

**MADE EASY**

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Test Centres: Delhi, Hyderabad, Bhopal, Jaipur, Pune, Kolkata**ESE 2025 : Prelims Exam** | **GS & ENGINEERING**
CLASSROOM TEST SERIES | **APTITUDE****Test 5****Section A :** General Principles of Design, Drawing, Importance of Safety [All Topics]**Section B :** Basics of Energy and Environment [All Topics]**Section C :** Basics of Material Science [All Topics]**Answer Key**

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

Section A : General Principles of Design, Drawing, Importance of Safety

1. (c)

Rules for dimensioning:

1. Do not repeat the same dimension in different views.
2. Centre line itself shall not be used as a dimension line with arrowheads at its end.
3. Location of holes shall be dimensioned in the view in which holes are visible.
4. Mark the dimensions outside the view.
5. A circle shall be dimensioned by its diameter symbol ϕ .
6. Dimension line with arrowheads at its ends.

2. (c)

The framework for working a QFD program is called as house of Quality (HOQ). It is a matrix, which displays the inter-relationship between customer need and technical know-how.

3. (a)

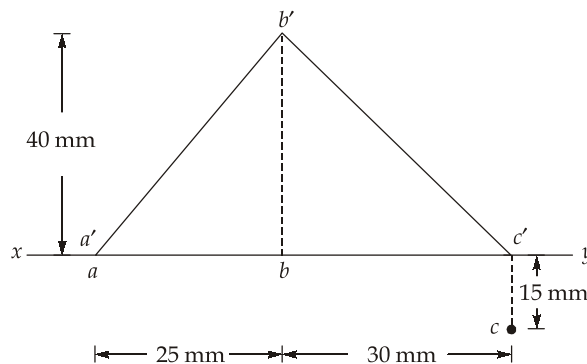
Oblong method is primarily used for drawing an ellipse in engineering drawing where we construct the ellipse by first drawing a rectangle that encompasses the desired ellipse shape, then dividing the sides and connecting points to create the curve.

4. (d)

We know that,

$$\begin{aligned} \text{R.F. of the scale of the map} &= \sqrt{\frac{\text{Area of drawing}}{\text{Actual area of land}}} \\ &= \sqrt{\frac{4 \text{ sq.cm}}{0.64 \times 10^4 \text{ sq.m}}} = \sqrt{\frac{4 \times 10^{-4} \text{ sq.m}}{64 \times 100 \text{ sq.m}}} \\ &= \sqrt{\frac{1}{16000000}} \\ \text{R.F.} &= \frac{1}{4000} \end{aligned}$$

5. (d)



$$\begin{aligned}
 \text{According to question, } a'b' + b'c' &= \sqrt{25^2 + 40^2} + \sqrt{30^2 + 40^2} \\
 &= \sqrt{2225} + \sqrt{2500} \\
 &= 47.17 + 50 \\
 &= 97.17 \text{ mm}
 \end{aligned}$$

6. (d)

Parallel line method : It is used for the development of prism and cylinders or solids that have parallel top and bottom surfaces.

Radial line method : This method is adopted for the development of pyramids and cones or solids that radially converge to the apex or vertex.

Triangular method : This method is adopted for the development of transition pieces that connect two different sizes and shapes.

Approximate method : This method is used to draw the development of double curved or warped surface such as hemisphere, sphere, ellipsoid, etc.

7. (c)

Orthographic projection : When the projector are parallel to each other and also perpendicular to the plane, the projection formed is known as orthographic projection.

Isometric projection : If all the three mutually perpendicular edges of the 3D object are making equal inclinations with the plane of projection, then the projection formed is known as isometric projection.

Trimetric projection : If all the three mutually perpendicular edges of a 3D object are inclined at different angle with the plane of projection, then the projection formed is known as trimetric projection.

Dimetric projection : If two of the three mutually perpendicular edge of the 3D object make equal inclination with the plane of projection, then the projection formed is known as dimetric projection.

8. (d)

COPY command : It is used to copy an object or a group of objects.

MIRROR command : It is used to create the mirror image copy of an object or a group of objects.

REGEN command : It is used to regenerate the complete drawing.

