



**G H RAISONI COLLEGE OF ENGINEERING & MANAGEMENT**  
**(An Autonomous Institute Affiliated to SPPU)**  
**WAGHOLI, PUNE – 412 207**

**DEPARTMENT OF FIRST YEAR B.TECH.**

**LABORATORY MANUAL**

**ENVIRONMENTAL CHEMISTRY**



**SUBJECT CODE: UBSP102**

**(As per 2020 pattern)**

**Common to All Branches of F.Y. B.Tech.**

**Academic Year: 2020 – 21**

**(Term II)**

Name of the Student: **Pratik Rajesh Jade**

Division: **A** Roll No. **72** Reg. No.: **2020AAIT1111019**

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Mr. Praveen Jangade

**Dean, FY B.Tech.**

Dr. Shubhangi Satdeve

**Lab Incharge**

## GENERAL LAB INSTRUCTIONS

1.	Make sure you are familiar with all the safety information given to you about each experiment before starting the experiment. This includes your manual, these safety guidelines, any posted information or any other information provided to by your Teacher.
2.	You <b>must</b> wear a lab coat (and do it up) in all Chemistry labs.
3.	Footwear <b>must</b> completely cover the foot and heel (no sandals, ballet flats, mules, open-toed footwear, etc.).
4.	Loose hair must be tied back so as to be out of the way. Dangling jewellery must be removed.
5.	Do <b>not</b> eat or drink in the lab.
6.	Visitors are not allowed to be in the lab
7.	Please keep your work area and the common work areas tidy. Also, please make sure the aisles, safety showers, eyewash stations and doorways are unobstructed.
8.	Please leave all glassware, equipment, tools, etc. as clean or cleaner than you found them
9.	Please clean up spills immediately. If the spill is large or is of a hazardous material, inform the TA immediately. Use spill mix to absorb solvent or caustic liquids
10.	Please dispose of waste properly and in a timely manner and according to the instructions provided in your lab manual. If you are not sure, please ask your Teacher for the proper method of disposal.
11.	Wash your hands before you leave the lab
12.	Do not remove chemicals or equipment from the lab except when required to do so for analysis
13.	Please notify your Teacher of any serious medical conditions
14.	Do not wear earbuds or earphones while in the lab.

## **EXPERIMENT NO.: 1**

**NAME OF EXPERIMENT:** Determination of Physical Parameters of Water.

**Date of Performance:** 20/05/2021    **Sign of Teacher:** 

**AIM:** Determination of PH, turbidity conductivity of given water sample.

### **Theory:**

It is needless to emphasize the importance of water in our life. Without water, there is no life on our planet. We need water for different purposes. We need water for drinking, for industries, for irrigation, for swimming and fishing, etc.

Water for different purposes has its own requirements as to composition and purity. Each body of water needs to be analyzed on a regular basis to confirm to suitability. The types of analysis could vary from simple field testing for a single analyte to laboratory based multi-component instrumental analysis. The measurement of water quality is a very exacting and time consuming process, and a large number of quantitative analytical methods are used for this purpose.

### **A] pH:**

pH may be measured accurately using a pH meter. The pH meter must be calibrated before making pH measurements. For calibration standard buffers of pH 4.00, 7.00 and 10.00 are used. pH of water indicates the hydrogen ion concentration in water. The concept of pH was put forward by **Sorenson** in 1909. It is expressed as the logarithm of the reciprocal of the hydrogen ion concentration in moles/litre at a given temperature. While the alkalinity or acidity measures the total resistance to the pH change or buffering capacity, the pH gives the hydrogen ion activity. The pH scale extends from 0 (very acidic) to 14 (very alkaline) with 7 corresponding to exact neutrality at 25°C. pH is used in the calculation of carbonate, bicarbonate and CO<sub>2</sub>, corrosion, stability index etc.

Practically every phase of water supply and waste water treatment such as water softening, acid-base neutralization, coagulation, precipitation,

disinfectant and corrosion control is pH dependent. The pH of a water sample measures its hydrogen ion concentration and indicates whether the sample is acidic, neutral or basic.

#### **pH meter:**



#### **pH of various samples:**

Samples	pH
Tap water	7
Sea water	Varies from 7.5 -8.4
Well water	Varies from 6.5-8.5
Distilled water	5.8

#### **B] Electrical conductivity:**

Electrical conductivity (EC) is a measure of how conductive the water is to electrical current. Greater the ion concentration, greater is the EC. Generally higher the EC, higher is the total dissolved solids. Electrical Conductivity is an indirect measure for finding the total dissolved solids in a water body. To convert the electrical conductivity of a water sample (micro Siemens per cm,  $\mu\text{S}/\text{cm}$ ) to the concentration of total dissolved solids (ppm), the conductivity must be multiplied by a factor between 0.46 and 0.9 (depending on the unique mixture of the dissolved materials). A widely accepted conversion factor is 0.67.  $\text{TDS (ppm)} = \text{Conductivity} \{(\mu\text{S}/\text{cm}) \times 0.67\}$ . The instrument used for measuring conductivity is conductivity meter.



### **Reagents:**

**1. Conductivity water:-** Any of several methods can be used to prepare reagent-grade water. Conductivity should be small compared to the value being measured.

**2. Standard Potassium Chloride solution (KCl) 0.01 M:-** Dissolve 745.6 mg anhydrous KCl in conductivity water and dilute to 1000 mL in a class A volumetric flask at 25°C and store in a CO<sub>2</sub>-free atmosphere. This is the standard reference solution, which at 25°C has a conductivity of 1412  $\mu$ S/cm. After standardization of conductivity meter store KCl solution in a glass-stoppered borosilicate glass bottle.

KCL concentration (M) or equivalent/L	Conductivity, ks $\mu$ mho/cm	KCl concentration (M) or equivalent/L	Conductivity,ks $\mu$ mho/cm
0		0.02	2765
0.0001	14.9	0.05	6667
0.0005	73.9	0.1	12890
0.001	146.9	0.2	24800
0.005	717.5	0.5	58670
0.01	1412	1	111900

### **Procedure:**

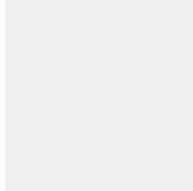
**Conductivity Measurement:-** Thoroughly rinse cell with one or more portions of sample. Adjust temperature of a final portion to about 25°C. Measure sample resistance of conductivity and note temperature to  $\pm 0.1^\circ\text{C}$ .

### Values of electrical conductivity:

Sample	µS/cm	Sample	µS/cm
<b>Totally pure water</b>	<b>0.055</b>	<b>Domestic "tap" water</b>	<b>500-800</b>
<b>Typical DI water</b>	<b>0.1</b>	<b>Potable water (max)</b>	<b>1055</b>
<b>Distilled water</b>	<b>0.5</b>	<b>Sea water</b>	<b>56,000</b>
<b>Raw water</b>	<b>50-100</b>	<b>Brackish water</b>	<b>1,00,000</b>

### C] Turbidity:

Turbidity is the amount of particulate matter that is suspended in water. Turbidity measures the scattering effect that suspended solids have on light: the higher the intensity of scattered light, the higher the turbidity.



Material that causes water to be turbid includes:

- Clay.
- Silt.
- Finely divided organic and inorganic matter.
- Soluble coloured organic compounds.
- Plankton.
- Microscopic organisms.

The turbidity of sample solution can be measured by using Nephelometer. It is usually measured in nephelometric turbidity units (NTU) or Jackson turbidity units (JTU).



