# MADE EASY

India's Best Institute for IES, GATE & PSUs

**Test Centres:** Delhi, Hyderabad, Bhopal, Jaipur, Pune, Kolkata

# ESE 2025 : Prelims Exam | GS & ENGINEERING APTITUDE | Test 3
## CLASSROOM TEST SERIES

**Section A :** Basics of Energy and Environment
**Section B :** Basic of Material Science
**Section C :** Engineering Mathematics + Reasoning & Aptitude

## ANSWER KEY

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1. | (c) | 11. | (d) | 21. | (a) | 31. | (a) | 41. | (b) |
| 2. | (b) | 12. | (d) | 22. | (b) | 32. | (b) | 42. | (b) |
| 3. | (c) | 13. | (a) | 23. | (b) | 33. | (d) | 43. | (d) |
| 4. | (d) | 14. | (d) | 24. | (b) | 34. | (b) | 44. | (d) |
| 5. | (a) | 15. | (a) | 25. | (b) | 35. | (a) | 45. | (a) |
| 6. | (d) | 16. | (b) | 26. | (b) | 36. | (c) | 46. | (d) |
| 7. | (b) | 17. | (a) | 27. | (b) | 37. | (c) | 47. | (a) |
| 8. | (b) | 18. | (c) | 28. | (b) | 38. | (d) | 48. | (b) |
| 9. | (c) | 19. | (c) | 29. | (b) | 39. | (b) | 49. | (b) |
| 10. | (d) | 20. | (c) | 30. | (d) | 40. | (b) | 50. | (b) |

## Section A : Basics of Energy and Environment

1. **(c)**
   - Short-lived climate pollutants (SLCPs), also referred to as "short-lived climate forcers" by the Intergovernmental Panel on Climate Change (IPCC), are greenhouse gases and other climate pollutants that have varying atmospheric lifespans, ranging from a few days to more than ten years.
   - The most significant short-lived climate pollutants are: Black carbon, methane, tropospheric ozone and hydrofluorocarbons. They primarily come from fossil fuel production and combustion.

2. **(b)**
   - Biodiversity, or biological diversity, is a term that refers to the number of genes, species, and individual organisms within a given species and biological communities within a defined geographic area, ranging from the smallest ecosystem to the global biosphere.
   - Biodiversity loss is a decrease in Biodiversity within a species, an ecosystem, a given geographic area, or Earth as a whole. Loss of biodiversity in a region may lead to
     - Decline in plant production.
     - Lowered resistance to environmental perturbations such as drought like situation.
     - Increased variability in certain ecosystem processes such as plant productivity, water use, and pest and disease cycles.

3. **(c)**
   - The National Board for Wildlife (NBWL) is a statutory board constituted by the Union Government under the Wildlife (Protection) Act, 1972.
   - NBWL has 47 members, with the Prime Minister in the Chair. The Vice-Chairperson is the Minister in charge of the Ministry of Environment & Forests in the Union Government.
   - The Board is responsible for promoting the conservation and development of wildlife and forests. No alternation of boundaries of National Parks can be done without the approval of the NBWL.

4. **(d)**
   - Chlorofluorocarbon (CFC), is any of several organic compounds composed of carbon, fluorine, and chlorine. Most of the CFCs have excellent chemical and physical properties, such as stability, non-reactivity, non-toxicity and non-flammability suited for a variety of industrial applications.
   - The uses of CFCs have been expanded to include air-conditioning, cleaning of electronic and mechanical components, aerosol propellants and expansion of plastics for energy-efficient foams.

5. **(a)**
   - In-situ conservation means the conservation of ecosystems in natural habitats and the maintenance and recovery of viable populations of species in their natural surroundings. Examples: National Parks, Wildlife Sanctuaries, Biosphere Reserves, Biodiversity Hotspots, Sacred groves, Wetlands, etc.
   - Ex-situ conservation means the conservation of components of biological diversity outside their natural habitats. Examples: Captive Breeding, Gene Banks, Seed Banks, Zoological Garden, Aquaria, Tissue Culture, etc.

**6.   (d)**

Ocean Thermal Energy Conversion (OTEC) uses the temperature difference between the surface of the ocean and the depths of about 1000 m to operate a heat engine, which produces electric power.

