Website: contoureducation.com.au | **Phone:** 1800 888 300
Email: hello@contoureducation.com.au

VCE Chemistry ¾
Features of Electrolytic Cells [0.13]
Workshop Solutions

Error Logbook:

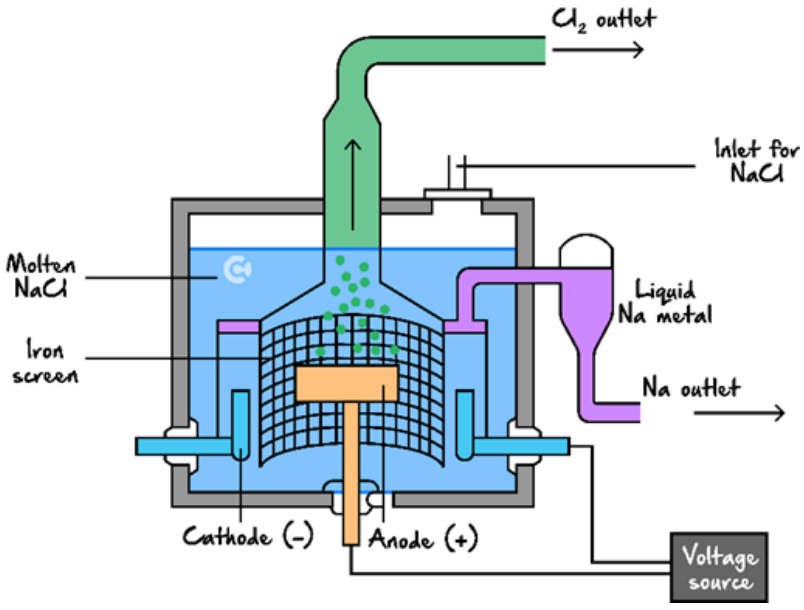
New Ideas/Concepts	Didn't Read Question
Pg / Q #: _____ Notes:	Pg / Q #: _____ Notes:
Algebraic/Arithmetic/ Calculator Input Mistake	**Working Out Not Detailed Enough**
Pg / Q #: _____ Notes:	Pg / Q #: _____ Notes:

Section A: Recap

Learning Objective: [2.2.1] – Find Electrolytic Reactions in Non-Standard Conditions (Molten & High Concentration)

- **High Concentration**:
  - Chloride ions at concentrations greater than _____ 4.0 M _____ concentration become a [stronger] / [weaker] reductant and [react] / [do not] react in preference to water.
  - Sodium ions are concentrations greater than $4.0\ M$ concentration [react] / [do not] react in preference to water.
- **Molten Concentration**: _ Water __ is not present, and the state of ions is ___ (l) not (aq) ___.

Learning Objective: [2.2.2] – Identify Features of Electrolytic Cells & Their Purpose

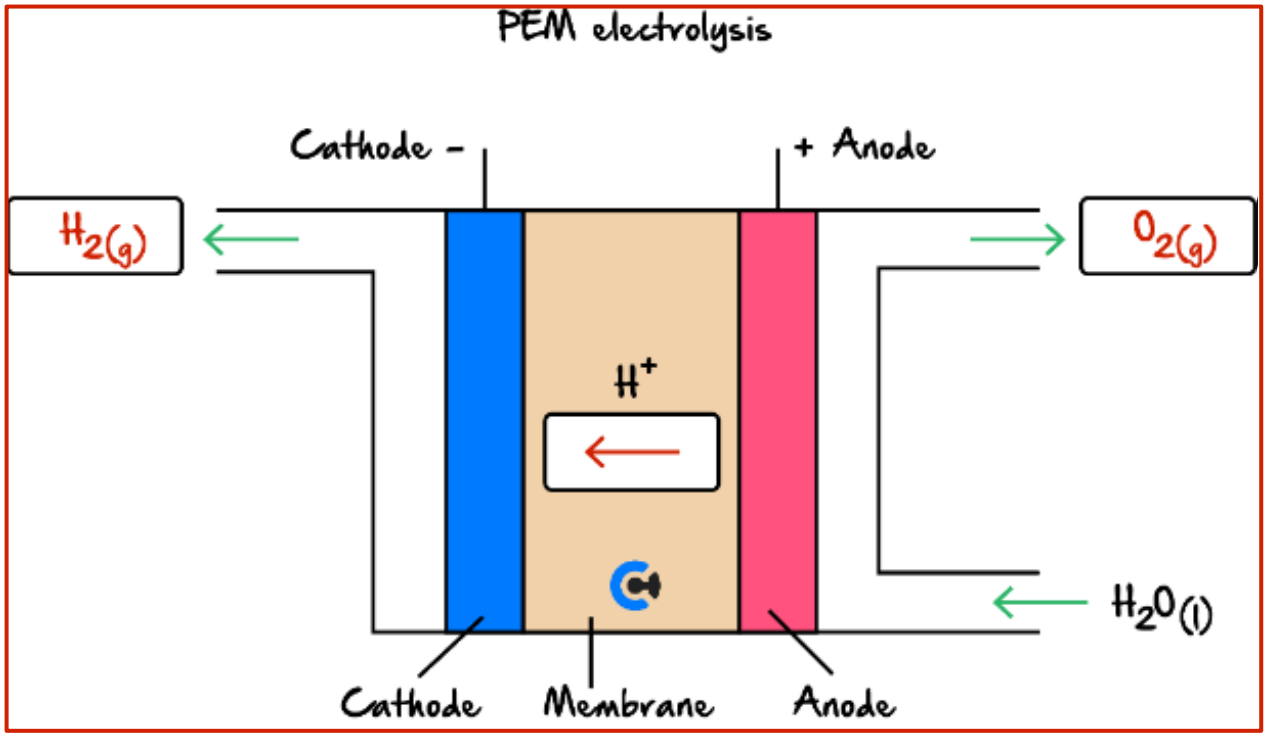


- Molten electrolyte purpose: React species weaker than water.
- Iron at the cathode: Cathode unreactive – cheaper.
- Other electrolytes (e.g., $CaCl_2$) added: Lower melting point of electrolyte.
- Barrier within the cell:
  - _ Prevent products from spontaneously re-reacting _.
  - _____ Still allow flow of ions _____.

- Products constantly removed:
  - Don't re-react back.
  - No interfere reaction.
- Enclosed container: Prevent O_2 from outside reacting spontaneously.

