Department of Chemistry
Lumding College, Lumding

Session: 2022-2023

1) Details of Papers:

Semester	Paper Name	Paper Code
3rd	Basic Analytical Chemistry	CHE-SE-3034
4th	Green Methods in Chemistry	CHE-SE-4024
5th	Chemical Technology & Society	CHE-SE-5014
6th	Fuel Chemistry	CHE-SE-6034

2) Course Syllabus:

A. Basic Analytical Chemistry (CHE-SE-3034):

Course Objective: *To familiarize students with different micro and semimicro analytical techniques and help develop the ability to use modern instrumental methods for chemical analysis of food, soil, air and water.*

Learning Outcome: *Upon completion of this course, students shall be able to explain the basic principles of chemical analysis, design/implement microscale and semimicro experiments, record, interpret and analyze data following scientific methodology.*

Introduction: Introduction to Analytical Chemistry and its interdisciplinary nature. Concept of sampling. Importance of accuracy, precision and sources of error in analytical measurements. Presentation of experimental data and results, from the point of view of significant figures.

Analysis of soil: Composition of soil, Concept of pH and pH measurement, Complexometric titrations, Chelation, Chelating agents, use of indicators

a. Determination of pH of soil samples.

b. Estimation of Calcium and Magnesium ions as Calcium carbonate by complexometric titration.

Analysis of water: Definition of pure water, sources responsible for contaminating water, water sampling methods, water purification methods.

a. Determination of pH, acidity and alkalinity of a water sample.

b. Determination of dissolved oxygen (DO) of a water sample.

Analysis of food products: Nutritional value of foods, idea about food processing and food preservations and adulteration. a. Identification of adulterants in some common food items like coffee powder, asafoetida, chilli powder, turmeric powder, coriander powder and pulses, etc. b. Analysis of preservatives and colouring matter.

Chromatography: Definition, general introduction on principles of chromatography, paper chromatography, TLC etc. a. Paper chromatographic separation of mixture of metal ion (Fe^{3+} and Al^{3+}). b. To compare paint samples by TLC method.

Ion-exchange: Column, ion-exchange chromatography etc. Determination of ion exchange capacity of anion / cation exchange resin (using batch procedure if use of column is not feasible).

Analysis of cosmetics: Major and minor constituents and their function a. Analysis of deodorants and antiperspirants, Al, Zn, boric acid, chloride, sulphate. b. Determination of constituents of talcum powder: Magnesium oxide, Calcium oxide, Zinc oxide and Calcium carbonate by complexometric titration.

Suggested Applications (Any one):

a. To study the use of phenolphthalein in trap cases.

b. To analyze arson accelerants.

c. To carry out analysis of gasoline.

Suggested Instrumental demonstrations:

a. Estimation of macro nutrients: Potassium, Calcium, Magnesium in soil samples by flame photometry.

b. Spectrophotometric determination of Iron in Vitamin / Dietary Tablets.

c. Spectrophotometric Identification and Determination of Caffeine and Benzoic Acid in Soft Drink.

Recommended Books:

1. Willard, H. H. *Instrumental Methods of Analysis*, CBS Publishers.

2. Skoog & Lerry. *Instrumental Methods of Analysis*, Saunders College Publications, New York.

3. Skoog, D.A.; West, D.M. & Holler, F.J. *Fundamentals of Analytical Chemistry 6th Ed.*,Saunders College Publishing, Fort Worth (1992).

4. Harris, D. C. *Quantitative Chemical Analysis*, W. H. Freeman.

5. Dean, J. A. *Analytical Chemistry Notebook*, McGraw Hill.

6. Day, R. A. & Underwood, A. L. *Quantitative Analysis*, Prentice Hall of India.

7. Freifelder, D. Physical Biochemistry *2nd Ed.*, W.H. Freeman and Co., N.Y. USA(1982).

8. Cooper, T.G. *The Tools of Biochemistry*, John Wiley and Sons, N.Y. USA. 16(1977).

9. Vogel, A. I. *Vogel's Qualitative Inorganic Analysis 7th Ed.*, Prentice Hall.

10. Vogel, A. I. Vogel's *Quantitative Chemical Analysis 6th Ed.*, Prentice Hall.

11. Robinson, J.W. *Undergraduate Instrumental Analysis 5th Ed.*, Marcel Dekker, Inc., New York (1995)

B. Green Methods in Chemistry (CHE-SE-4024):

Course Objectives: *This course introduces students to the utilization of green chemistry from industrial perspective and provides exposure to methods by which environmental problems are evaluated and designing of sustainable solutions.*

Learning Outcome: *Students shall be able to describe and evaluate chemical products and processes from environmental perspective, define and propose sustainable solutions and critically assess the methods for waste reduction and recycling.*

Tools of Green chemistry, Twelve principles of Green Chemistry, with examples.

