

GATE 2022 General Aptitude

Q.1 – Q.5 Carry ONE mark each.

1. After playing _____ hours of tennis, I am feeling _____ tired to walkback.
- too / too
 - too / two
 - two / two
 - two / too

Answer: D

2. The average of the monthly salaries of M, N and S is ₹ 4000. The average of the monthly salaries of N, S and P is ₹ 5000. The monthly salary of P is ₹ 6000. What is the monthly salary of M as a percentage of the monthly salary of P?
- 50%
 - 75%
 - 100%
 - 125%

Answer: A

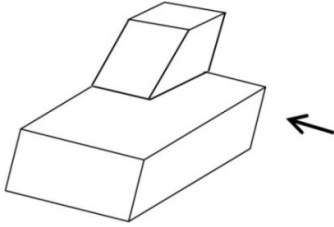
3. A person travelled 80 km in 6 hours. If the person travelled the first part with a uniform speed of 10 kmph and the remaining part with a uniform speed of 18 kmph. What percentage of the total distance is travelled at a uniform speed of 10 kmph?
- 28.25
 - 37.25
 - 43.75
 - 50.00

Answer: C

4. Four girls P, Q, R and S are studying languages in a University. P is learning French and Dutch. Q is learning Chinese and Japanese. R is learning Spanish and French. S is learning Dutch and Japanese. Given that: French is easier than Dutch; Chinese is harder than Japanese; Dutch is easier than Japanese, and Spanish is easier than French. Based on the above information, which girl is learning the most difficult pair of languages?
- P
 - Q
 - R
 - S

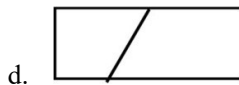
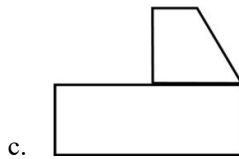
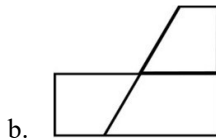
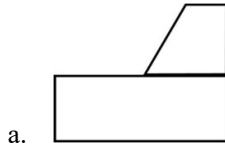
Answer: B

5.



A block with a trapezoidal cross-section is placed over a block with rectangular cross section as shown above.

Which one of the following is the correct drawing of the view of the 3D object as viewed in the direction indicated by an arrow in the above figure?



Answer: A

Q. 6 – Q. 10 Carry TWO marks each.

6. Humans are naturally compassionate and honest. In a study using strategically placed wallets that appear “lost”, it was found that wallets with money are more likely to be returned than wallets without money. Similarly, wallets that had a key and money are more likely to be returned than wallets with the same amount of money alone. This suggests that the primary reason for this behavior is compassion and empathy.

Which one of the following is the CORRECT logical inference based on the information in the above passage?

- a. Wallets with a key are more likely to be returned because people do not care about money
- b. Wallets with a key are more likely to be returned because people relate to suffering of others
- c. Wallets used in experiments are more likely to be returned than wallets that are really lost
- d. Money is always more important than keys

Answer: B

7. A rhombus is formed by joining the midpoints of the sides of a unit square.
What is the diameter of the largest circle that can be inscribed within the rhombus?

- a. $\frac{1}{\sqrt{2}}$
- b. $\frac{1}{2\sqrt{2}}$
- c. $\sqrt{2}$
- d. $2\sqrt{2}$

Answer: A

8. An equilateral triangle, a square and a circle have equal areas.
What is the ratio of the perimeters of the equilateral triangle to square to circle?
- a. $3\sqrt{3} : 2 : \sqrt{\pi}$
 - b. $\frac{\sqrt{3} \sqrt{3}}{2} : 2 : \sqrt{\pi}$
 - c. $\frac{\sqrt{3} \sqrt{3}}{4} : 4 : 2\sqrt{\pi}$
 - d. $\frac{\sqrt{3} \sqrt{3}}{2} : 2 : 2\sqrt{\pi}$

