PHYSICAL SCIENCE

CHLORALKALI

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Chloralkali this is about Chlorine and an Alkali (soluble base, sodium hydroxide)

Indust. Prep. of Chlorine

This is an electrolytic process.
Electrical energy is converted to chemical energy.
Electricity is used to generate chemical reactions.
New chemical compounds are thus formed.

Simply Stated:

- this involves the electrolysis of brine (sodium chloride solution)
- an electric current is sent through the salt solution

Anode Reaction (Oxidation Reaction)

$2Cl^- \longrightarrow Cl_2 + 2e^-$

Cathode Reaction (Reduction Reaction)

$2H_2O + 2e^- \longrightarrow H_2 + 2OH^-$

Nett Reaction

$2NaCl + 2H_2O \longrightarrow Cl_2 + H_2 + 2NaOH$

- **chlorine** is produced at the anode (pos)
- **hydrogen** is produced at the cathode (neg)
- **sodium hydroxide** collects at the bottom of the cell

N.B. The Cl_2 must be prevented from reacting with the NaOH or the foll. reaction will occur: $2NaOH + Cl_2 \rightarrow NaOCl + NaCl + H_2O$

No chlorine will be produced!

What are the industrial methods for producing chlorine

1. Mercury Cell

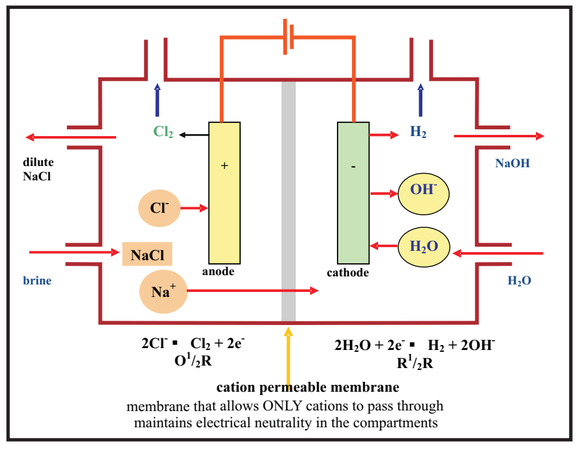
- liquid mercury stream
- mercury is highly volatile
- poisonous

2. Diaphragm Cell

- asbestos is involved
- health risk

3. Membrane Cell (most modern and popular)

- no environmental risks - does not use mercury
- most energy efficient - cost effective
- produces a purer product



How does the Membrane Cell work?

1. A saturated solution of brine flows into the anode (positive) compartment.
   $NaCl_{(s)} \rightarrow Na^+_{(aq)} + Cl^-_{(aq)}$
2. The Cl^- ions react by REDOX:
3. Cl_2 exits
   $2Cl^- \rightarrow Cl_2 + 2e^- \quad (O^1/_2R)$
4. The Na^+ ions that are now left behind, move through the "one way" membrane.
5. H_2O enters the cathode (negative) compartment. The following REDOX reaction occurs:
   $2H_2O + 2e^- \rightarrow H_2 + 2OH^- \quad (R^1/_2R)$
6. The H_2 exits. OH^- remains behind.
7. The Na^+ combines with the OH^- to form NaOH.
8. The NaOH exits.

Fresh brine flows continuously into the cell as it is being used up. The membrane (polymer) has negative charges built into it to help attract the Na^+ through to the cathode side, to the awaiting OH^- ions.

Chlorine Cl_2

Description: poisonous yellow-green gas

Uses

Manufacture of :

- hydrochloric acid
- dyes
- disinfectants
- plastics
- solvents
- pesticides
- medicines

It is also used :

- to extract titanium,
- to produce bromine
- to treat drinking water
- to purify swimming pool water
- to kill bacteria
- as a bleaching agent (remove colour from paper)
- as a colouring agent

Sodium Hydroxide NaOH

Description

- alkaline, corrosive
- usually supplied as small pellets

Uses

Manufacture of:

- soap
- paper
- textiles
- sodium salts
- bleaches

Also used:

- to extract aluminium
- treat effluent

Hydrogen H_2

Description

- colourless flammable gas

Uses

Manufacture of :

- margarine
- nylon
- hydrogen chloride
- hydrochloric acid
- ammonia
- hydrogen peroxide
- rocket fuel

Possible use in fuel cells in the future

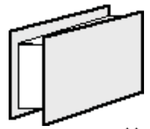
Capacitor

1. What is a capacitor

This is simply a device that can **store electric charge** (electrical energy).
It is also called a **condensor.**

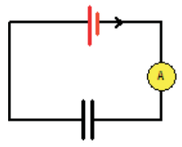
2. What is it made of?

