SAMPLE CONTENT

PERFECT

CHEMISTRY

Vol. II

Based on Latest Paper Pattern and Textbook

Optical isomers:
The horns of African gazelle show chirality and are mirror images of each other!

Std. XII Sci.

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PERFECT CHEMISTRY (Vol. II)

Std. XII Sci.

Salient Features

- Written as per **Latest Board Paper Pattern**
- Subtopic-wise segregation for powerful concept building
- Complete coverage of Textual Exercise Questions, and Intext Questions
- Marks provided to the Questions as per relevant weightage wherever deemed necessary
- Relevant Previous Years' Board Questions:
  March 2013 to July 2023
- Each chapter contains:
  - 'Quick Review' of the chapter for quick revision
  - 'Apply Your Knowledge' section for application of concepts
  - 'Important Formulae' and 'Solved Examples' to cover numerical aspect in detail
  - 'Exercise' to provide Theory questions, Numericals and MCQs for practice
  - 'Competitive Corner' to give the glimpse of prominent competitive examinations
  - 'Topic Test' at the end of each chapter for self-assessment
- Includes Important Features for holistic learning:
  - ***About the Chapter***
  - ***Reading Between the Lines***
  - ***NCERT Corner***
  - ***Enrich Your Knowledge***
  - ***Gyan Guru***
  - ***Connections***
  - ***Caution***
- Q.R. codes provide:
  - The Video/pdf links boosting conceptual retention
  - Solutions of Miscellaneous Questions for Practice and Topic Tests
  - Model Question Paper along with Solution

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PREFACE

Perfect Chemistry Vol. II, Std. XII Sci. is intended for every Maharashtra State Board aspirant of Std. XII, Science. The scope, sequence, and level of the book consistent with the latest textbook released by Maharashtra State board.

At this crucial juncture in their lives, when the students are grappling with the pressures of cracking a career-defining board examination, we wanted to create a book that not only develops the necessary knowledge, tools, and skills required to excel in the examination, but also enables students to appreciate the beauty of the subject and piques their curiosity.

We believe that students respond favourably to meaningful content, if it is presented in a way that is easy to read and understand, rather than being mired down with facts and information. Consequently, we have always placed the highest priority on writing clear and lucid explanations of fundamental concepts. Moreover, special care has been taken to ensure that the topics are presented in a logical order. The coherent Question/Answer approach helps students expand their horizon of understanding of the concepts.

The primary purpose of this book is to assist the students in preparing for the board examination. However, this is closely linked to other goals: to exemplify how important and how incredibly interesting chemistry is, and to help the student become an expert thinker and problem solver.

Every chapter in this book begins with ***'About the Chapter'*** that offers a brief introduction of the chapter and orients students towards the topic from examination point of view. The scope of the book extends beyond the State Board examination as it also offers a plethora of Multiple Choice Questions (MCQs) in order to familiarize the students with the pattern of competitive examinations.

In addition, the Topic Tests have been carefully crafted to focus on concepts, thus providing the students with a quick opportunity for self-assessment and giving them an increased appreciation of chapter-preparedness. '***Model Question Paper'*** based on latest paper pattern is provided along with solution through QR code to help students assess their preparedness for final board examination.

We believe that the study of chemistry helps in the understanding of many fascinating and important phenomena. In this vein, we have put an effort to relate chemistry to real-world events in order to show students that chemistry is a vibrant, constantly evolving science that has relevance in our modern world. We hope this book becomes a valuable tool for you and helps you to not only understand the concepts of chemistry but also to see the world from a molecular point of view.

Our **Perfect Chemistry Vol. II, Std. XII Sci.** adheres to our vision and achieves several goals: **building concepts**, **recapitulation, self-study, self-assessment** and **student engagement**—all while encouraging students toward cognitive thinking.

Publisher

Edition: Sixth

The journey to create a complete book is strewn with triumphs, failures and near misses. If you think we've nearly missed something or want to applaud us for our triumphs, we'd love to hear from you.
Please write to us on: mail@targetpublications.org

KEY FEATURES

'About the Chapter' is a short introduction designed to stimulate students' appetite for the topic.

Reading between the lines provides elaboration or missing fragments of concept which is essential for complete understanding of the concept.

NCERT Corner covers information from NCERT textbook relevant to topic.

Connections enable students to interlink concepts covered in different chapters.

Caution helps students to be watchful against commonly made mistakes.

QR code provides:

i. Access to a video/PDF in order to boost understanding of a concept or activity
ii. Solutions of Miscellaneous Questions for Practice
iii. Solutions to the Topic Tests
iv. Model Question Paper with solution

Enrich Your Knowledge presents fascinating information about the concept covered.

Continued…

KEY FEATURES

Gyan Guru illustrates real life applications or examples related to the concept discussed.

Apply Your Knowledge includes challenging questions.

Quick review includes tables/ flow chart to summarize the key points in chapter.

Competitive Corner includes selective questions from prominent [NEET (UG), JEE (Main), MHT CET] competitive exams based entirely on the syllabus covered in the chapter.

Includes relevant Board questions from March 2013 to July 2023

PAPER PATTERN

- There will be single question paper of 70 Marks and practical examination of 30 Marks in Chemistry.
- Duration of the question paper will be 3 hours.

Section A: **(18 Marks)**

This section will contain Multiple Choice Questions and Very Short Answer(VSA) type of questions.
There will be 10 MCQs and 8 VSA type of questions, each carrying **One** mark.
Students will have to attempt all the questions.

Section B: **(16 Marks)**

This section will contain 12 Short Answer (SA-I) type of questions, each carrying **Two** marks.
Students will have to attempt any 8 questions.

Section C: **(24 Marks)**

This section will contain 12 Short Answer (SA-II) type of questions, each carrying **Three** marks.
Students will have to attempt any 8 questions.

Section D: **(12 Marks)**

This section will contain 5 Long Answer (LA) type of questions, each carrying **Four** marks.
Students will have to attempt any 3 questions.

Distribution of Marks According to the Type of Questions

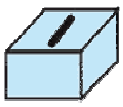
Type of Questions		
MCQ	1 Mark each	10 Marks
VSA	1 Mark each	8 Marks
SA - I	2 Marks each	16 Marks
SA - II	3 Marks each	24 Marks
LA	4 Marks each	12 Marks

CONTENTS

[Reference: Maharashtra State Board of Secondary and Higher Secondary Education, Pune - 04**]**

Note:
1. * mark represents Textual Exercise question.
2. # mark represents Intext question.
3. + mark represents Textual examples.
4. symbol represents textual questions that need external reference for an answer.
5. Chapters 1 to 9 are a part of Perfect Chemistry Vol. I, Std. XII Sci.

16 Green Chemistry and Nanochemistry



Nanowire

About the chapter…

This chapter introduces students to new emerging fields in chemistry: green chemistry and nanochemistry. Students should focus on the 12 principles of green chemistry, properties of nanoparticles, synthesis and uses of nanomaterials along with various instruments used for studying the nanomaterials.

Chapter weightage is 4 marks with option and 3 marks without option in the board examination.

CONTENTS AND CONCEPTS

16.1 Introduction

Q.1. Can you recall? *(Textbook page no. 340)*

i. What do you mean by environment? **[1 Mark]**

Ans: The physical, chemical and biological factors which influence an organism collectively is called as environment.

ii. Which are the factors affecting the environment? **[2 Marks]**

Ans:

a. The factors affecting the environment are natural and artificial factors.

b. Natural factors such as earthquakes, volcanoes, droughts, etc., can adversely affect the environment.

c. Also, artificial or man-made factors like environmental pollution caused due to population explosion, fast industrialization, and indiscriminate use of natural resources, deforestation and unplanned urbanization can harm the environment.

d. Biotic and abiotic factors are related to each other in an ecosystem, and if any of the factors is changed or removed, it can affect the entire ecosystem.

