

GATE 2026 ES Question Paper with Solutions

Time Allowed :3 Hour	Maximum Marks :100	Total Questions :65
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General Instructions

Please read the following instructions carefully:

1. This question paper is divided into three sections:
 - **General Aptitude (GA):** 10 questions (5 questions \times 1 mark + 5 questions \times 2 marks) for a total of 15 marks.
 - **Environmental Science and Engineering + Engineering Mathematics:**
 - **Part A (Mandatory):** 36 questions (1 questions \times 1 mark + 19 questions \times 2 marks) for a total of 55 marks.
 - **Part B (Section 1):** Candidates can choose either Part B1 (Surveying and Mapping) or Part B2 (Section 2). Each part contains 16 questions (8 questions \times 1 mark + 11 questions \times 2 marks) for a total of 30 marks.
2. The total number of questions is **65**, carrying a maximum of **100 marks**.
3. The duration of the exam is **3 hours**.
4. Marking scheme:
 - For 1-mark MCQs, $\frac{1}{3}$ mark will be deducted for every incorrect response.
 - For 2-mark MCQs, $\frac{2}{3}$ mark will be deducted for every incorrect response.
 - No negative marking for numerical answer type (NAT) questions.
 - No marks will be awarded for unanswered questions.
5. Ensure you attempt questions only from the optional section (Part B1 or Part B2) you have selected.
6. Follow the instructions provided during the exam for submitting your answers.

1. Which one of the following gases is primarily responsible for the formation of photochemical smog?

- (A) Carbon monoxide
- (B) Sulphur dioxide
- (C) Nitrogen oxides
- (D) Methane

Correct Answer: (C) Nitrogen oxides

Solution:

Step 1: Understanding photochemical smog.

Photochemical smog is a type of air pollution that forms due to chemical reactions between pollutants and sunlight. It is commonly observed in large cities with heavy vehicular traffic. This smog is characterized by the presence of ozone, nitrogen dioxide, aldehydes, and peroxyacetyl nitrate (PAN).

Step 2: Conditions required for photochemical smog formation.

The formation of photochemical smog requires three essential components: (i) Nitrogen oxides (NO and NO_2), (ii) Hydrocarbons or volatile organic compounds (VOCs), and (iii) Strong sunlight. Among these, nitrogen oxides act as the primary initiators of photochemical reactions.

Step 3: Role of nitrogen oxides in smog formation.

Nitrogen oxides are mainly released from automobile exhausts and combustion of fossil fuels. Under sunlight, nitrogen dioxide (NO_2) undergoes photodissociation to form nitric oxide (NO) and atomic oxygen. The atomic oxygen then reacts with molecular oxygen to produce ozone, which is the major harmful component of photochemical smog.

Step 4: Detailed analysis of options.

(A) Carbon monoxide: It is a toxic gas produced by incomplete combustion, but it does not participate in photochemical reactions leading to smog formation.

(B) Sulphur dioxide: This gas is mainly responsible for industrial smog and acid rain, not photochemical smog.

(C) Nitrogen oxides: Correct — These gases initiate sunlight-driven reactions that lead to the formation of ozone and other secondary pollutants in photochemical smog.

(D) Methane: Although methane is a hydrocarbon, it is relatively less reactive and does not play a primary role in smog formation.

Step 5: Final conclusion.

Since nitrogen oxides are the key gases that trigger photochemical reactions under sunlight, the correct answer is **(C) Nitrogen oxides**.

Quick Tip

Photochemical smog is always linked with **NO_x emissions + sunlight**. Vehicles are the major source.

2. BOD test is commonly carried out at:

(A) 20°C for 3 days

(B) 25°C for 3 days

(C) 20°C for 5 days

(D) 25°C for 5 days

Correct Answer: (C) 20°C for 5 days

Solution:

Step 1: Meaning of BOD.

Biochemical Oxygen Demand (BOD) is the amount of dissolved oxygen required by aerobic microorganisms to biologically decompose organic matter present in wastewater. It is an important parameter for measuring the strength and pollution level of sewage.

Step 2: Purpose of standard test conditions.

Microbial activity depends strongly on temperature and time. To obtain consistent, comparable, and reproducible results worldwide, the BOD test is conducted under standardized laboratory conditions.

Step 3: Standard temperature and duration.

The internationally accepted standard for BOD testing is incubation at 20°C for a period of 5 days. This duration allows sufficient time for microorganisms to stabilize their oxygen consumption without complete oxidation of all organic matter.

