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

Chemistry 30

Electrochemistry Workbook

*Net Ionic Equations*

For each of the following reactions, write and label the half reactions and the net ionic equation.

1. Fe(s) + Cu(NO3)2(aq) → Cu(s) + Fe(NO3)2(aq)
2. 2 Al(CH3COO)3(aq) + 3 Sn(s) → 3 Sn(CH3COO)2(aq) + 2 Al(s)
3. Cl2(g) + CaI2(aq) → I2(s) + CaCl2(aq)

*Predicting Redox Reactions*

For each of the following situations, determine the net redox reaction and state the spontaneity:

1. Aqueous solutions of tin (II) bromide and iron (III) nitrate are mixed.
2. A laboratory technician stores an aqueous solution of iron (III) chloride in a nickel plated container.
3. A chemistry teacher demonstrates the test for bromide ions by bubbling some chlorine gas cautiously through a sodium bromide solution.
4. Acidified potassium dichromate is added to a solution of tin(II) sulphate.
5. A solution of nickel(II) nitrate is stored in a copper container.
6. Two students attempt to etch their initials on a copper plate using hydrochloric acid.
7. An iron bolt is exposed to air and water, a reaction which causes millions of dollars of damage each year.

*Generating Redox Tables*

*Use the following information to answer the next question.*

In a laboratory, a student obtained the following results when testing, under standard conditions, reactions between various metals and their corresponding ions.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **W(s)** | **X(s)** | **Y(s)** | **Z(s)** |
| **W3+(aq)** | − | × | ✓ | ✓ |
| **X2+(aq)** | ✓ | − | ✓ | ✓ |
| **Y2+(aq)** | × | × | − | ✓ |
| **Z2+(aq)** | × | × | × | − |

× denotes no reaction

✓ denotes a reaction

− denotes not tested

1. Generate a table of relative strengths of oxidizing and reducing agents for the metals and metal ions in the data chart. Write all half-reaction equations as reductions and label the strongest oxidizing agent and the strongest reducing agent.
2. In an experiment, four metals were placed into test tubes containing various ion solutions. Their resulting behaviour is communicated by the equations below. List the oxidizing agents from strongest to weakest.

nonspont

Pt(s) + 2 H+(aq) → Pt2+(aq) + H2(g)

spont

 2 Ce(s) + 3 Ni2+(aq) → 2 Ce3+(aq) + 3 Ni(s)

spont

 3 Sr(s) + 2 Ce3+(aq) → 3 Sr2+(aq) + 2 Ce(s)

spont

 Ni(s) + 2 H+(aq) → Ni2+(aq) + H2(g)

*Use the following information to answer the next question.*

**C(s) in all solutions – no reactions**

**D(s) in only E(NO3)3(aq) and A(NO3)2(aq) – reaction and no reaction respectively**

**B(s) in all solutions – no reaction with A(NO3)2(aq)**

**Metals and Metal Nitrates**

E(s)

D(s)

C(s)

B(s)

A(s)

CNO3(aq)

B(NO3)2(aq)

E(NO3)3(aq)

D(NO3)3(aq)

A(NO3)2(aq)

1. Given the list of observations above, list the reducing agents from most reactive to least reactive.

*Oxidation Numbers*

1. Determine the oxidation number for **carbon** in each of the following substances:

a) CO2 b) C12H22O11 c) CO32−d) HCO3−

1. Determine the oxidation number of the element in ***bold*** type in each of the following compounds or polyatomic ions:

a) ***C***2H6O b) ***Os***O4 c) K2***Ta***F7 d) ***U***O2

e) Na2***Cr***3O10 f) ***As***2S5 g) ***S***2O3 h) ***S***4O6

i) Ca(***Cr***O2)2  j) H5***I***O6 k) H2***C***2O4 l) ***P***OCl3

1. For each of the following reactions, determine whether the element in ***bold*** type has been oxidized or reduced:
2. ***Mg***(s) + Fe2O3(s) → Fe(s) + ***Mg***O(s)
3. Na2***C***O3(s) → Na2O(s) + ***C***O2(g)
4. ***C***2H5OH(l) + O2(g)→ ***C***O2(g) + H2O(g)

*Balancing Redox Half Reactions*

Balance the following half reactions:

1. IO3−(aq) → I2(s)
2. S2O82−(aq) → SO42−(aq)
3. Cl2O2−(aq) → Cl−(aq)
4. AsO2(s) → AsO43−(aq)
5. SO32−(aq) → SO42−(aq)
6. IO3−(aq) → I−(aq)

***Balancing Redox Reactions – Half Reaction Method***

Complete and balance the following redox reactions using the half-reaction method. Include the net ionic equation in its simplified form.

1. H2C2O4(aq) + MnO4−(aq) → Mn2+(aq) + CO2(g)
2. AsO33−(aq) + BrO3−(aq) → Br−(aq) + AsO43−(aq)
3. NH3(aq) + Cu2+(aq) → NO3−(aq) + Cu+(aq)
4. Cr2O72−(aq) + Sn2+(aq) → Cr3+(aq) + Sn4+(aq) + H2O(l)

***Balancing Redox Reactions – Oxidation Number Method***

Complete and balance the following redox reactions using the oxidation number method. Please use the lowest whole number ratio.

1. \_\_\_H+(aq) + \_\_\_S2−(aq) + \_\_\_NO3−(aq) → \_\_\_S(s) + \_\_\_NO(g) + \_\_\_H2O(l)
2. \_\_\_H+(aq) + \_\_\_MoO3(s) + \_\_\_Zn(s) → \_\_\_Mo2O3(s) + \_\_\_Zn2+(aq) + \_\_\_H2O(l)
3. \_\_\_H2O(l) + \_\_\_Al(s) + \_\_\_NO3**−**(aq) → \_\_\_AlO2−(aq) + \_\_\_NH3(aq) + \_\_\_H+(aq)
4. \_\_\_H+(aq) + \_\_\_ClO2−(aq) + \_\_\_Fe(s) → \_\_\_Fe3+(aq) + \_\_\_Cl−(aq) + \_\_\_H2O(l)

***Redox Stoichiometry***

1. A 2.75 g piece of aluminum is placed in 250 mL of iron(III) nitrate solution. Assuming that the reaction reaches endpoint, calculate the concentration of the Fe3+(aq) ions.
2. If 6.00 mol/L nitric acid is poured into a beaker containing 50.0 mL of 1.50 mol/L hydrogen peroxide, what volume of acid is needed to reach endpoint?
3. If 30.0 mL of acidic dichromate ion solution is poured into a beaker containing 50.0 mL of 0.400 mol/L tin(II) nitrate, calculate the dichromate ion concentration and the Sn4+(aq) concentration.
4. In an experiment to analyze the iron in an iron ore sample, 0.05000 mol/L K2Cr2O7(aq) was used in an acidic solution to oxidize Fe2+(aq) ions to Fe3+(aq) ions. Use the following data to calculate the concentration of Fe2+(aq) in the solution:

volume of Fe2+(aq) solution………………………….25.0 mL

final buret reading (K2Cr2O7(aq))……………………48.7 mL

initial buret reading………………………………….3.7 mL

1. Another experiment was used to analyze the tin in a tin ore sample. The Sn2+(aq) ions in an acidic solution were oxidized to Sn4+(aq) by a 0.200 mol/L KMnO4(aq) solution. Use the following information to calculate the concentration of Sn2+(aq) in the solution.

volume of Sn2+(aq) solution………………………….10.0 mL

final buret reading (KMnO4(aq))…………………….39.3 mL

initial buret reading………………………………….1.8 mL

.7 g 13) 8.93 h 14) 175 g