### **Principle:**

This method is based on a comparison of the intensity of light scattered by the sample under defined conditions with the intensity of light scattered by a standard reference suspension under the same conditions. The higher the intensity of scattered light, the higher the turbidity. Commonly used primary standard reference suspension is *Formazin polymer*. The turbidity of a specified concentration of formazin suspension is defined as 400 NTU.<sup>(w.1)</sup>

### **Interference:**

<b>1.</b>	The presence of floating debris and coarse sediments will give high readings.
<b>2.</b>	Air bubbles will cause high results
<b>3.</b>	Coloured samples will cause low results

### **Apparatus:**

1. Laboratory or process nephelometer consisting of a light source for illuminating the sample and one or more photoelectric detectors with a readout device to indicate intensity of light scattered at 90° to the path of incident light.
2. Sample cells: Use sample cells or tubes of clear, colourless glass or plastic. Keep cells scrupulously clean, both inside and out, and discard if scratched or etched.

### **Reagents**

#### **1. Dilution water:**

High-purity water will cause some light scattering, which is detected by nephelometers as turbidity. To obtain low-turbidity water for dilutions, nominal value 0.02 NTU, pass laboratory reagent-grade water through a filter with pore size sufficiently small to remove essentially all particles larger than 0.1µm. The usual membrane filter used for bacteriological examinations is

not satisfactory. Rinse collecting flask at least twice with filtered water and discard the next 200 mL.

Procedure:

1. Switch on the instrument and allow sufficient warm-up period.
2. Take distilled water or bank solution in the test tube holder and close the lid. Make sure that the mark on the test tube coincides with mark on the panel.
3. Select required range for measurement.
4. Adjust the displayed to '000' by adjusting set zero knob.
5. Remove the test tube containing distilled water and insert another test tube containing standard solution (say 100 NTU or 400 NTU). Place it in test tube holder.
6. Adjust the calibrate knob so that the display reach the standard solution value.
7. Again check '0' display with distilled water. The instrument is now calibrated.

Turbidity	NTU
Drinking water	Between 5 NTU & 1 NTU
Sea water	Varies from 6-12 NTU

**Observations:**

Sr No	Sample No	pH	Conductivity in mho/cm	Turbidity in NTU
1	Drinking Water	6 to 8.5	50 ms /cm	0.02 to 0.05
2	Distilled Water	5 to 7	0.5 to 3 uh/cm	0.02
3	Spring Water	7.33	0.181 to 0.375 ms/cm	0.05 to 10

**Result**

- 1] pH, conductivity and Turbidity of sample 1 is found to be **6.1,50 ms/ cm, 0.03**
- 2] pH, conductivity and Turbidity of sample 2 is found to be **5.2, 0.9uh/cm, 0.02**
- 3] pH, conductivity and Turbidity of sample 3 is found to be **7.33, 0.181 ms/cm, 0.10**

## EXPERIMENT NO.: 2

**NAME OF EXPERIMENT:** Determination hardness and Alkalinity of Water.

**Date of Performance:** 21/05/2021 **Sign of Teacher:**

**AIM :** Determination of hardness of water by Complexometric method and Alkalinity by Warders Method.

**A]** Determination of hardness of water by Complexometric method.

**APPARATUS :** Burette, pipette, conical flask

**CHEMICALS :** 0.01M Disodium salt of EDTA Solution, 0.01M  $\text{ZnSO}_4$ ,

Eriochrome - Black T, Buffer solution of pH10, Water Sample-1.

**THEORY:** Water sample which does not produce leather readily with soap is known as hard water. The hardness is due to presence of dissolved bicarbonates, sulphates, fluorides and nitrates of Mg and Ca. The relation between the type of water sample and degree of hardness can be given by following table.

Hardness description of water sample	Total Hardness as ppm of $\text{CaCO}_3$
Soft	0-75
Moderately hard	75-150
Hard	150-300
Very hard	Above 300

The hardness can be removed by heating called temporary hardness.



**PROCEDURE:** Total hardness:

Pipette out 5 ml of hard water sample into 250 ml conical flask. Add 1 ml of the alkaline buffer pH10 solution and 2 drops of EBT indicator. Titrate the Solution with standard EDTA Solution from burette until the colour changes from wine red to clear blue at the end point. Note the titrate Value which correspond to the total hardness.

### **Permanent hardness:**

Measure out 250 ml of the hard water sample in 500 ml beaker. Boil gently for  $\frac{1}{2}$  hour, filter the solution into 250 ml measuring flask and make the solution up to the mark with distilled water and shake well. Pipette out 5 ml of this solution into a 250 ml conical flask add 1 ml of the buffer solution and 2 drops of indicator. Titrate with EDTA Solution until the wine red colour changes to clear blue at the end point. This titrate value correspond to the permanent hardness.

### **OBSERVATION:**

#### **1: Standardization of Na<sub>2</sub>EDTA solution:**

Burette	:	0.01M Na <sub>2</sub> EDTA Solution- (M <sub>1</sub> )
Pipette	:	5 ml of 0.01M ZnSO <sub>4</sub> (V <sub>1</sub> ) +1ml (pH =10) alkaline buffer
Indicator	:	Eriochrome Black-T
End Pt.	:	Wine red to Blue
B.R.	:	Burette Reading-(V <sub>2</sub> )
Equation	:	Na <sub>2</sub> EDTA + Zn <sup>2+</sup> $\longrightarrow$ [EDTA (Zn <sup>2+</sup> ) complex] <sup>2-</sup> + 2 Na <sup>+</sup>

### **OBSERVATION TABLE:**

Sr. No	Burette Reading		Vol. of EDTA used (ml)
	Initial	Final	
1.	0	8.0	8.0
2.	0	8.1	8.1
3.	0	8	8

### **CALCULATION :**



$$M_1 V_1 = M_2 V_2$$

$$\begin{aligned} M_2 &= M_1 V_1 / V_2 \\ &= 0.01 \times 5 / 8 \end{aligned}$$

Molarity of Na<sub>2</sub>EDTA is **0.00625 M**

## 2: Total hardness : Titration of water sample with Na<sub>2</sub>EDTA solution

- Burette : Na<sub>2</sub>EDTA solution  
 Pipette : 5 ml of water sample (V) +1ml (pH =10) alkaline buffer  
 Indicator : Eriochrome Black-T  
 End Pt. : Wine red to Blue  
 B.R. : Burette Reading- (X)  
 Equation : Na<sub>2</sub>EDTA + M<sup>2+</sup> (Ca<sup>2+</sup>, Mg<sup>2+</sup>) → M-EDTA + 2H<sup>+</sup>

### OBSERVATION TABLE:

Sr. No	Burette Reading		Vol. of EDTA used (Xml)
	Initial	Final	
1.	0	10	10
2.	0	9.9	9.9
3.	0	10	10

### CALCULATIONS :

$$1000 \text{ ml of } 1\text{M Na}_2\text{EDTA} = 100 \text{ gm of CaCO}_3$$

$$1 \text{ ml of } 1 \text{ M Na}_2\text{EDTA} = 100 \text{ mg of CaCO}_3$$

$$1 \text{ ml of M}_2 \text{ Na}_2\text{EDTA} = 100 \times M_2 \text{ mg of CaCO}_3$$

$$X \text{ ml of M}_2\text{Na}_2\text{EDTA} = X \times 100 \times M_2 \text{ mg of CaCO}_3$$

$$5 \text{ ml of water sample contains} = X \times 100 \times M_2 \text{ of CaCO}_3$$

$$1000 \text{ ml water sample contains} = \frac{X \times 100 \times M_2 \times 1000}{V} \text{ of CaCO}_3$$

$$= m_2 = \frac{M_1 v_1}{V_2} = \frac{0.01 \times 5}{8} = 0.00625 \text{M}$$

$$= \frac{10 \times 100 \times 0.006 \times 1000}{5}$$

Total hardness of given water sample is found to be 1200mg/l

## **B] Determination of alkalinity of water by Warders Method.**

**CHEMICALS:** 0.02 N HCl Solution, phenolphthalein, bromocresol indicator, Water Sample-2.

**THEORY:** Pure water is neutral. Its pH is exactly seven. But because dissociation or hydrolysis of different minerals present in water, concentration of OH<sup>-</sup> ions in water increases, this makes the water alkaline. Alkalinity of water means total content of OH<sup>-</sup>, HCO<sub>3</sub><sup>-</sup>, CO<sub>3</sub><sup>2-</sup> in water, which makes the water alkaline. In boiler for steam generation, water having high Alkalinity leads to caustic embitterment, precipitation of Sludge's and deposition of scales. These alkalinites can be estimated volumetrically by titrating water sample against standard acid using methyl orange and phenolphthalein indicators.

