

**ARCHITECTURE & PLANNING (AR)**

**Q.1 to Q. 25: Multiple Choice Questions (MCQ), carry ONE mark each (Negative Marking: for each wrong answer – 1/3)**

1. As per National Building Code of India, 2016, the function of an Automatic Rescue Device is to:
  - a. bring a stuck lift to the nearest landing level
  - b. control fire in electrical system at plenum level.
  - c. control the escape route lighting system.
  - d. trigger fire sprinkler system.

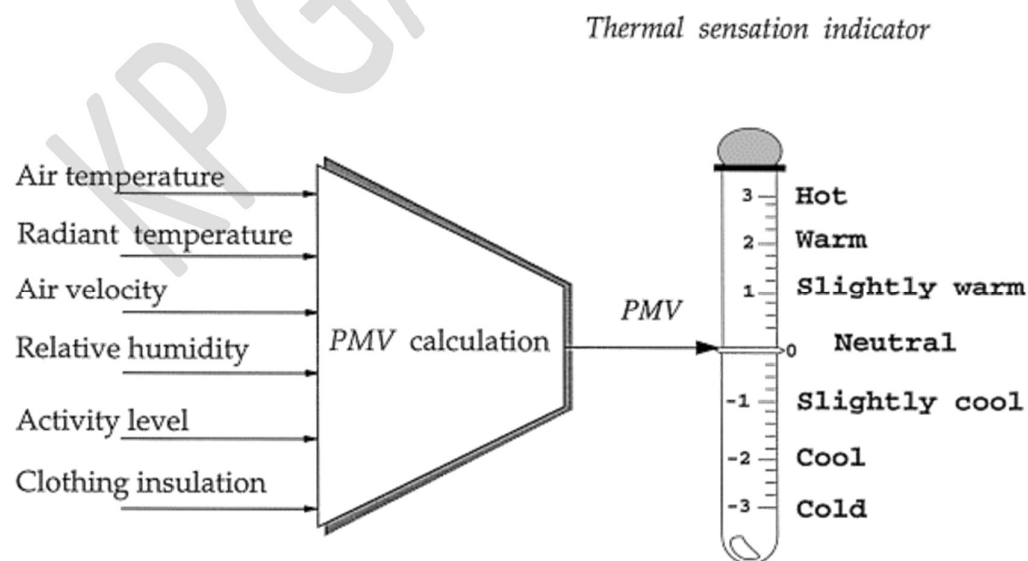
Answer: A

Explanation: Automatic Rescue Device (ARD) is a device meant to bring a lift stuck between floors due to loss of power, to the nearest landing level in either direction and open the doors in order to allow trapped passengers to be evacuated. Such a device may use some form of internal auxiliary power source for such purpose, complying with all the safety requirements of the lift during normal run. The speed of travel is usually lower than the normal speed. On reaching the level, in case of manual door lifts, the device shall allow the door to be opened and in case of power operated door lifts the device shall automatically open the door.

2. Which among the following acronyms represents a thermal comfort index?
  - a. PMV
  - b. NDVI
  - c. DEM
  - d. PCA

Answer: A

Explanation: PMV is an index that aims to predict the mean value of votes of a group of occupants on a seven-point thermal sensation scale. Thermal equilibrium is obtained when an occupant's internal heat production is the same as its heat loss.



3. Indian satellite sensor that can be used for very high resolution mapping of urban areas is
- LANDSAT.
  - CARTOSAT.
  - RESOURCESAT.
  - MODIS.

Answer: B

Explanation: Cartosat-3 is an advanced Indian Earth Observation satellite built and developed by ISRO, which will replace the IRS series. It has a panchromatic resolution of 0.25 metres making it the imaging satellite with highest resolution in the world and Mx of 1 metre with a high quality resolution which is a major improvement from the previous payloads in the Cartosat series. Potential uses include weather mapping, cartography or defence, and strategic applications.

4. What is the smallest entity of raster data used in GIS?
- Line
  - Pixel
  - Point
  - Polygon

Answer: B

Explanation: Rasters are digital aerial photographs, imagery from satellites, digital pictures, or even scanned maps. Data stored in a raster format represents real-world phenomena: Thematic data (also known as discrete) represents features such as land-use or soils data. The smallest entity of raster data is 'pixel'.

5. The correct sequence of stages during firing/burning of bricks is
- Dehydration – Oxidation – Vitrification – Cooling.
  - Vitrification – Dehydration – Oxidation – Cooling.
  - Oxidation – Dehydration – Vitrification – Cooling.
  - Cooling – Oxidation – Vitrification – Dehydration.

Answer: A

Explanation: The burning of clay may be divided into three main stages.

(1) Dehydration (400-650°C): This is also known as water smoking stage. During dehydration, the water which has been retained in the pores of the clay after drying is driven off and the clay loses its plasticity. Also, some of the carbonaceous matter is burnt and hydrous minerals like ferric hydroxide are dehydrated.

(2) Oxidation Period (650-900°C): During the oxidation period, remainder of carbon is eliminated and, the ferrous iron is oxidized to the ferric form. The removal of sulphur is completed only after the carbon has been eliminated. Sand is often added to the raw clay to produce a more open structure and thus provide escape of gases generated in burning.

(3) Vitrification – To convert the mass into glass like substance. The temperature ranges from 900-1100°C for low melting clay and 1000-1250°C for high melting clay. Great care is required in

cooling the bricks below the cherry red heat in order to avoid checking and cracking. Generally, clay products are vitrified to the point of viscosity. However, paving bricks are burnt to the stage of complete vitrification to achieve maximum hardness as well as toughness.

6. Industry Foundation Classes (IFC) in BIM is:
- a. a module used to improve energy savings
  - b. an algorithm related to the precision of the BIM model
  - c. a program based on Bezier Splines
  - d. an object oriented data model to facilitate interoperability

Answer: D

Explanation: The Industry Foundation Classes IFC specification is a neutral data format to describe, exchange and share information typically used within the building and facility management industry sector. IFC is the international standard for openBIM.

7. As per urban design principles proposed by Gordon Cullen, Rashtrapati Bhavan, New Delhi, is an example of:
- a. Serial Vision
  - b. Pinpointing
  - c. Occupied territory
  - d. Here and there

Answer: A

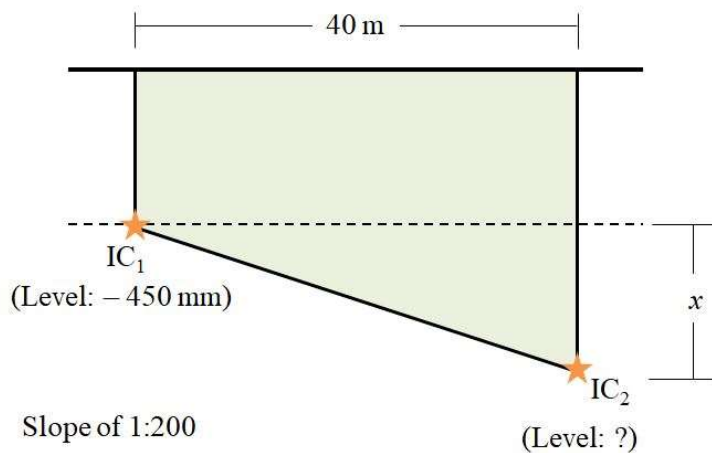
Explanation: Gordon Cullen (1961) also raised the idea of “Serial Vision”, which means people can experience a revelation of views while walking along the streets at a uniform pace. The Rajpath that leads to the Rashtrapati Bhavan has a series of visual screening as well as enhancing elements, thus, creating a progression of frames. A sense of progression is created and keeps the observer moving forward. The avenues and the water bodies confine you to the focal point and as you move forward your frame gets bigger with multiple buildings and different views. An illusion of nearness and closeness that is created in the first frame fades out as one approaches the main building in focus, revealing more and more buildings of different scales and functions. In this example, serial vision is used to suggest the majestic and authoritative nature of the building in focus.



8. A waste water pipe connecting two inspection chambers (IC) is laid at a slope of 1:200. The Invert Level of the starting IC is -450 mm. The Invert level of the second pit at a distance of 40 m from the first IC is:
- 650 mm.
  - 200 mm.
  - 250 mm.
  - 550 mm.

