Based on National Curriculum of Pakistan 2022-23

Textbook of

CHEMISTRY

Grade 12

National Curriculum Council
Ministry of Federal Education and Professional Training

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A Textbook of Chemistry for Grade 12
based on National Curriculum of Pakistan (NCP) 2022-23

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TEST EDITION

Note
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PREFACE

In a historic footstep, the national curriculum of Pakistan 2022-2023 has introduced a new era for schooling in the country, This is the first-ever core curriculum in the 75-year history of Pakistan. It is in line with the protected right to school education by Article 25-A.

Chemistry might be a difficult subject for someone, but it holds significance for those who embrace a systematic approach to understanding its concepts.

This new Textbook has been developed as a model Textbook for Pakistan. The book consolidates critical thinking methodologies, guiding scientific reasoning, and thinking abilities. The book incorporates problem-solving strategies, which will guide students toward analytical thinking and skills. These skills would be invaluable for both academic as well as practical life.

The book also inspires concept assessment exercises in every unit, which have been designed to evaluate acquired knowledge and promote critical thinking and analysing data.

One of the book`s distinctive features is the key points at the end of each unit, which serve as a quick reference to reinforce the salient features of each unit.

Dr. Kamran Jahangir
Managing Director

UTILITY OF CHEMISTRY IN EVERYDAY LIFE

Chemistry plays a vital role in our daily activities, from the food we eat to the medicines we use. Understanding how different chemical processes work helps us make sense of the world around us. From powering our phones with electrochemical cells to understanding the balance of acids and bases in our digestive systems, chemistry shapes every aspect of life. Electrochemistry studies chemical reactions involving the movement of electrons. These reactions help power our modern devices.

- Oxidizing and Reducing Agents are substances that either gain or lose electrons in chemical reactions, such as in batteries or rusting metals.
- Electrochemical Series ranks elements based on their ability to gain or lose electrons, crucial for predicting reaction behaviour.
- Cell Potential measures how much electrical energy is produced by a reaction, used in devices like smartphones.
- Electrochemical Cells are devices that convert chemical energy into electrical energy. Batteries are common examples, including dry cells and rechargeable cells.
- In many reactions, products and reactants exist in a balance, known as equilibrium. Buffers are solutions that resist changes in pH, essential in maintaining the pH balance of our blood. Partition Coefficient is used in separating compounds, it helps in designing effective drugs and understanding how they distribute in the body. Solubility Product concept is used in purifying water, removing unwanted salts, and forming precipitates in laboratory tests.

Acids and Bases are substances which interact with water to form ions. Acids, like vinegar, are sour, while bases, like baking soda, are slippery. They are used in household cleaning, digestion, and even in the environment.

Transition metals have lot of daily life applications from constructing strong materials (e.g., steel) to enhancing electrical efficiency. They play key roles in environmental protection, agriculture, and water treatment by reducing pollution and improving crop production. Additionally, transition metals are essential in advanced technologies, powering batteries, electronics, and space exploration equipment.

Organic compounds have potential use in the fields of agriculture and the chemical industry. They are used in the manufacture of fertilizers, pesticides, and herbicides, improving crop yields. They are also essential in producing pharmaceuticals, cosmetics, shampoos, lotions and cleaning agents. This highlights the vast applications of hydrocarbons in energy, manufacturing, agriculture, and healthcare, making them integral to modern life.

Hydrocarbons have significant contributions in serving our daily lives. They are excellent fuels for powering our houses, vehicles and industries. Pharmaceutical industries use hydrocarbons to synthesis medicines and vitamins to protect and improve our health. Halogenated hydrocarbons are used in making medicines like anesthetics (halothane) and propellant for inhalers. Freon is fluorinated hydrocarbon used as refrigerant.

Alcohols are used in disinfectants and perfumes, while carboxylic acids like vinegar are common in food. Naphthols and Phenols are used in making dyes and antiseptics, they are key ingredients in cleaning agents. Azo-compounds are used to create vivid dyes for fabrics and plastics.

Polymers (Nylon, Kevlar) are long chains of molecules, forming everyday items like clothing and bulletproof vests. Nylon is used in textiles, while Kevlar provides strength in protective gear.

