HW08 - Electrochemical Cells & Applications

1 1 point

Consider the voltaic cell:
Pt | Sn^{2+} (0.10 M), Sn^{4+} (0.0010 M) || Ag^{+} (0.010 M) | Ag
$Sn^{4+} + 2e^{-} \longrightarrow Sn^{2+}$ $E° = +0.15$ V
$Ag^{+} + e^{-} \longrightarrow Ag(s)$ $E° = +0.80$ V
The electrons flow in the*external* circuit from...

- Ag to Pt
- Pt to Ag
- Sn^{2+} to Ag^{+}
- Sn to Ag

2 1 point

What is the standard cell potential of a battery made from the half reactions below?
$2H^{+} + 2e^{-} \longrightarrow H_2$ $E° = 0.00$V
$O_2 + 4H^{+} + 4e^{-} \longrightarrow 2H_2O$ $E° = +1.23$ V

- −1.23
- −2.46
- 1.23
- 2.46

3 1 point

What is the E° for the following electrochemical cell where Zn is the cathode?
Fe | Fe^{2+} (1.0 M) || Zn^{2+} (1.0 M) | Zn
$E°_{(Zn)} = -0.76$, $E°_{(Fe)} = -0.44$

- −1.20
- +1.20
- −0.32
- +0.32

4 1 point

Using the standard potential tables, what is the largest approximate E° value that can be achieved using these reagents when two half-cell reactions are combined to form a battery?

- −3 V
- 6 V
- −6 V
- 3 V

5 1 point

Which of the metals in the list below will react with 1M H_2SO_4 to produce hydrogen gas? For reference,here is the standard reductions potentials list.
$Na^{+} + e^{-} \longrightarrow Na$ $E° = -2.714$
$Cd^{2+} + 2e^{-} \longrightarrow Cd$ $E° = -0.403$
$Pb^{2+} + 2e^{-} \longrightarrow Pb$ $E° = -0.126$
$Cu^{2+} + 2e^{-} \longrightarrow Cu$ $E° = +0.337$

- Cu only
- Na and Cd only
- Na, Cd, Pb, and Cu
- Na, Cd, and Pb only

6 1 point

Consider the cell:
Zn(s) | Zn^{2+}(aq) || Cl^{-}(aq) | AgCl(s) | Ag(s)
Calculate E°. For reference,here is the standard reduction potentials list.

- +0.98 V
- +1.20 V
- +0.54 V
- −1.20 V

7 1 point

Which species will oxidize Cr^{2+} ($E°_{red} = -0.407$) but not Mn^{2+} ($E°_{red} = +1.224$)?

- Zn^{2+} ($E°_{red} = -0.762$)
- Pb^{4+} ($E°_{red} = +1.68$)
- O_3 in acid ($E°_{red} = +2.076$)
- Fe^{2+} ($E°_{red} = -0.771$)
- V^{3+} ($E°_{red} = -0.255$)

8 1 point

If the standard potentials for the couples Cu^{2+}|Cu, Ag^{+}|Ag, and Fe^{2+}|Fe are +0.34, +0.80, and −0.44 V respectively, which is the strongest reducing agent?

- Cu
- Fe^{2+}
- Ag^{+}
- Fe
- Ag
- Cu^{2+}

9 1 point

For the cell diagram below:
Cd(s) | $CdSO_4$(aq) || Hg_2SO_4 | Hg(l) | Pt(s)
What half-reaction reaction occurs at the cathode?

- $2Hg(l) + SO_4^{2-}(aq) \longrightarrow Hg_2SO_4(s) + 2e^{-}$
- $2Cd(l) + SO_4^{2-}(aq) \longrightarrow CdSO_4(s) + 2e^{-}$
- $CdSO_4(s) + 2e^{-} \longrightarrow 2Cd(l) + SO_4^{2-}(aq)$
- $Hg_2SO_4(s) + 2e^{-} \longrightarrow 2Hg(l) + SO_4^{2-}(aq)$

10 1 point

Consider the cell diagram below:
Mg(s) | Mg^{2+}(aq) || Au^{+}(aq) | Au(s)
$Mg^{2+} + 2e^{-} \longrightarrow Mg$ $E° = -2.36$
$Au^{+} + e^{-} \longrightarrow Au$ $E° = +1.69$
What is the cathode and what is the cell type?