9. (b)

10. (a)

11. (b)

Contents of first air box :

- One snake bite lancet
- One pair of scissors
- Twelve rolled bandages 10 cm wide
- Eye drops
- Tincture of iodine
- A bottle (500 ml) of hydrogen peroxide

12. (a)

Direct losses

- Compensation paid to the worker.
- Medical expenses incurred on the worker.
- Money spent to reinstate the situation.

Indirect losses

- Loss of time of the injured person.
- Loss of time of supervisors/foremen.
- Loss due to damage caused to machines.

13. (d)

Principles laid down by ISI :

- Standards for proper layout, proper lighting and ventilation of factory building.
- Specifications for protective clothing, safety helmets, face shields, and safety equipments for eyes, lungs, hands, feet and legs.
- Safety codes for handling acids and other chemicals.
- Safety precautions to be taken during manufacturing operations.
- Standards and specifications of safe industrial operations and practices.
- Safety requirements for person protective equipment.

14. (a)

- A child, who has not completed 14 years, shall not be allowed to work in any factory.
- A child who has completed 14 years or an adolescent shall not be allowed to work unless a certificate of fitness is granted to him/her.
- An adolescent, who has been granted a certificate of fitness to work in a factory shall be deemed to be an adult.
- No child (14 to 17 years) shall be permitted to work for more than 4½ hours in a day and he/she will also in any case not be allowed to work in the night (10 pm to 7 am).

15. (d)

Expecters : Basic attributes that one would expect to seen in the product.**Spoken** : Specific features that customers say they want in product.**Unspoken** : Product attributes that the customers does not generally talk about, but they remain important to him or her.

16. (c)

For a continuously operating process, the dimension of the room are really irrelevant to the solution. It is true that for a short duration exposure the size of the room will affect the dilution of the chlorobenzene within the confines of the room but to deal with a continuous process, one must provide sufficient ventilation to yield an ample supply of makeup air to continuously dilute the chlorobenzene to levels within limits, regardless of room size.

Let x = the total ventilation necessary to dilute the chlorobenzene,

then,

$$\frac{2}{x} = \frac{75}{1000000}$$

$$x = \frac{2 \times 1000000}{75} = 26667 \text{ ft}^3/\text{hour}$$

$$x = \frac{26667}{60} \text{ ft}^3/\text{min}$$

$$x = 444 \text{ ft}^3/\text{min}$$

17. (a)

CO₂ → For class B and Class C fire
Foam → For class A and Class B fire
Water → For class A fire

18. (a)

Adoption : This is area of developing a product for which the market is already existing.

Invention : This is an area of innovation and doing something new which others have not done so far.

Modular design : Modular are common components grouped together in one interchangeable sub-assembly. Concept of modular design is very helpful in providing variety to the customers.

19. (d)

Some limitations of standardisation are as follows:

- Difficulty to undertake charges.
- Reduction in variety and limits on customized product.
- Stagnation in innovation.
- Chances that competitors may quickly develop similar product, standardised.

20. (a)

21. (d)

Four Elements of Concurrent Engineering:

1. Voice of customer (customer focus).
2. Multidisciplinary teams (team work; focus on producibility and supportability).
3. Automated tools (automation, CAD/CAM integration; at product development stage, evolve "build-to" technical data package).
4. Process management (Evolve process, plan it and stabilize it in parallel, while the product is being developed).

22. (c)

- **Decision under certainty** : Each action results in known outcome with probability.
- **Decision under uncertainty** : Each outcome has an assigned probability of occurrence.
- **Decision under risk**: Each action result in multiple outcomes, with probability unknown.
- **Decision under conflict** : Outcomes are replaced by course of action determined by opponent who is trying to maximize his/her objective function.

23. (d)

24. (b)

In every factory:

- Every hoist and lift should be of sound mechanical construction with adequate strength. They have to be properly maintained and thoroughly checked regularly. It should be marked with safe maximum load and should not be overloaded.
- Hoists and lifts used for carrying persons should have at least 2 ropes or chains separately connected with the cage and balance weight and each rope/chain with its attachment should be capable of carrying the weight of the cage together with its maximum load.
- Every hoist way and lift way must be adequately protected by enclosures or fitted with gates.

25. (c)

Weighting criteria is used in design evaluation method.

