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

VCE Chemistry ¾
AOS 2 Revision I [0.16]
Workshop

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: Warm Up (11 Marks)

INSTRUCTION: 11 Marks. 7 Minutes Writing.

Question 1 (1 mark)

An aluminium can is to be silver-plated in an electrolytic cell. The can forms one electrode and a silver rod the other electrode. The electrolyte provides a source of $Ag^+(aq)$.

The can to be plated, is connected to the:

A. Positive terminal of a battery so that oxidation occurs at the can.

B. Positive terminal of a battery so that reduction occurs at the can.

C. Negative terminal of a battery so that oxidation occurs at the can.

D. Negative terminal of a battery so that reduction occurs at the can.

Question 2 (1 mark)

Two types of electrochemical cells are the primary cell and the secondary cell. Which one of these features is exhibited by only one of these cells?

A. An energy transformation is from chemical energy to electrical energy.

B. The efficiency of the cell is close to 100%.

C. Products of the cell reaction remain in contact with the electrodes.

D. A spontaneous redox reaction is the overall reaction of the cell.

Space for Personal Notes

Question 3 (1 mark)

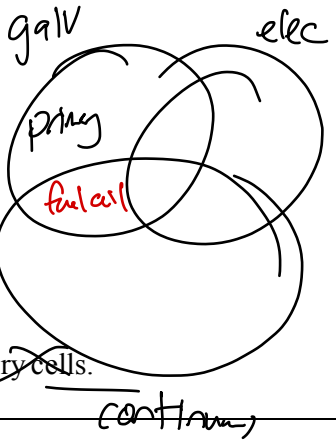
Which one of the following is the **most** accurate?

A. All fuel cells are galvanic cells.

B. All galvanic cells are primary cells.

C. All secondary cells have porous electrodes.

D. All fuel cells are more efficient than all secondary cells.



Question 4 (3 marks)

A solution containing 1.0 *M* of KBr(aq) is electrolysed with a silver attached to the positive terminal of the battery, and lead attached to the negative terminal of the battery.

a. Write the balanced half-equation which occurs at the:

i. Positive electrode. (1 mark)

$Ag_{(s)} \rightarrow Ag^+_{(aq)} + e^-$

ii. Negative electrode. (1 mark)

$2H_2O_{(l)} + 2e^- \rightarrow H_{2(g)} + 2OH^-_{(aq)}$

b. State the EMF required to be inputted for the reaction to take place. (1 mark)

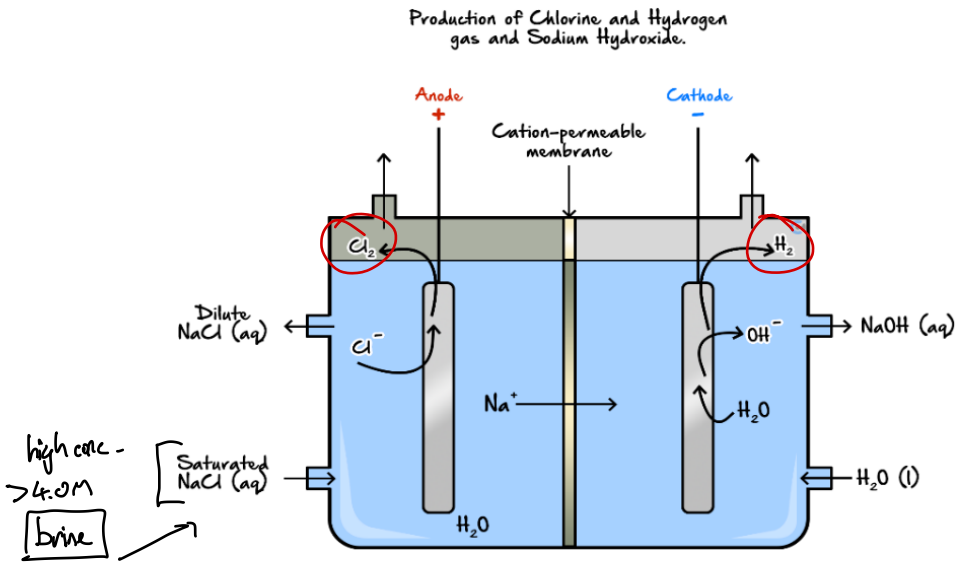
$-0.83 - 0.8 = -1.63\ V$

$> 1.63\ V$

Space for Personal Notes

Question 5 (5 marks)

The set-up below is used to produce a number of important chemicals. Sodium chloride is used as the raw material.



a. Determine the reaction occurring at the:

i. Anode. (1 mark)

$2Cl^-_{(aq)} \rightarrow Cl_{2(g)} + 2e^-$

ii. Cathode. (1 mark)

