General Aptitude (GA)

Q.1 – Q.5 Carry ONE mark Each

1. He did not manage to fix the car himself, so he _____ in the garage.
   (A) Got it fixed
   (B) Getting it fixed
   (C) Gets fixed
   (D) Got fixed

Answer: A

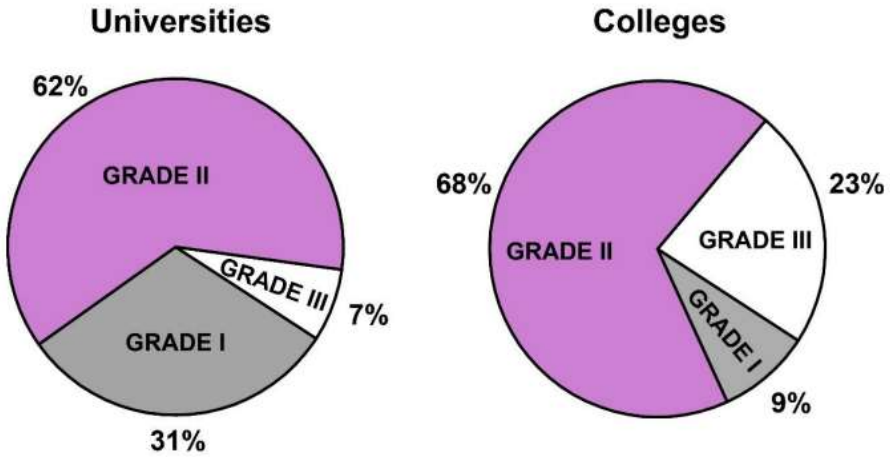
Explanation: As the first part of the statement is in past tense, the blank should be 'got it fixed'.

2. Planting : Seed : : Raising : _____ (By word meaning)
   (A) Child
   (B) Temperature
   (C) Height
   (D) Lift

Answer: A

Explanation: Planting a seed is analogous to 'raising a child'

3. A certain country has 504 universities and 25951 colleges. These are categorised into Grades I, II, and III as shown in the given pie charts.
   What is the percentage, correct to one decimal place, of higher education institutions (colleges and universities) that fall into Grade III?



   (A) 22.7
   (B) 23.7
   (C) 15.0
   (D) 66.8

Answer: A

Explanation: Total number of Grade III universities = 7% of 504 = 35.28 = 35 universities

Total number of Grade III colleges = 23% of 25951 = 5968.73 = 5969 colleges

Total number of Grade III higher education institutions = 6004

Percentage of higher education institutions that fall into Grade III = 6004/26455 = 22.7%

4. The minute-hand and second-hand of a clock cross each other _____ times between 09:15:00 AM and 09:45:00 AM on a day.
   (A) 30
   (B) 15
   (C) 29
   (D) 31

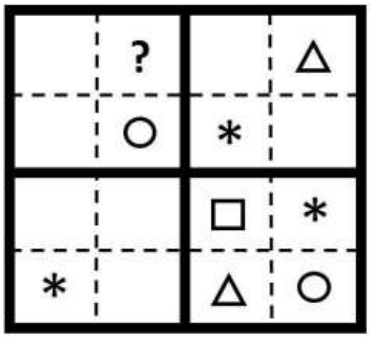
Answer: A

Explanation: In one hour, the minute hand makes one revolution, and the second hand goes round 60 times. This means that, in one hour, the second hand passes over the minute hand 60 - 1 = 59 times. The minute-hand and second-hand cross each other 30 times between 9:15:00 AM and 9:45:00 AM.

5. The symbols ○, ✱, △, and □ are to be filled, one in each box, as shown below. The rules for filling in the four symbols are as follows.

   1) Every row and every column must contain each of the four symbols.
   2) Every 2×2 square delineated by bold lines must contain each of the four symbols.

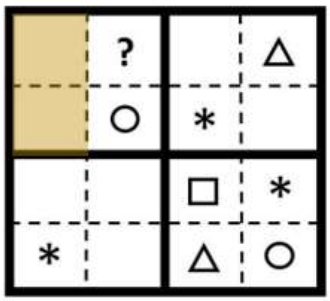
   Which symbol will occupy the box marked with '**?**' in the partially filled figure?



   (A) ○
   (B) ✱
   (C) △
   (D) □

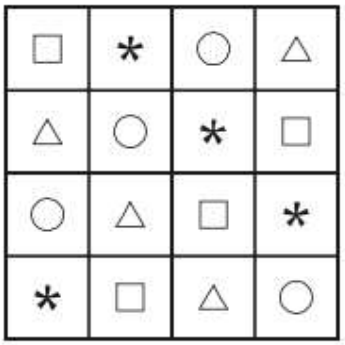
Answer: B

Explanation: In the first 2×2 square (left-most top) delineated by bold lines, the two boxes highlighted below are not suitable for ✱



So, the suitable box for ✱ will be **?**

The solved puzzle will be as follows:



6. In a recently held parent-teacher meeting, the teachers had very few complaints about Ravi. After all, Ravi was a hardworking and kind student. Incidentally, almost all of Ravi's friends at school were hardworking and kind too. But the teachers drew attention to Ravi's complete lack of interest in sports. The teachers believed that, along with some of his friends who showed similar disinterest in sports, Ravi needed to engage in some sports for his overall development.

   Based only on the information provided above, which one of the following statements can be logically inferred with certainty?

   (A) All of Ravi's friends are hardworking and kind.
   (B) No one who is not a friend of Ravi is hardworking and kind.
   (C) None of Ravi's friends are interested in sports.
   (D) Some of Ravi's friends are hardworking and kind.

Answer: D

Explanation: In the passage it is mentioned that 'almost all' of Ravi's friends at school were hardworking and kind too. So, it can be inferred that 'some' of Ravi's friends are hardworking and kind.

7. Consider the following inequalities:

$$p^2 - 4q < 4$$
$$3p + 2q < 6$$

   Where p and q are positive integers.

   The value of $(p + q)$ is _____

   (A) 2
   (B) 1
   (C) 3
   (D) 4

Answer: A

Explanation: It is mentioned that p and q are positive integers. The least positive integer is 1. The second inequality holds true only if both p and q are 1. So, the value of $(p + q)$ is 2

8. Which one of the sentence sequences in the given options creates a coherent narrative?

   (i) I could not bring myself to knock.

(ii) There was a murmur of unfamiliar voices coming from the big drawing room and the door was firmly shut.
(iii) The passage was dark for a bit, but then it suddenly opened into a bright kitchen.
(iv) I decided I would rather wander down the passage.

(A) (iv), (i), (iii), (ii)
(B) (iii), (i), (ii), (iv)
(C) (ii), (i), (iv), (iii)
(D) (i), (iii), (ii), (iv)

Answer: C

Explanation: As point (iv) uses the word '*rather* wander down the passage' it can be inferred that it comes after point (i) which states an alternative option – which is 'knocking the door'. As point (iv) mentions the decision to walk down the passage, point (iii) should be the next point as it describes the passage.

9. How many pairs of sets (S,T) are possible among the subsets of {1, 2, 3, 4, 5, 6} that satisfy the condition that S is a subset of T?
(A) 729
(B) 728
(C) 665
(D) 664

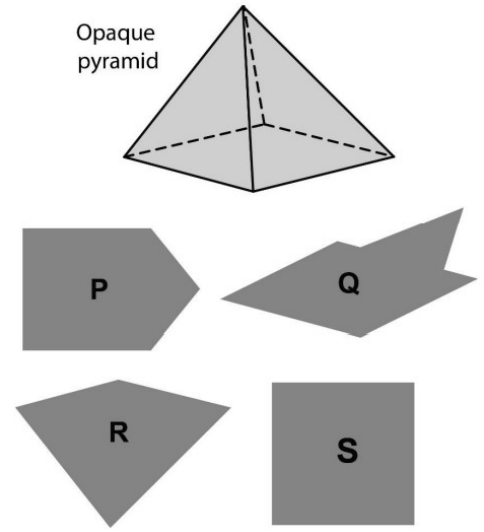
Answer: A

Explanation: Number of pairs of sets (A,B) exist such that both are subsets of {1,2,3,…, n} and A is a subset of B is 3^n

In this question, $n = 6$

So, the number of pairs of sets (S, T) for the given condition = $3^n = 3^6 = 729$

10. An opaque pyramid (shown below), with a square base and isosceles faces, is suspended in the path of a parallel beam of light, such that its shadow is cast on a screen oriented perpendicular to the direction of the light beam. The pyramid can be reoriented in any direction within the light beam. Under these conditions, which one of the shadows P, Q, R, and S is NOT possible?



(A) P

(B) Q
(C) R
(D) S

Answer: B

Explanation: Q is not a possible shadow as the pyramid tip doesn't connect to all four corners of the base.

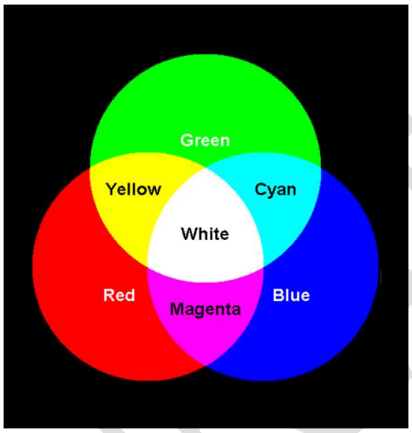
PART A: Common FOR ALL CANDIDATES

Q.11 – Q.28 Carry ONE mark Each

11. The triad of secondary colours in the additive colour system is _____.
    (A) Cyan, Magenta, Yellow
    (B) Red, Green, Blue
    (C) Purple, Green, Orange
    (D) Magenta, Blue, Yellow

Answer: A

Explanation: The primary colors in additive colour system are red, green and blue, or RGB. Additive color starts with black and adds red, green and blue light to produce the visible spectrum of colors. As more color is added, the result is lighter. When all three colors are combined equally, the result is white light.

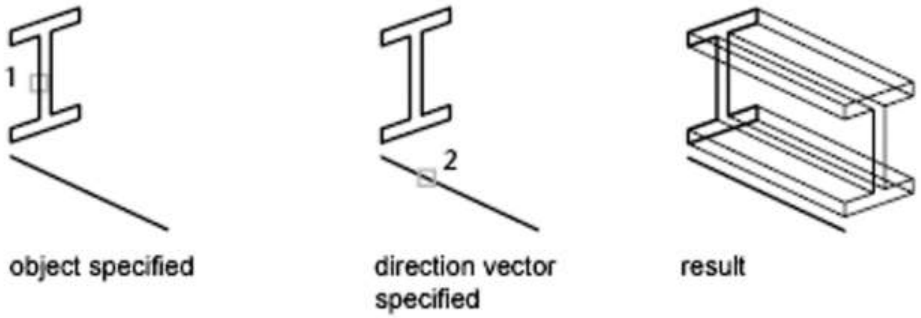


12. The criterion that is specifically mentioned in Special Conditions of Contract (SCC) is_____.
    (A) Scope and performance of the work
    (B) Site mobilization advance
    (C) Labour regulation
    (D) Arbitration and law

Answer: Marks to All

Explanation: Contract is composed of General Conditions of Contract (GCC) and Special Conditions of Contract (GCC). Special Conditions of Contract (SCC) shall supplement the General Conditions of Contract (GCC). Generally, whenever there is conflict, the provisions of SCC shall prevail over those in GCC.

