Maharashtra State Board Class 12 Chemistry Solutions Chapter 16 Green Chemistry and Nanochemistry

1. Choose the most correct option.

Question i.
The development that meets the needs of the 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
Answer:
b. Sustainable development

Question ii.
Which of the following is Y-isomer of BHC?
a. DDT
b. lindane
c. Chloroform
d. Chlorobenzene
Answer:
b. lindane

Question iii.
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
Answer:
(b) Greek word meaning dwarf

Question 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
Answer:
(a) Absorption of functional groups

Question v.
The concept of green chemistry was coined by
a. Born Haber
b. Nario Taniguchi
c. Richard Feynman
d. Paul T. Anastas
Answer:
(d) Paul T. Anastas

2. Answer the following

Question i.
Write the formula to calculate % atom economy.
Answer:

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

Question ii.
Name the Y-isomer of BHC.
Answer:
Lindane

Question iii.
Ridhima wants to detect structure of surface of materials. Name the technique she has to use.
Answer:
Scanning electron microscopy (SEM)

Question iv.
Which nanomaterial is used for tyres of car to increase the life of tyres?
Answer:
Carbon black

Question v.
Name the scientist who discovered scanning tunneling microscope (STM) in 1980.
Answer:
Gerd Binning and Heinrich Rohrer. (Nobel prize 1986)

Question vi.
1 nm = ...m?
Answer:
1 nm = 10^{9} m

3. Answer the following

Question i.
Define
(i) Green chemistry
(ii) sustainable development.
Answer:
(i) Green chemistry : Green chemistry is the use of chemistry for pollution prevention and it designs the use of chemical products and processes that reduce or eliminate the use or generation of hazardous substances.

(ii) Sustainable development : Sustainable development is the development that meets the needs of the present, without compromising the ability of future generations to meet their own needs.

Question ii.
Explain the role of green chemistry.
Answer:
When the waste and pollution that society generates exceeds the Earth's natural capacity for dealing with it, the green chemistry approach plays an important role.

- To reduce or eliminate the use or generation of hazardous substances in the design, manufacture and use of chemical products by promoting innovative chemical technologies.
- Capital expenditure required for prevention of pollution is controlled by the use of green chemistry.
- Since green chemistry incorporates and promotes pollution prevention practices in the manufacturing process of chemicals it helps industrial ecology.
- Green chemistry helps to protect the presence of ozone in the stratosphere. Ozone layer is essential for the survival of life on the earth.
- Global warming (Greenhouse effect) is controlled by green chemistry. At present it is the beginning of the green revolution.
- It is an exciting time with the new challenges for chemist involved with the discovery, manufacturing and use of chemicals. Green chemistry helps us to save environment and save earth, which is important for our future.

Question iii.
Give the full form (long form) of the names for the following instruments.
a. XRD
b. TEM.
c. STM
d. FTIR
e. SEM
Answer:
a. XRD-X-ray diffraction
b. TEM-Tunneling Electron Microscope
c. STM – Scanning Tunneling Microscope
d. FTIR-Fourier Transform Infrared Spectroscope
e. SEM-Scanning Electron Microscope

Question iv.
Define the following terms :
a. Nanoscience
b. Nanotechnology
c. Nanomaterial

d. Nanochemistry
Answer:
a. Nanoscience : The study of phenomena and manipulation of materials at atomic, molecular and macromolecular scales where properties differ significantly from those at a larger scale is called nanoscience.

b. Nanotechnology : The design, characterization, production and application of structures, device and system by controlling shape and size at nanometer scale is called nanotechnology.

c. Nanomaterial : A material having structural components with at least one dimension in the nanometer scale that is 1 -100 nm is called the nanomaterial. Nanomaterials are larger than single atoms but smaller than bacteria and cells.

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

Question v.
How nanotechnology plays an important role in water purification techniques?
Answer:

1. Water purification is an important issue as 1.1 billion people do not have access to improved water supply. Water contains water bom pathogens like viruses, bacteria.
2. Silver nanoparticles are highly effective bacterial disinfectant to remove E. Coli from water. Hence, filter materials coated with silver nanoparticles is used to clean water.
3. Silver nanoparticles (AgNps) is a cost effective alternative technology (for e.g. water purifier).

Question vi.
Which nanomaterial is used in sunscreen lotion? Write its use.
Answer:
Zinc oxide (ZnO) and Titanium dioxide (TiO_2) nanoparticles are used sunscreen lotions. The chemicals protect the skin against harmful u.v (ultraviolet) rays by absorbing or reflecting the light and prevent the skin from damage.

Question vii.
How will you illustrate the use of safer solvent and auxiliaries?
Answer:

- Use of safer solvents and auxiliaries – is a principle of green chemistry it states that safer solvent like water, supercritical CO_2 should be used in place of volatile halogenated organic solvents, like CH_2Cl_2, $CHCl_3$, CCl_4 for chemical synthesis and other purposes.
- Solvents dissolve solutes and form solutions, they facilitate many reactions. Water is a safer benign solvent while solvents like dichloromethane (CH_2Cl_2), chloroform ($CHCl_3$) etc are hazardous.
- Use of toxic solvents affect millions of workers every year and have implications for consumers and the environment. A large amount of waste is created by their use and they also have huge environmental and health impacts.
- Finding safer solvents or designing processes which are solvent free is the best way to improve the process and the product.