READING BETWEEN THE LINES

i. Biotic factors include producers, consumers and decomposers.

ii. Abiotic factors are non-living components i.e. water, sunlight, temperature, oxygen, soil, pH, etc.

iii. Changes in biotic and abiotic factors can have drastic effects on the environment. For example, if plants (producers) in an ecosystem do not receive adequate sunlight, they eventually will die, thereby disturbing the entire food chain. Due to lack of availability of food even the consumers will die. This ultimately creates an imbalance in the environment as consumers rely on producers for their food.

iii. What is pollution? Which are the types of pollution? **[2 Marks]**

Ans:

a. *Unnecessary and unacceptable changes in the environment due to natural events or human activities is known as* ***pollution****.*

OR

Direct or indirect changes in physical, chemical and biological properties of air, water and soil that are harmful to humans and other living beings is called as ***pollution****.*

b. There are three main types of pollution: Air pollution, water pollution and soil pollution.

iv. Why it occurs?

Ans: Following are the components and causes of different types of pollution: **[3 Marks]**

	Air pollution	Water pollution	Soil pollution
Components	Gases: CO_2, CO, Hydrocarbons, sulfur, NO_x, hydrogen sulphides, etc. Solid: dust, ash, carbon, lead, asbestos, etc.	Oil and derivatives; carbonic compounds; heavy metals like mercury, lead, cadmium, etc., silt and sediments; pathogens.	Organic chemicals, pesticides, radioactive materials, oils and tar.
Causes	Emissions released from chemical industries, automobiles, burning of garbage, burning of fuels like coal, petroleum, etc.	Releases of industrial wastes, domestic waste, sewage, chemicals discharged from industries, into water bodies. Pesticides used in agriculture also reach water bodies.	Emissions released from chemical industries; mining, biomedical wastes; Excessive uses of pesticides and fertilizers; Dumping of domestic wastes, etc.

***Q.2. Define green chemistry.** **[1 Mark] [Mar 22; July 22; Mar 23]**

Ans: ***Green chemistry*** *is the use of chemistry for pollution prevention by environmentally conscious design of chemical products and processes that reduce or eliminate the use or generation of hazardous substances.*

Q.3. What is green chemistry? Explain its importance. **[3 Marks]**

Ans:

i. Green Chemistry is an approach to chemistry that aims to maximize efficiency and minimize hazardous effects on human health and environment.

ii. The concept of green chemistry was coined by **Paul T. Anastas**.

iii. ***Green chemistry*** *is the use of chemistry for pollution prevention by environmentally conscious design of chemical products and processes that reduce or eliminate the use or generation of hazardous substances.*

iv. Due to increase in human population and the industrial revolution, energy crisis and environmental pollution are highlighted major global problems in the 21st century. To reduce the impact of energy crisis, pollution and to save natural resources, we need to implement 12 principles of green chemistry enunciated by Paul Anastas wherever possible.

ENRICH YOUR KNOWLEDGE

Do You Know? *(Textbook page no. 340)*

Paul T. Anastas (Born on May 16, 1962) is the director of Yale university's Center for green chemistry and green engineering. He is known as father of green chemistry.

16.2 Sustainable development

***Q.4. Define 'sustainable development'.** **[1 Mark]**

Ans: ***Sustainable development*** *is development that meets the needs of the present, without compromising the ability of future generations to meet their own need.*

Q.5. How can we achieve sustainable development? **[1 Mark]**

Ans: We can achieve sustainable development by adapting the twelve principles of green chemistry.

16.3 Principles of green chemistry

Q.6. List the 12 principles of green chemistry. [2 Marks]

Ans: The 12 principles of green chemistry are as follows:

i. Prevention of waste or by products
ii. Atom economy
iii. Less hazardous chemical synthesis
iv. Designing safer chemicals
v. Use of safer solvent and auxiliaries
vi. Design for energy efficiency
vii. Use of renewable feed stocks
viii. Reduce derivatives (Minimization of steps)
ix. Use of catalysis
x. Design for degradation
xi. Real-time analysis pollution prevention
xii. Safer chemistry for accident prevention

Q.7. With the help of suitable examples explain in detail the following principles of Green Chemistry.

i. Prevention of waste or by products [2 Marks]
ii. Atom economy [3 Marks]
iii. Less hazardous chemical synthesis [2 Marks]
iv. Designing safer chemicals [2 Marks]

Ans: The sustainable development can be achieved by adapting following 12 Principles of Green Chemistry:

i. Prevention of waste or by products: According to this principle of green chemistry, priority is given for the prevention of waste rather than cleaning up and treating waste after it has been generated.

Illustration: To develop zero waste technology (ZWT).

As per ZWT, in a chemical synthesis, waste product should be zero or minimum.

It also aims to use the waste product of one system as the raw material for other system.

For example:

a. Bottom ash of thermal power station can be used as a raw material for cement and brick industry.

b. Effluent coming out from cleansing of machinery parts may be used as coolant water in thermal power station.

ii. Atom economy:

a. ***Atom economy*** *is a measure of the amount of atoms from the starting materials that are present in the useful products at the end of the chemical process.*

b. Good atom economy means most of the atoms of the reactants are incorporated in the desired products and only small amounts of unwanted by-products are formed and hence lesser problems of waste disposal.

Illustration: The concept of atom economy gives the measure of the unwanted product produced in a particular reaction.

% atom economy

$$= \frac{\text{Formula weight of the desired product}}{\text{Sum of formula weight of all the reactants used in the reaction}} \times 100$$

For example: Conversion of Butan-1-ol to 1-bromobutane

$$CH_3CH_2CH_2CH_2OH + NaBr + H_2SO_4 \longrightarrow CH_3CH_2CH_2CH_2Br + NaHSO_4 + H_2O$$

% atom economy

$$= \frac{\text{mass of } (4C + 9H + 1Br) \text{ atoms}}{\text{mass of } (4C + 12H + 5O + 1Br + 1Na + 1S) \text{ atoms}} \times 100$$

$$= \frac{137\ u}{275\ u} \times 100$$

$$= 49.81\%$$

iii. Less hazardous chemical synthesis: According to this principle of green chemistry, designed chemical reactions and synthesis routes should be as safe as possible to avoid formation of hazardous waste from chemical processes.

Illustration:

Earlier Dichlorodiphenyltrichloroethane (DDT) was used as insecticide and which was effective in controlling diseases like typhoid and malaria carrying mosquitoes. It was realized that DDT is harmful to living things. Nowadays, benzene hexachloride (BHC) is used as insecticide. One of the γ-isomer (gamma) of BHC is called gammexane or lindane.

iv. Designing safer chemicals: This principle of green chemistry aims at developing products that are less toxic or which require less toxic raw materials.

Illustration:

In chemical industries workers are exposed to toxic environment. Safer chemicals must be designed in order to prevent the workers from exposure to toxicity.

For example:

Adipic acid is widely used in polymer industry.

Benzene is the starting material for the synthesis of adipic acid but benzene is carcinogenic and benzene being volatile organic compound (VOC) pollutes air.

In green technology developed by Drath and Frost, adipic acid is enzymatically synthesised from glucose.

*Q.8. **Explain atom economy with suitable example.** [3 Marks]

Ans: *Refer Q.7.(ii).*

*Q.9. **Write the formula to calculate % atom economy.** [1 Mark]

Ans: *Refer Q.7.(ii).(Formula).*

*Q.10. **Name the γ-isomer of BHC.** [1 Mark]

Ans: Gammexane or Lindane

*Q.11. **How will you illustrate the use of safer solvent and auxiliaries?** [3 Marks]

Ans: **Use of safer solvent and auxiliaries:** This principle of green chemistry involves the use of safer solvent and minimizing the total amount of solvents and auxiliary substances used for any given step of reaction. This is because solvents and auxiliary substances make up a large percentage of the total waste created.

Illustration:

i. The main aim behind this principle is to use green solvents.
For example, water or supercritical CO_2 in place of volatile halogenated organic solvents (such as CH_2Cl_2, $CHCl_3$, CCl_4) for chemical synthesis and other purposes.

ii. Solvents as chemicals that dissolve solutes and form solutions, facilitate many reactions.

iii. Water is a safe benign solvent while dichloromethane is hazardous.

iv. Use of toxic solvent affects millions of workers every year and has implications for consumers and the environment as well. Many solvents are used in high volumes and many are volatile organic compounds. Their use creates large amounts of waste, air pollution and other health impacts.

v. Finding safer, more efficient alternatives or removing solvents altogether is one of the best ways to improve a process or product.

