# AQA Chemistry A-level

## Topic 1.11 - Electrode Potentials and Electrochemical Cells

Flashcards

# What happens when a rod of a metal is dipped into a solution of its own ions?

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An equilibrium is set up between the solid metal and the aqueous metal ions

# Write a half-equation for zinc (s) to zinc (II).

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

Write a half-equation for copper (II) to copper (III).

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$Cu^{2+}(aq) \rightleftharpoons Cu^{3+}(aq) + e^-$

# What is the simplest salt bridge made of?

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Filter paper soaked in saturated solution of $KNO_3$ (potassium nitrate)

# Why are salt bridges necessary?

# Why are salt bridges necessary?

Complete the circuit, but avoid further metal/ion potentials as does not perform electrochemistry. Allows ion movement to balance the charge. Do not react with electrodes

# What symbol is used to represent a salt bridge in standard notation?

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||

# What type of species goes on the outside (furthest from the salt bridge) in standard cell notation?

What type of species goes on the outside (furthest from the salt bridge) in standard cell notation?

The most reduced species

# What does | indicate?

# What does | indicate?

Phase boundary (solid/liquid/gas)

# How would an Aluminium/Copper cell be represented?

# How would an Aluminium/Copper cell be represented?

$Al(s) \mid Al^{3+}(aq) \parallel Cu^{2+}(aq) \mid Cu(s)$

# What happens at the left-hand electrode?

# What happens at the left-hand electrode?

Left hand electrode is where oxidation occurs.

Left hand electrode is the half cell with the most negative $E^{o}$ value

# What happens at the right-hand electrode?

# What happens at the right hand electrode?

right hand electrode is where reduction occurs. Right hand electrode is the half cell with the most positive $E^{o}$ value

# Which side of the cell has the most negative E° value? what happens to the metal with the most negative E° value?

Which side of the cell has the most negative $E^{o}$ value? what happens to the metal with the most negative $E^{o}$ value?

Oxidation - left hand electrode

# Draw the standard hydrogen electrode

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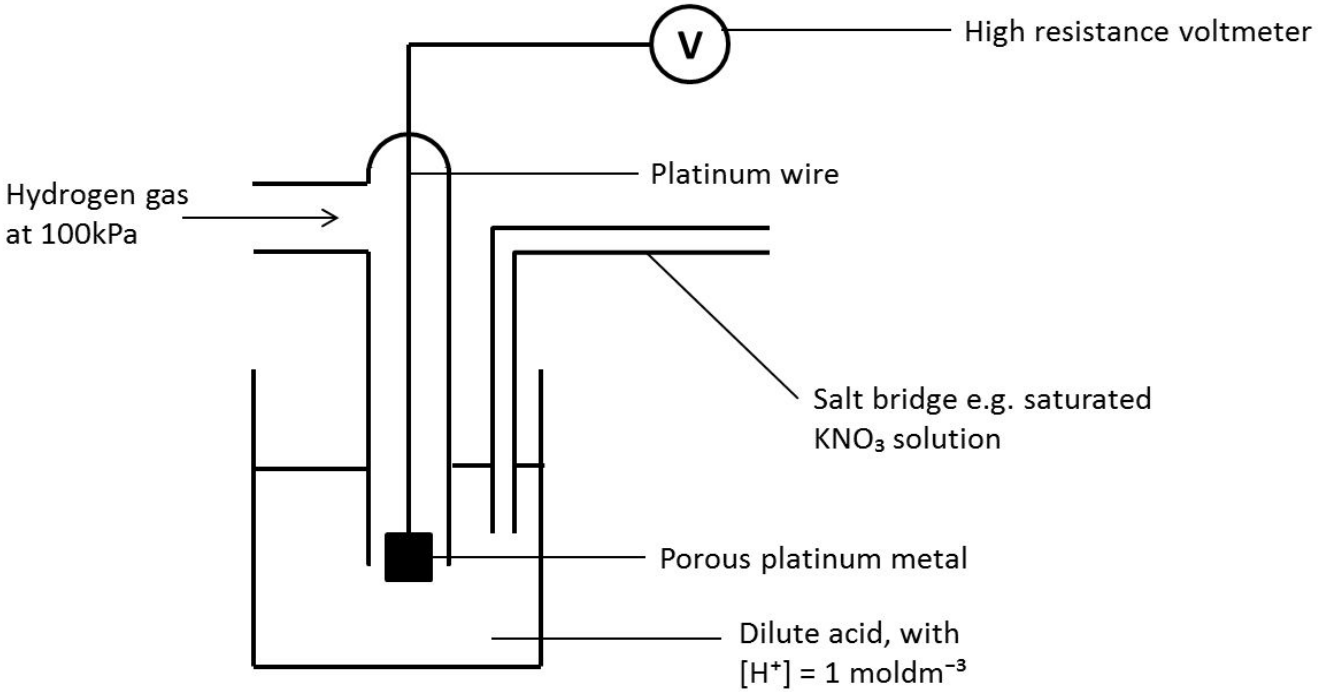

# What conditions is the standard hydrogen electrode used in?

What conditions is the standard hydrogen electrode used in?

