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**Test Centres:** Delhi, Noida, Hyderabad, Bhopal, Jaipur, Lucknow, Bhubaneswar, Indore, Pune, Kolkata, Patna**ESE 2020 : Prelims Exam**  
CLASSROOM TEST SERIES**GENERAL STUDIES**  
& **ENGG. APTITUDE****Test 3****Section A : Basics of Energy and Environment****Section B : Basics of Material Science****Section C : Engineering Mathematics + Reasoning & Aptitude**

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

**Answer with Explanation**

1. (a)
- Desertification refers to destruction of ecological or biological potential of the land which can ultimately lead to desert like conditions.  
**Causes:**
    - (i) Population pressure
    - (ii) Deforestation
    - (iii) Overgrazing, increase in cattle population
    - (iv) Increased agriculture
    - (v) Development activities
  - Established in 1994, the United Nations Convention to Combat Desertification (UNCCD) is the sole legally binding international agreement linking environment and development to sustainable land management.  
The Convention addresses specifically the arid, semi-arid and dry sub-humid areas, known as the drylands, where some of the most vulnerable ecosystems and people can be found.  
India is one of the parties of UNCCD and ratified this convention on 17 December 1996.  
India hosted Conference of Parties (COP-14) from 2 to 13 September, 2019 in New Delhi.
2. (b)
- Methanogenesis or Biomethanation is a process by which organic material is microbiologically converted under anaerobic conditions to methane-rich biogas. Biomethanation has strong potential for the production of energy from organic residues and wastes. It helps to reduce the use of fossil fuels and thus reduce CO<sub>2</sub> emission.
  - Composting is an aerobic method (i.e. it requires the presence of air) of decomposing organic solid wastes.
  - Incineration: In this process, waste is directly burned in the presence of excess air (oxygen) at high temperatures.
  - Pyrolysis: It is a process of chemical decomposition of organic matter brought about by heat.
3. (b)
- Most of the renewable sources of energy are fairly non-polluting and considered clean but biomass though a renewable source, is a major contributor of indoor pollution.
  - Ministry of New and Renewable Energy (MNRE) has set a target of installing 175 GW of renewable energy capacity by the year 2022, which includes 100 GW from solar, 60 GW from wind, 10 GW from bio-power and 5 GW from small hydro-power.
  - Government of India allows up to 100% Foreign Direct Investment (FDI) under the automatic route for projects of renewable power generation and distribution.
4. (c)
- Environmental Impact Assessment (EIA) has been made mandatory under the Environment (Protection) Act, 1986 for 29 categories of developmental activities including mining, hydel power projects, infrastructure, thermal power projects, etc. Not all industries are required to conduct EIA.

- Strategic Environmental Assessment (SEA) refers to systematic analysis of the environmental effects of development policies, plans, programmes and other proposed strategic actions. SEA takes place at earlier stages of decision-making cycle.

5. (b)

**Types of biotic interaction:**

- **Mutualism:** Both species get benefitted.
- **Commensalism:** One species get benefitted while the other is unaffected.
- **Competition:** Both species are harmed by the interaction.
- **Predation and parasitism:** One species get benefitted while the other is harmed.
- **Amensalism:** One species is harmed while the other is unaffected.
- **Neutralism:** No net benefit or harm to either species.

6. (d)

- Green building refers as a structure or using processes that are environmentally responsible and resource-efficient throughout a building's life-cycle from design to construction, operation, maintenance, re novation and destruction.
- Green Rating for Integrated Habitat Assessment (GRIHA) is a Indian rating tool that helps people assesses the performance of their building against certain nationally acceptable benchmarks.
- LEED (Leadership in Energy and Environmental Design) is the most widely used green building rating system in the world. Available for virtually all building project types, from new construction to interior fit-outs and operation & maintenance, LEED provides a framework that project teams can apply to create, highly efficient and cost-saving green buildings.

7. (b)

- A carbon offsetting is the process of reduction in emissions of carbon dioxide or other Greenhouse gases made in order to compensate for emissions made elsewhere. Offsets are measured in tones of carbon dioxide-equivalent (CO<sub>2</sub>e).
- One tonne of carbon offset represents the reduction of one tonne of carbon dioxide or its equivalent in other Greenhouse gases.