Answer: A

Explanation: The diagram below shows the two ICs laid at slope of 1:200;



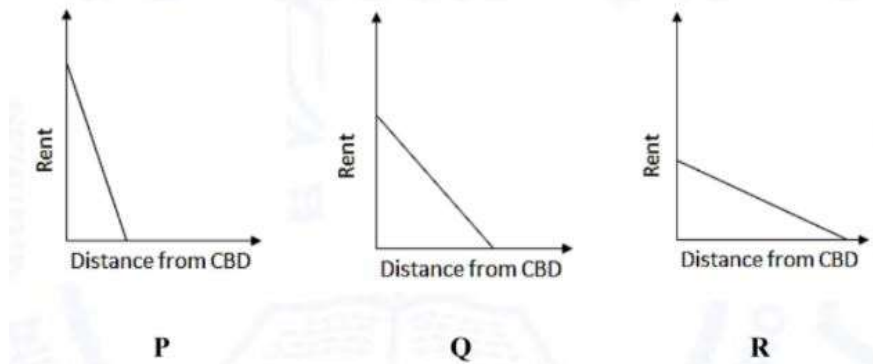
Slope is calculated as (rise/run). Here, rise = 'x' and run = 40 meters = 40,000 mm

$$\text{Slope} = \frac{\text{Rise}}{\text{Run}} \Rightarrow \frac{1}{200} = \frac{x}{40000}$$

$$\Rightarrow x = \frac{40000}{200} = 200 \text{ mm}$$

So, invert level of 2<sup>nd</sup> IC = -450 - 200 = -650 mm

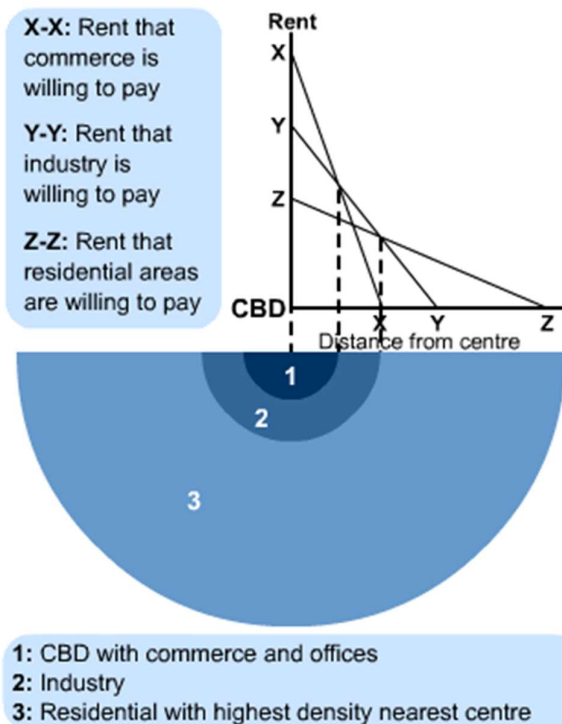
9. From the images P, Q and R given below, select the corresponding land use categories according to Alonso's Bid Rent Theory.



- a. P–Manufacturing; Q–Residential; R–Retail
- b. P–Retail; Q–Residential; R–Manufacturing
- c. P–Residential; Q–Retail; R–Manufacturing
- d. P–Retail; Q–Manufacturing; R–Residential

Answer: D

Explanation: The bid rent theory is a geographical economic theory that refers to how the price and demand for real estate change as the distance from the central business district (CBD) increases. It states that different land users will compete with one another for land close to the city centre.



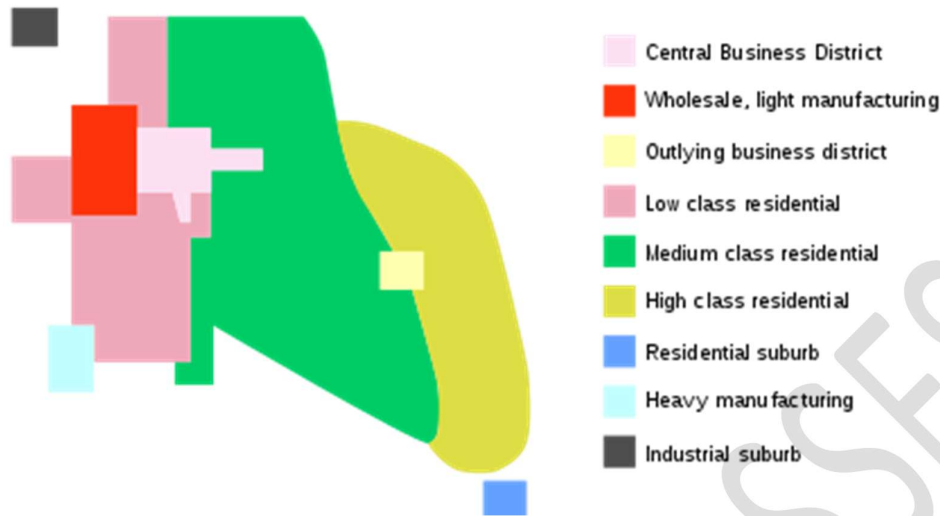
10. The urban land use model based on the concept of a polycentric city is known as:

- a. Burgess Model
- b. Harris and Ullman model
- c. Hagerstrand's Model
- d. Homer Hoyt's model

Answer: B

Explanation: Harris and Ullman argued that cities do not grow around a single nucleus but several separate nuclei. Each nucleus acts like a growth point. The theory was formed based on the idea that people have greater movement due to increased car ownership. The model is suitable for large, expanding cities.

### Harris and Ullman's Multiple Nuclei Model



11. The total head or total lift against which a pump works includes suction lift, discharge lift and:
- cone of depression
  - salvage lift
  - water horse power
  - frictional head loss

Answer: D

Explanation: Important terms related to pump are listed below;

- **Total Head:** Sum of discharge head, suction lift, and friction loss.
- **Discharge Head:** This is the vertical distance that you are able to pump liquid. For example, if your pump is rated for a maximum head of 18 feet, this does not mean that you are restricted to 18 feet of pipe. You can use 300 feet, so long as the final discharge point is not higher than 18 feet above the liquid being pumped.
- **Suction Lift:** This is the vertical distance that the pump can be above the liquid source. Typically, atmospheric pressure limits vertical suction lift of pumps to 25 feet at sea level. This does not mean that you are limited to 25 feet of pipe. You could use upwards of 300 feet of suction pipe, so long as the liquid source is not lower than 25 feet below the pump centre line.
- **Friction Head:** Pressure expressed in Lbs., required to overcome the resistance to the flow in the pipe system.

12. The two components for measuring time of concentration for storm water are:
- overland flow time and retention time
  - overland flow time and gutter flow time
  - detention time and gutter flow time
  - retention time and inlet time

Answer: B

Explanation: Time of concentration ( $t_c$ ) is the time required for an entire watershed to contribute to runoff at the point of interest for hydraulic design; this time is calculated as the time for runoff to flow from the most hydraulically remote point of the drainage area to the point under investigation. Travel time and  $t_c$  are functions of length and velocity for a particular watercourse. The total time of concentration is obtained by adding 'overland flow time' and 'gutter flow time'.

13. The traffic assignment technique where the traffic arranges itself in congested networks such that the journey time in all used routes between an Origin-Destination pair are equal and less than those that would be experienced in all unused routes. This is known as:
- System equilibrium
  - All-or-nothing
  - User equilibrium
  - Incremental

Answer: C

Explanation: John Glen Wardrop (1922–1989), born in Warwick, England, was an English mathematician and transport analyst who developed what became known as Wardrop's first and second principles of equilibrium in the field of traffic assignment. Network equilibrium models are commonly used for the prediction of traffic patterns in transportation networks that are subject to congestion.

14. What is the dependent variable in a regression based trip generation model?
- Population of Traffic Analysis Zone
  - Number of trips
  - Number of employees
  - Number of households

Answer: B

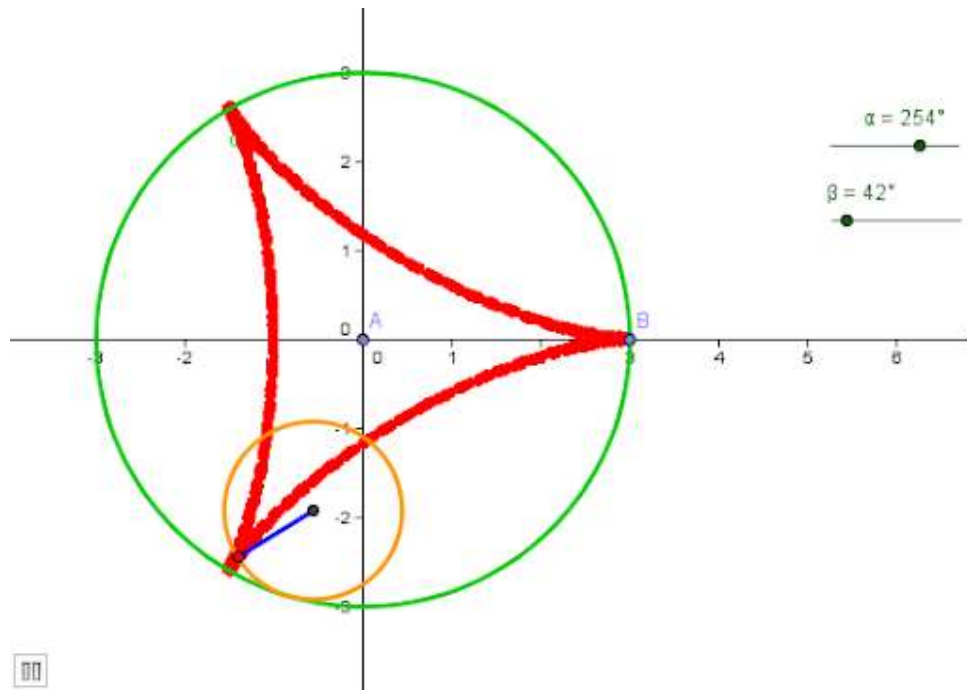
Explanation: Most trip production models are two- or three-way cross-classification tables with the dependent variable being trips per household or trips per person. The independent variables are most often income, auto ownership, and household size. The dependent variables would be the number of trip produced from each of the wards within the divided zones in the selected towns. The data pertaining to the number of trips produced from each of the ward can be obtained by conducting the socio-economic survey and forming the O-D matrix.

