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Environmental Chemistry

Objective Questions I (Only one correct option)

- The primary pollutant that leads to photochemical smog is
(2019 Main, 12 April II)
(a) acrolein (b) nitrogen oxides
(c) ozone (d) sulphur dioxide
- The correct set of species responsible for the photochemical smog is
(2019 Main, 12 April I)
(a) N_2 , NO_2 and hydrocarbons
(b) CO_2 , NO_2 , SO_2 and hydrocarbons
(c) NO , NO_2 , O_3 and hydrocarbons
(d) N_2 , O_2 , O_3 and hydrocarbons
- Air pollution that occurs in sunlight is (2019 Main, 10 April II)
(a) acid rain (b) oxidising smog
(c) fog (d) reducing smog
- The regions of the atmosphere, where clouds form and where we live, respectively, are (2019 Main, 10 April I)
(a) stratosphere and stratosphere
(b) troposphere and troposphere
(c) troposphere and stratosphere
(d) stratosphere and troposphere
- The layer of atmosphere between 10 km to 50 km above the sea level is called as (2019 Main, 9 April II)
(a) stratosphere (b) mesosphere
(c) thermosphere (d) troposphere
- Excessive release of CO_2 into the atmosphere results in
(2019 Main, 9 April I)
(a) formation of smog (b) depletion of ozone
(c) polar vortex (d) global warming
- The maximum prescribed concentration of copper in drinking water is (2019 Main, 8 April II)
(a) 5 ppm (b) 0.5 ppm
(c) 0.05 ppm (d) 3 ppm
- Assertion (A)** Ozone is destroyed by CFCs in the upper stratosphere.
Reason (R) Ozone holes increase the amount of UV radiation reaching the earth. (2019 Main, 8 April I)
(a) Assertion and Reason are incorrect.
(b) Assertion and Reason are both correct and the Reason is the correct explanation for the Assertion.
(c) Assertion and Reason are correct, but the Reason is not the explanation for the Assertion.
(d) Assertion is false, but the Reason is correct.
- Which is wrong with respect to our responsibility as a human being to protect our environment? (2019 Main, 8 April I)
(a) Restricting the use of vehicles
(b) Avoiding the use of floodlighted facilities
(c) Setting up compost tin in gardens
(d) Using plastic bags
- The upper stratosphere consisting of the ozone layer protects us from the sun's radiation that falls in the wavelength region of (2019 Main, 12 Jan II)
(a) 600 - 750 nm (b) 400 - 550 nm
(c) 0.8 - 1.5 nm (d) 200 - 315 nm
- The compound that is not a common component of photochemical smog is (2019 Main, 12 Jan II)
(a) CF_2Cl_2 (b) $\text{H}_3\text{C}-\overset{\text{O}}{\underset{\text{O}}{\text{C}}}-\text{OONO}_2$
(c) $\text{CH}_2 = \text{CHCHO}$ (d) O_3
- Water samples with BOD values of 4 ppm and 18 ppm, respectively, are (2019 Main, 12 Jan I)
(a) clean and clean
(b) highly polluted and clean
(c) highly polluted and highly polluted
(d) clean and highly polluted
- The molecule that has minimum/no role in the formation of photochemical smog, is (2019 Main, 12 Jan I)
(a) N_2 (b) $\text{CH}_2 = \text{O}$
(c) NO (d) O_3
- Taj Mahal is being slowly disfigured and discoloured. This is primarily due to (2019 Main, 11 Jan II)
(a) water pollution (b) soil pollution
(c) global warming (d) acid rain
- The higher concentration of which gas in air can cause stiffness of flower buds? (2019 Main, 11 Jan II)
(a) SO_2 (b) CO
(c) CO_2 (d) NO_2
- Peroxyacetyl nitrate (PAN), an eye irritant is produced by (2019 Main, 11 Jan I)
(a) organic waste
(b) acid rain
(c) classical smog
(d) photochemical smog