Question viii.
Define catalyst. Give two examples.
Answer:
A substance which speeds up the rate of a reaction without itself being changed chemically in the reaction is called a catalyst. It helps to increase selectivity, minimise waste and reduce reaction time and energy demands. For example : Hydrogenation of oil the catalyst used are platinum or palladium, Raney nickel.

4. Answer the following

Question i.
Explain any three principles of green chemistry.
Answer:

1. Environment protection is the prime concern which has lead to the need for designing chemicals that degrade and can be discarded easily. These chemicals and their degradation products should be non-toxic, non-bioaccumulative or should not be environmentally persistent.
2. This principle aims at waste product being automatically degradable to clean the environment. Thus the preference for biodegradable polymers and pesticides.
3. To make the separation and segregation easier for the consumer an international plastic recycle mark is printed on larger items.
4. There is a dire need to develop improvised analytical methods to allow for real time, in process monitoring and control prior to the formation of hazardous substances.
5. It is very much important for the chemical industries and nuclear reactors to develop or modify analytical methodologies so that continuous monitoring of the manufacturing and processing unit is possible.
6. It is needed to develop chemical processes that are safer and minimize the risk of accidents. It is important to select chemical substances used in a chemical reaction in such a way that they can minimize the occurrence of chemical accidents, explosions, fire and emissions.

7. For example : Chemical process that works with the gaseous substances can lead to relatively higher possibilities of accidents including explosion as compared to the system working with nonvolatile liquid and solid substances.

Question ii.
Explain atom economy with suitable example.
Answer:
(1) Atom economy is a measure of the amount of atoms from the starting material that are present in the final product at the end of a chemical process. Good atom economy means most of the atoms of the reactants are incorporated in the desired products. Only small amount of waste is produced, hence lesser problem of waste disposal.

(2) The atom economy of a process can be calculated using the following formula.

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

consider the conversion of Butan-1-Ol to 1-bromobutane

$$CH_3{-}CH_2{-}CH_2{-}CH_2\ OH + NaBr + H_2SO_4 \longrightarrow CH_3{-}CH_2{-}CH_2{-}CH_2{-}Br + NaHSO_4 + H_2O$$

$$\% \text{ atom economy} = \frac{\text{mass of 1-bromo butane}}{\text{sum of mass of 1-butanol} + \text{sodium bromide}} \times 100$$

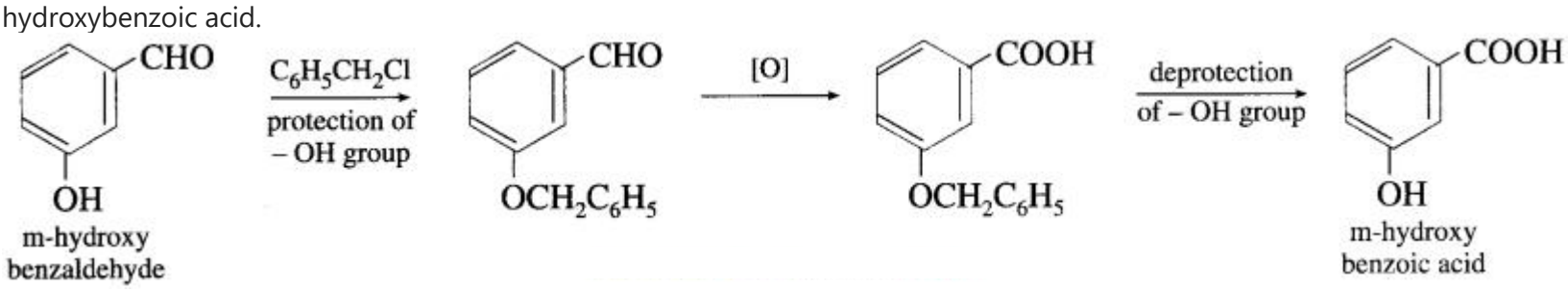
$$= \frac{\text{mass of } (4C + 9H + 1Br) \text{ atoms}}{\text{mass of } (4C + 12H + 5O + 1Br + 1Na + 1S) \text{ atoms}} \times 100$$

$$= \frac{137\ u}{275u} \times 100 = 49.81\%$$

The atom economy of the above reacijon is less than 50% and waste produced is higher.

Question iii.
How will you illustrate the principle, minimization of steps?
Answer:
(1) The technique of protecting or blocking group is commonly used in organic synthesis. Finally on completion of reaction deprotection of the group is required. This leads to unnecessary increase in the number of steps and decreased atom economy.