Temperature = 298 K

Pressure = 100 kPa

$[H^+] = 1.00 \text{ mol dm}^{-3}$

# What is the standard hydrogen electrode used for?

# What is the standard hydrogen electrode used for?

Comparing other cells against. $E^{O}$ of SHE is defined as 0, so all other $E^{o}$ values are compared against it.

# Why might you use other standard electrodes occasionally?

# Why might you use other standard electrodes occasionally?

They are cheaper/easier/quicker to use and can provide just as good a reference.

Platinum is expensive

If an $E^{o}$ value is more negative, what does it mean in terms of oxidising/reducing power?

If an $E^{o}$ value is more negative, what does it mean in terms of oxidising/reducing power?

Better reducing agent (easier to oxidise)

# If an E° value is more positive, what does it mean in terms of oxidising/reducing power?

If an $E^{o}$ value is more positive, what does it mean in terms of oxidising/reducing power?

Better oxidising agent (easier to reduce)

# What factors will change $E^{o}$ values?

# What factors will change $E^{o}$ values?

Concentration of ions

Temperature

# What happens if you reduce the concentration of the ions in the left hand half cell?

What happens if you reduce the concentration of the ions in the left hand half cell?

Equilibrium moves to the left to oppose the change of removing ions; this releases more electrons, the $E^{o}$ of the left hand cell becomes more negative, so the e.m.f. Of the cell increases.

# How do you calculate the emf of a cell from $E^{o}$ values?

# How do you calculate the emf of a cell from $E^{o}$ values?

$$E^{o}_{cell} = E^{o}_{right} - E^{o}_{left}$$

# When would you use a Platinum electrode?

# When would you use a Platinum electrode?

When both the oxidised and reduced forms of the metal are in aqueous solution

# Why is Platinum chosen?

# Why is Platinum chosen?

Inert so does not take part in the electrochemistry

Good conductor to complete circuit

# How would you predict if a reaction would occur?

# How would you predict if a reaction would occur?

Take the 2 half equations.

Find the species that is being reduced (this is effectively the right hand electrode)

Calculate its $E^{o}$ value minus the $E^{o}$ value of the species that is being oxidised (effectively the left hand cell).

If $E^{o}$ overall > 0, reaction will occur.

# What was the first commercial cell made from (Daniell cell)?

What was the first commercial cell made from (Daniell cell)?

Zinc/copper (II)

# What are zinc/carbon cells more commonly known as?

What are zinc/carbon cells more commonly known as?

Disposable batteries

# What are the two reactions that take place in zinc/carbon cells?

# What are the two reactions that take place in zinc/carbon cells?

$Zn$ oxidised to $Zn^{2+}$

$NH_4^+$ reduced to $NH_3$ at carbon electrode

# What are the reactions that occur in a lead/acid battery (car batteries)?

What are the reactions that occur in a lead/acid battery (car batteries)?

$$Pb + SO_4^{2-} \rightarrow PbSO_4\ (s) + 2e^-$$

$$PbO_2 + 4H^+ + SO_4^{2-} + 2e^- \rightarrow PbSO_4 + 2H_2O$$

# How are cells recharged (if they are rechargeable)?

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Reactions are reversible and are reversed by running a higher voltage through the cell than the cell's $E^{o}$

Nickel/cadmium cells are rechargeable AA batteries etc. What reactions occur at the electrodes?

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$$Cd(OH)_2\ (s) + 2e^- \rightarrow Cd(s) + 2OH^-$$

$$NiO(OH)\ (s) + H_2O + e^- \rightarrow Ni(OH)_2\ (s) + OH^-$$

# Where are lithium-ion cells used?

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Mobile phones

Laptops

# What reactions occur on discharge in lithium-ion cells?

What reactions occur on discharge in lithium-ion cells?

$$Li^+ + CoO_2 + e^- \rightarrow Li^+[CoO_2]^-$$

$$Li \rightarrow Li^+ + e^-$$

# What is a fuel cell?

# What is a fuel cell?

A cell that is used to generate electric current; does not require electrical recharging

# What are the reactions that take place at the two electrons in an alkaline hydrogen fuel cell?

What are the reactions that take place at the two electrons in an alkaline hydrogen fuel cell?