<u>Learning Objective: [2.2.3] – Identify Key Features, Write Reactions & Relate to Sustainability & Green Chemistry Principles Regarding Production of Green Hydrogen (PEM & Artificial Photosynthesis)</u>

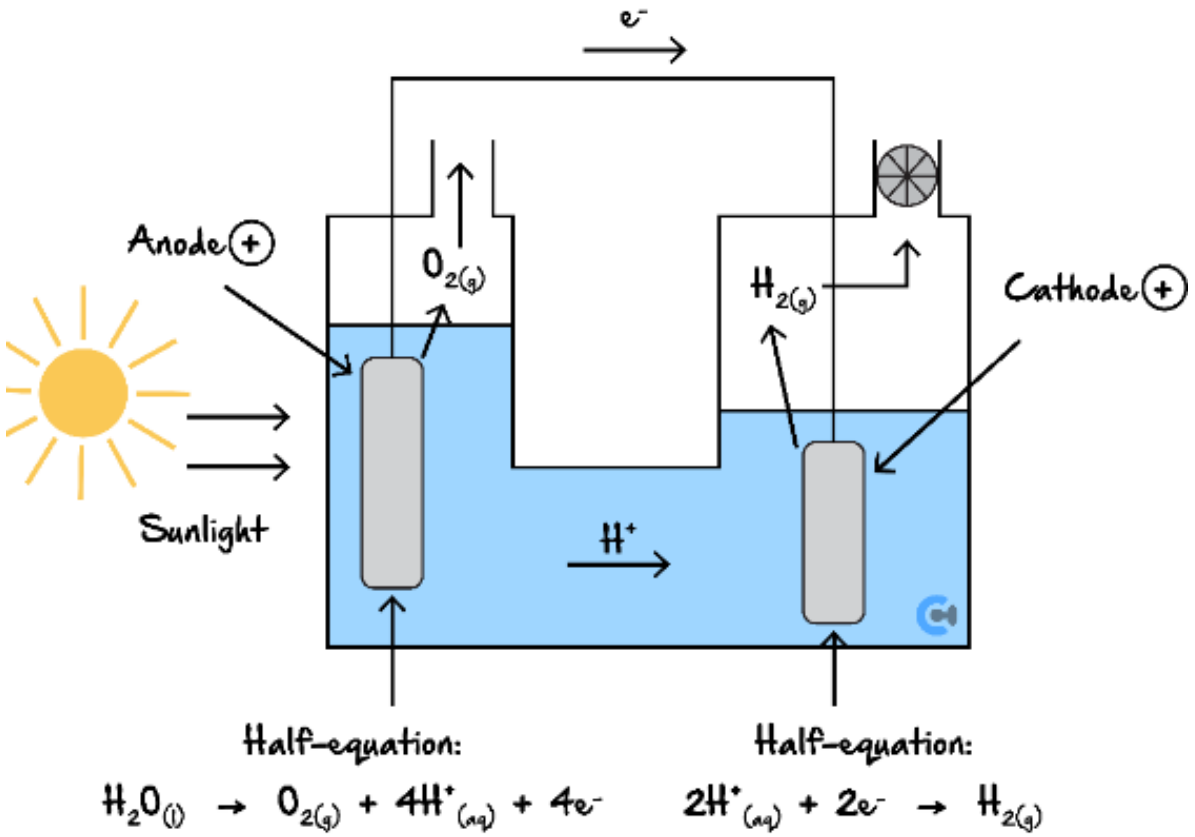
- Both PEM electrolyser & artificial photosynthesis involve electrolysis of acidic water.
- PEM Electrolyser:



Cathode	Anode
$2H^+(s) + 2e^- \rightarrow H_2(g)$	$2H_2O(l) \rightarrow O_2(g) + 4H^+(s) + 4e^-$

- **Energy Used:** Solar/wind energy.
- **Green Chemistry Principle:** Catalysis.

- Artificial Photosynthesis:



- Energy Conversion: Solar → Chemical.
- Green Chemistry Principle: Catalysis, design for energy efficient.

Space for Personal Notes

Question 1 Walkthrough.

A solution of aluminium chloride is electrolysed at high concentrations and is compared to when molten aluminium chloride is electrolysed.

a. Write the half-equations that occur when it is electrolysed at higher concentrations at the:

i. Cathode.

$2H_2O(l) + 2e^- \rightarrow H_2(g) + 2OH^-(aq)$

ii. Anode.

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

b. Write the half-equations that occur when it is electrolysed at molten at the:

i. Negative electrode.

$Al^{3+}(l) + 3e^- \rightarrow Al(l)$

ii. Positive electrode.

$2Cl^-(l) \rightarrow Cl_2(g) + 2e^-$

Space for Personal Notes

Section B: Warm Up (17 Marks)

INSTRUCTION: 17 Marks. 11 Minutes Writing.

Question 2 (1 mark)

Which statement is true for both a galvanic cell and an electrolytic cell?

A. Oxidation occurs at the negative electrode.

B. The anode is negatively charged.

C. The strongest oxidant will react with the weakest reductant.

D. Electrons flow from the anode to the cathode.

Question 3 (7 marks)

a.

i. Write the half-equation occurring at the positive electrode during the electrolysis of a 1.0 M solution of NaCl. (1 mark)

$2H_2O(l) \rightarrow O_2(g) + 4H^+(aq) + 4e^-$

ii. Write the half-equation occurring at the positive electrode during the electrolysis of a 10 M solution of NaCl. (1 mark)

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

iii. Write the half-equation occurring at the positive electrode during the electrolysis of a molten mixture of NaCl. (1 mark)

$2Cl^-(l) \rightarrow Cl_2(g) + 2e^-$

b. Suggest why a molten NaCl electrolyte is used in certain commercial cells if a concentrated solution of NaCl could be used as a cheaper alternative. Justify your reasoning. (2 marks)

Because their goal is to produce Na. (1)
Even with a concentrated solution of NaCl, the Na^+ is too weak of an oxidant to overwhelm water so molten conditions are needed to eliminate competition with water. (2)

c.

i. Explain what material commercial cells typically use as the anode. (1 mark)

Graphite → Inert and cheaper than Pt.

ii. Explain why a reactive metal such as iron is often used as the material for the cathode in commercial cells rather than inert ones like platinum or graphite. (1 mark)

Because it is even cheaper and since it's at the cathode so it won't react anyway.

