Question 28 - Industrial Chemistry.

a.) i) Saponification - is the process used to make soap. It is the reaction between an ester and NaOH to produce glycerol and a carboxylate (which is soap)

ii) Soap is a polar ~~molecules~~ molecule. ⌒⌒⌒⌒⊖. Its negative head is hydrophilic (water loving) which attracts the H_2O ~~molecules~~ molecules. While its tail which is hydrophobic (water hating) attacks the oily, greasy particles on the material. An ~~emulsion~~ emulsification occurs, the material ~~act~~ acting as the surfactant as the oily particles are lifted off the material by the hydrophobic tail. The soap acts as the emulsifier.

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(b) $SO_2(g) + \frac{1}{2}O_2(g) \rightleftharpoons SO_3(g)$

0.06	0.05	—	mol.L^{-1}
—	—	0.04	mol.L^{-1}
$0.06 - x$	$0.05 - x$	$2x$	

$\therefore x = 0.02$ mol.L^{-1}

$0.04 \quad 0.03 \rightleftharpoons 0.04$

$$K = \frac{[SO_3]}{[SO_2].[O_2]^{\frac{1}{2}}}$$

$$= \frac{0.04}{0.04 \times (0.03)^{\frac{1}{2}}}$$

$\therefore K = 5.77$ (2.d.p.)

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(c) (i)

$H_2O_{(l)} + H_2SO_{4(g)} \longrightarrow 2H^+_{(aq)} + SO_4^-{}_{(aq)} + H_2O_{(l)}$

The sulfuric acid completely ionises when added to H_2O.

(ii) ① Oxidising agent:

$H_2SO_{4(aq)} + Mg_{(s)} \longrightarrow MgSO_{4(aq)} + H_{2(g)}$

Sulfuric acid + Magnesium → Magnesium sulfate + Hydrogen gas

In this reaction the Magnesium has been oxidised, & the sulfuric acid reduced, hence H_2SO_4 is acting as an oxidising agent.

② Dehydrating agent:

$C_2H_5OH_{(l)} \xrightarrow{\text{conc. } H_2SO_4} C_2H_{4(g)} + H_2O_{(l)}$

(ethanol) (ethene) (water)

H_2SO_4 is used as a dehydrating agent (take water out). dehydrate to ethanol to form ethene and water.

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(3) Precipitating Sulfates:

$H_2SO_{4(aq)} + Pb(NO_3)_{2(aq)} \rightarrow PbSO_{4(s)} + 2H^+_{(aq)} + 2NO_3^-$

Sulfuric acid is used in this case as an agent to precipitate lead Sulfate out of a solution. This process can be utilised in many other situations (ie. Use something other than lead nitrate).

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d) (i) We investigated the equilibrium reaction in a coke bottle.

The procedure was to sample the solution then leave the cap of the bottle off for 2 days. sampling the same solution again after that period of time resulted in a drastically different taste.

(ii) The equilibrium reaction was:

$$CO_{2(aq)} \rightleftharpoons CO_{2(g)}$$

inside the closed system. But once the cap was off the bottle, the pressure of the system decreased causing a shift in the equilibrium to the right (product) As a result more $CO_{2(g)}$ formed as the solution of coke became 'flat'.

An analysis of the equilibrium reaction

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was achieved by tasting the difference in the solution. The quality of the solution after 2 days left open was much less than the newly opened, initial sample.

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e) Sodium hydroxide (NaOH) is produced by the electrolysis of NaCl, ~~which~~ the other products are H_2 and Cl_2 gas.

The general method for producing NaOH is $2NaCl + 2H_2O \xrightarrow{\text{electrolysis}} 2NaOH + H_2 + Cl_2$

There are ~~two~~ several ~~methods~~ processes used to produce NaOH, one process is by using the Mercury cell.

In the Mercury cell this occurs

anode $2Cl^- \rightarrow Cl_2 + 2e^-$

cathode $Na^+ + e^- \Rightarrow Na$

The Na is form an almalgam with mercury and travels to another chamber where it ~~is~~ reacts with H_2O

$Na + H_2O \Rightarrow NaOH + H^+$

The mercury process is able to produce large quantities of NaOH, which is reasonably pure and cheap. Yet it is not entirely pure as there will always

be Cl present. The method also is harmful to the environment, as it ~~produces~~ uses mercury. The mercury can enter the waterways and kill marine animals and also reach humans, where it cause serious health problems.

Another method used industrially to produce NaOH is the diaphragm method. where at the anode - $2Cl^- \rightarrow Cl_2 + 2e$ occurs and at the cathode H^+ is produced by - $2H_2O + 2e \rightarrow 2H^+ + 2OH^-$

The diaphragm cell uses asbestos diaphragm which makes this method environmentally unfriendly, because asbestos is damaging to living things.

Because the cathode and anode are separated there is no chance that the H^+ and Cl^- will react or the Cl^- react with OH^- to produce the unwanted by product of ClO.

~~De~~ This method does ~~XXX~~ produce

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pure NaOH, ~~as there is always Cl~~ present.

The lastest ~~industrial~~ process used to produce NaOH is ~~the~~ by ~~the~~ using the membrane cell. This process is similar to the diaphragm method but is more environmentally friendly. Instead of using asbestos for the diaphragm, it uses a polymer, PMX. ~~This is the~~ This cell represents the change in methods to produce NaOH. The mercury process is rarely used in ~~industrial~~ industry nowdays because of its harmful nature, and the diaphragm cell is being transformed into the membrane cell, which produces pure NaOH and is friendly to the environment.