PENANG SANGAM HIGH SCHOOL
P.O.BOX 44, RAKIRAKI

LESSON NOTES

Subject: Chemistry **Year/Level:** 12

Week 22

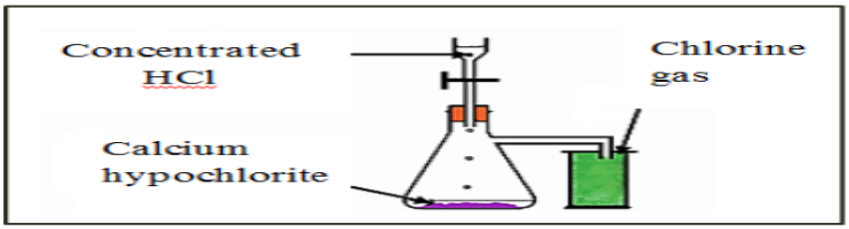
Strand	4 MATERIALS
Sub Strand	4.1 Inorganic chemistry
Content Learning Outcome	To discuss the properties, preparation and reactions of chlorine gas

Chlorine Gas

- Chlorine is a chemical element with symbol Cl and atomic number 17.
- It is in the halogen group (Group VII) and is the second lightest halogen following fluorine.
- Exists as diatomic molecules (Cl2).
- A yellow-green gas at 20^0C.
- Bleaches moist blue litmus paper.
- It is poisonous and has a suffocating or choking or irritating smell.

Laboratory Preparation of Chlorine gas

Chlorine can be prepared in the laboratory by reacting acids and calcium hypochlorite (bleaching powder).



Source: http://watertreatmentchemical.org

Method of Collection:

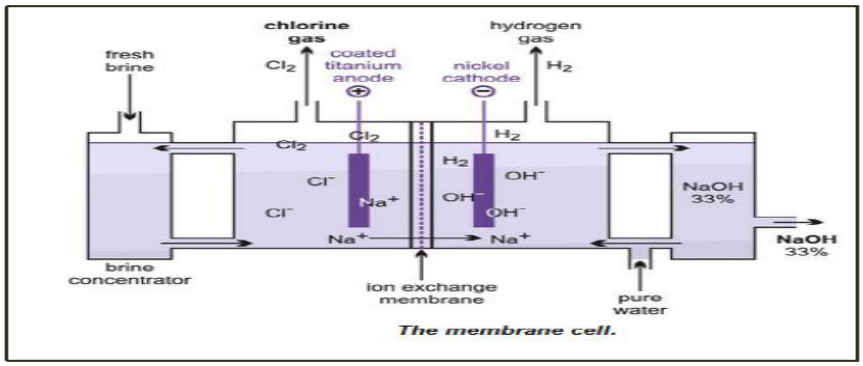
Chlorine gas is collected by upward displacement of air because it is denser than air.

Note: HNO_3 can also be used in place of concentrated HCl.

Reaction equation: $Ca(OCl)_{2(s)} + 4HCl_{(l)} \longrightarrow CaCl_{2(s)} + 2H_2O_{(l)} + 2Cl_{2(g)}$

Industrial Preparation of Chlorine gas

- Chlorine gas can be prepared in the industries by the electrolysis of sodium chloride solution (brine).



The membrane cell.

Source: http://www.essentialchemicalindustry.org

The reactions occurring during electrolysis are:

Anode (Oxidation)	Cathode (Reduction)
Chlorine is oxidised to chlorine gas. $2Cl^-_{(aq)} \rightarrow Cl_{2(g)} + 2e^-$	Water is reduced to hydrogen gas. $2H_2O_{(l)} + 2e^- \rightarrow 2OH^-_{(aq)} + H_{2(g)}$
The OH^- from water reacts with Na^+ in the electrolyte to form NaOH $Na^+_{(aq)} + OH^-_{(aq)} \rightarrow NaOH_{(aq)}$ Thus the overall equation for the reaction is: $2NaCl_{(aq)} + 2H_2O_{(l)} \rightarrow 2NaOH_{(aq)} + Cl_{2(g)} + H_{2(g)}$	

Reactions of chlorine gas (Cl_2)

1. Reaction with iron (Fe)

When chlorine gas is passed over hot iron in a combustion tank, the iron burns to form iron(III) chloride.

Iron(III) chloride forms black crystals.

$$2Fe_{(s)} + 3Cl_{2(g)} \rightarrow 2FeCl_{3(s)}$$

2. Reaction with calcium hydroxide solution

Calcium hydroxide reacts with chlorine gas to produce the bleaching agent, calcium hypochlorite.

$$Ca(OH)_{2(s)} + Cl_{2(g)} \rightarrow Ca(OCl)_{2(aq)} + H_2O_{(l)}$$

3. Reaction with sodium hydroxide solution

Chlorine reacts with warm concentrated NaOH solution to give sodium chloride and sodium hypochlorate ($NaClO_3$). The reaction between chlorine and warm concentrated sodium hydroxide solution is:

$$6NaOH_{(aq)} + 3Cl_{2(g)} \rightarrow 5NaCl_{(aq)} + NaClO_{3(aq)} + 3H_2O_{(l)}$$