$2H_2O_{(l)} + 2e^- \rightarrow H_{2(g)} + 2OH^-_{(aq)}$

b. Why is it important to remove diluted NaCl from the cell and replace it with saturated NaCl? (1 mark)

To keep NaCl highly concentrated. If it falls too low, water will be oxidised in preference to Cl^-. ✓

c. State **two** roles of the "cation permeable membrane". (2 marks)

- separate products (Cl_2 & H_2) ✓ so they do not come in direct contact & spontaneously react, producing heat → $H_{2(g)}$ is explosive
- allow for flow of ions, to maintain electric neutrality (Na^+)

Section B: Ramping Up (9 Marks)

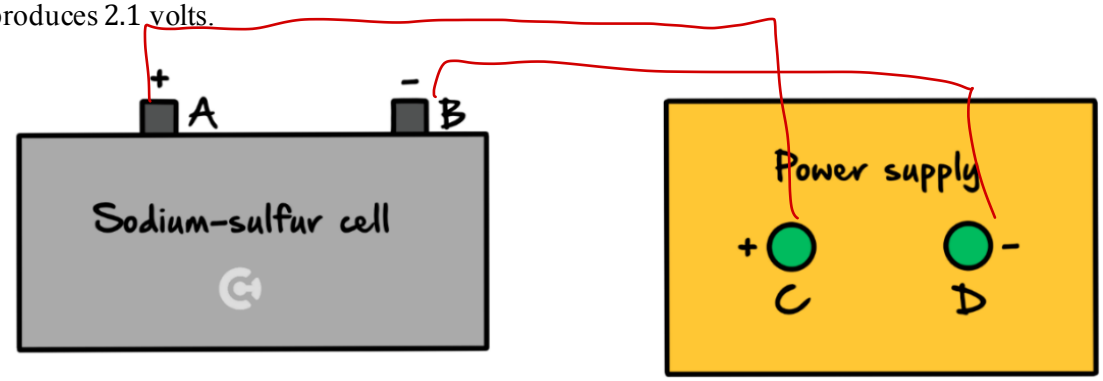
INSTRUCTION: 9 Marks. 7 Minutes Writing.

Question 6 (1 mark)

The sodium-sulphur cell shown below is a secondary galvanic cell with the overall cell reaction:

$$2Na(l) + S(l) \rightleftharpoons Na_2S(l)$$

The cell produces 2.1 volts.



The cell is to be recharged by connecting it to the power supply.

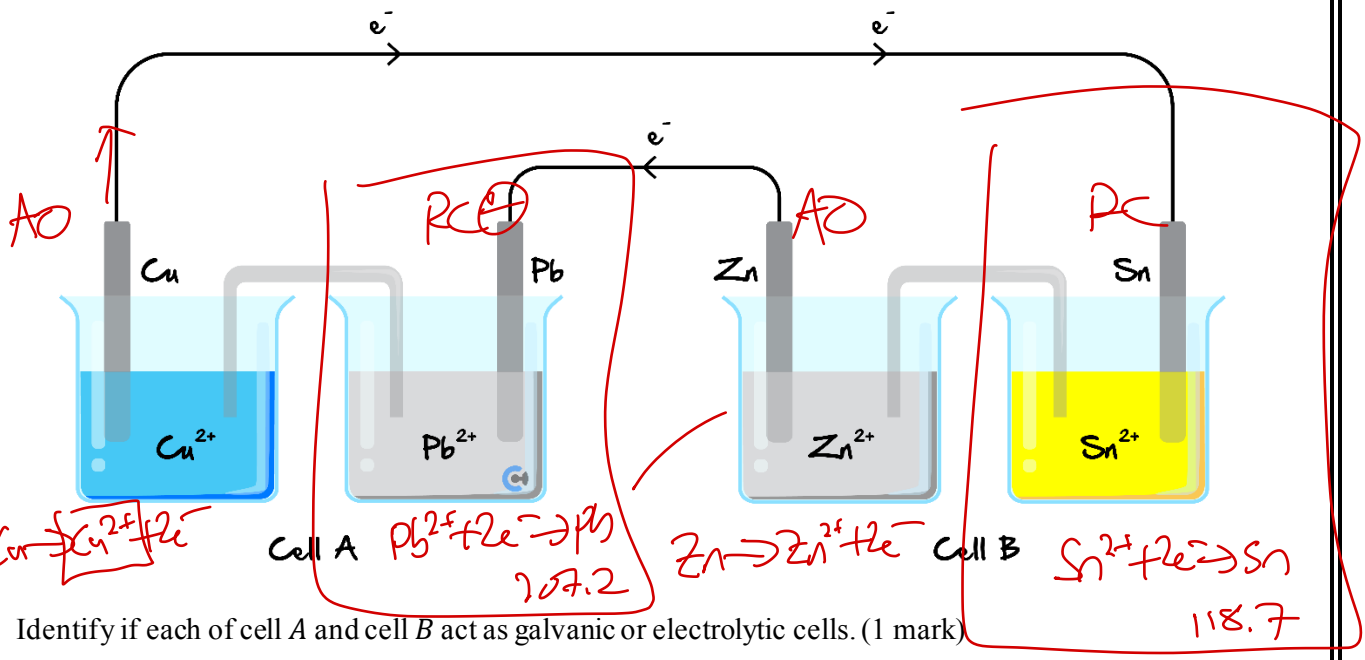
Which one of the following best describes the arrangement for recharging the cell?

