| --- | --- |
| A) | increasing the pH in the cathode compartment |
| B) | lowering the pH in the cathode compartment |
| C) | increasing the [Sn2+] in the anode compartment |
| D) | increasing the pressure of hydrogen gas in the cathode compartment |
| E) | Any of the above will change the measure cell potential. |

 12) Consider an electrochemical cell based on the reaction:

2H+ (aq) + Sn (s)  Sn2+ (aq) + H2 (g)

Which of the following actions would not change the measured cell potential?

|  |  |
| --- | --- |
| A) | lowering the pH in the cathode compartment |
| B) | addition of more tin metal to the anode compartment |
| C) | increasing the tin (II) ion concentration in the anode compartment |
| D) | increasing the pressure of hydrogen gas in the cathode compartment |
| E) | Any of the above will change the measured cell potential. |

 13) One of the differences between a voltaic cell and an electrolytic cell is that in an electrolytic cell \_\_\_\_\_\_\_\_\_\_.

|  |  |
| --- | --- |
| A) | an electric current is produced by a chemical reaction |
| B) | electrons flow toward the anode |
| C) | a nonspontaneous reaction is forced to occur |
| D) | O2 gas is produced at the cathode |
| E) | oxidation occurs at the cathode |

 14) The half-reaction occurring at the anode in the balanced reaction shown below is \_\_\_\_\_\_\_\_\_\_.

3MnO4- (aq) + 24H+ (aq) + 5Fe (s)  3Mn2+ (aq) + 5Fe3+ (aq) + 12H2O (l)

|  |  |
| --- | --- |
| A) | MnO4- (aq) + 8H+ (aq) + 5e-  Mn2+ (aq) + 4H2O (l) |
| B) | 2MnO4- (aq) + 12H+ (aq) + 6e-  2Mn2+ (aq) + 3H2O (l) |
| C) | Fe (s)  Fe3+ (aq) + 3e- |
| D) | Fe (s)  Fe2+ (aq) + 2e- |
| E) | Fe2+ (aq)  Fe3+ (aq) + e- |

 15) In a voltaic cell, electrons flow from the \_\_\_\_\_\_\_\_\_\_ to the \_\_\_\_\_\_\_\_\_\_.

|  |  |
| --- | --- |
| A) | salt bride, anode |
| B) | anode, salt bridge |
| C) | cathode, anode |
| D) | salt bridge, cathode |
| E) | anode, cathode |

 16) 1V = \_\_\_\_\_\_\_\_\_\_.

|  |  |
| --- | --- |
| A) | 1 amp · s |
| B) | 1 J/s |
| C) | 96485 C |
| D) | 1 J/C |
| E) | 1 C/J |

 17) The more \_\_\_\_\_\_\_\_\_\_ the value of E°red, the greater the driving force for reduction.

|  |  |
| --- | --- |
| A) | positive |
| B) | negative |
| C) | exothermic |
| D) | endothermic |
| E) | extensive |

 18) The standard cell potential (E°cell) of the reaction below is -0.55 V. The value of G° for the reaction is \_\_\_\_\_\_\_\_\_\_ J/mol.

I2 (s) + 2Br- (aq)  2I- (aq) + Br2 (l)

|  |  |
| --- | --- |
| A) | 0.54 |
| B) | 0.55 |
| C) | 5.5  10-6 |
| D) | 1.1  105 |
| E) | none of the above |

 19) The electrolysis of molten AlCl3 for 3.25 hr with an electrical current of 15.0 A produces \_\_\_\_\_\_\_\_\_\_ g of aluminum metal.

|  |  |
| --- | --- |
| A) | 147 |
| B) | 0.606 |
| C) | 4.55  10-3 |
| D) | 16.4 |
| E) | 49.1 |

20) Which statement is true for the cell as it discharges? Zn | Zn2+(1 .0 M) || Sn2+(1.0 M) | Sn

 (A) Oxidation occurs at the tin electrode.

 (B) Electrons will flow from the tin electrode to the zinc electrode.

 (C) The concentration of Zn2+ will increase.

 (D) The mass of the tin electrode will decrease

21) Five metals are represented by the symbols **L**, **M**, **T**, **R**, and **Z**. When a solution containing all five ions at 1 M concentration is electrolyzed with a small applied voltage, which metal is most likely to be deposited first on the cathode?