Answer: B

9. Given below are three conclusions drawn based on the following three statements.
Statement 1: All teachers are professors.
Statement 2: No professor is a male.
Statement 3: Some males are engineers.
- Conclusion I: No engineer is a professor.
Conclusion II: Some engineers are professors.
Conclusion III: No male is a teacher.
- Which one of the following options can be logically inferred?
- a. Only conclusion III is correct
 - b. Only conclusion I and conclusion II are correct
 - c. Only conclusion II and conclusion III are correct
 - d. Only conclusion I and conclusion III are correct

Answer: A

10. In a 12-hour clock that runs correctly, how many times do the second, minute, and hour hands of the clock coincide, in a 12-hour duration from 3 PM in a day to 3 AM the next day?
- a. 11
 - b. 12
 - c. 144
 - d. 2

Answer: Marks to All

PART A: COMMON FOR ALL CANDIDATES

Q.11 – Q .28 Carry ONE mark Each

11. The concentric circles in a sun-path diagram represent _____.
- Altitude angle
 - Azimuth angle
 - Day of the year
 - Hour of the day

Answer: A

Explanation: In a sun-path diagram or solar chart diagram; Straight lines passing from the centre represent various azimuth angles. Concentric circles represent circles of equal altitude above the horizon. The point at the intersection of the corresponding date and hour line represents the instantaneous location of the sun.

12. The operational guidelines on Credit Linked Subsidy Scheme for Economically Weaker Sections (EWS), January 2017, by the erstwhile Ministry of Housing & Urban Poverty Alleviation, Government of India, defines EWS households as those having an annual income up to _____ (in Indian Rupees).
- 2,00,000
 - 2,50,000
 - 3,00,000
 - 3,50,000

Answer: C

Explanation: The operational guidelines on Credit Linked Subsidy Scheme for Economically Weaker Sections (EWS), January 2017, by the erstwhile Ministry of Housing & Urban Poverty Alleviation, Government of India, defines EWS households as those having an annual income up to 3,00,000 Indian Rupees and defines EWS house as “An all-weather single unit or a unit in a multistoried super structure having carpet area of up to 30 sq. m. with adequate basic civic services and infrastructure services like toilet, water, electricity etc.”

13. Which of the following is a Vector Graphics Software?
- Inkscape
 - Odeon
 - Adobe Dreamweaver
 - Design Builder

Answer: A

Explanation: Inkscape is a free and open-source vector graphics editor used to create vector images, primarily in Scalable Vector Graphics format. Other formats can be imported and exported. Inkscape can render primitive vector shapes and text.

14. The main cable of a suspension bridge supports the deck with hangars. These hangars are equidistant along the length of the bridge and represent a uniformly distributed load. Assuming the cable to be weightless as compared to the applied loading, the best approximation of the shape that the cable takes for this loading is a__.

- a. Catenary curve
- b. Circular arc
- c. Parabolic curve
- d. Hyperbolic curve

Answer: C

Explanation: Despite their visual similarities, catenaries and parabolas are two very different curves, both conceptually and mathematically. A catenary curve is created by its own weight, pulling down because of gravity. The parabolic curves of the suspension cable are not created by gravity alone, but also by other forces: compression and tension acting on it. Also, the weight of the suspension cable is negligible compared to that of the deck, but it is also supporting the weight of the deck. This is also another conceptual reason why the suspension cables hang in a parabolic curve.