8. (d)

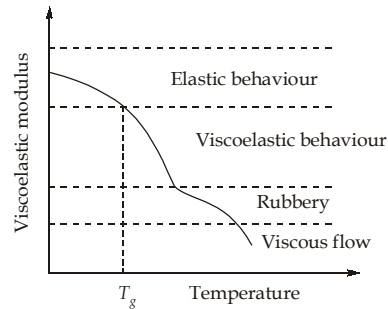
- Global Environment Facility (GEF) is an independently operating financial organization, which provides grants to developing countries for projects that benefit global environment and promote sustainable livelihoods in local communities.
- It was established on the eve of the 1992 Rio Earth Summit to help tackle Earth's most pressing environmental problems.
- GEF serves as financial mechanism for:
  - (i) Convention on Biological Diversity (CBD)
  - (ii) United Nations Framework Convention on Climate Change (UNFCCC)
  - (iii) UN Convention to Combat Desertification (UNCCD)
  - (iv) Stockholm Convention on Persistent Organic Pollutants (POPs)
  - (v) Minamata Convention on Mercury
- India is both donor and recipient of GEF.

9. (c)
- Fly Ash is one of the coal combustion products, composed of the fine particles that are driven out of the boiler with the flue gases.
  - Fly Ash is generally captured by electrostatic precipitators or other particle filtration equipment before the flue gases reach the chimneys.
  - Depending upon the source and makeup of the coal being burned, the components of Fly Ash vary considerably, but all Fly Ash includes substantial amounts of silicon dioxide ( $\text{SiO}_2$ ), aluminium oxide ( $\text{Al}_2\text{O}_3$ ) and calcium oxide ( $\text{CaO}$ ), the main mineral compounds in coal bearing rock strata.
12. (c)
- 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 specified in Ramsar Convention, adopted in 1971 in Ramsar, Iran.
  - **Bonn Convention:** It is the Convention on the Conservation of Migratory Species of Wild Animals.
  - **Vienna Convention:** It is the Convention on the Protection of the Ozone Layer.
  - **Basel Convention:** It is the Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal.
15. (b)
- Low power production due to intermittent tides is a limitation of tidal energy.
18. (c)
- REN21 is the global renewable energy policy multi-stakeholder network that connects a wide range of key actors. It brings together governments, non-governmental organizations, research and academic institutions, international organizations and industry to learn from one another and build on successes that advance renewable energy.
19. (b)
- Bell metal is a hard alloy used for making bells and other related instruments. It is a form of bronze with higher % of tin content, approximately having 4 : 1 of copper to tin (typically, 78 to 80% copper and 20 to 22% tin by mass).
- It is hard and resistant to surface wear. It can be readily cast.
20. (b)
- Knoop hardness test used a pyramid-shaped diamond indenter.
- It is suitable for measuring hardness of small or thin specimens. That is why, it is a microhardness test.
- Since the impression made in this test is generally very small, considerable care must be taken in preparing the surface.

21. (b)

At low temperature, thermoplastic polymer shows elastic behaviour. As temperature increases above the glass transition temperature ( $T_g$ ), the polymer becomes visco-elastic.

As temperature increases further, it becomes soft and rubbery. At still higher temperatures, it exhibits viscous characteristics.



24. (c)

Steel bar is added in the reinforced concrete, so steel bar is not the ingredient of Portland cement concrete.

26. (d)

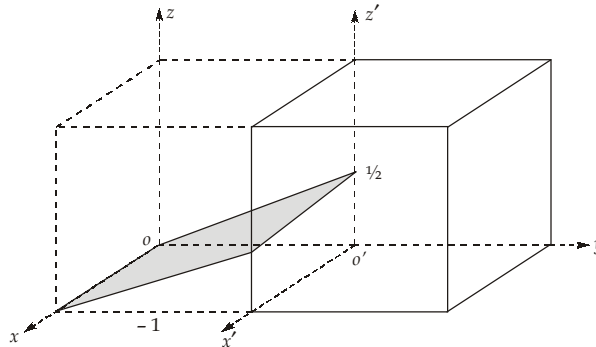
Reinforcement technique for strengthening concrete involves:

Introduction of residual compressive stresses into the structural member, the resulting material is called pre-stressed concrete. This method utilizes one characteristic of brittle ceramics—namely, that they are stronger in compression than in tension. Thus, to fracture a pre-stressed concrete member, the magnitude of the pre-compressive stress must be exceeded by an applied tensile stress.