Q.12. Explain the principle of green chemistry: 'Design for energy efficiency'. [2 Marks]

Ans: **Design for energy efficiency:** According to this principle of green chemistry, chemical synthesis should be designed to minimize the use of energy by carrying out reactions at room temperature and pressure.

This can be achieved by use of proper catalyst, microorganisms for organic synthesis, renewable materials, etc.

Illustration:

The biocatalyst can work at the ambient condition. Similarly, in chemical synthesis, refluxing conditions require less energy, improving the technology of heating system, use microwave heating, etc.

Q.13. Explain the use of renewable feedstocks. [2 Marks]

Ans: **Use of renewable feedstocks:** The perspective of this principle of green chemistry is largely toward petrochemicals. Use chemicals which are made from renewable (plant based) sources rather than other non-renewable sources for such as crude oil.

Illustration:

i. Overexploitation of non-renewable feedstocks will deplete the resources and future generation will be deprived and also puts burden on the environment.

ii. On the other hand, use of renewable resources such as agricultural or biological product ensures the sharing of resources by future generation.

iii. This practice generally does not put much burden on environment. The products and waste are generally biodegradable.

*Q.14. **How will you illustrate the principle, minimization of steps?** [3 Marks]

Ans: **Reduce derivatives (Minimization of steps):** In organic synthesis protecting or blocking groups are commonly used.

According to this principle of green chemistry, unnecessary derivatization, for example, installation / removal of use of protecting groups should be minimized or avoided if possible, because such steps require additional reagents and can generate waste.

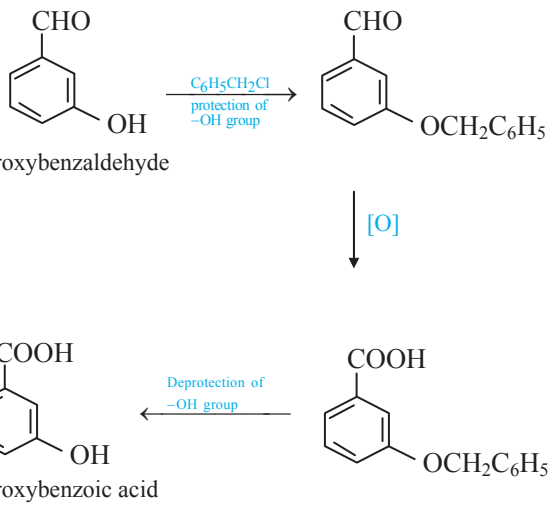
Illustration:

i. In organic synthesis, protection of some functional groups is required. Again, the deprotection of functional group is required at the end.

For example: Synthesis of m-hydroxybenzoic acid from m-hydroxybenzaldehyde.

ii. In such cases, atom economy is also less.

iii. The green chemistry principle aims to develop the methodology where unnecessary steps should be avoided. This can be done if possible, by using practicable biocatalytic reactions, which very often need no protection of selective group.



m-Hydroxybenzaldehyde

m-Hydroxybenzoic acid

Q.15. Explain following principles of green chemistry in detail. **[2 Marks Each]**

i. Use of catalysis

ii. Design for degradation

iii. Real-time analysis pollution prevention

iv. Safer chemistry for accident prevention

Ans:

i. **Use of catalysis:** Catalysis is the process of increasing the rate of a chemical reaction by adding a substance known as a catalyst, which is not consumed in the catalyzed reaction and can continue to act repeatedly. Thus, the use of catalyst in the chemical reaction speeds up its rate and also helps to increase selectivity, minimize waste and reduce reaction times and energy demands.

For example, In the contact process of industrial production of sulfuric acid; sulphur dioxide and oxygen from the air react reversibly over a solid catalyst of platinised asbestos.

ii. **Design for degradation:** According to this principle of green chemistry, chemicals are designed in such way that they degraded and can be discarded easily. It is ensured that both chemicals and their degradation products are not toxic, bioaccumulative or environmentally persistent.

Illustration:

The aim of this principle is that the waste product should degrade automatically to clean the environment.

Thus, the biodegradable polymers and pesticides are always preferred.

To make separation easier for the consumer, an international plastic recycle mark is printed on larger items.

iii. **Real-time analysis pollution prevention:** This principle of green chemistry focuses on developing analytical methods which allow real-time, in process monitoring and control prior to the formation of hazardous substances.

Illustration:

Analytical methodologies should be developed or modified, so that continuous monitoring of the manufacturing and processing units is possible. This is very much important for the chemical industries and nuclear reactors.

iv. **Safer chemistry for accident prevention:** According to this principle of green chemistry, we need to develop chemical processes that are safer and minimize the risk of accidents.

Illustration:

The substances to be used in a chemical reaction should be selected in such a way that they can minimize the occurrence of chemical accidents, explosions, fire and emission.

For example, if the chemical process works with the gaseous substances, then the possibility of accidents including explosion is relatively higher compared to the system working with nonvolatile liquid and solid substances.

***Q.16. Explain any three principles of green chemistry.** **[3 Marks]**

Ans: *Refer Q.7, 11, 12, 13, 14, 15. (Any three principles of green chemistry).*

***Q.17. Define catalyst. Give two examples.** **[2 Marks]**

Ans: *A **catalyst** is a substance that increases the rate of chemical reaction without being consumed in the process.*

e.g. i. In the contact process of industrial production of sulfuric acid; sulphur dioxide and oxygen from the air react reversibly over a solid catalyst of platinised asbestos.

ii. Hydrogenation with nickel as catalyst is used to convert inedible oils into solid fat for the production of margarine.

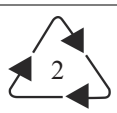
#Q.18. Complete the chart. *(Textbook page no. 342)* **[½ Mark Each]**

	Reaction	Name of catalyst used
i.	Hydrogenation of oil (Hardening)	---
ii.	Haber's process of manufacture of ammonia	---
iii.	Manufacture of HDPE polymer	---
iv.	Manufacture of H_2SO_4 by contact process	---
v.	Fischer-Tropsch process (Synthesis of gasoline)	---

Ans:

	Reaction	Name of catalyst used
i.	Hydrogenation of oil (Hardening)	Nickel
ii.	Haber's process of manufacture of ammonia	Mo/Fe
iii.	Manufacture of HDPE polymer	Ziegler-Natta catalyst
iv.	Manufacture of H_2SO_4 by contact process	Platinised asbestos
v.	Fischer-Tropsch process (Synthesis of gasoline)	Co-Th alloy

Note: Chart to sort plastic materials in daily life: *(Textbook page no. 343)*

	Symbol	Used In	Status	Is recycled to make
Number 1: *PETE or PET (Polyethylene terephthalate)*	 PETE	microwavable food trays; salad dressing, soft drink, water and beer bottles	Hard to clean; absorbs bacteria and flavours; avoid reusing	carpet, furniture, new containers, polar fleece
Number 2: *HDPE (High density polyethylene)*	 HDPE	household cleaner and shampoo bottles	Transmits no known chemicals into food	Detergent bottles, fencing, floor tiles, pens
Number 3: *V or PVC (vinyl)*	 V	cooking oil bottles, clear food packaging, mouthwash bottles	Is believed to contain phthalates that interfere with hormonal development; avoid	Cables, mud flaps, panelling, roadway gutters
Number 4: *LDPE (Low density polyethylene)*	 LDPE	bread and shopping bags, carpet, clothing, furniture	Transmits no known chemicals into food	envelopes, floor tiles, lumber, trash-can liners
Number 5: *PP (Polypropylene)*	 PP	ketchup bottles, medicine, and syrup bottle, drinking straws	Transmits no known chemicals into food	Battery, cables, brooms, ice scrapers, rakes
Number 6: *PS (Polystyrene)*	 PS	disposable cups and plates, egg cartons, take-out containers	Is believed to leach styrene, a possible human carcinogen into food; avoid	Foam packaging, insulation, light switch plates, rulers
Number 7: *Other (Miscellaneous)*	 Other	3- and 5- gallon water-jugs, nylon, some food containers	Contains bisphenol A, which has been linked to heart disease and obesity; avoid	Custom-made products

ENRICH YOUR KNOWLEDGE

Do You Know? *(Textbook page no. 343)*

Plastic packaging impact the food they wrap: Phthalates leach into food through packaging so you should avoid microwaving food or drinks in plastic and not use plastic cling wrap and store your food in glass container whenever possible. Try to avoid prepackaging, processed food so that you will reduce exposure to harmful effect of plastic.