Biochemistry involves studying living organisms at the molecular level. Amines and Amides are found in proteins, amines are essential for life, and amides form the backbone of synthetic fibers like nylon. Lipids, Carbohydrates, and Proteins are macromolecules are the building blocks of life, providing energy, structure, and function to our bodies. Enzymes are proteins that speed up chemical reactions, playing critical roles in digestion and metabolism. Cholesterol is a key component of cell membranes, while insulin regulates blood sugar. DNA and RNA store genetic information, guiding the development of every living thing.

Chromatography ensures drug safety, detects food additives, and monitors water and air quality. It's vital in forensic science for identifying substances at crime scenes. It also ensures the safety of cosmetics and beverages by detecting contaminants.

Materials science impacts daily life through alloys for strength, plastics for durability, and ceramics for heat resistance. Concrete is essential for infrastructure, while catalysts speed up industrial reactions. X-ray crystallography aids drug design by revealing molecular structures.

Qualitative Analysis helps in identifying contaminants, additives, and adulterants in food products, such as checking for harmful heavy metals in water or verifying the purity of food ingredients. Collecting and analyzing data on nutrients like proteins, carbohydrates, and fats in food to provide accurate nutritional information on packaging. Tracking pollutant levels in air, soil, and water to assess environmental quality and comply with safety standards.

Understanding errors like systematic and random errors helps improve accuracy in measuring ingredients or temperatures in cooking and laboratory experiments. Minimizing errors in production lines, for instance, by ensuring precise amounts of chemicals are used in pharmaceutical or food products.

Spectroscopy Techniques like infrared (IR) Spectroscopy is used in identifying organic compounds in essential oils and fragrances by analyzing their IR absorption patterns. Visible Spectroscopy is applied in determining the colour intensity of food dyes and beverages, helping to control colour consistency in food products. Nuclear Magnetic Resonance (NMR) is utilized in pharmaceuticals to determine molecular structure and verify the purity of synthesized drugs.

Industrial Chemistry deals with synthesizing preservatives like sodium benzoate to extend the shelf life of food products. Using organic chemistry to create artificial flavours that mimic natural tastes for beverages, snacks, and desserts.

Drugs like aspirin, penicillin, and antiviral drugs help combat pain and infections.

Chemicals like fertilizers help plants grow, while pesticides protect crops from pests. These substances improve food production, ensuring a steady food supply.

The study of these processes not only enhances our knowledge but also enables us to solve real-world problems. Through this textbook, we will explore everyday applications, helping you connect the science of chemistry with the world around you.