	Power Supply Voltage	Connect Terminals
A.	2.1 volts.	A to C and B to D.
B.	2.1 volts.	A to D and B to C.
C.	More than 2.1 volts.	A to C and B to D.
D.	More than 2.1 volts.	A to D and B to C.

Space for Personal Notes

Question 7 (2 marks)

The following cell is set up.



a. Identify if each of cell *A* and cell *B* act as galvanic or electrolytic cells. (1 mark)

Cell *A*	Cell *B*
electrolytic	galvanic

b. Select the correct option. (1 mark)

A. The copper electrolyte will become less intensely blue.

B. The negative electrode in cell *A* will decrease in size.

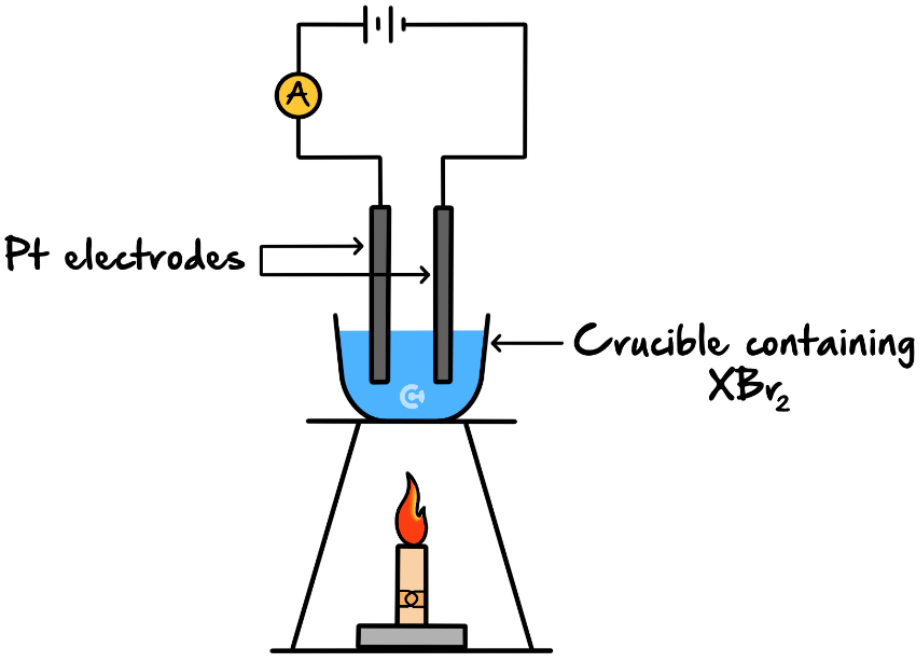
C. The mass deposited at the cathode of cell *A* will be greater than the mass deposited at the cathode of cell *B*.

D. The concentration of tin (II) ions will increase with time.

Space for Personal Notes

Question 8 (6 marks)

A teacher demonstrated the process of electrolysis of a molten salt using an unknown metal salt, XBr_2. The apparatus was set up as shown below.



At the conclusion of the demonstration, the students were provided with the following information.

- A current of 1.50 amperes was applied for 30.0 minutes.
- 2.90 g of metal X was produced.

a. Write a balanced half-equation for the anode reaction in this electrolytic cell. (1 mark)

$2Br^-_{(l)} \rightarrow Br_{2(l)} + 2e^-$ 9%

b.

i. Determine the amount, in *mol*, of metal *X* that was deposited on the cathode. (3 marks)

$Q = It = 1.50\,A \times 30 \times 60\,s = 2.70 \times 10^3\,C$

$n(e^-) = \frac{Q}{F} = \frac{2.70 \times 10^3\,C}{96500\,C/mol} = 0.0280\,mol$

charge of X in XBr_2 is +2 $(X^{2+} + 2e^- \rightarrow X)$

$n(X) = \frac{1}{2} n(e^-) = 0.0140\,mol$

ii. Identify metal *X*. (2 marks)