The following Real world Cases in Green Chemistry should be discussed:

1. A green synthesis of ibuprofen which creates less waste and fewer byproducts (Atom economy).
2. Surfactants for Carbon Dioxide – replacing smog producing and ozone depleting solvents with CO_2 for precision cleaning and dry cleaning of garments.
3. Environmentally safe antifoulant.
4. CO_2 as an environmentally friendly blowing agent for the polystyrene foam sheet packaging market.
5. Using a catalyst to improve the delignifying (bleaching) activity of hydrogen peroxide.
6. A new generation of environmentally advanced preservative: getting the chromium and arsenic out of pressure treated wood.
7. Rightfit pigment: synthetic azopigments to replace toxic organic and inorganic pigments.
8. Development of a fully recyclable carpet: cradle to cradle carpeting.

Recommended Books:

1. Manahan S.E. (2005) Environmental Chemistry, CRC Press
2. Miller, G.T. (2006) Environmental Science 11th edition. Brooks/Cole
3. Mishra, A. (2005) Environmental Studies. Selective and Scientific Books, New

C. Chemical Technology & Society (CHE-SE-5014):

Course Objective: *The objective of the course is to enable students to have a firsthand understanding of different types of equipments needed in chemical technology and offer them concepts regarding some important parameters. The syllabus also emphasizes the dynamic nature of the relations between society on one hand and technological achievement from chemical industries on the other hand. In other words, it tries to explore societal and technological issues from a chemical perspective.*

Learning Outcome: *Students shall be familiarized with processes and terminologies in chemical industry, like mass balance, energy balance etc. Learners will be able to use chemical and scientific literacy as a means to better understand the topics related to the society.*

Chemical Technology

Different types of equipments needed in chemical technology, including reactors, distillation columns, extruders, pumps, mills, emulgators. Scaling up operations in chemical industry.

Introduction to clean technology. Concept of relative humidity, molal humidity, dew point, partial saturation. Material Balance: Recycle, bypass in batch, stage wise and continuous operations in systems with and without chemical reactions. Energy balance: Energy balance of systems with and without chemical reactions.

Society

Social issues related to soil, air and water pollution. Energy crisis of modern society and search for alternatives such as energy from natural sources (i.e. solar and renewable forms), and from nuclear fission, biofuel etc. Pros and cons of use of materials like plastics and polymers and their natural analogues, Genetic engineering and the manufacture of drugs (proteins and nucleic acids, and molecular reactivity and interconversions)

Recommended Book:

1. John W. Hill, Terry W. McCreary & Doris K. Kolb, *Chemistry for changing times* 13th Ed.
2. E.J. Hackett, O. Amsterdamska, M. Lynch and J. Wajcman (eds.), The Handbook of Science and Technology Studies, The MIT Press, 2008.
3. D. MacKenzie and J. Wajcman (eds.), The Social Shaping of Technology, The Open University Press, 1999

D. Fuel Chemistry (CHE-SE-6034):

Course Objectives: *This course discusses about the chemistry of various sources of energy. Students are expected to learn about the composition of coal and petroleum products, their extraction, purification methods and usage. A section also covers classification and applications of natural and synthetic lubricants. Students will also learn about the determination and significance of various industrially relevant physical parameters for different fuels and lubricants.*

Learning Outcomes: *At the end of this course students will learn about the classes of renewable and non-renewable energy sources. Students will learn about the composition of coal and crude petroleum, their classification, isolation of coal and petroleum products and their usage in various industries. They will also learn to determine industrially significant physical parameters for fuels and lubricants.*

Fuel Chemistry

Review of energy sources (renewable and non-renewable). Classification of fuels and their calorific value.

