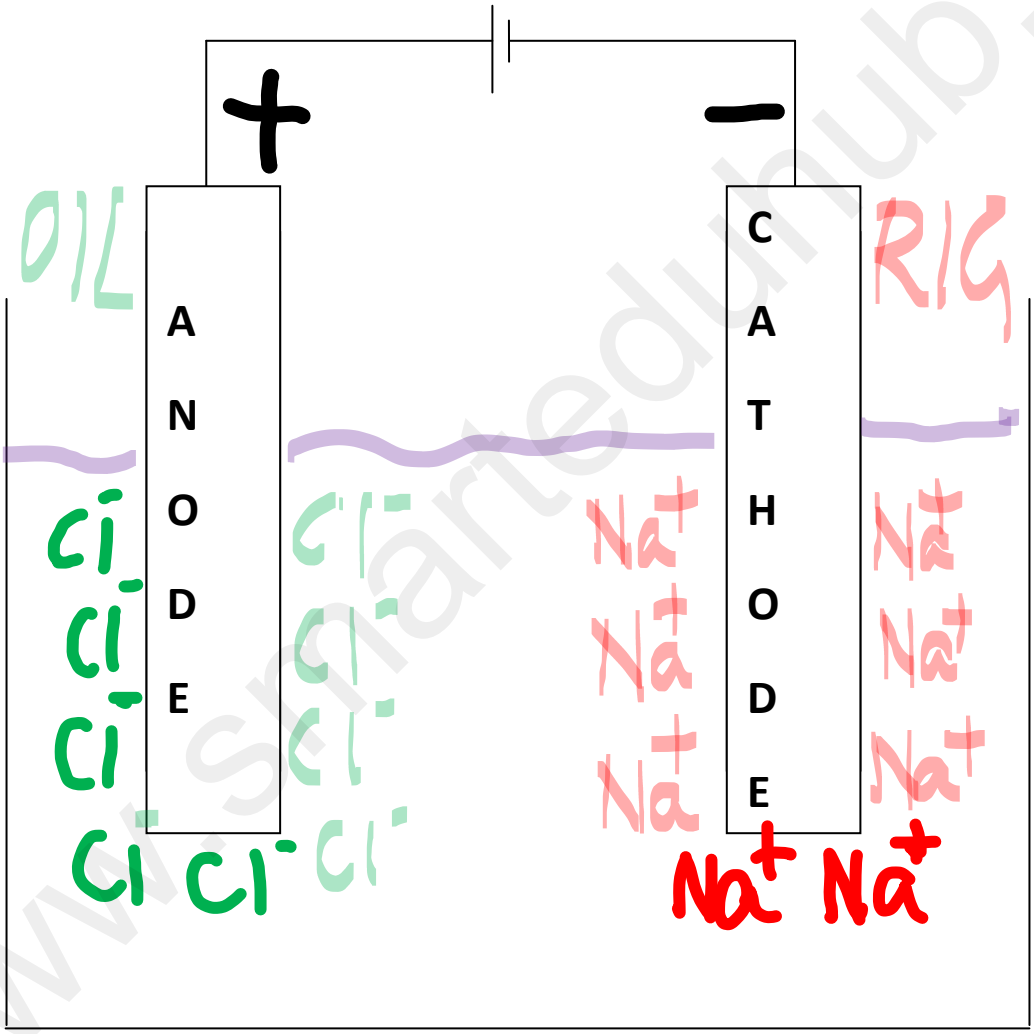
Electrolysis of molten ionic compounds

- Whenever a molten ionic compound is electrolysed with inert or reactive electrodes, a metal is always formed at the cathode and a non-metal is always formed at the anode.
- Knowledge of reactivity series is not needed.

Example: Electrolysis of molten sodium chloride produces silvery white sodium metal at the cathode and a yellow green chlorine gas at the anode.



Half equations :

Metal ions get reduced

At the cathode: (Reduction)

$Na^+(aq) + e^- \longrightarrow Na(s)$

Non-metal ions get oxidised

At the anode: (Oxidation)

$2Cl^-(aq) - 2e^- \longrightarrow Cl_2(g)$

Overall reaction is: $2NaCl \longrightarrow 2Na + Cl_2$

The following table shows the half reactions for the electrolysis of molten ionic compounds and the colour of the compounds formed.