Space for Personal Notes

Question 4 (3 marks)

a. Outline why hydrogen gas leaks are challenging to detect without a gas detector. (1 mark)

Because it is colourless, odourless and tasteless.

b. Explain the safety concerns associated with the leakage of hydrogen, and subsequently, outline what precautions can be taken to mitigate these risks. (2 marks)

It is flammable and therefore if ignited, could cause an explosion
→ Store away from ignition sources; well-ventilated areas; cool and dry areas.

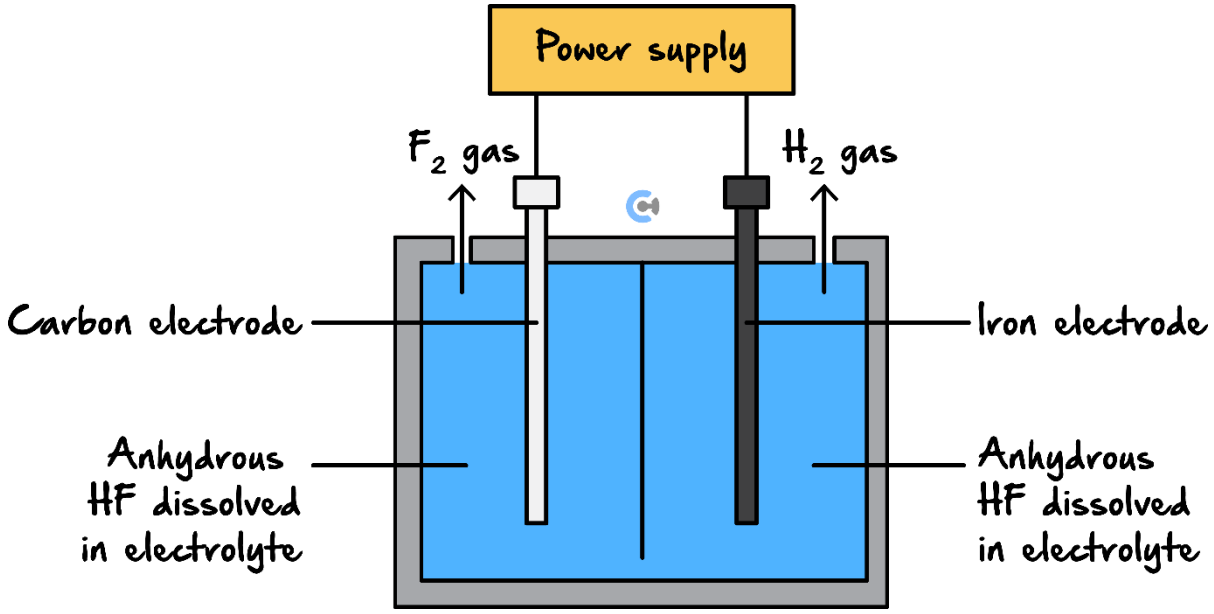
Space for Personal Notes

Question 5 (6 marks)

Many industrial processes result in the accumulation of deposits in reaction chambers. To clean these chambers a powerful oxidant, such as fluorine gas, F_2, is required. A safe and cheap method of generating F_2 on-site uses anhydrous hydrogen fluoride, HF.

Anhydrous is when there is no water present, whereby a solvent other than water is used instead.

An electrolytic cell used for the on-site production of F_2 is shown below.



a. Indicate which of the electrodes is the cathode. (1 mark)

Iron electrode (is the site of reduction).

b. Write the half equations for the reactions expected at the:

i. Iron electrode. (1 mark)

$2H^+(l) + 2e^- \rightarrow H_2(g)$ **(1 mark)**

(*or* $2HF(l) + 2e^- \rightarrow H_2(g) + 2F^-(l)$

ii. Carbon electrode. (1 mark)

$2F^-(l) \rightarrow F_2(g) + 2e^-$ **(1 mark)**

(*or* $2HF(l) \rightarrow F_2(g) + 2H^+(l) + 2e^-$)

Deduct one mark for incorrect states. **Reactants must not be (aq).**

c. Anhydrous hydrogen fluoride is used rather than an aqueous solution of HF. Suggest a reason for this and include a relevant chemical equation to assist in your response. (2 marks)

The fluoride ion is a weaker reductant than water. **(1 mark)**. Therefore water would be oxidised in preference producing O_2 and H^+ according to the equation:

$2H_2O\,(l) \rightarrow O_2\,(g) + 4H^+\,(aq) + 4e^-$ **(1 mark)**

Alternatively, could give: $2H_2O\,(l) \rightarrow O_2\,(g) + 2H_2\,(g)$

d. The cell is fully enclosed, with only passageways for the products to come out of the cell. State one reason for this. (1 mark)

To prevent oxygen gas from coming in contact with substances in the cell which can react via direct spontaneous redox reaction spontaneously.

Space for Personal Notes

Section C: Ramping it Up (13 Marks)

INSTRUCTION: 13 Marks. 10 Minutes Writing.

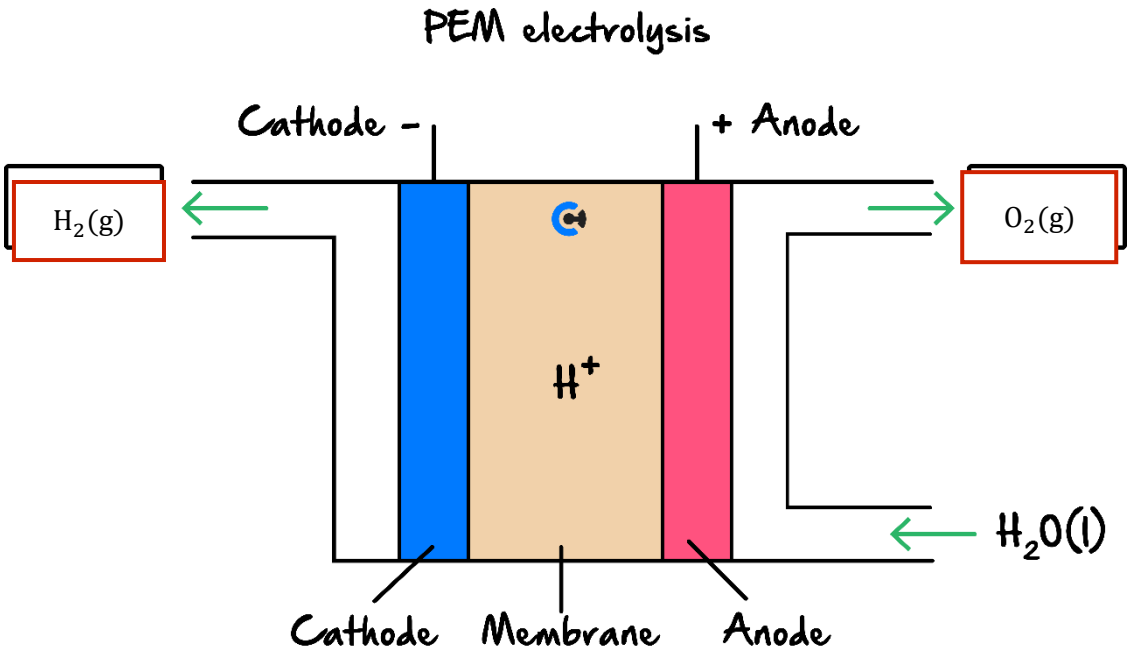
Question 6 (8 marks)

