HW03 - Electrochemistry

1 4 points

Which best describes the process of oxidation ?

- oxidation is the numeric decrease in oxidation number
- oxidation is the gain of hydrogen atoms
- oxidation is the gain of electrons
- oxidation is the loss of electons

2 4 points

Match the term with the best pair:

- reduction
- oxidization
- oxidizing agent
- reducing agent

Possible answers

- the species that gets oxidized
- the process of gaining electrons
- the process of losing electrons
- the species that gets reduced

3 4 points

What is the coefficient of lead (Pb) in the redox reaction after the following half-reactions are balanced?

$$Pb \rightarrow Pb^{2+} + 2e^-$$
$$Fe^{3+} + 3e^- \rightarrow Fe$$

4 4 points

What is the sum of coefficientsin the redox reaction after the following half-reactions are balanced?

$$Al \rightarrow Al^{3+} + 3e^-$$
$$Cu^{2+} + 2e^- \rightarrow Cu$$

5 4 points

In the reaction of thiosulfate ion with chlorine gas in an acidic solution, what is the reducing agent?

$$Cl_2(g) + S_2O_3^{2-}(aq) \longrightarrow Cl^-(aq) + SO_4^{2-}(aq)$$

- Cl_2
- S^{2+}
- $S_2O_3^{2-}$
- Cl

6 4 points

Silicon tetrachloride will readily decompose in the presence of hydrogen into elemental silicon by the following reaction:

$$SiCl_4(g) + H_2(g) \longrightarrow Si(s) + 4\,HCl(g)$$

During this process, the Si is _________ and the change in oxidation number is equal to ______.

- reduced ; -2
- oxidized ; +4
- reduced ; +4
- reduced ; −4
- oxidized ; +2
- oxidized ; −2

7 4 points

Balance the following redox reaction in acidic conditions:

$$Nb + WO_4^{2-} \rightleftharpoons NbO_2 + W$$

Choices below are the sum of reactant coefficients → sum of product coefficients followed by the total number of electrons transferred. Note that the sums do include any H_2O and/or H^+ you added. Pick the right choice.

- $12 \rightarrow 17$, $12e^-$
- $9 \rightarrow 11$, $4e^-$
- $9 \rightarrow 11$, $12e^-$
- $12 \rightarrow 17$, $4e^-$
- $8 \rightarrow 10$, $6e^-$
- $3 \rightarrow 4$, $4e^-$
- $9 \rightarrow 7$, $12e^-$

8 4 points

What is the coefficient on H^+ when you balance the following redox reaction in acid? Is H^+ a product or reactant?

$$MnO_4^- + NO_2^- \rightarrow MnO_2 + NO_3^-$$

- 6, reactant
- 6, product
- 2, reactant
- 3, reactant
- 4, product
- 4, reactant
- 2, product
- 3, product
- 0, neither

9 4 points

Based on the push and pull of electrons in a redox reaction, it can be inferred that the species being oxidized is also the...

- strong acid
- oxidizing agent
- oxidizer
- reducing agent

10 4 points

What is the change in oxidation number of sulfur when SO_3 reacts to form SO^- in a redox reaction?
(note that answer can be + or – so include the sign, no sign means positive)

11 4 points

When $Na_2Cr_2O_7$ reacts to form $Cr(OH)_3$, the Cr atom gets ________ and the change in oxidation number is equal to ____.

- reduced, +3
- oxidized, -6
- reduced, -3
- oxidized, +3
- reduced, -6

12 4 points

A methanol fuel source (CH_3OH) is burned to form CO_2. What is the change in oxidation number for carbon? Is this an oxidation or reduction reaction?

- +1, oxidation
- −3, reduction
- +6, reduction
- +2, oxidation
- −1, oxidation
- +1, reduction
- +6, oxidation
- −1, reduction
- +5, oxidation
- 0, this is not a redox half-reaction

13 4 points

What is the oxidation number of chlorine in ClO_4^- ?

14 4 points

What is the oxidation number of sulfur in SO_4^{2-} ?