Managing Author

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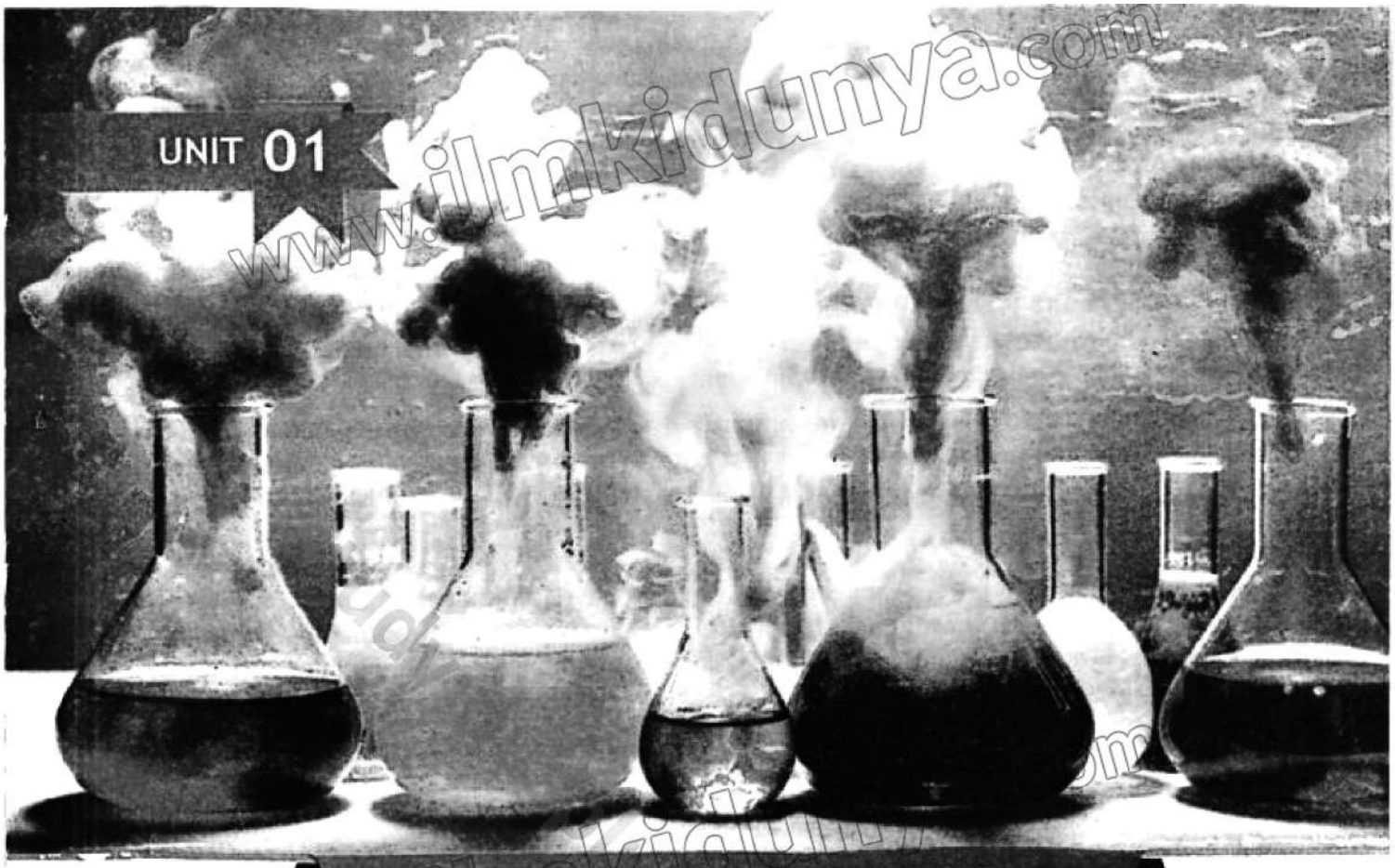

UNIT 01

ETHICS AND VALUES IN CHEMISTRY

Student Learning Outcomes

- Identify common cognitive biases/fallacies that can hinder sound scientific reasoning in physical sciences(some examples include: a. The conformation bias, b. Hasty generalizations, c. Post hoc ergo propter hoc(false cause), d. the straw man fallacy, e. Redefinition(moving the goalposts), f. The appeal to tradition, g. False authority, h. Falling Occam`s Razor, i. Argument from non-testable hypothesis, j. Begging the question, k. Fallacy of exclusion, l. Faulty analogy.
- Explain the pros and cons of ethical considerations involved in the production and use of chemical substances and the processes(some examples include: the impact on human health and the environment; the responsibility of scientists and companies; the role of regulations and laws).
- Explain and apply the following terms to deconstruct the structure of a scientific argument in a variety of formats such as speeches, written articles and advertisement brochures: a. Claims, b. Counterclaims, c. Rebuttals, d. premises, d. conclusions, e.assumptions.

Morals and beliefs in the field of chemistry are essential for guaranteeing the ethical and positive progress of the discipline. Researchers in chemistry need to follow the rules of truthfulness and openness in their work and writings. They should make sure that their results are precise and can be replicated.

1.1 Cognitive Biases and Fallacies

Cognitive bias is the tendency to make decisions or behave illogically because of our values, memory, socialization and other personal characteristics. In other words, it refers to a certain pattern of thinking based on how our brain works.

Logical fallacies refer to the way we currently make claims and construct our arguments. These are claims that sound convincing at first but can be refuted by logical reasoning.

Some common ones are as follows:

1. Confirmation Bias:

Confirmation bias is the tendency of people to process information by searching for or interpreting information that is consistent with their existing beliefs. This biased approach to decision-making is largely unintentional and results in the individual ignoring information that contradicts their beliefs.

