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**ESE 2026 : Prelims Exam | GS & ENGINEERING
CLASSROOM TEST SERIES | APTITUDE**
Test 3
Section A : Basics of Energy and Environment [All Topics]

Section B : Basic of Material Science [All Topics]

Section C : Engineering Mathematics + Reasoning & Aptitude [All Topics]

Answer Key

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

Section A : Basics of Energy and Environment

1. (a)
 - The gradual and fairly predictable change in the species composition of a given area is called ecological succession.
 - A 'sere' refers to a sequence of communities that change overtime through the process of ecological succession, from pioneer species to a stable climax community.
 - Ecological Succession leads to an establishment of a relatively stable community that is in near equilibrium with the environment and is called climax community.
2. (d)
 - Ecotone is a zone of junction between two or more diverse ecosystems. For e.g. the mangrove forests represent an ecotone between marine and terrestrial ecosystem.
 - Ecotone also appear where one body of water meets another (e.g., estuaries and lagoons) or at the boundary between the water and the land (e.g., marshes, river bank etc.).
 - It has the conditions intermediate to the adjacent ecosystems. Hence, it is a zone of transition.
 - It is linear as it shows progressive increase in species composition of one in coming community and a simultaneous decrease in species of the other outgoing adjoining community.
 - It may be very narrow or quite wide.
3. (d)
4. (d)
 - The Montreux Record lists wetlands; whether or not lakes.
 - The Montreux Record is a register of wetland sites on the List of Wetlands of International Importance where changes in ecological character have occurred, are occurring, or are likely to occur as a result of technological developments, pollution or other human interference. It is maintained as part of the Ramsar List.
 - Chilika lake (Odisha) was placed in the record in 1993, and was removed from it in 2002 following the rehabilitation efforts of the government.
5. (a)
 - The functional characteristics of a species in its habitat are referred to as "niche" in that common habitat. Habitat of a species is like its 'address' (i.e. where it lives) whereas niche can be thought of as its "profession" (i.e. activities and responses specific to the species).
 - The term niche means the sum of all the activities and relationships of a species by which it uses the resources in its habitat for its survival and reproduction.
 - A niche is unique for a species while many species share the habitat.
 - No two species in a habitat can have the same niche. This is because if two species occupy the same niche they will compete with one another until one is displaced.
6. (b)
 - In bioaccumulation, there is an increase in the concentration of a pollutant from the environment to the first organism in a food chain.
 - Biomagnification can occur only if the pollutant is fat-soluble.

- In bioaccumulation, there is an increase in the concentration of a pollutant from the environment to the first organism in a food chain. Thus, it refers to how pollutants enter a food chain.
- In Biomagnification, there is an increase in the concentration of a pollutant from one trophic level to another.
- Condition for bioaccumulation is the high level of pollutants in the environment.
- Condition for bio-magnifications is that pollutants must be fat-soluble, long-lived, biologically active, etc.

7. (a)

Characteristics of human modified ecosystems:

- Highly simplified.
- Species diversity is very low.
- Food chains are simple and small.
- Depend on human (anthropogenic) support for survival; need for fossil fuel energy, fertilizers, irrigation etc.
- Attract large number of weeds.
- More susceptible to epidemic diseases.
- Suffer from soil erosion.
- Highly unstable.

8. (a)

The process by which zooplankton species cope up with external environmental conditions is known as diapause.

9. (c)

- A core zone secures legal protection and management and research activities that do not affect natural processes and wildlife are allowed.
- Destructive sampling for scientific investigations is prohibited.
- Strict nature reserves and wilderness portions of the area are designated as core areas of Biosphere Reserve. The core zone is to be kept free from all human pressures external to the system.