Society has recently been pushing for 'green' chemistry. One such example of this principle is the 'green' production of hydrogen gas.

a. Outline why the 'regular' electrolysis of water use is not considered to be green. (1 mark)

Because the electricity supplied is not sourced renewably.

b. The polymer electrolyte membrane (PEM) electrolyser is a commercial cell that will be used in society very soon. A diagram of it is shown below:



i. Explain **one** feature of this electrolyser that makes it more environment-friendly than the electrolysis of an acidic solution and refer to **one** United Nations Sustainability Development Goals. Use Item 26. i of the Data Book. (2 marks)

Powered via solar panels/wind turbines → renewable sources.
Goal 13: climate change

ii. State **one** disadvantage of this electrolyser, and refer to **one** United Nations Sustainability Development Goals. Use Item 26. i of the Data Book. Justify your answer. (2 marks)

Expensive as electrodes are PICCY.
This links to goal 7: affordable and clean energy, the cell is clean but does not produce affordable energy.

iii. Write the products formed at the cathode and anode by filling in the boxes provided on the diagram above. (1 mark)

c.

i. Indium, a porous material, is often used in this cell as the material for the electrodes. Explain how this feature aids the functioning of the cell. (1 mark)

It allows for the gaseous products to escape through.

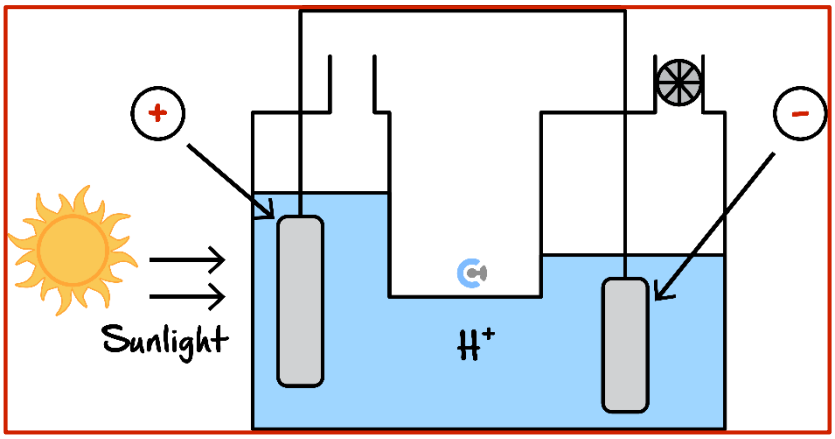
ii. Indium also poses a second benefit in that it increases the rate of the reactions occurring. State **one** green chemistry principle this quality relates to. (1 mark)

Catalysis.

Space for Personal Notes

Question 7 (5 marks)

Another green method for the production of hydrogen gas is via the principle of artificial photosynthesis. The cell which allows for this process to occur is depicted below.



a. Given that the sunlight causes the oxidation of water, label the polarities of the electrodes by placing a + or − sign in the circles above. (1 mark)

b.

i. Compare the energy conversions in this cell compared to that in the polymer electrolyte membrane (PEM) electrolyser. (1 mark)

Solar → Chemical in this cell.
Solar/Wind → Electrical → Chemical in PEM electrolyser.

ii. Explain whether this artificial photosynthesis cell or the PEM electrolyser is more energy efficient. Refer to **one** green chemistry principle. (Use **Item (26) (ii)** of the Data Book) (2 marks)

Major difference is "design for energy efficiency" → the artificial photosynthesis is better for this green chemistry principle. (2)

c. State the alternative name for the artificial photosynthesis cell. (1 mark)

Water oxidation and proton reduction catalyst system.

Section D: Getting Trickier I (8 Marks)

INSTRUCTION: 8 Marks. 6 Minutes Writing.

Question 8 (8 marks)

The electrolysis of 1 *M* LiBr (aq), and molten LiBr, i.e. LiBr (l) were investigated using carbon electrodes and a potential difference of 5 volts.

a. Write balanced half-equations for the reactions expected during:

i. The electrolysis of 1 *M* LiBr (aq). (2 mark)

Cathode: _____

Anode: _____

- Cathode: $2H_2O + 2e^- \rightarrow H_2 + 2OH^-$
- Anode: $2Br^- \rightarrow Br_2 + 2e^-$

ii. The electrolysis of molten LiBr (l). (2 marks)

Cathode: _____

Anode: _____

- Cathode: $Li^+ + e^- \rightarrow Li$
- Anode: $2Br^- \rightarrow Br_2 + 2e^-$
- Remember states are liquid not aqueous.

iii. Explain how pH changes at one of the electrodes during the electrolysis of 1 *M* LiBr. (1 mark)

_____

_____

pH increases, as OH^- is produced at the cathode, making the solution turn more basic.

b. When 0.1 *M* LiBr (aq) was electrolysed instead of 1 *M* LiBr (aq), it was observed that the products produced were different.