- Mg(s); a voltaic cell
- Mg(s); an electrolytic cell
- Au(s); an electrolytic cell
- Au(s); a voltaic cell

11 1 point

Consider the half-reactions:
$Mn^{2+} + 2e^{-} \longrightarrow Mn$ $E° = -1.029$ V
$Ga^{3+} + 3e^{-} \longrightarrow Ga$ $E° = -0.560$ V
$Fe^{2+} + 2e^{-} \longrightarrow Fe$ $E° = -0.409$ V
$Sn^{2+} + 2e^{-} \longrightarrow Sn$ $E° = -0.136$ V
Which of these redox couples could not be used to make a voltaic cell?

- $Sn^{2+} + Fe \longrightarrow Sn + Fe^{2+}$
- $2Ga^{3+} + 3Fe \longrightarrow 2Ga + 3Fe^{2+}$
- $2Ga + 3Sn^{2+} \longrightarrow 2Ga^{3+} + 3Sn$
- $Fe^{2+} + Mn \longrightarrow Mn^{2+} + Fe$
- $Sn^{2+} + Mn \longrightarrow Sn + Mn^{2+}$

12 1 point

Find the standard emf of the given cell diagram:
$Cu(s) \mid Cu^{2+}(aq) \parallel Au^{+}(aq) \mid Au(s)$
$Cu^{2+} + 2e^{-} \longrightarrow Cu \quad E° = +0.34\ V$
$Au^{+} + e^{-} \longrightarrow Au \quad E° = +1.69\ V$

- −2.03 V
- −1.35 V
- +1.35 V
- +2.03 V

13 1 point

Using this list from gchem, which species will reduce Ag^{+} but not Fe^{2+}?

- K
- Co^{2+}
- Cr
- H_2

14 1 point

If the table of standard reduction potentials is ordered with the strongest reducing agents at the top, how are the reduction potentials ordered (from top to bottom)?

- from most common to least common
- from most positive to most negative
- from most negative to most positive
- from most spontaneous to least spontaneous

15 1 point

Which species is the weakest reducing agent in this table of half-reactions?

- Li
- F_2
- Li^{+}
- F^{-}

16 1 point

How many moles of $Cl_2(g)$ are produced by the electrolysis of concentrated sodium chloride if 2.00 A are passed through the solution for 4.00 hours? The equation for this process (the "chloralkali" process) is given below.
$2NaCl(aq) + 2H_2O(l) \longrightarrow 2NaOH(aq) + H_2(g) + Cl_2(g)$

- 0.149 mol
- 0.0745 mol
- 0.298 mol
- 0.00248 mol

17 1 point

A steel surface has been electroplated with 5.10 g of vanadium (V, molar mass = 51 g/mol). If 2.90×10^4 C of charge were used, what was the original oxidation number of V?

- +4
- +2
- +3
- +1

18 1 point

What is $\Delta G°$ for the half-reaction below?
$ClO_3^{-} + 6H^{+}(aq) \longrightarrow 0.5Cl_2(g) + 3H_2O(l) \quad E° = +1.47\ V$

- −709,000 kJ/mol
- 194,000 kJ/mol
- 194 kJ/mol
- −709 kJ/mol

19 1 point

Consider the cell:
$Zn(s) \mid Zn^{2+}(aq) \parallel Fe^{2+}(aq) \mid Fe(s)$
If run at standard conditions, calculate the value of $\Delta G°_{rxn}$ for the reaction that occurs when current is drawn from this cell.

- −31 kJ/mol
- +62 kJ/mol
- −62 kJ/mol
- −230 kJ/mol

20 1 point

Consider the cell:
$Pb(s) \mid PbSO_4(s) \mid SO_4^{2-}(aq, 0.60\ M) \parallel H^{+}(aq, 0.70\ M) \mid H_2(g, 192.5\ kPa) \mid Pt$
If E° for the cell is 0.36 V at 25°C, write the Nernst equation for the cell at this temperature.
[NOTE: These answer choices are written using natural log instead $\log_{10}$, so the familiar factor of (0.0591/n) does not appear in these equations. What should that factor be when you are using natural log instead of $\log_{10}$?