Step 4: Evaluation of options.

(A) 20°C for 3 days: Duration is too short and does not represent standard BOD measurement.

(B) 25°C for 3 days: Both temperature and time are non-standard.

(C) 20°C for 5 days: Correct — This is the globally accepted standard condition for the BOD₅ test.

(D) 25°C for 5 days: Higher temperature increases microbial activity and leads to inaccurate BOD values.

Step 5: Final conclusion.

Since the BOD test must be conducted at 20°C for 5 days to ensure uniform and reliable results, the correct answer is **(C) 20°C for 5 days**.

Quick Tip

Always remember: **BOD₅ = 5 days at 20°C**. This is a very high-frequency exam fact.

3. Which air pollutant is mainly responsible for acid rain?

(A) CO and CO₂

(B) NO₂ and SO₂

- (C) O_3 and PAN
- (D) NH_3 and CH_4

Correct Answer: (B) NO_2 and SO_2

Solution:

Step 1: Understanding acid rain.

Acid rain refers to precipitation such as rain, snow, or fog that contains strong acidic components. These acids are mainly sulfuric acid (H_2SO_4) and nitric acid (HNO_3), which are formed due to chemical reactions of certain air pollutants in the atmosphere.

Step 2: Formation mechanism of acid rain.

Sulphur dioxide (SO_2) and nitrogen dioxide (NO_2) are released into the atmosphere from burning fossil fuels, industrial processes, and vehicle emissions. These gases react with oxygen, water vapor, and oxidizing agents in the atmosphere to form sulfuric acid and nitric acid.

Step 3: Analysis of options.

(A) CO and CO_2 : Carbon monoxide is toxic, and carbon dioxide causes global warming, but neither directly forms strong acids responsible for acid rain.

(B) NO_2 and SO_2 : Correct — These gases are the primary precursors of nitric acid and sulfuric acid, which cause acid rain.

(C) O_3 and PAN: These are components of photochemical smog, not acid rain.

(D) NH_3 and CH_4 : Ammonia can neutralize acids, and methane is mainly a greenhouse gas.

Step 4: Final conclusion.

Since sulphur dioxide and nitrogen dioxide directly form strong acids in the atmosphere, the correct answer is **(B) NO_2 and SO_2** .

Quick Tip

Acid rain is always linked with **SO_2 and NO_x** . Remember: sulphuric and nitric acids are the culprits.

4. The most suitable method for disposal of municipal solid waste in large cities is:

- (A) Open dumping
- (B) Incineration
- (C) Sanitary landfill
- (D) Composting

Correct Answer: (C) Sanitary landfill

Solution:

Step 1: Nature of municipal solid waste in cities.

Municipal solid waste in large cities consists of household waste, commercial refuse, street sweepings, and institutional waste. The quantity is large, and the waste composition is highly mixed, requiring a safe and long-term disposal method.

Step 2: Requirements of an ideal disposal method.

An ideal disposal method should prevent groundwater contamination, control odors, minimize health hazards, and allow safe handling of large volumes of waste over long periods.

Step 3: Evaluation of options.

(A) Open dumping: This causes severe environmental pollution, foul odor, and health hazards, and is not suitable for cities.

(B) Incineration: Although it reduces volume, it is costly and causes air pollution if not properly controlled.

(C) Sanitary landfill: Correct — It is a scientifically designed method that safely isolates waste from the environment using liners, covers, and leachate control systems.

(D) Composting: Useful only for biodegradable waste and not suitable for handling total municipal waste in large cities.

Step 4: Final conclusion.

Due to its environmental safety, capacity to handle large waste volumes, and long-term effectiveness, the most suitable method is **(C) Sanitary landfill**.

Quick Tip

For large cities, the answer is almost always **sanitary landfill**. Open dumping is outdated and unsafe.

5. The microorganism mainly responsible for nitrification in soil is:

- (A) Nitrosomonas and Nitrobacter
- (B) Azotobacter and Rhizobium
- (C) Pseudomonas and Bacillus
- (D) Clostridium and Thiobacillus

Correct Answer: (A) Nitrosomonas and Nitrobacter

Solution:

Step 1: Understanding nitrification.

Nitrification is a biological process in which ammonia (NH_3) present in soil is converted into nitrite (NO_2^-) and then into nitrate (NO_3^-). This process is essential for making nitrogen available to plants.