Write half equations for the reactions at each half cell and thus describe which products are observed to be produced, giving justification for your reasoning. (2 marks)

- At lower concentrations, water will oxidise in preference to Br^-.
- Cathode: $2H_2O + 2e^- \rightarrow H_2 + 2OH^-$
- Anode: $2H_2O \rightarrow O_2 + 4H^+ + 4e^-$
- As such, H_2 gas and O_2 gas will be produced.

c. The production of the products for the electrolysis of 0.1 *M* LiBr (aq) comes with a safety risk. List one safety precaution which should be undertaken to minimise this risk. (1 mark)

Produces H_2 gas which is flammable - keep away from ignition sources.

Space for Personal Notes

Section E: Getting Trickier II (9 Marks)

INSTRUCTION: 9 Marks. 8 Minutes Writing.

Question 9 (1 mark)

Pure NaCl is not used in a Down's cell. The liquid that is in a Down's cell is a mixture of $CaCl_2$ and NaCl.
The $CaCl_2$/NaCl mixture is used instead of pure NaCl because it:

A. Has a higher melting temperature.

B. Improves the yield of chlorine produced.

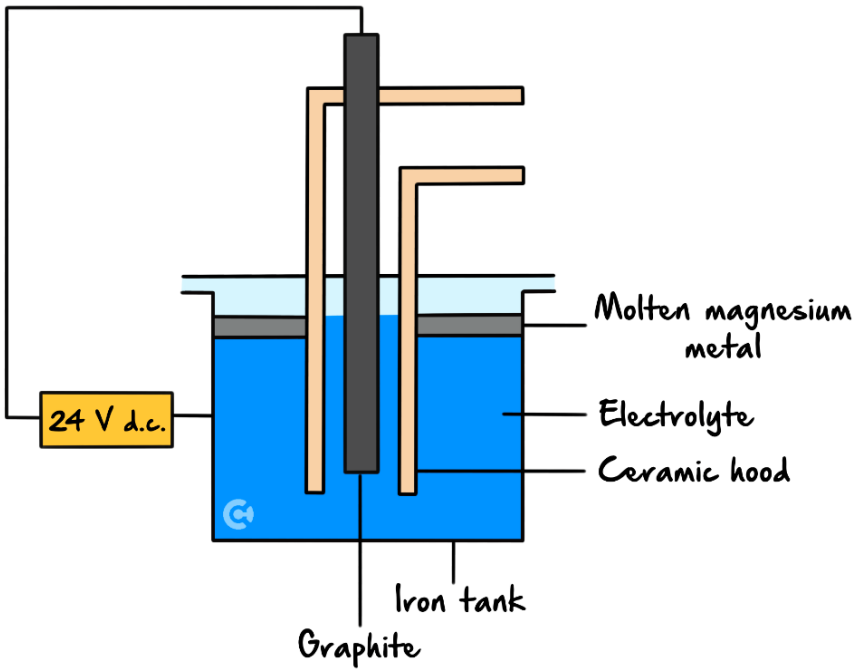
C. Improves the purity of the sodium produced.

D. Enables the process to be carried out at a lower temperature.

Space for Personal Notes

Question 10 (8 marks)

Magnesium is produced by the electrolysis of molten magnesium chloride. The diagram below shows the main features of the electrolytic cell, which is used.



a.

i. Write the half-equation for the process which occurs at the graphite electrode. (1 mark)

$2Cl^-(l) \rightarrow Cl_2(g) + 2e^-$

ii. Tick one box in the table below to show the identity and polarity of the graphite electrode in the electrolytic cell shown above. (1 mark)

	Positive	**Negative**
Anode	✓	
Cathode		

iii. Explain the likely role of the ceramic hood. (1 mark)

The ceramic hood is to ensure that the electrolytic products magnesium metal and chlorine gasdo not come into contact; otherwise, a spontancous reaction will occur.

b. It can be predicted from the electrochemical series that the magnesium ions in the electrolyte will not react with the iron tank.

i. What is the basis of this prediction? (1 mark)

An oxidant (A) will only react spontaneously with a reductant (B) if the conjugate of A is a weaker reductant than B. The conjugate of Mg^+ is the reductant Mg. Mg is a stronger reductant than Fe.

ii. This prediction could be unreliable. Explain why. (2 marks)

The electrochemical series is formulated using standard conditions of 1 M concentration of solutions, gas pressure of 1 atm and temperature of 25°C.
The conditions in this cell vary significantly from these conditions and thus any predictions may be unreliable.

c. To obtain the magnesium chloride electrolyte, the following reaction is used:

$$MgO(s) + C(s) + Cl_2(g) \rightarrow MgCl_2(s) + CO(g)$$

Suggest one reason why molten magnesium oxide is not used directly in the electrolytic cell to produce magnesium. (2 marks)

Using molten electrolytes is costly because of the energy required to melt the solid and keep it molten.
The melting point of magnesium chloride is likely to be much lower than the melting point of magnesium oxide. Less energy is required to produce a molten electrolyte, and so costs are reduced.

Let's take a BREAK!

Space for Personal Notes

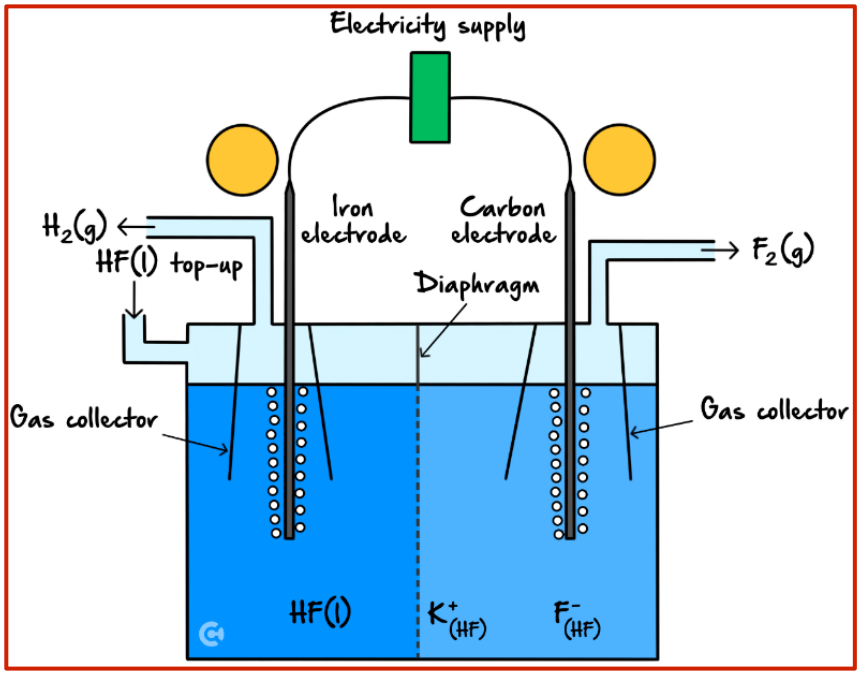
Section F: VCAA-Level Questions I (9 Marks)

INSTRUCTION: 9 Marks. 30 Seconds Reading. 8 Minutes Writing.