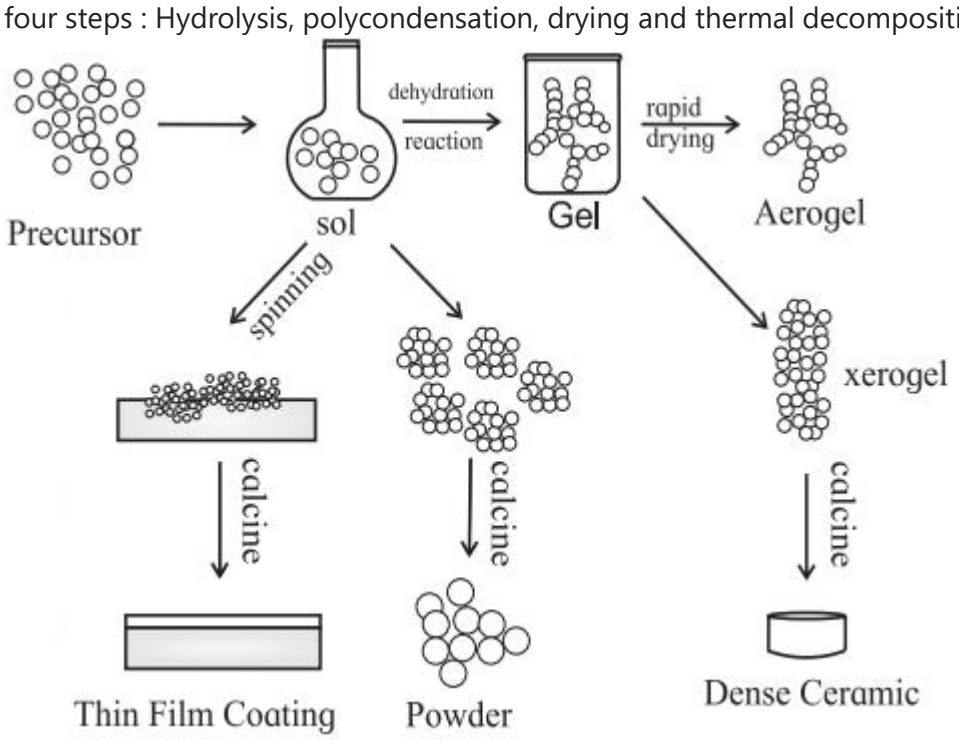
(2) The green chemistry principle aims to develop processes to avoid necessary steps i.e. (minimization of steps). When biocatalyst is used very often there is no need for protection of selective group. For example, conversion of m-hydroxyl benzaldehyde to m-hydroxybenzoic acid.



Question iv.
What do you mean by sol and gel? Describe the sol-gel method of preparation for nanoparticles.
Answer:
(1) Sol : Sols are dispersions of colloidal particles in a liquid. Colloids are solid particles with diameter of 1-100 nm.

(2) Gel : A gel is interconnected rigid network with pores of submicrometer dimensions and polymeric chains whose average length is greater than a micrometer.

(3) Sol-gel Process : A sol-gel process is an inorganic polymerisation reaction. It is generally carried out at room temperature, it includes four steps : Hydrolysis, polycondensation, drying and thermal decomposition. This method is widely used to prepare oxide materials.



The reactions involved in the sol-gel process are as follows :
MOR + H_2O → MOH + ROH (hydrolysis)
metal alkoxide
MOH + ROM → M-O-M + ROH (condensation)

- Formation of different stable solution of the alkoxide or solvated metal precursor.
- Gelation involves the formation of an oxide or alcohol-bridged network (gel) by a polycondensation reaction.
- Aging of the gel means during that period gel transforms into a solid mass.
- Drying of the gel involves removal of water and other volatile liquids from the gel network.
- Dehydration is achieved when the material is heated at temperatures up to 800°C.

Question v.
Which flower is an example of self-cleaning?
Answer:

- Lotus is an example of self cleansing.
- Nanostructures on the lotus plant leaves are super hydrophobic, they repel water which carries dirt as it rolls off. Thus though lotus plant (Nelumbonucifera) grows in muddy water, its leaves always appear clean.

Activity :
Collect information about the application of nanochemistry in cosmetics and pharmaceuticals

12th Chemistry Digest Chapter 16 Green Chemistry and Nanochemistry Intext Questions and Answers

Do you know? (Textbook page 343)

Question 1.
Does plastic packaging impact the food they wrap ?
Answer:
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 the harmful effects of plastic.

Used Catalyst (Textbook page 342)

Question 18.
Complete the chart:

Reaction	Name of Catalyst used
1. Hydrogenation of oil (Hardening)	.....
2. Haber's process of manufacture of ammonia	.....
3. Manufacture of HDPE polymer	.....
4. Manufacture of H_2S0_4 by contact process	.....

5. Fischer-Tropsch process (synthesis of gasoline)	.....

Answer:

Reaction	Name of Catalyst used
1. Hydrogenation of oil (Hardening)	Nickel (Ni)
2. Haber's process of manufacture of ammonia	Iron
3. Manufacture of HDPE polymer	Zeigler-Natta catalyst
4. Manufacture of H_2S0_4 by contact process	Vanadium oxide (V_20_5)
5. Fischer-Tropsch process (synthesis of gasoline)	Cobalt-based or Iron based