$n = \frac{m}{M_r}$ $M_r = \frac{m}{n} = \frac{2.90\,g}{0.0140\,mol} = 207.1\,g\,mol^{-1}$

∴ metal is lead (Pb) 64%

Space for Personal Notes

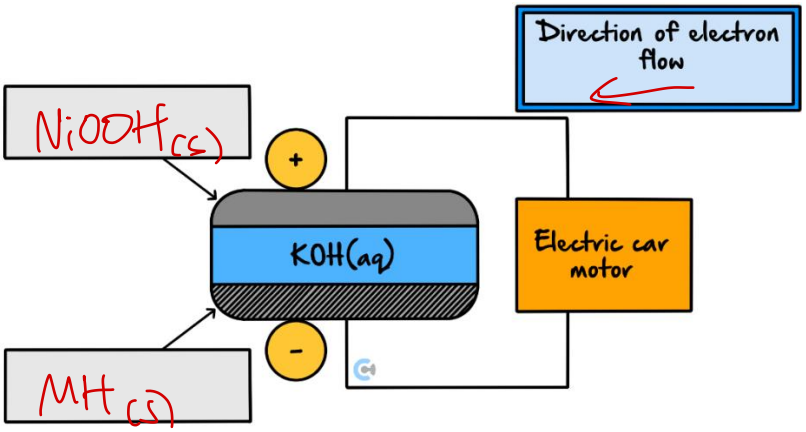
Section C: Getting Trickier I (13 Marks)

INSTRUCTION: 13 Marks. 10 Minutes Writing.

Question 9 (6 marks)

Inspired from VCAA Chemistry Exam 2015
https://www.vcaa.vic.edu.au/Documents/exams/chemistry/2015/2015chem-w.pdf#page=37

The storage battery to be used in the hybrid cars is comprised of a series of nickel metal hydride, NiMH, cells. MH represents a metal hydride alloy that is used as one electrode. The other electrode contains nickel oxide hydroxide, NiOOH. The electrolyte is aqueous KOH.



The simplified equation for the reaction at the anode while **recharging** is:

$$Ni(OH)_2(s) + OH^-(aq) \rightarrow NiOOH(s) + H_2O(l) + e^-$$

The simplified equation for the reaction at the cathode while **recharging** is:

$$M(s) + H_2O(l) + e^- \rightarrow MH(s) + OH^-(aq)$$

a. What is the overall equation for the **discharging** reaction? (1 mark)

$NiOOH_{(s)} + H_2O_{(l)} + MH_{(s)} + OH^-_{(aq)} \rightarrow M_{(s)} + H_2O_{(l)} + Ni(OH)_{2(s)} + OH^-_{(aq)}$

$MH_{(s)} + NiOOH_{(s)} \rightarrow M_{(s)} + Ni(OH)_{2(s)}$

b. In the boxes on the diagram above, indicate which is the MH electrode and which is the NiOOH electrode. (1 mark)

c. In the bold box provided above the cell diagram, use an arrow, → or ←, to indicate the direction of the electron flow as the cell is discharging. (1 mark)

d. The battery discharged for 60 minutes, producing a current of 1.15 *A*. What mass, in grams, of NiOOH would be used during this period? (3 marks)

$Q = It = 1.15A \times 60 \times 60s = 4.14 \times 10^3 C$

$n(e^-) = \frac{Q}{F} = \frac{4.14 \times 10^3 C}{96500 \, C mol^{-1}} = 0.0429 mol$

$n(NiOOH) = n(e^-) = 0.0429 mol$

$m(NiOOH) = n \times Mr = 0.0429 \times (58.7 + 32 + 1)$

$= 3.93g = 3.9g$ (2 s.f.)

Question 10 (7 marks)

The lithium-ion battery is a secondary cell that is now widely used in portable electronic devices.

In these batteries, lithium ions, Li^+, move through a special non-aqueous electrolyte between the two electrodes. The batteries are housed in sealed containers to ensure that no moisture can enter them.

Both electrodes are made up of materials that allow the lithium ions to move into and out of their structures. The anode consists of LiC_6, where lithium is embedded in the graphite structure. Lithium cobalt oxide, $LiCoO_2$, is commonly used as the material in the cathode. The reaction at the cathode is quite complex.