15. The curve traced by a point on a circle rolling inside another circle is known as:
- hypocycloid
  - helix
  - involute
  - hyperbola

Answer: A

Explanation: Hypocycloid is a curve traced by a point on the circumference of a circle which is rolling on the interior of another circle.





16. The law of Primate City was first proposed by:

- a. Samuel A. Stouffer
- b. Colin Clark
- c. Mark Jefferson
- d. Harold Hotelling

Answer: C

Explanation: A primate city is a neologism used to refer to the largest city in its country, province, state, or region, disproportionately larger than any others in the urban hierarchy. The law of the primate city was first proposed by the geographer Mark Jefferson in 1939.

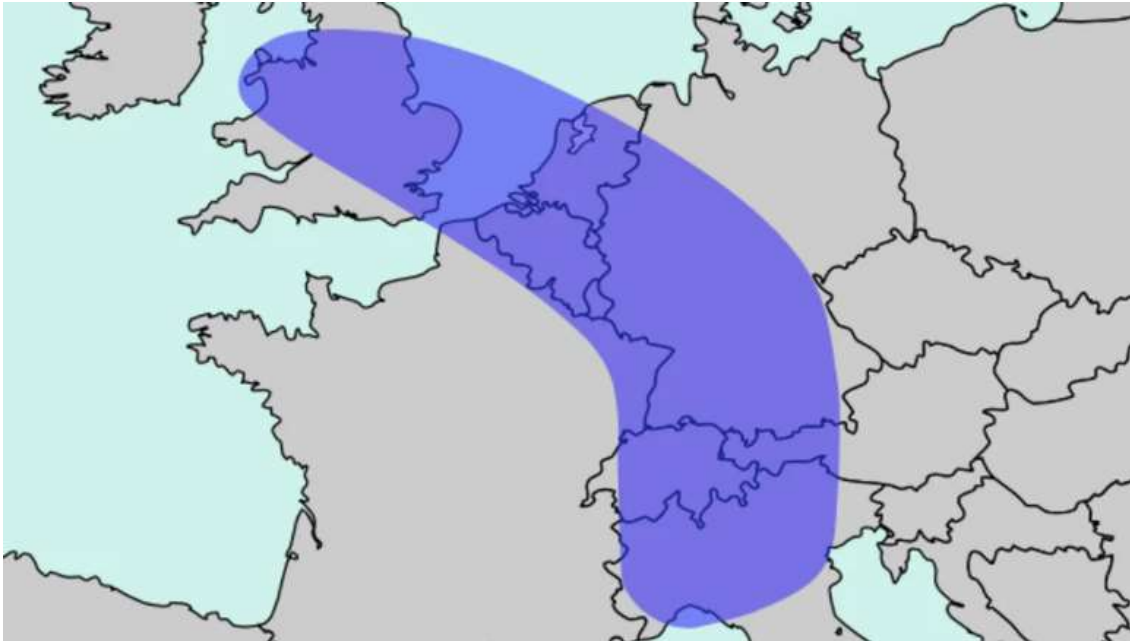
17. In the European Union which constitutes the cities namely, London, Paris, Brussels, Amsterdam, Cologne, Frankfurt, Munich and Milan, lie within a linear megalopolitan zone known as:

- a. Purple Zone
- b. Golden Polygon
- c. Blue Banana
- d. Yellow Corridor

Answer: C

Explanation: The Blue Banana (also known as the European Megalopolis or the Liverpool–Milan Axis) is a discontinuous corridor of urbanization spreading over Western and Central Europe, with a population of around 111 million. The concept was developed in 1989 by RECLUS, a group of French geographers managed by Roger Brunet.





18. An urban governance tool to mobilize financial resources by permitting additional FAR over and above the prescribed FAR by imposing a charge or fee for the same is known as:
- Betterment Levy
  - Impact Fee
  - Land Value Increment Tax
  - Floor Area Incentive Tax

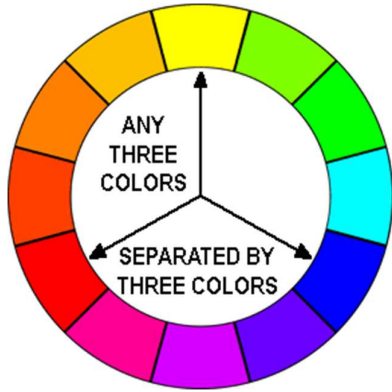
Answer: C

Explanation: Land value increment tax or betterment tax is an old land based fiscal tool that was introduced in the legislation related to city improvement trusts in the last decade of the nineteenth century. Later the concept was incorporated in the town planning schemes. Provisions also exist to capture land value increments in case of specific projects. (Source: Land Based Fiscal Tools and Practices for Generating Additional Financial Resources, August 2013; supported under Capacity Building for Urban Development project (CBUD), a partnership program between Ministry of Urban Development, Government of India & The World Bank)

19. Identify the colour palette that is created using any three equally spaced hues around the colour wheel.
- Split – complementary
  - Analogous
  - Triads
  - Complementary

Answer: C

Explanation: A triadic colour scheme is comprised of three colours evenly spaced on the colour wheel. The two most basic triadic palettes are the primary colours red, blue, and yellow and the secondary hues orange, purple, and green.



20. Coefficient of Performance (COP) for heat pump is used to calculate:

- a. the number of air changes
- b. the Energy Efficiency Ratio
- c. the Energy Select Sector index
- d. the Indoor Air Quality index

Answer: B

Explanation: Both Energy Efficiency Ratio (EER) and Coefficient of Performance (COP) indicate the ratio of heating or cooling provided by a unit relative to the amount of electrical input required to generate it. Thus, if an air conditioner generates 5kW of heat from a 1kW electrical input, its COP is said to be 5.0. The higher the COP and EER, the more energy efficient is the equipment.

21. Freight flows are converted to truck flows using:

- a. Volume factor
- b. Weight factor
- c. Payload factor
- d. Distance load factor

Answer: C

Explanation: Transportation agencies analyze highway deficiencies based on the number of vehicles traveling on highway facilities and comparing that demand to the capacity of those facilities. Freight Analysis Framework reports forecasts annual flows in tons between origins and destinations. **In truck based models:** Truck surveys are used for estimating choice parameter. **Freight flows are converted into truck flows using payload factor.** Payload factors are determined from truck surveys and weigh bridge data. (Average amount of load in different kind of vehicles can be determined by survey or weigh bridge)

22. Rebound hammer test is used to measure:

- a. permeability of concrete
- b. bond stress between rebar and concrete
- c. compressive strength of concrete
- d. tensile strength of concrete