Coal: Uses of coal (fuel and nonfuel) in various industries, its composition, carbonization of coal.Coal gas, producer gas and water gas—composition and uses. Fractionation of coal tar, uses of coal tar bases chemicals, requisites of a good metallurgical coke, Coal gasification (Hydro gasification and Catalytic gasification), Coal liquefaction and Solvent Refining.

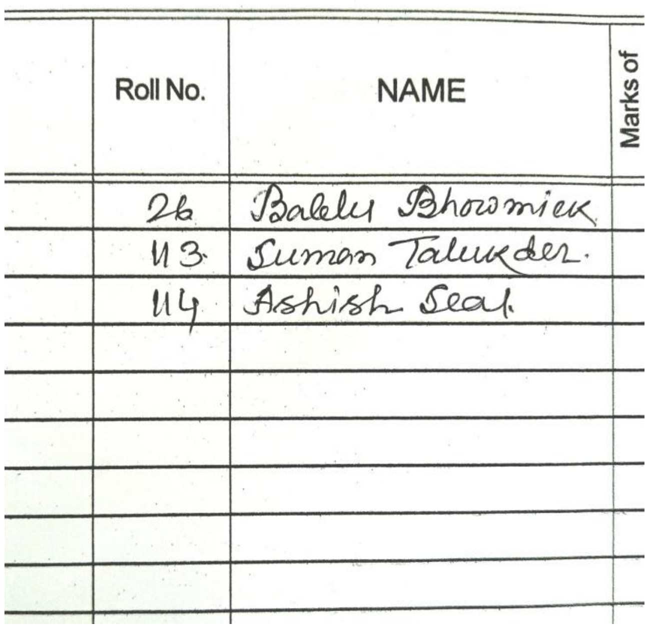
Petroleum and Petrochemical Industry: Composition of crude petroleum, Refining and different types of petroleum products and their applications. Fractional Distillation (Principle and process), Cracking (Thermal and catalytic cracking), Reforming Petroleum and non-petroleum fuels (LPG, CNG, LNG, bio-gas, fuels derived from biomass), fuel from waste, synthetic fuels (gaseous and liquids), clean fuels. Petrochemicals: Vinyl acetate, Propylene oxide, Isoprene, Butadiene, Toluene and its derivatives Xylene.

Lubricants: Classification of lubricants, lubricating oils (conducting and non-conducting) Solid and semisolid lubricants, synthetic lubricants. Properties of lubricants (viscosity index, cloud point, pore point) and their determination.

Recommended Books:

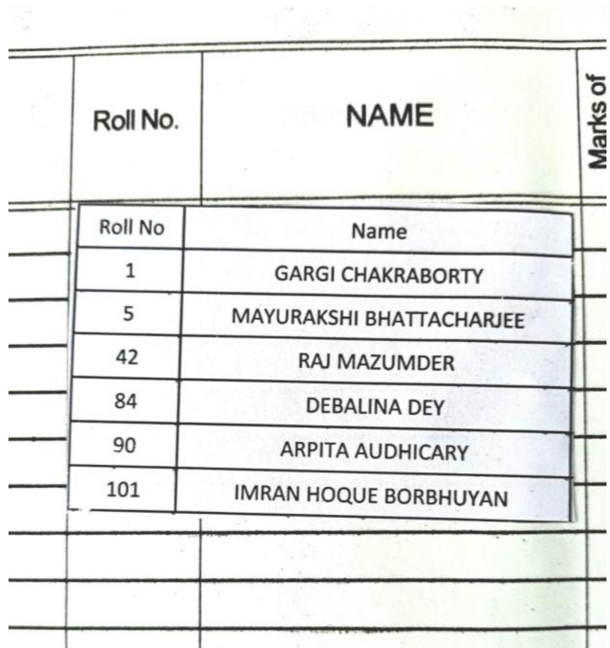
1. E. Stocchi: *Industrial Chemistry*, Vol -I, Ellis Horwood Ltd. UK.
2. P.C. Jain, M. Jain: *Engineering Chemistry*, Dhanpat Rai & Sons, Delhi.
3. B.K. Sharma: *Industrial Chemistry*, Goel Publishing House, Meerut.

