DETAILED SOLUTIONS

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ESE 2022 : Prelims Exam | GS & ENGINEERING APTITUDE

CLASSROOM TEST SERIES

Test 3

Section A : Basics of Energy and Environment **[All topics]**

Section B : Basics of Material Science **[All topics]**

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

ANSWER KEY

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

*Q.41 [*Answer Key has been Updated*]

*Q.42 [*Marks to All*]

DETAILED EXPLANATIONS

1. (b)

The NGT deals with civil cases under the seven laws related to the environment, these include:

- The Water (Prevention and Control of Pollution) Act, 1974,
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- The Forest (Conservation) Act, 1980,
- The Air (Prevention and Control of Pollution) Act, 1981,
- The Environment (Protection) Act, 1986,
- The Public Liability Insurance Act, 1991 and
- The Biological Diversity Act, 2002.

Any violation pertaining to these laws or any decision taken by the Government under these laws can be challenged before the NGT.

2. (d)

In naturalism, there is no net benefit or harm to either species. Perhaps in some inter-specific interactions, the costs and benefits experienced by each partner are exactly the same so that they sum to zero.

3. (b)

Primary production is defined as the amount of biomass or organic matter produced per unit area over a time period by plants during photosynthesis. It is expressed in terms of weight or energy. The rate of biomass production is called productivity.

4. (b)

- Bioventing is an in-situ remediation technology that uses microorganisms to biodegrade organic constituents adsorbed on soils in the unsaturated zone.
- Bioventing enhances the activity of indigenous bacteria and simulates the natural in-situ biodegradation of hydrocarbons in soil by inducing air or oxygen flow into the unsaturated zone and, if necessary, by adding nutrients.

5. (a)

- Global Learning and Observation to Benefit the Environment (GLOBE) is an international environmental science and education programme that brings students, teachers and scientists together to study the global environment.
- GLOBE is sponsored by the U.S. National Aeronautics and Space Administration (NASA) with support from the National Science Foundation (NSF), National Oceanic and Atmospheric Administration (NOAA) and Department of State. Internationally, GLOBE is implemented through government-to- government agreements with each country partner responsible for in-country activities.

6. (c)

- **Radiatively Active Gas:** A term used to describe a gas occurring naturally or produced anthropogenically that affects atmospheric radiation by absorption or emission.
- The outgoing long wave infrared radiation is absorbed by the GHGs. The atmosphere radiates back part of this energy to the earth. This downward flux of radiation is called the greenhouse flux. It keeps the earth warm.
- The atmospheric lifetime of CFC ranges from 45 years to 260 years. While that of Methane is about 12 years.

7. (b)

- The Government has notified the Plastic Waste Management Rules, 2016, in suppression of the earlier Plastic Waste (Management and Handling) Rules, 2011.
- The Plastic Waste Management Rules, 2016 aim to: Increase minimum thickness of plastic carry bags from 40 to 50 microns and stipulate minimum thickness of 50 micron for plastic sheets also to facilitate the collection and recycling of plastic waste, Expand the jurisdiction of applicability from the municipal area to rural areas, because plastic has reached rural areas also; To bring in the responsibilities of producers and generators, both in plastic waste management system and to introduce collect back system of plastic waste by the producers/brand owners, as per extended producers responsibility.

8. (c)

Bioremediation is the use of living organisms, primarily microorganisms to degrade environmental contaminants or pollutants into less toxic forms. It uses naturally occurring bacteria and fungi or plants to degrade or detoxify substances hazardous to human health and the environment.

9. (a)

- Nutrient Cycles are of two types: (a) gaseous and (b) sedimentary. The reservoir for gaseous type of nutrient cycle (e.g., nitrogen, carbon cycle) exists in the atmosphere and for the sedimentary cycle (e.g., sulphur and phosphorus cycle), the reservoir is located in Earth's crust.
- The function of the reservoir is to meet with the deficit which occurs due to an imbalance in the rate of influx and efflux and therein lies the difference between Carbon and Phosphorus Cycle.
- Unlike the carbon cycle, there is no respiratory release of phosphorus into the atmosphere. Also, atmospheric inputs of phosphorus through rainfall are much smaller than carbon inputs and Gaseous exchange of phosphorus between organism and environment are negligible compared to carbon.