Answer: C

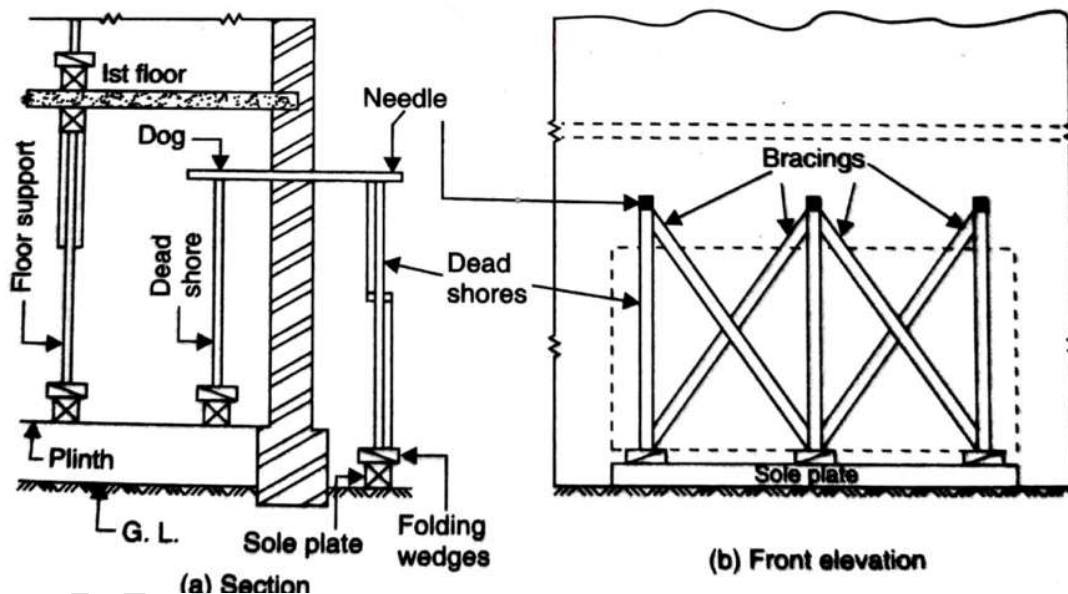
Explanation: Rebound hammer test is done to find out the compressive strength of concrete by using rebound hammer as per IS: 13311 (Part 2) - 1992. The underlying principle of the rebound hammer

test is: The rebound in the hammer is a function of the surface hardness and therefore the rebound is taken to be related to the compressive strength of the concrete.

23. Which type of temporary supporting structure can be used in case of rebuilding the lower part of a load bearing wall at ground floor above plinth level?
- Dead Shore
  - Pit Underpinning
  - Flying Shore
  - Needle Scaffolding

Answer: A

Explanation: Shoring is a temporary structure used to provide temporary support to an unsafe structure. Three types of shoring are raking shoring, flying shoring and dead shoring. Dead shoring is also called vertical shoring. It can be defined as the type of shoring which is mostly used to provide support to the wall, roofs, floors etc. particularly when the lower part of a wall has been removed to provide an additional opening in the wall or even to rebuild a defective load bearing wall in a structure. The shores that are used for such purposes are known as dead shores.



24. During earthquake, soft storey failure in a building is due to:
- shear failure initiated by short column effect
  - stress discontinuity initiated by abrupt changes of stiffness
  - failure of column initiated by weak column – strong beam effect
  - drift of building storey initiated by pounding effect

Answer: B

Explanation: A soft storey building is a multi-storey building in which one or more floors have windows, wide doors, large unobstructed commercial spaces, or other openings in places where a shear wall would normally be required for stability.



25. Following five activities are associated with construction contract management. Choose the option showing the correct progressive sequence of the activities.

- P. Opening of Bid  
 Q. Submission of Security Deposit  
 R. Publication of Notice Inviting Tender (NIT)  
 S. Issue of Letter of Intent (LOI)  
 T. Submission of Earnest Money Deposit (EMD)

- a. R – Q – P – T – S  
 b. S – P – R – T – Q  
 c. R – T – P – S – Q  
 d. S – T – P – R – Q

Answer: C

Explanation: The first step is 'Notice Inviting Tender' which is a public advertisement inviting tenders for a given project. Bidders participating in the tender process are required to submit a deposit to ensure that they do not submit dummy bids – this deposit is termed as 'earnest money deposit'. Once the bid is opened, the letter of intent is issued to the successful bidder. The successful bidder has to submit a security deposit for the contract.

**Q.26 – Q.36 Multiple Choice Question (MCQ), carry TWO mark each (for each wrong answer: – 2/3).**

26. Match the acronyms in Group I with the particulars in Group II.

Group I	Group II
P. LCA	1. building certification system
Q. IPCC	2. hydrological assessment tool
R. Mtoe	3. climate change
S. LEED	4. equivalent measure of energy expended
	5. Cradle to grave

- a. P–3, Q–5, R–4, S–2  
 b. P–4, Q–3, R–1, S–2  
 c. P–5, Q–4, R–2, S–1  
 d. P–5, Q–3, R–4, S–1

Answer: D





Explanation: Life Cycle Assessment (LCA) is a technique for assessing the potential environmental aspects and potential aspects associated with a product (or service), by: compiling an inventory of relevant inputs and outputs.

The IPCC (Intergovernmental Panel on Climate Change) was created to provide policymakers with regular scientific assessments on climate change, its implications and potential future risks, as well as to put forward adaptation and mitigation options. Through its assessments, the IPCC determines the state of knowledge on climate change.

Mtoe is an acronym that stands for million or mega tonnes of oil equivalent. The unit quantifies the amount of energy released when burning one mega tonne of crude oil.

LEED (Leadership in Energy and Environmental Design) is an internationally recognized green building certification system, providing third-party verification that a building or community was designed and built using strategies aimed at improving performance across metrics like water efficiency, energy savings, etc.

27. Match the buildings in Group I with their corresponding architect in Group II.

Group I				
				
P	Q	R	S	
Group II				
(1) Renzo Piano	(2) Daniel Libeskind	(3) David Childs	(4) Frank Owen Gehry	(5) Norman Foster

- a. P-4, Q-3, R-1, S-2
- b. P-2, Q-4, R-2, S-5
- c. P-3, Q-5, R-4, S-1
- d. P-2, Q-3, R-4, S-5

Answer: D

Explanation: Building P: Jewish Museum Building, Berlin by Daniel Libeskind

Building Q: One World Trade Center, NY by David Childs

Building R: Louis Vuitton Foundation, Paris by Frank Owen Gehry

Building S: The Gherkin, London by Norman Foster

28. Match the heritage conservation charters in Group I with their focus areas in Group II.

Group I	Group II
P. Washington Charter	1. Conservation of historic gardens
Q. Florence Charter	2. Conservation of places of cultural significance
R. Venice Charter	3. Authenticity
S. Burra Charter	4. Conservation and restoration of monuments and sites
	5. Conservation of historic towns

- a. P-3, Q-1, R-4, S-5
- b. P-5, Q-4, R-1, S-2
- c. P-5, Q-1, R-4, S-2
- d. P-4, Q-1, R-3, S-2

Answer: C

Explanation: The **Washington Charter: Charter on the Conservation of Historic Towns and Urban Areas (1987)** was adopted by the ICOMOS General Assembly, Washington DC, October, 1987. This Charter, adopted by the ICOMOS General Assembly in 1987, establishes the principles and guidelines for the protection and conservation of historic towns.

The Florence Charter sets forth the principles and guidelines for the preservation of historic gardens. It outlines strategies for maintenance, conservation, restoration, and reconstruction of gardens, including their plans, vegetation, structural and decorative features, and use of water.

The Venice Charter codifies internationally accepted standards of conservation practice relating to architecture and sites. It sets forth principles of conservation based on the concept of authenticity and the importance of maintaining the historical and physical context of a site or building.

The Burra Charter defines the basic principles and procedures to be followed in the conservation of heritage places. It does not prescribe the techniques to be used or the manner in which a heritage place should be cared for. These principles and procedures can be applied to a monument, building, garden, shell midden, rock art site, road, mining or archaeological site, or to a whole region.

29. Match the Buildings (name of architects) in Group I with the abstractions used in Group II.

Group I	Group II
P. The School for Spastic Children, New Delhi (Romi Khosla)	1. Cosmos in geometric form
S. Jawahar Kala Kendra, Jaipur (Charles Correa)	2. Panchavati
R. Capitol Complex, Chandigarh (Le Corbusier)	3. Plan form of Hindu Temple
S. Oberoi Hotel, Bhubaneswar (Satish Grover)	4. Bull's horns
	5. Mother's womb



- a. P-4, Q-2, R-1, S-3
- b. P-5, Q-1, R-4, S-3
- c. P-2, Q-1, R-3, S-2
- d. P-5, Q-2, R-4, S-1

Answer: B

Explanation: Romi Khosla's design of the School for Spastic Children with its use of abstract forms is regarded as a classic example of post-modern architecture in India. The architect's concern was to create a secure world for children with special needs. The structure is well secured and almost fort-like, a building which is often compared to mother's womb.

Charles Correa, India's foremost modern architect, who designed Jawahar Kala Kedra (JKK), Jaipur, applied a modern interpretation of Jai Singh's nine mandalas of Jaipur's plan. The design is a pursuit of the mathematics of the cosmos—the navagraha that formed the basis of the nine sectors in Jaipur and the nine squares at the JKK.

Le Corbusier's oeuvre of symbols were not limited to the two dimensional murals that adorned the walls, ceilings, tapestries and doorways. From the upturned arc of the recurrent parasol roof, that was a mere sculptural abstraction of the bull's horns to the more philosophically rooted Open Hand monument, Le Corbusier developed these symbols into a full-fledged architectural language and conscientiously incorporated them into the three dimensional design of the buildings of the Capitol Complex and the city itself.