16.4 The role of green chemistry

***Q.19. Explain the role of green chemistry.** **[3 Marks]**

Ans: The green chemistry approach recognizes that the Earth does have a natural capacity for dealing with much of the waste and pollution that society generates. It is only when that capacity is exceeded that we become unsustainable.

Following is the role of Green Chemistry:

i. To promote innovative chemical technologies that reduce or eliminate the use or generation of hazardous substances in the design, manufacture and use of chemical products.

ii. The green chemistry helps to reduce capital expenditure, to prevent pollution.

iii. Green chemistry incorporates pollution prevention practices in the manufacture of chemicals and promotes pollution prevention and industrial ecology.

iv. Green chemistry is a new way of looking at chemicals and their manufacturing process to minimize any negative environmental effects.

v. Green chemistry helps to protect the presence of ozone in the stratosphere essential for the survival of life on the earth.

vi. Green chemistry is useful to control green house effect (Global warming).

16.5 Introduction to nanochemistry

Q.20. Can you recall? *(Textbook page no. 344)*

i. What are the shapes of a bacillus and coccus? **[1 Mark]**

Ans: Bacillus is rod shaped and coccus is spherical in shape.

ii. Which instrument is used to observe the cells? **[1 Mark]**

Ans: We cannot observe cells with our naked eyes due to their small size. Hence, we use microscope for observing cells.

iii. What is the size range of molecules of lipids and proteins? **[1 Mark]**

Ans: The size range of molecules of lipids and proteins is about 1 - 10 nm.

*[**Note:** Students can refer Figure 16.1-Macro-materials to atoms and Figure 16.2-Scale of nanomaterials from Textbook page no. 345 to compare sizes of different natural and man-made materials.]*

***Q.21. Define the following terms:** **[1 Mark Each]**

i. Nanoscience
ii. Nanotechnology **[July 22]**
iii. Nanomaterial
iv. Nanochemistry **[July 22]**

Ans:

i. Nanoscience:
Nanoscience *is the study of phenomena and manipulation of materials at atomic, molecular and macromolecular scales where properties differ significantly from those at a larger scale.*

ii. Nanotechnology:
Nanotechnology *is the design, characterization, production and application of structures, devices and systems by controlling shape and size at nanometer scale.*

iii. Nanomaterial:
The ***nanomaterial*** *is a material having structural components with at least one dimension in the nanometer scale, that is, 1-100 nm.*

iv. Nanochemistry:
Nanochemistry *is the combination of chemistry and nanoscience which deals with designing and synthesis of materials of nanoscale with different size and shape, structure and composition and their organization into functional architectures.*

Q.22. Write a note on 'nanometer scale'. **[2 Marks]**

Ans: Nanometer scale:

i. Conventionally, the nanometer scale is defined as 1-100 nm.

ii. One nanometer is one billionth of a meter. (that is, 1 nm = 10^{-9} m).

iii. The materials we see around us are bulk materials that possess macroscopic physical properties. Grain of sand that is micron-sized material also possesses same bulk properties.

iv. However, the material synthesized at nanoscale (1 nm-100 nm) possesses unique optical, structural, thermal, catalytic, magnetic and electrical properties. These properties change as a function of size and are very different from their bulk materials.

*Q.23. 1 nm = _____ m [1 Mark]

Ans: 10^{-9}

Q.24. Explain the term nanomaterial. [2 Marks]

Ans: Nanomaterial:

i. *The **nanomaterial** is a material having structural components with at least one dimension in the nanometer scale, that is, 1-100 nm.*

ii. Nanomaterials are larger than single atoms but smaller than bacteria and cells.

iii. Nanomaterials may be nanoparticles, nanowires and nanotubes according to dimensions.

iv. Nanostructured materials may be large organic molecules, inorganic cluster compounds and metallic or semiconductor particles.

#**Q.25. What are zero, one and two dimensional nanoscale system?** *(Textbook page no. 346)* [3 Marks]

Ans:

i. Zero-Dimensional Nanostructures:

A zero dimensional structure is one in which all three dimensions are in the nanoscale.

That is, all three dimensions < 100 nm

e.g. Nanoparticles, quantum dots, nanoshells, nanorings, microcapsules

ii. One-Dimensional Nanostructures:

A one dimensional nanostructure is one in which two dimensions are in the nanoscale.

That is, two dimensions < 100 nm

e.g. Nanowires, nanofibres, nanotubes and nanorods

iii. Two-Dimensional Nanostructures:

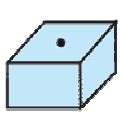
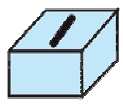
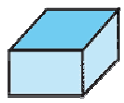
A two-dimensional nanostructure is one in which one dimension is in the nanoscale.

That is, one dimension < 100 nm

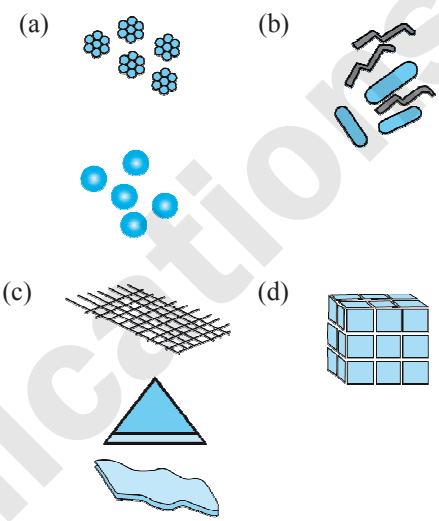
e.g. Thin films, layers and coatings

Note:

i. Illustration of zero, one, two dimensions: *(Textbook page no. 346)*

Nanomaterial Dimension	Nanomaterial Type	Example
All three dimensions < 100 nm	Nanoparticles, Quantum dots, nanoshells, nanorings, microcapsules	
Two dimensions < 100 nm	Nanotubes, fibres, nanowires	
One dimension < 100 nm	Thin films, layers and coatings	

ii. Figure showing classification of nanomaterials: *(Textbook page no. 350)*



(a) 0D spheres and clusters, (b) 1D nanofibers, wires and rods (c) 2D films, plates and networks, (d) 3D nanomaterials

Classification of nanomaterials

ENRICH YOUR KNOWLEDGE

i. Three-dimensional nanomaterials (3D) are materials that are not confined to the nanoscale in any dimension. This class can contain bulk powders, dispersions of nanoparticles, bundles of nanowires, and nanotubes as well as multi-nanolayers.

ii. A very highly useful application of nanochemistry is 'medicine'. A simple skin care product of nanochemistry is sunscreen.

***Q.26. Which nanomaterial is used in sunscreen lotion? Write its use.** [2 Marks]

Ans: Sunscreen lotions contain nanoparticles of zinc oxide (ZnO) and titanium dioxide (TiO_2).

These chemicals protect the skin against harmful UV (ultraviolet) rays by absorbing or reflecting the light. Hence, sunscreen lotions prevent the skin from damage.

Q.27. Internet my friend. *(Textbook page no. 346)*
Find out applications of nanochemistry in medicine related to wounds, healing process. Also find out applications of TiO_2 and ZnO in other areas.