Section B : Basics of Energy & Environment

26. (d)

Biomass can be converted into electric power through several methods:

- **Combustion of biomass material:** The most common is direct combustion of biomass material, such as agricultural waste or wood materials.
- **Gasification:** It produces a synthesis gas with usable energy content by heating the biomass with less oxygen than needed for complete combustion.
- **Pyrolysis:** In this process, the biomass is rapidly heated in the absence of oxygen.
- Bioventing and Biosparging are methods of Bioremediation.

27. (c)

- Ecological Succession is the process by which the composition and structure of a biological community evolve over time in response to the changing environmental conditions.
- During ecological succession, some species colonize an area whereas populations of other species decline and even disappear. The entire sequence of communities that successively change in a given area is called sere. The individual transitional communities are termed seral stages or seral communities. These changes lead finally to a community that is in near equilibrium with the environment and that is called a climax community.

28. (d)

- The Minamata Convention on Mercury is a global treaty to protect human health and the environment from the adverse effects of mercury and its compounds.
- India has ratified the Minamata Convention.

29. (d)

- **Alpha diversity:** It refers to the diversity within a particular area or ecosystem, and is usually expressed by the number of species (i.e., species richness) in that ecosystem.
- **Beta diversity:** It is a comparison of diversity between ecosystems, usually measured as the change in amount of species between the ecosystems
- **Gamma diversity:** It is a measure of the overall diversity for the different ecosystems within a region.

30. (a)
- Detritus food chain starts from the dead organic matter such as dead bodies of animals or fallen leaves, which are eaten by microorganisms and then followed by detritus feeding organisms (detritivores) and their predators.
 - Unlike the grazing food chain, the detritus food chain produces a large amount of energy. This type of food chain ensures maximum utilization and minimum wastage of the available material. It is useful in the fixation of inorganic nutrients and utilizing them up to the maximum.
31. (a)
- Environmental Impact Assessment (EIA) in India is statutorily backed by the Environment Protection Act, 1986 which contains various provisions on EIA methodology and process.
 - The EIA report is prepared by the project proponent, and is evaluated by the Expert Appraisal Committee (EAC) of the MoEFCC.
 - Public hearings for Environmental Impact Assessments (EIAs) are typically conducted after the EIA report has been completed and is available for review.
32. (a)
- The amount of oxygen required by bacteria to break down the organic matter present in a certain volume of a sample of water is called Biochemical Oxygen Demand (BOD).
 - The amount of BOD in the water is a measure of the amount of organic material in the water, in terms of how much oxygen will be required to break it down biologically.
 - Clean water would have a BOD value of less than 5 ppm whereas highly polluted water could have a BOD value of 17 ppm or more.
 - Chemical pollutants are not included in Biochemical Oxygen Demand (BOD).
33. (b)
- **Ecotone:** It is the zone of transition between two ecosystems.
 - **Habitat:** It is the surroundings in which an organism lives.
34. (a)
35. (d)
- Adopted in 1987, the Montreal Protocol is a worldwide agreement to stop the production of substances causing ozone-depletion.
 - **Kigali Amendment to the Protocol:** Parties to the Montreal Protocol agreed to phase down production and consumption of Hydrofluorocarbons, commonly known as HFCs.
 - India is not a signatory to the Gothenburg Protocol.
36. (d)
- Bio-CNG is a renewable fuel obtained by purifying biogas, in contrast to Compressed Natural Gas (CNG) which is a non-renewable source of energy.
 - It is similar to natural gas in terms of its composition and properties and is a cleaner alternative to fuels such as petrol and diesel.

37. (c)
- 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.
 - Primary Productivity depends on the plant species inhabiting a particular area. It also depends on a variety of environmental factors, availability of nutrients and photosynthetic capacity of plants.
 - Despite occupying about 70 percent of the surface, the productivity of the oceans is only 55 billion tons, which is lower compared to that of land.
38. (b)
- A carbon credit is a credit for greenhouse emissions reduced or removed from the atmosphere by an emission reduction project.
 - A carbon market turns emission reductions and removals into tradable assets, thus creating incentives to reduce emissions or improve energy efficiency.
 - Carbon credits are based on the “cap-and-trade” model that was used to reduce sulfur pollution in the 1990s.