The Oberoi Hotel, Bhubaneswar is set amidst the rich cultural heritage of the city and was conceived as a design to imitate the gradual enlargement and expansions of volumes in the architecture of Hindu temples.

30. Match the names of the gardens in Group I with their type in Group II.

Group I	Group II
P. Shalimar Bagh, Srinagar	1. Hanging Garden
Q. Pherozeshah Mehta Garden, Mumbai	2. Memorial Garden
R. Lalbagh Garden, Bangalore	3. Rock Garden
S. Nek Chand's Garden, Chandigarh	4. Botanical Garden
	5. Mughal Garden

- a. P-3, Q-1, R-2, S-4
- b. P-5, Q-1, R-4, S-3
- c. P-5, Q-3, R-4, S-2
- d. P-5, Q-4, R-1, S-3

Answer: B

Explanation: Shalimar Bagh is a Mughal garden in Srinagar, Jammu and Kashmir, India, linked through a channel to the northeast of Dal Lake. The Hanging Gardens, in Mumbai, also known as Pherozeshah Mehta Gardens, are terraced gardens perched at the top of Malabar Hill, on its western side, just opposite the Kamala Nehru Park. Lalbagh is a popular botanical garden situated in Bangalore (Bengaluru). This garden is a home to a variety of flora and fauna. The Rock Garden of



Chandigarh is a sculpture garden for rock enthusiasts in Chandigarh, Punjab and Haryana, India. It is also known as Nek Chand's Rock Garden after its founder Nek Chand.

31. Match the various types of impurities present in water in Group I with the appropriate water treatment process given in Group II.

Group I	Group II
P. Fine suspended matter	1. Aeration
Q. Pathogenic bacteria	2. Plain sedimentation
R. Colour, odour and taste	3. Sedimentation with coagulation
S. Floating matter as leaves	4. Screening
	5. Disinfection

- a. P-2, Q-5, R-3, S-4
- b. P-3, Q-4, R-1, S-2
- c. P-1, Q-4, R-3, S-2
- d. P-3, Q-5, R-1, S-4

Answer: D

Explanation: Screening in water purification involves using screens to remove floating impurities such as leaves. Solids are removed by sedimentation (settling) followed by filtration. Small particles are not removed efficiently by sedimentation because they settle too slowly; they may also pass through filters. They would be easier to remove if they clumped together (coagulated) to form larger particles, but they don't because they have a negative charge and repel each other. In coagulation, we add a chemical such as alum which produces positive charges to neutralize the negative charges on the particles. Then the particles can stick together, forming larger particles which are more easily removed. The aeration of water serves the following purposes; carbon dioxide, hydrogen sulphide and other volatile substances imparting taste and odour to water are easily expelled by aeration. Iron and manganese present in water are oxidized to certain extent by aeration. Water disinfection means the removal, deactivation or killing of pathogenic microorganisms. This is done by using water disinfectants like chlorine, ozone, etc.

32. Match the temples in Group I with their style of Architecture in Group II

Group I	Group II
P. Badami Cave Temples	1. Pandya style
Q. Kalugumalai Temple Complex	2. Chola style
R. Airavatesvara Temple	3. Chalukya style
S. Chennakeshava Temple	4. Vijayanagara style
	5. Hoysala style

- a. P-3, Q-1, R-2, S-5
- b. P-3, Q-4, R-2, S-1
- c. P-2, Q-1, R-3, S-5
- d. P-5, Q-1, R-4, S-2

Answer: A

Explanation: The Badami cave temples are a complex of Hindu and Jain cave temples located in Badami, a town in the Bagalkot district in northern part of Karnataka, India. The caves are important examples of Indian rock-cut architecture, especially Badami Chalukya architecture, and the earliest date from the 6th century. Kalugumalai is a priceless unfinished Pandyan monolith cave temple. About 7.5 meter of the mountain is excavated in a rectangular fashion and in the middle the temple is sculpted from a single piece of rock. The carvings reflect the southern temple style of the Pandya era. Only the top portion of the temple is completed. Airavatesvara Temple is Hindu temple of Dravidian architecture located in the town of Darasuram, near Kumbakonam, Thanjavur District in the South Indian state of Tamil Nadu. This temple, built by Rajaraja Chola II in the 12th century CE is a UNESCO World Heritage Site, along with the Brihadeeswara Temple at Thanjavur, the Gangaikondacholisvaram Temple at Gangaikonda Cholapuram that are referred to as the Great Living Chola Temples. The Chennakeshava Temple, also referred to as Keshava, Kesava or Vijayanarayana Temple of Belur, is a 12th-century Hindu temple in the Hassan district of Karnataka state, India.

33. Match the urban form/structure in Group I with their respective proponents in Group II.

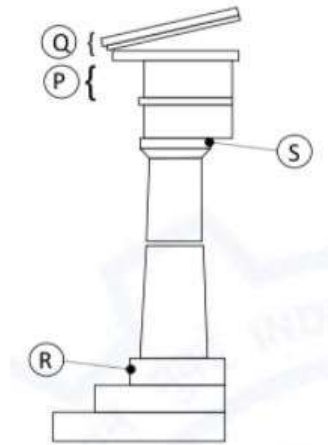
Group I	Group II
P. Trabantenstadte	1. Arturo Soria Y Mata
Q. Liner city	2. Le Corbusier
R. Bloomsbury Precinct	3. Ernst May
S. Radiant city	4. Frank Lloyd Wright
	5. Patrick Abercrombie

- a. P-4, Q-1, R-5, S-3
- b. P-5, Q-1, R-4, S-2
- c. P-3, Q-1, R-5, S-2
- d. P-3, Q-4, R-1, S-2

Answer: C

Explanation: Ernst May implemented garden city and regionalist ideas in his earliest independent planning work in Silesia, in his canonical housing developments (Siedlungen) in Frankfurt, and even in his urban master plans in the Soviet Union. In each case he worked towards dissolution of the crowded metropolitan centre into a looser constellation of 'satellite cities' (Trabantenstädte) or regional 'garden colonies'. The linear city was an urban plan for an elongated urban formation, the concept given by Arturo Soria y Mata. The city would consist of a series of functionally specialized parallel sectors. Generally, the city would run parallel to a river and be built so that the dominant wind would blow from the residential areas to the industrial strip. Abercrombie worked on Bloomsbury Precinct, in the County of London Plan, 1943. Designed in the 1920s by Le Corbusier, one of Modernism's most influential architects, the "Radiant City" was to be a linear and ordered metropolis of the future. It was ambitious, a blueprint not only for a more rational urban environment but also for radical social reform.

34. Match the elements in Group I to their description in Group II.

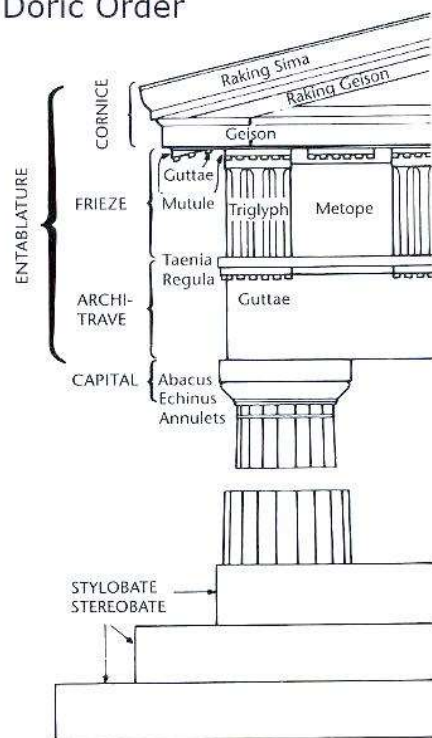
Group I	Group II
	1. Cornice
	2. Stylobate
	3. Stereobate
	4. Abacus
	5. Frieze

- a. P-3, Q-1, R-5, S-4
- b. P-4, Q-3, R-1, S-2
- c. P-5, Q-4, R-2, S-1
- d. P-5, Q-1, R-2, S-4

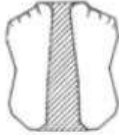
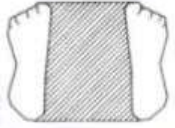

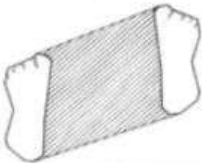
Answer: D

Explanation: Typical parts of a Greek temple for Doric order type are shown in the image below;