15. Arrange the following road types in descending order of accessibility.

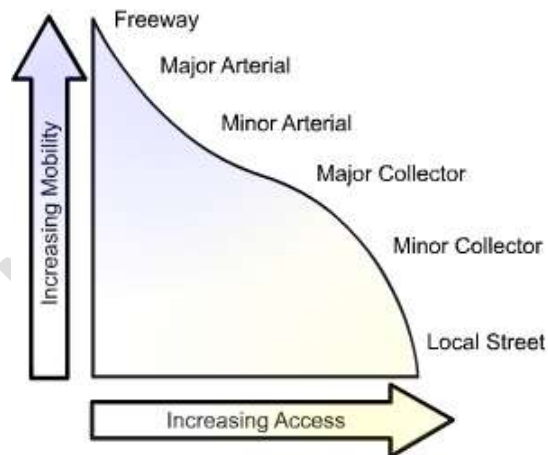
- a. Arterial Road
- b. Expressway
- c. Collector Road
- d. Local Street

Options:

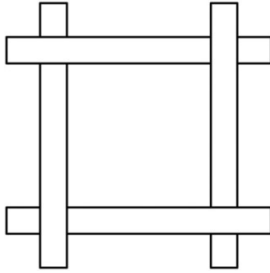
- a. Q-P-R-S
- b. S-R-P-Q
- c. S-P-R-Q
- d. P-Q-S-R

Answer: B

Explanation:



16. The following two-dimensional visual composition represents_____.



- a. Interlocking
- b. Intersecting
- c. Interlacing
- d. Interpenetrating

Answer: C

Explanation: The interlace pattern includes all those patterns which are formed of several broad lines interlaced together. It is of primary importance that the interlacing broad lines shall pass under and over one another alternately. Interlacing pattern can be either repeating or self-contained. They are usually symmetrical and never lose their geometric nature.

17. The Golden Ratio refers to__.

- a. $1:\sqrt{2}$
- b. $2:(1 + \sqrt{5})$
- c. 1:1
- d. 16:9

Answer: B

Explanation: Golden ratio, also known as the golden section, golden mean, or divine proportion, in mathematics, the irrational number $(1 + \text{Square root of } \sqrt{5})/2$, often denoted by the Greek letter ϕ or τ , which is approximately equal to 1.618.

18. Hogarth's Line of Beauty is a_____.

- a. Horizontal straight line
- b. Zigzag line
- c. Vertical straight line
- d. Serpentine line

Answer: D

Explanation: In "The Analysis of Beauty" (1753), William Hogarth identifies, in contradistinction to "straight lines" and "curved lines," a "serpentine line" that he terms the "line of beauty." According to this theory, S-shaped curved lines signify liveliness and activity and excite the attention of the viewer as contrasted with straight lines, parallel lines, or right-angled intersecting lines, which signify stasis, death, or inanimate objects.

19. Which of the following sites were added to Ramsar List in the year 2020?

- a. Ashtamudi Wetland
- b. Asan Conservation Reserve
- c. Chilika Lake
- d. Lonar Lake

Answer: B, D

Explanation: In 2020, the following sites were added to the Ramsar Sites of India List:

- December 2020 – The Tso Kar Wetland Complex was added to the list of Ramsar sites in India. This includes the high-altitude wetland complex of two connected lakes, Startsapuk Tso and Tso Kar, in Ladakh.
 - November 2020 – Maharashtra – Lonar Lake
 - November 2020 – Agra (Uttar Pradesh) – Sur Sarovar also called, Keetham Lake
 - November 2020 – Uttarakhand – Asan Barrage
 - July 2020 – Bihar – Kanwar Lake or KabalTaal
 - February 2020 – Kolkata – Sunderban Reserve Forest (Sunderban Wetlands)
- Four new sites have been added to the list of Ramsar Sites in India in August 2021. These are:
- Sultanpur National Park – Gurugram, Haryana
 - Bhindawas Wildlife Sanctuary – Jhajjar, Haryana
 - Thol Lake Wildlife Sanctuary – Near Ahmedabad, Gujarat
 - Wadhvana Wetland – Vadodara, Gujarat

20. Which of the following help(s) in keeping direct solar radiation out of the building?
- a. Mashrabiya
 - b. Badgir
 - c. Malquf
 - d. Chajja

Answer: A, D

Explanation: The projection of the mashrabiya achieves several purposes: it allows air from three sides to enter, even if the wind outside is blowing parallel to the house façade; it serves the street, and in turn the neighborhood, as a row of projected mashrabiya provides shelter for those in the streets from rain or sun. It also stops direct solar radiation from entering the building. A chhajja is an overhanging eave or roof covering found in Indian architecture. It is characterised with large support brackets with different artistic designs. Its main purpose is to stop direct solar radiation from entering into the building. Badgir and Malquf are traditional windcatchers in Iranian and Egyptian architecture.