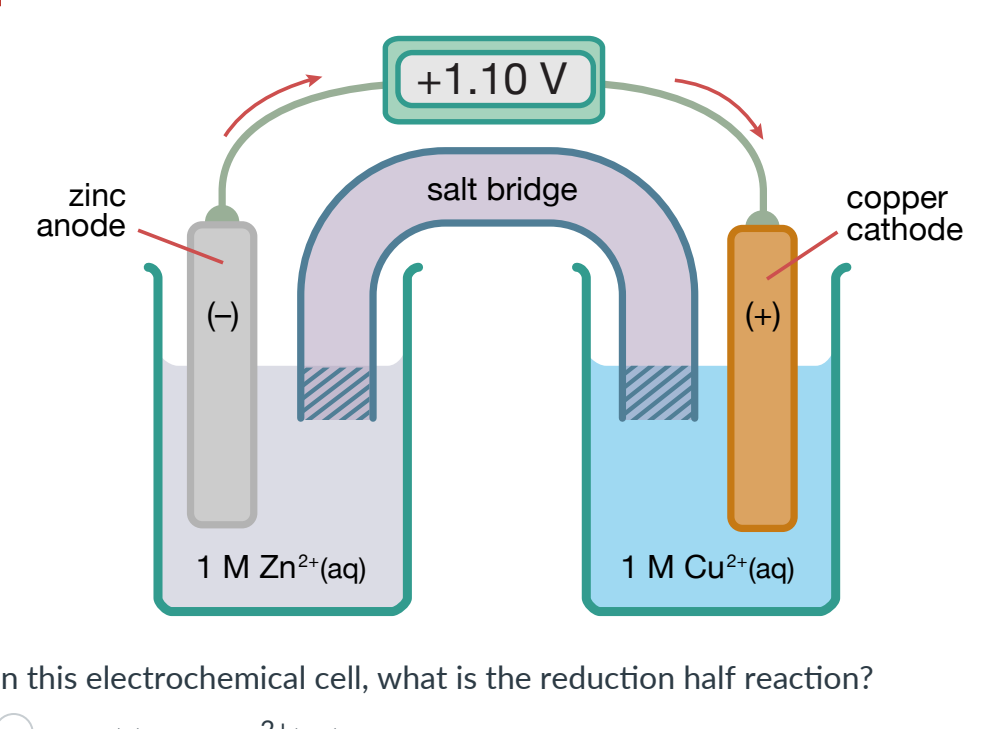
15 4 points

What is the oxidation number of an individual sulfur in thiosulfate, $S_2O_3^{2-}$?

16 4 points

What is the oxidation number of phosphorus in hydrogen phosphate, HPO_4^{2-} ?

17 4 points



In this electrochemical cell, what is the reduction half reaction?

- $Cu(s) \longrightarrow Cu^{2+}(aq) + 2e^-$
- $Zn^{2+}(aq) + 2e^- \longrightarrow Zn(s)$
- $Cu^{2+}(aq) + 2e^- \longrightarrow Cu(s)$
- $Zn(s) \longrightarrow Zn^{2+}(aq) + 2e^-$

18 4 points

Consider the cell reaction represented by the skeletal equation:

$$Mn(s) + Ti^{2+}(aq) \longrightarrow Mn^{2+}(aq) + Ti(s)$$

What is the proper cell diagram for this reaction?

- $Ti(s) \mid Ti^{2+}(aq) \parallel Mn^{2+}(aq) \mid Mn(s)$
- $Mn(s) \mid Mn^{2+}(aq) \parallel Ti^{2+}(aq) \mid Ti(s)$
- $Ti^{2+}(aq) \mid Ti(s) \parallel Mn(s) \mid Mn^{2+}(aq)$
- $Mn^{2+}(aq) \mid Mn(s) \parallel Ti(s) \mid Ti^{2+}(aq)$

19 4 points

Consider the cell:
$Zn(s) \mid Zn^{2+}(aq) \parallel Cl^-(aq) \mid AgCl(s) \mid Ag(s)$
Calculate E°.

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

20 4 points

In a working electrochemical cell (a voltaic or a battery), the cations in the salt bridge move toward the cathode.

- It is impossible to tell unless we know if the cathode is "+" or "-".
- False
- True
- It depends on the charge of the cation.

21 4 points

What is the voltage of a standard voltaic cell made from the following half-reactions?

$$Cu^{2+} + 2e^- \rightarrow Cu$$
$$Mg^{2+} + 2e^- \rightarrow Mg$$

- 2.70 V
- -2.70 V
- -2.02 V
- 2.02 V

22 4 points

For the cell in the previous question, identify the solid anode and cathode.