3) Students details:



Roll No.	NAME	Marks of
26	Bablu Bhowmick	
113	Suman Talukder.	
114	Ashish Seal	

B. Sc. 5th and 6th Semester (CBCS)



Roll No	Name
1	GARGI CHAKRABORTY
5	MAYURAKSHI BHATTACHARJEE
42	RAJ MAZUMDER
84	DEBALINA DEY
90	ARPITA AUDHICARY
101	IMRAN HOQUE BORBHUYAN

B. Sc. 3rd and 4th Semester (CBCS)

4) Project Reports:

A. Basic Analytical Chemistry (CHE-SE-3034):

1

ANALYSIS OF WATER SAMPLES COLLECTED FROM LUMDING, ASSAM

ESTD 1959

Paper Name & Code: Basic Analytical Chemistry (CHE-SE-3034

SUBMITTED BY:
NAME: JESSICA SINGHA
ROLL NO.: US-211-0024

SUBMITTED TO:
DEPARTMENT OF CHEMISTRY
LUMDING COLLEGE,
LUMDING (ASSAM)-782447

2

ABSTRACT:

By analyzing the water sample of the region of lumding we want to understand the quality of water used by the people of this region. Water quality refers to the chemical, physical, biological, and radiological characteristics of water. It is a measure of the condition of water relative to the requirements of one or more biotic species and or to any human need or purpose. It is most frequently used by reference to a set of standards against which compliance can be assessed. Water samples for the analysis where collected from well, bore well, and corporation in lumding region. The samples were analysed for parameters like pH, electrical conductivity and total hardness. The values of each parameter gave interesting values which therefore where used to determine the quality. Illustrations were made for the ease of comparison. Out of all samples the parameters had very disappointing values; therefore water quality is not up to the standard.

Keywords: Analyzing; Chemical, Physical; Parameters; Illustrations; Quality.

3

1. INTRODUCTION

Water is one of the most important of all natural resources known on earth. It is important to all living organisms, most ecological systems, human health, food production and economic development. The safety of drinking water is an ongoing concern within the global village. Traditionally, the safety of potable water supplies has been controlled by disinfection, usually by chlorination and coli form population estimates. However, it has been reported that coli form-free potable water may not necessarily be free of pathogens.

Many congenital diseases such as goiter and cancer have been associated with presence of high concentration of a chemical or its inadequate supply in water. Low concentration of iodine in Homo sapiens results in goiter. Infants have been considered as a potential high risk group to the toxic effects of sodium from drinking water.

Currently, about 20% of the world's population lacks access to safe drinking water, and more than 5 million people die annually from illness associated with safe drinking water or inadequate sanitation. If everyone had safe drinking water and adequate sanitation services, there would be 200milion fewer cases of diarrhea and 2.1 million fewer deaths caused by diarrhea illness each year. Biofilms in drinking water distribution system has generated health concerns. Biofilms are coating of organic and inorganic materials in pipes that can harbor, protect and allow the proliferation of several bacterial pathogens, including Legionella and Mycobacterium avium complex (MAC). Factors that affect bacterial growth on biofilms include water temperature, type of disinfectant and residual concentration, biodegradable organic carbon level, degree of pipe corrosion and treatment/distribution system characteristics. Chloramines are considerably more effective than chlorine for controlling legionella in biofilms distribution system deficiencies linked to a number of water born disease outbreaks.

6

2. MATERIALS AND METHOD

2.1 Sample collection and preservations:

The water samples were collected from the region of Lumding; samples were from well and open well on the month of March and April 2024. The collected water samples were stored in a clean bottle for analysis. Labels were used to prevent sample misidentification. The tests for hardness were conducted on the same day of collection. The temperature was determined with the help of laboratory method. The pH was determined using the pH meter. The conductivity was determined using conductivity meter.

2.2 Details of Sampling Locations:

Sampling stations are situated in and around Lumding. Their details are given below.