The reaction between chlorine and cold dilute sodium hydroxide solution produces sodium hypochlorite (NaClO).

$$2NaOH_{(aq)} + Cl_{2(g)} \rightarrow NaCl_{(aq)} + NaClO_{(aq)} + H_2O_{(l)}$$

4. Reaction with water

Chlorine is only slightly soluble in water. It usually forms a mixture of two acids; hypochlorous acid (HOCl) and hydrochloric acid (HCl).

$$Cl_{2(g)} + H_2O_{(l)} \rightarrow HOCl_{(aq)} + HCl_{(l)}$$

5. Reaction with moist litmus paper (Test for chlorine)

Chlorine gas (Cl_2) turns moist blue litmus paper red and then bleaches it white. The litmus paper turns red because of formation of HCl and it turns white because of HClO.

$$Cl_{2(g)} + H_2O_{(l)} \rightarrow HOCl_{(aq)} + HCl_{(l)}$$

6. Reaction with damp starch iodide paper (Test for chlorine)

Chlorine makes damp starch-iodide paper turn bluish-black. This is because the chlorine releases iodine from the potassium iodide and the iodine reacts with starch to produce a bluish-black color.

$$2KI_{(aq)} + Cl_{2(g)} \rightarrow 2KCl_{(aq)} + I_{2(g)}$$

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

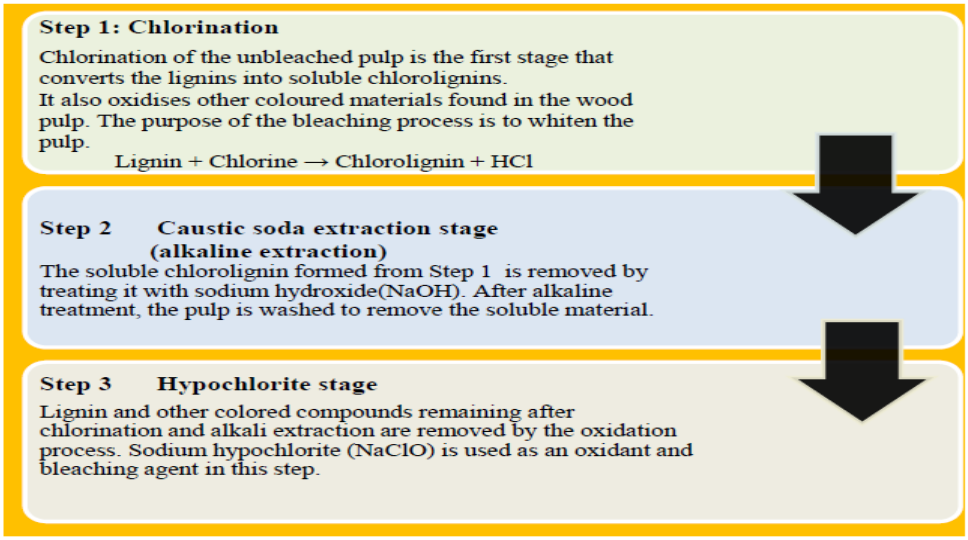
Uses of chlorinating agent (sodium hypochlorite)

1. Bleaching
Sodium hypochlorite (NaClO) is the main ingredient in laundry bleach.It is used extensively as a bleaching agent in the textile, detergents, and paper and pulp industries.

2. Anti-bacterial
Large quantities of sodium hypochlorite are also used as a disinfectant in water and waste water treatment and sanitary equipment. For example, in food processing, sodium hypochlorite is used to sanitize food preparation equipment. It is also used in fruits and vegetable processing, mushroom production, hog and poultry production, maple syrup production, and fish processing.

3. Oxidising Properties
Sodium hypochlorite is also used as an oxidizing agent for organic products.

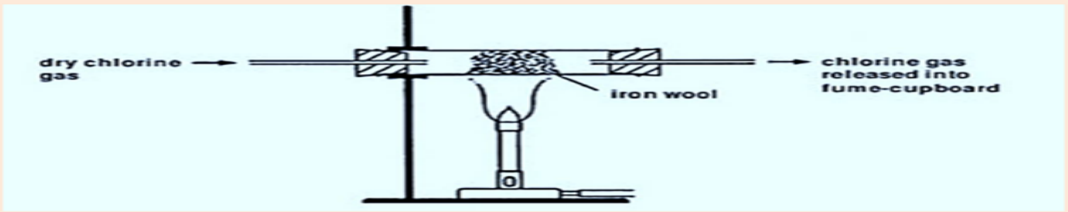
Example: Paper and Pulp Industry
The paper and pulp industry converts wood or recycled fibre into pulp and primary forms of paper.The uses of chlorine and NaClO in paper and pulp industry are as follows:



Other Uses of Chlorine (Cl_2)
- Chlorine is used to make consumer products such as paper, paints and other textiles and insecticides.
- About 20% of chlorine produced is used to make PVC as an oxidising agent.

Activity

4. Study the diagram given below and answer the question that follows.



Source: http://www.nuffieldfoundation.org

Write the balanced chemical equation showing iron wool reacting with chlorine gas.

_____