**7.   (b)**

- Sendai Framework for Disaster Risk Reduction (2015-2030) is an international document which was adopted in 2015 at the World Conference on Disaster Risk Reduction held in Sendai, Japan.
- It is the successor agreement to the Hyogo Framework for Action (2005-2015).

**8.   (b)**

- The graphic representation of the total number of individuals of different species belonging to each trophic level in an ecosystem, is known as pyramid of numbers. The length of each bar represents the total number of individuals at each trophic level in an ecosystem.
- To overcome the shortcomings of the pyramid of numbers, the pyramid of biomass is used. Biomass represents the total dry weight of living beings of different species at each trophic level at a particular time. In pyramid of biomass, the organisms in each trophic level are weighted instead of being counted.
- Energy pyramid more accurately reflects the laws of thermodynamics, with loss of energy being depicted at each transfer to another trophic level, hence the pyramid of energy is always upright even where the pyramid of biomass is inverted.

**9.   (c)**

- The National Clean Air Programme has been launched by the Ministry of Environment, Forest and Climate Change as a comprehensive initiative in partnership with various Ministries and States to improve air quality at city, regional and national level.
- PM10 or particulate matters that do not exceed 10 micrograms in diameter are small enough to enter the lungs through breathing causing serious health hazards.
- National Clean Air Programme (NCAP) aims for a reduction of 20-30% in PM10 concentrations by 2024-25 compared to the baseline year of 2017-18. The target has been revised to achieve up to a 40% reduction in PM10 levels or to meet national standards ($60 \ \mu g/m^3$) by 2025-26.

**10.   (d)**

- The World Wide Fund for Nature's 2024 Living Planet Report highlights India's food practices as a model of sustainability.
- According to the report, if the world adopted India's consumption habits, we would only need 0.84 of an Earth by 2050 to sustain global food production. This recognition positions India as a potential leader in the global movement towards environmentally responsible consumption.

**11.   (d)**

- The National Tiger Conservation Authority (NTCA) is a statutory body under the Ministry of Environment, Forests and Climate Change constituted for strengthening tiger conservation, as per powers and functions assigned to it under the Wildlife (Protection) Act, 1972 Act, as amended in 2006.

- The Project Tiger was launched in 1973 with the objective "to ensure maintenance of a viable population of Tigers in India for scientific, economic, aesthetic, cultural and ecological values, and to preserve for all times, areas of biological importance as a national heritage for the benefit, education and enjoyment of the people".

**12.    (d)**

- Hydrofluoroolefins (HFOs) are unsaturated organic compounds composed of hydrogen, fluorine and carbon. These are used as refrigerants in household and car Air Conditioning (AC) systems.
- Hydrofluoroolefins have a Low Global Warming Potential, zero ODP (Ozone Depletion Potential) and a shorter atmospheric lifetime than Hydrofluorocarbons (HFCs).

**13.    (a)**

- Biosparging is process of injection of air under pressure below the water table to increase groundwater oxygen concentrations and enhance the rate of biological degradation of contaminants by naturally occurring bacteria.
- Bioreactors involves the processing of contaminated solid material (soil, sediment, sludge) or water through an engineered containment system.
- Bioaugmentation is a process in which microorganisms are imported to a contaminated site to enhance degradation process.

**14.    (d)**

- The Vienna Convention for the Protection of the Ozone Layer and its Montreal Protocol on Substances that Deplete the Ozone Layer are dedicated to the protection of the Earth's ozone layer. Vienna Convention was adopted in 1985 and entered into force in 1988.
- The Montreal Protocol on Substances that Deplete the Ozone Layer was designed to reduce the production and consumption of ozone-depleting substances in order to reduce their abundance in the atmosphere and thereby protect the Earth's fragile ozone Layer.
- Montreal Protocol has been recognised as the most successful international environment treaty in history. It was adopted on September 16, 1987. The Montreal Protocol has received universal ratification; all countries in the world have now ratified this landmark agreement.
- The ozone layer in the stratosphere absorbs a portion of the radiation from the Sun, preventing it from reaching the planet's surface.