Table: 1- Details of Sample Sources

Sample no.	Sample Station	Type of source	Depth in feet	Latitude N	Longitude E
1	Brick field colony	Well	28	25.750214°	93.169866°
2	Railway colony	Well	58	25.745407°	93.170627°

B. Green Methods in Chemistry (CHE-SE-4024):

Atom Economy: Green Synthesis of Ibuprofen

Paper: Green Methods in Chemistry (CHE-SE-4024)

Green Chemistry

Submitted by:

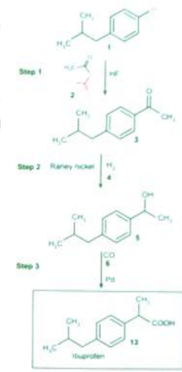
Imran Hoque Borbhuyan
Roll No. 101
University Roll No. US-211-304-0021

Submitted to:

Department of Chemistry
Lumding College

Green Synthesis of Ibuprofen:

Traditional synthesis of ibuprofen involves multiple steps with significant waste production. However, a more efficient synthetic route developed by Boots Company and further optimized by BHC (Boots-Hoechst-Celanese) improved atom economy by reducing the number of steps and minimizing by-products. The optimized process increased atom economy and significantly reduced the environmental footprint. The process involves three steps and results in 99% atom economy if the acetic acid formed as byproduct is recovered.



Step I: Acylation of isobutylbenzene by acetic anhydride and catalytic amount of HF. The HF is recovered and reused.

Step II: Reduction of the acylated isobutylbenzene by raney Ni.

Step III: Carbonylation in presence of CO and Pd.

The brown synthesis uses aluminum trichloride in stoichiometric amounts for the first step, which generates large amounts of aluminum trichloride hydrate as a waste byproduct that is generally landfilled. By contrast, the green synthesis uses hydrogen fluoride as a catalyst that is recovered and reused repeatedly. It should also be noted that the Raney nickel and the palladium catalysts in Steps 2 and 3 of the green synthesis are recovered and reused. In addition to the elimination of large quantities of waste, by virtue of only requiring three steps, the green synthesis offers the advantage of a greater throughput compared with the six step brown synthesis. This translates into the ability to produce larger quantities of ibuprofen in less time and with less capital expenditure, resulting in significant economic benefits to the company. Thus, the green synthesis is a win–win situation with both the environment and the bottom line benefiting.

What is Atom Economy?

Atom economy is a concept in green chemistry that measures the efficiency of a chemical reaction in terms of how well atoms in the reactants are utilized to form the desired products. This principle was introduced by Professor Barry Trost in 1991 and has since become a fundamental guideline for designing environmentally friendly and sustainable chemical processes.

It is defined as the ratio of the molecular weight of the desired product to the total molecular weight of all reactants, expressed as a percentage. It indicates how many of the reactants' atoms are incorporated into the final product and how many are wasted as by-products. The formula for calculating atom economy is:

$$\%\text{ Atom Economy} = \frac{\text{Molar Mass of Product}}{\text{Molar Mass of All Reactants}} \times 100\%$$

High atom economy means that fewer waste products are generated, reducing the environmental impact of chemical processes. This aligns with the goals of green chemistry to minimize hazardous waste and improve sustainability. Improving atom economy can also lead to cost savings. By maximizing the use of reactants, chemical manufacturers can reduce the amount of raw materials needed and lower waste disposal costs. This makes the process more economically viable. Efficient use of atoms in chemical reactions conserves resources by ensuring that more of the starting materials are converted into useful products. This is particularly important for reactions involving rare or expensive materials.

Several strategies can be employed to improve atom economy in chemical reactions:

a) Choice of Reagents: Selecting reagents that are fully incorporated into the final product can enhance atom economy. For example, using reagents that do not produce by-products or side-products is preferable.

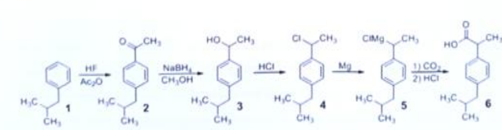
b) Catalysis: Catalysts can significantly improve atom economy by enabling reactions to proceed via more efficient pathways. Catalysts often allow for the use of less reactive but more abundant and less toxic reagents.

c) Reaction Pathways: Designing synthetic routes that minimize the number of steps and maximize the incorporation of reactants into the desired product is crucial. Multi-step processes often result in lower atom economy due to the generation of by-products at each stage.

d) Alternative Solvents: Using solvents that can be easily recovered and reused, or employing solvent-free reactions, can reduce waste and improve the overall efficiency of the process.

