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Environmental Chemistry Class 11 Notes | CBSE Chemistry

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Environmental Chemistry Class 11 Notes | CBSE Chemistry

Environmental Chemistry is the part of CBSE Class 11 Chemistry that finally connects everything you have learnt — oxides, acids, equilibria, organic compounds — to the air you breathe, the water you drink, and the soil that grows your food. It studies the chemical processes happening in our environment and how human activity disturbs them. The good news for exams: it is mostly definitions, causes, effects, and named reactions, so it is one of the easiest places to lock in full marks.

By the end of these notes you will be able to explain every type of pollution (atmospheric, water, and soil), write the reactions behind smog and acid rain, describe ozone-layer depletion, define BOD, COD, and eutrophication precisely, and list the green-chemistry strategies CBSE loves to ask. This is a scoring, NCERT-supplementary chapter — short on numericals, heavy on crisp 1, 2, and 3-mark answers.

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Key Concepts

1. Environmental Pollution

Environmental pollution is the effect of undesirable changes in our surroundings that have harmful effects on plants, animals, and human beings. The substances that cause this pollution are called **pollutants**.

A pollutant is any substance present in concentrations higher than the natural level, capable of producing a harmful effect. Pollutants are classified in two useful ways for exams.

- **Biodegradable pollutants:** broken down by microorganisms — e.g. sewage, domestic waste. They cause harm only when they accumulate faster than they degrade.
 - **Non-biodegradable pollutants:** not decomposed by natural agents — e.g. DDT, plastics, heavy metals (mercury, lead). These persist and biomagnify in food chains.
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2. Atmospheric Pollution

The atmosphere is layered. For this chapter only two layers matter: the **troposphere** (0–10 km, where we live and weather happens) and the **stratosphere** (10–50 km, which contains the protective ozone layer).

Tropospheric pollution occurs due to the presence of undesirable solid or gaseous particles in the lower atmosphere. The main gaseous pollutants are oxides of sulphur, nitrogen, and carbon, plus hydrocarbons and ozone, while the main particulate pollutants are dust, smoke, mist, and smog.

Oxides of Sulphur (SO₂, SO₃)

Produced mainly by burning sulphur-containing fossil fuels (coal). Even low concentrations of SO₂ cause irritation to the respiratory tract and damage to plants (chlorosis — loss of green colour).



Oxides of Nitrogen (NO, NO₂)

At the high temperatures inside engines and during lightning, nitrogen and oxygen combine. NO₂ is a major contributor to photochemical smog and acid rain, and it harms leaves and lowers plant resistance to disease.



Oxides of Carbon (CO and CO₂)

- **Carbon monoxide (CO)**: a deadly poison from incomplete combustion. It binds with haemoglobin about 300 times more strongly than oxygen to form **carboxyhaemoglobin**, reducing the blood's oxygen-carrying capacity and causing suffocation.
 - **Carbon dioxide (CO₂)**: not toxic at normal levels, but excess CO₂ from burning fossil fuels and deforestation enhances the **greenhouse effect**, leading to global warming.
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3. Global Warming and the Greenhouse Effect

The **greenhouse effect** is the trapping of the Sun's heat near the Earth's surface by certain gases. Greenhouse gases — CO₂, methane (CH₄), water vapour, CFCs, ozone, and nitrous oxide (N₂O) — absorb the infrared radiation re-emitted by the Earth and keep it warm.

Without it the Earth would be frozen, but the rising concentration of these gases is increasing the average global temperature — this is **global warming**. Its effects include melting of polar ice, rising sea levels, and erratic weather.

4. Smog

The word **smog** comes from *smoke* + *fog*. There are two distinct types, and CBSE almost always asks you to contrast them.

Feature	Classical (London) Smog	Photochemical (Los Angeles) Smog
Weather	Cool and humid	Warm, dry, and sunny
Chemical nature	Reducing (smoke + SO ₂ + fog)	Oxidising
Main pollutants	SO ₂ , smoke, fog	NO ₂ , O ₃ , hydrocarbons, PAN, aldehydes
Chief problem	Bronchial irritation	Eye irritation, breathing trouble, crop damage

Photochemical smog forms when sunlight acts on a mixture of NO₂ and hydrocarbons from vehicle exhaust. NO₂ breaks down to give atomic oxygen, which makes ozone, and a chain of reactions produces strong oxidants like **ozone (O₃)** and **peroxyacetyl nitrate (PAN)**.



Control: use of catalytic converters in vehicles prevents the release of NO₂ and hydrocarbons; planting certain trees (e.g. *Pinus*, *Juniparus*) that metabolise nitrogen oxides also helps.

5. Acid Rain

Normal rain is slightly acidic (pH $\approx$ 5.6) because dissolved CO₂ forms carbonic acid. When the pH of rain falls **below 5.6**, it is called **acid rain**.

It is caused by oxides of sulphur and nitrogen (from burning fossil fuels), which form sulphuric acid and nitric acid in the atmosphere.



Harmful effects: corrodes buildings and statues made of marble (CaCO₃) — including damage to the Taj Mahal — lowers the pH of lakes killing aquatic life, and damages plants and soil.

6. Stratospheric Pollution — The Ozone Layer

The **ozone layer** in the stratosphere acts as a protective shield, absorbing harmful ultraviolet (UV) radiation from the Sun before it reaches the Earth. Ozone is formed and destroyed naturally by the action of UV light on oxygen.



Ozone Layer Depletion

The balance is disturbed mainly by **chlorofluorocarbons (CFCs)** — also called *freons* — released from refrigerators, air conditioners, and aerosol sprays. In the stratosphere, UV light breaks CFCs to release chlorine free radicals.



The chlorine radical then destroys ozone in a chain reaction, where the radical is regenerated and goes on to destroy thousands more ozone molecules.



This thinning of ozone is the **ozone hole**, first detected over Antarctica. **Effects of increased UV:** skin cancer, cataracts, weakened immunity, ageing of skin, and damage to plants and phytoplankton.

7. Water Pollution

Water pollution is the contamination of water bodies by harmful substances that make the water unfit for use. Major causes include pathogens, organic and inorganic wastes, and chemical pollutants.

- **Pathogens:** disease-causing microorganisms (bacteria, viruses) from domestic sewage and animal excreta.
- **Organic wastes:** leaves, grass, sewage. Their decomposition by aerobic bacteria consumes dissolved oxygen, harming aquatic life.
- **Chemical pollutants:** heavy metals (cadmium, mercury, lead), acids, alkalis from industries — these are water-soluble and toxic.

Dissolved Oxygen, BOD and COD

Clean water has a high level of **dissolved oxygen (DO)**. The amount of oxygen consumed tells us how polluted the water is.

- **Biochemical Oxygen Demand (BOD):** the amount of oxygen required by bacteria to break down the *organic* matter in a certain volume of water. **Clean water has BOD < 5 ppm; polluted water has BOD > 17 ppm.** Higher BOD means more pollution.
- **Chemical Oxygen Demand (COD):** the oxygen required to oxidise both biodegradable and non-biodegradable organic matter by a strong chemical oxidant. COD is always greater than or equal to BOD.

Eutrophication

Eutrophication is the process in which a water body becomes over-enriched with nutrients (nitrates and phosphates from fertilisers and detergents). This causes excessive growth of algae — an **algal bloom**. When the algae die, their decomposition by bacteria uses up the dissolved oxygen, killing fish and other aquatic organisms.

8. Soil Pollution

Soil pollution is the contamination of soil by harmful chemicals, mainly from the excessive use of pesticides, herbicides, fungicides, and industrial waste. These chemicals are largely non-biodegradable.

- **Pesticides (e.g. DDT):** control pests but persist in soil, enter the food chain, and undergo **biomagnification** — their concentration increases at higher trophic levels.
- **Herbicides:** kill weeds; some (like sodium arsenite) are toxic to mammals.