**15.    (a)**

- Warmer water temperatures can result in coral bleaching. When water is too warm, corals will expel the algae (zooxanthellae) living in their tissues, causing the coral to turn completely white. This is called coral bleaching.
- Warmer sea surface temperatures intensify tropical storm wind speeds, giving them the potential to deliver more damage while making landfall.
- Carbon sequestration is the process of capturing and storing atmospheric carbon dioxide. If Water temperature increases, its ability to dissolve $CO_2$ decreases.

**16. (b)**

An ecotone is a transition area between two biomes. It is where two communities meet and integrate. It may be narrow or wide, and it may be local (the zone between a field and forest) or regional (transition between forest and grassland ecosystem).

**17. (a)**

- The Convention on Wetlands of International Importance (Ramsar Convention) was adopted in 1971 and entered into force in 1975.
- It is a legally binding framework instrument embodying the commitments of its member countries to maintain the ecological character of their Wetlands of International Importance and to plan for the wise use, or sustainable use, of all wetlands in their territories.
- A wetland should be considered internationally important if it contains a representative, rare, or unique example of a natural or near-natural wetland type found within the appropriate bio-geographic region.

**18. (c)**

- First Generation biofuels are produced directly from food crops by abstracting the oils for use in biodiesel or producing bioethanol through fermentation.
- Second Generation biofuels are produced from non-food crops such as wood, organic waste, food crop waste and specific biomass crops.
- Third generation biofuels refer to biofuels derived from algae.
- Fourth generation biofuels are created using petroleum like hydro-processing or advanced biochemistry. These are derived from specially engineered plants or biomass that may have higher energy yields or lower barriers to cellulosic breakdown or are able to be grown on non-agricultural land or bodies of water.

**19. (c)**

- The relative loss of energy increases in successive trophic levels. In other words, energy decreases as it moves up in trophic levels because energy is lost (as metabolic heat) when the organisms from one trophic level are consumed by organisms from the next level.
- Grazing food chain begins from green plants at the base and the primary consumer is herbivores.
- An ecosystem may consist of several interrelated food chains, which are interlocked with each other.

**20. (c)**

- In hydrothermal convection systems, most of the heat is transferred by the convective circulation of water or steam rather than by thermal conduction through solid rocks.
- Hydrothermal convection occurs in rocks of adequate permeability because of the buoyancy effect of heating and consequent thermal expansion of fluids in a gravity field. The heated fluid tends to rise and the more dense, cooler fluid tends to descend into the earth's crust, and this process continues in the cycle.

**21. (a)**

- Microplastics come from a variety of sources, including from larger plastic debris that degrades into smaller and smaller pieces.

- Microplastics also adversely affect plankton, which are an essential component of the marine habitat. The penetration of microplastics along the cell wall of phytoplankton results in the reduction of chlorophyll absorption.

**22.  (b)**
- GRIHA is a tool to evaluate Greenhouse gas (GHG) reduction from habitats to mitigate climate change in the nationally determined contributions.
- GRIHA, the national rating system, evaluates the environmental performance of a building holistically over its entire life cycle, thereby providing a definitive standard for what constitutes a 'green building'.

**23.  (b)**
- Waste-to-energy projects use non-recyclable dry waste to generate electricity. The process increases power generation capacity and eases the burden of solid waste management (SWM).
- Waste-to-energy helps in reducing the reliance on landfills and helps to eliminate the need for landfills in urban areas of India.

**24.  (b)**
- $CO_2$ is much more abundant in the atmosphere compared to $CH_4$ and HFCs.
- $CO_2$ remains in the atmosphere longer than the other major GHGs emitted due to human activities. It takes about a decade for $CH_4$ emissions to leave the atmosphere (it converts into $CO_2$) and about a century for nitrous oxide ($N_2O$).

**25.  (b)**

## Section B : Basics of Material Science

**26.  (b)**

The intercepts made by the plane on the ($x$, $y$, $z$) axis respectively are $\left( 1 \quad -1 \quad \dfrac{1}{2} \right)$

Taking reciprocal of the interrupts, the Miller indices are obtained as (1,  –1,  2)

**27.  (b)**
Edge dislocations in a crystal are much more in number than screw dislocations in any crystalline material.

**28.  (b)**
The following remedial measures are suggested to minimize the occurrence of dislocations:
- Use of thermal energy such as annealing process for reduction of dislocation density.
- Careful control of various parameters during crystallization process, i.e. grain growth.
- Prevention of undesired mechanical deformations.
- Use of the material in whisker's form, in which the dislocations are reduced to a minimum level

On heating the crystals to a high temperature, many dislocations are either annihilated among themselves or are driven out of the crystal surfaces.