Traditional Synthesis of Ibuprofen:

The synthesis of ibuprofen was accomplished through a five-step process. Initially, isobutylbenzene (1) and acetic anhydride, were reacted under Friedel-Crafts acylation conditions to create p-isobutylacetophenone. Acetic anhydride and $AlCl_3$ formed a lewis acid complex that produced an acylinium ion, which was then attacked by 1 to form p-isobutylacetophenone (2) through electrophilic aromatic substitution. In the second step, ketone 2 was reduced with $NaBH_4$ in CH_3OH to form 3. Next, alcohol 3 was substituted by chlorine under acidic conditions to form 4 via an S_N1 mechanism. Next, the Grignard reagent, 5, was formed by reacting 4 with magnesium in refluxing ether. Carbon dioxide was bubbled through 5, which permitted the nucleophilic attack of the Grignard reagent onto CO_2 to form 6 followed by protonation.



Even if this reaction were to proceed with 100% yield, only 27% (by weight) of the atoms of the reactants are incorporated into the desired product, with 73% of the reactant atoms ending up as unwanted byproducts.

C. Chemical Technology & Society (CHE-SE-5014):

ESTD 1959

Project Title:

EFFECT OF AIR POLLUTION ON LIVING ORGANISMS AND VEGETATION

(5th Semester Project Report)

Paper Name & Code: Chemical Technology & Society (CHE-SE-5014)

Submitted by:

Name: ASHISH SEAL

Roll No.: US-201-304-0046

Lumding College, Lumding (Assam)-782447

Submitted to:
Department of Chemistry
Lumding College,
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Contents

Abstract:

Air pollution is the presence of harmful substances in the Earth's atmosphere, resulting from natural and human activities. These pollutants include particulate matter (PM), nitrogen oxides (NOx), sulfur dioxide (SO2), carbon monoxide (CO), volatile organic compounds (VOCs), and ozone (O3). The sources of air pollution are diverse, encompassing industrial emissions, vehicle exhaust, agricultural practices, and natural events like wildfires and volcanic eruptions. This project outline provides a comprehensive approach to studying the effects of air pollution on living organisms and vegetation. It combines various research methods to ensure a thorough investigation and aims to offer practical solutions to mitigate the adverse effects of air pollution.

1. Introduction: Air pollution is a pressing environmental issue that affects the health of living organisms and the stability of ecosystems. It is the presence of harmful substances in the atmosphere, resulting from both natural processes and human activities. These pollutants can be gases, particulates, or biological molecules, and their sources are diverse, ranging from industrial emissions and vehicle exhaust to agricultural practices and natural events like wildfires and volcanic eruptions.

Air pollutants are categorized based on their physical state and chemical composition:

a) Particulate Matter (PM): These are tiny particles suspended in the air, including dust, soot, smoke, and liquid droplets. Particulate matter is classified into PM10 (particles with a diameter of 10 micrometers or less) and PM2.5 (particles with a diameter of 2.5 micrometers or less). PM2.5 is particularly dangerous as it can penetrate deep into the lungs and enter the bloodstream, causing severe health issues.

b) Nitrogen Oxides (NOx): These are gases produced from the combustion of fossil fuels, particularly in vehicles and industrial activities. NOx includes nitrogen dioxide (NO_2) and nitric oxide (NO), which contribute to the formation of smog and acid rain, and can cause respiratory problems.

c) Sulfur Dioxide (SO_2): Emitted primarily from the burning of fossil fuels at power plants and during industrial processes, SO_2 is a gas that can lead to respiratory issues and the formation of acid rain, which harms ecosystems and structures.

d) Carbon Monoxide (CO): A colorless, odorless gas produced by the incomplete combustion of fossil fuels. High levels of CO can be lethal as it interferes with the blood's ability to transport oxygen.

e) Volatile Organic Compounds (VOCs): These organic chemicals evaporate easily into the air and originate from vehicle emissions, industrial processes, and solvents. VOCs play a significant role in the formation of ground-level ozone and smog, which are harmful to health and the environment.

f) Ozone (O_3): While ozone in the upper atmosphere protects us from ultraviolet radiation, ground-level ozone is a major component of smog and poses serious health risks, including respiratory problems and lung disease.