**PROCEDURE:** First check the pH of the given sample of water with pH paper. Pipette out 10 ml of water sample in a conical flask, if pH of the sample is above 8.5 unit, then titrate it against 0.02 N HCL using phenolphthalein as an indicator, till pink colour just vanishes. Let this reading be V<sub>1</sub>. To this solution adds 3 to 4 drops of bromocresol indicator and continue the titration till green colour changes to red . Let this reading are V<sub>2</sub>. This is called the bromocresol end point. This procedure is repeated for different samples of water.

### **OBSERVATION:**

- Burette : 0.02 N HCL Solution (M<sub>2</sub>)
- Beaker : Water sample 10 ml (V)
- Indicators : 1) Phenolphthalein in the beginning (V<sub>1</sub>)  
                  2) Bromocresol to the same solution (V<sub>2</sub>)
- End points : 1) Pink to colourless (V<sub>1</sub>)  
                  2) Green to red (V<sub>2</sub>)

### OBSERVATION TABLE:

		V 1(P)			V2(B)		
Sr No	Sample No	Volume of HCl in ml		Constant Reading in ml	Volume of HCl in ml		Constant Reading in ml
1	I	0	0	4.6	1.8	1.8	1.7
2	II	4.6	4.5		5.5	5.6	5.5
3							

### CALCULATION:-

#### (A) Phenolphthalein Alkalinity:

$$v1 = 4.5$$

$$v2 = 5.5$$

$$\text{Phenolphthalein Alkalinity (P)} = \frac{V1 \times 50 \times \text{Molarity of acid} \times 1000}{\text{volume of water sample}} \text{ ppm}$$

$$= \frac{4.5 \times 50 \times 0.02 \times 1000}{10} \text{ ppm}$$

**Phenolphthalein Alkalinity (P) in given water sample = 450 ppm**

#### (B) Bromocresol Alkalinity

$$\text{Bromocresol Alkalinity (B)} = \frac{V2 \times 50 \times \text{Molarity of acid}_2 \times 1000}{\text{volume of water sample}} \text{ ppm}$$

$$= \frac{5.5 \times 50 \times 0.02 \times 1000}{10}$$

**$\therefore$  Total Alkalinity due to Bromocresol in given water sample = B = 550 ppm  $\text{CaCO}_3$**

The possible combinations of alkalinites in water are:

- i) Only  $\text{OH}^-$
- ii) Only  $\text{CO}_3^{2-}$
- iii) Only  $\text{HCO}_3^-$
- iv)  $\text{OH}^-$  and  $\text{CO}_3^{2-}$  together

v)  $\text{CO}_3^{2-}$  and  $\text{HCO}_3^-$  together

The amounts of alkalinites due to the  $\text{OH}^-$ ,  $\text{CO}_3^{2-}$ , and  $\text{HCO}_3^-$  are calculated from Following table.

Sr. No .	Alkalinity	Quantity of $\text{-OH}$	Quantity of $\text{CO}_3^{2-}$	Quantity of $\text{HCO}_3^-$
1	$P = 0$	0	0	$B = 550$
2	$P = \frac{1}{2} B$	0	$2P = 900$	0
3	$P = B$	$B = 550$	0	0
4	$P < \frac{1}{2} B$	0	$2P$	$B - 2P = 350$
5	$P > \frac{1}{2} B$	$(2P - B) = 350$	$2(B-P) = 350$	0

### CALCULATIONS:-

Now calculate type of alkalinity for sample using above table

### RESULT:

A] Total Hardness of water sample-1 is found to be 1200ppm

B] Alkalinity of water sample -2 is found to be

Water Sample	$\text{OH}^-$ ,alkalinity in ppm	$\text{CO}_3^{2-}$ , alkalinity in ppm	$\text{HCO}_3^-$ , alkalinity in ppm
(1) Water Sample – 1	0	900	180
(2) water sample - 2	350	550	0

Signature of Teacher

## **EXPERIMENT NO: 3**

**AIM: Case study on current scenario of region specific waste generation.**

**Date of Performance:** 28/05/2021 **Sign of Teacher:**

1. By reading an article
2. Having own experience
3. Visiting to a particular site – and taking views from society.

### **Points to Write Case Study**

1. The information in your content is more important than the format. Here are all the elements you'll find in a typical case study:
2. Title or Headline: Ideally, it should summarize the customer, their problem, and the result.
3. Executive Summary: This is a one or two paragraph section summarizing the case study's contents.
4. Problem or Challenge: What did they have trouble accomplishing?
5. Solution: How did your company or product resolve the issue or drive a benefit?
6. Results: Use percentages, if possible.

Date - 28/05/2021

Name - Pratik Rajesh Jade

Roll no - A72

Sub - Environmental Chemistry.

Practical no. 3

## Introduction

Municipal Solid waste (MSW) has become a serious environmental problem in major cities all over world. The problem of solid waste is also influencing the urban environment of Pune city. Therefore, the present study was undertaken to enlist the causes of solid waste generation & possibilities of associated problem. Study was mainly concentrated to investigate the present status of Municipal Solid waste management (MSWM) in Pune city. The study detailed survey was carried out on existing facilities of Solid Waste Management (SWM) & Manpower resources & management system. The detail study. The generated quantity of waste, there collection, transportation, treatment & disposal of (MSW) in Pune city was conducted. Solid waste Management system in Solapur City on Basis of MSW.

Aim - Current Scenario of ~~Pune~~ municipal waste generation.

Method Secondary data collection method desktop study to determine current municipal waste generation

Generation of municipal solid waste -

Municipal waste (MSW) also called urban solid waste & is waste type include predominantly household waste with sometimes the addition of commercial waste, construction & demolition debris, sanitisation residue & waste from streets collected by municipality within a given area .

Pune is one of the fastest developing city, it generates total quantity of waste is about 1300 to 1400 metric tons per day. Municipal Waste is generated as Dry waste & wet waste. It is observed that the previous literature tropical countries show the higher percentage of wet waste than Dry. Pune city generates dry & wet waste approx in equal proportion (50% - 50%). About 40% of waste is generated from households (domestic waste) followed by hotels & other. Commercial waste is 25%. Market areas 5%. Hotels & restaurants 25%. & Vegetable waste 5%. Presently PMC generated 1300 to 1400 tons of waste per day. Per capita waste generated is 500 grams. Future generation will be 3106 ton per day by 2031.

#### Conclusion -

The rapid increased in the quantities of Municipal Solid waste & the inability to provide day-to-day solid waste collection service may causes an irritation & health hazard. Segregation of waste is essential component of solid waste management which is ~~comparatively~~ comparatively very poor. Solid waste can be minimize at source using geographical tools.