10. (d)

- Launched in 1971, UNESCO's Man and the Biosphere Programme (MAB) is an Intergovernmental Scientific Programme that aims to establish a scientific basis for the improvement of relationships between people and their environments.
- MAB is funded through the regular budget of UNESCO and mobilizes funds-in-trust granted by Member States, bilateral and multilateral sources, and extra-budgetary funds provided by countries, the private sector and private institutions.
- MAB-related activities are nationally financed. The Programme can grant seed funding to assist countries in developing projects and/or to secure appropriate partnership contributions.
- The first biosphere reserve of the world was established in 1979.

11. (c)

- Genetic diversity refers to any variation in the nucleotide, gene, chromosome or whole genome of the organism.
- According to Williams and Humphries, it is the currency of diversity.
- Approximately 1 billion of genes have been recognised from all the species on the earth.
- Genetic diversity is the key for the survival of any species with changing environmental factors.
- Two major sources of genetic diversity are mutation and sexual reproduction (meiotic cell division).
- Genetic diversity in a species ensures the success of only that particular species which may impact other species in the region either positively or negatively.

12. (b)

- In general, species diversity decreases as we move away from the equator towards the poles. With very few exceptions, tropics (latitudinal range of 23.5° N to 23.5° S) harbour more species than temperate or polar areas. Tropics are also known as optimum Biome.

13. (b)

Ocean Acidification

- Increase in CO₂ concentrations not only leads to warmer oceans but also to more acidic oceans.
- As the uptake of atmospheric carbon dioxide by the ocean increases, the concentration of hydrogen ions in the ocean increases, the concentration of carbonate ions decreases, the pH of the oceans decreases and the oceans become less alkaline – this process is known as ocean acidification.
- Carbonic acid reacts with carbonate ions in the water to form bicarbonates. Ocean Acidification will convert more carbonate ions (which are required for shell-building by marine organisms) into bicarbonates, the animals need to expend more energy to build their shells. As a result, the shells end up being thinner and more fragile.

14. (a)

Environmental Impact Assessment (EIA)

- It started in 1976-77 when the Planning Commission asked the Department of Science and Technology to examine the river-valley projects from an environmental angle.
- Till 1994, environmental clearance from the Central Government was an administrative decision and lacked legislative support.
- On 27 January 1994, the then Union Ministry of Environment and Forests, under the Environmental (Protection) Act 1986, promulgated an EIA notification making Environmental Clearance (EC) mandatory for expansion or modernization of any activity or for setting up new projects listed in Schedule 1 of the notification.
- The Ministry of Environment, Forests and Climate Change (MoEFCC) notified new EIA legislation in September 2006.
- Environmental Impact Assessment (EIA) is a process of evaluating the likely environmental impacts of a proposed project or development, taking into account inter-related socio-economic, cultural and human-health impacts, both beneficial and adverse.

15. (a)

16. (c)

- Ozone (O_3) is a gas that occurs both in the Earth's upper atmosphere and at ground level. Ozone can be "good" or "bad" for the health and the environment, depending on its location in the atmosphere.
- Ground level or "bad" ozone is an air pollutant that is harmful to breathe and it damages crops, trees and other vegetation. It is a main ingredient of urban smog.
- Ground-level ozone is not emitted directly into the air, but is created by chemical reactions between oxides of nitrogen (NO_x) and volatile organic compounds (VOC) in the presence of sunlight. Emissions from industrial facilities and electric utilities, motor vehicle exhaust, gasoline vapors, and chemical solvents are some of the major sources of NO_x and VOC.

17. (b)

Shale gas consists of 70 to 90% of Methane gas.

18. (c)

19. (d)

20. (a)

Incineration is not considered a chemical process that converts biomass to useful products because it primarily burns biomass to generate heat, essentially destroying the biomass rather than converting it into a useful product.

21. (c)

- Blue hydrogen is produced when natural gas is split into hydrogen and carbon dioxide.
- Green hydrogen is produced when hydrogen is produced by splitting water by electrolysis.
- Brown hydrogen is formed through coal gasification.