Question 11 (9 marks)

Inspired from VCAA Chemistry Exam 2017
https://www.vcaa.vic.edu.au/Documents/exams/chemistry/2017/2017chem-w.pdf#page=30

Given that fluorine gas, F_2, is the most reactive of all metals, it is extremely beneficial to have access to it. In order to form fluorine gas, we electrolyse liquid hydrogen fluoride, HF, to form fluorine and hydrogen gases.



a. Write the equation for:

i. The half-reaction occurring at the cathode. (1 mark)

$$2H^+(l) + 2e^- \rightarrow H_2(g)$$

ii. The overall reaction. (1 mark)

$$2\,HF(l) \rightarrow F_2(g) + H_2(g)$$

b. Label the polarities for each electrode in the circles provided above. (1 mark)

c. Suggest why the diaphragm as shown in the diagram above is important for the safe operation of the cell. (2 marks)

Acceptable responses included:

- If the products H_2 and F_2 can mix they will react explosively.
- The diaphragm keeps the products of the electrolysis, $H_2(g)$ and $F_2(g)$, from coming in contact.

Many responses to this question suggested that the safe operation of the cell was not the key focus. The significance of the structure of the diaphragm – solid in the gas collection region, but porous in the electrolyte – was missed by many students.

d. Explain why the carbon electrode cannot be replaced with an iron electrode. (2 marks)

Distinct points that could have been made were:

- iron is a stronger reducing agent than $F^-_{(HF)}$ and would be preferentially oxidised at the anode
- no F_2 would be produced
- $Fe(s) \rightarrow Fe^{2+}_{(HF)} + 2e^-$.

This proved to be one of the more challenging questions on the examination. Students should have considered the likelihood of the change of electrode having an impact on the reaction occurring at the anode. The implication of the change given the purpose of the cell was the production of fluorine. While predictions based on the electrochemical series are most accurate at standard conditions, it was still a valid point of reference.

There was evidence that many students struggled to interpret the supplied information effectively.

e. Explain why the left electrode as shown in the diagram above can be made of iron. (2 marks)

It is the cathode → reduction occurs at the cathode → oxidation cannot occur → even though in theory iron is a stronger reductant than F^-, the iron cannot oxidise.

Space for Personal Notes

Section G: Multiple Choice Questions (6 Marks)

INSTRUCTION: 6 Marks. 6 Minutes Writing.

Question 12 (1 mark)

If we compare a galvanic cell with an electrolytic cell, it is true to state that:

A. In a galvanic cell reduction occurs at the negative electrode.

B. In both cells the anode is positive and the cathode is negative.

C. In an electrolytic cell oxidation occurs at the cathode.

D. In both cells reduction occurs at the cathode.

Question 13 (1 mark)

To produce magnesium metal and chlorine gas from magnesium chloride, a molten electrolyte needs to be used. This is because:

A. Water is a stronger reductant than chloride ions.

B. Water is a stronger oxidant than magnesium ions.

C. Less energy is used when electrolysing a molten electrolyte as water does not react.

D. The products produced from an aqueous solution can react together spontaneously.

Question 14 (1 mark)

Calcium metal can be obtained from the electrolysis of molten calcium chloride. During this process, calcium ions flow to the:

A. Anode and are reduced to calcium metal.

B. Anode and are oxidised to calcium metal.

C. Cathode and are reduced to calcium metal.

D. Cathode and are oxidised to calcium metal.

Question 15 (1 mark)

Inspired from VCAA Chemistry NHT Exam 2022
https://www.vcaa.vic.edu.au/Documents/exams/chemistry/2022/NHT/2022ChemistryNHT-w.pdf#page=14

Fluorine can be produced commercially by the electrolysis of a mixture of potassium hydrogen difluoride, KHF_2, and hydrogen fluoride, HF. HF is a molecular gas at standard laboratory conditions (SLC).

Which of the following about the electrolysis of HF to produce fluorine is correct?

	Molten HF is not used in electrolysis to produce fluorine because	Aqueous HF is not used in electrolysis to produce fluorine because
A.	HF is a molec	
B.	HF is a molec	
C.	The melting temperature of HF is too high.	Oxygen would be produced.
D.	The melting temperature of HF is too high.	Hydrogen would be produced.

HF is a molecular compound and does not produce ions when heated.

HF(aq) contains $H^+(aq)$ and $F^-(aq)$ as well as H_2O. In electrolysis of HF(aq) the stronger reducing agent, $H_2O(l)$, will be oxidised producing $O_2(g)$ at the anode.

Question 16 (1 mark)

Brine is a concentrated solution of sodium chloride. The electrolysis of brine is a common industry due to the useful products it yields. The products are:

A. Hydrogen gas, chlorine gas and sodium hydroxide.

B. Hydrogen gas and oxygen gas.

C. Sodium metal and oxygen gas.

D. Sodium metal and chlorine gas.

Space for Personal Notes

Question 17 (1 mark)

When comparing the electrolysis of molten CuI_2 with that of a 1.0 *M* aqueous solution of CuI_2, which one of the following statements is correct?