21. As per the Handbook of Professional Documents 2015, Council of Architecture, India, architects are liable ____.
- a. If the building is used for any other purpose than the one for which it was designed
 - b. If any unauthorized changes or illegal modifications are made by the owner(s)/occupant(s)
 - c. If the client suffers damage/loss due to lack of proper professional service
 - d. If the architect fails to attain the standard of care as prescribed by law

Answer: C, D

Explanation: An architect is not liable for any liability, if the damage to the building has occasioned in the following circumstances:

- Use of building for the purposes other than for which it has been designed
- Any changes/modifications to the building carried out by the owner(s)/occupant(s) without the consent or approval of the architect who designed and/ or supervised the construction of the building

- Any changes/alterations/modifications carried out by consulting another architect without the knowledge and consent of erstwhile architect or without obtaining No Objection Certificate from him
 - Illegal/unauthorized changes/alteration/renovations/modifications carried out by the owner(s) or the occupant(s)
 - Any compromise with the safety norms by the owner(s)/ occupant(s)
 - Distress due to leakage from terrace, toilets, water logging within the vicinity of the building and that would affect the strength/stability of the structure or general well-being
 - Lack of periodical maintenance or inadequate maintenance by the owner(s)/occupant(s)
 - Damages caused due to any reasons arising out of 'specialized consultants' deficient services with regard to design and supervision of the work entrusted to them, who were appointed/ engaged in consultation with the Client
 - Damages caused to the building for the reasons beyond the control of the architect
22. As per the United Nations Transforming our world: The 2030 agenda for sustainable development, 2015, which of the following Sustainable Development Goals (SDGs) directly address water related issues?
- a. SDG-1
 - b. SDG-4
 - c. SDG-6
 - d. SDG-14

Answer: C, D

Explanation: The 17 Sustainable Development Goals (SDGs) are: (1) No Poverty, (2) Zero Hunger, (3) Good Health and Well-being, (4) Quality Education, (5) Gender Equality, (6) Clean Water and Sanitation, (7) Affordable and Clean Energy, (8) Decent Work and Economic Growth, (9) Industry, Innovation and Infrastructure, (10) Reduced Inequality, (11) Sustainable Cities and Communities, (12) Responsible Consumption and Production, (13) Climate Action, (14) Life Below Water, (15) Life On Land, (16) Peace, Justice, and Strong Institutions, (17) Partnerships for the Goals.

23. For a masonry section, the line of action of force shifts to incorporate the effects of lateral forces and induced moments. Consider a masonry section of width 600 mm. Assuming a zero tensile stress capacity and a linear stress-strain response for the entire domain of loading, the minimum value of eccentricity at which the section will crack (in mm, rounded off to one decimal place) is_____.

Answer: 97.0 to 103.0

Explanation: Minimum value of eccentricity at which the section will crack = width/6 = 600/6 = 100 mm

24. The maximum and minimum indoor dry bulb temperature of a room are 38 °C and 34 °C, respectively. If the corresponding outdoor maximum and minimum dry bulb temperature are 42 °C and 30 °C, respectively, then the thermal damping of the room (in percentage, rounded off to two decimal places) is__.

Answer: 66.00 to 67.00

Explanation: Difference in outside temperatures, $\Delta T_o = 42 - 30 = 12^\circ\text{C}$
Difference in inside temperatures, $\Delta T_i = 38 - 34 = 4^\circ\text{C}$

$$\text{Thermal damping} = \frac{\Delta T_o - \Delta T_i}{\Delta T_o} = \frac{12 - 4}{12} = \frac{8}{12} = 66.67\%$$

25. A building site measures 96 sq.cm on a scale of 1:12500. The actual area it represents (in hectare, in integer) is _____.