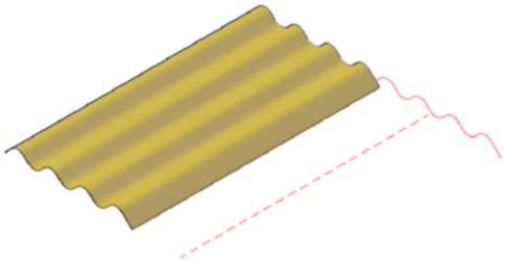
13. The command employed in AutoCAD® to create a mesh from a line or curve that is swept along a straight path (as shown in the figure below) is _____.



(A) TABSURF
(B) REVSURF
(C) RULESURF
(D) EDGESURF

Answer: A

Explanation: TABSURF creates a mesh that represents a general tabulated surface. The surface is defined by the extrusion of a line or curve (called a path curve) in a specified direction and distance (called a direction vector or path).



The path curve can be a line, arc, circle, ellipse, elliptical arc, 2D polyline, 3D polyline, or spline. The direction vector can be based on a line or an open 2D or 3D polyline.

This method creates the mesh as a series of parallel polygons running along a specified path.

14. As per the Burra Charter (2013) 'Cultural Significance' means _____ for past, present or future generations.
(A) historic, aesthetic, scientific, social or spiritual value
(B) archaeological, architectural, environmental, cultural value
(C) natural, cultural, mixed, intangible heritage
(D) heritage value, authenticity, integrity

Answer: A

Explanation: Some important definitions from Article 1 of Burra Charter are listed below:

Place means a geographically defined area. It may include elements, objects, spaces and views. Place may have tangible and intangible dimensions.

Cultural significance means aesthetic, historic, scientific, social or spiritual value for past, present or future generations. Cultural significance is embodied in the place itself, its fabric, setting, use, associations, meanings, records, related places and related objects.

Fabric means all the physical material of the place including elements, fixtures, contents and objects.

Conservation means all the processes of looking after a place so as to retain its cultural significance.

Maintenance means the continuous protective care of a place, and its setting. Maintenance is to be distinguished from repair which involves restoration or reconstruction.

Preservation means maintaining a place in its existing state and retarding deterioration.

Restoration means returning a place to a known earlier state by removing accretions or by reassembling existing elements without the introduction of new material.

Reconstruction means returning a place to a known earlier state and is distinguished from restoration by the introduction of new material.

Adaptation means changing a place to suit the existing use or a proposed use.

15. As per URDPFI (2015), the density range (in persons per Hectare) suggested for overall planning approach for small towns in hill areas is _____.
    (A) 20-30
    (B) 45-75
    (C) 100-125
    (D) 125-150

Answer: B

Explanation: For overall planning approach following density ranges are suggested in URDPFI Guidelines, Volume 1:

Table 5.1: Developed Area Average Densities

Settlement Type	Persons per Hectare(pph) in	
	Plain Areas	Hill Areas
Small Towns	75-125	45-75
Medium Town	100-150	60-90
Large Cities	125-175	60-90
Metropolitan Cities	125-175	100-150
Megapolis	More than 200	--

16. In ecology, the term 'niche' refers to _____.
    (A) the ways in which species interact with biotic and abiotic factors of the environment
    (B) only the abiotic factors such as temperature and rainfall
    (C) the gradient change of physiochemical characteristics between two ecosystems
    (D) the zone of junction or a transition area between two biomes

Answer: A

Explanation: In ecology, 'Niche' describes the role of an organism in its particular ecosystem" The term 'niche' was first used by Joseph Grinnel in 1917. He stated niche as an ultimate distributional unit, within which each organism is held by its instinctive and structural limitations. He also stated that no two species can inhabit the same niche for a long time. In other words, it can be loosely defined as the requirement of a species for existence in a given environment and its impacts on that environment.

17. Lowry's model of Metropolis (1964) includes two _____ spatial interaction models.
    (A) Singly constrained
    (B) Doubly constrained
    (C) Unconstrained
    (D) Triply constrained

Answer: A

Explanation: The Lowry model conceives of the major spatial features of an urban area in terms of three broad sectors of activity i.e., basic employment sector, the population serving employment and the household sector. The basic employment is employment whose products and services are utilized outside the study area. The Lowry model is based on two principles, namely that of the urban economic base and that of spatial interaction. Lowry's model includes singly constrained spatial interaction models.

18. Select the method that involves a pairwise comparison matrix for quantifying the weights of decision criteria.
    (A) Analytical hierarchy process
    (B) Exploratory factor analysis
    (C) Latent class analysis
    (D) Multiple linear regression

Answer: A

Explanation: The AHP combines math and psychology to compare several options and select the best one. It does this by using a concept called pairwise comparisons. Instead of comparing several criteria at once, they are compared two at a time. That way, the choice is easier to make.

19. Select the micro-organism which is NOT an enteric pathogen.
    (A) *Staphylococcus aureus*
    (B) *Vibrio cholerae*
    (C) *Escherichia coli*
    (D) *Salmonella typhi*

Answer: A

Explanation: Enteric bacteria are bacteria that exist in the intestines of animals and humans. Enteric bacteria are typically harmless and help maintain a healthy intestinal environment. However, certain strains of enteric bacteria may be pathogenic, causing illness in humans. Vibro cholerae, Escherichia coli, and Salmonella typhi are examples of enteric panthogens.

20. Select the publication by Ministry of Statistics and Programme Implementation (MoSPI) related to Environmental Accounts as per UN-SEEA framework.
    (A) EnviStats India 2022
    (B) Energy Conservation Building Code 2017
    (C) Eco Niwas Samhita 2018
    (D) Climate Change 2022: Impacts, Adaptation and Vulnerability

Answer: A

Explanation: This first volume of the EnviStats – India 2022 was published by the National Statistical Office of the Ministry of Statistics and Programme Implementation, Government of India, on March 31, 2022. The EnviStats were first published in 2018 and this is the fifth edition in the series. Volume II of this edition was published on September 30, 2022. The report follows the United Nations Statistics Division's Framework for the Development of Environment Statistics – which is a comprehensive guide for the "collection and compilation of environmental statistics at the national level." It collates national as well as state-wide data on rainfall, soil conditions, water and wetlands, forests, biodiversity, climate conditions and the factors influencing them. It also carries data on natural resources, natural disasters, and government schemes and regulations aimed at protecting the environment.

21. Ebenezer Howard suggested the maximum population of 'Garden City' as_____ persons.
    (A) 10,000
    (B) 22,000
    (C) 32,000
    (D) 58,000

Answer: C

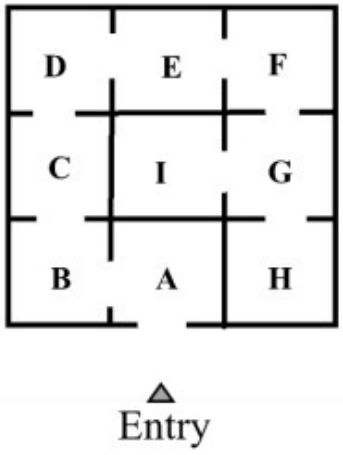
Explanation: The garden city movement was a 20th century urban planning movement promoting satellite communities surrounding the central city and separated with greenbelts. Ebenezer Howard published the book To-morrow: a Peaceful Path to Real Reform in 1898 (which was reissued in 1902 as Garden Cities of To-morrow). His idealised garden city would house 32,000 people on a site of 9,000 acres (3,600 ha), planned on a concentric pattern with open spaces, public parks and six radial boulevards, 120 ft (37 m) wide, extending from the centre. The garden city would be self-sufficient and when it reached full population, another would be developed nearby. Howard envisaged a cluster of several garden cities as satellites of a central city of 58,000 people, linked by road and rail.

22. In eighteenth century English gardens, _____was used to eliminate visual boundaries between the garden and the landscape.
    (A) Stroll garden
    (B) Sunken fence
    (C) Topiary
    (D) Qanat

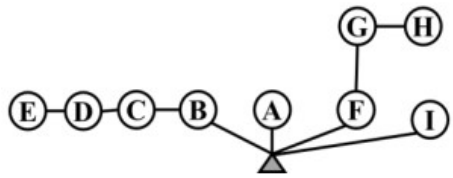
Answer: B

Explanation: The sunken fence, fosse, or ha-ha, is an English invention, used in separating that portion of the lawn near the house, from the part grazed by deer or cattle, and is only a ditch sufficiently wide and deep to render communication difficult on opposite sides. When the ground slopes from the house, such a sunk fence is invisible to a person near the latter and answers the purpose of a barrier without being in the least obtrusive.

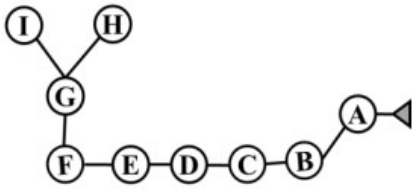
23. The figure below shows the spatial arrangement of rooms in a building with access from the exterior, marked as 'entry'. Identify the appropriate diagram showing the access to rooms starting from the entry.



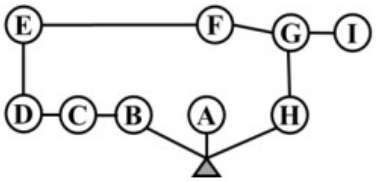
(A)



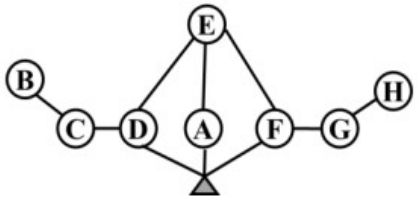
(B)



(C)



(D)



Answer: B

Explanation: By observation, there should be continuous link from Entry to 'A' and then to 'B'. Link from A to B can be seen only in Option B and the remaining options can be directly eliminated.

24. In high-rise buildings, the method adopted to prevent ingress of smoke in an enclosed fire staircase is _____.
    (A) Polarization
    (B) Pressurization
    (C) Perpetuation
    (D) Fumigation

Answer: B

Explanation: Pressurization is defined as the establishment of a pressure difference across a barrier to protect exit, stairway, lobby, exit passageway or room of a building from smoke penetration.