When the cell discharges, Li^+ ions move out of the anode and enter the cathode. During discharge, the half-cell reaction at the anode is:

O: AO R: RC

$LiC_6 \rightarrow Li^+ + e^- + C_6$

a. During discharge, what is the polarity of the graphite electrode? (1 mark)

negative (−)

b. Write the half-equation for the reaction that occurs at the cathode of a lithium-ion battery when it is recharged. (1 mark)

$Li^+ + e^- + C_6 \rightarrow LiC_6$

c. In a lithium-ion battery, lithium metal must not be in contact with water. Explain why and justify your answer with the use of appropriate equations. (3 marks)

span.

Li is a strong reductant & reacts readily w/ water (1)

$Li_{(s)} \rightarrow Li^+_{(aq)} + e^-$ $2H_2O_{(l)} + 2e^- \rightarrow H_{2(g)} + 2OH^-_{(aq)}$

$2H_2O_{(l)} + 2Li_{(s)} \rightarrow H_{2(g)} + 2LiOH_{(aq)}$ (1)

$H_{2(g)}$ is produced which is highly flammable & may explode as reaction is exothermic.

d. Identify **one** design feature of the lithium-ion battery that enables it to be recharged. (1 mark)

products remain in contact w/ electrode.

Li^+ can move in/out & used to balance charges & acts as a reactant/prod at electrode

e. What is **one** advantage of using a secondary cell compared to using a fuel cell? (1 mark)

Secondary cell can be recharged, whereas a fuel cell continuously needs a supply of reactants.

secondary cell is new cheaper.

secondary cell more portable

Space for Personal Notes

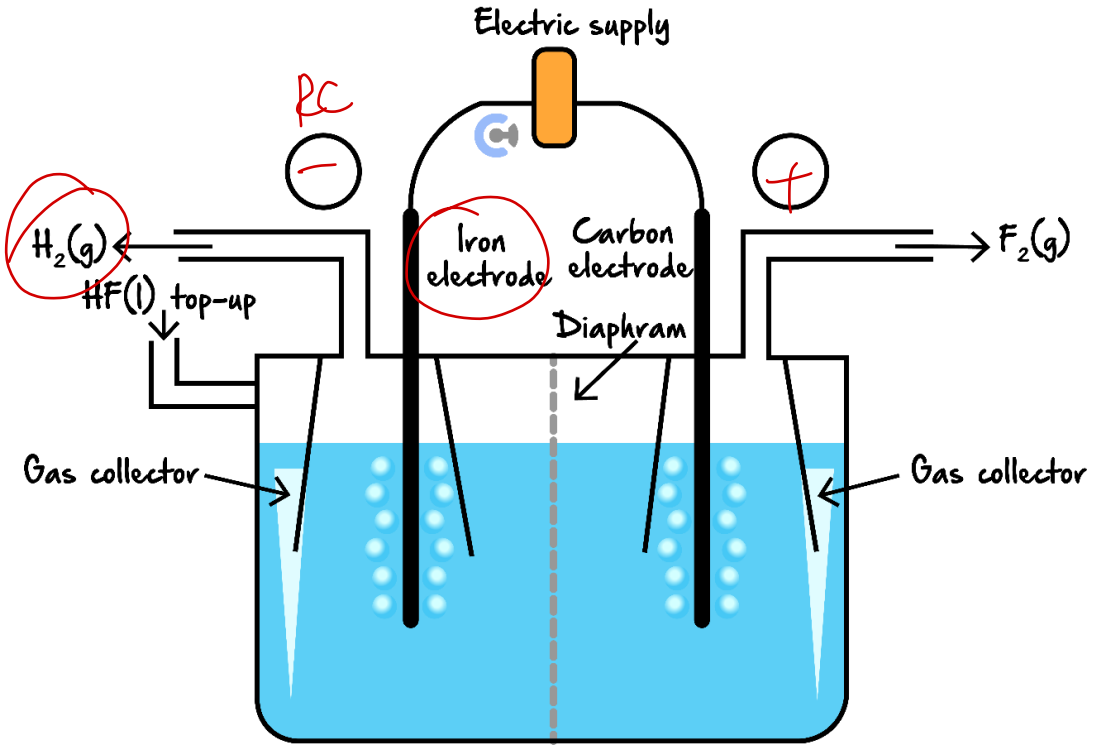
Section D: Getting Trickier II (14 Marks)

INSTRUCTION: 14 Marks. 13 Minutes Writing.