In one such pre-stressing technique, high-strength steel wires are positioned inside the empty molds and stretched with a higher tensile force, which is maintained constant. After the concrete has been placed and allowed to harden, the tension is released. As the wires contract, they put the structure in a state of compression because the stress is transmitted to the concrete via the concrete-wire bond that is formed.

27. (d)

Since the plane passes through origin  $O$ , a new origin must be chosen at the corner of an adjacent unit cell, taken as  $O'$ .



	$x$	$y$	$z$
Intercept	$\infty$	$-1$	$1/2$
Reciprocals	$0$	$-1$	$2$
Enclosure	$(0 \bar{1} 2)$		

28. (d)

Muntz metal  $\rightarrow$  60% Copper and 40% Zinc

German silver  $\rightarrow$  60% Copper, 30% Nickel and 10% Zinc

Gun metal  $\rightarrow$  88% Copper, 10% Tin and 2% Zinc

**White metal:** White metals are any of several light colored alloys used as a base for plated silverware, ornaments or novelties.

White metal alloys are generally made up of antimony, tin, cadmium, bismuth and zinc, though which ones being used vary based on the need.

30. (a)

$$\text{Loss} = \frac{1}{2} \epsilon_0 \epsilon_r'' \omega E_0^2$$

So,  $\text{loss} \propto \omega$

$\therefore$  Loss increases as  $\omega$  increases.

31. (b)

$$\chi(\text{susceptibility}) \propto \frac{1}{\text{Temperature}}$$

As  $T$  increases,  $\chi$  decreases, so these losses their magnetic properties.

33. (c)

In semiconductor current flow due to drift and diffusion. Displacement current flows in a dielectric or (conductor not perfect) under alternative field.

35. (a)

Alloy has less regular structure than a metal because of which conductivity of alloy decreases with increase in alloy content and resistivity of alloy increases in comparison to metal.

36. (b)

Using determinants,

$$\text{The area of the given triangle} = \frac{1}{2} \begin{vmatrix} -3 & 5 & 1 \\ 3 & -6 & 1 \\ 7 & 2 & 1 \end{vmatrix}$$

Applying  $R_1 \rightarrow R_1 - R_2$  and  $R_2 \rightarrow R_2 - R_3$

$$= \frac{1}{2} \begin{vmatrix} -6 & 11 & 0 \\ -4 & -8 & 0 \\ 7 & 2 & 1 \end{vmatrix}$$

$$= \frac{1}{2} \times 1 \begin{vmatrix} -6 & 11 \\ -4 & -8 \end{vmatrix}$$

$$= \frac{1}{2} (48 + 44) = 46 \text{ sq. units.}$$

37. (a)

Given,

$$r = a(1 - \cos\theta) \quad \dots(1)$$

Differentiating (1) with respect to  $\theta$ ,

$$\text{We get} \quad \frac{dr}{d\theta} = a \sin\theta \quad \dots(2)$$

Dividing (2) by (1) to eliminate a, we get

$$\frac{1}{r} \frac{dr}{d\theta} = \frac{\sin\theta}{1 - \cos\theta} = \frac{2 \sin \frac{\theta}{2} \cos \frac{\theta}{2}}{1 - 1 + 2 \sin^2 \frac{\theta}{2}}$$

$$\frac{1}{r} \frac{dr}{d\theta} = \cot \frac{\theta}{2} \quad \dots(3)$$

Replacing  $\frac{dr}{d\theta}$  by  $-r^2 \frac{d\theta}{dr}$

$$\frac{1}{r} \left( -r^2 \frac{d\theta}{dr} \right) = \cot \frac{\theta}{2}$$

Separating the variables we get

$$\frac{dr}{r} = -\tan \frac{\theta}{2} d\theta \quad \dots(4)$$

Integrating (4), we get

$$\ln r = 2 \ln \cos \frac{\theta}{2} + \ln C$$

$$r = C \cos^2 \frac{\theta}{2}$$

or

$$r = \frac{C}{2}(1 + \cos \theta)$$

38. (c)

Let us convert the given integral into spherical polar co-ordinates.