D. Fuel Chemistry (CHE-SE-6034):

Solar Energy: Applications and Impact

(6th Semester Project Report)

Paper Name & Code: Fuel Chemistry (CHE-SE-6034)

ESTD 1959

Submitted by:

BABLU BHOWMICK

Roll No. US-201-304-0047

B. Sc. 6th Semester

Lumding College, Lumding (Assam)-782447

Submitted to:

Department of Chemistry

Lumding College,

Lumding (Assam)-782447

Outline:

Abstract:

This project explores the multifaceted dimensions of solar energy, focusing on recent innovations, diverse applications, and their socio-economic and environmental impacts. It aims to provide a comprehensive overview of the current state of solar technology, assess its potential for future development, and evaluate the implications of widespread solar energy adoption.

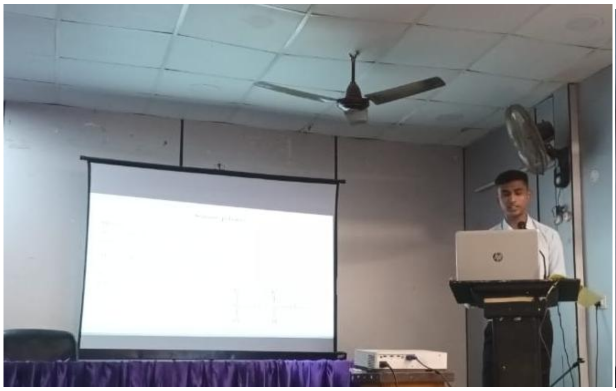
Chapter 1: Introduction

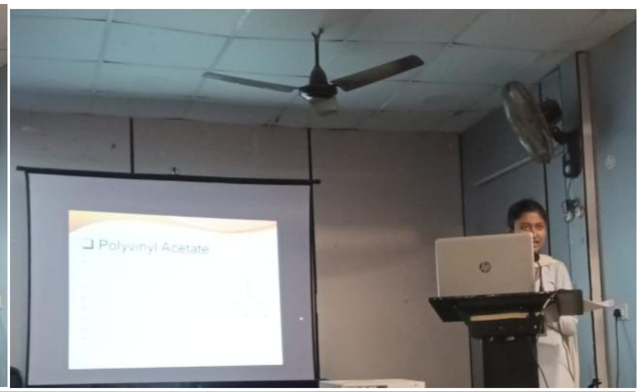
Solar energy, derived from the Sun's radiation, is a potent and abundant source of renewable energy that has the potential to meet the world's energy demands sustainably. Unlike fossil fuels, which are finite and contribute to environmental degradation, solar energy is inexhaustible and environmentally friendly. The Sun provides more energy to the Earth in one hour than the entire world consumes in a year, highlighting its vast potential.

Solar energy systems produce electricity without emitting greenhouse gases, making them crucial in combating climate change. By reducing dependence on fossil fuels, solar energy helps decrease air pollution and mitigates global warming. Solar energy systems have minimal impact on the environment compared to conventional energy sources. They require less water for maintenance, which is beneficial in regions where water scarcity is an issue. The solar energy industry has seen significant cost reductions, making it more accessible and competitive with traditional energy sources. The declining cost of solar panels and improvements in technology have contributed to the widespread adoption of solar energy. Solar energy projects create jobs in manufacturing, installation, and maintenance, contributing to economic growth and development. The industry supports a range of employment opportunities, from high-tech positions to skilled labor. Solar energy enhances energy security by diversifying the energy supply and reducing dependence on imported fuels. Countries can harness their own solar resources, decreasing vulnerability to geopolitical tensions and market fluctuations. Decentralized solar energy systems, such as rooftop solar panels, increase the resilience of energy infrastructure by reducing the risk of widespread power outages. Solar energy can provide electricity to remote and underserved areas, improving access to energy and enhancing the quality of life. Off-grid solar systems are particularly beneficial in developing regions with limited energy infrastructure.

The development of solar technology has a rich history, marked by key milestones and technological advancements. The photovoltaic effect, the underlying principle of solar cells, was first observed by French physicist Edmond Becquerel in 1839. He discovered that certain materials produced small electric currents when exposed to light. In the late 19th and early 20th

5) Photos of Departmental Seminar:





6) Pictures of digital classes: