

MAULANA AZAD NATIONAL INSTITUTE OF TECHNOLOGY BHOPAL

DEPARTMENT OF CHEMISTRY

End Term Examination (Dec 2024) Answer Key

B.Tech. (First Semester)

Course Code: CHY 24110

Course: Environmental Science

Section A

Q A1 The comparative study of physico-chemical properties of peat, lignite, bituminous and anthracite coals is as follows:

Peat	Lignite	Bituminous	Anthracite
Partially decayed plant matter in swamps and bogs	Completely decomposed plant matter	Completely decomposed plant matter	Completely decomposed plant matter
Lowest heat and carbon content	Low heat and carbon content	High heat and carbon content	Highest heat content
Low sulphur content	Low sulphur content	High sulphur content	Low sulphur content
Limited supply	Limited supply	Large supply	Limited supply

Q A2 (a) Goals of Green Chemistry:

- **Maximize atom economy:** Design syntheses so that the final product contains the maximum proportion of the starting materials. Waste few or no atoms.
- **Design less hazardous chemical syntheses:** Design syntheses to use and generate substances with little or no toxicity to either humans or the environment.
- **Use safer solvents and reaction conditions:** Avoid using solvents, separation agents, or other auxiliary chemicals. If you must use these chemicals, use safer ones.
- **Avoid chemical derivatives:** Avoid using blocking or protecting groups or any temporary modifications if possible. Derivatives use additional reagents and generate waste.
- **Increase energy efficiency:** Run chemical reactions at room temperature & pressure whenever possible.
- **Use renewable feedstocks:** Promoting the use of renewable feedstocks and sustainable raw materials.

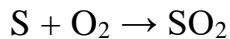
Any three goals among the above points or any other goals are also acceptable.

Q A2 (b) L₁₀ (18 hour) Index:

L₁₀ (18 hour) Index is used for road traffic noise measurement, which is expressed in dBA. This index is an arithmetic average hourly values of noise level over 18 hours between 6am and 12 am on any normal weekend (or any particular day).

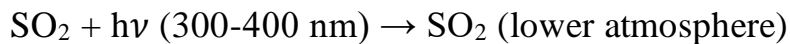
Q A3 The chemical expressions for generation of H₂SO₄ from elemental sulphur using thermal and photochemical reactions are as follows:

Combustion of sulfur bearing materials:

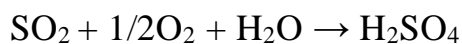


H₂SO₄ can be generated from SO₂ using any of the four routes:

- i Photochemical reaction
- ii Photochemical and chemical reaction in the presence of (NO_x) and/or hydrocarbon's
- iii Chemical process in water droplets containing metal salts and ammonia.
- iv Reaction on solid particles in the atmosphere.

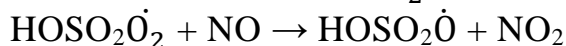
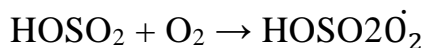
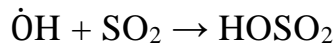


In natural sunlight at 5-10 ppm SO₂ and relative humidity 32-90%:

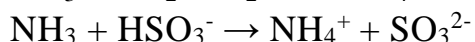
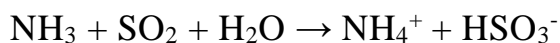


which is promoted by hydrocarbons and nitrogen oxides.

In the presence of OH radicals ($\dot{\text{O}}\text{H}$), the following reactions take place:



In humid atmosphere, SO₂ is oxidized by water of aerosol droplets. It becomes faster in the presence of NH₃, Mn²⁺, Fe²⁺, Ni²⁺, etc.



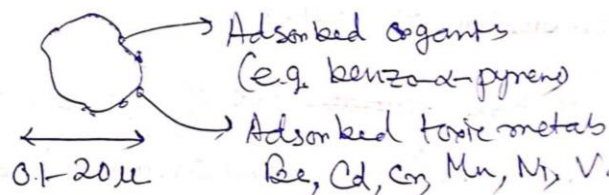
Q A4 At higher temperature, organic matter decomposes faster in warm water, filling it with nutrients that feed the algae. Therefore, eutrophication increases with the increase in temperature.

Preventive measures of eutrophication are:

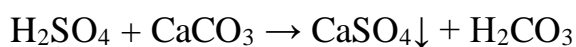
- Controlled use of synthetic fertilizers in the agricultural fields.
- Prevention of mixing of hot water (from various industrial sources) with surface water.

Section B

Q B1 Yes. Soot is a highly condensed product of polyaromatic hydrocarbons consisting of several thousand interconnected crystallites. Due to large surface area, soot acts as a carrier for toxic organics.



Q B2 Yes. If river bed is constituted with CaCO_3 , it can resist the acid mine drainage by neutralizing the acid (like H_2SO_4).