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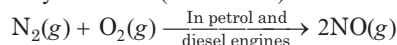
17. The concentration of dissolved oxygen (DO) in cold water can go upto (2019 Main, 11 Jan I)
 (a) 14 ppm (b) 10 ppm
 (c) 8 ppm (d) 16 ppm
18. The reaction that is not involved in the ozone layer depletion mechanism in the stratosphere is (2019 Main, 10 Jan II)
 (a) $\text{CH}_4 + 2\text{O}_3 \longrightarrow 3\text{CH}_2 = \text{O} + 3\text{H}_2\text{O}$
 (b) $\text{Cl}\dot{\text{O}}(\text{g}) + \text{O}(\text{g}) \longrightarrow \dot{\text{Cl}}(\text{g}) + \text{O}_2(\text{g})$
 (c) $\text{HOCl}(\text{g}) \xrightarrow{h\nu} \dot{\text{O}}\text{H}(\text{g}) + \dot{\text{Cl}}(\text{g})$
 (d) $\text{CF}_2\text{Cl}_2(\text{g}) \xrightarrow{h\nu} \dot{\text{C}}\text{F}_2\text{Cl}(\text{g}) + \dot{\text{C}}\text{F}_2\text{Cl}(\text{g})$
19. Water filled in two glasses *A* and *B* have BOD values of 10 and 20, respectively. The correct statement regarding them, is (2019 Main, 10 Jan I)
 (a) *A* is more polluted than *B* (b) *A* is suitable for drinking, whereas *B* is not
 (c) Both *A* and *B* are suitable for drinking
 (d) *B* is more polluted than *A*
20. The pH of rain water, is approximately (2019 Main, 9 Jan II)
 (a) 7.5 (b) 6.5
 (c) 5.6 (d) 7.0
21. The condition for methemoglobinemia by drinking water is (2019 Main, 9 Jan II)
 (a) > 50 ppm nitrate (b) > 50 ppm chloride
 (c) > 50 ppm lead (d) > 100 ppm sulphate
22. A water sample has ppm level concentration of the following metals: Fe = 0.2; Mn = 5.0; Cu = 3.0; Zn = 5.0. The metal that makes the water sample unsuitable for drinking is (2019 Main, 9 Jan I)
 (a) Cu (b) Fe
 (c) Mn (d) Zn

Answers

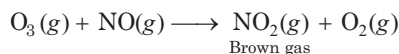
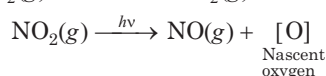
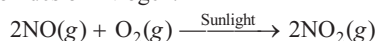
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|--------|---------|---------|---------|---------|---------|---------|---------|
| 1. (b) | 2. (c) | 3. (b) | 4. (b) | 13. (a) | 14. (d) | 15. (a) | 16. (d) |
| 5. (a) | 6. (d) | 7. (d) | 8. (c) | 17. (b) | 18. (a) | 19. (d) | 20. (c) |
| 9. (d) | 10. (d) | 11. (a) | 12. (d) | 21. (a) | 22. (c) | | |

Hints & Solutions

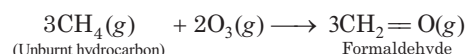
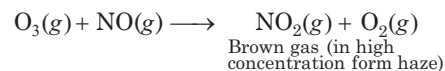
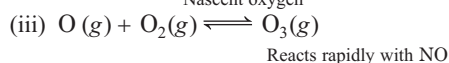
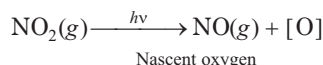
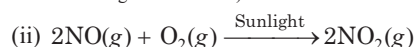
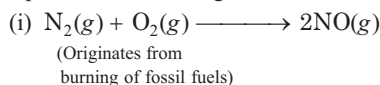
1. The primary pollutant that leads to photochemical smog is nitrogen oxides. Burning of fossil fuels such as petrol and diesel in automobiles, reaction between nitrogen and oxygen and other such reactions result in a variety of pollutants, two main of which are hydrocarbons (unburnt fuel) and nitric oxide (NO).



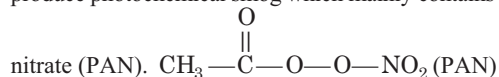
When the concentration of these pollutants is sufficiently high, a chain reaction initiate because of the interaction of sunlight with oxides of nitrogen.



2. The correct set of species responsible for the photochemical smog is NO, NO₂, O₃ and hydrocarbons. Photochemical smog appears in warm, dry and sunny climate which are obtained by the action of sunlight on unsaturated hydrocarbons and nitrogen oxides. Following reactions are involved during the formation of photochemical smog.