**29. (b)**

During recrystallization, following changes take place in the metals:

1. The mechanical properties are abruptly changed, i.e. increase in ductility and decrease in electrical resistivity. But the strength and hardness are decreased.
2. Distorted grains disappear and new equiaxed grains are formed.
3. Internal stresses are further reduced.
4. Slip bands formed during plastic deformation disappear.
5. No change in crystal structure.
6. Grain refinement occurs.
7. Dislocation density is reduced from $10^{10}$-$10^{12}$/cm$^2$ to $10^6$/cm$^2$.

**30. (d)**

Creep phenomenon is most pronounced in components that are subjected to high temperatures and sustained mechanical stress, such as Industrial belts, Gas turbine blades, Nuclear reactor, etc.

**31. (a)**

Lead babbit is tin and lead based alloy. It possesses excellent anti-friction properties and sufficient mechanical strength, so most commonly used in bearing metal.

$$\begin{array}{rl}
\textbf{ALLOY} & \textbf{APPLICATIONS}
\end{array}$$

Lead babbit bearing $\rightarrow$ Railway wagon bearings

Silver bearing $\rightarrow$ Anti-friction instrument bearings

Copper bearing $\rightarrow$ Heavy-duty bearings

Nickel-Cadmium bearing $\rightarrow$ High-temperature bearings

**32. (b)**

| Property | Glass fibres (E Glass) | Carbon fibres (High Strength) | Aramid Fibres (Kevlar-49) |
|---|---|---|---|
| Specific gravity | 2.1 | 1.6 | 1.4 |
| Tensile modulus (Longitudinal)(GPa) | 45 | 145 | 76 |
| Tensile modulus (Transverse) (GPa) | 12 | 10 | 5.5 |
| Tensile strength Longitudinal (MPa) | 1020 | 1240 | 1360 |
| Ultimate tensile strain (%) | 2.3 | 0.9 | 1.8 |

**33. (d)**

- In a dielectric material, $D = \varepsilon_0 E + P$.

  Thus, the total electric flux density in a dielectric material is due to applied external electric field and due to polarization.

- Statement-2 pertains to the inverse piezoelectric effect.

Hence, both the statements are correct.

**34. (b)**

A crystal is a physical object while a lattice is a geometrical concept. Thus, statement 2 is not correct.

**35.   (a)**

Anti-ferromagnetic materials possess permanent dipoles which are equal in magnitude but anit-parallel to each other and these materials above neel temperature ($\theta_N$) remain anti-ferromagnetic and above neel temperature they behave paramagnetic material.

**36.   (c)**

Thermal conductivity of the metal is

$$k = \sigma L T$$

where,     $L = 2.447 \times 10^{-8}$  $W\Omega/K^2$

: Lorentz number

**37.   (c)**

- Critical magnetic field is the minimum amount of field required at a given temperature to destroy superconductivity.
- In superconducting state with increase in temperature, the value of critical magnetic field decreases and beyond $T_C$, temperature alone is enough to destroy super conductivity.



$$T_2 > T_1$$
$$H_{C_2} < H_{C_1}$$
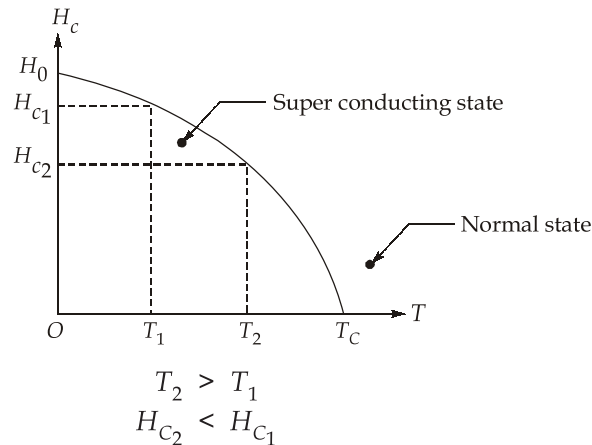
**38.   (d)**

Magnesium and platinum are the examples of paramagnetic material.