### Doric Order



35. Match the position of feet in Group I to the most appropriate description of stability of human body in Group II.

Group I		Group II	
<b>P</b>		<b>1</b>	<b>Stable antero-posteriorly</b>
<b>Q</b>		<b>2</b>	<b>Laterally stable</b>
<b>R</b>		<b>3</b>	<b>Fairly stable in all directions</b>
<b>S</b>		<b>4</b>	<b>Vertically stable</b>
		<b>5</b>	<b>Unstable</b>

- a. P-5, Q-5, R-2, S-1
- b. P-5, Q-3, R-1, S-2
- c. P-1, Q-3, R-4, S-2
- d. P-4, Q-3, R-2, S-1

Answer: B

Explanation: Self-explanatory

36. Match the buildings in Group I with their corresponding structural systems in Group II.

Group I	Group II
P. Empire State Building, New York, USA	1. Trusses tube
Q. John Hancock Centre, Chicago, USA	2. Bundled tube
R. Taipei 101, Taiwan	3. Tube in tube
S. Sears Tower, Chicago, USA	4. Outrigger frame
	5. Shear truss

- a. P-5, Q-3, R-4, S-1
- b. P-3, Q-5, R-1, S-2

- c. P-5, Q-4, R-1, S-2
- d. P-5, Q-1, R-4, S-2

Answer: D

Explanation: Structural system that defined the Sears Tower is bundled tube system, which gave the building its physical strength. Thirty columns support Taipei 101 including eight “mega-columns” packed with 69 MPa concrete. Every eight floors, outrigger trusses connect the columns in the building’s core to those on the exterior.

**Q.37 – Q.43 Multiple Select Question (MSQ), carry TWO mark each (no negative marks).**

37. Choose the correct options with respect to cycle track design as per Indian Road Congress guidelines.

- a. The minimum width of cycle track is 3 m if overtaking is to be provided for
- b. Cycle tracks may be provided when peak hour cycle traffic is 400 or more on routes with a traffic of 100 to 200 vehicles/hour
- c. Maximum gradient allowed for cycle tracks is 1 in 15
- d. Cyclist should have a clear view of at least 80 m

Answer: A, B

Explanation: The question is based on The Indian Roads Congress Publication; IRC: 11-1962: Recommended Practice for the Design and Layout of Cycle Tracks. As per IRC: 11-1962; gradients steeper than 1 in 30 should generally be avoided. Also, desirable clear view for cyclist should be at least of 25 meters.

38. As per the Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013, for which purposes can the urgency clause for land acquisition be invoked?

- a. National defence and security purposes
- b. Affordable housing program
- c. Industrial projects
- d. Emergency arising out of natural calamities

Answer: A, D

Explanation: As per the Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013, the urgency clause should be exercised in the rarest of rare cases like national defence or for resettlement purposes (during natural calamities).

39. Which of the following international treaties are related to Climate Change and global warming?

- a. Cartagena protocol, 2000
- b. Copenhagen summit, 2001
- c. Nagoya protocol, 2010
- d. Paris Agreement, 2016

Answer: B, D; or D

Explanation: The Paris Agreement is a legally binding international treaty on climate change. It was adopted by 196 Parties at COP 21 in Paris, on 12 December 2015 and entered into force on 4 November 2016. Its goal is to limit global warming to well below 2, preferably to 1.5 degrees Celsius, compared to pre-industrial levels. The Copenhagen Climate Change Conference (December, 2009) raised climate change policy to the highest political level. Close to 115 world leaders attended the high-level segment, making it one of the largest gatherings of world leaders ever outside UN headquarters in New York. The year for Copenhagen summit mentioned in the options is incorrect.

40. Which of the following algorithms are used for finding the shortest path in an urban transportation network?
- Logit
  - Huff
  - Floyd Warshall
  - Dijkstra

Answer: C, D

Explanation: The Floyd Warshall Algorithm is for solving the All Pairs Shortest Path problem. The problem is to find shortest distances between every pair of vertices in a given edge weighted directed Graph. Dijkstra's algorithm is an algorithm for finding the shortest paths between nodes in a graph, which may represent, for example, road networks.

41. Which of the following statements are true with respect to surface paint?
- Paint is glossy when Pigment Volume Concentration is high
  - Vehicle is the volatile part of the paint
  - Base of the paint is usually oxides of metals
  - High VOC content is preferred in paints

Answer: B, C

Explanation: The vehicle is basically composed of an oily liquid in which both the base and the pigment are soluble. The primary objective of the vehicle is to allow the paint to spread over the surface to which it is applied. Base is a solid substance in a fine state that forms the body of paint. It forms the bulk of paint. It conveys the character of the paint. Base makes the film of the paint, opaque, harder, and elastic & prevents formation of shrinkage cracks. White lead, red lead, zinc oxide, zinc white, iron oxide, titanium white, aluminium powder, lithophone, etc. are examples of the base.

42. As per the Solid Waste Management Rules 2016, which among the following are 'Duties of waste generators'?
- Segregate and store waste generated in four separate streams namely, combustible, non-combustible, organic and domestic hazardous waste
  - Store construction and demolition waste separately within own premise before disposal
  - All waste generators shall pay user fee for solid waste management
  - Compost horticulture waste and garden waste separately within own premise

Answer: B, C

Explanation: As per the Solid Waste Management Rules 2016, responsibilities of Generators have been introduced to segregate waste in to three streams, Wet (Biodegradable), Dry (Plastic, Paper, metal, wood, etc.) and domestic hazardous wastes (diapers, napkins, empty containers of cleaning

agents, mosquito repellents, etc.) Generator will have to pay 'User Fee' to waste collector and for 'Spot Fine' for Littering and Non-segregation. Construction and demolition waste should be stored, separately disposed, as per the Construction and Demolition Waste Management Rules, 2016.

43. Choose the correct options with regard to activated sludge process.
- The activated sludge process is an aerobic process
  - The entire settled sludge is sent back to the aeration tank
  - The entire effluent from the final settling tank is sent back to the aeration tank
  - In aeration tanks, sewage is aerated and agitated for a few hours

Answer: A, D

Explanation: The activated sludge process is a type of wastewater treatment process for treating sewage or industrial wastewaters using aeration and a biological floc composed of bacteria and protozoa. It is an aerobic biological process. The general arrangement of an activated sludge process for removing carbonaceous pollution includes the following items: An aeration tank where air (or oxygen) is injected in the mixed liquor. This is followed by a settling tank (usually referred to as "final clarifier" or "secondary settling tank") to allow the biological flocs (the sludge blanket) to settle, thus separating the biological sludge from the clear treated water.

**Q.44 – Q.55 Numerical Answer Type (NAT), carry TWO mark each (no negative marks).**

44. A rectangular hall having dimension of  $8.0 \text{ m} \times 14.0 \text{ m} \times 4.0 \text{ m}$  has total 4 windows ( $1.5 \text{ m} \times 1.0 \text{ m}$  each) and 2 doors ( $1.0 \text{ m} \times 2.0 \text{ m}$  each).

The coefficients of absorption are given below. Considering all windows open and doors closed, the reverberation time in seconds is \_\_\_\_\_. [round off to 2 decimal places]

Description of Item	Absorption Coefficient
Coefficient of absorption of wall, floor and ceiling	0.2
Coefficient of absorption of door and window	0.4

Answer: 0.82 to 0.86

Explanation: The hall has three types of surfaces; Type 1 – Wall, floor and Ceiling; Type 2 – Open windows, and Type 3 – Closed doors.

Total surface area of hall =  $2(lh + bh + lb) = 2 * (32 + 56 + 112) = 400 \text{ sqm}$

For type 2, surface area,  $S_2 = 4 * 1.5 * 1 = 6 \text{ sqm}$  and absorption coefficient,  $\alpha_1 = 1$  (open window has absorption coefficient of 1)

For type 3, surface area,  $S_3 = 2 * 1 * 2 = 4 \text{ sqm}$  and absorption coefficient,  $\alpha_2 = 0.4$  (as given)

For type 1; surface area,  $S_1 = 400 - 6 - 4 = 390 \text{ sqm}$  and absorption coefficient,  $\alpha_3 = 0.2$  (as given)

Total absorption of the hall,  $A = (\alpha_1 * S_1) + (\alpha_2 * S_2) + (\alpha_3 * S_3) = (0.2 * 390) + (1 * 6) + (0.4 * 4) = 85.6$

RT of hall =  $0.16 * (V/A) = 0.16 * (448/85.6) = 0.8374 \text{ sec}$



45. If surface conductance of external surface is  $20 \text{ W/m}^2\text{ }^\circ\text{C}$ , absorptance of the surface is 0.66 and  $U$  value of the wall is  $1.2 \text{ W/m}^2\text{ }^\circ\text{C}$ , the solar gain factor of a wall is \_\_\_\_\_. [round off to 2 decimal places]