Ans: *Students can use the following links as reference.*
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6650835/pdf/materials-12-02176.pdf
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3637140/pdf/1743-8977-10-15.pdf
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3838497/pdf/nihms-523362.pdf

16.6 Characteristic features of nanoparticles

Q.28. Enlist any three characteristic features of nanoparticles and write significance of each. **[3 Marks]**

Ans: Nanoparticles possess unique properties due to their nanoscale size which ranges between 1 nm-100 nm.
Following are the characteristic features of nanoparticles:

i. Colour:
It is an optical property that is different at nanoscale.
e.g. Elemental gold has shining yellow colour. However, if only 100 gold atoms are arranged in a cube, its colour would be red.

ii. Surface area:
High surface-to-volume ratio is a very important characteristic of nanoparticles. If a bulk material is sub divided into a group of individual nanoparticles, the total volume remains the same, but the collective surface area is largely increased. With large surface area for the same volume, these small particles react much faster because more surface area provides more number of reaction sites, leading to more chemical reactivity.

iii. Catalytic activity:
a. Due to increase in surface area with decrease in particle size, nanomaterial-based catalysts show increased catalytic activity.
b. Usually they are heterogeneous catalysts that means catalysts are in solid form and the reactions occur on the surface of the catalyst.
c. Nanoparticle catalysts can be easily separated and can be recycled.
e.g. Pd, Pt metal nanoparticles used in hydrogenation reactions.
TiO_2, ZnO are used in photocatalysis.
Gold in bulk form is unreactive, but gold nanoparticles are found to be very good catalyst for various organic reactions.

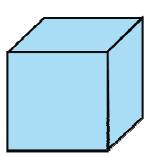
iv. Thermal properties - Melting point:
The melting point of nanomaterial changes drastically and depends on size.
e.g. Sodium clusters (Na_n) of 1000 atoms appeared to melt at 288 K while cluster of 10,000 atoms melted at 303 K and bulk sodium melts at 371K.

v. Mechanical properties - Mechanical strength:
Nanosized copper and palladium clusters with diameter in the size range of 5-7 nm can have hardness up to 500% greater than bulk metal.

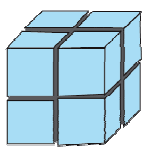
vi. Electrical conductivity:
Electrical conductivity is observed to change at nanoscale.
e.g. Carbon nanotube can act as a conductor or semiconductor in behaviour.

(Any three features)

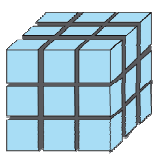
Note: Illustration showing increase in surface area with decrease in particle size. It shows the surface areas when a cube of 1 m^3 were progressively cut into smaller cubes. *(Textbook page no. 347)*



Area = $6 \times 1m^2 = 6\ m^2$



Area = $6 \times (1/2m)^2 \times 8 = 12\ m^2$



Area = $6 \times (1/3m)^2 \times 27 = 18\ m^2$

Surface area of nanoparticles

Q.29. Name two compounds used in photocatalysis. **[1 Mark]**

Ans: Titanium dioxide (TiO_2) and zinc oxide (ZnO)

Q.30. Internet my friend. *(Textbook page no. 347)*
Find out various applications or use of gold nanoparticles.

Ans: Some applications of gold nanoparticles:
i. Gold nanoparticles are able to dissociate unwanted trichloroethylene in ground water. Hence, they can be used for purification of ground water.

ii. Gold nanoparticles also interact with pesticides and are useful in removing them from water.
iii. Gold nanoparticles can be used to remove the important toxic element mercury present in water effluent from coal mining industry.
iv. Gold nanoparticles as a catalyst can also be used in the air conditioners to successfully remove CO from air in the rooms.

[Note: Students are expected to find out more information about gold nanoparticles on their own.]

16.7 Synthesis of nanomaterials

Q.31. Name the two approaches to the synthesis of nanomaterials. **[1 Mark]**

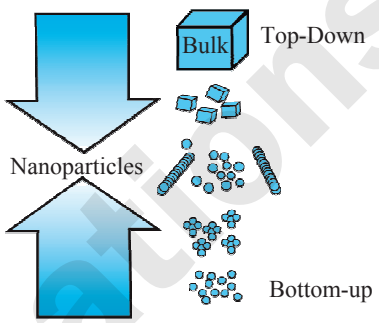
Ans: Two approaches to the synthesis of nanomaterials are:
i. Bottom-up approach
ii. Top-down approach

Q.32. Explain the two approaches that are followed for the synthesis of nanomaterials. Draw a suitable schematic illustration representing the two approaches. **[3 Marks]**

Ans: Following are the two approaches to the synthesis of nanomaterials:

i. Bottom-up approach: In this approach, molecular components arrange themselves into more complex assemblies atom by atom, molecule by molecule and cluster by cluster from the bottom.
e.g. Synthesis of nanoparticles by colloidal dispersion.

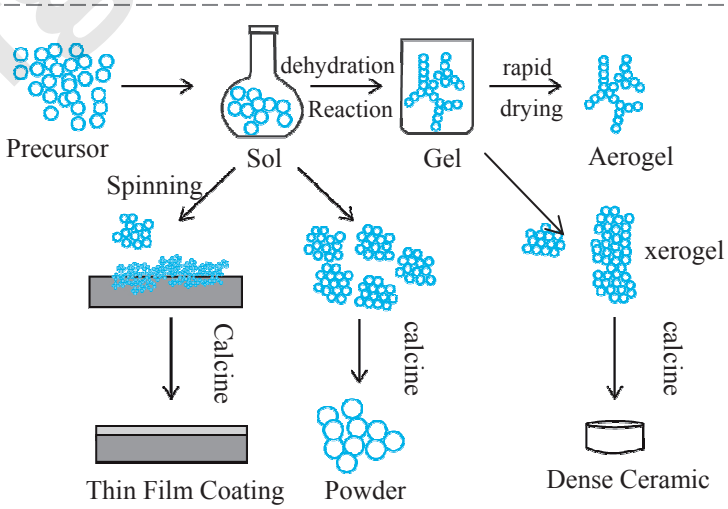
ii. Top-down approach: In this approach, nanomaterials are synthesized from bulk material by breaking the material in stepwise manner.
The bulk solids are dis-assembled into finer pieces until they are constituted of only few atoms.



Schematic illustration of the preparation of nanoparticles

*Q.33. i. **What do you mean by sol and gel?** **[2 Marks]**
ii. **Describe the sol-gel method of preparation of nanoparticles.** **[4 Marks]**

Ans: Sol-gel method (Wet chemical synthesis of nanomaterials):
i. Sol: Sols are dispersions of colloidal particles in a liquid.
ii. Gel: A gel is interconnected rigid network with pores of sub-micrometer dimensions and polymeric chains whose average length is greater than a micrometer.
iii. Sol-gel process:
a. Sol-gel process is an example of wet chemical synthesis of nanomaterials.
b. This technique is based on inorganic polymerization reactions.
c. It is generally carried out at room temperature and includes four steps: Hydrolysis, polycondensation, drying and thermal decomposition.
d. This method is widely employed to prepare oxide materials.
e. Schematic representation:



Schematic representation of sol-gel process of synthesis of nanoparticles

f. The reactions and steps involved in the sol-gel process can be described as follows:

$$MOR + H_2O \rightarrow MOH + ROH \quad \text{(Hydrolysis)}$$

(Metal alkoxide)

$$MOH + ROM \rightarrow M\text{-}O\text{-}M + ROH \quad \text{(Condensation)}$$

1. Formation of different stable solution of the alkoxide or solvated metal precursor.
2. Gelation resulting from the formation of an oxide or alcohol-bridged network (gel) by a polycondensation reaction.
3. Aging of the gel means during that period gel transforms into a solid mass.
4. Drying of the gel: In this step, water and other volatile liquids are removed from the gel network.
5. Dehydration: The material is heated at temperatures up to 800 °C.