2. Hasty Generalizations:

A hasty generalization fallacy is a claim made on the basis of insufficient evidence. Instead of examining examples and evidence that are much more representative of a typical or average situation, you are using a small, unrepresentative sample to draw a conclusion about a large population.

3. Post Hoc Ergo Propter Hoc (False Cause):

A false cause fallacy happens when an individual wrongly believes that there's a cause-and-effect connection between two objects or happenings. This is an incorrect inference since either there's no such connection or the proof for it is not enough.

This fallacy assumes that if one event occurs after another, the first must be the cause of the second. In the physical sciences, it can mislead scientists into false causal relationships.

4. The Straw Man Fallacy:

The straw man fallacy occurs when someone distorts or exaggerates another's claim and then attacks the distorted version of the claim instead of refuting the original claim.

5. Redefinition (Shifting the Standards):

Altering the criteria for success or acceptance of a theory once it has been achieved. This can hinder scientific advancement by establishing unrealistic expectations for proof.

6. The Appeal to Tradition

Believing something is true or superior just because it's a traditional practice or has been done that manner for a long time. In the realm of physical sciences, this mindset can hinder the acceptance of fresh approaches or concepts that might be more precise or effective.

7. False Authority:

An informal logical error or a convincing method where it's taken for granted that the views of a well-known authority in one field should be followed in another field. In physical sciences, this could lead to the acceptance of incorrect theories based on an expert's general prestige rather than their specific knowledge.

8. Falling Occam's Razor:

The principle of Occam's razor is frequently mentioned. A 14th-century monk named William of Ockham suggested that if there are two possible explanations for the same event, you should choose the more straightforward one.

9. Argument from Non-Testable Hypothesis:

Proposing a hypothesis that cannot be verified or disproven. This is a major problem in the physical sciences because it weakens the foundation of scientific investigation based on evidence.

10. Begging the Question:

Asking a question that begs an answer is referred to as "begging the question," and is frequently substituted with "a question that seems to require an answer." On the other hand, a less common but more precise definition is "to overlook a question, presuming it has been previously addressed." The term originates from a rendering of an Aristotelian expression translated as "beg the question," but with the actual meaning being "assume the conclusion. In scientific reasoning, this fallacy can result in circular arguments that do not advance understanding.

11. The Fallacy of Exclusion:

Excluding evidence that could disprove a hypothesis. This can severely skew scientific research by ignoring contradictory data.

12. Faulty Analogy:

This error is based on the idea that if two objects share similarities in one or more aspects, they must also share similarities in another aspect. In the realm of physical sciences, this can result in wrong deductions if the comparison doesn't prove valid when examined closely.

1.2 Ethical Considerations in the Production and Use of Chemical Substances

The production and use of chemical substances involve various ethical considerations. These impact human health, the environment, the responsibilities of scientists and companies, and the role of regulations and laws. There are many pros and cons associated with these ethical considerations:

1. Impact on Human Health and the Environment

Chemical substances contribute to numerous benefits, including medical advancements, agricultural improvements, and the creation of everyday products that enhance the quality of life.

Pros:

Chemicals can solve pressing issues, such as pharmaceuticals treating diseases, fertilizers increasing food production, and clean energy technologies reducing carbon footprints.

Cons:

Exposure to harmful chemicals can cause health problems, such as cancer, respiratory issues etc. This risk is significant for both workers in the chemical industry and the general public. Improper disposal and accidental releases of chemicals can lead to environmental, water and soil pollution.

2. Responsibility of Scientists and Companies

Scientists and companies have the opportunity to lead by example in ethical practices, prioritizing safety and sustainability in their operations and research.

Pros:

Companies can enhance their reputation and consumer trust by adopting corporate social responsibility, practices that focus on reducing their environmental impact and promoting community health.

Cons:

The financial incentives might lead companies to prioritize profits over safety and ethical considerations, potentially resulting in harmful practices and cover-ups of negative effects. Determining who is responsible for chemical-related incidents can be challenging, especially in cases of long-term or diffuse pollution.

3. Role of Regulations and Laws

Regulations and laws are designed to protect public health and the environment by setting safety standards, controlling emissions, and ensuring proper handling and disposal of chemicals.