If the Ca salt is water soluble (like CaCl_2), the neutralization process is continued, but for water insoluble salts (like CaSO_4), such neutralization process is interrupted due to formation of a layer over the river bed.

Q B3 Soil air is useful for the respiration of microorganisms and plants. Good aeration also removes toxic elements.

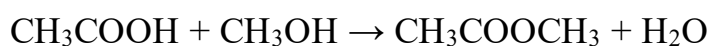
In presence of excess soil water, the pores inside the soil is completely filled with water and therefore, continuous supply O_2 to the underground biota is hampered. On the other hand, the evolved CO_2 can not be easily escaped from the soil.

Section C

Q C1 Atom Economy: Atom economy is a measure of the proportion of atoms in reactants that end up in the desired product(s) of a chemical reaction.

$$\text{Atom Economy} = \frac{\text{Molecular mass of desired product(s)}}{\text{Sum of molecular masses of all reactants}} \times 100 \%$$

For the following reaction.



Molecular mass of desired product, $\text{CH}_3\text{COOCH}_3 = 74 \text{ a.m.u}$

Sum of molecular weights of reactants = 92 a.m.u

$$\text{Atom Economy} = 74/92 * 100 \% = 80.4\%$$

If the experimental yield of the same reaction is 40% and 60% at two different conditions, it will not affect the atom economy, since atom economy is a theoretical fixed quantity.

Q C2 Sound reduction index (R) for a sound insulating material can be expressed as:

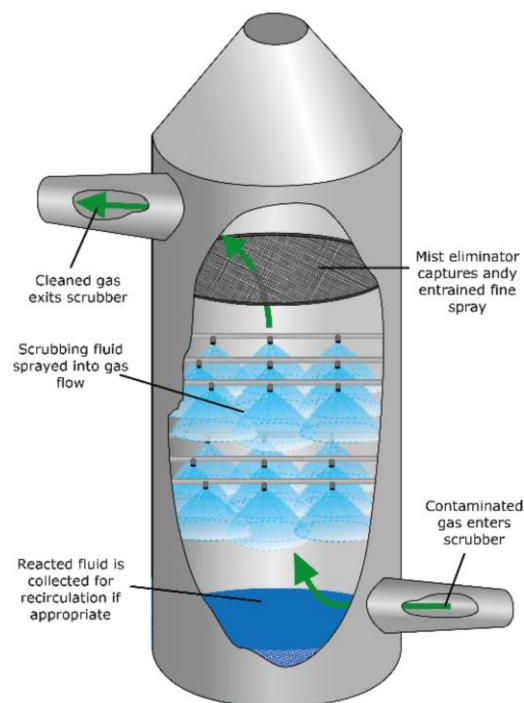
$$R = 10\log_{10}\frac{P_1}{P_2}, \text{ dB}$$

P_1 and P_2 are sound pressure level at the source and receiving sides.

$P_1 = 50$, $P_2 = 5$ (in any arbitrary unit)

$$\text{Therefore, } R = 10\log_{10}\frac{50}{5}, \text{ dB} = 10 \text{ dB}$$

Q C3 In gas scrubber, waste gas streams are brought into contact with liquid and it allows some of the gas components to pass through the liquid.



Applications of gas scrubber:

1. Scrubbers are useful to prevent air pollution from industrial processes, power plants and various chemical industries, like semiconductor manufacturing.
2. Gas scrubbers are employed to remove harmful emissions from oil refineries and gas processing plants.

Q C4 The salient features of the Air (Prevention and Control of Pollution) Act, 1981 are:

- The Act was passed to implement the decisions taken at the 1972 United Nations Conference on the Human Environment, which India participated in, to preserve the quality of air and control air pollution. It has been amended multiple times, including in 1987 to include noise as an air pollutant.
- The Act establishes the Central Pollution Control Board (CPCB) at the national level and State Pollution Control Boards (SPCBs) at the state level to implement its provisions. The CPCB and SPCBs are empowered to take measures for the abatement and prevention of air pollution.
- The Act provides the declaration of certain heavily polluted areas as “Air pollution control area” & no industrial plants operated without consent of SPCB.
- Failure to comply with the CPCB's directions can lead to imprisonment up to 7 years and a fine.

Q C5 The agriculture run-off contains substantial concentration of nutrients like nitrogen and phosphorous. These waters supply nutrients to the plants and may stimulate the growth of algae and other aquatic weeds in receiving waters. Thus, the value of the water body is degraded. In long run, water body reduces dissolved oxygen (DO), leads to eutrophication and ends up as a dead pool of water. In other words, turbidity increases and rate of sedimentation increases (shortening the lifespan of the lake). Ultimately, nutrients for agricultural land appear as a curse for surface water and aquatic biota.