Q.34. Mention the techniques and instruments used for analysis or characterization of nanomaterials. **[2 Marks]**

Ans: The nanomaterials synthesized using variety of processes are analyzed by different analytical tools or techniques. Following are the techniques and instruments used for analysis or characterization of nanomaterials:

	Name of technique	Instrument used
i.	UV-visible spectroscopy	UV-visible spectrophotometer
ii.	X-ray diffraction (XRD)	X-ray diffractometer
iii.	Scanning Electron Microscopy (SEM)	Scanning Electron Microscope
iv.	Transmission Emission Microscopy (TEM)	Transmission Emission Microscope
v.	Fourier Transform Infrared Spectroscopy (FTIR)	Fourier Transform Infrared Spectrophotometer

***[Note:** Students can refer Textbook page no.348-349 to see the photographs of the above mentioned instruments.]*

Q.35. Write the information obtained about nanomaterials with the help of following techniques. **[1 Mark Each]**

i. UV-visible spectroscopy
ii. X-ray diffraction (XRD)
iii. Scanning Electron Microscopy (SEM)
iv. Transmission Emission Microscopy (TEM)
v. Fourier Transform Infrared Spectroscopy (FTIR)

Ans:

i. UV-visible spectroscopy:
Information obtained: Preliminary confirmation of formation of nanoparticles

ii. X-ray diffraction (XRD):
Information obtained: Particle size, crystal structure, geometry

iii. Scanning Electron Microscopy (SEM):
Information obtained: Structure of surface of material i.e., morphology

iv. Transmission Emission Microscopy (TEM):
Information obtained: Particle size

v. Fourier Transform Infrared Spectroscopy (FTIR):
Information obtained: Absorption of functional groups and binding nature

***Q.36. Ridhima wants to detect structure of surface of materials. Name the technique she has to use.** **[1 Mark]**

Ans: Scanning Electron Microscopy

***Q.37. Give the full form (long form) of the names for the following instruments:** **[½ Mark Each]**

i. XRD **ii. TEM**
iii. FTIR **iv. SEM**

Ans:

i. X-ray diffractometer
ii. Transmission Electron Microscope
iii. Fourier Transform Infrared Spectrophotometer
iv. Scanning Electron Microscope

16.8 History of nanotechnology

Q.38. Nanomaterials have been produced and used by humans for hundreds of years. Explain the statement with suitable examples. **[3 Marks]**

Ans: Nanomaterials have been produced and used by humans for hundreds of years. However, the understanding of certain materials as nanostructured materials is relatively recent. Due to the development of sophisticated instruments, it has been possible to reveal the information at nanoscale.

e.g. i. Beautiful ruby red colour of some ancient glass paintings is due to gold and silver nanoparticles trapped in the glass matrix.

ii. The decorative glaze or metallic film known as lustre found on some medieval pottery is due to certain spherical metallic nanoparticles.

iii. Carbon black is a nanostructured material that is used in tyres of car to increase the life of tyre. (Discovery in 1900). Carbon nanotubes are made up of graphite sheets with nanosized diameter. They have highest strength.

iv. Fumed silica, a component of silicon rubber, coatings, sealants and adhesives is also a nanostructured material.

*Q.39. **Which nanomaterial is used for tyres of car to increase the life of tyres?** [1 Mark] [Mar 23]

Ans: Carbon black

Q.40. Internet my friend. *(Textbook page no. 350)*
Find out more number of nanostructured materials in day to day used products.

Ans:

i. Silver nanoparticles are used as antimicrobial agents in hand washes, bandages and socks.

ii. Zinc oxide or titanium dioxide nanoparticles are the active UV-protective elements in modern sunscreens.

iii. Carbon nanotubes are much stronger than steel and are lighter which makes them ideal material for sports equipment such as tennis racket or bikes.

iv. Improved display screens on desktop, portable and handheld electronic devices and memory chips make use of nanomaterials.

[Note:** Students are expected to find out additional information on their own.**]

ENRICH YOUR KNOWLEDGE

Do You Know? *(Textbook page no. 350)*
The term 'nanotechnology' was defined by Tokyo science University Professor, Nario Taniguchi in 1974.
Invention of Scanning Tunneling Microscope (STM) in 1980, led to the discovery of fullerenes in 1986 and carbon nanotubes a few years later.

*Q.41. **Give the full form (long form) of the name for the following instrument:**
STM [½ Mark]

Ans: Scanning Tunneling Microscope

Q.42. Name the scientist who discovered scanning tunneling microscope (STM) in 1980. [1 Mark]

Ans: Gerd Binnig and Heinrich Rohrer

Q.43. Internet my friend *(Textbook page no. 350)*
Collect the information about the scientists who discovered SEM, STM, TEM instruments.

Ans:

i. Scanning Electron Microscope was discovered by Manfred von Ardenne.

ii. Scanning Tunneling Microscope was discovered by Gerd Binnig and Heinrich Rohrer.

iii. Transmission Electron Microscope was discovered by Ernst Ruska.

[Note:** Students are expected to collect more information on their own.**]

Q.44. Can you think? *(Textbook page no. 350)*
Visualize the size effect: Size difference between the earth and an apple is equal to the size difference between atoms (30 nm) and an apple. [2 Marks]

Ans: The size of atoms is 30 nm = 3×10^{-8} m. …(Given)
The size of an apple (approx. diameter) is 6 cm = 6×10^{-2} m.
The size of earth (diameter) is 1.27×10^{7} m
If we compare the size difference between the earth and an apple, we see, earth is 2.1×10^{8} times bigger than an apple.
If we compared the size difference between an apple and atoms, we see, apple is 2×10^{6} times bigger than atoms.
However, the atoms vary in size according to the element, but their diameters are of the order of 1×10^{-8} cm = 1×10^{-10} m
In this case, if we compared the size difference between an apple and an atom, we see, apple is 6×10^{8} times bigger than an atom.
Now, we can say size difference between the earth and an apple is approximately equal to the size difference between an atom and an apple.

16.9 Applications of nanomaterials

Q.45. Explain in detail the applications of nanotechnology/nanomaterials in various discipline. [3 Marks]

Ans: Nanochemistry has contributed to number of innovative products in various disciplines because of their unique physical, chemical, optical, structural, catalytic properties, etc.
Following are the few applications:

i. Nanoparticles can contribute to stronger, lighter, cleaner and smarter surfaces and systems. They are used in the manufacturing of scratchproof eyeglasses, transport, sunscreen, crack resistant paints and so on.

ii. Used in electronic devices.
e.g. Magnetoresistive Random Access Memory (MRAM).
iii. Nanotechnology plays an important role in water purification techniques.
a. Water contains waterborne pathogens like viruses, bacteria.
b. Cost-effective filter materials coated with silver nanoparticles (AgNps) is an alternative technology and can be used in water purification.
c. Silver nanoparticles act as highly effective antibacterial agent which kills *E. coli* from water.
iv. Self-cleaning materials:
a. Lotus is an example of self-cleaning. The lotus plant (*Nelumbo nucifera*) although grows in muddy water, its leaves always appear clean.
b. The plants' leaves are super-hydrophobic.
c. Nanostructures on lotus leaves repel water which carries dirt as it rolls off. Lotus effect is the basis of self-cleaning windows.

ENRICH YOUR KNOWLEDGE

Lotus effect: When a lotus leaf is observed under the microscope, it exhibits some bumps of nanometer size. These nanometer sized structures and the waxy substance on the lotus leaf can help a water drop stay on the lotus leaf without spreading on the surface. When the water-drop rolls on the leaf, it collects the dirt on the surface and cleans the surface. This effect is known as **Lotus effect**.

Water contact angle is defined as the angle between solid surface and the liquid-surface. Based upon the contact angle of water drop, one can quantify the amount of hydrophilicity or hydrophobicity. This contact angle depends upon surface roughness, surface condition and surface material. Interaction between liquid and solid surface plays important role.

When the contact angle is less than 90° the surface is called as the hydrophilic and if it is more than 90° it is known as hydrophobic. If the angle is approximately above 150° then it is super-hydrophobic and if less than approximately 20° then it is superhydrophilic.

The angles which differentiate between superhydrophilic and hydrophilic or hydrophobic and superhydrophobic are not very precise and could vary within 5°–10°. Recently, scientists have tried to use of this phenomenon to artificially obtain the hydrophilic/hydrophobic surfaces in various materials of various shapes and sizes.

Do You Know? *(Textbook page no. 351)*
Sol-gel processes: These are used in the motor vehicle industry to produce water repellent coatings for wing screens or exterior mirrors.