Answer: 150 to 150

Explanation: Given scale = 1:12500

Scale factor for area = $(1/12500)^2 = 1:156250000$

- ⇒ 1 sqcm on site map = 156250000 sqcm = 15625 sqm = 1.5625 hectares
 ⇒ 96 sqcm on site map = $(96 * 1.5625) = 150$ hectares

26. An off-street car parking lot contains a total of 75 bays. If the parking lot was used by 687 cars over a period of 12 hours, the average parking turn-over of the parking lot (in vehicles per hour per bay, rounded off to two decimal places) is _____.

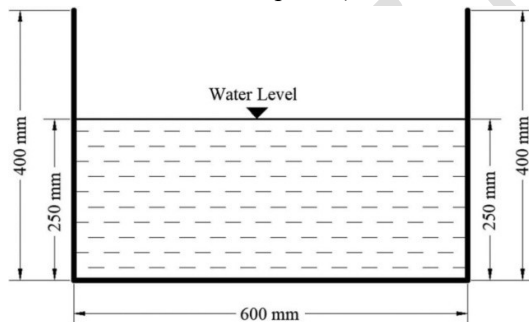
Answer: 0.76 to 0.77

Explanation: Given, number of bays = 75 bays

Number of cars which used parking lot in 12-hour period = 687 cars

$$\text{Average parking turnover} = \frac{687}{12 * 75} = 0.7633$$

27. The hydraulic radius of the following rectangular open drainage section (in mm, Rounded off to two decimal places) is _____.



Answer: 135.00 to 138.00

Explanation: Wet cross-sectional area = $(600 \text{ mm} \times 250 \text{ mm})$

Wet cross-sectional perimeter = $(250 + 600 + 250) = 1100 \text{ mm}$

$$\text{Hydraulic radius} = \frac{\text{Wet c/s area}}{\text{Wet c/s perimeter}} = \frac{600 * 250}{1100} = 136.3636 \text{ mm}$$

28. A town with 0.45 million population sends its entire organic waste to a composting site on a daily basis through a truck of 15 ton carrying capacity. Assume total waste generated per capita per day is 0.21 kg and 40% of the total waste is organic waste. The minimum number of weekly round trips required by the truck (in integer) will be _____.

Answer: 21 to 21

Explanation: Total organic post generated by the town per day = $0.45 * 1000000 * 0.21 * 0.4 = 37800$ kg = 37.8 ton

Number of trips required on daily basis = $37.8 / 15 = 2.52 \approx 3$ trips

Minimum number of weekly round trips = $7 * 3 = 21$ trips

Q.29 – Q .49 Carry TWO marks Each

29. The correct sequence of the following Construction Project Development stages, as per the National Building Code of India 2016 is _____.

- p. Resource Planning
- q. Project Inception
- r. Commissioning and Handing over
- s. Tendering
- t. Site Survey and Soil Investigation
- u. Selection of Construction Methodology

Options:

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

Answer: C

Explanation: Stages of a construction project as per National Building Code, 2016 are:

a) Project formulation and appraisal stage:

- 1) Inception,
- 2) Feasibility, and
- 3) Strategic planning

b) Pre-construction stage:

- 1) Project development,
- 2) Planning for construction, and
- 3) Tender action

c) Construction stage, and

d) Commissioning and handing over stage.

30. Match the aspects in **Group I** with the corresponding items in **Group II**.

Group I		Group II	
p.	Fire safety	1.	Intruder alarm
q.	Seismic safety	2.	Zero–strength barrier
r.	Water efficiency	3.	Stair lift
s.	Accessible design	4.	Aerator
		5.	Auxiliary damper

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

Answer: D

Explanation: Fluid viscous dampers, or seismic dampers as they are sometimes referred to, are hydraulic devices that, when stroked, dissipate the energy placed on a structure by seismic events, wind buffeting or thermal motion. Aeration treatment consists of passing large amounts of

air through water and then venting the air outside. The air causes the dissolved gases or volatile compounds to release from the water. The air and the contaminants released from the water are vented. A stair lift is a mechanical device for lifting people, typically those with disabilities, up and down stairs.

