STANDARD ELECTRODE POTENTIAL 28 MAY 2013

Lesson Description

In this lesson, we:

- Become familiar with the Table of Standard Electrode Potentials.
- See how the Standard Hydrogen Electrode will be used to find out the potentials of other electrodes.
- Use the Table to find out the combined cell potentials of two half-reactions.
- Answer examination questions about potentials.

Key Concepts

The Standard Electrode Potential table ranks the half reactions from lowest to highest.

These are reduction potentials - the likelihood that the reaction would undergo reduction.

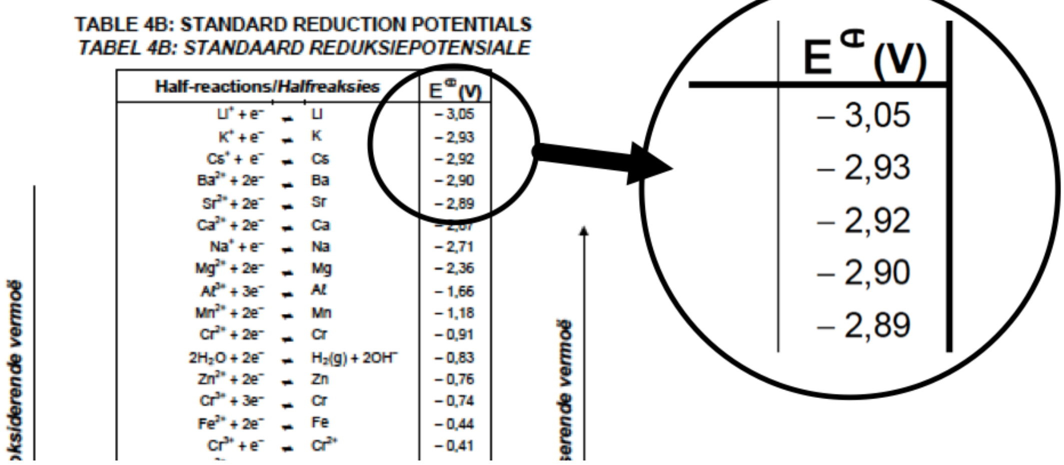

TABLE 4B: STANDARD REDUCTION POTENTIALS
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Half-reactions/*Halfreaksies*			E^θ (V)
$Li^+ + e^-$	⇌	Li	−3,05
$K^+ + e^-$	⇌	K	−2,93
$Cs^+ + e^-$	⇌	Cs	−2,92
$Ba^{2+} + 2e^-$	⇌	Ba	−2,90
$Sr^{2+} + 2e^-$	⇌	Sr	−2,89
$Ca^{2+} + 2e^-$	⇌	Ca	−2,87
$Na^+ + e^-$	⇌	Na	−2,71
$Mg^{2+} + 2e^-$	⇌	Mg	−2,36
$Al^{3+} + 3e^-$	⇌	Al	−1,66
$Mn^{2+} + 2e^-$	⇌	Mn	−1,18
$Cr^{2+} + 2e^-$	⇌	Cr	−0,91
$2H_2O + 2e^-$	⇌	$H_2(g) + 2OH^-$	−0,83
$Zn^{2+} + 2e^-$	⇌	Zn	−0,76
$Cr^{3+} + 3e^-$	⇌	Cr	−0,74
$Fe^{2+} + 2e^-$	⇌	Fe	−0,44
$Cr^{3+} + e^-$	⇌	Cr^{2+}	−0,41

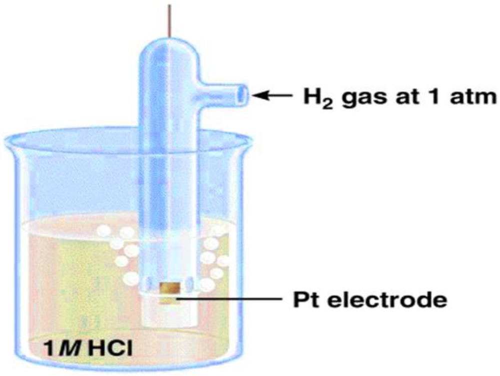
Notice how the reactions are ranked from left to right.