A. The products at the anode and the cathode are the same in both cases.

B. The product at the cathode is the same in both cells but the products at the anode are different.

C. The product at the anode is the same in both cells but the products at the cathode are different.

D. The products at the cathodes of both cells are different from the products at the anodes.

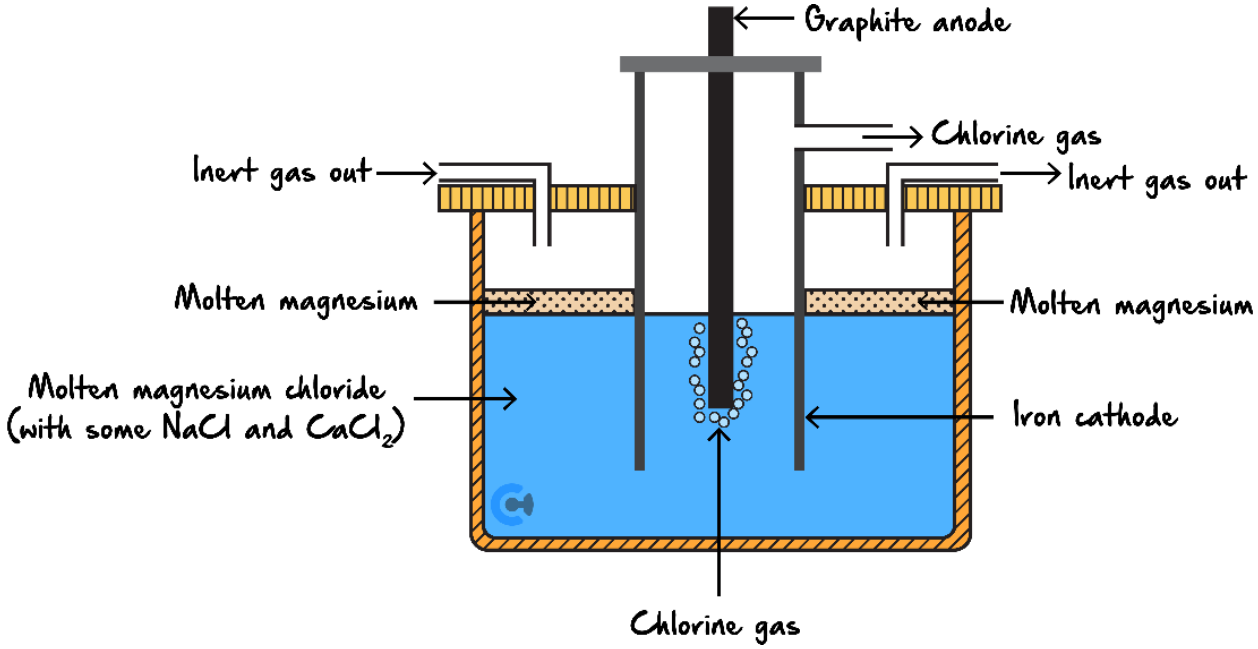
Space for Personal Notes

Section H: VCAA-Level Questions II (8 Marks)

INSTRUCTION: 8 Marks. 30 Seconds Reading. 7 Minutes Writing.

Question 18 (8 marks)

Magnesium is one of the most abundant elements on Earth. It is used extensively in the production of magnesium-aluminium alloys. It is produced by the electrolysis of molten magnesium chloride. A schematic diagram of the electrolytic cell is shown below.



The design of this cell takes into account the following properties of both magnesium metal and magnesium chloride:

- Molten magnesium reacts vigorously with oxygen.
- At the temperature of molten magnesium chloride, magnesium is a liquid.
- Molten magnesium has a lower density than molten magnesium chloride and forms a separate layer on the surface.

a. Write a balanced half-equation for the reaction occurring at each of: (2 marks)

Anode: _____

Cathode: _____

Marks	0	1	2	Average
%	59	26	15	**0.6**

Cathode: $Mg^{2+}(l) + 2e^- \rightarrow Mg(l)$

Anode: $2Cl^-(l) \rightarrow Cl_2(g) + 2e^-$

Most students missed out on marks for the use of incorrect states and/or use of equilibrium arrows.

b. Explain why an inert gas is constantly blown through the cathode compartment. (1 mark)

Marks	0	1	Average
%	78	22	0.2

To prevent:
- molten Mg reacting with oxygen in the air
- contact between Mg and air/oxygen.

c. The melting point of a compound can often be lowered by the addition of small amounts of other compounds. In an industrial process, this will save energy. In this cell, NaCl and $CaCl_2$ are used to lower the melting point of $MgCl_2$. Why can NaCl and $CaCl_2$ be used to lower the melting point of $MgCl_2$ but $ZnCl_2$ cannot be used? (2 marks)

Marks	0	1	2	Average
%	65	18	17	0.5

According to the electrochemical series:
- both Na^+ and Ca^{2+} are weaker oxidants than Mg^{2+} and so are unlikely to interfere with the production of Mg at the cathode.
- Zn^{2+} is a stronger oxidant than Mg^{2+}(aq) and could be reduced to Zn, thus either preventing the production of Mg or contaminating the Mg produced.

One mark was awarded for recognition that:
- Na^+ and Ca^{2+} are weaker oxidants that Mg^{2+}
- Zn^{2+} is a stronger oxidant than Mg^{2+} and an implication of this for the production of Mg.

d. What difference would it make to the half-cell reactions if the graphite anode were replaced with an iron anode? Write the half-equation for any different half-cell reaction. Justify your answer. (3 marks)

Marks	0	1	2	3	Average
%	56	20	21	3	0.7

According to the electrochemical series Fe is a stronger reductant than Cl^-.
At the anode, Fe would be oxidised instead of Cl^-/Fe^{2+} would be produced rather than Cl_2.
Half-equation: $Fe(s) \rightarrow Fe^{2+}(l) + 2e^-$
The cations $Fe^{2+}(l)$ would migrate to the cathode/Fe^{2+} is a stronger oxidant than Mg^{2+} hence Fe could be produced/cathode half-equation would be $Fe^{2+}(l) + 2e^- \rightarrow Fe(s)$.

One mark each was awarded for:
- explaining why Fe^{2+} is produced at the anode
- the correct anode half-equation
- explanation of, or half-equation for, production of Fe at the cathode or other valid consequence of the production of Fe at the anode.