- Cu: anode
  Mg: cathode
- Cu: cathode
  Mg: anode

23 4 points

What is the voltage of a standard electrolytic cell made from the following half-reactions?

$$Ag^+ + e^- \rightarrow Ag$$
$$Al^{3+} + 3e^- \rightarrow Al$$

- -2.46 V
- 0.86 V
- -0.86 V
- -1.66 V
- 2.46 V

24 4 points

Use the following table for the next three questions:

$F_2 + 2e^-$	$\rightleftharpoons 2F^-$	+2.87 V
$Pb^{4+} + 2e^-$	$\rightleftharpoons Pb^{2+}$	+1.67 V
$Cl_2 + 2e^-$	$\rightleftharpoons 2Cl^-$	+1.36 V
$Ag^+ + e^-$	$\rightleftharpoons Ag$	+0.80 V
$Fe^{3+} + e^-$	$\rightleftharpoons Fe^{2+}$	+0.77 V
$Cu^{2+} + 2e^-$	$\rightleftharpoons Cu$	+0.34 V
$2H^+ + 2e^-$	$\rightleftharpoons H_2$	**0.000 V**
$Fe^{3+} + 3e^-$	$\rightleftharpoons Fe$	−0.04 V
$Pb^{2+} + 2e^-$	$\rightleftharpoons Pb$	−0.13 V
$Fe^{2+} + 2e^-$	$\rightleftharpoons Fe$	−0.44 V
$Zn^{2+} + 2e^-$	$\rightleftharpoons Zn$	−0.76 V
$Al^{3+} + 3e^-$	$\rightleftharpoons Al$	−1.66 V
$Mg^{2+} + 2e^-$	$\rightleftharpoons Mg$	−2.36 V
$Li^+ + e^-$	$\rightleftharpoons Li$	−3.05 V

(Part 1 of 3) Which out of the following is the strongest reducing agent?

- Li^+
- Zn
- Li
- Mg
- Ag^+
- Ag

25 4 points

(Part 2 of 3) What is the standard cell potential for the strongest battery possible using the table? Note: for this question, only compare standard cell potential to assess the strength of the battery.

- 5.92 V
- 3.05 V
- 2.87 V
- 0.00 V

26 4 points

(Part 3 of 3) If you wanted to spontaneously reduce Al^{3+} to form Al, you should pair it with...

- the reduction of Mg
- the oxidation of Pb
- the oxidation of Mg
- the S.H.E reaction

27 4 points

In a voltaic cell...

- oxidation and reduction take place at the same time, but at different electrodes
- oxidation takes place at the cathode
- electrolytes are added to carry electrons between electrodes
- electrical energy is used to reverse spontaneous chemical reactions

28 4 points

A discharging battery is a voltaic cell, meaning it is...

- spontaneous with a positive cell potential
- non-spontaneous with a negative cell potential
- spontaneous with a negative cell potential
- non-spontaneous with a positive cell potential

29 4 points

Suppose you set up an electrochemical cell. In one beaker, you have a 1 M copper(II) ion solution with a copper metal electrode. You use an external wire to connect the copper electrode to an aluminum electrode in another beaker with a 1 M aluminum ion solution. Then you add a salt bridge with sodium sulfate ions. All things are in place to have a functional cell. Which of the following statements is FALSE?

- Nothing will happen until you add an external power source.
- You can run this as a voltaic cell and get out a maximum of 2.00 V
- Without a power source, electrons will travel from the aluminum beaker to the copper beaker
- You can run this as an electrolytic cell only if you input a minimum of 2.00 V

30 4 points

The two half-reactions below must be arranged (a red and an ox) such that overall, Au^+ is reduced.

$$Au^+ + e^- \rightleftharpoons Au$$
$$Li^+ + e^- \rightleftharpoons Li$$

After correctly arranging this cell, what reaction is occurring at the anode?

- $Li^+ + e^- \rightleftharpoons Li$
- $Li \rightleftharpoons Li^+ + e^-$
- $Au \rightleftharpoons Au^+ + e^-$
- $Au^+ + e^- \rightleftharpoons Au$