Redox Reactions & Electrolysis

Q-1) What is oxidation? [OILRIG]

- gain of oxygen
- removal of hydrogen
- loss of electrons
- increase in oxidation no.

Q-2) What is reduction?

> - gain of hydrogen
- removal of oxygen
- gain of electrons
- decrease in oxidation no

Q-3) What is oxidation number/state?

> It is a number given to an atom in a compound which describes how oxidised or reduced it is.
(numerical charge value : eg: Al^{3+})

Q-4) Rules for oxidation no./state.

① The oxidation no. of any uncombined element is zero
eg: Cl_2, O_2, Fe, C ...

② The sum of oxidation no. of all atoms in a neutral compound is zero.
eg: H_2SO_4, MgO, NaCl...

③ The sum of oxidation no. of all atoms in an ion, is equal to the charge on that ion.
eg: SO_4^{2-}

$S + 4(0) = -2$
$S + 4(-2) = -2$
$-8 = -2.$
$= -6$. $\therefore S = +6$

④ The more electronegative element in a substance is given a negative oxidation state.

eg: $NaCl$, HCl, SO_2, CO_2, IO_3^-

⑤ Group I elements have oxidation no. +1
Group II elements have oxidation no. +2.

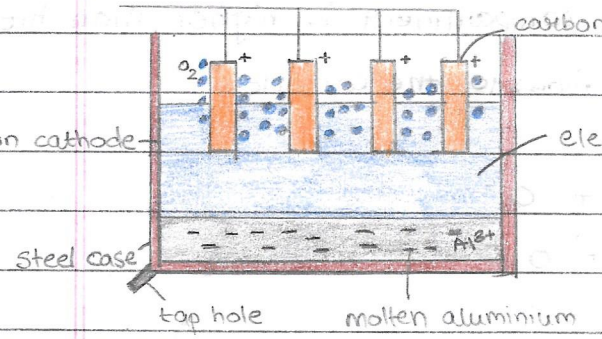
⑥ Oxygen ~~had~~ has oxidation no. -2.
except : $\overset{+2}{O}F_2$ & $\overset{+1}{O_2}F_2$
& peroxides : $H_2\overset{-1}{O_2}$, $Ba\overset{-1}{O_2}$, $Na_2\overset{-1}{O_2}$

⑦ Hydrogen has oxidation no. +1
except hydrides (-1).
↳ eg: $Na\overset{-1}{H}$, $Ca\overset{-1}{H_2}$

⑧ Flourine has oxidation no. -1
↳ it's the most electronegative element.

⑨ Chlorine has oxidation no. -1
except ~~with~~ in compound with O or F, where it is positive.
eg: $Na\overset{+5}{Cl}O_3$, $Na\overset{+1}{Cl}O$, $HO\overset{+1}{Cl}$.

Q-5) Electrolysis - extraction of Aluminium.
> Aluminium is extracted from bauxite ore.



* Aluminium is dissolved in molten cryolite because cryolite
  - lowers melting point of Aluminium
  - it improves the electrical conductivity of the electrolyte.

at cathode (reduction). $(Al^{3+} + 3e^- \longrightarrow Al) \times 4$ make e^- same.

at anode (oxidation) $(2O^{2-} \longrightarrow O_2 + 4e^-) \times 3$

$$4Al^{3+} + 12e^- \longrightarrow 4Al$$
$$6O^{2-} \longrightarrow 3O_2 + 12e^-$$