Standard Hydrogen Electrode

These voltages are found by comparing the unkown electrode to the Standard Hydrogen Electrode

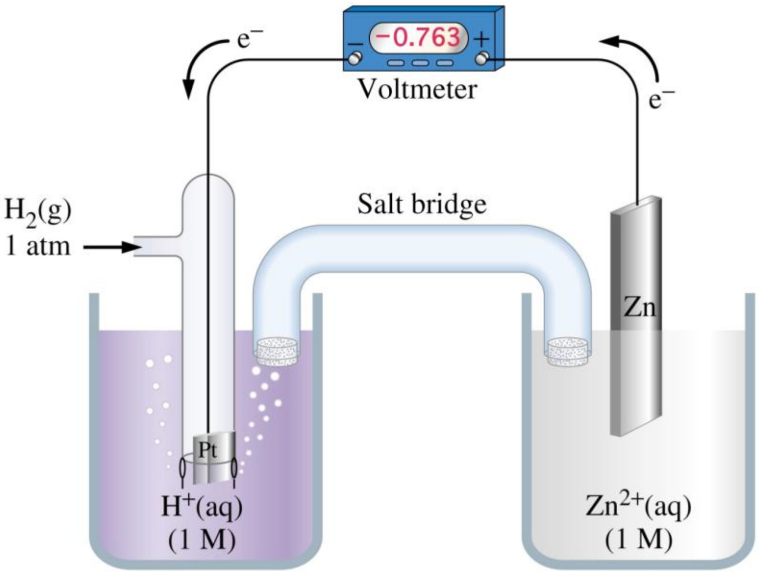
$$2H^+ + 2e^- \rightarrow H_2$$

The standard conditions are: 1mol·dm^{-3} concentration of H^+, 1atm. pressure of H_2 and 25 °C.



Because hydrogen is a non-conductive gas, platinum is used to capture and react the hydrogen gas.

When connected to another unknown electrode, it looks as follows:



If you look at zinc on the table, you will see the voltage of -0,76 V. This means that zinc is LESS likely to undergo reduction than hydrogen.

Cell Potential

By using the numbers on the table, we can calculate the voltage, or emf, that we can expect from a combination of two electrodes.

$E_{cell} = E_{cathode} – E_{anode}$

So, first you need to find out where oxidation is taking place (anode) and then reduction (cathode).

Hint: Always substitute using brackets as the signs may need to change.

Terminology

Electrode: A conductive rod that moves electricity in and out of cells.

Cathode: The electrode where reduction takes place.

Anode: The electrode where oxidation takes place.

Oxidation: Loss of electrons.

Reduction: Gain of Electrons

Cell: A combination of reduction and oxidation half-reactions with an attached circuit.

Potential: Voltage or potential difference.

Emf: Electromotive force.

Demonstration

When making the copper-zinc lemon battery, try substituting different metals and see if you get a different voltage (1 V for the zinc-copper).

Perhaps even change the electrolyte.

Did you know? Potatoes contain phophoric acid, which is an excellent electrolye, much like the citric acid in lemons!

Questions

Question 1

(Adapted from Mar 2010, DoE, Paper 2, Question 10)

Batteries consist of one or more galvanic cells. A galvanic cell is a combination of two half-cells.

John wants to determine which one of Options A or B, shown below, can be used to assemble a galvanic cell with the highest potential difference.

Option	Combination of half-cells
A	Ag(s) in $AgNO_3$(aq) & Ni(s) in $Ni(NO_3)_2$(aq)
B	Mg(s) in $Mg(NO_3)_2$(aq) & Ag(s) in $AgNO_3$(aq)

a.) Draw a fully labelled diagram of the galvanic cell that John can use to measure the potential difference for the cell in Option B. Use a positive (+) and negative (-) sign to indicate the positive and negative electrodes respectively. (5)

b.) Write a balanced chemical equation, excluding spectator ions, for the net (overall) cell reaction for the galvanic cell in Option B. (3)

c.) Calculate the initial potential difference that can be obtained under standard conditions for the galvanic cell in Option B. (4)

Links

- http://www.mindset.co.za/learn/xtra
- http://www.education.gov.za/Examinations/PastExamPapers/tabid/351/Default.aspx
- http://electrochemistryh5t34.blogspot.com/2011/01/standard-hydrogen-potential.html
- http://alsamman.webs.com/chapter18.htm