## Section C : Engineering Mathematics + Reasoning & Aptitude

**39.   (b)**

$$z = \frac{1+\sqrt{3}i}{1+i}$$

$$\text{Argument}(z) = \text{Argument}\left(1+\sqrt{3}i\right) - \text{Argument}(1+i)$$

$$= \tan^{-1}\sqrt{3} - \tan^{-1}1$$

$$= \frac{\pi}{3} - \frac{\pi}{4}$$

$$\text{Argument}(z) = \frac{\pi}{12}$$

**40.** **(b)**

Given:      $P(A) = 0.20, \quad P(A \cup B) = 0.40$

$\because A$ and $B$ are independent events

Hence, $$P(A \cap B) = P(A) \cdot P(B)$$

So, $$P(A \cup B) = P(A) + P(B) - P(A \cap B)$$

$$0.40 = 0.20 + P(B) - 0.20 \times P(B)$$

$$0.20 = P(B) \times 0.80$$

$$P(B) = \frac{1}{4}$$

Hence, $$P(\overline{B}) = 1 - P(B)$$

$$= 1 - \frac{1}{4} = \frac{3}{4}$$

**41.** **(b)**

$$\tan\theta = \sqrt{6 + \sqrt{6 + \sqrt{6 + \ldots}}} \qquad\qquad 0° < \theta < 90°$$

$$\tan\theta = \sqrt{6 + \tan\theta}$$

$$\tan^2\theta = 6 + \tan\theta$$

$$\tan^2\theta - \tan\theta - 6 = 0$$

Let $$\tan\theta = y$$

$$y^2 - y - 6 = 0$$

$$(y - 3)(y + 2) = 0$$

$$y = 3, \, y \neq -2 \qquad\qquad [y \in (0, \infty)]$$
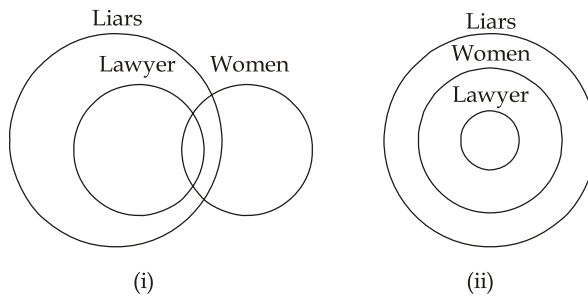
So, $$\tan\theta = 3$$

$\because$ $$\sec^2\theta = 1 + \tan^2\theta$$

Hence, $$\sec^2\theta = 1 + 3^2 = 10$$

**42.** **(b)**

The possible cases are:



From the above possible diagrams, we can conclude that both conclusion I and II follows from the given statements.

    

**43.** **(d)**

On shifting by 4 places, Komal is 10$^{th}$ from the left end of the row. Thus, Komal's original position was 14$^{th}$ from the left end. Swati is 3 places to the right of Komal's original positions. Thus, Swati is 17$^{th}$ from the left end.

Number of girls to the right of Swati,

$$= 40 - 17 = 23$$

Thus, Swati is 24$^{th}$ from the right end of the row.

**44.** **(d)**

From the given data, the following can be determined:
- Gauhar is wearing Orange.
- Fatima is wearing Red.
- Ellie is wearing Indigo.
- Dipti is wearing Violet.
- Chinni is wearing Green/Yellow/Blue
- Babita is wearing Green/Yellow/Blue
- Asha is wearing Green/Yellow/Blue

Colour of the cap worn by Babita cannot be determined.

