

HW11 - Electrochemical Potential, Free Energy, and Applications

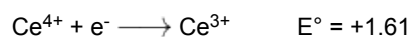
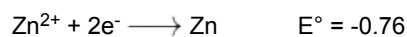
Homework 11

Electrochemical Potential, Free Energy, and Applications

Question 1

1 pts

What is the E°_{cell} for



-2.37 V

1.61 V

0.85 V

2.37 V

Question 2

1 pts

Standard reduction potentials are established by comparison to the potential of which half-reaction?

$2\text{H}^+ + 2\text{e}^- \longrightarrow \text{H}_2$

$\text{Li}^+ + \text{e}^- \longrightarrow \text{Li}$

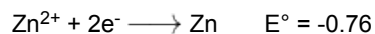
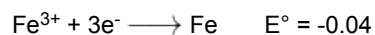
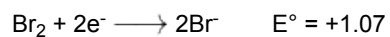
$2\text{H}_2\text{O} + 2\text{e}^- \longrightarrow \text{H}_2 + 2\text{OH}^-$

$\text{F}_2 + 2\text{e}^- \longrightarrow 2\text{F}^-$

Question 3

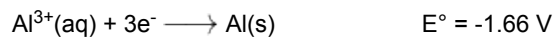
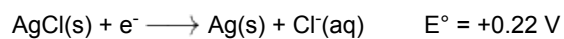
1 pts

What is the standard cell potential of the strongest battery that could be made using these half-reactions?

 -2.56 1.84 2.56 1.11**Question 4**

1 pts

What would be the E° of an electrolytic cell made from the half-reactions below?

 1.88 -1.88 -1.44 1.44**Question 5**

1 pts

Sodium is produced by the electrolysis of molten sodium chloride. What are the products at the anode and cathode, respectively?

 Na(l) and O₂(g)

$\text{O}_2(\text{g})$ and $\text{Na}(\text{l})$

$\text{Cl}_2(\text{g})$ and $\text{Na}_2\text{O}(\text{l})$

$\text{Cl}_2(\text{g})$ and $\text{Na}(\text{l})$

Question 6

1 pts

The electrolysis of an aqueous sodium chloride solution using inert electrodes produces gaseous chlorine at one electrode. At the other electrode gaseous hydrogen is produced and the solution becomes basic around the electrode. What is the equation for the cathode half-reaction in the electrolytic cell?

$2\text{H}_2\text{O} + 2\text{e}^- \longrightarrow \text{H}_2 + 2\text{OH}^-$

$\text{H}_2 + 2\text{OH}^- \longrightarrow 2\text{H}_2\text{O} + 2\text{e}^-$

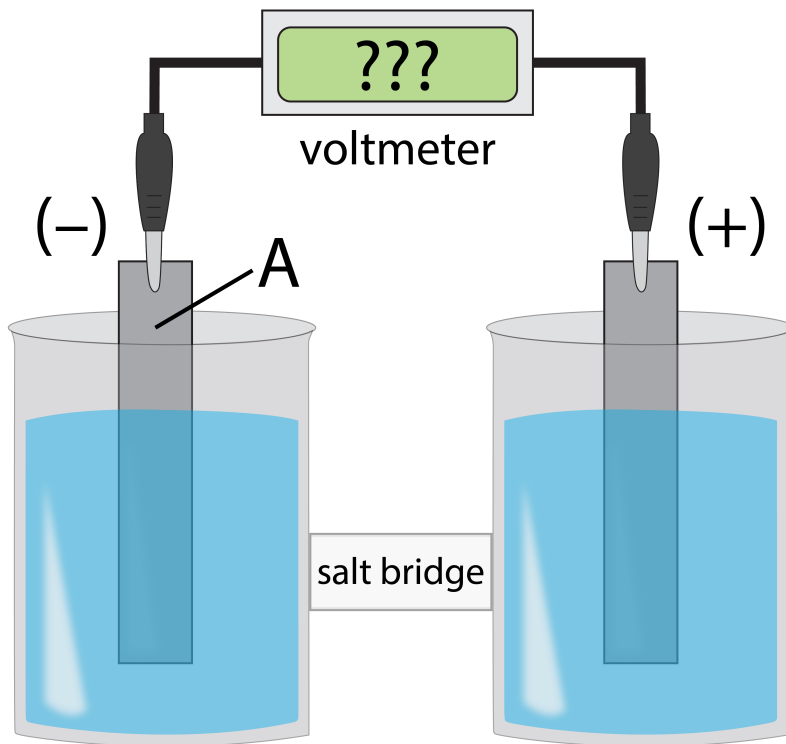
$2\text{Cl}^- \longrightarrow \text{Cl}_2 + 2\text{e}^-$