## EXPERIMENT NO: 4

**AIM:** Determination of Chloride ions from given water sample by Argentometric Method.

**Date of Performance:** 29/05/2021 **Sign of Teacher:**

**Principal:** The determination of chloride involves the use of silver nitrate in the presence of potassium chromate as a indicator.  $\text{Ag}^+ + \text{Cl}^- = \text{AgCl}$  (white precipitate) But when all the chloride ions have been precipitate, a drop of silver nitrate in excess gives a red precipitate of silver chromate



**Theory:** Chloride in the form of chloride ( $\text{Cl}^-$ ) ion is one of the major inorganic anions in water and wastewater. The chloride concentration is higher in wastewater than in raw water because sodium chloride is a common article of diet and passes unchanged through the digestive system (Average estimate of excretion: 6 g of chlorides/person/day; additional chloride burden due to human consumption on wastewater: 15 mg/L). Along the sea coast chloride may be present in high concentration because of leakage of salt water into the sewage system. It also may be increased by industrial process. In potable water, the salty taste produced by chloride concentration is variable and depends on the chemical composition of water. Some waters containing 250 mg/L  $\text{Cl}^-$  may have a detectable salty taste if sodium cation is present. On the other hand, the typical salty taste may be absent in waters containing as much as 1000 mg/L when the predominant cations are calcium and magnesium. In addition, a high chloride contents may harm metallic pipes and structures as well as growing plants. The measured chloride ions can be used to know salinity of different water sources. For brackish water (or sea water or industrial brine solution), it is an important parameter and indicates the extent of desalting of apparatus required. It as interferes with COD determination and thus it requires a correction to be made on the basis of amount present or else a complexing agent, such as  $\text{HgSO}_4$  can be added. Further, chloride ions are used as tracer ions in column studies to model fate of different contaminants in soil and liquid media.

## **PROCEDURE:**

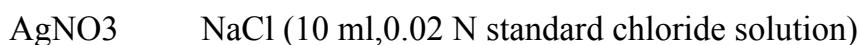
1. Filter the given water sample so as to remove any suspended material. Pipette out 50ml of this filtered sample in large porcelain disc and add 3-4 drop of phenolphthalein indicator to it if pink colour just disappear. To the red coloured solution obtained after adding methyl orange indicator add N/50 sodium carbonate solution until the colour of the solution changes to orange.
2. Transfer the resultant solution in a 250 ml conical flask. Pipette out 10ml water sample in a clean conical flask and add 1 ml of potassium chromate indicator.
3. Fill the burette with 0.02N  $\text{AgNO}_3$  solution and add slowly standard N/50 silver nitrate solution from the burette with constant shaking.
4. A white precipitate of silver chloride will be obtained. Continue the addition process slowly, a red colour will appear in the flask, which disappear on shaking. Now add silver nitrate solution drop by drop until a permanent reddish brown colour is obtained.

## **OBSERVATION TABLE:**

### **STANDARDIZATION OF SILVER NITRATE SOLUTION**

Sr. No	Burette Reading		Vol. of $\text{AgNO}_3$ in (ml)
	Initial	Final	
1.	0	10.1	10.1
2.	0	10.1	10.1
3.	0	9.8	9.8

## **CALCULATION :**



$$N_1 V_1 = N_2 V_2$$

$$N_1 = N_2 V_1 / V_2$$

$$= 0.02 \times 10 / 10.1$$

Normality of  $\text{AgNO}_3$  is 0.0198N

### OBSERVATION:

Burette : 0.02 N AgNO<sub>3</sub>  
Beaker : Water sample 10 ml (V)  
Indicators : potassium chromate  
End points : White precipitate converted to Red colour precipitate.

### OBSERVATION TABLE:

Sr. No	Vol. of AgNO <sub>3</sub> in (ml)		Constant Reading
	Initial	Final	
1.	0	6.9	6.9
2.	0	7	
3.	0	6.9	

### CALCULATIONS:-

$$\text{Chloride (mg/l)} = \frac{\text{Burette reading} \times \text{Normality of AgNO}_3 \times 35.45 \times 1000}{\text{Volume of water sample}}$$
$$\frac{6.9 \times 0.0198 \times 35.45 \times 1000}{10}$$

### RESULT AND DISCUSSION:-

The concentration of chloride measured in the given water Sample is found to be **484.31mg/l**

Signature of Teacher

## **EXPERIMENT NO: 5**

**AIM:** Proximate analysis of coal.

**Date of Performance:** 04/06/2021 **Sign of Teacher:**

**APPARATUS:** Coal sample, muffle furnace, oven balance, desiccators.

**THEORY:** Moisture content is the loss in weight of coal due to which the calorific value is reduced. High volatile matter containing coal burns with a long smoky flame, which has less calorific value and hence volatile matter lowers the calorific value of coal.

### **PROCEDURE:**

#### **Part A : Moisture content**

1. Weigh the crucible
2. Weigh about 1 kg given air dried coal sample in crucible and weigh the crucible with sample.
3. Heat it in electric oven at 110 °C for one hour.
4. Cool it in desiccators for ten minutes and weigh it.

#### **Part B : Volatile matter**

1. Weigh the crucible with lid and weigh about 1gm of coal Sample.
2. Heat it in muffle furnace at 950° C for 7 minutes with Crucible covered with lid.
3. Cool it in desiccators for ten minutes and weigh it.

#### **Part C : Ash Content**

1. Weigh the crucible
2. Weigh about 1gm given air dried coal sample in crucible.
3. Place it in muffle furnace for half an hour at 700 to 800°C without lid.
4. Cool it in desiccators for ten minutes and weigh it .

## **OBSERVATION :**

### **PART A : Moisture Content**

**Observation table:**

Sr. No.	Description	Value
1	Weight of empty crucible ( w <sub>1</sub> )gm	<b>22.53gm</b>
2	Weight of crucible and coal ( w <sub>2</sub> )gm	<b>23.55gm</b>
3	Weight of coal (w <sub>2</sub> – w <sub>1</sub> ) gm	<b>1. 02gm</b>
4	Weight of crucible and coal after heating (w <sub>3</sub> ) gm	<b>23.53gm</b>
5	Loss in weight of coal after heating (w <sub>2</sub> –w <sub>3</sub> ) gm	<b>0.02gm</b>

## **CALCULATION :**

$$\begin{aligned}
 \text{Loss in weight due to heating} &= \text{moisture content of sample} \\
 &= (w_2 - w_1) - (w_3 - w_1) \text{ gm} \\
 &= (1.02) - (23.53 - 22.53) \text{ gm} \\
 &= 0.02 \text{ gm}
 \end{aligned}$$

$$\begin{aligned}
 \% \text{ moisture} &= [\text{loss in weight} / \text{weight of coal}] 100 \\
 &= [(w_2 - w_3) / (w_2 - w_1)] 100 \\
 &= [(0.02) / (1.02)] 100 \\
 &= 2\%
 \end{aligned}$$

## **PART B: Volatile matter Content:**

### **Observation table:**

Sr. No.	Description	Value
1	Weight of empty crucible (w <sub>1</sub> gm)	<b>22.58 gm</b>
2	Weight of crucible + coal (w <sub>2</sub> )gm	<b>25.59gm</b>
3	Weight of coal (w <sub>2</sub> - w <sub>1</sub> ) gm	<b>3.01gm</b>
4	Weight of crucible + coal after heating (w <sub>4</sub> )gm	<b>25.30gm</b>
5	Weight of Volatile matter expelled or loss in weight ( w <sub>2</sub> - w <sub>4</sub> ) gm	<b>0.29gm</b>

### **Calculation:**

$$\% \text{ of volatile matter} = \text{Loss in weight due to removal of volatile matter} /$$

$$\begin{aligned} \text{Weight of dry Coal} \times 100 - \% \text{ moisture} &= (w_2 - w_4) / (w_2 - w_1) \times 100 - \% \text{ moisture} \\ &= (0.29) / (3.01) \times 100 - 2 \\ &= 7.63\% \end{aligned}$$