**45.** **(a)**

Let

$$AB = \begin{bmatrix} 3 & 2 & 2 \\ 1 & 3 & 1 \\ 5 & 3 & 4 \end{bmatrix} \begin{bmatrix} l & m & n \\ p & q & r \\ u & v & w \end{bmatrix} = \begin{bmatrix} 3 & 4 & 2 \\ 1 & 6 & 1 \\ 5 & 6 & 4 \end{bmatrix}$$

$$3l + 2p + 2u = 3 \qquad \qquad ...(i)$$
$$3m + 2q + 2v = 4 \qquad \qquad ...(ii)$$
$$3n + 2r + 2w = 2 \qquad \qquad ...(iii)$$

Only option (a) satisfy equations (i), (ii) and (iii).

**46.** **(d)**

For an orthogonal matrix $A$, $AA^T = I \Rightarrow A^T = A^{-1}$
- The inverse of an orthogonal matrix $A^{-1}$ is orthgonal as $A^{-1}(A^{-1})^T = A^{-1}A = I$
- The transpose of an orthogonal matrix $A^T$ is orthgonal as $A^T(A^T)^T = A^TA = I$
- For the product of two orthogonal matrices, $(AB)(AB)^T = A(BB^T)A^T = AA^T = I$. Thus, the product of two orthogonal matrices is an orthogonal matrix.
- The eigenvalues of an orthogonal matrix are always ±1.

Hence, all the given statements are correct.

**47.** **(a)**

Using L-Hospital rule,

$$\lim_{x \to 0} \frac{\log x}{\cot x} = \lim_{x \to 0} \frac{1/x}{-\operatorname{cosec}^2 x} = \lim_{x \to 0} \frac{\sin^2 x}{x}$$

$$= -\lim_{x \to 0} \frac{2\sin x \cos x}{1} = 0$$

**48.** **(b)**

Let $f(x) = \sin x(1 + \cos x)$

$$
\begin{aligned}
f'(x) &= \cos x(1 + \cos x) + \sin x(-\sin x) \\
&= \cos x(1 + \cos x) - (1 - \cos^2 x) = (1 + \cos x)(2\cos x - 1)
\end{aligned}
$$

To obtain extreme points, we put

$$f'(x) = 0$$

$$\cos x = \frac{1}{2} \text{ or } -1$$

i.e. $$x = \frac{\pi}{3} \text{ or } \pi$$

Now, 
$$
\begin{aligned}
f''(x) &= -\sin x(2\cos x - 1) + (1 + \cos x)(-2\sin x) \\
&= -\sin x(4\cos x + 1)
\end{aligned}
$$

$$f''\left(\frac{\pi}{3}\right) = -\frac{3\sqrt{3}}{2}$$

and $$f''(\pi) = 0$$

Since $f''\left(\dfrac{\pi}{3}\right) < 0$, Thus $f(x)$ has a maximum at $x = \dfrac{\pi}{3}$.

Since $f''(\pi)$ is 0, let us see whether $f'(x)$ changes sign or not.

When $x$ is slightly $< \pi$, $f'(x)$ is –ve, then when $x$ is slightly $> \pi$, $f'(x)$ is again –ve i.e., $f'(x)$ does not change sign as $x$ passes through $\pi$.

So, $f(x)$ is neither maximum nor minimum at $x = \pi$.

**49.** **(b)**

Given 
$$f(x, y) = x^2 + xy^2$$

$$\nabla f = \left(2x + y^2\right)\hat{i} + 2xy\hat{j}$$

$$\nabla f\Big|_{(2,0)} = (2 \times 2)\hat{i} = 4\hat{i}$$

The directional derivative along the given direction a is given by,

$$\text{Directional derivative} = \nabla \cdot f\,\frac{\vec{a}}{|a|} = \left(4\hat{i}\right)\frac{\left(\hat{i} + \sqrt{3}\hat{j}\right)}{\sqrt{1+3}} = \frac{4}{2} = 2$$

**50.** **(b)**

Newton's iterative formula,

$$x_{n+1} = x_n - \frac{f(x_n)}{f'(x_n)}$$

Here, 
$$f(x_o) = f(3) = 3 - \ln 3 - 2 = 1 - \ln 3$$

$$f'(x) = 1 - \frac{1}{x} \Rightarrow f'(x_o) = f'(3) = \frac{2}{3}$$

$\therefore$ 
$$x_1 = 3 - \frac{(1 - \ln 3)}{2/3} = 3 - \frac{3}{2}(1 - \ln 3)$$

○○○○