25. Select the Act which stipulates prohibited area of 100 m around centrally protected monuments in India.
    (A) The Antiquities and Art Treasures Act, 1972
    (B) The AMASR (Amendment and Validation) Act, 2010
    (C) Urban Land (Ceiling and Regulation) Act, 1976
    (D) Environment Protection Act, 1986

Answer: B

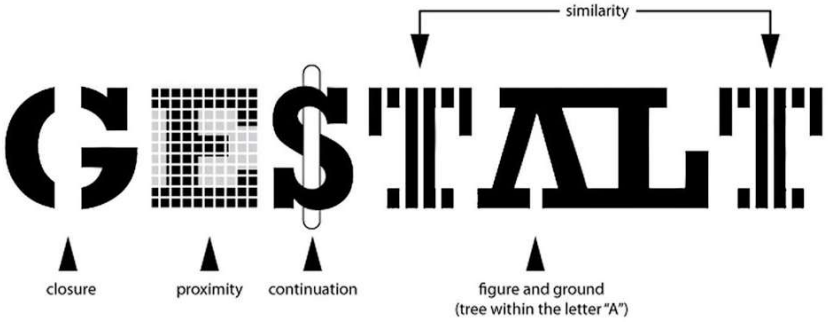
Explanation: National Monuments Authority has been established under the provisions of 'The Ancient Monuments and Archaeological Sites and Remains (Amendment and Validation) Act, 2010'. The

minimum prohibited area in respect of centrally protected monuments and protected areas is 100m, in all directions beginning at the limit of the protected area of the centrally protected monument or site. The minimum limit of regulated area of centrally protected monuments and protected areas is 200m which will begin from the limit of the prohibited area. These limits area extendable as per the classification of the centrally protected monuments and protected areas on the recommendation of the National Monuments Authority.

26. Select the option(s) which include(s) a pair of 'Gestalt' principles.
    (A) Proximity and Similarity
    (B) Continuity and Closure
    (C) Grain and Texture
    (D) Scale and Proportion

Answer: A, B

Explanation: There are six individual principles commonly associated with gestalt theory: similarity, continuation, closure, proximity, figure/ground, and symmetry & order (also called prägnanz). There are also some additional, newer principles sometimes associated with gestalt, such as common fate.



27. Select the option(s) which is/are NOT considered as primary air pollutant(s).
    (A) Suspended particulate matter
    (B) Oxides of nitrogen
    (C) Volatile organic compounds
    (D) Peroxyacetyl Nitrate

Answer: D

Explanation: AQI will consider eight pollutants (PM10, PM2.5, NO2, SO2, CO, O3, NH3, and Pb) for which short-term (up to 24-hourly averaging period) National Ambient Air Quality Standards are prescribed. VOCs in air pollution are also a concern because they contribute to the formation of ground-level ozone when they react with nitrogen oxides in the air.

28. Select the Biosphere Reserve(s) in India which is/are listed in the 'Man and the Biosphere' program of UNESCO.
    (A) Sunderban
    (B) Sena Oura
    (C) Majang Forest
    (D) Gulf of Mannar

Answer: A, D

Explanation: 12 of the 18 biosphere reserves in the country have become part of the World Network of Biosphere Reserves which is based on the UNESCO Man and the Biosphere (MAB) Programme list.

The recent additions to the list are Panna Biosphere Reserve (in 2020) and Khangchendzonga Biosphere Reserve (in 2018)

Year	Name of the Biosphere	State
2000	Nilgiri Biosphere Reserve	Tamil Nadu
2001	Gulf of Mannar Biosphere Reserve	Tamil Nadu
2001	Sundarbans Biosphere Reserve	West Bengal
2004	Nanda Devi Biosphere Reserve	Uttarakhand
2009	Pachmarhi Biosphere Reserve	Madhya Pradesh
2009	Nokrek Biosphere Reserve	Meghalaya
2009	Simlipal Biosphere Reserve	Odisha
2012	Achanakmar-Amarkantak Biosphere Reserve	Chhattisgarh
2013	Great Nicobar Biosphere Reserve	Andaman and Nicobar
2016	Agasthyamala Biosphere Reserve	Kerala and Tamil Nadu
2018	Kanchenjunga Biosphere Reserve	Sikkim
2020	Panna Biosphere Reserve	Madhya Pradesh

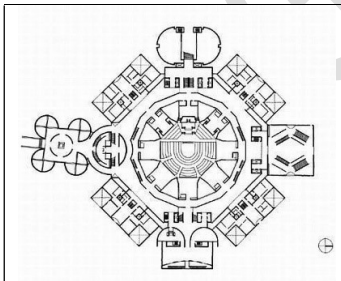
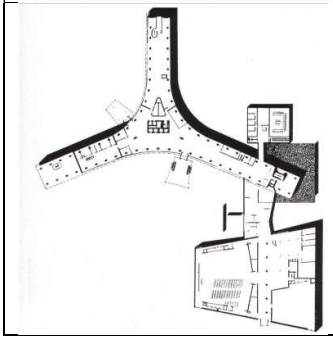
29. Match the buildings in Group I with their dominant spatial pattern in Group II.

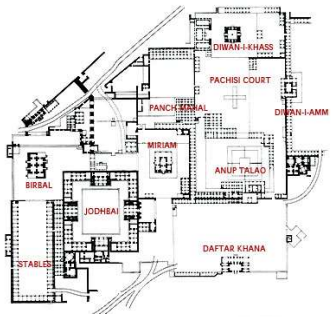
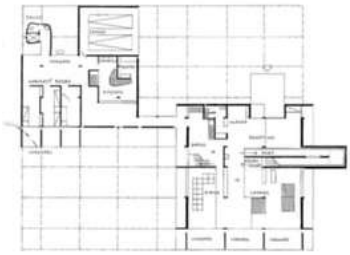
Group I	Group II
(P) National Assembly Building, Capitol Complex, Dhaka	(1) Centralized organization
(Q) Secretariat Building, UNESCO Headquarters, Paris	(2) Clustered organization
(R) Fatehpur Sikri Palace Complex	(3) Radial organization
(S) Shodhan House, Ahmedabad	(4) Linear organization
	(5) Grid organization

(A) P-1, Q-3, R-2, S-5
(B) P-5, Q-3, R-1, S-4
(C) P-3, Q-4, R-1, S-5
(D) P-1, Q-4, R-2, S-3

Answer: A

Explanation: Below are the plans showing the spatial pattern corresponding to the given buildings:

	National Assembly Building, Capitol Complex, Dhaka, designed by Louis I Kahn – Centralized Organization
	Secretariat Building, UNESCO Headquarters, Paris (also known as The Place de Fontenoy) designed by Bernard Zehrfuss and Pier Luigi Nervi – Radial Organization

	Fatehpur Sikri Palace Complex – Clustered Organization
	Shodhan House (or Villa Shodhan), Ahmedabad designed by Le Corbusier – Grid Organization

30. Match the Parts of Residential Buildings in Group-I with their respective minimum width (in m) in Group-II as per the National Building Code 2016

Group I	Group II
(P) Habitable room	(1) 1.0
(Q) Stair flight	(2) 3.0
(R) Kitchen	(3) 1.2
(S) Bathroom	(4) 1.8
	(5) 2.4

(A) P-2, Q-1, R-5, S-3
(B) P-5, Q-3, R-4, S-1
(C) P-2, Q-3, R-5, S-4
(D) P-5, Q-1, R-4, S-3

Answer: D

Explanation: Below are the standards as per Part 3: Development Control Rules and General Building Requirements of NBC Volume 1, 2016

- The area of habitable room shall not be less than 9.5 m², where there is only one room with a minimum width of 2.4 m. Where there are two rooms, one of these shall not be less than 9.5 m² and the other not less than 7.5 m², with a minimum width of 2.1 m.
- Minimum width of staircase for Residential (A-2) is 1.00 meter
- The area of a kitchen where separate dining area is provided, shall not be less than 5.0 m² with a minimum width of 1.8 m. Where there is a separate store, the area of the kitchen may be reduced to 4.5 m². A kitchen which is intended for use as dining area also, shall have a floor area of not less than 7.5 m² with a minimum width of 2.1m
- The area of a bathroom shall not be less than 1.8 m² with a minimum width of 1.2 m. The floor area of water-closet shall be 1.1 m² with a minimum width of 0.9 m. If bath and water-closet are combined, its floor area shall not be less than 2.8 m² with a minimum width of 1.2 m.

31. Match the following City Planning concepts in Group-I with their proponents in Group-II

Group I	Group II
(P) Radiant City	(1) Clarence Perry
(Q) Conservative surgery	(2) Soia-Y-Mata
(R) Broadacre City	(3) Le Corbusier
(S) Linear City	(4) Patrick Geddes
	(5) Frank Lloyd Wright

(A) P-2, Q-4, R-5, S-3
(B) P-3, Q-4, R-5, S-2
(C) P-3, Q-2, R-1, S-4
(D) P-1, Q-5, R-3, S-2

Answer: B

Explanation: Designed in the 1920s by Le Corbusier, one of Modernism's most influential architects, the "Radiant City" or Ville Radieuse was to be a linear and ordered metropolis of the future. Designed to contain effective means of transportation, as well as an abundance of green space and sunlight, Le Corbusier's city of the future would not only provide residents with a better lifestyle but would contribute to creating a better society. Though radical, strict and nearly totalitarian in its order, symmetry and standardization, Le Corbusier's proposed principles had an extensive influence on modern urban planning and led to the development of new high-density housing typologies.

In 1886 Geddes and his wife, Anna Geddes, purchased a row of slum tenements in James Court, Edinburgh, making it into a single dwelling. In and around this area Geddes commenced upon a project of "conservative surgery": "weeding out the worst of the houses that surrounded them…widening the narrow closes into courtyards" and thus improving sunlight and airflow. The best of the houses were kept and restored. Geddes believed that this approach was both more economical and more humane.

Broadacre City was proposed by F. L Wright to be a continuous urban area with a low population density and services grouped depending on the type. The city had a futuristic highway and airfields to help curb traffic. The highways connecting different cities were gigantic, with detailed design and landscaping.

The linear city was an urban plan for an elongated urban formation proposed by Arturo Soria y Mata in 1882. 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.

32. With reference to planning and design of housing, identify the correct statements.
(P) Gross population density is higher than net population density
(Q) Gross population density is lower than net population density
(R) Net population density is directly proportional to area of the plot
(S) Net population density is inversely proportional to area of the plot

(A) Both Q and S are correct
(B) Both Q and R are correct
(C) Both P and R are correct
(D) Both P and S are correct

Answer: A

Explanation: Net density is calculated for residential land uses only, as opposed to gross density, which is calculated over the whole land area, including urban and non-urban land uses where people do not live. So, Gross population density is lower than net population density. Net population density is

defined as population divided by the residential plat area. So, net population density is inversely proportional to the plot area for a given population.