Answer: 0.03 to 0.05

Explanation: Given,  $SC_o = 20 \text{ W/m}^2\text{ }^\circ\text{C}$ ; absorptance of surface,  $a = 0.66$  and  $U = 1.2 \text{ W/m}^2\text{ }^\circ\text{C}$

Solar gain factor, SGF is calculated as;

$$SGF = \frac{a * U}{SC_o} = \frac{0.66 * 1.2}{20} = 0.0396$$

46. The initial cost of a property is INR 4,00,000 and its future life is 30 years. Considering the scrap value as 10% of its initial cost and rate of interest as 5%, the sinking fund (deposited at the end of year) for the property is INR \_\_\_\_\_. [round off to 2 decimal places]

Answer: 5405.00 to 5422.00

Explanation: Scrap value = 10% of 4,00,000 = Rs. 40,000/-

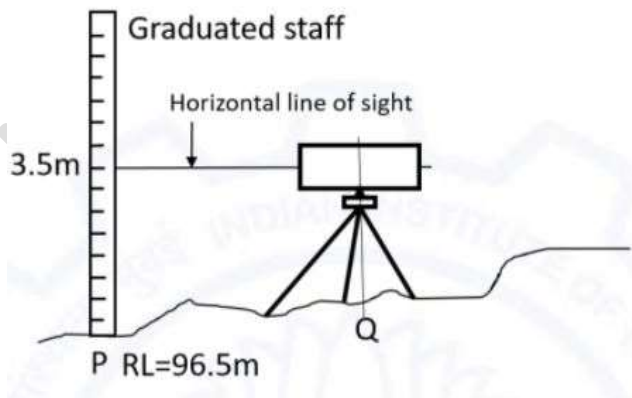
Total amount for sinking fund,  $T$  = Total depreciation = Rs. 4,00,000 – Rs. 40,000 = Rs. 3,60,000/-

Annual investment for sinking fund,  $A = T * \text{Sinking Fund Factor}$ ; where, Sinking Fund Factor is calculated as; (given  $r = 0.05$  and  $n = 30$ )

$$SFF = \left[ \frac{r}{(1 + r)^n - 1} \right] = \frac{0.05}{1.05^{30} - 1} = 0.015051 \dots$$

$$A = T * SFF = 3,60,000 * 0.015051 = \text{Rs. } 5418.52/-$$

47. Reading in the staff stationed at P measured by a dumpy level is 3.5 m. The dumpy level is stationed at Q. The Reference Level (RL) at point P is 96.5 m and the height of the dumpy level is 1.25 m. The RL at point Q is \_\_\_\_\_ m. [round off to 2 decimal places]



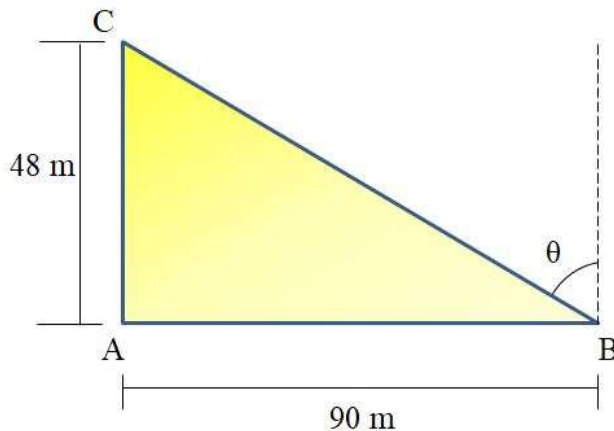
Answer: 98.75

Explanation: RL at point Q = RL at P + (3.5 – 1.25) = 96.5 + 2.25 = 98.75 m

48. A circular cricket field of 180 m diameter is illuminated by four floodlight towers. The floodlight towers are equally spaced along the perimeter of the field. The height of the floodlight tower is 48 m. Using 'Inverse Square Law', the illumination level at the centre of the field is found as 750 Lux. Each tower is consisting of 50 lamps. The rating of each lamp is 700 Watt. The efficacy of each lamp is \_\_\_\_\_ Lumen /Watt. [round off to 2 decimal places]

Answer: (117.00 to 119.00) or (1483 to 1496)

Explanation: The triangle connecting centre of stadium, base of a floodlight tower and the top of a floodlight tower is shown in the image below;



Illumination at the centre of stadium due to one floodlight tower = Total illumination/4 =  $750/4 = 187.5$  lux

Distance from source to centre of stadium,  $R = BC$  in the diagram above =  $\sqrt{(AC^2)+(AB^2)} = \sqrt{(48^2)+(90^2)} = \sqrt{10404}$

Illumination is given by,  $E = (I/R^2) * \cos\theta = (I/10404) * (48/\sqrt{10404}) = 187.5$  lux

By simplifying the above equation, we get;  $I = 4145343.75$  candela

Intensity due to one lamp =  $I/50 = 82906.875$  candela

Total lumen output of one lamp =  $4\pi I = 4 * \pi * 82906.875 = 1041838.52$  lumen (as it is given 'using inverse square law' – total lumen will be intensity \* total solid angle which is  $4\pi$  steradian)

Luminous efficacy of each lamp = lumen output/wattage =  $1041838.52/700 = 1488.34$  lm/Watt

49. A building is constructed on a plot measuring 70 m × 40 m. The utilized FAR of the building is 1.5. An energy audit team found that the average monthly electricity bill of the building is INR 2,94,000. The unit cost of the electricity is INR 7. The Building Energy Index is \_\_\_\_\_ kW-hr/m<sup>2</sup>/year. [in integer]

Answer: 120

Explanation: Total built-up area = Plot area \* FAR =  $70 * 40 * 1.5 = 4200$  sqm

Annual electricity consumption = Annual bill/7 (as unit cost is Rs. 7) =  $(12 * 2,94,000)/7 = 5,04,000$  kWh

Building Energy Index = Annual electricity consumption/Total built-up area =  $5,04,000/4200 = 120$  kW-hr/m<sup>2</sup>/year

50. A simply-supported steel beam made of an I-section has a span of 8 m. The beam is carrying a uniformly distributed load of 15 kN/m. The overall depth of the beam is 450 mm. The moment of inertia of the beam section is 18000 cm<sup>4</sup>. The maximum bending stress in the beam will be \_\_\_\_\_ N/mm<sup>2</sup>. [in integer]

Answer: 150

Explanation: For simply supported beam of length 'L' m with a UDL of 'w' kN/m; maximum bending will be  $(wL^2/8)$  at the mid-span

So, maximum bending moment (at mid-span),  $M = (15 * 8 * 8)/8 = 120$  kNm or  $(12 * 10^7)$  N-mm

Given,  $I = 18000 \text{ cm}^4 = (18 * 10^7) \text{ mm}^4$

Maximum distance from Neutral Axis,  $y = \text{depth}/2 = 450/2 = 225$  mm

Maximum bending stress,  $\sigma$  can be calculated from flexure equation as;

$$\sigma = \frac{M * y}{I} = \frac{12 * 10^7 * 225}{18 * 10^7} = 150 \text{ N/mm}^2$$

51. The slenderness ratio of a circular column of diameter 300 mm and effective height 3 m is \_\_\_\_\_. [in integer]

Answer: 40

Explanation: Given effective height,  $L_{eff} = 3 \text{ m} = 3000 \text{ mm}$

For circular cross-section, radius of gyration,  $R'$  will be; (I: Moment of Inertia; A: Area of c/s)

$$R' = \sqrt{\frac{I}{A}} = \sqrt{\frac{\pi r^4}{4 * \pi r^2}} = \sqrt{\frac{r^2}{4}} = \frac{r}{2} = \frac{150}{2} = 75 \text{ mm}$$

Slenderness ratio, 'S' is calculated as;

$$S = \frac{L_{eff}}{R'} = \frac{3000}{75} = 40$$

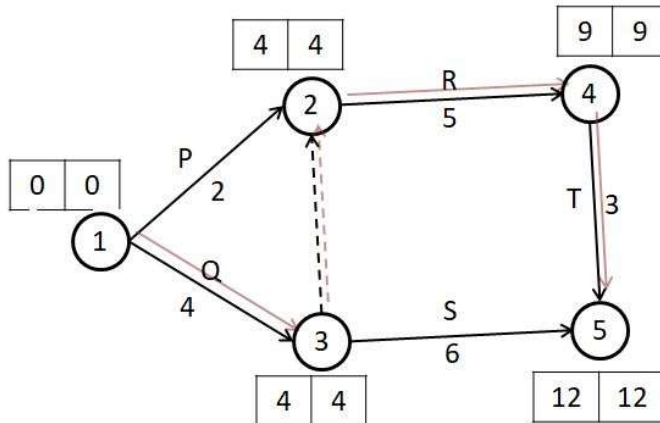
52. A construction project consists of following five activities. The immediate successor activity relationship and duration of each activity are mentioned in the table below.