It consists of: (a) two conducting sheets (b) separated by an insulating material.
The insulating material is called a **dielectric**.



3. What is the symbol for a capacitor? ‖ Two parallel lines of equal length

4. How is it connected in a circuit, and what happens to the current from the battery?



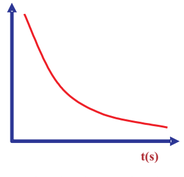
Electrons flow from the **negative terminal** of the **battery** to the **first plate** of the **capacitor**. This plate of the capacitor is called the **negative plate**.
The electrons **collect here**. As this plate becomes **more** and **more negative**, this plate then **opposes** the continued **flow** of **electrons from** the **battery** to itself, (like charges repel). Hence the **current** being supplied **from** the **battery decreases** as the **capacitor** is **being charged**.

The **other plate** is connected to the **positive** terminal of the **battery** and is called the **positive** plate. This plate **loses electrons** to the battery.

As a result of this process, the **capacitor** develops a **potential difference**. (This simply means that if given the chance, electrons would naturally move from one plate to the other)

5. What happens to the current from the battery as the capacitor is being charged?

The current decreases as explained above.



Notice how the current flowing in the circuit decreases as time goes by (as the capacitor is being charged)

When the capacitor is fully charged, the current from the battery becomes (virtually)zero.
The ammeter reading would be zero.
The capacitor would have the same potential difference as the battery that charged it.

6. Why is a capacitor a useful device?

When it is connected in a circuit, it acts similar to a battery.
It is different in that it is able to produce a large amount of current in a short time. This makes it very useful, example for a camera flash.

7. What is CAPACITANCE?

Capacitance is a measure of the ability of a capacitor to store charge.
The **symbol** for capacitance is **C**.
The **unit** for capacitance is **farad** or **F**.
Typical capacitance values are very small hence uF (10^{-6} F)is often used.

The equation is :

$$C = \frac{Q}{V}$$

From the equation, it is noticed that the unit for capacitance (F) is also $C.V^{-1}$.
Please remember that the UNIT for Q(charge) is C(coulombs). This must not be confused with the symbol for capacitance C.

8. What factors affect capacitance?

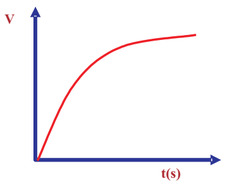
(a) The **AREA** of the plates.
The **larger the area** of the plates, the **larger the capacitance**.

(b) The **DISTANCE between** the plates.
The **smaller** the **distance** between the plates, the **greater** the **capacitance**.

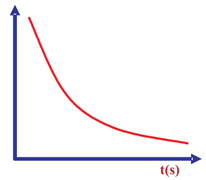
(c) The **type** of **dielectric** between the plates.

9. Draw a graph of Voltage vs. Time for Charging Rate of a capacitor?

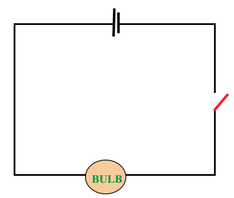
Notice how the voltage of the capacitor increases to a maximum. Then it is fully charged.



10. Draw a graph of Voltage vs. Time for Discharging Rate of a capacitor?

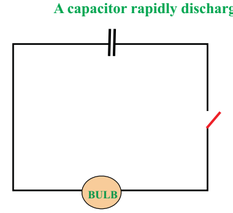


A capacitor rapidly discharges.



If the switch is closed, the bulb will glow moderately for an extended period of time, Due to the slow release of current.

A battery is "chemically driven".



If the switch is closed, the bulb will glow very brightly for a limited period of time, due to the rapid release of current.