Some examples of electrolysis of molten ionic compounds		
Compounds	$PbBr_2$	Al_2O_3
Product at cathode (-ve electrode)	Pb -Bluish white	Al-Silvery white
Half equation	$Pb^{2+} + 2e^- \rightarrow Pb$	$Al^{3+} + 3e^- \rightarrow Al$
Product at the anode (+ve electrode)	Br_2 gas-Reddish brown	O_2 gas-colourless
	$Br^- - 2e^- \rightarrow Br_2$	$4OH^- - 4e^- \rightarrow 2H_2O + O_2$

Colour of products formed during electrolysis	
Colours of metals	Colours of non metals
Li-Silvery white	F_2-pale yellow
Na-Silvery white	Cl_2-yellow green
K-Silvery white	Br_2-reddish brown
Mg-Silvery white	I_2-purple
Ba- Silvery white	O_2-colourless
Ca-Silvery grey	H_2-colourless
Cu^{2+}-Brown	N_2-Colourless
Zn-Bluish grey	CO_2-Colourless
	CO-Colourless

Type of past paper questions asked so far:

Example 1: From the tabulated data identify the products of electrolysing a molten ionic compound

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8 Which row describes the electrolysis of molten potassium bromide?

	product at anode	product at cathode
A	bromine	hydrogen
B	bromine	potassium
C	hydrogen	bromine
D	potassium	bromine

Example 2:You must be able to identify the products of electrolysing compounds using inert electrodes

8 What are the electrode products when molten silver iodide is electrolysed between inert electrodes?

0620/13/O/N/15

	cathode	anode
A	hydrogen	iodine
B	iodine	silver
C	silver	iodine
D	silver	oxygen

Note:

- **The products do not change in case of molten ionic compounds whether it involves inert or reactive electrodes.**
- **The only thing that changes is the colour of the electrolyte.**
- **In the case of reactive electrode the colour of the electrolyte stays the same**
- **In the case of inert electrode, the colour of the electrolyte fades away and become lighter(pale) than what it was earlier.**

Example 3:Deriving the formula of the electrolyte from the products obtained at the cathode and anode.

12 A molten compound is electrolysed. Two atoms of X are deposited at the negative electrode at the same time as three atoms of Y are deposited at the positive electrode.

These results show that: **0620/01/M/J/07**

X is a ...1...;

Y is a ...2...;

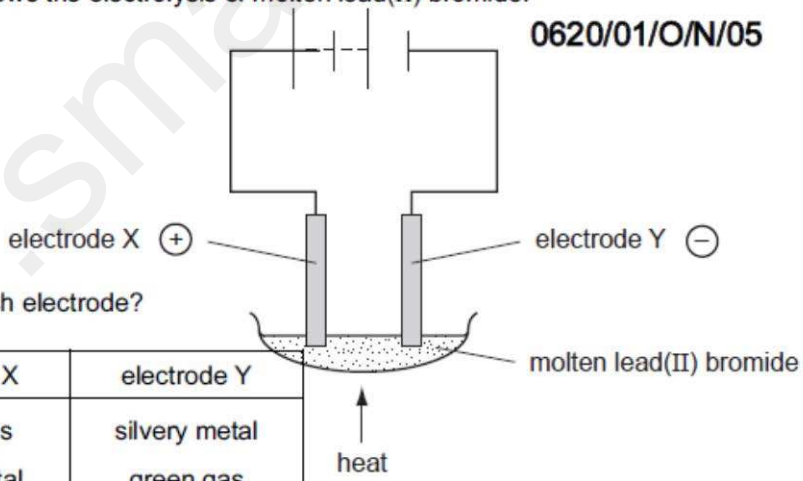
the formula of the compound is ...3... .

How are gaps 1, 2 and 3 correctly completed?

	1	2	3
A	metal	non-metal	X_3Y_2
B	metal	non-metal	X_2Y_3
C	non-metal	metal	X_3Y_2
D	non-metal	metal	X_2Y_3

Example 4:Identifying the products and the colour of the products obtained.

10 The diagram shows the electrolysis of molten lead(II) bromide. **0620/01/O/N/05**



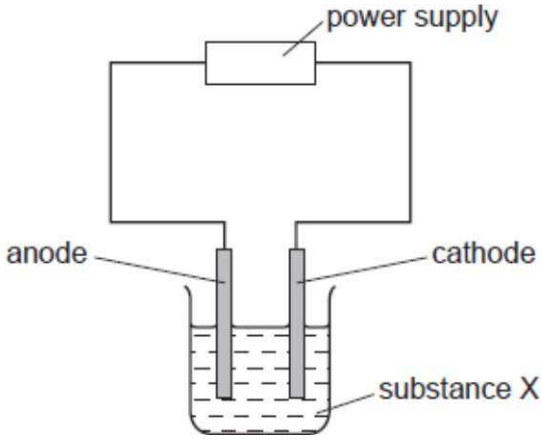
What is seen at each electrode?

	electrode X	electrode Y
A	brown gas	silvery metal
B	brown metal	green gas
C	green gas	brown metal
D	silvery metal	brown gas

Example 5:Identiying the electrolyte from the given products.

11 Substance X was electrolysed in an electrolytic cell.

A coloured gas was formed at the anode and a metal was formed at the cathode.



0620/12/O/N/10

What is substance X?