By putting  $x = r \sin \theta \cos \phi$ ;  $y = r \sin \theta \sin \phi$ ,  $z = r \cos \theta$

$$\begin{aligned} \iiint (x^2 + y^2 + z^2) dx dy dz &= \int_0^{2\pi} \int_0^{\pi} \int_0^1 r^2 (r^2 \sin \theta d\theta d\phi dr) \\ &= \int_0^{2\pi} d\phi \int_0^{\pi} \sin \theta d\theta \int_0^1 r^4 dr \\ &= [\phi]_0^{2\pi} [-\cos \theta]_0^{\pi} \left[ \frac{r^5}{5} \right]_0^1 = 2\pi \times 2 \times \frac{1}{5} = \frac{4\pi}{5} \end{aligned}$$

39. (c)

Statement (1) and (3) are correct.

If  $f(z)$  is an analytic function and  $f'(z)$  is continuous at each point within and on the boundary of closed curve  $C$ , then  $\oint_C f(z) dz = 0$ .

40. (b)

$$\text{Probability of drawing two black balls} = \frac{10C_2}{20C_2}$$

$$\text{Probability of drawing two white balls} = \frac{10C_2}{20C_2}$$

$$\text{Probability of drawing two balls of the same colour} = \frac{10C_2}{20C_2} + \frac{10C_2}{20C_2}$$

$$= \frac{2 \times 10C_2}{20C_2} = \frac{2 \times \frac{10 \times 9}{2 \times 1}}{\frac{20 \times 19}{2 \times 1}} = \frac{9}{19}$$



41. (a)

Let  $x = \sqrt[k]{N}$

or  $x^k - N = 0$

Taking  $f(x) = x^k - N$

We have  $f'(x) = kx^{k-1}$

Then Newton-Raphson's formula gives

$$\begin{aligned} x_{n+1} &= x_n - \frac{f(x_n)}{f'(x_n)} = x_n - \frac{x_n^k - N}{kx_n^{k-1}} \\ &= \frac{1}{k} \left[ (k-1)x_n + \frac{N}{x_n^{k-1}} \right] \end{aligned}$$

42. (c)

Characteristics equation,

$$|A - \lambda I| = 0$$

$$\begin{vmatrix} 1-\lambda & 2 & -3 \\ 0 & 3-\lambda & 2 \\ 0 & 0 & -2-\lambda \end{vmatrix} = 0$$

$$\Rightarrow (1 - \lambda)(3 - \lambda)(-2 - \lambda) = 0$$

or  $\lambda = 1, 3 \text{ and } -2$

Eigen values of  $A^3 = 1, 27, -8$

Eigen values of  $A^2 = 1, 9, 4$

Eigen values of  $A = 1, 3, -2$

Eigen values of  $I = 1, 1, 1$

Eigen values of matrix  $B$ .

First eigen value =  $3(1)^3 + 5(1)^2 - 6(1) + 2(1) = 4$

Second eigen value =  $3(27) + 5(9) - 6(3) + 2(1) = 110$

Third eigen value =  $3(-8) + 5(4) - 6(-2) + 2(1) = 10$

The determinant of matrix  $B = \text{Product of eigen values} = 4 \times 110 \times 10 = 4400$

43. (b)

Width of the patio is 5 m greater than the width of the walkway.

So, width of the Patio =  $5 + x$  (since  $x$  is the width of the walkway)

To get the area of the walkway, we need to subtract the area of the patio from the bigger square.