- $E = 0.36 - 0.01285 \cdot \ln \frac{192.5}{(0.70)^2(0.60)}$
- $E = 0.36 - 0.01285 \cdot \ln \frac{1.90}{(0.70)^2(0.60)}$
- $E = 0.36 - 0.02569 \cdot \ln \frac{192.5}{(0.70)^2(0.60)}$
- $E = 0.36 - 0.01285 \cdot \ln \frac{1.90}{(0.70)(0.60)}$

21 1 point

A concentration cell consists of the same redox couples at the anode and the cathode and different concentrations of the ions in the respective compartments. Find the unknown concentration for the following cell:
$Pb(s) \mid Pb^{2+}(aq, ?\ M) \parallel Pb^{2+}(aq, 0.1\ M) \mid Pb(s) \quad E_{cell} = 0.065\ V$

- 7.97×10^{-3} M
- 1.26 M
- 6.35×10^{-4} M
- 15.8 M

22 1 point

The standard potential of the cell:
$Pb(s) \mid PbSO_4(s) \mid SO_4^{2-}(aq) \parallel Pb^{2+}(aq) \mid Pb(s)$
is +0.23 V at 25°C. Calculate the equilibrium constant for the reaction of 1 M $Pb^{2+}(aq)$ with 1 M $SO_4^{2-}(aq)$.

- 8.0×10^{17}
- 6.0×10^{7}
- 1.7×10^{-8}
- 7.7×10^{3}

23 1 point

The equilibrium constant for the reaction below:

$2Hg(l) + 2Cl^-(aq) + Ni^{2+}(aq) \longrightarrow Ni(s) + Hg_2Cl_2(s)$

is 5.6×10^{-20} at 25°C. Calculate the value of E°_{cell} for this reaction.

- −0.57 V
- +0.57 V
- +1.14 V
- −1.14 V

24 1 point

How long will it take to deposit 0.00235 moles of solid gold by the electrolysis of $KAuCl_4(aq)$ using a current of 0.214 amperes?

- 26.5 min
- 53.0 min
- 70.7 min
- 106 min

25 1 point

You turn on a flashlight containing brand new NiCad batteries and keep it lit for a minute or two. Which of the following can be considered TRUE regarding the chemical state of these batteries?

I. The chemical reaction is spontaneous
II. $E_{cell} > 0$
III. The overall redox reaction in the battery is at equilibrium
IV. E_{cell} is *substantially* decreasing during this time

- All are true.
- All but III
- I and II only
- III only
- All but IV

26 1 point

Consider the following three species involving lead in various oxidation states:

Pb $PbSO_4$ PbO_2

What are the oxidation states of lead in the order that the species are written?

- +2, +4, +2
- 0, -2, -4
- 0, -2, +4
- +2, 0, -4
- 0, +2, +4

27 1 point

The common alkaline cell batteries (D, AA, AAA, etc.) share the same voltage but differ on the basis that...

- The maximum current that can be delivered is inversely proportional to the radius of the battery - so the smaller battery (AAA) is more concentrated and therefore able to deliver more current.
- The maximum current that can be delivered is proportional to the surface area of the electrodes - so the bigger battery sizes are able to deliver more current.

28 1 point

You start you car and begin driving. After about 10 to 15 minutes of driving your car just dies and will not restart. Which of the following reasons is the most logical explanation why your car died?

- The alternator is not properly recharging the battery as you are driving
- The battery is damaged and you need to buy a new one
- The battery was completely dead when you started your car
- The alternator is running your battery as an electrolytic cell

29 1 point

The overall reaction for an alkaline battery is:

$$2MnO_2(s) + Zn(s) \rightarrow Mn_2O_3(s) + ZnO(s)$$

Which species is oxidized as the battery is used?

- MnO_2 (s)
- Zn (s)
- Mn_2O_3 (s)
- ZnO (s)

30 1 point

Which of the following batteries are rechargeable?

I. alkaline battery
II. NiMH battery
III. lithium battery
IV. Li-ion battery
V. Pb-acid battery

- All except I
- I and III only
- II, IV, and V only
- II and V only