Pros:

Regulations encourage the development of industry standards and best practices, fostering innovation in safer and more sustainable chemical processes.

Cons:

In some regions, weak or outdated regulations may fail to address current risks, leaving populations and ecosystems vulnerable.

Strict regulations can impose significant compliance costs on companies, potentially stifling innovation and making it difficult for smaller enterprises to compete.

Examples of Ethical Considerations

Pesticides: The use of pesticides in agriculture improves crop yields but poses risks to human health (e.g., exposure to toxic chemicals) and the environment (e.g., contamination of water bodies, harm to non-target species).

Pharmaceuticals: The development of life-saving drugs benefits society, but the ethical dilemma arises with issues like drug pricing, access to medication, and potential side effects.

Industrial Chemicals: Chemicals used in manufacturing processes can lead to pollution if not managed properly, raising ethical concerns about environmental justice, particularly in low-income communities disproportionately affected by industrial activities.

1.3 Deconstructing the Structure of a Scientific Argument

To break down the framework of a scientific argument presented in different forms like oral presentations, written pieces, and promotional pamphlets, it's important to grasp and pinpoint the main elements of the argument. These components include claims, counterclaims, rebuttals, premises, conclusions, and assumptions.

1. Claims

A claim is a declaration or proposition that represents the central idea or stance of a debate. It's the evidence the speaker or author is attempting to demonstrate.

For instance, in a presentation supporting the use of green energy, a claim could be, "Green energy options like solar and wind are important for minimizing carbon dioxide emissions."

2. Counterclaims

A counterclaim is a statement that opposes the main claim. It represents an opposing viewpoint or objection.

For example, an article discussing renewable energy might include a counterclaim such as, "Renewable energy sources are unreliable and cannot provide a stable energy supply."

3. Rebuttals

A rebuttal challenges and opposes an opposing viewpoint, offering proof or logic to undermine or disprove it.

For instance, when countering the argument that renewable energy is not dependable, a counterargument might be, "Innovations in technology and enhanced methods of energy storage have greatly enhanced the dependability of renewable energy sources."

4. Premises

Premises are the statements or reasons that provide the foundation for the claim. These are the supporting points that lead to the conclusion.

For example, premises for the claim about renewable energy might include:

"Burning fossil fuels releases large amounts of carbon dioxide into the atmosphere."

"Solar and wind power do not produce carbon emissions during operation."

5. Conclusions

The conclusion is the final statement that naturally follows from the initial statements. It represents the ultimate goal of the argument.

For instance, considering the initial statements given, the conclusion could be, "Hence, it is essential to invest in renewable energy to fight against climate change.

6. Assumptions

Assumptions are the basic convictions or declarations accepted without evidence. They lay the groundwork for the reasoning, yet they are not directly mentioned.

For instance, in the case of the renewable energy debate, some assumptions could be:

"Cutting down on carbon emissions is an essential objective."

"The listeners agree that climate change is a significant issue."

"Innovations in technology will keep enhancing the effectiveness of renewable energy technologies."

Application for Various Formats

1. Speeches

Claim: Investing in renewable energy is very important for our future.

Premises: Fossil fuels are limited. They pollute the environment. Renewable energy reduces dependence on foreign oil, so it can boost the economy.

Counterclaim: Renewable energy is insufficient and too expensive.

Rebuttal or Objections: New technologies have improved efficiency and have reduced costs.

Conclusion: We must prioritize investments in renewable energy. This can ensure a sustainable future,

2. Written Articles

Claim: We should switch over to electric vehicles to significantly reduce air pollution in cities.

Premises: Electric cars do not produce emissions. Urban areas suffer from high air pollution.

Counterclaim or Objection: Electric cars still have high costs due to battery production.

Rebuttal: Recycling and advances in battery technology have reduced these environmental impacts.

Conclusion: "Therefore, promoting the use of electric cars is the best strategy to improve air quality.

3. Brochures

Claim: Our new eco-friendly product is the best choice for environmentally conscious consumers.

Premises: It is made from 100% recycled materials. It reduces waste and pollution. Hence, it supports sustainable practices.

Counterclaim: It is eco-friendly products but tends to be more expensive and less durable.

Objections: Our product is competitively priced. It has undergone rigorous durability testing.

Conclusion: Choosing our products ensure a greener and more sustainable lifestyle.

KEY POINTS

- Sound scientific reasoning is essential for accurate results and meaningful discoveries.
- Drawing broad conclusions from a small or unrepresentative sample can lead to erroneous results.
- Drawing an analogy between two unrelated things and assuming they share a particular property is called faulty analogy.
- Chemical substances contribute to numerous benefits, including medical advancements, agricultural improvements, and the creation of everyday products that enhance quality of life.
- Regulations and laws are designed to protect public health and the environment.
- The use of pesticides in agriculture improves crop yields but poses risks to human health.
- A claim is a statement or assertion that is the main point or position of an argument. It is what the speaker or writer is trying to prove.
- A counterclaim is a statement that opposes the main claim. It represents an opposing viewpoint or objection.

EXERCISE

1. Multiple Choice Questions (MCQs)

i. What is cognitive bias?

a) The process of making decisions based on logical reasoning.

b) The tendency to make decisions based on personal characteristics and beliefs.

c) The evaluation of arguments using empirical evidence.

d) The method of constructing arguments using logical fallacies.

ii. What is a hasty generalization fallacy?

a) Drawing a conclusion based on a large, representative sample

b) Drawing a conclusion based on insufficient evidence

c) Drawing a conclusion by misrepresenting an opponent's argument

d) Drawing a conclusion based on a false cause-and-effect relationship

iii. What does the post hoc ergo propter hoc fallacy assume?

a) One event is caused by another simply because it follows it

b) One event is unrelated to another

c) One event is the result of a thorough investigation

d) One event is part of a larger series of events

iv. Which fallacy involves attacking a distorted version of an opponent's claim?

a) Confirmation Bias
b) Hasty Generalizations
c) The Straw Man Fallacy
d) Redefinition

v. What does the principle of Occam's Razor advocate?

a) Choosing the most complex explanation for an event
b) Choosing the simplest explanation for an event
c) Choosing an explanation based on tradition
d) Choosing an explanation based on authority

vi. What is an example of the appeal to tradition fallacy?

a) Believing a theory is valid because an expert supports it
b) Believing a practice is correct because it has always been done that way
c) Believing an argument because it cannot be tested
d) Believing a hypothesis because it is the simplest explanation

vii. Which of the following is a pro of chemical substances?

a) They always have a negative impact on health
b) They reduce carbon footprints through clean energy technologies
c) They are always safe for workers
d) They never cause environmental pollution

viii. What is a con of weak or outdated regulations regarding chemicals?

a) They protect public health effectively
b) They foster innovation in chemical processes
c) They fail to address current risks
d) They reduce compliance costs for companies

ix. What role do premises play in a scientific argument?

a) They oppose the main claim
b) They provide the foundation for the claim
c) They represent the conclusion
d) They are unsupported assumption

x. In the context of written articles, what would be a counterclaim for promoting electric vehicles?

a) Electric cars produce no emissions
b) Urban areas suffer from high air pollution
c) Electric cars still have high environmental costs due to battery production

3. Short Answer Questions

i. Define cognitive bias.
ii. What is a false cause fallacy?
iii. Describe the straw man fallacy.
iv. What does the fallacy of exclusion involve?
v. Give an example of a faulty analogy.
vi. List one pro and one con of chemical substances in terms of human health and the environment.
vii. What is the responsibility of scientists and companies in the production and use of chemical substances?
viii. Why are regulations and laws important in the chemical industry?
ix. What is a claim in the context of a scientific argument?
x. Provide an example of an assumption in a debate about renewable energy.

4. Long Answer Questions

i. Explain confirmation bias and its potential impact on scientific research.
ii. Discuss the ethical considerations in the production and use of chemical substances, highlighting the balance between benefits and risks.
iii. Deconstruct the structure of a scientific argument using the example of promoting electric vehicles to reduce air pollution.
iv. Analyse the role of regulations and laws in ensuring ethical practices in the chemical industry, citing specific examples.
v. Evaluate the pros and cons of using pesticides in agriculture, considering both human health and environmental impacts.