## **PART C: Ash Content:**

### **Observation table:**

Sr. No.	Description	Value
1	Weight of empty crucible                   (w <sub>1</sub> ) gm	<b>22.54gm</b>
2	Weight of crucible with dry coal           (w <sub>2</sub> ) gm	<b>23.60gm</b>
3	Weight of dry coal                          (w <sub>2</sub> - w <sub>1</sub> ) gm	<b>1.06 gm</b>
4	Weight of crucible and coal ash left   (w <sub>5</sub> ) gm	<b>23.50gm</b>
5	Weight of ash                                (w <sub>5</sub> - w <sub>1</sub> ) gm	<b>0.96gm</b>

### **CALCULATION:**

$$\begin{aligned}
 \text{Percentage of ash} &= [\text{weight of ash formed} / \text{weight of dry coal}] 100 \\
 &= \{(w_5 - w_1) / (w_2 - w_1)\} \times 100 \\
 &= \{(0.96) / (1.06)\} \times 100 \\
 &= 0.9056\%
 \end{aligned}$$

### **RESULT:**

<b>1</b>	<b>Percentage of moisture</b>	<b>= 2%</b>
<b>2</b>	<b>Percentage of volatile matter</b>	<b>= 7.63%</b>
<b>3</b>	<b>Percentage of ash</b>	<b>= 0.9056%</b>

Signature of Teacher

## **EXPERIMENT NO: 6**

**AIM:** To determine neutralization number of Oil.

**Date of Performance:** 05/06/2021 **Sign of Teacher:**

**APPARATUS:** Burette, pipette, conical flask, glass rod etc.

**CHEMICALS:** Ethyl alcohol, Std. KOH solution, Oil, Phenolphthalein, Acetone, Benzene etc.

**THEORY:** The acid value of lubricating oil is defined as number of milligrams of KOH required to neutralize the free acid present in one gram of oil sample. In good lubricating oil acid value should minimum increase in acid value should be taken as an indicator of oxidation of oil which may lead to gum and sludge formation decides corrosion. A known weight of oil sample is dissolved in a suitable solvent and titrates with a standard alcoholic KOH solution

### **REACTIONS:**



### **PROCEDURE:**

- 1) Weight exactly around 5 gr of the sample on watch glass and dissolved it In to 50 ml of neutral ethanol.
- 2) Heat the solution for 30 minute in water bath cools it and adds 2 to 3 drops of Phenolphthalein indicator.
- 3) Titrate the solution with 0.1 N KOH till the color of solution is faint pink color.

Sr. No.	Weight of Sample (in gm)	Burette reading (in ml)	Constant Reading
1.	5gm	2.7	2.7
2.	5gm	2.4	2.4
3.	5gm	2.4	2.4

### FORMULA:

$$\text{Neutralization number} = \frac{\text{Burrate Reading} \times 56.1 \times \text{Normaliti of KOH}}{\text{Volume of oil}}$$

$$\text{Neutralization number} = \frac{\text{Burrate Reading} \times 56.1 \times 0.1}{\text{Volume of oil}}$$

### CALCULATIONS

$$= 2.4 \times 56.1 \times 0.1 / 5 = 2.6928$$

**RESULT:** Neutralization number of given Oil sample is 2.692

Signature of Teacher

## **EXPERIMENT NO: 7**

**AIM: Demonstration on different type of cells and batteries.**

**Date of Performance:** 07/06/2021 **Sign of Teacher:**

A battery is a collection of one or more cells that go under chemical reactions to create the flow of electrons within a circuit. There is lot of research and advancement going on in battery technology, and as a result, breakthrough technologies are being experienced and used around the world currently. Batteries came into play due to the need to store generated electrical energy. As much as a good amount of energy was being generated, it was important to store the energy so it can be used when generation is down or when there is a need to power standalone devices which cannot be kept tethered to the supply from the mains. Here it should be noted that only DC can be stored in the batteries, AC current can't be stored.

Battery cells are usually made up of three main components;

1. The Anode (Negative Electrode)
2. The Cathode (Positive Electrode)
3. The electrolytes

The anode is a negative electrode that produces electrons to the external circuit to which the battery is connected. When batteries are connected, an electron build-up is initiated at the anode which causes a potential difference between the two electrodes. The electrons naturally then try to redistribute themselves, this is prevented by the electrolyte, so when an electrical circuit is connected, it provides a clear path for the electrons to move from the anode to the cathode thereby powering the circuit to which it is connected. By changing the arrangement and material used to build the Anode, Cathode and Electrolyte we can achieve many different types of battery chemistries enabling us to design different types of battery cells. In this article lets understand the different types of batteries and their uses, so let's get started.

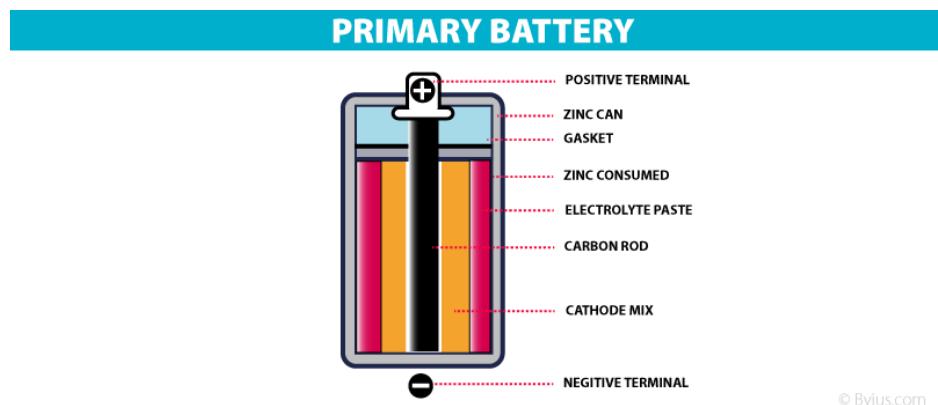
**Types of Batteries**

Batteries generally can be classified into different categories and types, ranging from chemical composition, size, form factor and use cases, but under all of these are two major battery types;

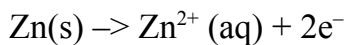
1. Primary Batteries
2. Secondary Batteries

Let's take a deeper look to understand the major differences between a Primary cell and Secondary Cell.

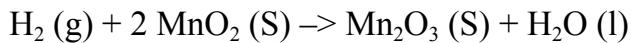
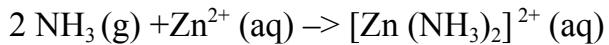
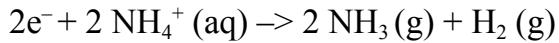
### 1. Primary Batteries



At Anode



At Cathode



Thus, the overall cell equation is:



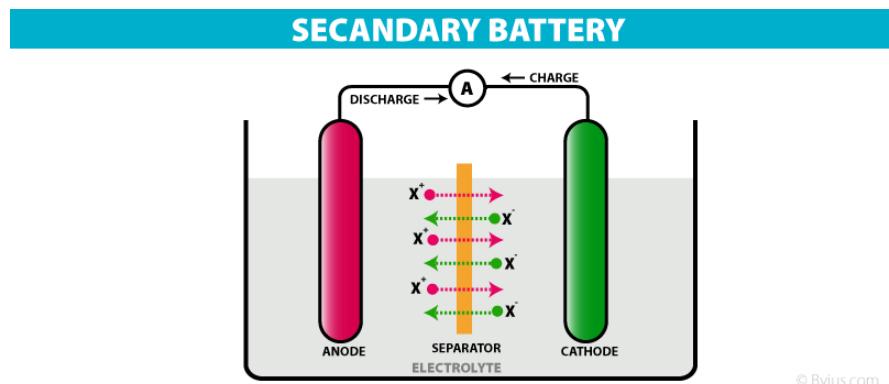
Primary batteries are batteries that cannot be recharged once depleted. Primary batteries are made of electrochemical cells whose electrochemical reaction cannot be reversed.

Primary batteries exist in different forms ranging from coin cells to AA batteries. They are commonly used in standalone applications where charging is impractical or impossible. A good example of which is in military grade devices and battery powered equipment. It will be impractical to use rechargeable batteries as recharging a battery will be the last thing in the mind of the soldiers. Primary batteries always have high specific energy and the systems in which they are used are always designed to consume low amount of power to enable the battery last as long as possible.

Some other examples of devices using primary batteries include; Pace makers, Animal trackers, Wrist watches, remote controls and children toys to mention a few.

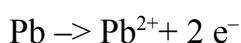
The most popular type of primary batteries are alkaline batteries. They have a high specific energy and are environmentally friendly, cost-effective and do not leak even when fully discharged. They can be stored for several years, have a good safety record and can be carried on an aircraft without being subject to UN Transport and other regulations. The only downside to alkaline batteries is the low load current, which limits its use to devices with low current requirements like remote controls, flashlights and portable entertainment devices.

## 2. Secondary Batteries

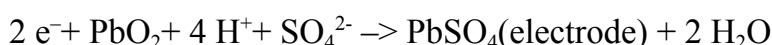
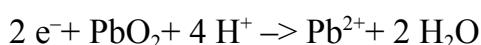


© Byjus.com

At Anode



At Cathode



Secondary batteries are batteries with electrochemical cells whose chemical reactions can be reversed by applying a certain voltage to the battery in the reversed direction. Also referred to as rechargeable batteries, secondary cells unlike primary cells can be recharged after the energy on the battery has been used up.

They are typically used in high drain applications and other scenarios where it will be either too expensive or impracticable to use single charge batteries. Small capacity secondary batteries are used to power portable electronic devices like mobile phones, and other gadgets and appliances while heavy-duty batteries are used in powering diverse electric vehicles and other high drain applications like load levelling in electricity generation. They are also used as standalone power sources alongside Inverters to supply electricity. Although the initial cost of acquiring rechargeable batteries is always a whole lot higher than that of primary batteries but they are the most cost-effective over the long-term.

Secondary batteries can be further classified into several other types based on their chemistry. This is very important because the chemistry determines some of the attributes of the battery including its specific energy, cycle life, shelf life, and price to mention a few.

The following are the different types of rechargeable batteries that are commonly used.

1. Lithium-ion(Li-ion)
2. Nickel Cadmium(Ni-Cd)
3. Nickel-Metal Hydride(Ni-MH)
4. Lead-Acid

## **1. Nickel-Cadmium Batteries**

The nickel–cadmium battery (NiCd battery or NiCad battery) is a type of rechargeable battery which is developed using nickel oxide hydroxide and metallic cadmium as electrodes. Ni-Cd batteries excel at maintaining voltage and holding charge when not in use. However, NI-Cd batteries easily fall a victim of the dreaded “memory” effect when a partially charged battery is recharged, lowering the future capacity of the battery.



In comparison with other types of rechargeable cells, Ni-Cd batteries offer good life cycle and performance at low temperatures with a fair capacity but their most significant advantage will

be their ability to deliver their full rated capacity at high discharge rates. They are available in different sizes including the sizes used for alkaline batteries, AAA to D. Ni-Cd cells are used individual or assembled in packs of two or more cells. The small packs are used in portable devices, electronics and toys while the bigger ones find application in aircraft starting batteries, Electric vehicles and standby power supply.

Some of the properties of Nickel-Cadmium batteries are listed below.

- Specific Energy: 40-60W-h/kg
- Energy Density: 50-150 W-h/L
- Specific Power: 150W/kg
- Charge/discharge efficiency: 70-90%
- Self-discharge rate: 10%/month
- Cycle durability/life: 2000cycles

### **3. Nickel-Metal Hydride Batteries**

Nickel metal hydride (Ni-MH) is another type of chemical configuration used for rechargeable batteries. The chemical reaction at the positive electrode of batteries is similar to that of the nickel–cadmium cell (NiCd), with both battery type using the same nickel oxide hydroxide (NiOOH). However, the negative electrodes in Nickel-Metal Hydride use a hydrogen-absorbing alloy instead of cadmium which is used in NiCd batteries



NiMH batteries find application in high drain devices because of their high capacity and energy density. A NiMH battery can possess two to three times the capacity of a NiCd battery of the same size, and its energy density can approach that of a lithium-ion battery. Unlike the NiCd chemistry, batteries based on the NiMH chemistry are not susceptible to the “memory” effect that NiCads experience.

Below are some of the properties of batteries based on the Nickel-metal hydride chemistry;

- Specific Energy: 60-120h/kg
- Energy Density: 140-300 Wh/L
- Specific Power: 250-1000 W/kg
- Charge/discharge efficiency: 66% - 92%
- Self-discharge rate: 1.3-2.9%/month at 20°C
- Cycle Durability/life: 180 -2000

### **3. Lithium-ion Batteries**

Lithium-ion batteries are one of the most popular types of rechargeable batteries. There are many different types of Lithium batteries, but among all the lithium-ion batteries are the most commonly used. You can find these lithium batteries being used in different forms popularly among electric vehicles and other portable gadgets. If you are curious to know more about batteries used in Electric vehicles, you can check out this article on Electric Vehicle Batteries. They are found in different portable appliances including mobile phones, smart devices and several other battery appliances used at home. They also find applications in aerospace and military applications due to their lightweight nature.



Lithium-ion batteries are a type of rechargeable battery in which lithium ions from the negative electrode migrate to the positive electrode during discharge and migrate back to the negative electrode when the battery is being charged. Li-ion batteries use an intercalated lithium compound as one electrode material, compared to the metallic lithium used in non-rechargeable lithium batteries.

Lithium-ion batteries generally possess high energy density, little or no memory effect and low self-discharge compared to other battery types. Their chemistry alongside performance and cost vary across different use cases, for example, Li-ion batteries used in handheld electronic devices are usually based on lithium cobalt oxide ( $\text{LiCoO}_2$ ) which provides high energy density and low safety risks when damaged while Li-ion batteries based on Lithium iron phosphate which offer a lower energy density are safer due to a reduced likelihood of unfortunate events happening are widely used in powering electric tools and medical equipment. Lithium-ion batteries offer the best performance to weight ratio with the lithium sulphur battery offering the highest ratio.

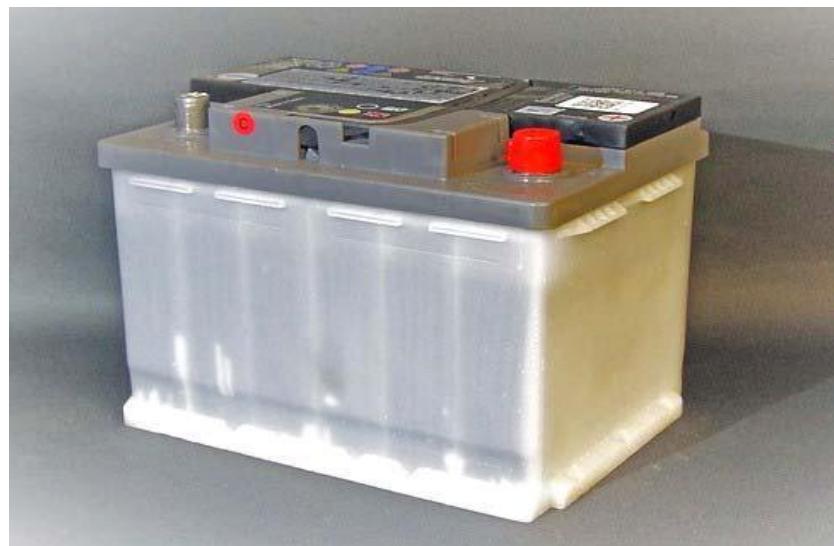
Some of the attributes of lithium-ion batteries are listed below;

- Specific Energy: 100: 265W-h/kg
- Energy Density: 250: 693 W-h/L
- Specific Power: 250: 340 W/kg
- Charge/discharge percentage: 80-90%
- Cycle Durability: 400: 1200 cycles

- Nominal cell voltage: NMC 3.6/3.85V

#### 4. Lead-Acid Batteries

Lead-acid batteries are a low-cost reliable power workhorse used in heavy-duty applications. They are usually very large and because of their weight, they're always used in non-portable applications such as solar-panel energy storage, vehicle ignition and lights, backup power and load levelling in power generation/distribution. The lead-acid is the oldest type of rechargeable battery and still very relevant and important into today's world. Lead-acid batteries have very low energy to volume and energy to weight ratios but it has a relatively large power to weight ratio and as a result, can supply huge surge currents when needed. These attributes alongside its low cost make these batteries attractive for use in several high current applications like powering automobile starter motors and for storage in backup power supplies. You can also check out the article on Lead Acid Battery working if you want to know more about the different types of Lead-acid batteries, its construction and applications.



Each of these batteries has its area of best fit and the image below is to help choose between them.

Selecting the right battery for your application

One of the main problems hindering technology revolutions like IoT is power, battery life affects the successful deployment of devices that require long battery life and even though several power management techniques are being adopted to make the battery last longer, a compatible battery must still be selected to achieve the desired outcome.

Below are some factors to consider when selecting the right type of battery for your project.

1. Energy Density: The energy density is the total amount of energy that can be stored per unit mass or volume. This determines how long your device stays on before it needs a recharge.
2. Power Density: Maximum rate of energy discharge per unit mass or volume. Low power: laptop, i-pod. High power: power tools.
3. Safety: It is important to consider the temperature at which the device you are building will work. At high temperatures, certain battery components will breakdown and can undergo exothermic reactions. High temperatures generally reduces the performance of most batteries.
4. Life cycle durability: The stability of energy density and power density of a battery with repeated cycling (charging and discharging) is needed for the long battery life required by most applications.
5. Cost: Cost is an important part of any engineering decisions you will be making. It is important that the cost of your battery choice is commensurate with its performance and will not increase the overall cost of the project abnormally.

### **Viva Questions –**

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**Result – Detail study of all types of batteries were carried out with construction, reactions Advantages and disadvantages in lab.**

Date - 02/06/2021

Name - Pratik Rajesh Jade

Roll no - A72

Sub - Environmental Chemistry.

Practical no - 7

Aim - Demonstration on different type of cells and batteries.

A battery is collection of one or more cells that go under chemical reactions to create the flow of electrons within a circuit. There is lot of research & advancement going on in battery technology, and as result, breakthrough technologies are being experienced and used around the world currently. Batteries came into play due to the need to store generated electrical energy. As much as a good amount of energy was being generated, it was important to store the energy so it can be used when generation is down or when there is a need to power standalone devices which cannot be kept tethered to the supply from the mains. Here it should be noted that only DC can be stored in the batteries, AC current can't be stored.

Battery cells are usually made up of three main components;

1. The Anode (Negative electrode)
2. The Cathode (Positive electrode)
3. The electrolytes

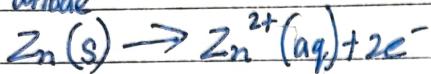
The anode is a negative electrode that produces electrons to the external circuit to which the battery is connected. When batteries are connected an electron build up is initiated at the anode which causes a potential difference between the two electrodes. The electrons naturally then try to redistribute themselves, this is prevented by the electrolyte, so when an electrical circuit is connected, it provides a clear path for the electrons to move from the anode to the cathode.

By changing the arrangement and material used to build the Anode, Cathode & electrolyte we can achieve many different types of battery chemistry enabling us to design different types of battery cells.

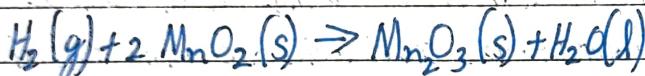
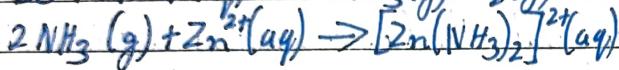
## Types of batteries.

### ① Primary Batteries-

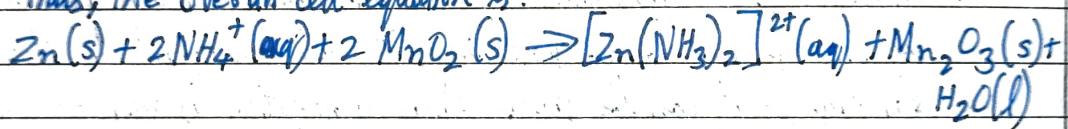
At anode



At cathode



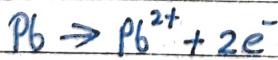
Thus, the overall cell equation is:



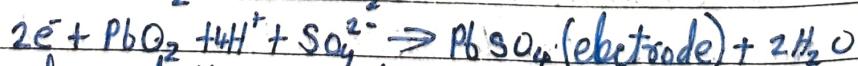
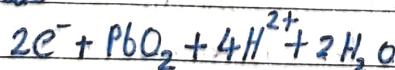
Primary batteries are batteries that cannot be recharged once depleted.  
Primary batteries are made of electrochemical cells whose electrochemical reaction cannot be reversed.

### ② Secondary battery

At anode



At Cathode



Secondary batteries are batteries with electrochemical cells whose reactions can be reversed by applying a certain voltage to the battery in reversed directions. It is typically used in high drain applications & other scenarios. It also used to power portable electronic device like mobile phone & other gadgets & many more.

The following are the different type of rechargeable batteries that are commonly used.

1. Lithium-ion
2. Nickel Cadmium
3. Nickel-Metal Hydride (Ni-MH)
4. Lead acid

### 1. Nickel-Cadmium batteries:-

It is rechargeable battery which develop using nickel oxide hydroxide & Metallic cadmium as electrodes. Ni-Cd batteries excel at maintaining voltage & holding charge when not in use. Ni-Cd batteries easily fall a victim of the dreaded "memory" effect when a partially charged battery is recharged lowering the future capacity of the battery. It has offers good life cycle & performance at low temp with a fair capacity. But their most significant advantage will be their ability to deliver full rated ~~atting~~ capacity. It is small in size, portable. It is used portable devices electronics & toys.

#### Some other properties of Ni-Cd battery

1. Specific energy - 40-60 W-h/kg
2. Energy Density - 50-150 W-h/l
3. Specific Power - 150W/kg
4. Charge /discharge efficiency - 70-90%
5. Self-discharge rate - 10%/month
6. Cycle durability/life - 2000 cycles

### 2. Nickel-Metal Hydride batteries:-

Ni-MH is another type of chemical configuration used for rechargeable batteries. The chemical reactions at the positive electrode of batteries is similar to that of the Ni-Cd cell with both battery type using some nickel-cadmium oxide hydroxide.

It uses a hydrogen absorbing alloy instead of cadmium which is used in NiCd battery.

NiMH batteries find application in high drain device because of their high capacity & energy density.

Some other properties of Ni-MH battery

- 1) Specific energy :- 60 - 120 Wh/Kg
- 2) Energy density :- 140 - 300 Wh/L
- 3) Specific power :- 250 - 1000 W/kg
- 4) Charge/discharge :- 66% - 92%

### 3. Lithium-ion batteries

It is one of the most popular type of rechargeable battery. There are different types of lithium-ion batteries but among all the lithium-ion batteries are the most commonly used. It used in different forms popularly among electric vehicles & other portable gadgets. Batteries used in electric vehicle you can check out the article on electrical vehicle batteries. It is found in different portable applicances including mobile phone, laptop & other device & other battery used home & also find applications in aerospace & military applications in aerospace & military application due to their light weight nature.

It is rechargeable battery in which lithium ions from the negative electrode migrate to the positive electrode during discharge & migrate back. Li-ion batteries use an intercalated lithium compound as one electron material compared to the metallic lithium used in non-rechargeable lithium batteries.

It possess high energy density little or no memory effect & low self-discharge compared to the battery type.

Li-ion batteries used in handheld electronic devices are based on lithium cobalt-oxide which provide high energy density & low safety risks when damaged while Li-ion battery.

based on lithium iron phosphate which offer a lower energy density, are safer due to a reduced likelihood of unfortunate event happening are widely used in powering electric tools & medical equipment

Some basic properties of ion.

1. Specific energy : 100 : 265 W-h/Kg
2. Energy Density : 250 : 693 W-h/L
3. Specific power : 250 : 340 W/kg
4. Charge/discharge : 40a : 1200 cycles

#### 4. Lead-Acid battery

Lead acid battery are low-cost reliable power workhorse used in heavy-duty application they are usually very large & because of their weight, they are always used in non portable application such as solar panel energy storage, vertical ignition & lights, backup power & load levelling in power generation. Battery have very low energy to volume & energy to weight ratio but it has a relatively large power to weight ratio & as a result can supply huge surge currents when needed. Battery attractive for use in several high current application like powering automobile starters-motors & for storage in backup power supplies.

\* Some factors to consider when selecting the right type of battery for your project

##### 1. Energy Density -

The total amount of energy that can be stored per unit mass or volume. The determines how long your device stays on before it need a recharge.

##### 2. Power density - Maximum rates of energy discharge per unit mass. Low power, laptop, i-pod, High power, power tools.

3. Safety : The temp at which the device you are building will work. At higher temp certain battery component will breakdown & can undergo exothermic reaction. High temp generally reduces the performance of most batteries.
4. Life cycle durability : The stability of energy density & power density of a battery with repeated cycling is need for the long battery life required by most applications.
5. Cost : Cost is an important part of any engineering decisions you will making it is important that the cost of your battery choice is commensurate with its performance & will not increase of the project abnormally.

## **EXPERIMENT NO.: 8**

**NAME OF EXPERIMENT:** **Determination of DO**

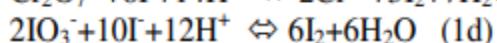
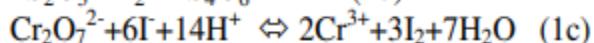
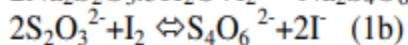
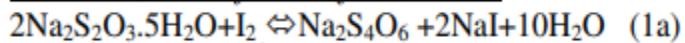
**Date of Performance:** 11/06/2021    **Sign of Teacher:** 

### **AIM- Determination of DO of given water sample by Iodometric Method.**

Objective: Determine DO content of a given sample  
Background: Dissolved oxygen (DO) levels in environmental water depend on the physiochemical and biochemical activities in water body and it is an important useful in pollution and waste treatment process control. Two methods are commonly used to determine DO concentration: (1) The iodometric method which is a titration-based method and depends on oxidizing property of DO and (2) The membrane electrode procedure, which works based on the rate of diffusion of molecular oxygen across a membrane. In the Iodometric method, divalent manganese solution is added to the solution, followed by addition of strong alkali in a glass-stopper bottle. DO rapidly oxidize an equivalent amount of the dispersed divalent manganese hydroxide precipitates to hydroxides of higher valence states. In the presence of iodide ions in an acidic solution, the oxidized manganese reverts to the divalent state, with the liberation of iodine equivalent of the original DO content. The iodine is then titrated with a stranded solution of thiosulfate. The titration end point can be detected visually with a starch indicator. Some oxidizing and reducing agents present in solution can interfere with the iodometric method.

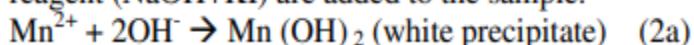
Oxidizing agents liberate iodine from iodides (positive interference) and some reducing agents reduce iodine to iodide (negative interference). Also, organic matter present in solution can be oxidized partially in the presence of oxidized manganese precipitate, thus causing negative errors. Thus some modification of procedure is required.

### Standardization of thiosulfate solution

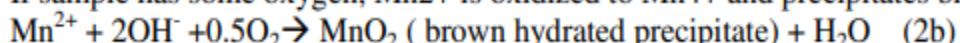


### The Winkler Method for DO Determination

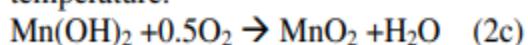
If no oxygen is present, a pure white precipitate is formed when  $\text{MnSO}_4$  and alkali-iodide reagent ( $\text{NaOH} + \text{KI}$ ) are added to the sample.



If sample has some oxygen,  $\text{Mn}^{2+}$  is oxidized to  $\text{Mn}^{4+}$  and precipitates brown hydrated oxide.



The oxidation of  $\text{Mn}^{2+}$  to  $\text{MnO}_2$  is called fixation of the oxygen, occurs slowly at low temperature.



### **Principle**

Dissolved oxygen (DO) determination measures the amount of dissolved (or free) oxygen present in water or wastewater. Aerobic bacteria and aquatic life such as fish need dissolved oxygen to survive. If the amount of free or DO present in the wastewater process is too low, the aerobic bacteria that normally treat the sewage will die. DO is determined by the titrimetric method developed by Winkler.

1. Dissolved molecular oxygen in water is not capable of reacting with KI, therefore an oxygen carrier such as manganese hydroxide is used.  $\text{Mn}(\text{OH})_2$  is produced by the action of KOH on  $\text{MnSO}_4$ .
2.  $\text{Mn}(\text{OH})_2$  so obtained reacts with dissolved molecular oxygen to form a brown precipitate of basic manganic oxide,  $\text{MnO}(\text{OH})_2$ .
3.  $\text{MnO}(\text{OH})_2$  then reacts with concentrated sulphuric acid to liberate nascent oxygen.
4. Nascent oxygen results in oxidation of KI to  $\text{I}_2$ .
5. This liberated iodine is then titrated against standard sodium thiosulphate solution using starch as an indicator.
6. Thiosulphate reduces iodine to iodide ions and itself gets oxidized to tetrathionate ion.  
(Refer the reactions below.)

### Observation table I :

Standardization ( 0.01N)  $\text{Na}_2\text{S}_2\text{O}_3$  with potassium dichromate (0.01N) solution(10 ml)  
with starch as an indicator color change from blue to colorless

Sr. No	Burette Reading		Vol. of $\text{Na}_2\text{S}_2\text{O}_3$ used (Xml)
	Initial	Final	
1.	0	5.3	5.3
2.	0	4.9	4.9
3.	0	4.9	4.9

### CALCULATION:

$$\begin{aligned} \text{Na}_2\text{S}_2\text{O}_3 &\quad \text{K}_2\text{Cr}_2\text{O}_7 \\ \text{N}_1\text{V}_1 &= \text{N}_2\text{V}_2 \\ \text{N}_2 &= \text{N}_1\text{V}_1/\text{V}_2 \\ &= 0.01 \times 10 / 4.9 \end{aligned}$$

Normality of  $\text{Na}_2\text{S}_2\text{O}_3$  is 0.0204

### Observation table II:

Sr. No	Burette Reading		Vol. of $\text{Na}_2\text{S}_2\text{O}_3$ used (Xml)
	Initial	Final	
1.	0	1.8	1.8
2.	0	2.4	2.4
3.	0	2.4	2.4

### Calculations:

$$\text{DO of Water Sample in mg/lit} = \frac{\text{Burrete Reading} \times 8 \times \text{Normaliti of Na}_2\text{S}_2\text{O}_3 \times 1000}{\text{Volume of water sample}} \text{ of mg/lit}$$

$$= 0.0204 \times 8 \times 2.4 \times 1000 / 10 = 39.168 \text{ mg/l}$$

**RESULT :-**The given water sample has 39.168 mg/lit of dissolved oxygen.