- **Industrial waste:** heavy metals and toxic chemicals from factories degrade soil fertility and contaminate groundwater.
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9. Industrial Waste

Industries produce both **biodegradable** waste (from food-processing, textile, and paper industries) and **non-biodegradable** waste (thermal power plants, metal-extraction, fertiliser, and chemical industries — including toxic metals and fly ash). Untreated industrial effluents pollute air, water, and soil simultaneously and are a major source of heavy-metal contamination.

10. Strategies to Control Environmental Pollution

Pollution control focuses on proper waste management — reducing, reusing, recycling, and safely treating waste before it is released.

- **Collection and disposal:** segregate biodegradable and non-biodegradable wastes; collect domestic waste in separate bins.
 - **Recycling:** reuse materials like paper, glass, and metals to reduce fresh waste.
 - **Treatment:** treat sewage and industrial effluents before discharge; use scrubbers and electrostatic precipitators to remove particulates from chimney gases.
 - **Vermicomposting:** use earthworms to convert biodegradable waste into nutrient-rich manure.
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11. Green Chemistry — A Sustainable Solution

Green chemistry is the design of chemical products and processes that reduce or eliminate the generation of substances hazardous to the environment. Its aim is to use existing knowledge to make industrial processes environment-friendly.

Key Green-Chemistry Practices

- **Dry cleaning of clothes:** the harmful solvent tetrachloroethene is replaced by **liquefied CO₂** with a suitable detergent.
- **Bleaching of paper:** chlorine is replaced by **hydrogen peroxide (H₂O₂)**, which needs less water and gives a cleaner process.
- **Synthesis of chemicals:** for example, ethanal (CH₃CHO) is now made in a single step from ethene in water with 90% yield, using a catalyst.

Goal: use safer reagents, less energy, renewable raw materials, and produce minimal or no waste.

Weightage in Board & Entrance Exams

Exam	Typical Weightage	Most-Tested Areas
CBSE Board (Class 11)	3–4 marks	Smog types, acid rain, BOD/COD, eutrophication, ozone depletion
NEET	1–2 questions	Pollutants, greenhouse gases, BOD, photochemical smog
JEE Main	0–1 question	Definitions, CFC reactions, green chemistry

[TABLE: Question-type split — VSA (1 mark): definitions of BOD, eutrophication, green chemistry; SA (2–3 marks): classical vs photochemical smog, acid-rain reactions, ozone depletion; LA (3 marks): causes & control of water/soil pollution.]

Important Definitions

Term	Definition
Pollutant	A substance present above its natural level that has a harmful effect on the environment
Tropospheric pollution	Pollution of the lowest atmospheric layer by gases (SO_2 , NO_x , CO) and particulates
Smog	A mixture of smoke and fog; classical (reducing) or photochemical (oxidising)
Acid rain	Rain with pH below 5.6 due to dissolved H_2SO_4 and HNO_3
Greenhouse effect	Trapping of the Earth's infrared radiation by gases like CO_2 , CH_4 , CFCs
Ozone-layer depletion	Thinning of stratospheric ozone, mainly by chlorine radicals from CFCs
BOD	Oxygen required by bacteria to decompose organic matter in water
COD	Oxygen needed to chemically oxidise all organic matter in water
Eutrophication	Nutrient enrichment of water causing algal blooms and oxygen depletion
Green chemistry	Designing processes that reduce or eliminate hazardous substances

Solved Examples

Example 1

Why does the burning of coal containing sulphur lead to acid rain? Write the reactions.

Answer: Burning sulphur gives SO_2 , which is oxidised to SO_3 ; SO_3 reacts with rainwater to form sulphuric acid, lowering rain pH below 5.6. $2\text{SO}_2 + \text{O}_2 \rightarrow 2\text{SO}_3$; $\text{SO}_3 + \text{H}_2\text{O} \rightarrow \text{H}_2\text{SO}_4$.

Example 2

A sample of river water has a BOD of 22 ppm. Comment on its quality.