10. (a)

Ecotones often have a larger number of species and larger population densities than the communities on either side. This tendency for increased biodiversity within the ecotone is referred to as the "edge effect." Those species which occur primarily or most abundantly in the ecotones are called "edge" species.

11. (c)

Hydroponics Method: It is a method of growing plants without soil in which plants get their nutrients from a mineral solution. The method is suitable for growing greens and herbs as they don't have deep roots. Tomatoes and strawberries are other popular items.

12. (b)

- The Rotterdam convention was adopted in 1998 by a conference of Plenipotentiaries in Rotterdam, Netherlands and entered into force on 24th February 2004.
- The Convention covers pesticides and industrial chemicals that have been banned or severely restricted for health or environmental reasons by parties and which have been notified by parties for inclusion in the PIC procedure.

13. (c)

- Habitat is the physical environment in which an organism lives (address of an organism). Many habitats make up the environment.
- A single habitat may be common for more than one organism which have similar requirements. For example, a single aquatic habitat may support a fish, frog, crab, phytoplankton and many others.

15. (c)

- Water pollution is the addition/presence of undesirable substances to/in water such as organic, inorganic, biological, radiological, heat, which degrades the quality of water so that it becomes unfit for use'.
- Natural sources of pollution of water are soil erosion, leaching of minerals from rocks (due to natural solubility and solubility triggered by acid rain) and decaying of organic matter.

16. (a)

- Desertification, along with climate change and the loss of biodiversity were identified as the greatest challenges to sustainable development during the 1992 Rio Earth Summit. Adopted in 1994, United Nations Convention to Combat Desertification (UNCCD) entered into force in 1996 and became a legally binding international agreement linking environment and development to sustainable land management.
- India became a signatory to UNCCD on 14th October 1994 and ratified it on 17th December 1996.

17. (c)

- Renewable Energy Certificate (REC) is a policy instrument to catalyze the development of renewable energy. It is a market-based mechanism which will help the states meet their regulatory requirements (such as Renewable Purchase Obligations (RPOs)) by overcoming the geographical constraints on existing renewable potential in different states.
- Renewable Energy Certificates (RECs), also known as green energy certificates or tradable renewable certificates which are proof that energy has been generated from renewable sources such as solar or wind power.
- Each REC represents the environmental benefits of 1MWh of renewable energy generation. When you purchase RECs, renewable energy is generated on your behalf.

18. (b)

- 'Global stocktake' refers to a proposed five-yearly review of the impact of countries' climate change actions. Under the Paris Agreement, every country must present a climate action plan in five-yearly cycles. It is supposed to be similar to the plan countries submitted in the run-up to the talks that concluded last week.
- Under the Paris Agreement, the first global stocktake will happen in 2023.

19. (b)

Under Intended Nationally Determined Contributions (INDCs), India's target consists of:

- Produce 40 percent of electricity from non-fossil fuel based energy resources by 2030, if the international community helps with technology transfer and low cost finance.
- Create an additional carbon sink of 2.5 to 3 billion tonnes of carbon dioxide equivalent by 2030 through additional forest and tree cover.
- Develop robust adaptation strategies for agriculture, water and health sectors.
- Reduce emission intensity by 33 to 35 percent by 2030 compared to 2005 levels.

21. (c)

- Species diversity is defined as the number and abundance of different species that occupy a location. Species diversity increases the number of links in the food web.
- There can be various reasons for the stability of the ecosystem because of species diversity: Increased food web diversity increases the resilience of the system to outside invasions of exotic organisms and reduces the fluctuation in the population within a given ecosystem.

23. (c)

- The hydrologic cycle is a conceptual model that describes the storage and movement of water between the biosphere, atmosphere, lithosphere, and the hydrosphere.
- Water moves from one reservoir to another by way of processes like evaporation, condensation, precipitation, deposition, runoff, infiltration, sublimation, transpiration, melting, and groundwater flow.