22. (b)

- Desert plants show phenomenon of Allelopathy i.e. they secrete some chemical substance which inhibits the growth of plants growing in their near vicinity.
- Succulent plants store water in fleshy leaves, stems or roots. All cacti are succulents, as are such non-cactus desert dwellers as agave, aloe, elephant trees, and many euphorbias.
- A succulent must be able to absorb large quantities of water in short periods.
- Desert rains are often light and brief, and the soil dries rapidly under an intense sun. To cope with these conditions, nearly all succulents have extensive, shallow root systems.

23. (a)

- Primary succession takes place over a bare or unoccupied areas such as rocks outcrop, newly formed deltas and sand dunes, emerging volcano islands and lava flows as well as glacial moraines (muddy area exposed by a retreating glacier) where no community has existed previously.
- The plants that invade first bare land, where soil is initially absent are called pioneer species.

The assemblage of pioneer plants is collectively called pioneer community. A pioneer species generally show high growth rate but short life span.

- Primary succession is much more difficult to observe than secondary succession because there are relatively very few places on earth that do not already have communities of organisms.
- Furthermore, primary succession takes a very long time as compared to secondary succession as the soil is to be formed during primary succession while secondary succession starts in an area where soil is already present.

24. (d)

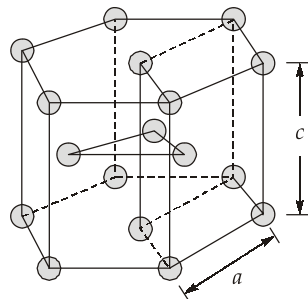
- Nutrient cycle of an ecosystem is not unidirectional. They are recycled back to physical environment.
- The nutrient cycle is a concept that describes how nutrients move from the physical environment to the living organisms, and subsequently recycled back to the physical environment.
- This movement of nutrients from the environment into plants and animals and again back to the environment is essential for life and it is the vital function of the ecology of any region.
- Based on the replacement period a nutrient cycle is referred to as a Perfect or Imperfect cycle.
- A perfect nutrient cycle is one in which nutrients are replaced as fast as they are utilized.
- Most gaseous cycles are generally considered as perfect cycles.

25. (c)

- Methane's short atmospheric lifetime means taking action now can quickly reduce atmospheric concentrations and result in similarly rapid reductions in climate forcing and ozone pollution.

Section B : Basics of Material Science

26. (d)



HCP crystal structure : a and c represent short and long dimensions, respectively. The c/a ratio should be 1.633, whereas for some HCP metals this ratio deviates from the ideal value.

27. (d)

Gray Cast irons do have some desirable characteristics and in fact are utilized extensively. They are very effective in damping vibrational energy, Base structures for machines and heavy equipments that are exposed to vibrations are frequently constructed of this material. In addition, gray iron exhibit a high resistance to wear. And most importantly, gray cast irons are among the least expensive of all metallic materials.

28. (d)

Test

Brinell hardness test

Vickers hardness test

Knoop hardness test

Rockwell and Superficial Rockwell hardness test

Indenter

10 mm sphere of steel or tungsten carbide

Pyramidal diamond

Pyramidal diamond

Diamond cone; Steel spheres

29. (c)

Given, diameter of the indenter, $D = 20$ mm; $HB = 500$; Load applied, $P = 400\pi$ kg

$$\therefore HB = \frac{2P}{\pi D \left[D - \sqrt{D^2 - d^2} \right]}$$

$$500 = \frac{2 \times 400\pi}{\pi \times 20 \left[20 - \sqrt{20^2 - d^2} \right]}$$

$$\Rightarrow \sqrt{20^2 - d^2} = 20 - 0.08 = 19.92$$

$$\Rightarrow d^2 = 20^2 - 19.92^2 = (20 + 19.92)(20 - 19.92)$$

$$d = \sqrt{0.08 \times 39.92} = 1.787 \text{ mm} \simeq 1.8 \text{ mm}$$

30. (b)

Glass-ceramic materials have been designed to have the following characteristics : Relatively high mechanical strength, low coefficient of thermal expansion (to avoid thermal shock), relatively high temperature capabilities, good dielectric properties (for electronic packaging) and good biological Compatibility. Some glass- ceramics may be made optically transparent, others are opaque.