$\text{Cl}_2 + 2\text{e}^- \longrightarrow 2\text{Cl}^-$

Question 7

1 pts

The galvanic cell below uses the standard half-cells $\text{Mg}^{2+} | \text{Mg}$ and $\text{Zn}^{2+} | \text{Zn}$, and a salt bridge containing $\text{KCl}(\text{aq})$.



Identify A and write the half-reaction that occurs in that compartment.

- $\text{Zn(s)}; \text{Zn}^{2+}(\text{aq}) + 2\text{e}^- \longrightarrow \text{Zn(s)}$
- $\text{Zn(s)}; \text{Zn(s)} \longrightarrow \text{Zn}^{2+}(\text{aq}) + 2\text{e}^-$
- $\text{Mg(s)}; \text{Mg(s)} \longrightarrow \text{Mg}^{2+}(\text{aq}) + 2\text{e}^-$
- $\text{Mg(s)}; \text{Mg}^{2+}(\text{aq}) + 2\text{e}^- \longrightarrow \text{Mg(s)}$

Question 8

1 pts

Refer to the diagram in question 7. What happens to the size of the electrode A during the operation of the cell?

- it decreases
- it increases
- it doesn't change
- There is no way to tell.

Question 9

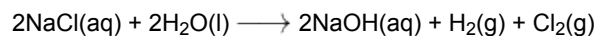
1 pts

Refer to the diagram in question 7. What should the voltmeter read?

 +4.30 V +3.40 V +2.50 V +1.60 V**Question 10**

1 pts

How many moles of $\text{Cl}_2(\text{g})$ 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.

 0.298 mol 0.149 mol 0.00248 mol 0.0745 mol**Question 11**

1 pts

A steel surface has been electroplated with 5.10g 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?

 +2 +1 +4 +3

Question 12

1 pts

How long will it take to deposit 0.00235 moles of gold by the electrolysis of $\text{KAuCl}_4(\text{aq})$ using a current of 0.214 amperes?

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

Question 13

1 pts

Consider 3 electrolysis experiments:

1. One Faraday of electricity is passed through a solution of AgNO_3 .
2. Two Faradays of electricity are passed through a solution of $\text{Zn}(\text{NO}_3)_2$.
3. Three Faradays of electricity are passed through a solution of $\text{Bi}(\text{NO}_3)_3$.

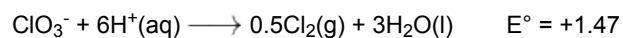
Which of the following statements is true?

- Equal numbers of moles of all three metals are produced.
- Equal masses of all three metals are produced.
- Twice as many moles of metallic zinc are produced than metallic silver.
- The reaction producing the smallest mass of metal is that of the silver solution.

Question 14

1 pts

What is ΔG° for the half-reaction below?



- 194 kJ/mol
- 709 kJ/mol

-709,000 kJ/mol

194,000 kJ/mol

Question 15

1 pts

For the reduction of Cu^{2+} by Zn, $\Delta G^\circ = -212 \text{ kJ/mol}$ and $E^\circ = +1.10 \text{ V}$. If the coefficients in the chemical equation for this reaction are multiplied by 2, $\Delta G^\circ = -424 \text{ kJ/mol}$. Does this mean E° for the cell would be $+2.20\text{V}$?

It is impossible to know without testing it empirically.

Not enough information is given.

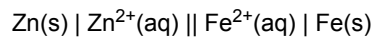
No.

Yes.

Question 16

1 pts

Consider the cell:



If run at standard conditions, calculate the value of ΔG_{rxn}° for the reaction that occurs when current is drawn from this cell.

-31 kJ/mol

-230 kJ/mol

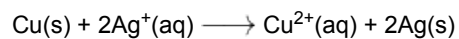
+62 kJ/mol

-62 kJ/mol

Question 17

1 pts

Calculate the cell potential for a cell based on the reaction below:



when the concentrations are as follows:

$$[\text{Ag}^+] = 0.7 \text{ M}$$

$$[\text{Cu}^{2+}] = 0.9 \text{ M}$$

(The temperature is 25°C and $E^\circ = 0.4624 \text{ V}$.)

