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

2 — 4 points

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

- ⭘ Your half-reaction involves aqueous ions being reduced into metal
- ⭘ Your half-reaction does not include a solid state conductor
- ⭘ 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

3 — 6 points

If a scientist wants to plate out the largest mass of metal possible in the shortest period of time using his 5 amp electroplating system, which of these solutions should he choose as his plating solution?
Hint: consider both the mass and oxidation states in the context of Faraday's law.

- ⭘ $Mg(NO_3)_2$
- ⭘ $Co(NO_3)_3$
- ⭘ $Zn(NO_3)_2$
- ⭘ KNO_3

4 — 4 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 one mole of electrons
- ⭘ the total charge on an individual electron

5 — 6 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.
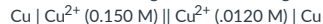
- ⭘ 4.252 g
- ⭘ 752.0 g
- ⭘ 250.7 g
- ⭘ 376.0 g

6 — 6 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?

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

7 — 6 points

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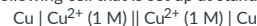$Cu \mid Cu^{2+}$ (0.150 M) $\parallel Cu^{2+}$ (.0120 M) $\mid Cu$
Convert your final answer to mV.

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

8 — 5 points

Consider the following cell that is set up at standard conditions:
$Cu \mid Cu^{2+}$ (1 M) $\parallel Cu^{2+}$ (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 overall potential will increase slightly becoming positive
- ⭘ the voltage will remain unchanged an stay at zero
- ⭘ the overall potential will decrease slightly becoming negative

9 — 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) $\parallel Mn^{2+}$ (? 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?

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

10 — 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:
$$3A + B + 3e^- \rightarrow 3C + D + 3e^-$$

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

11 — 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

12 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

○ I and II only

○ III only

○ All but III

○ All are true.

○ All but IV

13 3 points

A primary battery is...
Select all that apply if necessary.

☐ an electrolytic cell

☐ rechargeable

☐ a voltaic cell

14 3 points

A secondary cell can be...
Select all that apply.

☐ a voltaic cell

☐ recharged

☐ an electrolytic cell

15 4 points

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

○ lithium

○ lead

○ nickel

○ cadmium

○ zinc

16 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 alternator is running your battery as an electrolytic cell

○ The battery was completely dead when you started your car

○ The battery is damaged and you need to buy a new one

17 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, nonspontaneous

○ spontaneous, nonspontaneous

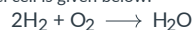○ spontaneous, spontaneous

○ nonspontaneous, spontaneous

18 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.

19 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?

○ $O_2 + 4e^- \longrightarrow 2 O^{2-}$

○ $O_2 \longrightarrow 2 O^{2+} + 4e^-$

○ $H^+ + OH^- \longrightarrow H_2O$

○ $H_2 \longrightarrow 2H^+ + 2e^-$

20 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.

☐ $Q > 1$

☐ $E_{cell} < E^\circ_{cell}$

☐ $E_{cell} > E^\circ_{cell}$

☐ $Q < 1$

21 4 points

Consider the following three species involving lead in various oxidation states:
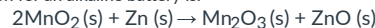$$Pb \qquad PbSO_4 \qquad PbO_2$$
What are the oxidation states of lead in the order that the species are written?

○ 0, -2, +4

○ 0, +2, +4

○ +2, +4, +2

○ +2, 0, -4

○ 0, -2, -4

22 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?

○ $Mn_2O_3 (s)$

○ $MnO_2 (s)$

○ $Zn (s)$

○ $ZnO (s)$

23 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 and V only

○ II, IV, and V only

○ All except I

○ I and III only