HW04 - Electrochemical Applications

1 4 points

The shorthand notation for a standard cell is:
$Pt \mid H_2 \mid H^+ \parallel Co^{3+}, Co^{2+} \mid Pt$
What is the purpose of Pt?

- Pt is an inert electrode used to conduct electrons into the external circuit
- Pt is the oxidizing agent
- Pt is being both oxidized an reduced
- Pt is the reducing agent

2 4 points

Why might you use an inert electrode in your standard cell set-up?

- Your half-reaction has the solid on the product side of the reaction
- Your half-reaction has the solid on the reactant side of the reaction
- Your half-reaction involves aqueous ions being reduced into metal
- Your half-reaction does not include a solid state conductor

3 2 points

One Faraday (the F constant we use in Faraday's law) represents...

- the standard potential of one mole electron
- the current delivered by an electron over one minute
- the total charge on an individual electron
- the total charge on one mole of electrons

4 5 points

A superior little league baseball bat is made by electroplating solid cobalt on a metal surface from a concentrated cobalt(II) chloride solution. If 3.80 amps of current is passed for a total of two and a half days, what is the mass of the solid cobalt surface?
To be clear, you are reducing cobalt(II) ions in solution to form cobalt solid.

- 376.0 g
- 4.252 g
- 752.0 g
- 250.7 g

5 5 points

Suppose it takes 291 seconds to electroplate 65.3 mg of chromium metal from a concentrated aqueous solution of chromium ions with an average current of 1.25 amps. What is the oxidation state (the charge) of the chromium ions in solution?

- +2
- +5
- +6
- +3
- +4
- +1

6 4 points

A manufacturing facility is producing pure scandium for use in a variety of applications, such as bike frames, golf clubs, baseball bats, and fishing rods. The source is Sc^{3+} ions, and a batch of scandium is produced by running a 3.76 amp current for one and a half days. What is the mass of scandium metal manufactured in this process? **Report your answer to the nearest gram.**

Type your answer...

7 6 points

Calculate the voltage of the following cell at nonstandard conditions:
$Cu \mid Cu^{2+}$ (0.150 M) || Cu^{2+} (.0120 M) $\mid Cu$
Convert your final answer to mV.

- -16.2 mV
- 32.4 mV
- 64.9 mV
- -32.4 mV

8 5 points

Consider the following cell that is set up at standard conditions:
$Cu \mid Cu^{2+}$ (1 M) || Cu^{2+} (1 M) $\mid Cu$
If you were to increase the copper ion concentration in the cathode compartment, what would happen to the overall cell potential (E)?

- the voltage will remain unchanged an stay at zero
- the overall potential will increase slightly becoming positive
- the overall potential will decrease slightly becoming negative

9 2 points

A concentration cell is made by putting two Ag^+ solutions in separate beakers and connecting them with a wire and a salt bridge. The cathode has a concentration of 3.80 M and the anode has a concentration of 0.0150 M. What type of cell is this at these nonstandard conditions?

- Voltaic
- Electrolytic
- The nonstandard cell potential is equal to 0 for these conditions.

10 5 points

Consider the following non-standard cell with an unknown concentration of Mn^{2+} in the cathode compartment:
$Mn \mid Mn^{2+}$ (0.20M) || Mn^{2+} (? M) $\mid Mn$
The voltage of this cell is measured to be +8.9 mV. What is the concentration of Mn^{2+} in the cathodic solution?

- 3.5 M
- 0.20 M
- 0.10 M
- 0.14 M
- 140 M
- 0.40 M

11 4 points

What is the cell potential for the following nonstandard cell made from only copper and copper ions?

$$Cu \mid Cu^+ (8.5 \times 10^{-4}\ M) \parallel Cu^+ (0.660\ M) \mid Cu$$

- +171 mV
- −135 mV
- −75 mV
- + 85.5 mV
- +120 mV
- −175 mV
- +343 mV
- +150 mV

12 4 points

How much energy (electrical work) is produced from a redox reaction with a potential of +1.75 V, and passing 3 moles of electrons? Assume the fully balanced reaction is run to completion. An example of a generic reaction (before cancelling out the electrons) like this would be:

$$3A + B + 3e^- \rightarrow 3C + D + 3e^-$$

- 1013 kJ
- 167 kJ
- 507 kJ
- 338 kJ

13 4 points

You are examining a non-rechargeable D-cell battery that you are about to put in a flashlight. You see that one end is labeled **+** and the other is labeled **–** . Now that you have studied batteries, you know that the **+** indicates the end of the battery that is the:

- anode
- cathode

14 4 points

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

15 3 points

A primary battery is...

Select all that apply if necessary.

- [ ] a voltaic cell
- [ ] an electrolytic cell
- [ ] rechargeable

16 3 points

A secondary cell can be...

Select all that apply.

- [ ] a voltaic cell
- [ ] recharged
- [ ] an electrolytic cell

17 4 points

What metal (in various oxidation states) is present at both the cathode and the anode in a typical car battery?

- cadmium
- zinc
- nickel
- lithium
- lead

18 4 points

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 alternator is running your battery as an electrolytic cell
- The battery was completely dead when you started your car

19 4 points

A secondary battery that is discharging is running a _____ chemical reaction and a secondary battery that is recharging is running a _____ chemical reaction.

- nonspontaneous, spontaneous
- nonspontaneous, nonspontaneous
- spontaneous, spontaneous
- spontaneous, nonspontaneous

20 4 points

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.

21 4 points

The net redox reaction in a fuel cell is given below:

$$2H_2 + O_2 \longrightarrow H_2O$$

What is the reaction at the anode in a fuel cell?

- $O_2 \longrightarrow 2\,O^{2+} + 4e^-$
- $H_2 \longrightarrow 2H^+ + 2e^-$
- $O_2 + 4e^- \longrightarrow 2\,O^{2-}$
- $H^+ + OH^- \longrightarrow H_2O$

22 4 points

It is not a good idea to make a battery out of standard conditions (1 M of all aqueous products). Instead, you can modify the concentrations so that...

Select all that apply.

- $E_{cell} < E^\circ_{cell}$
- $Q > 1$
- $E_{cell} > E^\circ_{cell}$
- $Q < 1$

23 4 points

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?

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

24 4 points

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?

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

25 4 points

Which of the following batteries are rechargeable?

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

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