A aqueous sodium chloride

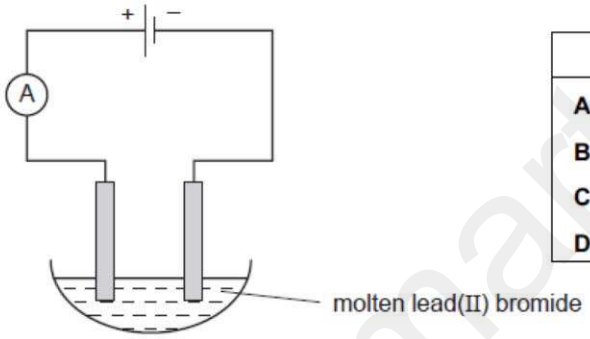
B molten lead bromide

C molten zinc oxide

D solid sodium chloride

Example 6:You should be able to identify the ions present in a given ionic compound and then the products of the electrolysis.

14 Molten lead(II) bromide is electrolysed as shown. Which ions are discharged at each electrode?



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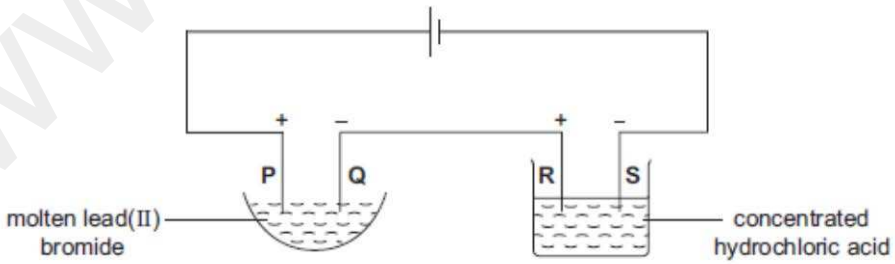
	positive electrode	negative electrode
A	Pb^{+}	Br^{2-}
B	Pb^{2+}	Br^{-}
C	Br^{2-}	Pb^{+}
D	Br^{-}	Pb^{2+}

Example 7: Identifying the product formed and linking it to the its position in the periodic table.

13 The following electrolysis circuit is set up, using inert electrodes **P**, **Q**, **R** and **S**.



At which of the electrodes is a Group VII element produced?

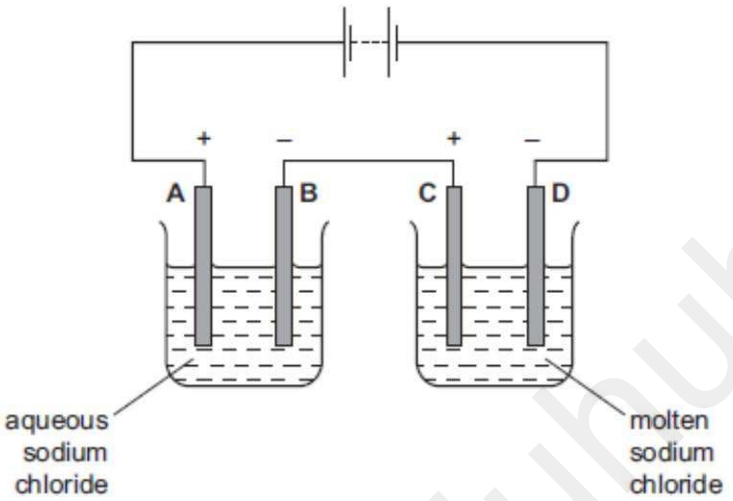
A P only **B** P and R **C** Q only **D** Q and S

Example 8:

Identifying products formed from the combination of two electrodes.

12 The diagram shows an electrolysis circuit. **0620/11/M/J/13**

At which electrode is hydrogen formed?



Example 9: You must know that energy is taken in during electrolysis

14 Two chemical processes are described below. **0620/11/M/J/14**

- In the combustion of methane, energy is .....1..... .
- In the electrolysis of molten lead(II) bromide, energy is .....2..... .

Which words correctly complete gaps 1 and 2?

	1	2
A	given out	given out
B	given out	taken in
C	taken in	given out
D	taken in	taken in

Theory Questions:

Example 1:You must know to write ionic equations at each electrode

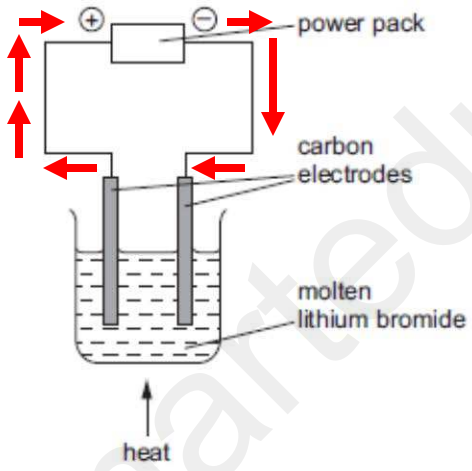
(ii) The electrolysis of molten strontium chloride produces strontium metal and chlorine. Write ionic equations for the reactions at the electrodes. **O/N/05-Q5c**

negative electrode (cathode) .....

positive electrode (anode) ..... [2]

Example 2:You must know to label the direction of electron flow, which is towards the negative terminal of the battery as shown by the arrows

(b) The diagram shows the electrolysis of molten lithium bromide. **O/N/15-P33-Q3b**



(i) Mark on the diagram the direction of the electron flow. [1]