Question 11 (14 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~~ chemicals, 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)

$2HF_{(l)} \rightarrow F_{2(g)} + H_{2(g)}$

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)

Prevent H_2 & F_2 from mixing & reacting spontaneously, whereby $H_2O_{(g)}$ may result in an explosion. (1) (1)

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

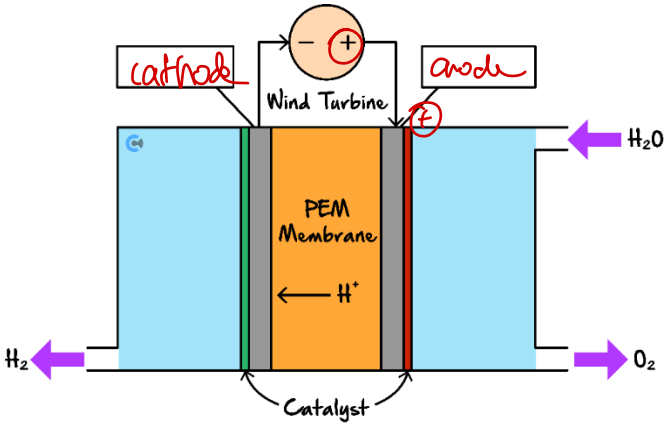
If carbon electrode is replaced by iron, iron becomes the new strongest reductant & oxidises in preference (spontaneously): $Fe_{(s)} \rightarrow Fe^{2+}_{(l)} + 2e^-$, (1) & thus $F_{2(g)}$ is no longer produced. (1)

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

The left electrode is the cathode, where reduction takes place. (1) As such, even though $Fe_{(s)}$ would become the strongest reductant, it would be present at the cathode & not the anode, & as such would not oxidise. This means the reaction continues unchanged. (1)

7/12

f. This method of producing hydrogen gas is then compared to obtaining hydrogen gas from a Polymer Electrolyte Membrane (PEM) Electrolyser. An example of a PEM electrolyser powered by wind energy is shown below.



i. Label the cathode and anode in the boxes provided above. (1 mark) positive terminal of the power source.

ii. Write the balanced half-equation which takes place at the electrode attached to the power source. (1 mark)

$2H_2O_{(l)} \rightarrow O_{2(g)} + 4H^+_{(aq)} + 4e^-$

iii. Production of hydrogen gas using this cell is considered to be 'green'. State **one** requirement for a fuel to be considered to be 'green', and explain how the PEM electrolyser fulfils this requirement. (2 marks)

Renewable	no greenhouse gas emission
The cell uses renewable energy such as wind energy in this example.	The cell produced H_2 & O_2 which are not greenhouse gases.

iv. One method to source the water used for this electrolysis is from freshwater sources in rivers and lakes. State **one** sustainability challenge which arises from this, with reference to United Nations Sustainable Development Goal 14. (1 mark)

Sourcing water from freshwater rivers affects the livelihood of natural wildlife (e.g. fishes, ducks etc) which affects their life below water.

Let's take a BREAK!

Section E: VCAA-Level Questions I (10 Marks)

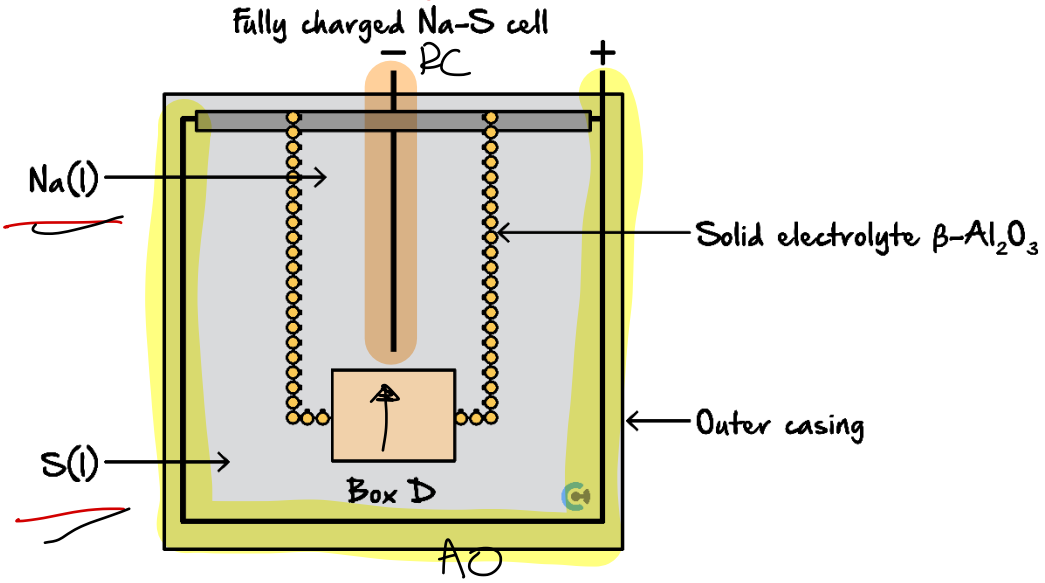
INSTRUCTION: 10 Marks. 30 Seconds Reading. 10 Minutes Writing.