***Q.46. How nanotechnology plays an important role in water purification techniques?** **[2 Marks]**
Ans: *Refer Q.45.(iii).*

***Q.47. Which flower is an example of self-cleaning?** **[1 Mark]**
Ans: Lotus is an example of self-cleaning.

GG - Gyan Guru

How nanosilver socks work?

Coating the surface of textiles and clothing with nanoparticles has become a common approach for the production of highly active surfaces to have UV blocking, antimicrobial, flame retardant, water repellant or self-cleaning properties. Silver nanoparticles have antimicrobial and antibacterial properties. That's why they can be used in socks, to kill bacteria and prevent bad smells.

16.10 Nanoparticles and nanotechnology

Q.48. Mention the advantages of nanoparticles and nanotechnology. **[2 Marks]**
Ans: Advantages of nanoparticles and nanotechnology:
i. Revolution in electronics and computing.
ii. Energy sector:
a. Nanotechnology will make solar power more economical.
b. Energy storage devices will become more efficient.
iii. Medical field:
a. Manufacturing of smart drugs, helps cure faster and without side effects.
b. Curing of life threatening diseases like cancer and diabetes.

Q.49. What are the disadvantages of nanoparticles and nanotechnology? **[3 Marks]**

Ans: Disadvantages of nanoparticles and nanotechnology:

Despite the possibilities and the advancements that the nanotechnology offers to the world, there also exist certain potential risks involved with it.

i. Nanotechnology has raised the standard of living but at the same time, it has increased the pollution which includes air pollution. The pollution caused by nanotechnology is known as nano pollution. This kind of pollution is very dangerous for living organisms.

ii. Nanoparticles can cause lung damage. Inhaled particulated matter may get deposited throughout the human respiratory tract and then in the lungs.

iii. The characteristics of nanoparticles that are relevant for health effects are size, chemical composition and shape.

***Q.50. Activity:**

Collect information about application of nanochemistry in cosmetics and pharmaceuticals.

Ans:

i. Nanochemistry in cosmetics:

a. Skin creams that uses proteins derived from stem cells to prevent aging of the skin. These proteins are encapsulated in liposome nanoparticles which merge with the membranes of skin cells to allow delivery of the proteins.

b. Skin care lotions in which nutrients are encapsulated in nanoparticles suspended in a liquid, making up a nanoemulsion. The small size of the nanoparticles, compared to particles in conventional emulsions, allows the nanoparticles to penetrate deeper into the skin, delivering the nutrients to more layers of skin cells.

*[**Note:** Students can use the following link as reference and find out additional information on their own.]*

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3425166/

ii. Nanochemistry in pharmaceuticals:

a. Nanotechnology has become an essential element of pharmaceutical sciences and finds multiple applications in drug delivery systems in enhancing therapeutic performance of drugs.

b. Nanosuspension is an approach to deliver water insoluble and poorly bioavailable drugs by reducing size to submicron range. Thereby its dissolution rate is increased and hence the bioavailability, where drug dissolution rate is the limiting factor.

c. Polymeric nanoparticles are used as carriers for controlled and sustained delivery of drugs.

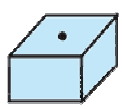
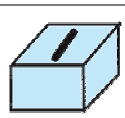
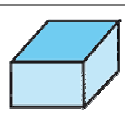
d. Nano crystalline materials: These are manufactured to act as substitutes for the materials which have poor characteristics like bioavailability, solubility, etc.

e. Metallic nanoparticles are emerging as new carrier and contrast agents in cancer treatment. These metallic nanoparticles have been used for imaging of tumour cells by means of active and passive targeting. Recent advances have opened the way to site-specific targeting and drug delivery by these nanoparticles.

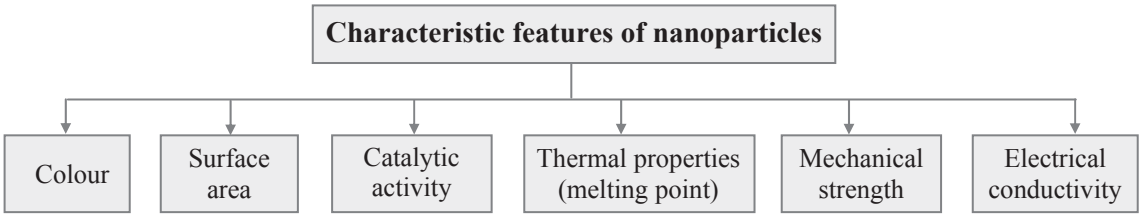
*[**Note:** Students are expected to find out additional information on their own.]*

QUICK REVIEW

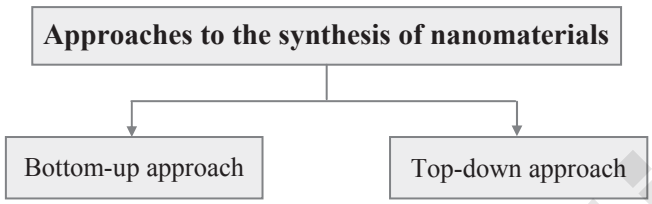
➢ **Types of nanomaterials according to dimensions:**

Nanomaterial Dimension	Nanomaterial Type	Example
All three dimensions < 100 nm	Nanoparticles, Quantum dots, nanoshells, nanorings, microcapsules	
Two dimensions < 100 nm	Nanotubes, fibres, nanowires	
One dimension < 100 nm	Thin films, layers and coatings	

➢ **Characteristic features of nanoparticles:**



➢ **Synthesis of nanomaterials:**



➢ **Techniques used for analysis or characterization of nanomaterials:**

Name of technique	Information obtained
UV-visible spectroscopy	Preliminary confirmation of formation of nanoparticles
X-ray diffraction (XRD)	Particle size, crystal structure, geometry
Scanning Electron Microscopy (SEM)	Structure of surface of material i.e. morphology
Transmission Emission Microscopy (TEM)	Particle size
Fourier Transform Infrared Spectroscopy (FTIR)	Absorption of functional groups and binding nature

EXERCISE

16.1 Introduction

1. Define the term: Green chemistry. **[1 Mark]**

Ans: *Refer Q.2.*

16.3 Principles of green chemistry

2. Write the 12 principles of green chemistry. **[2 Marks]**

Ans: *Refer Q.6.*

3. Explain the following principle of green chemistry: **[2 Marks]**
'Prevention of waste or by products'

Ans: *Refer Q.7.(i).*

4. Define atom economy. **[1 Mark]**

Ans: *Refer Q.7.(ii-a).*

5. How will you illustrate the principle, Safer chemistry for accident prevention? **[2 Marks]**

Ans: *Refer Q.15.(iv).*

16.4 The role of green chemistry

6. Explain the role of Green chemistry (Any four). **[2 Marks]**

Ans: *Refer Q.19.*

16.5 Introduction to nanochemistry

7. Define the term: Nanoscience. **[1 Mark]**

Ans: *Refer Q.21.(i).*

8. Give two examples of zero dimensional nanostructures. **[1 Mark]**

Ans: *Refer Q.25.(i).*

16.6 Characteristic features of nanoparticles

9. Describe the following characteristic features of nanoparticles: **[4 Marks]**

i. Colour
ii. Surface area
iii. Mechanical properties
iv. Electrical conductivity