Unknown Metals

Standard Reduction Potentials *E*0

**L**  **L**2+ + 2*e*– 0.76 V **M**  **M**2+ + 2*e*– 0.44 V

**T**  **T**2+ + 2*e*– 0.13 V **R**  **R**3+ + 3*e*– –0.34 V

**Z**  **Z**+ + *e*– –0.80 V

 (A) **L** (B) **M** (C) **T** (D) **R** (E) **Z**

22)The best ***experimental*** evidence for the observation that the common ionic charge for calcium is 2+ is that

 (A) calcium has a low ionization potential.

 (B) all elements of Group 2A have an ionic charge of 2+.

(C) two faradays are required to liberate one mole of calcium at the cathode during the electrolysis of molten calcium chloride.

 (D) one mole of calcium combines with two grams of hydrogen.

 (E) the calcium atom has two weakly held electrons in its outermost shell.

[H+] = 1.0 M initially, *P*O2 = 1.0 atm 4*e*– + O2*(g)* + 4H+*(aq)*  2H2O*(l)* *E*0 = 1.23 V

23) Based on the information in the box, which statement is correct?

 (A) *n* = l, since one mole of oxygen is being considered.

 (B) Addition of base should result in an *E* value which is less than 1.23 V.

 (C) *E* is independent of the pH of the solution.

 (D) *Q* =

**Short Answer**

24) You want to plate out nickel metal from a nickel nitrate solution onto a piece of metal inserted into the solution. Should you use copper or zinc? Explain.

25) Consider the cell: Al⏐Al+3(1.0M) ⏐⏐ Pb+2(1.0M) ⏐Pb

Calculate the cell potential after the reaction has operated long enough for the [Al+3] to have changed by 0.60 mol/L (assume T = 25°C)

26) A cell is set up with copper and lead electrodes in contact with with CuSO4(aq) and Pb(NO3)2(aq), respectiviely, at 25°C. The standard reduction potentials are

Cu  Cu2+ + 2*e*– –0.34  V Pb  Pb2+ + 2*e*– 0.13  V

What would happen to the cell potential if sulfuric acid is added and why?

**AP question #1**

Explain each of the following.

1. When an aqueous solution of NaCl is electrolyzed, Cl2(g) is produced at the anode, but no Na(s) is produced at the cathode
2. The mass of Fe(s) produced when 1 faraday is used to reduce a solution of FeSO4 is 1.5 times the mass of Fe(s) produced when 1 faraday is used to reduce a solution of FeCl3.
3. Zn + Pb2+ (1–molar) → Zn2+ (1–molar) + Pb

The cell that utilizes the reaction above has a higher potential when [Zn2+] is decreased and [Pb2+] is held constant, but a lower potential when [Pb2+] is decreased and [Zn2+] is held constant.

1. The cell that utilizes the reaction given in (c) has the same cell potential as another cell in which [Zn2+] and [Pb2+] are each 0.1–molar.

**AP question #2**

Answer the following questions that refer to the galvanic cell shown in the diagram above. (A table of standard reduction potentials is printed on the green insert and on page 4 of the booklet with the pink cover.)

(a) Identify the anode of the cell and write the half reaction that occurs there.

(b) Write the net ionic equation for the overall reaction that occurs as the cell operates and calculate the value of the standard cell potential, *E°cell* .

(c) Indicate how the value of *Ecell*  would be affected if the concentration of Ni(NO3)2*(aq)* was changed from 1.0 *M* to 0.10 *M* and the concentration of Zn(NO3)2*(aq)* remained at 1.0 *M*. Justify your answer.

(d) Specify whether the value of *Keq* for the cell reaction is less than 1, greater than 1, or equal to 1. Justify your answer.

**AP Question #3**

A direct current of 0.125 ampere was passed through 200 millilitres of a 0.25 molar solution of Fe2(SO4)3 between platinum electrodes for a period of 1.100 hours. Oxygen gas was produced at the anode. The only change at the cathode was a slight change in the color of the solution.

At the end of the electrolysis, the electrolyte was acidified with sulfuric acid and was titrated with an aqueous solution of potassium permanganate. The volume of the KMnO4 solution required to reach the end point was 24.65 millilitres.

(a) How many faradays were passed through the solution?

(b) Write a balanced half-reaction for the process that occurred at the cathode during the electrolysis.

(c) Write a balanced net ionic equation for the reaction that occurred during the titration with potassium permanganate.

(d) Calculate the molarity of the KMnO4 solution.