27. (a)

For demand, $r = \frac{\sqrt{3}a}{8}, \qquad N = 8$

$$\text{APF}\% = \frac{8 \times \frac{4\pi}{3}\left(\frac{\sqrt{3}a}{8}\right)^3}{a^3} = \frac{\sqrt{3}}{16}\pi = 34\%$$

28. (c)

To identify generation of dislocations.

Frank-Reed mechanism explains the generation of multiple dislocations in specific well spaced slip planes in crystals when they are deformed.

29. (b)

1 and 4 only

$\Rightarrow \qquad x = \mu_r - 1$

$\Rightarrow$ Magnetic susceptibility can be negative also.

30. (c)

The tetrahedral coordination of SiO_4^{4-} satisfies the directionality requirement of covalent bonding and radius ratio requirement of ionic bonding.

34. (d)

Resilience of material plays important role while choosing material for springs.

35. (b)

White cast iron has low fluidity.

39. (b)

$$[D] = [A][B] + [C] = \begin{bmatrix} 2 & 5 \\ 3 & 2 \\ 1 & 0 \end{bmatrix} \times \begin{bmatrix} 7 & 0 & 1 \\ 5 & 1 & 4 \end{bmatrix} + \begin{bmatrix} 3 & 1 & 0 \\ 2 & 2 & 3 \\ 4 & 7 & 6 \end{bmatrix}$$

$$[D] \Rightarrow [D] = \begin{bmatrix} 39 & 5 & 22 \\ 31 & 2 & 11 \\ 7 & 0 & 1 \end{bmatrix} + \begin{bmatrix} 3 & 1 & 0 \\ 2 & 2 & 3 \\ 4 & 7 & 6 \end{bmatrix}$$

$$[D] = \begin{bmatrix} 42 & 6 & 22 \\ 33 & 4 & 14 \\ 11 & 7 & 7 \end{bmatrix}$$

Product of eigen values $= |D| = 42\,(28 - 98) - 6\,(33 \times 7 - 14 \times 11) + 22\,(33 \times 7 - 11 \times 4) = 712$

40. (a)

$$\sec U = \left[\frac{x^{\frac{1}{3}} + y^{\frac{1}{3}}}{x^{\frac{1}{4}} + y^{\frac{1}{4}}}\right]^{\frac{1}{2}} = f(x,y)$$

$$f(tx, ty) = \left[\frac{t^{\frac{1}{3}} x^{\frac{1}{3}} + t^{\frac{1}{3}} y^{\frac{1}{3}}}{t^{\frac{1}{4}} x^{\frac{1}{4}} + t^{\frac{1}{4}} y^{\frac{1}{4}}}\right]^{\frac{1}{2}}$$

$$f(tx, ty) = t^{\frac{1}{24}} f(x,y)$$

Thus $f(x, y)$ is homogeneous function,

Let, $f(U) = \sec U$

$f'(U) = \sec U \tan U$

$$g(U) = \frac{1}{24}\frac{f(U)}{f'(U)} = \frac{1}{24}\cot U$$

$$\Rightarrow \quad x^2\frac{\partial^2 U}{\partial x^2} + 2xy\frac{\partial^2 U}{\partial x \partial y} + y^2\frac{\partial^2 U}{\partial y^2} = g(U)\,[g'(U) - 1]$$

$$= \frac{1}{24}\cot U\left[\frac{1}{24}\left(-\operatorname{cosec}^2 U\right) - 1\right]$$

$$= -\frac{1}{576}\cot U\left[\left(\cot^2 U + 1\right) + 24\right]$$

$$= -\frac{\cot U}{576}\left[\cot^2 U + 25\right]$$

41. (c)

$[x] = x + \{x\}$ Where $\{x\}$ is fractional part of x.