Answer: Clean water has BOD below 5 ppm and highly polluted water above 17 ppm. A BOD of 22 ppm means the water is **highly polluted** with a large amount of biodegradable organic matter.

Example 3

Why is carbon monoxide more dangerous than carbon dioxide?

Answer: CO binds to haemoglobin about 300 times more strongly than oxygen, forming carboxyhaemoglobin and starving the body of oxygen, whereas CO_2 is non-toxic at normal levels and only contributes to the greenhouse effect.

Example 4

Explain how CFCs deplete the ozone layer.

Answer: UV light splits CFCs to release chlorine radicals: $\text{CF}_2\text{Cl}_2 \rightarrow \text{Cl}^\cdot + \text{C}^\cdot\text{F}_2\text{Cl}$. Each $\text{Cl}^\cdot$ destroys ozone and is regenerated: $\text{Cl}^\cdot + \text{O}_3 \rightarrow \text{ClO}^\cdot + \text{O}_2$; $\text{ClO}^\cdot + \text{O} \rightarrow \text{Cl}^\cdot + \text{O}_2$, so one radical destroys thousands of O_3 molecules.

Example 5

What is eutrophication and why does it kill fish?

Answer: Eutrophication is nutrient over-enrichment (nitrates, phosphates) of water that causes algal blooms. When the algae die, bacterial decomposition consumes the dissolved oxygen, so fish suffocate due to oxygen depletion.

Example 6

Give one green-chemistry alternative used in the dry cleaning of clothes.

Answer: The toxic solvent tetrachloroethene is replaced by **liquefied carbon dioxide** with a suitable detergent, which is far less harmful and reduces groundwater contamination.

Important Questions for Board Exams

1-Mark Questions (VSA)

1. Define BOD. What does a high BOD value indicate?
2. What is the normal pH of rainwater, and when is rain called acid rain?
3. Name the two gases mainly responsible for acid rain.

4. Why is carbon monoxide a more serious pollutant than carbon dioxide?
5. What is meant by green chemistry?

2–3-Mark Questions (SA)

1. Distinguish between classical smog and photochemical smog on the basis of weather conditions and chemical nature.
2. Explain how photochemical smog is formed. Write the reactions involved.
3. What is eutrophication? How does it lead to the death of aquatic life?
4. Describe how CFCs are responsible for the depletion of the ozone layer, with reactions.

3-Mark Questions (LA)

1. Discuss the major causes of water pollution and explain the terms DO, BOD, and COD.
 2. What is the greenhouse effect? Name four greenhouse gases and state two effects of global warming.
 3. How can environmental pollution be controlled? Mention the role of green chemistry with two examples.
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Quick Revision Points

- Pollutant = substance above natural level causing harm; biodegradable vs non-biodegradable
 - Tropospheric pollutants: SO_2 , NO_x , CO, CO_2 , hydrocarbons, particulates
 - CO forms carboxyhaemoglobin (binds Hb $\sim 300\times$ more than O_2); CO_2 drives the greenhouse effect
 - Classical smog = reducing (SO_2 + smoke + fog); photochemical smog = oxidising (NO_2 , O_3 , PAN)
 - Acid rain: $\text{pH} < 5.6$, due to H_2SO_4 and HNO_3 ; damages marble (Taj Mahal)
 - Ozone layer absorbs UV; depleted by $\text{Cl}^\cdot$ radicals from CFCs (freons) $\rightarrow$ ozone hole
 - DO = dissolved oxygen; clean water has high DO
 - $\text{BOD} < 5 \text{ ppm}$ = clean, $> 17 \text{ ppm}$ = polluted; $\text{COD} \geq \text{BOD}$
 - Eutrophication: nutrient enrichment $\rightarrow$ algal bloom $\rightarrow$ O_2 depletion $\rightarrow$ fish die
 - Soil pollution mainly from pesticides (DDT) that biomagnify
 - Green chemistry: liquefied CO_2 for dry cleaning, H_2O_2 for paper bleaching
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Next Chapter: Structure of Atom Class 11 Notes



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