Ans: *Refer Q.28.*

10. Write a note on catalytic activity of nanoparticles. **[2 Marks]**

Ans: *Refer Q.28.(iii).*

11. Give an example that shows thermal property of nanomaterial depends on size. **[1 Mark]**

Ans: *Refer Q.28.(iv).*

16.7 Synthesis of nanomaterials

12. Explain bottom-up and top-down approaches in the synthesis of nanomaterials. **[3 Marks]**

Ans: *Refer Q.32.(i).*

13. Define: Sol. **[1 Mark]**

Ans: *Refer Q.33.(i).*

14. Explain in detail the wet chemical synthesis of nanomaterials. **[4 Marks]**

Ans: *Refer Q.33.*

15. What informations are obtained about nanomaterials using XRD and FTIR? **[2 Marks]**

Ans: *Refer Q.35.*

16. Write the name of the technique used to know geometry of nanoparticles. **[1 Mark]** **[Mar 23]**

Ans: *X-ray diffraction (XRD)*

16.9 Applications of nanomaterials

17. Explain any two applications of nanotechnology. **[2 Marks]**

Ans: *Refer Q.45.*

16.10 Nanoparticles and nanotechnology

18. Write two advantages of nanoparticle and nanotechnology. **[1 Mark]** **[Mar 23]**

Ans: *Refer Q.48.*

19. Write two disadvantages of nanotechnology. **[2 Marks]** **[Mar 22]**

Ans: *Refer Q.49.*

2. Write any three advantages and disadvantages of nanoparticles and nanotechnology. **[3 Marks]** **[July 23]**

Ans: *Refer Q.48 and Q.49.*

MULTIPLE CHOICE QUESTIONS

[1 Mark Each]

*1. The concept of green chemistry was coined by _____.
(A) Born Haber (B) Nario Taniguchi
(C) Richard Feynman (D) Paul T. Anastas

*2. The development that meets the needs of present without compromising the ability of future generations to meet their own need is known as _____.
(A) continuous development
(B) sustainable development
(C) true development
(D) irrational development

3. ZWT in green chemistry stands for: **[July 22]**
(A) zero waiting time
(B) zero waste technology
(C) zubl water technology
(D) zhen wu tang

*4. Which of the following is γ-isomer of BHC?
(A) DDT (B) Lindane
(C) Chloroform (D) Chlorobenzene

5. The size of nanomaterials ranges between _____.
(A) 100 nm to 1000 nm
(B) 0.01 nm to 100 nm
(C) 1 nm to 10 nm
(D) 1 nm to 100 nm

*6. The prefix 'nano' comes from _____.
(A) French word meaning billion
(B) Greek word meaning dwarf
(C) Spanish word meaning particle
(D) Latin word meaning invisible

7. Which of the following property of nanomaterials play significant role in providing more number of reaction sites?
(A) Electrical conductivity
(B) Thermal property
(C) High surface area to volume ratio
(D) Colour

8. Which of the following step is NOT involved in sol-gel process?
(A) Hydrolysis
(B) Hydrogenation
(C) Polycondensation
(D) Thermal decomposition

*9. Which of the following information is given by FTIR technique?
(A) Absorption of functional groups
(B) Particle size
(C) Confirmation of formation of nanoparticles
(D) Crystal structure

10. Ruby red colour of some ancient glass paintings is due to _____ and _____ nanoparticles trapped in glass matrix.
(A) gold, titanium
(B) gold, silver
(C) silver, zinc
(D) gold, zinc

11. Carbon nanotubes are made up of _____ sheets with nano-sized diameter.
(A) silver (B) silicon
(C) graphite (D) fumed silica

12. The term '_____' was defined by Tokyo Science University Professor, Nario Taniguchi in 1974.
(A) Green Chemistry (B) Catalyst
(C) Nanotechnology (D) Nanochemistry

13. The name of metal nanoparticle which acts as highly effective bacterial disinfectant in water purification process is _____. **[Mar 22]**
(A) carbon black (B) silver
(C) gold (D) copper

14. Lotus effect is the basic of _____.
(A) sunscreen lotions
(B) medieval pottery
(C) self-cleaning windows
(D) water-purification techniques

ANSWERS TO MULTIPLE CHOICE QUESTIONS

1.	(D)	2.	(B)	3.	(B)	4.	(B)
5.	(D)	6.	(B)	7.	(C)	8.	(B)
9.	(A)	10.	(B)	11.	(C)	12.	(C)
13.	(B)	14.	(C)				

COMPETITIVE CORNER

1. Which of the following polymer is used in the manufacture of drinking straws? **[MHT CET 2021]**
(A) Polypropylene (B) PET
(C) LDPE (D) Polystyrene

2. Which among the following statements is against to the principles of green chemistry? **[MHT CET 2022]**
(A) Use of biodegradable polymers help to clean the environment.
(B) Use of renewable resources ensures the sharing of resources by future generation.
(C) Unnecessary derivatization should be minimized.
(D) Protecting and deprotecting functional groups in organic reactions reduces the number of steps.

3. Find the formula weight of product obtained if percent atom economy is 66.6% and the sum formula weight of reactants used is 210 u. **[MHT CET 2023]**
(A) 80 u
(B) 140 u
(C) 70 u
(D) 35.5 u

Hint:

$$\%\ \text{atom economy} = \frac{\text{Formula weight of the desired product used in the reaction}}{\text{Sum of formula weight of all the reactants}} \times 100$$

$$\therefore \quad 66.6 = \frac{x\ \text{u}}{210\ \text{u}} \times 100$$

$$\therefore \quad x = \frac{66.6}{100} \times 210 = 139.86\ \text{u} \approx 140\ \text{u}$$

4. Which among following solvents is considered as green solvent? **[MHT CET 2023]**
(A) $CHCl_3$
(B) CH_2Cl_2
(C) Super critical CO_2
(D) CCl_4

5. Identify nanomaterial having all three dimensions. **[MHT CET 2023]**
(A) Quantum dots
(B) Thin films
(C) Nano wires
(D) Fibres

6. Which from following nanoparticle catalysts is used in photocatalysis? **[MHT CET 2023]**
(A) TiO_2
(B) Pd
(C) Pt
(D) Au

Time: 1 Hour 30 Min | **TOPIC TEST** | **Total Marks: 25**

SECTION A

Q.1. Select and write the correct statement. **[04]**

i. _____ is a nanostructured material that is used in tyres of car to increase the life of tyre.
(A) Carbon black (B) Gold (C) Graphite (D) Fumed silica

ii. Earlier _____ was used as insecticide and which was effective in controlling diseases like malaria and typhoid carrying mosquitoes.
(A) benzene pentachloride (B) dichlorodiphenyltrichloroethane
(C) 1-Bromobutane (D) m-hydroxybenzoic acid

iii. In green technology developed by Drath and Frost, _____ is enzymatically synthesised from glucose.
(A) adipic acid (B) benzene (C) lindane (D) sucrose

iv. Which of the following information is given by FTIR technique?
(A) Absorption of functional groups
(B) Particle size
(C) Confirmation of formation of nanoparticles
(D) Crystal structure

Q.2. Answer the following. **[03]**

i. Define Nanotechnology.

ii. Name the four basic steps involved in sol-gel process.

iii. Sumit prepared a nanomaterial in laboratory. Name the technique he can use for the preliminary confirmation of formation of nanoparticles.

SECTION B

Attempt any Four: **[08]**

Q.3. Lotus is an example of self-cleaning. Explain.

Q.4. Give full form of the names for the following instruments:
i. STM ii. SEM

Q.5. What is meant by the term sol and gel?

Q.6. Draw the schematic illustration showing two approaches used in the preparation of nanoparticles.

Q.7. Explain the role of nanotechnology in water purification techniques.

Q.8. Complete the chart.

	Reaction	Name of catalyst used
i.	Hydrogenation of oil (Hardening)	-------
ii.	Fischer-Tropsch process (Synthesis of gasoline)	-------
iii.	Manufacture of HDPE polymer	-------
iv.	Manufacture of H_2SO_4 by contact process	-------

SECTION C

Attempt any Two: **[06]**

Q.9. Explain the following principle of green chemistry with suitable illustration:
'Use of safer solvent and auxiliaries'

Q.10. What are zero, one and two dimensional nanoscale system?

Q.11. What are the disadvantages of nanoparticles and nanotechnology?

SECTION D

Attempt any One: **[04]**

Q.12. i. Define nanomaterial.
ii. Explain catalytic activity and thermal properties of nanomaterials with examples.

Q.13. i. Define green chemistry.
ii. Explain atom economy with suitable example.

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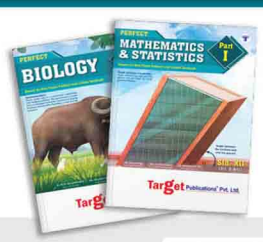

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