33. Match the Mission in Group I with their objectives in Group II.

Group I	Group II
(P) National Mission on Enhanced Energy Efficiency	(1) Gain better understanding of climate science, impacts, challenges by setting up climate research fund
(Q) National Mission on Sustainable Habitat	(2) Weather insurance mechanism and afforestation of 6 million hectares of degraded forest land
(R) National Water Mission	(3) Decrease energy consumption in large consuming industries
(S) National Mission on Strategic Knowledge for Climate Change	(4) 20% improvement of water use efficiency through pricing
	(5) Enforcement of automotive fuel economy standards using pricing measures

(A) P-3, Q-5, R-4, S-1
(B) P-2, Q-5, R-4, S-3
(C) P-3, Q-4, R-5, S-1
(D) P-2, Q-5, R-3, S-4

Answer: A

Explanation: NMEEE (National Mission on Enhanced Energy Efficiency) aims to strengthen the market for energy efficiency by creating conducive regulatory and policy regime and has envisaged fostering innovative and sustainable business models to the energy efficiency sector. The Mission is implemented since 2011.

The objectives of the NMSH (National Mission on Sustainable Habitat) are as follows: 1. Promote low-carbon urban growth towards reducing GHG emissions intensity for achieving India's NDC. 2. Build resilience of cities to climate change impacts and strengthen their capacities to 'bounce back better' from climate-related extreme events and disaster risks.

The National Action Plan on Climate Change (NAPCC) describes the features of National Water Mission as under: "A National Water Mission will be mounted to ensure integrated water resource management helping to conserve water, minimize wastage and ensure more equitable distribution both across and within states. The Mission will consider the provisions of the National Water Policy and develop a framework to optimize water use by increasing water use efficiency by 20% through regulatory mechanisms with differential entitlements and pricing. It will seek to ensure that a considerable share of the water needs of urban areas are met through recycling of waste water.

The National Mission on Strategic Knowledge for Climate Change proposes a coordinated mechanism and process with a view to further enhance the effectiveness and impact of the various existing intra- and extra-mural knowledge generating systems in the country.

34. Select the option(s) that is/are listed among the Sustainable Development Goals as articulated by the United Nations.
(A) Globalization and Free Trade
(B) Sustainable Cities and Communities
(C) Protection of Indigenous Culture and Architecture
(D) Good Health and Well-being

Answer: B, D

Explanation: **The 17 sustainable development goals (SDGs) to transform our world:**
GOAL 1: No Poverty
GOAL 2: Zero Hunger
GOAL 3: Good Health and Well-being
GOAL 4: Quality Education
GOAL 5: Gender Equality
GOAL 6: Clean Water and Sanitation
GOAL 7: Affordable and Clean Energy
GOAL 8: Decent Work and Economic Growth
GOAL 9: Industry, Innovation and Infrastructure
GOAL 10: Reduced Inequality
GOAL 11: Sustainable Cities and Communities
GOAL 12: Responsible Consumption and Production
GOAL 13: Climate Action
GOAL 14: Life Below Water
GOAL 15: Life on Land
GOAL 16: Peace and Justice Strong Institutions
GOAL 17: Partnerships to achieve the Goal

35. Select the statement(s) that are TRUE regarding 'Building Security Services'.
    (A) 'Radio Frequency Identification Device' is used for electronic access control system.
    (B) 'Magnetic Loop Detector' is used for fire detection system.
    (C) 'Infrared Sensor' is used in public broadcasting system.
    (D) 'Iris Scan' is a type of biometric access control system.

Answer: A, D

Explanation: RFID technology uses electromagnetic waves to capture and read transmitted data. RFID tags, like the one on modern credit cards, hold electronic data. In the case of access control, these RFID tags hold the credential information that, when placed near a compatible reader, will transmit the info to unlock the door.

Iris recognition or iris scanning is the process of using visible and near-infrared light to take a high-contrast photograph of a person's iris. It is a form of biometric technology in the same category as face recognition and fingerprinting. It is a type of biometric access control system.

36. Select the statement(s) that are TRUE regarding 'Quality and Cost-Based Selection (QCBS)' system for tendering.
    (A) Financial bid is opened before technical bid.
    (B) Earnest Money Deposit (EMD) is submitted before the opening of technical bid.
    (C) Technically qualified bidder with lowest financial bid is always awarded the job.
    (D) A composite scoring system considering both the financial and technical bids is adopted for awarding the job.

Answer: B, D

Explanation: Quality cum Cost-Based Selection (QCBS) is a type of bid valuation based on the cost committed by the bidder and the technical qualification of the bidder. So, cost is not the only parameter for selection in this system. Least cost method (LCM) is a system where the evaluation is purely based only on the cost. Like other bids, in this system of tendering also, EMD is submitted before the opening of technical bid. In QCBS, a composite scoring system considering both the financial and technical bids is adopted for awarding the job.

37. Design of septic tank requires consideration of space for the following item(s).

(A) Settling of incoming sewage
(B) Storage of digested sludge
(C) Installation of liner to allow seepage of effluent
(D) Digestion of the settled sludge

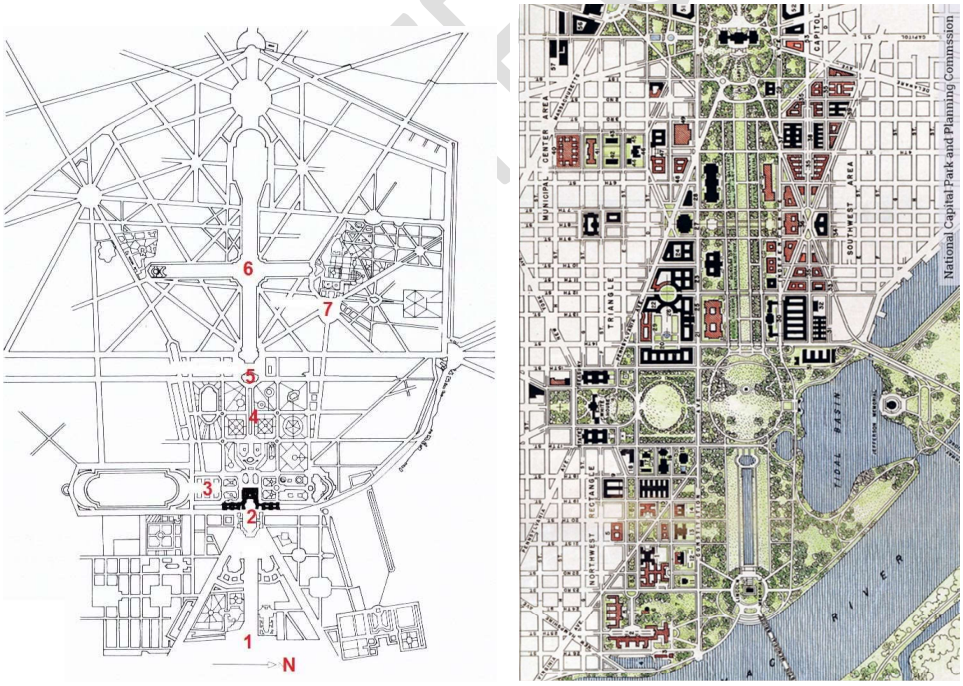
Answer: A, B, D

Explanation: The main processes which take place within the tank include segregation of settleable and floatable solids, accumulation, consolidation and storage of solids, digestion of organic matter and discharge of treated effluent. The main function of a septic tank is solids removal, where particles tend to sink or float to develop a stratification of separate layers – a bottom sludge layer, a middle liquid layer, and a top layer of scum made up of grease and fine particles. The volume of septic tank is governed by the rate of settling of incoming sewage (based on retention period of sewerage), digestion of the settled sludge, and storage of the digested sludge.

38. Select the place(s) which have adopted the "star pattern" of the French Garden in the design of its /their urban form(s).
(A) Versailles
(B) Washington D.C.
(C) Islamabad
(D) Jaipur

Answer: A, B

Explanation: Start pattern is evident in the forms of Versailles and Washington DC. The plan of Versailles, France – 1661 by Andre Le Notre & Louis Le Vau and Plan for Washington DC are shown below:



Versailles consists of a central axis with a series of cross axes which creates the framework for the layout of the highly organized palace and garden. The palace creates one of the cross axes off of the central axis. In 1791 Pierre L'Enfant set out to create Washington DC as a "magnificent city, worthy of the nation, free of its colonial origins, and bold in its assertion of a new identity." His design proposed

an orthogonal, gridded street network with diagonal avenues visually and physically connecting key civic buildings and spaces.

39. Select the parameter(s) required for determining peak rates of runoff using the Rational formula.
    (A) Intensity of rainfall
    (B) Coefficient of runoff
    (C) Velocity of flow
    (D) Hydraulic mean depth of flow

Answer: A, B

Explanation: In runoff calculation, the Rational Formula is expressed as Q = CiA where: Q =Peak rate of runoff in cubic feet per second C =Runoff coefficient, an empirical coefficient representing a relationship between rainfall and runoff.

40. As per Solid Waste Management Rules 2016 (Ministry of Environment, Forest and Climate, Govt. of India) select the correct statement(s).
    (A) "dry waste" means waste other than bio-degradable waste and inert street sweepings.
    (B) "combustible waste" means biodegradable, recyclable, reusable, hazardous solid waste having maximum calorific value of 800 kcal/kg.
    (C) "domestic hazardous waste" includes expired medicine, CFL bulbs, discarded paint drums.
    (D) "biodegradable waste" means any inorganic material that cannot be degraded by micro-organisms into simpler stable compounds.

Answer: A, C

Explanation: As per Solid Waste Management Rules 2016:

"Dry waste" means waste other than bio-degradable waste and inert street sweepings and includes recyclable and non-recyclable waste, combustible waste and sanitary napkin and diapers, etc;

"Combustible waste" means non-biodegradable, non-recyclable, non-reusable, non-hazardous solid waste having minimum calorific value exceeding 1500 kcal/kg and excluding chlorinated materials like plastic, wood pulp, etc;

"Domestic hazardous waste" means discarded paint drums, pesticide cans, CFL bulbs, tube lights, expired medicines, broken mercury thermometers, used batteries, used needles and syringes and contaminated gauge, etc., generated at the household level.

"Biodegradable waste " means any organic material that can be degraded by micro- organisms into simpler stable compounds.

41. Select the correct statement(s) from the following.
    (A) Introduction of automobiles led to urban sprawl.
    (B) Compact cities show relatively higher carbon emissions.
    (C) Land use and transportation planning is inter-dependent on each other.
    (D) Addition of a transport mode in an urban area does not change accessibility.

Answer: A, C

Explanation: Since the invention of the automobile in the 1880s, city planners have been motivated to publish numerous theories on modern city planning, which has strongly relied on the potential of cars to overcome urban sprawl. In 1894, for example, Soria Y. Mata would not have been able to link two existing cities, without evolution in the means of transportation. He coined his idea of the linear city in 1882 and implemented it in Spain twelve years after publishing it.