3. In sunlight oxidising smog or photochemical smog or Los-Angeles smog is formed. This smog is brown in colour. It occurs in warm, dry and sunny climate. In presence of sunlight, NO_x (N-oxides), O₂ and unburnt hydrocarbons of air combine to produce photochemical smog which mainly contains peroxyacetyl



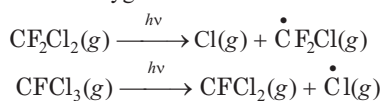
4. The lowest region of atmosphere is troposphere which extends upto the height of 10 km (approx) from sea level. We live in the tropospheric region. It contains air, water vapour and dust which can form clouds with the help of strong air movement. Above the troposphere, stratospheric region extends upto 50 km from sea level. It contains mainly N₂, O₂, O₃ and little water vapour. O₃ in the stratosphere absorbs 99.5% of the sun's harmful UV radiations and thus protects the lives on the earth.
5. The atmosphere between the heights 10 to 50 km above the sea level is stratosphere. Atmosphere is not of the same thickness at heights.
6. The effect of release of CO₂ gas into atmosphere is global warming.

7. According to W.H.O. and US environmental protection agency guidelines, maximum allowable concentration of metals in drinking water are as follows :

Metal	Maximum concentration (ppm or mg dm ⁻³)
Cd	0.005
Mn	0.05 (option-c)
Al	0.2
Fe	0.2
Cu	3.0 (option-d)
Zn	5.0 (option-a)

8. Ozone is destroyed by CFCs in the upper stratosphere.

These compounds ultimately reach the stratosphere where they get broken down by powerful UV radiations and release chlorine free radical. The chlorine free radicals react with ozone and cause its depletion by converting it into chlorine monoxide radical and molecular oxygen.



Ozone holes increase the amount of UV radiation reaching the earth. These radiations can cause skin cancer, sunburns, ageing of skin.

9. Using plastic bags is wrong with respect to responsibility as a human being to protect our environment. Plastic bags are non-biodegradable in nature. It remains in the environment as such and does not degraded by bacteria. If it is not disposed properly then it may lead serious threat to the environment. The activities that can be used to protect our environment are as follows:

- Restricting the use of vehicles.
- Avoiding the use of flood lighted facilities.
- Setting up compost tin in gardens.

10. Sun emits UV-radiations, which according to following EM categorisation have the wavelength range from 1 nm to 400 nm.

Type	Wavelength range
Radio wave	> 0.1 m
Microwave	0.1 m to 1 mm
Infrared wave	1 mm to 700 nm
Visible rays	700 nm to 400 nm
Ultraviolet rays	400 nm to 1 nm
X-rays	1 nm to 10 ⁻³ nm
Gamma rays	< 10 ⁻³ nm

Thus, option (d) with 200-315 nm range is the correct option.

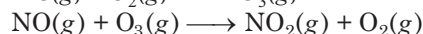
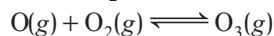
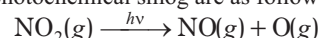
11. Freons or CFCs or chlorofluoro carbons, i.e. CF₂Cl₂ is not the common component of photochemical smog. This smog is produced as the result of tropospheric pollution while freons are the components of stratospheric pollution. These are infact considered as the major cause of ozone layer depletion.

12. The amount of oxygen required by bacteria to break down the organic matter present in a certain value of a sample of water is called biochemical oxygen demand (BOD). The amount of BOD in the water is a measure of the amount of organic material in the water, in terms of how much oxygen will be required to break it down biologically. Clean water would have BOD value of less than 5ppm whereas highly polluted water would have BOD value of 17 ppm or more.