$$2H_2 + 4OH^- \rightarrow 4H_2O + 4e^-$$

$$O_2 + 2H_2O + 4e^- \rightarrow 4OH^-$$

# Draw a diagram of a hydrogen fuel cell.

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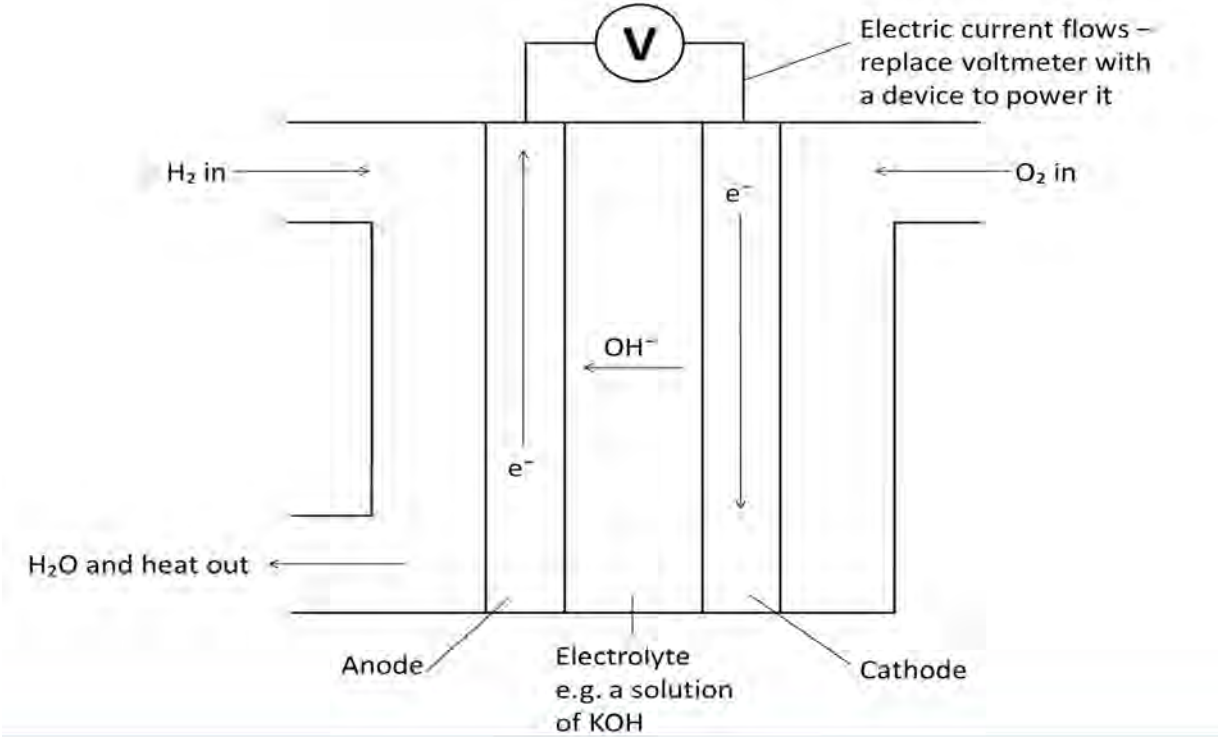

Why is it better to use a fuel cell than to burn $H_2$ in air, even though the same overall reaction occurs?

# Why is it better to use a fuel cell than to burn $H_2$ in air, even though the same overall reaction occurs?

In combustion, sulfur containing compounds ($SO_2$ , $SO_3$) and nitrogen containing compounds ($NO_2$, $NO_x$) are produced due to the high temperatures and the S and N in air. These are bad for the environment.

This does not occur in a fuel cell; the only product is water.

More efficient

# Disadvantages of fuel cells?

# Disadvantages of fuel cells?

Hydrogen is a flammable gas with a low b.p. → hard and dangerous to store and transport → expensive to buy

Fuel cells have a limited lifetime and use toxic chemicals in their manufacture

# How do you find the weakest reducing agent from a table of electrode potential data?

# How do you find the weakest reducing agent from a table of electrode potential data?

Most positive $E^{\theta}$ value. Then it is the PRODUCT of the reduction equation i.e. imagine equation going from right to left

# What is the reason that some cells cannot be recharged?

# What is the reason that some cells cannot be recharged?

Reaction of the cell is not reversible - a product is produced that either dissipates or cannot be converted back into the reactants

# Why might the e.m.f. Of a cell change after a period of time?

Why might the e.m.f. Of a cell change after a period of time?

Concentrations of the ions change - the reagents are used up

# How can the e.m.f. Of a cell be kept constant?

# How can the e.m.f. Of a cell be kept constant?

Reagents are supplied constantly, so the concentrations of the ions are constant; $E^{o}$ remains constant