$$\lim_{n\to\infty}\frac{x + 2x + 3x + ...nx + \{x\} + \{2x\} + \{3x\} + ...\{nx\}}{n^2}$$

$$= \lim_{n\to\infty}\frac{x(1 + 2 + 3...n) + \{x\} + \{2x\} + ...\{nx\}}{n^2}$$

$$= \lim_{n\to\infty}\frac{x(1 + 2 + 3 + ...n)}{n^2} + \lim_{n\to\infty}\frac{\{x\} + \{2x\} + ...\{nx\}}{n^2}$$

Since $\{x\}$ is $t[0, 1]$ i.e. it is a finite quantity

On solving

$$= \lim_{n\to\infty}\frac{xn(n+1)}{2n^2} + 0$$

$$= \frac{x}{2}$$

42. (b)

Newton's iterative formula,

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

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

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

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

43. (b)

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

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

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

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

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

44. (b)

Probability of occurrence of exactly one of A or B is

$$P(A)P(\overline{B}) + P(\overline{A})P(B) = \frac{3}{4}$$

$$x(1-y) + y(1-x) = \frac{3}{4}$$

$$x - xy + y - xy = \frac{3}{4}$$

$$4x + 4y - 8xy = 3$$

45. (c)

$$f(x) = x^5 - 13x^4 + 14x^3 - 10x^2 + 6x + 10$$

$$f(12) = 12^5 - 13 \times 12^4 + 14 \times 12^3 - 10 \times 12^2 + 6 \times 12 + 10$$

$$f(12) = 12^5 - (12 \times 12^4 + 12^4) + (12 \times 12^3 + 2 \times 12^3) - (12 \times 12^2 - 2 \times 12^2) + 72 + 10$$

$$f(12) = 12^5 - 12^5 - 12^4 + 12^4 + 2 \times 12^3 - 12^3 + 2 \times 12^2 + 72 + 10$$

$$f(12) = 12^3 + 288 + 82$$

$$f(12) = 2098$$

46. (a)

$$x = \frac{1}{\sqrt{7}+\sqrt{5}} \text{ and } y = \frac{1}{\sqrt{7}-\sqrt{5}}$$

$$y = \frac{\sqrt{7}+\sqrt{5}}{7-5} = \frac{\sqrt{7}+\sqrt{5}}{2}$$

$$y = \frac{1}{2x}$$

$$= \frac{1}{8x^3+1} + \frac{1}{y^3+1} = \frac{1}{8x^3+1} + \frac{1}{\left(\frac{1}{2x}\right)^3+1}$$

$$= \frac{1}{8x^3+1} + \frac{8x^3}{1+8x^3} = \frac{1+8x^3}{1+8x^3} = 1$$

47. (d)

At 4 'O' clock the hour hand is at 4 and the minute hand is at 12, i.e. they are 20 min spaces apart. To be together, the minute hand must gain 20 min over the hour hand.

Now, 55 minutes are gained by it in 60 min

$\therefore$ 20 min will be gained in $\frac{60}{55} \times 20 = 21\frac{9}{11}$ min. The hands will coincide at $21\frac{9}{11}$ min. past 4.

48. (c)

$$\frac{149}{5} + \frac{149}{25} + \frac{149}{125} + \frac{149}{625} + \ldots\ldots\ldots$$

29 + 5 + 1 + 0 = 35 zeros

49. (a)

By BODMAS

$$6 - \left[4 \div 3 \times \overline{5-2}\right][6 - 3 \times 2 \div 3]$$

$$= 6 - \left[\frac{4}{3} \times 3\right][6 - 2]$$

$$= 6 - 16 = -10$$

50. (a)

Let the first number be n, then the other three numbers will be $\frac{n}{2}, \frac{n}{3}$ and $\frac{n}{4}$

$$150 = \frac{n + \frac{n}{2} + \frac{n}{3} + \frac{n}{4}}{4}$$

$$150 = \frac{12n + 6n + 4n + 3n}{48} = \frac{25n}{48}$$

$$n = 288$$

$$\text{Smallest number} = \frac{288}{4} = 72$$

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