Transportation and land use are part of a retroactive feedback system. Accessibility is shaped by the structure, capacity, and connectivity of transportation infrastructure, which is not uniform. Since accessibility differs, this attribute has an impact on land use, such as the location of new activities, their expansion, or densification. These changes will influence activity patterns in terms of their distribution and level of transport demand.

42. Choose the correct statement(s) with regard to composting.
    (A) It produces natural soil amendment and enhances the effectiveness of fertilizer.
    (B) Warm temperature of tropical regions is least suitable for composting.
    (C) Composting is an aerobic thermophilic process.
    (D) Windrow composting and in-vessel composting are two of the common composting methods.

Answer: A, C, D

Explanation: Composting is a controlled, aerobic (oxygen-required) process that converts organic materials into a nutrient-rich soil amendment or mulch through natural decomposition. The end product is compost – a dark, crumbly, earthy-smelling material. Warm temperature of tropical regions is most suitable for composting.

The process of windrow composting is where the feedstock is shredded, mixed, and placed into windrows along a non-permeable surface. The windrows are turned on a regular basis to improve oxygen content, distribute heat to regulate temperature and to distribute moisture.

In-vessel composting involves feeding organic materials into a drum, silo, concrete-lined trench, or similar equipment. This allows good control of the environmental conditions such as temperature, moisture, and airflow. The material is mechanically turned or mixed to make sure the material is aerated.

43. Select the item(s) that are NOT stipulated as obligatory function(s) of the urban local bodies as per the 12th Schedule of the Indian Constitution.
    (A) Urban poverty alleviation
    (B) Promotion of cultural, educational and aesthetic aspects
    (C) Special measures for disaster mitigation
    (D) Prevention of cruelty to animals

Answer: C

Explanation: The obligatory functions of the urban local bodies as per the 12th Schedule of Indian Constitution are as follows:

1. Urban planning including town planning. 2. Planning of land- use and construction of buildings. 3. Planning for economic and social development. 4. Roads and bridges. 5. Water supply for domestic, industrial, and commercial purposes. 6. Public health, sanitation conservancy and solid waste management. 7. Fire services. 8. Urban forestry, protection of the environment and promotion of ecological aspects. 9. Safeguarding the interests of weaker sections of society, including the handicapped and mentally retarded. 10. Slum improvement and upgradation. 11. Urban poverty alleviation. 12. Provision of urban amenities and facilities such as parks, gardens, playgrounds. 13. Promotion of cultural, educational and aesthetic aspects. 14. Burials and burial grounds; cremations, cremation grounds and electric crematoriums. 15. Cattle pounds; prevention of cruelty to animals. 16. Vital statistics including registration of births and deaths. 17. Public amenities including street lighting, parking lots, bus stops and public conveniences. 18. Regulation of slaughter houses and tanneries.

44. The annual precipitation recorded in a town is 400 mm. Rainwater is being collected from the flat roof of a building, and then treated to potable standards, and stored. Water loss due to evaporation, transmission and treatment is 40 percent of the total harvested volume. The roof area is 500 sq.m.

There are 3 occupants, with average daily water demand as 200 lpcd. The stored rainwater will be adequate for the household's daily use for _____ days [*in integer*].

Answer: 200

Explanation: Loss of water = 40%. So run-off coefficient = 0.6

Volume of stored water from runoff = C*i*A = 0.6 * 0.4 m * 500 sqm = 120 cu.m

Daily water demand of the household = 3*200 = 600 liters = 0.6 cu.m

No. of days the stored water will be adequate for = 120/0.6 = 200 days

45. A primary school is having 8 classrooms, each having internal dimensions of 15m × 10m × 4m (height). Only the internal walls of all the classrooms are proposed to be painted. Assume a deduction of 10% internal wall area due to doors, windows etc. The specification suggests two coats of paint application. The spreading rates of the selected paint during base coat and finish coat are 4.5 l/sq.m and 2.5 l/sq.m respectively. The amount of paint (in liters) required for the job will be _____ [*in integer*].

Answer: 10080

Explanation: Total internal wall area = 8 * (2*4) * (15+10) = 1600 sqm

Area of paintwork = 1600 * 0.9 = 1440 sqm (after deduction of 10% wall area)

Paint required for first coat = 4.5 * 1440 = 6480 liters

Paint required for second coat = 2.5 * 1440 = 3600 liters

Total paint required = 10080 liters

46. A construction project consists of four activities. The quantity of work, manpower requirement, and the productivity of the activities are listed in the table below. The interrelationship between the activities are also mentioned in the table. The construction project will start on January 29. Assume no holidays for the entire duration of the project. The project will finish on February _____ [*mention date in number*].

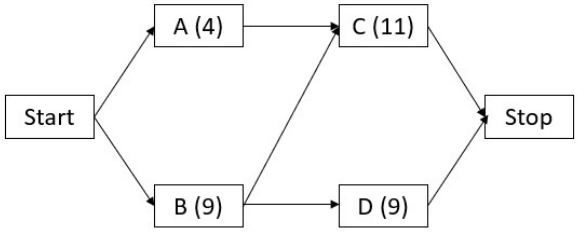
Activity	Quantity (cu.m)	Manpower (persons)	Productivity (cu.m/ man-day)	Immediate Successor Activity
A	96	8	3	C
B	252	7	4	C & D
C	275	5	5	Nil
D	126	6	3	Nil

Answer: 17

Explanation: Duration of an activity = Quantity ÷ (Manpower * Productivity). Based on this the durations of all activities are calculated and tabulated below:

Activity	Duration (days)	Immediate successor
A	96/24 = 4	C
B	252/28 = 9	C, D
C	275/25 = 11	---
D	126/18 = 7	---

The project network for the given project will be:



From the network, the critical path is B – C = 9 + 11 = 20 days

Project starts on January 29. Project completion will be 20 days from January 29. So, the project completion date will be February 17.

47. For a privately developed group housing project, the ratio of total number of dwelling units of HIG: MIG: LIG is 3:2:1. The proposed average size of HIG, MIG and LIG units in sq.m are 100, 60 and 30 respectively. The ratio of the total built up area between (MIG + LIG) to HIG will be 1: _____ [*in integer*].

Answer: 2

Explanation: Let the number of HIG, MIG and LIG dwelling units be: 3a, 2a, and a.

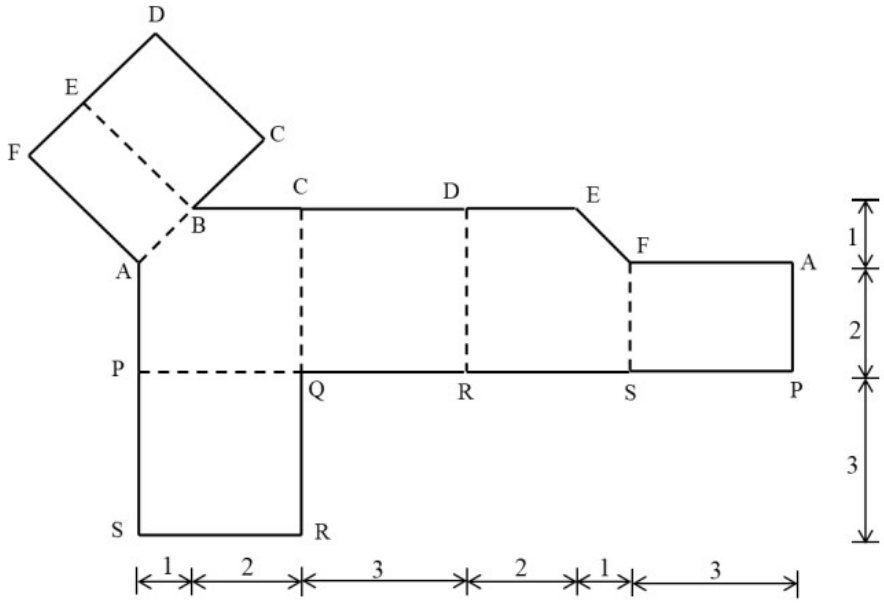
Total area of HIG = 3a * 100 = 300a

Total area of MIG = 2a * 60 = 120a

Total area of LIG = a * 30 = 30a

Ratio of the total built up area between (MIG + LIG) to HIG = (120a + 30a) ÷ 300a = 150a/300a = 1/2

48. The surface development of a three dimensional object is shown in the figure below. The dotted lines indicate the folds. The dimensions given in the figure are in centimeter. The volume of the three-dimensional object (in cu.cm) is_____ [*rounded off to one decimal place*].



Answer: 25.5

Explanation: The form of the folded solid is a cube with one corner cut-off as a triangular prism. The solid is also a prismatic solid.

Volume for such solids is given by: Area of c/s * Ht

Area of cross section for the given solid = (3*3) – (0.5*1*1) = 9 – 0.5 = 8.5 sqm

Volume of given solid = Area * Height = 8.5 * 3 = 25.5 cu.m

49. A residential housing project is designed in a plot measuring 1 hectare. The car parking area is equally distributed between the ground floor and the basement. Considering the data given below, the number of cars accommodated in the basement will be_____ [*in integer*].
Data:
FAR consumed = 2.0
Car parking area is exempted from built up area for FAR calculations.
One car parking to be given for each 100 sq.m of built-up area.
Area required for accommodating each car in ground floor = 15 sq.m
Area required for accommodating each car in basement = 25 sq.m

Answer: 75

Explanation: Total built-up area = Plot area * FAR = 10,000 sqm * 2 = 20,000 sqm

Number of car parking required = 20,000/100 = 200 cars

Let parking area on ground floor = 'x' and parking area on basement level = 'y'. Given, x = y

Number of cars on ground floor = x/15 and Number of cars on basement level = y/25

(x/15) + (y/25) = 200

- ⇨ (5y + 3y)/75 = 200
- ⇨ 8y = 200*75
- ⇨ Area of parking on basement level, y = 1875 sqm

Number of cars that can be accommodated on basement level = 1875/25 = 75

PART B1: FOR Architecture CANDIDATES ONLY

Q.50 – Q.56 Carry ONE mark Each

50. As per the CPWD Specifications (2019), the material used for cleaning marble flooring after polishing is_____.
    (A) Oxalic Acid
    (B) Caustic Soda
    (C) Bleaching Power
    (D) White Cement

Answer: A

Explanation: CPWD specifications, 2019 mentions:

"After the marble work is cured, it shall be rubbed with carborandum stone of different grades no. 60, 120 and 320 in succession or with electrical rubbing machines rubbed with carborandum items 0 to 6 nos.in succession, so as to give a plane true and highly smooth surface. It shall then be cleaned with a solution of oxalic acid, washed and finished clean".

51. The proportion of the sides of a traditional Japanese tatami mat is _____.
    (A) 1 : 1.414
    (B) 1 : 1.5
    (C) 1 : 2
    (D) 1 : 1.618

Answer: C

Explanation: A tatami is a type of mat used as a flooring material in traditional Japanese-style rooms. Tatamis are made in standard sizes, twice as long as wide, about 0.9 m by 1.8 m depending on the region.