Space for Personal Notes

Section I: Extension Questions (19 Marks)

Question 19 (11 marks)

It has been suggested that aluminium could be used as a fuel source by reacting it with water to produce hydrogen gas. The aluminium rods could be replaced when the vehicle is "refuelled". The hydrogen gas produced could then be used in a fuel cell.

a. What is the advantage of producing hydrogen gas in this way? (1 mark)

No CO_2 emissions are directly produced from this method of producing hydrogen.

b. The aluminium could be prepared using electrolysis.

i. Should the electrolyte be a molten liquid or an aqueous solution? Why? (2 marks)

The electrolyte should be a molten solution as water is a strong oxidant than aluminium ions, thus preventing the formation of aluminium metal from the electrolysis of an aqueous solution.

ii. Write the half equation for the reaction occurring at the cathode. (1 mark)

$Al^{3+}(l) + 3e^- \rightarrow Al(s)$

iii. Assuming aluminium chloride is being electrolysed to create aluminium, calculate the voltage required to prevent the products from re-reacting and hence, justify why this is the minimum potential to be provided in the electrolysis cell. (2 marks)

EMF = -1.66 - 1.36 = -3.02 V

Hence, > 3.02 V of voltage is required to force non-spontaneous redox reaction.

c. When the aluminium is reacted to form hydrogen from water, write half equations for the oxidation and reduction process.

i. Oxidation. (1 mark)

$Al(s) \rightarrow Al^{3+}(l) + 3e^-$

ii. Reduction. (1 mark)

$2H_2O(l) + 2e^- \rightarrow H_2(g) + 2OH^-(aq)$

d. The fuel cell uses a potassium hydroxide electrolyte.

i. Write the half equation for the reaction occurring at the positive electrode. (1 mark)

$O_2(g) + 2H_2O(l) + 2e^- \rightarrow 4OH^-(aq)$

ii. Ions move through the electrolyte. In what direction would the hydroxide ions move and why do they move in this direction? (2 marks)

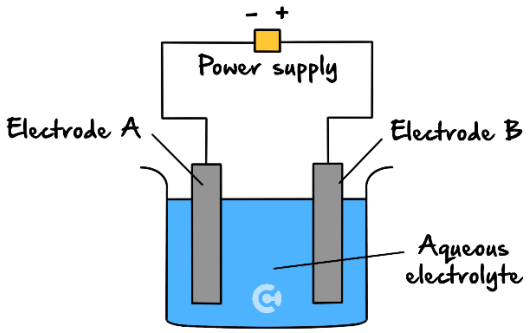
The hydroxide ions in the electrolyte move towards the anode as to balance the positive charge created there by the loss of electrons and to provide the hydroxide ions necessary for the reaction.

Space for Personal Notes

Question 20 (8 marks)

Three experiments were conducted to investigate electrolytic cell reactions.

a. In the experiment 1, the apparatus shown below was used.



After the current had passed through the cell for some time, a reddish brown liquid was formed at the electrode *B*, while a metal was found deposited on the electrode *A*.

i. Suggest the probable formula of the reddish-brown liquid. (1 mark)

Br_2

ii. Explain why the deposited metal could not be magnesium. (2 marks)

H_2O is a stronger oxidant than Mg^{2+}. In aqueous solution, water will be reduced to form hydrogen gas and hydroxide ions in preference to the reduction of magnesium ions to deposit magnesium.

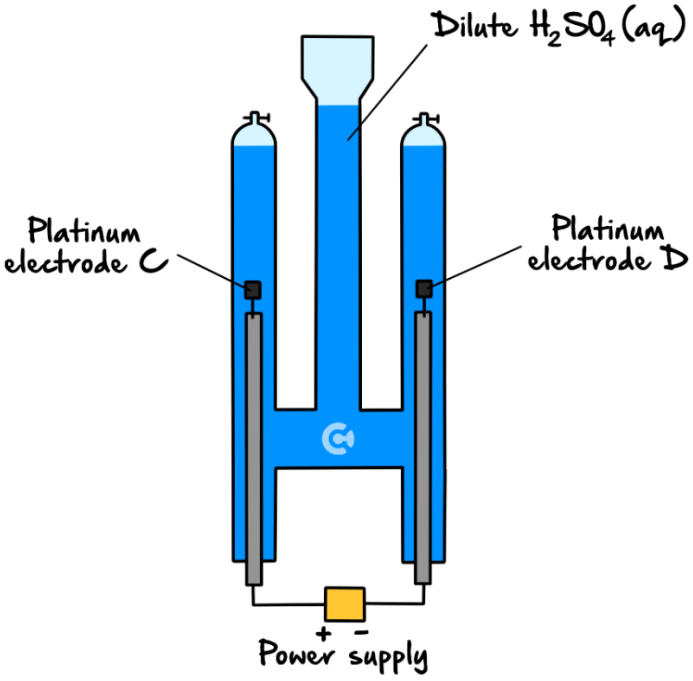
iii. Suggest a possible electrolyte for this cell which is consistent with the observations made. (1 mark)

For example, $CrBr_2(aq)$

iv. Explain why, regardless of the choice of electrolyte (assuming no spontaneous reaction occurs), identify which of the electrodes can be iron and explain why this is so. (2 marks)

Electrode *A* is able to be iron as it is the cathode where reduction occurs. Solid iron cannot be further reduced, thus making it inert in the cell itself and thus the choice of electrolyte and their oxidation and reduction strengths will not impact whether iron reacts in the cell or not. Stronger.

b. In experiment 2, the apparatus shown below was used with a dilute sulphuric acid solution as the electrolyte. A steady current of 0.060 amperes was maintained during the experiment.



i. Write a half-equation for the gas-producing reaction expected at the electrode C. (1 mark)

$2H_2O(l) \rightarrow O_2(g) + 4H^+(aq) + 4e^-$

ii. The cell is planned to be used to create reactants for an acidic fuel cell. Identify the component of the cell that allows this to occur. (1 mark)

The apparatus keeps the products, $H_2(g)$ and $O_2(g)$ separate, preventing a reaction and allowing them to be used properly in a fuel cell rather than them spontaneously reacting.

Space for Personal Notes

CONTOUREDUCATION

Website: contoureducation.com.au | **Phone:** 1800 888 300 | **Email:** hello@contoureducation.com.au

VCE Chemistry ¾

Free 1-on-1 Support

Be Sure to Make the Most of These (Free) Services!

- Experienced Contour tutors (45 + raw scores, 99 + ATARs).
- For fully enrolled Contour students with up-to-date fees.
- After school weekdays and all-day weekends.

1-on-1 Video Consults	Text-Based Support
➢ Book via bit.ly/contour-chemistry-consult-2025 (or QR code below). ➢ One active booking at a time (must attend before booking the next).	➢ Message +61 440 137 304 with questions. ➢ Save the contact as "Contour Chemistry".

Booking Link for Consults
bit.ly/contour-chemistry-consult-2025

Number for Text-Based Support
+61 440 137 304