31. (d)

We know that,

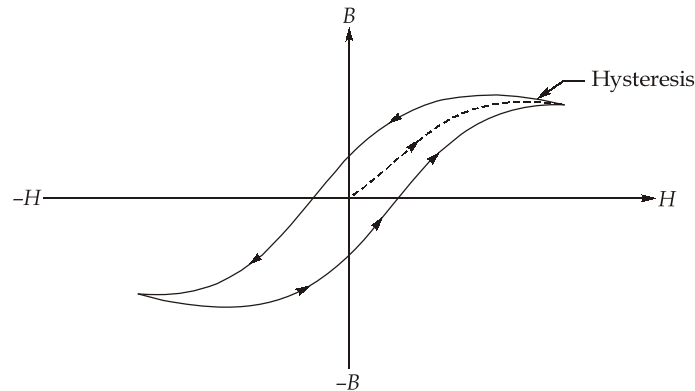
$$DP = \frac{M_n}{m}$$

Given: $M_n = 22500$ g/molRepeat unit molecular weight, $m = 2(12) + 3(1) + 35.5 = 62.5$ g/mol

$$\therefore DP = \frac{22500}{62.5} = 360$$

32. (b)

When a magnetic material is subjected to a cycle of magnetization, then the flux density (B) linked to the material lags behind the magnetizing force (H).



33. (d)

(d) is incorrect because a hole itself represents an empty state. Holes can move (i.e., contribute to current) without requiring additional empty levels-only the presence of holes is enough for acceleration under an electric field.

34. (a)

At the Curie temperature, a ferromagnetic material loses its magnetism because the magnetic domains become randomly oriented due to heat. As a result, saturation magnetization becomes zero.

35. (b)

When a material becomes superconducting, it expels magnetic field lines from its interior, also known as the Meissner effect.

36. (c)

A ferromagnetic material is one in which the atomic magnetic moments of the atoms align parallel to each other in the same direction, even without an external magnetic field.

37. (d)

- The resistivity of metallic conductors generally increases with increasing temperature because the thermal vibrations of the metal ions increase, making it more difficult for the electrons to move through the material.
 - Tungsten is commonly used as a resistance wire because it has high resistivity and a very high melting point.
 - A superconducting material has zero electrical resistance below its critical temperature.
- All the three statements are correct.

38. (d)

Diffusion also occurs for pure metals, but all atoms exchanging positions are of the same type, this is termed self-diffusion. Thus, self diffusion is not normally subject to observation by noting compositional changes.

Section C : Engineering Mathematics + Reasoning & Aptitude

39. (b)

The least possible dimension of cube is LCM of 2, 3, 4 = 12

$$\text{Number of cuboids that can be obtained} = \frac{12 \times 12 \times 12}{2 \times 3 \times 4} = 72$$

40. (c)

We have to find average cost, so we can take,

$$C_1 = 35, C_2 = 45$$

$$\text{Now, } W_1 = 15, W_2 = 10$$

$$\text{So, Average cost} = \frac{W_1 C_1 + W_2 C_2}{W_1 + W_2}$$

$$\begin{aligned} \text{The average cost of mixture} &= \frac{15 \times 35 + 10 \times 45}{15 + 10} = \frac{525 + 450}{25} \\ &= ₹39 \text{ per kg} \end{aligned}$$

41. (d)

$$x = y^a = (z^b)^a = z^{ab} = (x^c)^{ab} = x^{abc}$$

$$\therefore abc = 1$$

42. (a)

Let numerator be x and denominator be y .