52. As per IS:4954 – 1964, the acceptable noise level (in dB) for urban residential areas is_____.
    (A) 35-45
    (B) 65-75
    (C) 20-30
    (D) 15-25

Answer: A

Explanation: The acceptable noise levels for residential areas and for various types of buildings as per IS 4954 – 1964 are as follows:

TABLE 2 ACCEPTABLE NOISE LEVELS

ACCEPTABLE OUTDOOR NOISE LEVELS IN RESIDENTIAL AREAS

Sl No.	Location	Noise level dB (A)
i)	Rural	25-35
ii)	Suburban	30-40
iii)	Residential (urban)	35-45
iv)	Urban (residential and business)	40-50
v)	City	45-55
vi)	Industrial area	50-60

ACCEPTABLE INDOOR NOISE LEVELS FOR VARIOUS TYPES OF BUILDINGS

Sl No.	Location	Noise level dB (A)
i)	Radio & TV studio	25-30
ii)	Music room	30-35
iii)	Hospitals, class room, auditoria	35-40
iv)	Apartments, hotels, homes	35-40
	Conference rooms, small offices	
v)	Court rooms, private offices, libraries	40-45
vi)	Large public offices, banks, stores, etc	45-50
vii)	Restaurants	50-55

53. Identify the Indian tribe that is associated with the vernacular dwelling illustrated in the image below.

(A) *Bhotia,* Uttarakhand
(B) *Toda,* Tamil Nadu
(C) *Naga,* Nagaland
(D) *Kutia Kondh,* Odisha

Answer: B

Explanation: The toda huts are based in the Nilgiri range of Tamil Nadu, in southern India. This hut is more like a dwelling than a hut, the dwellings are built close together and often aligned in a row. A typical settlement may contain up to 5 dwellings, a dairy dairy house and various buffalo pens for their cattle known as Hundi. Their houses are barrel vaulted with a largely sheltered roof that covers the whole structure and goes down till the ground. Sturdy bamboo poles are placed on the front and back facade which span the whole length of the house. This forms the structure of the house, the largest pole being in the center for support. Over this bamboo structure there are arches made from split bamboo and a vine like plant leaf called Rattan. Dried grass is used for the thatched exterior as a roof covering. The front and back sides sometimes have granite or decorated stone. The main entrance is very small

and odd, about 90 cm in height and width to protect the occupants from harsh weather and wild animals. The front is usually decorated with tribal symbols and patterns.

54. Thermal diffusivity of a wall is influenced by the choice of building material. Identify the statement(s) that is/are correct.
    (A) Thermal diffusivity is inversely proportional to thermal conductivity.
    (B) Increase in specific heat capacity increases the thermal diffusivity.
    (C) Materials with low thermal diffusivity have a high amplitude dampening effect.
    (D) Thermal diffusivity is inversely proportional to the density of material.

Answer: C, D

Explanation: Thermal diffusivity is the thermal conductivity divided by density and specific heat capacity at constant pressure. It measures the ability of a material to conduct thermal energy relative to its ability to store thermal energy. High diffusivity means heat transfers rapidly. Materials with low thermal diffusivity obstructs heat transfer through them – and hence have a higher thermal dampening effect.

55. Select the statement(s) which are NOT correct with respect to burnt clay bricks.
    (A) Lime (1% of clay) in carbonated form lowers the fusion point of bricks
    (B) Magnesia (>1% of clay) imparts red colour to the bricks.
    (C) Iron Pyrites tend to oxidize and decompose the brick during burning.
    (D) Alkalis (alkaline salts) when present in excess (>10% of clay) decrease the probability of efflorescence.

Answer: B, D

Explanation: A small quantity of magnesia in brick earth imparts a yellow tint to the bricks and decreases shrinkage. But excess magnesia leads to the decay of bricks. Efflorescence is caused because of alkalies present in bricks. When bricks come into contact with moisture, water is absorbed and the alkalies crystallize. After drying, grey or white powder patches appear on the brick surface.

56. Select the example(s) of Art Nouveau architecture.
    (A) Basilica of the Sagrada Familia, Barcelona
    (B) Chrysler Building, New York
    (C) Eiffel Tower, Paris
    (D) Mackintosh Building of the Glasgow School of Art, Glasgow

Answer: A, D

Explanation: On 19 March 1882, construction of the Sagrada Família began under architect Francisco de Paula del Villar. In 1883, when Villar resigned, Gaudí took over as chief architect, transforming the project with his architectural and engineering style, combining Gothic and curvilinear Art Nouveau forms. The Glasgow School of Art's Mackintosh Building is an iconic British Art Nouveau style building which was severely damaged by fire in 2014.

57. Match the buildings in Group I with their architectural feature in Group II.

Group I	Group II
(P) Erechtheion, Athens	(1) Hypostyle Hall
(Q) Temple of Karnak, near Luxor	(2) Caryatid
(R) Hagia Sophia, Istanbul	(3) Pendentive
(S) Pantheon, Rome	(4) Flying Buttress
	(5) Oculus

    (A) P-2, Q-1, R-3, S-5
    (B) P-1, Q-2, R-4, S-3

(C) P-3, Q-1, R-5, S-2
(D) P-2, Q-3, R-4, S-5

Answer: A

Explanation: A caryatid is a sculpted female figure serving as an architectural support taking the place of a column or a pillar supporting an entablature on her head – seen at the caryatid porch of Erechtheion, Athens.

The Great Hypostyle Hall is located within the Karnak temple complex, in the Precinct of Amon-Re. It is one of the most visited monuments of Ancient Egypt.

Famous in particular for its massive dome, Hagia Sophia has its central dome in pendentive structure sets on top of the square spaced nave.

The Pantheon Oculus is an opening at the center of the dome. This 25-foot wide opening is the only natural light source in the Pantheon interior. Curiously, some believe the oculus was not only designed to illuminate the Pantheon interior, but to also serve as a sundial.

58. Match the architects in Group I with their key architectural ideas in Group II.

Group I	Group II
(P) Ludwig Mies van der Rohe	(1) Bowellism
(Q) Kisho Kurokawa	(2) Skin-and-bones architecture
(R) Richard Rogers	(3) Served and servant spaces
(S) Louis I. Kahn	(4) Dymaxion
	(5) Metabolism

(A) P-2, Q-5, R-1, S-3
(B) P-4, Q-1, R-3, S-5
(C) P-2, Q-1, R-5, S-3
(D) P-4, Q-5, R-1, S-2

Answer: A

Explanation: Mies van der Rohe, famous for his saying "less is more," was one of the preeminent modernist architects, well known for pioneering the extensive use of glass in buildings. His works introduced a new level of simplicity and transparency, and his buildings were often referred to as "skin-and-bones" architecture for their emphasis on steel structure and glass enclosure.

Kisho Kurokawa first came into the public eye in 1960 when, along with other architects, he founded Metabolism, an architectural movement and philosophy of change. This philosophy was invented, almost as propaganda, for the World Design Conference held that year in Tokyo.

Bowellism is a modern architectural style heavily associated with Richard Rogers. It is described as a transient architectural and flippant style. The style consists of services for the building, such as ducts, sewage pipes, and lifts, being located on the exterior to maximise space in the interior.

Louis I Kahn categorized space into two categories. Served and servant. Servant spaces are supporting the main areas of the building. Toilets, storage and technical rooms, stairs and corridors, duct shaft and kitchens are main examples of spaces that are considered as servant spaces. Servant spaces are not meant for habitation, they will be visited only briefly or by internal staff. They are mostly meant for mechanical equipment, ducts and pipes. Served spaces are the primary areas. Concert halls, commercial spaces, living rooms, bedrooms, auditoriums, classes and exhibition spaces are common examples of served spaces. Served spaces are meant for habitation and are meant for primary occupants of the space or visitors. They are meant for people.

59. Match the pump types in Group-I with their key components in Group-II.

Group I	Group II
(P) Centrifugal pumps	(1) Piston rod
(Q) Reciprocating pumps	(2) Impeller
(R) Rotary pumps	(3) Gear
(S) Impulse pumps	(4) Eductor pipe
	(5) Hydraulic ram

(A) P-2, Q-1, R-3, S-5
(B) P-1, Q-2, R-5, S-3
(C) P-2, Q-5, R-4, S-1
(D) P-1, Q-2, R-3, S-4

Answer: A

Explanation: A centrifugal pump is a mechanical device designed to move a fluid by means of the transfer of rotational energy from one or more driven rotors, called impellers. Fluid enters the rapidly rotating impeller along its axis and is cast out by centrifugal force along its circumference through the impeller's vane tips.

In a reciprocating pump, piston is directly connected to a rod that is the piston rod. This piston rod is again connected to the connecting rod. Piston makes the reciprocating motion in forward and backward motion and creates pressure inside the cylinder.

Rotary Gear Pumps are designed to run at 1440 RPM and maximum temperature up to 200ºc. Performance at low speed is always advantageous as it improves efficiency, reduce noise level and enhances operational life.

Hydraulic Ram or Impulse Pumps convert the difference in elevation between the feed pipe intake (e.g. from a nearby river or flow from an elevated reservoir) and the pump itself into kinetic energy that moves water through the delivery pipe.

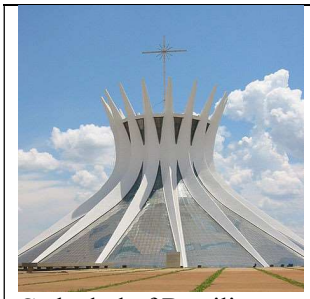
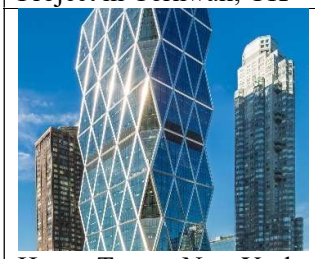
60. Match the geometric forms in Group I with the buildings in Group II.