Section C : Basics of Material Science

39. (c)
- BCC : Li, Na, K, Rb, Cs, Fr, Cr, Fe (α iron and δ -iron), Mo, Nb, Ta, W, V, Zr, Ti
 FCC : Al, Cu, Ni, Ag, Pt, Fe (γ -iron), Th, Pt
 HCP : Be, Cd, Co, Mg, Ti, Zn, Zr, He
40. (d)
- On heating the crystals to a high temperature many dislocations are either annihilated among themselves or driven out of the crystal surfaces. Other way to remove dislocations include careful control of various parameters during crystallization process and changing the form of crystalline material. Normally, the materials are in bulk form. If they could be produced as whiskers, dislocation density will decrease immensely. Thus, all the given statements are correct.
41. (a)
- The three slip systems present in HCP metals are basal, prismatic and pyramidal.
- | Crystal structures | Metals | No. of slip systems |
|--------------------|--------------------|---------------------|
| FCC | Al, Cu, Ni, Ag, Pt | $12 = 6 \times 2$ |
| BCC | Fe, W, V, G, Mo | $12 = 4 \times 3$ |
| HCP | Mg, Co, Zn, Ti, Zr | $3 = 3 \times 1$ |
42. (c)
- Due to its speed of measurement, freedom from personal errors, small size of indentation and ability to distinguish small hardness differences, Rockwell hardness test is most widely used.
43. (c)
- The ductile-to-brittle transition temperature is the temperature below which the test specimen will start to become more brittle than ductile.

- Face-centered cubic materials do not have any ductile-to-brittle transition and instead remain ductile at low temperatures.
- BCC and HCP structured alloys experience a ductile-to brittle transition, which is sensitive to alloy composition and microstructure. Hence, option (c) is correct.

44. (c)

Martensite, although hard, is quite brittle and impractical for most uses. However, its toughness can be greatly improved by tempering. Tempering is done at temperature between 200°C and 650°C to release some of the carbon trapped at the interstitial sites of the bcc crystal and thereby relax the lattice strain. The main purpose of tempering martensite in steel is to relieve internal stresses, and improve toughness.

45. (b)

Given:

$$\epsilon_r = 4.8$$

$$\tan \delta = 0.001$$

$$f = 50 \text{ Hz}$$

$$E = 60 \text{ kV/cm}$$

$$\begin{aligned} \text{Power absorbed per unit volume, } W &= \frac{E^2 f \epsilon_r \tan \delta}{1.8 \times 10^{12}} \text{ W/cm}^3 \\ &= \frac{(60 \times 10^3)^2 \times 50 \times 4.8 \times 0.001}{1.8 \times 10^{12}} \text{ W/cm}^3 \\ &= 0.48 \text{ mW/cm}^3 \end{aligned}$$

46. (d)

- A quartz crystal is a mono-crystalline form of silica (SiO_2) that exhibits piezo-electric characteristics, allowing it to resonate when an alternating voltage is applied.
- Quartz has a complex atomic structure formed by a three-dimensional network of silica tetrahedral.
- Quartz crystal is a piezoelectric material but it is not ferro electric material.

Thus, all the given statements are correct.

47. (c)

- Ferromagnetic materials possess a permanent magnetic moment in the absence of an external field and thus, exhibit large spontaneous magnetization.
- Cobalt is a ferromagnetic material and has curie temperature of about 1404 K.
- Nickel is a ferromagnetic material with curie temperature of 627 K.

48. (a)

- Ferrites are ceramic (inorganic) magnetic materials containing iron oxide as the main component.
- Ferrites have high magnetic permeability.

Ferrites have high resistivity and thus, provides low eddy current losses. Thus, statements 1 and 2 are correct.

49. (d)

The conductivity of semiconductor is given by

$$\sigma = \eta e \mu_e + p e \mu_h$$

For intrinsic semiconductor, $\eta = p = \eta_i$

Thus, Conductivity, $\sigma = \eta_i e (\mu_e + \mu_h)$

50. (c)

The Meissner's effect refers to the expulsion of magnetic fields from the interior of a superconducting material when it transitions into the superconducting state.