Question 12 (10 marks)

Inspired from VCAA Chemistry Exam 2022
https://www.vcaa.vic.edu.au/Documents/exams/chemistry/2022/NHT/2022ChemistryNHT-w.pdf#page=28

Researchers are developing rechargeable cells containing sodium, Na, and sulphur, S. A simplified diagram of a fully charged Na-S cell is shown below.

The solid electrolyte consists of ceramic beta-alumina, β-Al_2O_3. β-Al_2O_3 separates the two half-cells and selectively conducts sodium ions, Na^+.



a.

i. Draw an arrow in Box *D* to show the direction of flow of Na^+ across the membrane when the cell is charging. (1 mark)

ii. Identify and explain **one** of the features of the Na-S cell that would make it suitable to power electric vehicles. (2 marks)

The cell is rechargeable, thus after use in electric vehicle does not need to be replaced - instead can be recharged.

The cell is portable, it can be used in a moving vehicle.

b. Environmental conditions can influence reactions during the discharge of the battery. When a particular Na-S test cell is discharging, the half-equation for the reaction at one of the electrodes is:

$$3S + 2e^- \rightarrow S_3^{2-}$$

S_3^{2-}

i. Write the half-equation that occurs for the reaction at the other electrode. (1 mark)

$Na \rightarrow Na^+ + e^-$ (1) (1)

ii. When the Na-S test cell is discharging, solid sodium trisulphide, Na_2S_3, is formed. Write the overall equation for the charging process in this cell. (1 mark)

$3S + 2Na \rightarrow S_3^{2-} + 2Na^+$ | $3S + 2Na \rightarrow Na_2S_3$

$Na_2S_3 \rightarrow 2Na + 3S$ (s) (l) (l)

iii. Identify and explain one factor that may affect the useful life of the Na-S test cell. (2 marks)

Physical stress (shaking of battery) causes products to fall off electrode & lose contact, decreasing battery life. (1)

Side reactions occurring, decreasing the amount of useful product that can be recharged. (1)

High temperature increasing the possibility of side reactions. (1) exp

c. The Na-S cell contains pure Na metal. Safety information for a Na-S cell includes the requirement that the system must be protected from water. Explain why this would be one of the safety requirements. Include any relevant equations in your answer. (3 marks)

Na(s) reacts spontaneously w/ water when placed in direct contact. (1)

$Na_{(s)} \rightarrow Na^+_{(aq)} + e^-$ $2H_2O_{(l)} + 2e^- \rightarrow H_{2(g)} + 2OH^-_{(aq)}$ (1)

$2Na_{(s)} + 2H_2O_{(l)} \rightarrow H_{2(g)} + 2NaOH_{(aq)}$

This produces H_2 which is highly flammable & explosive. (1)

Section F: Multiple Choice Questions (5 Marks)

INSTRUCTION: 5 Marks. 5 Minutes Writing.

Question 13 (1 mark)

A highly concentrated salt solution, called brine, is used as the electrolyte in this cell.

The main reason that a highly concentrated, rather than a dilute solution is used is in order to:

A. Allow an electric current to pass through the cell.

B. Produce chlorine gas, in preference to oxygen gas.

C. Allow sodium hydroxide to be separated from the salt by crystallisation.

D. Create non-standard conditions that ensure hydrogen gas production.

Question 14 (1 mark)

A student prepares aqueous solutions of 1.0 M $AgNO_3$, $Co(NO_3)_2$, and KNO_3 all in the same beaker. Platinum electrodes were placed in the solution and the cell undergoes electrolysis with the current applied under SLC. Each cathode is then dried and weighed to determine mass change. The cell runs for a very long time until no reaction occurs. The last product that was produced at the cathode is:

A. Potassium.

B. Cobalt.

C. Silver.

D. Hydrogen gas.

Space for Personal Notes

Question 15 (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 as are the products at the anodes.

Question 16 (1 mark)

The silver oxide-zinc battery is rechargeable and utilises sodium hydroxide, NaOH, solution as the electrolyte. The battery is used as a backup in spacecraft, if the primary energy supply fails. The overall reaction during discharge is:

$$Zn + Ag_2O \rightarrow ZnO + 2Ag$$

When the silver oxide-zinc battery is being recharged, the reaction at the anode is:

A. $2Ag + 2OH^- \rightarrow Ag_2O + H_2O + 2e^-$

B. $Ag_2O + H_2O + 2e^- \rightarrow 2Ag + 2OH^-$

C. $ZnO + H_2O + 2e^{-1} \rightarrow Zn + 2OH^-$

D. $Zn + 2OH^- \rightarrow ZnO + H_2O + 2e^-$

Question 17 (1 mark)

Which of the following processes will **not** produce a gas at the anode?