Group I	Group II
(P) Hyperboloid	(1) Petronas Twin Towers, Kuala Lumpur, by Cesar Pelli
(Q) Geodesic Dome	(2) Palazzo del Lavoro, Turin, by Pier Luigi Nervi
(R) Diagrid structure	(3) The Biomes at the Eden Project in Cornwall, UK, by Nicholas Grimshaw
(S) Umbrella Structures	(4) Hearst Tower, New York, by Norman Foster
	(5) Cathedral of Brasilia, by Oscar Niemeyer

(A) P-5, Q-3, R-4, S-2
(B) P-3, Q-5, R-2, S-4
(C) P-5, Q-3, R-1, S-4
(D) P-3, Q-1, R-4, S-2

Answer: A

Explanation: The given builds and their respective geometric forms are discussed below:

 Cathedral of Brasilia	It was designed by Brazilian architect Oscar Niemeyer and calculated by Brazilian structural engineer Joaquim Cardozo. The cathedral is a hyperboloid structure constructed from 16 concrete columns, weighing 90 tons each.
 The Biomes at the Eden Project in Cornwall, UK	Designed as geodesic domes by Grimshaw Architects, two Biome buildings - the Rainforest Biome and the Mediterranean Biome - each consist of several domes joined together and are joined in the middle by the Link building.
 Hearst Tower, New York	Designed by Norman Foster with a series of 16, 5-meter-tall triangulated structural elements form a steel "diagrid" – an efficient structural form that results in a 20-percent reduction in the volume of steel required to support the building, when compared to a conventional moment frame structure.
 Palazzo del Lavoro, Turin	The Palace of Labour designed and built by Nervi and his son Antonio for the Turin exhibition of 1961 was the result of a competition held in 1959. The vast roof of this exhibition space was supported by 16 independent 'umbrellas', each made of steel beams fixed to a central concrete column.

61. Match the instruments in Group I with the physical quantities they measure in Group II.

Group I	Group II
(P) Goniophotometer	(1) Electromagnetic Energy at Specific Wavelengths of Light
(Q) Pyrheliometer	(2) Luminous Flux of Directed Light Sources
(R) Spectrophotometer	(3) Direct Solar Irradiance
(S) Forward-Looking Infrared Camera	(4) Temperature
	(5) Global Solar Radiation

(A) P-5, Q-2, R-1, S-3
(B) P-2, Q-3, R-1, S-4
(C) P-2, Q-3, R-1, S-5
(D) P-5, Q-1, R-2, S-4

Answer: B

Explanation: A Goniophotometer is a device used for measurement of the light emitted from an object at different angles. A goniophotometer can be used for various applications: (i) Measurement of luminous flux of a light source. (ii) Measurement of luminous intensity distribution from a source much smaller than the size of the goniophotometer

A pyrheliometer is an instrument for measurement of direct beam solar irradiance. Sunlight enters the instrument through a window and is directed onto a thermopile which converts heat to an electrical signal that can be recorded. The signal voltage is converted via a formula to measure watts per square metre.

A spectrophotometer is an analytical instrument used for the objective calculation of visible light, UV light, or infrared light emission or reflection. Spectrophotometers measure intensity as a function of the wavelength of the light source.

Forward-looking infrared (FLIR) cameras, typically used on military and civilian aircraft, use a thermographic camera that senses infrared radiation. They can be used to help pilots and drivers steer their vehicles at night and in fog, or to detect warm objects against a cooler background. FLIR thermal imaging cameras can also be a useful, efficient tool for screening people for signs of elevated skin temperature.

62. Match the terms in Group I with their associated items in Group II.

Group I	Group II
(P) Scotopic vision	(1) ability to see under low light condition using rod cells
(Q) Presbyopia	(2) vision in bright light using cone cells
(R) Emmetropia	(3) inability to focus on distant objects
(S) Photopic vision	(4) ideal distance vision
	(5) inability to focus on nearby objects

(A) P-1, Q-4, R-5, S-2
(B) P-4, Q-3, R-1, S-2
(C) P-1, Q-5, R-4, S-2
(D) P-4, Q-2, R-1, S-5

Answer: C

Explanation: In the study of human visual perception, scotopic vision (or scotopia) is the vision of the eye under low-light conditions. Scotopic vision uses only rods to see, meaning that objects are visible, but appear in black and white, whereas photopic vision uses cones and provides color. Presbyopia is the gradual loss of your eyes' ability to focus on nearby objects. Emmetropia is the refractive state in a healthy eye in which, any individual achieves the perfect visual function.

63. Choose the correct statement(s) from the following:
(A) Waste water from sinks, baths, etc. enters through the top inlet of a gully trap, while foul water from sweeping of rooms or courtyards enters from side inlet.
(B) Anti-siphon traps have a reduced water-way at the inlet side, while the outlet being larger prevents the pipe from filling full and causing siphonic action.
(C) Intercepting traps prevent foul gases from street sewer to enter into the house.
(D) P, Q and S traps are classified according to their shape.

Answer: C, D

Explanation: In a Gully Trap, wastewater from sinks, bath etc. enters in through back inlet and un-foul water from the sweeping of rooms, courtyards etc. enters from the top, where a coarser screen grating is fitted to check the solid matter. The water-way in the anti-D trap is reduced, which ensures the removal of all refuse, while the outlet being larger prevents the pipe from filling full and causing siphonic action. The construction of anti-siphon trap is such that when water seal is subjected to the

pull due to siphonic action, the heavier atmospheric pressure on the inlet side presses the water down and the air can pass from by – pass tube and the water is stored in trough, when the pressure on both sides becomes equal, the water stored in trough falls back in the tube and seals it. The street sewers contain foul gases in it and if their passage are not checked from street sewers to the house they may enter in the house drain and pollute the atmosphere. For this purpose a trap in one inspection chamber is provided outside the houses, which is called an intercepting trap. This trap is provided at top with a cleaning eye with a plug. P, Q and S traps are classified according to their shape. They essentially consist of a U-tube which retains water acting as a seal between the foul gas atmosphere.

64. A steel wire of 5.65 mm diameter and 50 m length is used for a hoisting crane. The wire is used to vertically lift a weight of 200 kg attached to its lowest end. Assume the Young's Modulus of Elasticity of Steel as 2×10^5 N/mm² and gravitational acceleration as 10 m/sec². The elongation of the steel wire (in mm) will be ____ [*rounded off to two decimal places*].

Answer: 19.75 to 20.15

Explanation: Force on the steel wire = weight * gravitational acceleration = 200 * 10 = 2000 N

Area of cross-section = (π * 5.65 * 5.65)/4 = 25.0719 sqmm

Stress for the given steel wire = Force/area = 2000/25.0719 = 79.7706 N/sqmm

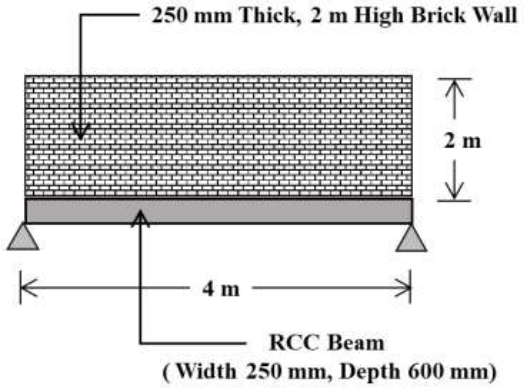
Strain = elongation/original length = elongation/50

Youngs modulus = stress/strain = 79.7706/strain = 2×10^5 N/mm²

Strain = 79.7706/(2×10^5) = elongation/50

⇨ Elongation = (50 * 79.7706)/(2×10^5) = 0.0199 m = 19.94 mm

65. A simply supported RCC beam of span 4 m is supporting a brick wall over its entire span. The brick wall is 250 mm thick and 2 m high. The RCC beam has a depth of 600 mm and width of 250 mm. The density of brick masonry and RCC can be assumed as 18 KN/m³ and 25 KN/m³ respectively. Considering the load of the wall and self-weight of the RCC beam, the maximum bending moment in the beam (in KN-m) will be _____ [*rounded off to two decimal places*].



Answer: 25.4 to 25.6

Explanation: Total self-weight (load) of brick wall = volume * density = (4 * 2 * 0.25) * (18 KN/m³) = 36 kN

Total self-weight (load) of RCC beam = volume * density = (4 * 0.6 * 0.25) * (25 KN/m³) = 15 kN

Total UDL on the given beam = 36 + 15 = 51 kN

Total UDL value on beam = Total load/span = 51/4 = 12.75

Maximum bending moment in the beam = $wL^2/8$ = (12.75 * 4 * 4)/8 = 25.5 kNm

PART B2: FOR Planning CANDIDATES ONLY

Q.66 – Q.72 Carry ONE mark Each

66. Select the most appropriate scale to measure Attitude, Opinion and Perception.
    (A) Likert scale
    (B) Ratio scale
    (C) Richter scale
    (D) Armstrong scale

Answer: A

Explanation: A Likert scale is a unidimensional scale that researchers use to collect respondents' attitudes and opinions. Researchers often use this psychometric scale to understand the views and perspectives towards a brand, product, or target market.

67. Jal Shakti Abhiyan initiated by the Ministry of Jal Shakti does NOT include ____.
    (A) Water conservation and rainwater harvesting
    (B) Renovation of traditional water bodies
    (C) Hydroelectric power generation
    (D) Intensive afforestation

Answer: C

Explanation: The intervention areas of Jal Shakti Abhiyan are: (1) Water conservation and rainwater harvesting (2) Renovation of traditional and other water bodies/tanks (3) Reuse of recharge structures (4) Watershed development and (5) Intensive afforestation.

68. Select the correct sequence of activities for transit-operation planning process.
    (A) Network Route Design → Timetable Development → Vehicle Scheduling → Crew Scheduling
    (B) Timetable Development → Crew Scheduling → Vehicle Scheduling → Network route design
    (C) Vehicle Scheduling → Crew Scheduling → Network Route Design → Timetable Development
    (D) Crew Scheduling → Vehicle Scheduling → Timetable Development → Network Route Design

Answer: A

Explanation: The public-transport (transit) operation planning process commonly includes four basic activities, usually performed in sequence: (1) network route design, (2) timetable development, (3) vehicle scheduling, and (4) crew scheduling. The purpose of this work is to address the vehicle scheduling problem, while taking into account the association between the characteristics of each trip (urban, peripheral, inter-city, etc.) and the vehicle type required for the particular trip.

69. Select the correct sequence of steps for designing the operation of a signalized intersection.
    (A) Signal Phasing → Green Allocation → Cycle Length Selection
    (B) Green Allocation → Cycle Length Selection → Signal Phasing
    (C) Cycle Length Selection → Signal Phasing → Green Allocation
    (D) Signal Phasing → Cycle Length Selection → Green Allocation

Answer: D

Explanation: The signal design procedure involves six major steps. They include: (1) phase design, (2) determination of amber time and clearance time, (3) determination of cycle length, (4) apportioning of

green time, (5) pedestrian crossing requirements, and (6) performance evaluation of the design obtained in the previous steps.

70. Considering the following statements (P, Q, and R), select the correct option.
(P) Prediction of travel demand depends on target year modal alternatives.
(Q) Prediction of travel demand depends on target year population.
(R) Prediction of travel demand depends on target year land use.

(A) Only P is correct
(B) Only P & R are correct
(C) Only Q & R are correct
(D) P, Q, and R are all correct

Answer: D

Explanation: Inputs required for prediction of travel demand in a future target year include – target year land use data, population (the two of which are required for trip generation and trip distribution) and modal alternatives.