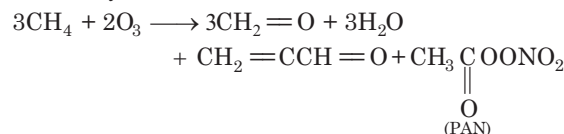
BOD value of clean water = 4 ppm

BOD value of highly polluted water = 18 ppm

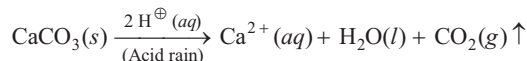
13. N₂ molecule has minimum role in the formation of photochemical smog. While CH₂ = O, O₃ and NO has major role. When fossil fuels are burnt, a variety of pollutants are emitted. Two of them are hydrocarbons (unburnt) and NO. When these pollutants build upto high levels, a chain reaction occurs from their interaction with sunlight. The reactions involved in the formation of photochemical smog are as follows:



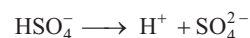
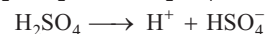
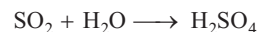
O₃ reacts with unburnt hydrocarbons to produce chemicals such as formaldehyde, acrolein and PAN.



14. Acid rain (pH = 3.5 – 5.6) constitutes strong acids like HNO₃, H₂SO₄ and H₂SO₃ which slowly react with marble (CaCO₃) of Taj Mahal and make it disfigured and discoloured. Here, CaCO₃ (marble) gets dissolved in acids.



15. Organic pigments (colourents) present in flower buds retain their colour in the oxidised form of the pigment as their nature is itself oxidising in nature. When they comes in contact with moist SO₂ (acid rain) of higher concentration, they get decoloured and stiff.



Due to the release of H⁺ ion (acid), the flower get decoloured and stiff.

As a result, flower eventually falls off from plants.

16. Molecular formula of peroxyacetyl nitrate (PAN) is

$\text{CH}_3 - \overset{\text{O}}{\underset{||}{\text{C}}} - \text{O} - \text{O} - \text{NO}_2$. It is a secondary pollutant. It is present in photochemical smog (oxidising or Los Angeles smog). PAN is a powerful lachrymator or tear producer and it also causes breathing troubles.

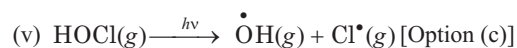
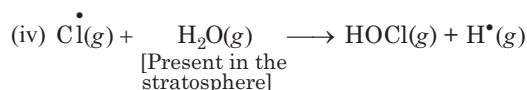
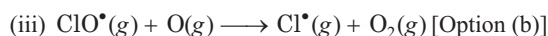
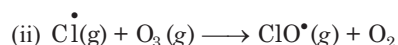
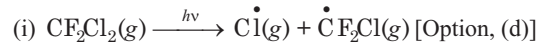
17. Dissolved oxygen (DO) is the oxygen dissolved in water either from atmosphere or by photosynthesis. The lower the concentration of DO in a water sample, the more polluted is the water sample.

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The concentration range of dissolved oxygen (DO) in cold water reaches upto 10 ppm, but that in normal water (at room temperature) is within 5 ppm.

18. CH_4 is not present in the stratosphere and also it cannot diffuse or escape into the stratosphere like freon-12 (CF_2Cl_2) from the atmosphere.

In the stratosphere, ozone layer depletion take place mainly by chlorofluorocarbons (CFCs) like CF_2Cl_2 and the mechanism of ozone layer depletion can be shown as:



\Rightarrow One Cl^\bullet can destroy or deplete 10^5 O_3 molecules.

As (i) reaction is involved in the formation of photochemical smog, not in ozone layer depletion. So option (a) is correct.

19. BOD is defined as the amount of oxygen required by bacteria to break down the organic matter present in a certain volume of a

sample of water. Clean water or drinking water has a BOD value < 5 ppm.

So, water filled with A, BOD = 10 ppm is polluted and water filled with B, BOD = 20 ppm, is also polluted. But, B is more polluted than A.

20. In clean air, rain water picks up some acidic oxides like CO_2 and SO_2 (obtained from volcanic eruptions). These substance make the rain slightly acidic (pH = 5.6 – 6).

21. According to EEC (European Environment Commission), excess of NO_3^- (> 50 ppm) in drinking water may lead to methemoglobinemia ('Blue baby syndrome'). It also may cause stomach-cancer.

22. For drinking water, the maximum recommended levels of some metals, set by European Environment Commission (EEC) is

Metal	Max. concentration in ppm
Zn	5
Mn	0.05
Fe	0.2
Cu	3

As the concentration of Mn in the given water sample is more than the recommended concentration. Thus, it makes water unsuitable for drinking.