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a) - Mercury cell

- Brine is electrolysed in the electrolysis cell, where the anode reaction occurs:

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

- and aqueous $Na^+_{(aq)}$ ion is dissolved in the flowing mercury

- aqueous Na^+ is then passed through the decomposer, where the cathode reaction occurs:

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

The product OH^- ion then forms with Na^+ in mercury

$Na^+_{(aq)} + OH^-_{(aq)} \rightarrow NaOH_{(aq)}$

- and so sodium hydroxide is extracted.

b)	Molten NaCl	aqueous NaCl (concentrated)
anode	$2Cl^-_{(l)} \rightarrow Cl_{2(g)} + 2e^-$	$2Cl^-_{(aq)} \rightarrow Cl_{2(g)} + 2e^-$
cathode	due to lack of H_2O $Na^+_{(l)} + e^- \rightarrow Na_{(s)}$	due to presence of H_2O $2H_2O_{(l)} + 2e^- \rightarrow H_{2(g)} + 2OH^-_{(aq)}$
overall	$2Cl^-_{(l)} + 2Na^+_{(l)} \rightarrow Cl_{2(g)} + 2Na_{(s)}$	$2Cl^-_{(aq)} + 2H_2O_{(l)} \rightarrow H_{2(g)} + Cl_{2(g)} + 2OH^-_{(aq)}$

∴ Though both are similar in anode reaction, there are differences in cathode reaction, where, due to lack of $H_2O_{(l)}$, solid $Na_{(s)}$ is formed in electrolysis of molten NaCl.

c) i) $2SO_2 + O_2 \rightleftharpoons 2SO_3$

$K = \frac{[SO_3]^2}{[SO_2]^2[O_2]}$

	$2SO_2$	$+ O_2$	$\rightleftharpoons 2SO_3$
∴ n_i	0.80	0.40	0
Δn	−0.30	−0.15	+0.30
n_e	0.50	0.25	0.30
$[\ ]_e$	5.0	2.5	3.0

10 L

∴ $q = \frac{[SO_3]^2}{[SO_2]^2[O_2]}$

$= \frac{[3.0]^2}{[5.0]^2[2.5]}$

$= 0.144$

$\doteqdot 0.14$ at time A

∴ eqⁿ constant at time A is 0.14.

ii) The temperature could have been lowered.

$2SO_2 + O_2 \rightleftharpoons 2SO_3$ $\Delta H = \underline{-ve}$

The forward reaction is exothermic.

- By reducing the temperature of the system the eqⁿ according to Le Chatelier's principle, would counteract the changes applied to it. Therefore, the system would release heat to counteract the drop of temperature, thus the exothermic reaction

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is favoured, and so is the forward reaction. Thus, more SO_3 is produced and the ~~conc~~ mole of SO_2 is decreased, eqm shifts to the right.

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d) i) - reactant A - sodium ~~[illegible]~~ hydroxide
- saponification

ii) - Safety : conc sodium ~~[illegible]~~ hydroxide is caustic and so gloves should be worn when handling it
- around 70 mL of oil are placed in a big test tube (olive oil)

- ~~[illegible]~~ 200 mL of hot water bath is prepared
- the excess sodium chloride (around 20 mL) is added to the test tube and the test tube is put in the hot water bath.
- The mixture is stirred for 10 minutes.
- the 8mL of concentrated NaCl solution is then added.
- The soap is then further stirred until all the soaps has precipitated out
- The soap is taken out and dried.

- safety! water bath is used to prevent the oil from lighting up (as the oils can possibly be volatile, though unlikely)

e) Importance : - Lime stone is used to generate CO_2

$$CaCO_{3(s)} \xrightarrow{\Delta} CaO_{(s)} + CO_{2(g)}$$

which is used to produce sodium bicarbonate

$$CO_{2(g)} + H_2O_{(l)} \rightleftharpoons H_2CO_{3(aq)}$$

$$H_2CO_{3(aq)} + NH_{3(aq)} \rightarrow NH_{4(aq)}^{+} + HCO_{3(aq)}^{-}$$

$$HCO_{3(aq)}^{-} + NaCl_{(aq)} \rightarrow NaHCO_{3(s)} + Cl^{-}_{(aq)}$$

and heated to produce sodium carbonate

$$2NaHCO_{3(s)} \xrightarrow{\Delta} Na_2CO_{3(s)} + CO_{2(g)} + H_2O_{(l)}$$

the CaO is also used to recover ammonia

$$NH_{4(aq)}^{+} + Cl^{-}_{(aq)} \rightarrow NH_4Cl_{(aq)}$$

$$2NH_4Cl_{(aq)} + CaO_{(s)} \rightarrow 2NH_{3(aq)} + CaCl_{2(aq)} + H_2O_{(aq)}$$

Thus, lime stone is a vital part of the Solvay process, as it is not only used for production of $Na_2CO_{3(s)}$, but also for recycling of $NH_{3(aq)}$ which is also used in the production.

- By using limestone, there are both positive and negative environmental impact.

- positive

  - assist in recycling of ammonia.

    - CaO obtained from generating CO_2 can be used to recycle ammonia from ammonium ion.

      Thus, there is no need of using more ammonia

      - also, there is no need to dispose ammonia, which is toxic to the environment

        - causes respiratory problems if inhaled.

- however, there is also the bad environmental impact

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- mining of limestone
  - mining of limestone can cause noises and increase in particles in the air
  - the noise can disturb the wild life around the mining area
    - the increase in particles in the air is also bad for various organisms
      - the particles can clog up the plant's leaf (and stomates), preventing the plant's respiration and also hindering the photosynthesis
      - The small particles are bad for breathing.
  - mining in sensitive area can also cause instability of land, and so, collapse

Thus, the location of the mine must be considered to minimise the impact to the environment

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