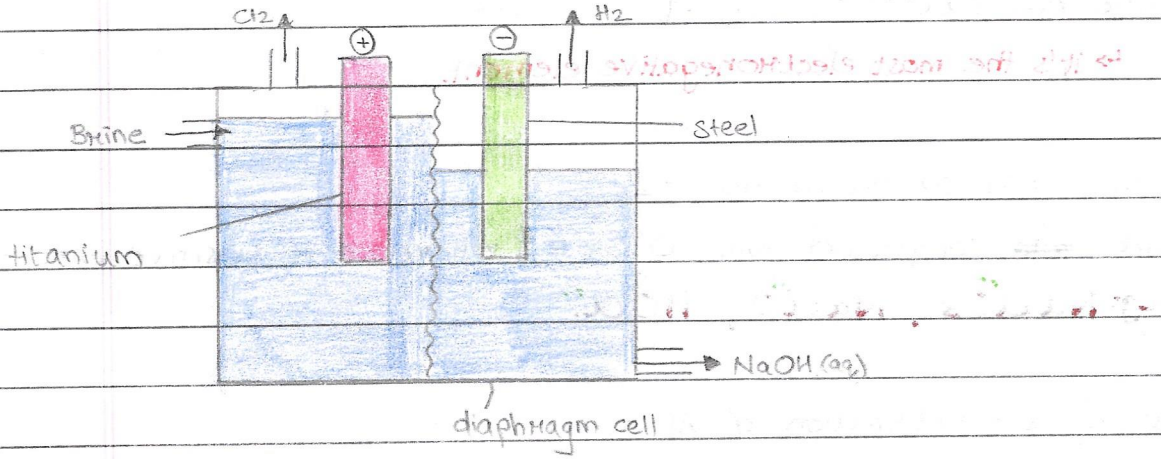
overall reaction: $4Al^{3+} + 6O^{2-} \longrightarrow 4Al + 3O_2$

OR

$$2Al_2O_3 \longrightarrow 4Al + 3O_2$$

Q-6) Electrolysis of Brine

* Brine is concentrated $NaCl_{(aq)}$ - with water.



* The electrolyte level in the anode compartment is higher than the cathode to make sure it always flows to the cathode.

$$NaCl_{(aq)} \longrightarrow Na^+ + Cl^-$$
$$H_2O \rightleftharpoons H^+ + OH^-$$

at anode (oxidation). $2Cl^- \longrightarrow Cl_2 + 2e^-$

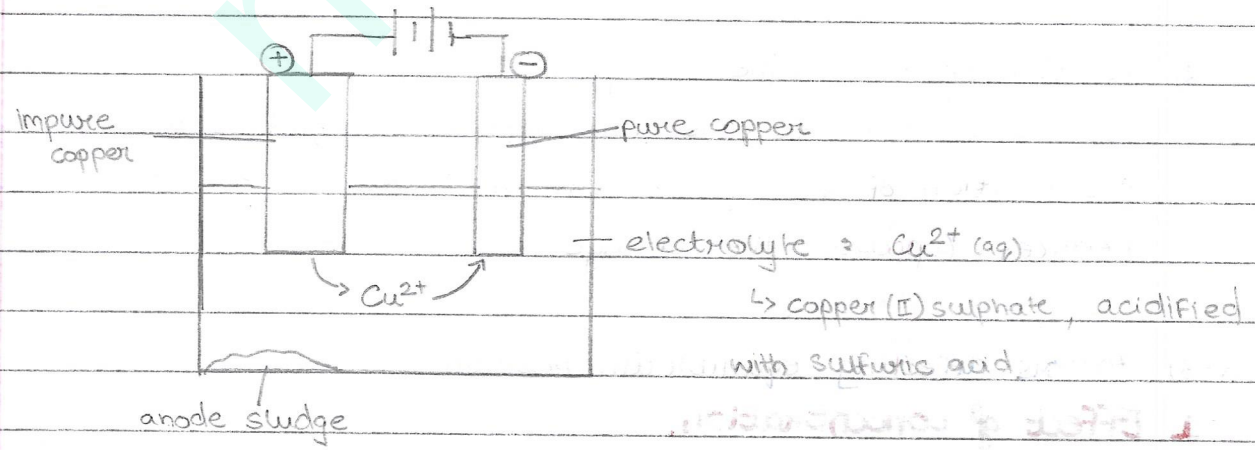
↳ Cl^- is oxidised because concentration of Cl^- is greater than OH^-

at cathode (reduction) $2H^+ + 2e^- \longrightarrow H_2$

↳ H^+ ions are reduced as they are lower in electronegative chemical series than Na^+.

* As concentration of H^+ ions reduces, equilibrium shifts to right.

Q-7) Electrolysis - purification of copper.



at anode (oxidation). $Cu(s) \longrightarrow Cu^{2+}(aq) + 2e^-$

at cathode (reduction). $Cu^{2+}(aq) + 2e^- \longrightarrow Cu(s)$

* The anode decreases in thickness & impurities are deposited as anode sludge.

* The cathode increases in thickness and when enough pure copper is deposited, it's replaced.