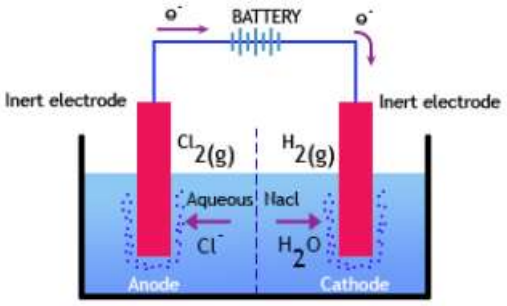
Name: Class:

Total Possible Marks: 33

Electrolysis



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1. In the process of (a) electrolysis, if an electric (b) current is passed through an (c) ionic substance that is either (d) molten or (e) dissolved in (f) solution, the ions in the liquid all solution will move (g) towards the (h) electrodes where they can react. This causes the ionic substance to (i) decompose. Electrolysis requires a liquid to conduct the electricity, this is called the (j) electrolyte and this contains free ions. It is these free ions which conduct the electricity and allow the whole process to work.

electrolysis	electrodes	dissolved	molten	electrolyte
solution	decompose	current	towards	ionic

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2. Identify the true and false statements concerning electrolysis, from the list below.

A. **T** F Electrolysis always involves an oxidation reaction and the reduction reaction.

B. T **F** Reduction occurs at the positive electrode, oxidation occurs at the negative electrode * this is incorrect, reduction occurs at the negative electrode otherwise known as the anode, and oxidation occurs at the positive electrode otherwise known as the cathode

C. T **F** Positive metal anions are attracted towards the negative electrode * this is incorrect, the positive ions are cations not anions

D. **T** F The negative ions produced are called anions and will migrate towards the positive (cathode) electrode.

E. **T** F Electrolysis involves binary compounds which consist of a positive metal ion and a negative nonmetallic ion.

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3. In the electrolysis of molten lead bromide, electricity will be conducted as the substance breaks down into lead and bromide ions.

2 A. State which of the elements lead/bromine will produce positive ions and which will produce negative ions * 2 marks on offer, one for the correct statement lead producing positive ions, and the other for the correct statement bromine produces negative ions

The element Lead will produce positive ions and the element Bromine will produce negative ions *

Lead atoms will be produced at the negative electrode as the positively charged lead ions will collect electrons to become neutral lead atoms. At the other electrode, the positive one, bromide ions will surrender their extra electron to become neutral bromine atoms. These bromine atoms will quickly covalently bond with each other to form neutral bromine molecules

1 B. Write out the ionic equation to show the reduction of lead ions to lead metal

$Pb^{2+} + 2e^- \Rightarrow Pb$

2 C. Write out the ionic equation to show the oxidation of bromide ions to bromine gas (2 steps for 2 marks) * 2 marks on offer because I want the students to realise that the oxidation is only one step, the second step is the covalent bonding of 2 bromine atoms to form a bromine molecule

$Br^- - e^- \Rightarrow Br$

$Br + Br \Rightarrow Br_2$

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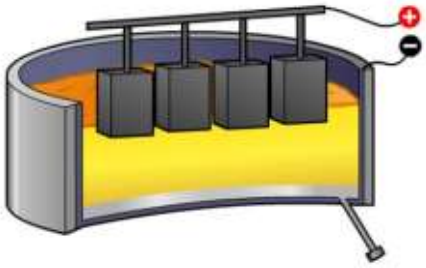
4. The picture shows a simple setup of the electrolysis of bauxite. Bauxite is mined and purified to give aluminium oxide, from which the aluminium metal is extracted by electrolysis. The electrodes shown are made from graphite (carbon) as is the lining of the tank which forms the negative cathode. The electrolyte is a mixture of bauxite and cryolite and the products of the electrolysis are aluminium metal and oxygen gas.



1 A. The molten mixture is heated to approximately 900°C during the electrolysis. Describe the actions that take place at the cathode.

At the cathode (the negative electrode) * remember PANIC the triple positively charged aluminium ions collect 3 electrons each and are subsequently reduced to aluminium metal. These newly created uncharged aluminium atoms then sink to the bottom of the electrolysis tank.

2 B. Describe the processes that take place at the positive anode. * Looking for 2 things here to award 2 marks

Since electrolyte is molten aluminium oxide Al_2O_3 the only ions in existence during the electrolysis are aluminium and oxygen. The oxygen ions are double negatively charged and when they reach the positively charged anode, they surrender their to negative electronic charges, becoming oxidised in the process to oxygen gas. These neutral oxygen atoms then combine to form diatomic oxygen molecules.

$O^{2-} - 2e^- \Rightarrow O$

$O + O \Rightarrow O_2$

1 C. Explain why the positively charged anodes have to be replaced every now and then.

The product at the anode is oxygen gas, however some of this oxygen gas reacts with the carbon making up at the anode to produce carbon dioxide gas which is discharged with the oxygen. Losing carbon in this way causes the electrodes to be eaten away, so they therefore need to be replaced every now and then.

1 D. Why is the less familiar aluminium ore bauxite added to the mixture for electrolysis?

Aluminium oxide has an incredibly high melting point of over 2000°C, the amount of energy that would be needed to melt this is quite high and could make the economics of the process unfavourable. Adding bauxite reduces at melting point to approximately 900°C which makes the process more economical in terms of energy required.

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5. Complete the following table concerning electrolysis.

Metal	Cation	Positive	Oxidation
Non-metal	Anion	Negative	Reduction
Bromine	Reduced	Bromide Anion	Br^-
Lead	Oxidised	Lead Cation	Pb^{2+}

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6. Molten zinc chloride can undergo electrolysis. The ions in the electrolyte are Zn^{2+} and Cl^{-}. The electrodes are made of graphite

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A. Give the name of the electrolyte?

The electrolyte in this case is molten zinc chloride

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B. Which electrode do the chloride ions move towards?

The chloride ions, being negatively charged will migrate towards the positive electrode (anode)

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C. Describe what happens to the chloride ions when they reach the anode (looking for 2 things here)

* looking for the students to realise that the chloride ions will be oxidised to chlorine atoms but that chlorine atoms do not exist individually and will therefore quickly pair up

When the negatively charged chloride ions reach the anode they:

1. Surrender the single negative electronic charge becoming oxidised to chlorine atoms,

2. Two chlorine atoms will quickly covalently bond with each other to form a single chlorine molecule.

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D. With regard to the zinc cations, will they be oxidised or reduced in this process?

The zinc ions will be reduced to zinc atoms by the gain of an electron.