Activity	Immediate Successor Activity	Duration (Weeks)
P	R	2
Q	R and S	4
R	T	5
S	-	6
T	-	3

The total duration of the project is \_\_\_\_\_ weeks [*in integer*]

Answer: 12

Explanation: The project network with calculations for forward and backward path is shown in the diagram below;



The total project duration will be 12 weeks.

53. It is proposed to have ceramic tile flooring in a room having internal clear dimension of 1.8 m × 2.4 m. Tile sizes are 300 mm × 300 mm. The door opening is 900 mm and the door is flushed with the internal face of the wall. The height of skirting is 600 mm. The number of ceramic tiles required for internal flooring and skirting is \_\_\_\_\_. [*in integer*]

Answer: 98

Explanation: Total area of tile-work = Area of flooring + Area for skirting

$$\text{Area of flooring} = 1.8 \times 2.4 = 4.32 \text{ sqm}$$

$$\text{Area of skirting} = [2(1+b) - 0.9] \times 0.6 = 4.5 \text{ sqm}$$

$$\text{Total area of tile-work} = 4.32 + 4.5 = 8.82 \text{ sqm}$$

$$\text{Number of ceramic tiles required} = \text{Area of tile-work} / \text{Area of each tile} = 8.82 / 0.09 = 98 \text{ tiles}$$

54. In a housing project, 75% of the permissible FAR was utilised after constructing four numbers eight storey MIG towers with identical floor area of 400 sqm. If three numbers seven storey LIG towers with identical floor area are built utilising the remaining FAR, the floor area of each LIG tower is \_\_\_\_\_ sqm. [*round off to 2 decimal places*]

Answer: 202 to 204

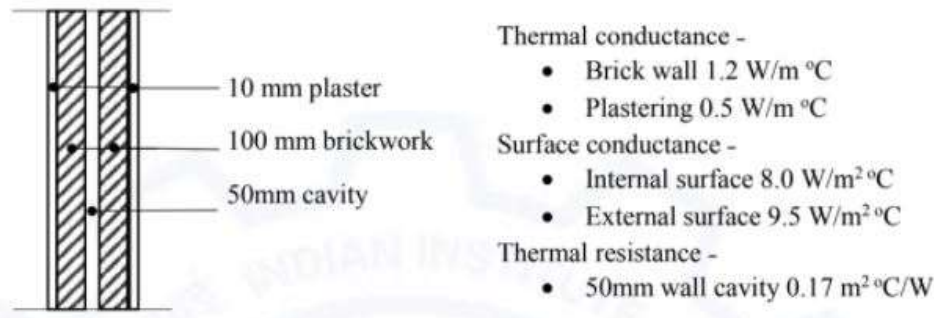
$$\text{Explanation: Total built-up area of MIG towers} = 4 \times 8 \times 400 = 12,800 \text{ sqm}$$

$$\text{Given, } 0.75 \times \text{Permissible built-up} = 12,800$$

$$\text{So, remaining permissible built-up} = (12800 / 0.75) \times 0.25 = 4266.67 \text{ sqm}$$

Floor area of each LIG tower =  $4266.67/(3 \times 7) = 4266.67/21 = 203.17 \text{ sqm}$

55. Using the following values of thermal conductance, surface conductance and thermal resistance, the U value across the given wall cross-section is \_\_\_\_\_  $\text{W/m}^2 \text{ } ^\circ\text{C}$ . [round off to 2 decimal places]



Answer: 1.50 to 1.70

Explanation: U-value of the wall is calculated as;

$$\frac{1}{U} = \frac{1}{SC_o} + \frac{l_1}{K_1} + \frac{l_2}{K_2} + R_{cavity} + \frac{l_3}{K_3} + \frac{l_4}{K_4} + \frac{1}{SC_i}$$

$$\Rightarrow \frac{1}{U} = \frac{1}{9.5} + \frac{0.01}{0.5} + \frac{0.1}{1.2} + 0.17 + \frac{0.1}{1.2} + \frac{0.01}{0.5} + \frac{1}{8} = 0.6069$$

$$\Rightarrow U = \frac{1}{0.6069} = 1.6477 \text{ W/m}^2 \text{ } ^\circ\text{C}$$

**General Aptitude (GA)**

**Q.1 – Q.5 Multiple Choice Question (MCQ), carry ONE mark each (for each wrong answer: – 1/3).**

Q.1 (i) Arun and Aparna are here.

(ii) Arun and Aparna is here.

(iii) Arun's families is here.

(iv) Arun's family is here.

Which of the above sentences are grammatically CORRECT?


(A) (i) and (ii)

(B) (i) and (iv)

(C) (ii) and (iv)

(D) (iii) and (iv)

Answer: B

Q.2	 <p>The mirror image of the above text about the X-axis is</p>
(A)	PHYLAXIS
(B)	PHYLAXIS
(C)	PHYLAXIS
(D)	PHYLAXIS

Answer: B

Q.3	Two identical cube shaped dice each with faces numbered 1 to 6 are rolled simultaneously. The probability that an even number is rolled out on each dice is:
(A)	$\frac{1}{36}$
(B)	$\frac{1}{12}$
(C)	$\frac{1}{8}$
(D)	$\frac{1}{4}$

Answer: D



<b>Q.4</b>	$\oplus$ and $\odot$ are two operators on numbers $p$ and $q$ such that $p \odot q = p - q$ , and $p \oplus q = p \times q$ <b>Then, <math>(9 \odot (6 \oplus 7)) \odot (7 \oplus (6 \odot 5)) =</math></b>
(A)	40
(B)	-26
(C)	-33
(D)	-40

Answer: D

Q.5 Four persons P, Q, R and S are to be seated in a row. R should not be seated at the second position from the left end of the row. The number of distinct seating arrangements possible is:

- (A) 6
- (B) 9
- (C) 18
- (D) 24

Answer: C

**Q. 6 – Q. 10 Multiple Choice Question (MCQ), carry TWO marks each (for each wrong answer: – 2/3).**

Q.6 On a planar field, you travelled 3 units East from a point O. Next you travelled 4 units South to arrive at point P. Then you travelled from P in the North-East direction such that you arrive at a point that is 6 units East of point O. Next, you travelled in the North-West direction, so that you arrive at point Q that is 8 units North of point P. The distance of point Q to point O, in the same units, should be \_\_\_\_\_

- (A) 3
- (B) 4
- (C) 5
- (D) 6

Answer: C

Q.7 The author said, “Musicians rehearse before their concerts. Actors rehearse their roles before the opening of a new play. On the other hand, I find it strange that many public speakers think they can just walk on to the stage and start speaking. In my opinion, it is no less important for public speakers to rehearse their talks.” Based on the above passage, which one of the following is TRUE?

- (A) The author is of the opinion that rehearsing is important for musicians, actors and public speakers.
- (B) The author is of the opinion that rehearsing is less important for public speakers than for musicians and actors.
- (C) The author is of the opinion that rehearsing is more important only for musicians than public speakers.
- (D) The author is of the opinion that rehearsal is more important for actors than musicians.

Answer: A

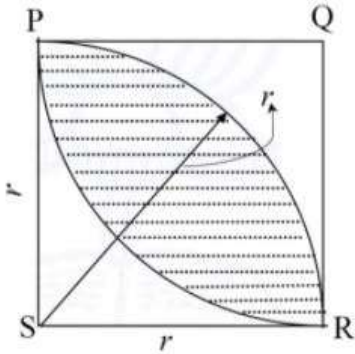
Q.8)

1. Some football players play cricket.
2. All cricket players play hockey.

Among the options given below, the statement that logically follows from the two statements 1 and 2 above, is:

- (A) No football player plays hockey.
- (B) Some football players play hockey.
- (C) All football players play hockey.
- (D) All hockey players play football.

Answer: B

Q.9	 <p>In the figure shown above, PQRS is a square. The shaded portion is formed by the intersection of sectors of circles with radius equal to the side of the square and centers at S and Q.</p> <p>The probability that any point picked randomly within the square falls in the shaded area is _____</p>
(A)	$4 - \frac{\pi}{2}$
(B)	$\frac{1}{2}$
(C)	$\frac{\pi}{2} - 1$
(D)	$\frac{\pi}{4}$

Answer: C

Q.10 In an equilateral triangle PQR, side PQ is divided into four equal parts, side QR is divided into six equal parts and side PR is divided into eight equal parts. The length of each subdivided part in cm is an integer. The minimum area of the triangle PQR possible, in  $\text{cm}^2$ , is

- (A) 18
- (B) 24
- (C)  $48\sqrt{3}$
- (D)  $144\sqrt{3}$

Answer: D