Area of patio =  $(5 + x)^2$

Side of the bigger square =  $x + x + (5 + x) = 5 + 3x$

So, area of the bigger square is =  $(5 + 3x)^2$

Hence,  $132 = (3x + 5)^2 - (x + 5)^2$

$$132 = (9x^2 + 30x + 25) - (x^2 + 10x + 25)$$

$$132 = 9x^2 + 30x + 25 - x^2 - 10x - 25$$

$$132 = 8x^2 + 20x$$

$$\begin{aligned} \Rightarrow & 8x^2 + 20x - 132 = 0 \\ \Rightarrow & 2x^2 + 5x - 33 = 0 \\ \Rightarrow & x = 3 \text{ or } x = -5.5 \\ \text{Width of patio} & = x + 5 = 8 \text{ m} \\ \therefore & \text{Area of patio} = 8^2 = 64 \text{ m}^2 \end{aligned}$$

44. (c)

$$\text{Work done by Anita and Renu in 10 days} = 10 \left( \frac{1}{25} + \frac{1}{20} \right) = \frac{9}{10}$$

Thus, in 10 days working together they will complete only 90% of the work.

Hence, the remaining work will surely be done by Sonali, which is 10%.

Thus, Sonali will get 10% of ₹ 700, which is ₹ 70.

45. (d)

Clock loses: 1 minute in 3 hours = 8 minutes in 24 hours = 32 minutes in 4 days.

Clock gains: 1% in the subsequent 6 days = 1% in  $6 \times 24 \times 60$  minutes = 86.40 minutes in 6 days;

$$\text{Net gain in 10 days} = 86.40 - 32 = 54.4 \text{ minutes}$$

$$11 \text{ AM} + 54.4 \text{ minutes} = 11:54 \text{ and } 4/10\text{th of a minute or } 24 \text{ seconds.}$$

46. (c)

The bowl originally (i.e., before the 1 cup of nuts is added) contains 2 cups of nuts, of which  $\frac{2}{3}$  cup is peanuts,  $\frac{2}{3}$  cup is cashews, and  $\frac{2}{3}$  cup is almonds.

When the 1 cup of nuts is added,  $\frac{1}{2}$  cup of peanuts and  $\frac{1}{2}$  cup of cashews are added. Therefore,

now we have  $\frac{2}{3} + \frac{1}{2} = \frac{4}{6} + \frac{3}{6} = \frac{7}{6}$  cups of peanuts in the resulting 3-cup mixture of nuts. So now we have  $\frac{(7/6)}{3} = \frac{7}{18}$  of the nut mixture as peanuts.

47. (d)

The smallest number of identical cubes that can fit into the box without any space left unfilled is one with an edge that is the greatest common factor (GCF) of the three dimensions of the box. Since the dimensions of the box are 54, 36 and 12, their GCF is 6. We should fit 6-inch cubes inside the box, and the number of cubes we can fit is:

$$\frac{(54 \times 36 \times 12)}{(6 \times 6 \times 6)} = 9 \times 6 \times 2 = 108$$

48. (b)

The average speed (including stoppages) is 45 km/hr

$$\text{Distance} = \text{rate} \times \text{time}$$

So, in ONE hour, the distance travelled =  $45 \times 1 = 45$  km

The average speed (excluding stoppage) is 54 km/hr

At this speed, HOW long will it take the bus travel 45 km?

$$\text{time} = \frac{\text{distance}}{\text{rate}}$$

So, 
$$\text{time} = \frac{45}{54} = \frac{5}{6} \text{ hours} = 50 \text{ minutes}$$

At a speed of 54 km/hr, the bus can travel 45 km every 50 minutes.

So, it must be motionless for 10 minutes.

49. (d)

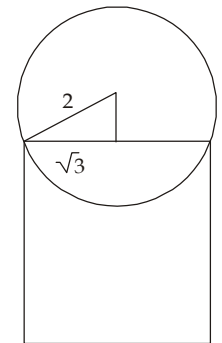
The volume of a cylinder is  $\pi \times r^2 \times 3 = 9\pi$

$$r = \sqrt{3} \text{ cm}$$

Radius of the ball is 2 cm.

Using Pythagoras theorem, the other leg will be 1 cm.

Thus, the height will be  $3 + 1 + 2 = 6$  cm



50. (c)