71. During Covid-19 pandemic, the ARHC scheme was launched in 2021 by the Government of India to address the problems of poor urban migrants. The term ARHC refers to_____.
(A) Accessible Rural Health Centre
(B) Affordable Rental Housing Complexes
(C) Affordable Rentals for Homeless Citizens
(D) Accessible Rural Housing Complexes

Answer: B

Explanation: Affordable Rental Housing Complexes (ARHCs) is a sub-scheme under Pradhan Mantri Awas Yojana- Urban (PMAY-U).

72. Choose the non-probability sampling method where the sample is taken from a group of people easy to contact or reach.
(A) Simple random sampling
(B) Snowball sampling
(C) Convenience sampling
(D) Stratified random sampling

Answer: C

Explanation: Convenience sampling is a non-probability sampling method where units are selected for inclusion in the sample because they are the easiest for the researcher to access. This can be due to geographical proximity, availability at a given time, or willingness to participate in the research.

Q.73 – Q.81 Carry TWO marks Each

73. Match the items in Group-I with the most appropriate stages of travel demand modelling in Group-II.

Group I	Group II
(P) US-EPA's MOVES	(1) Trip Assignment
(Q) Fratar Model	(2) Trip Production
(R) Growth Factor Model	(3) Trip Distribution
(S) User Equilibrium	(4) Mobile source emission estimation
	(5) Destination Choice

(A) P-4, Q-3, R-2, S-1

(B) P-3, Q-4, R-5, S-1
(C) P-4, Q-3, R-1, S-5
(D) P-3, Q-4, R-2, S-5

Answer: A

Explanation: EPA's MOtor Vehicle Emission Simulator (MOVES) is a state-of-the-science emission modeling system that estimates emissions for mobile sources at the national, county, and project level for criteria air pollutants, greenhouse gases, and air toxics.

Fratar method is used for trip distribution. The basic premise of the Fratar procedure is that. the distribution of trips from a zone is proportional to the present movements out of. the zone modified by the growth factor of the zone to which the trips are attracted. The future volume of trips out of a zone is determined from the present trips out of.

Growth factor model is a method which respond only to relative growth rates at origins and destinations and this is suitable for short-term trend extrapolation.

User equilibrium is a user-driven traffic assignment in which each user chooses the most convenient path selfishly. It guarantees that fairness among users is respected since, when the equilibrium is reached, all users sharing the same origin and destination will experience the same travel time.

74. Match the Acts in Group-I with the corresponding organizations empowered by the Act in Group-II.

Group I	Group II
(P) RERA 2016	(1) Chief Information Commission
(Q) RTI Act 2005	(2) Land Registration Board
(R) Town and Country Planning Act	(3) Real Estate Regulatory Authority
(S) Municipal Act	(4) Development Authority
	(5) Board of Councillors

(A) P-4, Q-1, R-2, S-3
(B) P-2, Q-3, R-4, S-5
(C) P-3, Q-1, R-4, S-5
(D) P-3, Q-1, R-5, S-2

Answer: C

Explanation: RERA Act establishes a Real Estate Regulatory Authority (RERA) in each state for regulation of the real estate sector and also acts as an adjudicating body for speedy dispute resolution. The bill was passed by the Rajya Sabha on 10 March 2016 and by the Lok Sabha on 15 March 2016.

The Central Information Commission is a statutory body, set up under the Right to Information Act in 2005 under the Government of India to act upon complaints from those individuals who have not been able to submit information requests to a Central Public Information Officer or State Public Information Officer due to either the officer not have been appointed, or because the respective Central Assistant Public Information Officer or State Assistant Public Information Officer refused to receive the application for information under the Right to Information Act.

Development authorities are generally set up under the provision of town and country planning act. Board of municipal councillors is set up under the provisions of municipal act.

75. As per IRC 11:1962, separate bicycle tracks may be provided when the peak hour _____.

Which of the following statement(s) can be used to correctly fill in the blank?

(P) Bicycle traffic is 400 bicycles/hour or more and the volume of motorized vehicles is 100-200 vehicles/hour
(Q) Bicycle traffic is 100 bicycles/hour or more and the volume of motorized vehicles exceed 200 vehicles/hour
(R) Bicycle traffic is 100-200 bicycles/hour and the volume of motorized vehicle is 100-200 vehicles/hour

(A) Only P & Q
(B) Only P & R
(C) Only R
(D) P, Q & R

Answer: A

Explanation: As per IRC 11:1962 – separate cycle tracks may be provided when the peak hour cycle traffic is 400 or more on routes with a traffic of 100 motor vehicles or more but not more than 200 per hour. When the number of motor vehicles using the route is more than 200 per hour, separate cycle tracks may be justified even if the cycle traffic is only 100 per hour.

76. As per URDPFI Guidelines (2015), match the following settlement types in Group-I to their population range in Group-II.

Group I	Group II
(P) Large city	(1) 50,000 to 1 lakh
(Q) Metropolitan city II	(2) 50 lakh to 1 crore
(R) Small town II	(3) 20,000 to 50,000
(S) Medium town I	(4) More than 1 crore
	(5) 5 lakh to 10 lakh

(A) P-5, Q-2, R-3, S-1
(B) P-2, Q-4, R-1, S-5
(C) P-5, Q-4, R-1, S-2
(D) P-4, Q-2, R-3, S-5

Answer: A

Explanation: Classification of Urban Settlements as per URDPFI Guidelines Volume 1 is given below:

Table 1.2: Classification of Urban Settlements

S.No.	Classification	Sub-category	Population Range	Governing Local Authority	Number of Cities as per Census of India, 2011
1	Small Town*	Small Town I	5,000 - 20,000	Nagar Panchayat	7467
		Small Town II	20,000- 50,000	Nagar Panchayat/ Municipal Council	
2	Medium Town	Medium Town I	50,000 to 1,00,000	Municipal Council	
		Medium Town II	1 lakh to 5 lakh	Municipal Council	372
3	Large City	--	5 lakh to 10 lakh	Municipal Corporation	43
4	Metropolitan City	Metropolitan City I	10 lakh to 50 lakh	Municipal Corporation/ Metropolitan Planning Committee	45
		Metropolitan City II	50 lakh to 1 Crore	- Same -	5
5	Megapolis	--	More than 1 Crore	- Same -	3

77. Match the application areas in Group I with the Satellites/Satellite sensors in Group II.

Group I	Group II

(P) Cyclone prediction	(1) IRNSS 11
(Q) Communication	(2) HySIS
(R) High resolution mapping	(3) GSAT 30
(S) Navigation	(4) CARTOSAT 3
	(5) SCATSAT 1

(A) P-5, Q-3, R-4, S-1
(B) P-3, Q-5, R-1, S-4
(C) P-5, Q-2, R-4, S-3
(D) P-2, Q-3, R-5, S-1

Answer: A

Explanation: ScatSat-1 (Scatterometer Satellite-1) was a satellite providing weather forecasting, cyclone prediction, and tracking services to India. GSAT-3, also known as EDUSAT, was a communications satellite which was launched on 20 September 2004 by the Indian Space Research Organisation. EDUSAT is the first Indian satellite built exclusively to serve the educational sector. Cartosat-3 is the 3rd generation of high-resolution imaging satellites developed by ISRO. It was developed in response to increased demand for imaging services. IRNSS-1I is the eighth satellite in the Indian Regional Navigational Satellite System.

78. Select the institution(s) that are mandated as per the 73rd Constitutional Amendment Act, 1992 of India.
(A) Panchayat
(B) Municipal council
(C) Ward committee
(D) Gram Sabha

Answer: A, D

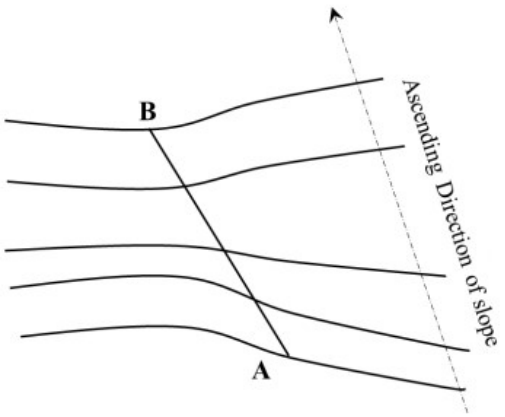
Explanation: The Constitution (73rd Amendment) Act was passed in 1992 and it came into effect on 24 April 1993. The Act empowered state governments to take the necessary steps that would lead to the formalisation of the gram panchayats and gram sabhas and help them operate as units of self-governance.

79. Select the method(s) that can be used for landuse classification based on satellite images.
(A) Maximum Likelihood
(B) Northwest Corner Method
(C) K Means
(D) ANN

Answer: A, C, D

Explanation: Maximum likelihood classification assumes that the statistics for each class in each band are normally distributed and calculates the probability that a given pixel belongs to a specific class. K-Means Clustering is an unsupervised learning algorithm that is used to solve the clustering problems in machine learning or data science. It is used in land use classification based on satellite images. Artificial Neural Networks (ANN) are algorithms based on brain function and are used to model complicated patterns and forecast issues. The Artificial Neural Network (ANN) is a deep learning method which can be used for determination of land use classification from satellite imagery.

80. The figure below shows a contour diagram and two points (A & B) on the continuously ascending surface. The horizontal projection of AB is 200 m long, and the gradient of AB is 1 in 25. The constant contour interval (in m) is _____ [*in integer*].



Answer: 2

Explanation: The slope between A and B is given as 1 in 25 and horizontal projection (i.e., run) is 200 m. So, rise/run = 1/25. Rise/200 = 1/25.

Total rise = 200/25 = 8. The number of contour intervals from the map is 4. So, the contour interval = 8m/4 = 2 meters

81. A given zone is characterized in the following tables in terms of household size, and vehicle ownership. Table I shows the trip rates of households, and Table II shows the household composition. For households of size two and above, having one or more vehicles, the total daily home-based trips made are _____ [*in integer*].

Table I: Trip rate of households
(unit: number of daily home-based trips per household)

Vehicles / household	**Persons / household**		
	One (1)	Two (2)	Three & above (3+)
Zero (0)	0.5	2	4
One (1)	0.6	2.5	5
Two & above (2+)	1	3	6

Table II: Household composition of zone
(unit: number of households)

Vehicles / household	**Persons / household**		
	One (1)	Two (2)	Three & above (3+)
Zero (0)	100	200	150
One (1)	200	300	200
Two & above (2+)	50	100	50

Answer: 2350

Explanation: The households of size two and above, having one or more vehicles are highlighted in table 2 below:

Vehicles / household	**Persons / household**		
	One (1)	Two (2)	Three & above (3+)
Zero (0)	100	200	150
One (1)	200	300	200
Two & above (2+)	50	100	50

The daily number of home-based trips for each category = Number of households of that category (given in table 2) * The trip rate of that category (given in table 1)

Total home-based trips made (for households of size two and above, having one or more vehicles) = (300*2.5) + (200*5) + (100*3) + (50*6) = 750 + 1000 + 300 + 300 = 2350