A. Electrolysis of silver nitrate solution using carbon electrodes.

B. Electrolysis of dilute lead (II) nitrate using platinum electrodes.

C. Electrolysis of very concentrated sodium chloride solution using carbon electrodes.

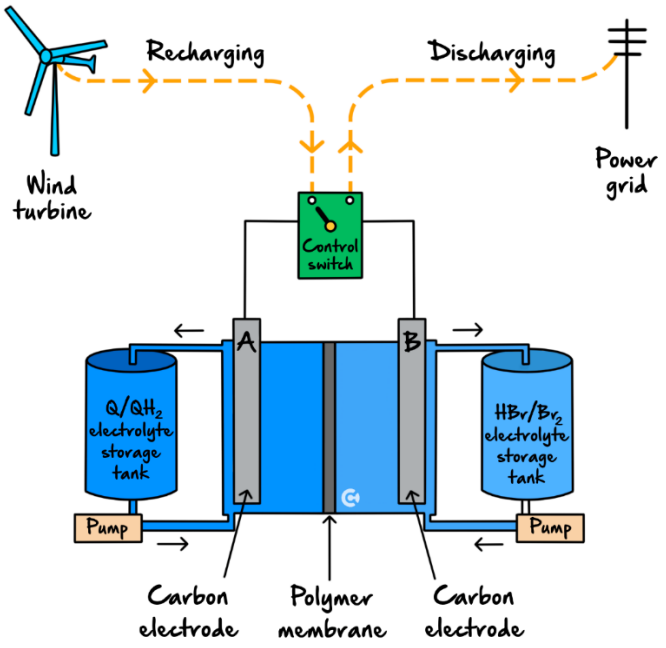
D. Electrolysis of dilute copper (II) chloride solution using a carbon cathode and a copper anode.

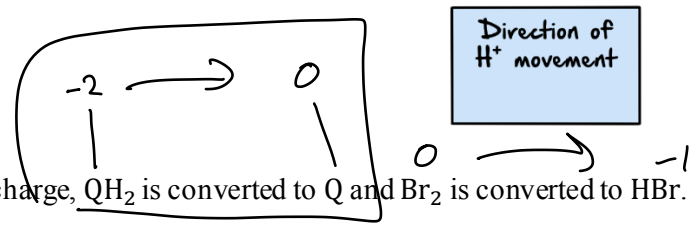
Section G: VCAA-Level Questions II (7 Marks)

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

Question 18 (7 marks)

Redox flow batteries are used to store the excess electrical energy generated by commercial wind and solar farms. The batteries are recharged using electricity generated by the wind turbines or solar cells. A scientific report, published in January 2014, described a redox flow battery that used a family of chemicals commonly occurring in plants such as rhubarb. These are organic and are known as quinones and hydroquinones. A diagram showing how such a redox flow battery might operate is provided below. In the diagram, Q represents the quinone and QH_2 represents the corresponding hydroquinone. The researchers made a model of the redox flow battery using aqueous solutions of the redox pairs, Q/QH_2 and Br_2/Br^-. Refer to the diagram below.





During discharge, QH_2 is converted to Q and Br_2 is converted to HBr. KOTHES

a. Write balanced half-equations for the reactions occurring at the positive and negative electrodes as the cell is **discharged**. Assume the electrolytes are acidic. (2 marks)

Positive electrode: $Br_{2(aq)} + 2H^+_{(aq)} + 2e^- \rightarrow 2HBr_{(aq)}$

Negative electrode: $QH_{2(aq)} \rightarrow Q_{(aq)} + 2H^+_{(aq)} + 2e^-$

b. Write an overall equation for the reaction that occurs when the cell is **recharged**. (1 mark)

_____

_____

_____

c. The researchers reported that their tests indicated that only hydrogen ions were able to move through the polymer membrane separating the cells.

i. In the box provided on the diagram, use an arrow, → or ←, to indicate the direction of movement of hydrogen ions as the cell is **recharged**. (1 mark)

ii. Why is it important that the other reactants in the half-cells are not able to pass through the polymer? (1 mark)

_____

_____

_____

d. The researchers also reported that the voltage applied to the cell during recharging was kept below 1.5 *V* to avoid the electrolysis of water.

Write an equation for the overall reaction that occurs when water is electrolysed. (1 mark)

_____

_____

e. Quinones have a number of industrial applications and are cheaply synthesised on a large scale from anthracene, which is found in crude oil. The report's researchers suggest that because these compounds also exist in plants such as rhubarb, the electrolyte material is itself a renewable resource.

What is meant by the term 'renewable' in this context? (1 mark)

_____

_____

_____

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