$$\text{then, } x = y - 4$$

$$\text{Also, it is given that } 8(x - 2) = y + 1$$

The above equations can be written as

$$y - x = 4 \quad \dots(i)$$

$$8x - y = 17 \quad \dots(ii)$$

$$\Rightarrow x = 3 \text{ and } y = 7$$

$$\text{Hence, the required fraction } \frac{x}{y} = \frac{3}{7}.$$

43. (c)

$$3 \times 2 - 1 = 5$$

$$5 \times 2 - 2 = 8$$

$$8 \times 2 - 3 = 13$$

$$13 \times 2 - 4 = 22$$

$$22 \times 2 - 5 = 39$$

44. (b)

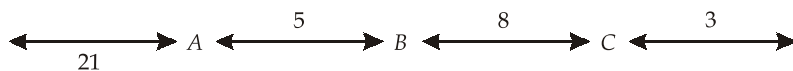
The numbers from 11 to 50, which are divisible by 7 are 14, 21, 28, 35, 42, 49.

But out of these, 21 and 42 are divisible by 3.

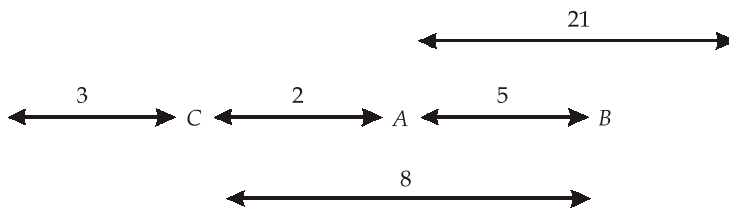
∴ Required numbers are 14, 28, 35, 49.

45. (b)

Condition I



Condition II



∴ For minimum number of persons, we consider condition II

Minimum number of persons in the queue = 3 + 1 + 2 + 1 + 21 = 28

46. (c)

Two - dimensional heat flow equation ; $\frac{\partial^2 u}{\partial t^2} = c^2 \left(\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} \right) = 0$

47. (b)

We have a deck of 52 cards; probability of drawing the queen of clubs in one trial is $p = \frac{1}{52}$. For

$n = 156$ independent trials, the poisson approximation parameter is

$$\lambda = np = 156 \times \frac{1}{52} = 3$$

$$\begin{aligned} \text{Probability of at least one success} &= 1 - P(0) \\ &= 1 - e^{-\lambda} = 1 - e^{-3} \end{aligned}$$

48. (a)

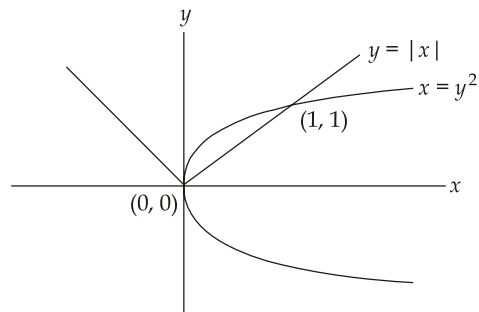
$$\text{div}(\vec{V}) = \frac{\partial V_1}{\partial x} + \frac{\partial V_2}{\partial y} + \frac{\partial V_3}{\partial z}$$

$$\text{div}(\vec{V}) = 4xy + 3x + 10z$$

At (0, 2, 1),

$$\begin{aligned} \text{div}(\vec{V}) &= 4 \times 0 \times 2 + 3 \times 0 + 10 \times 1 \\ &= 10 \end{aligned}$$

49. (a)



The two curves $y = x^2$ and $y = |x|$ intersect at $(0, 0)$ and $(1, 1)$. Thus,

$$\begin{aligned} \text{Required area} &= \int_0^1 (\sqrt{x} - x) dx \\ &= \left[\frac{2}{3} x^{3/2} - \frac{x^2}{2} \right]_0^1 \\ &= \frac{2}{3} - \frac{1}{2} = \frac{1}{6} \end{aligned}$$

50. (a)

Let x = Number of heads

Considering binomial distribution, $n = 4$, $p = \frac{1}{2}$, $q = \frac{1}{2}$

Required probability = $P(x = 3)$

$$= {}^4C_3 \left(\frac{1}{2}\right)^3 \left(\frac{1}{2}\right)^1 = \frac{1}{4}$$

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