0.455 V

0.470 V

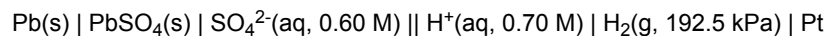
0.447 V

0.459 V

Question 18

1 pts

Consider the cell:



If E° for the cell is 0.36 V at 25°C, write the Nernst equation for the cell at this temperature.

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

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

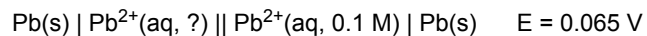
$E = 0.36 - 0.01285 \cdot \ln \frac{192.5}{(0.70)^2 (0.60)}$

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

Question 19

1 pts

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:



1.26 M

7.97 x 10⁻³ M

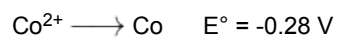
15.8 M

6.35 x 10⁻⁴ M

Question 20

1 pts

What is the ratio of [Co²⁺] / [Ni²⁺] when a battery built from the two half-reactions below reaches equilibrium?



0.31

0.10

10.33

3.20

Question 21

1 pts

If E° for the disproportionation of Cu⁺(aq) to Cu²⁺(aq) and Cu(s) is +0.37 V at 25°C, calculate the equilibrium constant for the reaction.

3.2 x 10¹²

1.3 x 10³

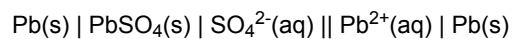
1.8 x 10⁶

2.4 x 10²

Question 22

1 pts

The standard potential of the cell:



is +0.23 V at 25°C. Calculate the equilibrium constant for the reaction of 1 M $\text{Pb}^{2+}\text{(aq)}$ with 1 M $\text{SO}_4^{2-}\text{(aq)}$.

8.0×10^{17}

7.7×10^3

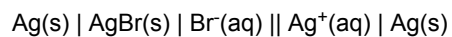
1.7×10^{-8}

6.0×10^7

Question 23

1 pts

The standard voltage of the cell:



is +0.73 V at 25°C. Calculate the equilibrium constant for the cell reaction.

5.1×10^{14}

2.2×10^{12}

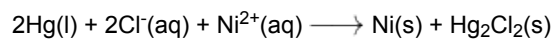
4.6×10^{-13}

2.0×10^{-15}

Question 24

1 pts

The equilibrium constant for the reaction below:



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

-1.14 V

-0.57 V

+0.57 V

+1.14 V

Question 25

1 pts

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. ΔG for the battery reaction is negative.
- II. $E_{\text{cell}} > 0$
- III. The batteries are at equilibrium.
- IV. E_{cell} is substantially decreasing during this time.

All but IV

III only

All but III

I and II only

All are true.

Question 26

1 pts

Which of the following batteries are rechargeable?

- I. Alkaline Battery
- II. NiMH Battery
- III. Lithium Battery
- IV. Lithium Ion Battery
- V. Lead-Acid Battery

II, IV, and V only

I and III only

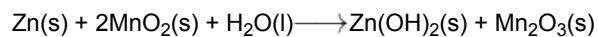
II and V only

All except I

Question 27

1 pts

Here is the discharge reaction for an alkaline battery:



Which species is reduced as the battery is discharged?

$\text{Mn}_2\text{O}_3\text{(s)}$

$\text{H}_2\text{O(l)}$

Zn(s)

$\text{MnO}_2\text{(s)}$

Question 28

1 pts

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

lead

nickel

zinc

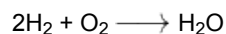
lithium

cadmium

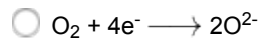
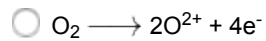
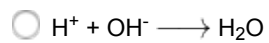
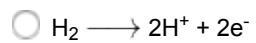
Question 29

1 pts

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



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



Question 30

1 pts

Which of the following is NOT an important characteristic of the proton exchange membrane (PEM) in a PEM fuel cell?

It must withstand the high operating temperatures of the fuel cell.

It physically separates the half-reactions.

It is permeable to protons.

It must be stable in an acidic environment.

It is coated with catalysts that increase the rates of both the oxidation and reduction reactions.

Not saved

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