A capacitor is "electronically driven".

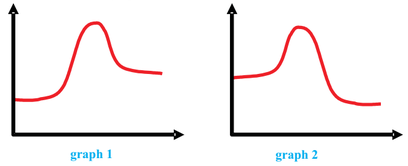
Question 1

1. The K_c for the following reaction at a certain temperature T is 2,25. Initially 9 mols of SO_2 and 144g of oxygen gas, together with one mole of SO_3 was placed in a gas syringe.

$2SO_2 + O_2 \Longleftrightarrow 2SO_3$ **(all are gases)**

The plunger was depressed to a certain volume V and it was then found that the Equilibrium number of moles of SO_3 was 6.

1.1. Calculate the value of V at temperature T.
1.2. When it was cooled, it was found that the K_c increased. Which of the potential energy(Y) vs. course of reaction (X) graphs best suit the reaction?

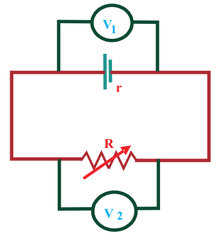


1.3. How will the rate of production of SO_3 be affected by pulling the plunger outwards?

Answers 1.1. $V = 2dm^3$ 1.2. graph 2 1.3. Decrease

Question 2

Study the diagram.



The cell has intenal resistance and R is a variable resistor. It is noticed that $V_1 = V_2$.

2.1. What can be concluded about R and r?
A. R = r **B.** R > r **C.** R < r **D.** no conclusion can be made

2.2. R is now increased to five times the value of r. i.e. R now equals to 5r
a) How would the readings on the voltmeters compare?
A. $V_1 = 5V_2$ **B.** $V_1 = V_2$ **C.** $V_1 = V_2$ **D.** $V_1 = V_2 + 5V_1$

b) What would happen to the magnitude of the lost volts? The lost volts will…
A. increase **B.** decrease **C.** remain unchanged **D.** become zero

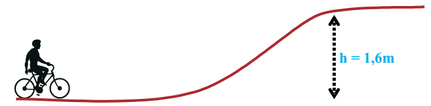
2.3. If R blows, what would happen to the readings on V_1 and V_2?

	V_1	V_2
A.	increases	becomes zero
B.	increases	increases
C.	decreases	increases
D.	decreases	becomes zero

Answers
2.1. D 2.2.(a) C 2.2.(b) B 2.3. B

Question 3

A cyclist of entire mass 50kg, coasts at a velocity of 20ms^{-1} towards an incline of height 1,6m. When using the brakes, the frictional force produced is 125N.

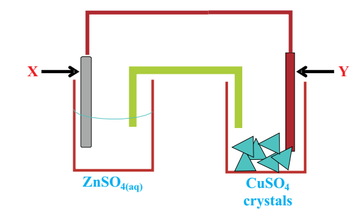


Assuming that he does not apply brakes along the slope, calculate from how far away he should continuously apply the brakes along the horizontal section, so that he reaches the top at 6ms^{-1}.

Answer 66,4m

Question 4

The following diagram shows a typical voltaic cell, complete except for the crystals of copper sulphate instead of a solution.



In order for the usual and proper functioning of the cell, which one of the following liquids should be added to the copper sulphate crystals?

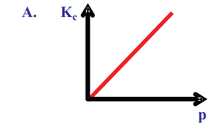
A. water
B. CCl_4
C. zinc sulphate solution
D. no liquid needs to be added as the cell functions as is

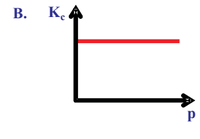
Answer A

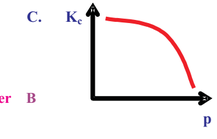
Question 5

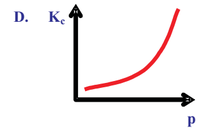
The following diagram shows $NO_{2(g)}$ and $N_2O_{4(g)}$ in a gas syringe. Equilibrium has been established.

If the plunger is gently depressed so that the temperature remains constant, which one of the following graphs of Kc against pressure would represent the changes?

A. 

B. 

C. 

D. 

Answer B

BEST OF LUCK
FOR THE EXAMS!