Step 2: Two-step process of nitrification.

In the first step, ammonia is oxidized to nitrite by *Nitrosomonas*. In the second step, nitrite is further oxidized to nitrate by *Nitrobacter*. Both steps require aerobic conditions.

Step 3: Analysis of options.

(A) Nitrosomonas and Nitrobacter: Correct — These bacteria carry out the two sequential steps of nitrification.

(B) Azotobacter and Rhizobium: These are nitrogen-fixing bacteria, not nitrifying bacteria.

(C) Pseudomonas and Bacillus: These are mainly decomposers and denitrifiers.

(D) Clostridium and Thiobacillus: These bacteria are involved in anaerobic processes and sulfur oxidation.

Step 4: Final conclusion.

Since nitrification occurs through oxidation of ammonia and nitrite by specific bacteria, the correct answer is **(A) Nitrosomonas and Nitrobacter**.

Quick Tip

Remember: **Nitrification = Nitrosomonas + Nitrobacter**. Two-step aerobic process.

6. The unit used to measure sound intensity level is:

- (A) Hertz
- (B) Decibel
- (C) Pascal
- (D) Joule

Correct Answer: (B) Decibel

Solution:

Step 1: Understanding sound intensity and sound intensity level.

Sound intensity is defined as the sound power transmitted per unit area perpendicular to the

direction of sound propagation. However, the human ear cannot perceive sound intensity on a linear scale; instead, it responds logarithmically to changes in sound intensity. Therefore, sound intensity is expressed in terms of *sound intensity level*.

Step 2: Definition of sound intensity level.

Sound intensity level is a logarithmic measure of sound intensity relative to a reference intensity. It is given by the formula:

$$L = 10 \log_{10} \left(\frac{I}{I_0} \right)$$

where I is the sound intensity and I_0 is the reference sound intensity. The unit of sound intensity level is the decibel (dB).

Step 3: Reason for using decibel scale.

The decibel scale compresses a very wide range of sound intensities into a manageable scale. This makes it suitable for representing noise levels in environmental studies and noise pollution assessment.

Step 4: Analysis of options.

(A) **Hertz:** Hertz is the unit of frequency and measures the pitch of sound, not intensity level.

(B) **Decibel:** Correct — Decibel is the standard unit used to measure sound intensity level on a logarithmic scale.

(C) **Pascal:** Pascal is the unit of pressure and is used to measure sound pressure, not sound intensity level.

(D) **Joule:** Joule is the unit of energy and has no direct relation to sound intensity level.

Step 5: Final conclusion.

Since sound intensity level is expressed on a logarithmic scale and measured in decibels, the correct answer is **(B) Decibel**.

Quick Tip

Always remember: **Sound intensity level = Decibel (dB)** and **Frequency = Hertz (Hz)**.

7. Which of the following is the first step in Environmental Impact Assessment (EIA)?

- (A) Impact evaluation
- (B) Public hearing
- (C) Screening
- (D) Mitigation

Correct Answer: (C) Screening

Solution:

Step 1: Understanding Environmental Impact Assessment (EIA).

Environmental Impact Assessment (EIA) is a systematic process used to identify, predict, and evaluate the potential environmental effects of a proposed project before decision-making and project approval. It helps in ensuring that environmental considerations are integrated into development planning.

Step 2: Purpose of the first step in EIA.

Before conducting a detailed environmental study, it is necessary to decide whether a proposed project actually requires an EIA or not. This avoids unnecessary assessment for projects with negligible environmental impact and focuses resources on significant projects.

Step 3: Explanation of Screening.

Screening is the initial step of the EIA process. In this stage, the project is examined to determine whether it falls under categories that require environmental clearance and the level of assessment needed (full EIA, partial EIA, or no EIA).

Step 4: Analysis of options.

(A) Impact evaluation: This is carried out after impacts have been identified and predicted, not at the beginning.

(B) Public hearing: This occurs at a later stage to obtain public opinion on the proposed project.

(C) Screening: Correct — It is the very first step used to decide whether an EIA study is required.

(D) Mitigation: Mitigation measures are proposed only after environmental impacts have been assessed.

Step 5: Final conclusion.

Since screening is used to decide the necessity and extent of environmental assessment at the very beginning of the EIA process, the correct answer is **(C) Screening**.

Quick Tip

Always remember the EIA sequence starts with **Screening**, followed by scoping, impact assessment, public hearing, and mitigation.