31. Match the States in Group I with the corresponding Vernacular Building Typologies in Group II

Group I		Group II	
(P)	Kerala	(1)	<i>Morung</i>
(Q)	Jharkhand	(2)	<i>Pol</i>
(R)	Nagaland	(3)	<i>Dhumkuria</i>
(S)	Gujarat	(4)	<i>Nalukettu</i>
		(5)	<i>Ghotul</i>

- P-4, Q-5, R-3, S-2
- P-5, Q-1, R-2, S-4
- P-5, Q-3, R-1, S-4
- P-4, Q-3, R-1, S-2

Answer: D

Explanation: The vernacular building typologies given in the question are described below, The traditional big house of Kerala was called the nalukettu. These houses were built according to the scientific principles of the traditional ThachuSasthra (the science of architecture). Dhumkuria is a youth-centric dormitory in the Oraon tribe. As in any other dormitories, members engage in singing and dancing, and the elders of Dhumkuria provide training in socio-cultural, politico-economic, and religious grounds to the young members of the group. They encourage *cooperativism* and *collectivism*. A Morung served as the educational centre for the Nagas, where the traditional training and learning process was maintained and implemented. A pol in India is a housing cluster which comprises many families of a particular group, linked by caste, profession, or religion. Pols are typical of urban centres in Gujarat especially of Old Ahmedabad.

32. Match the examples in Group I with their corresponding typologies in Group II.

Group I		Group II	
(P)	Navi Mumbai	(1)	Counter Magnet
(Q)	Hissar	(2)	Urban Agglomeration
(R)	Greater Mumbai	(3)	Satellite Town

(S)	Delhi-Mumbai Industrial Corridor	(4)	University Town
		(5)	Investment Region

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

Answer: C

Explanation: Navi Mumbai is a planned township of Mumbai. It was developed in 1972 as a new urban township of Mumbai. The population of Navi Mumbai has reached more than 1 million inhabitants. It is one of the world's largest planned new cities that was conceived as a satellite city to relief the strain on Mumbai

Hisar has been identified as a counter-magnet city for the region to develop as an alternative center of growth to Delhi

As per Census 2011, Mumbai is an Urban Agglomeration coming under category of Mega City with total population of 1,83,94,912. Mumbai UA includes cities like Mumbai, Thane, Kalyan and Dombivali, Navi Mumbai and 4 other cities.

The Delhi–Mumbai Industrial Corridor Project (DMIC) is a planned industrial development project between India's capital, Delhi and its financial hub and major port city, Mumbai. It's a major invest region having 24 industrial regions and 8 investment regions.

33. Match the Place(s)/Event(s) in **Group I** with the corresponding Heritage Significance/Characteristics in **Group II**.

Group I		Group II	
(P)	Chhatrapati Shivaji Terminus, Mumbai	(1)	A long interaction between people and the landscape
(Q)	Kumbh Mela	(2)	Cultural routes
(R)	Walled City of Jaipur	(3)	Victorian Gothic revival and traditional Indian features
(S)	Rock Shelters of Bhimbetka	(4)	Intangible cultural heritage
		(5)	Traditional human settlement, land use reflecting an interchange of ancient Hindu and Mughal ideas

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

Answer: B

Explanation: The Chhatrapati Shivaji Terminus, formerly known as Victoria Terminus Station, in Mumbai, is an outstanding example of Victorian Gothic Revival architecture in India, blended with themes deriving from Indian traditional architecture. According to a report released by the Ministry

of External Affairs, the Kumbha Mela has been inscribed on the Representative List of Intangible Cultural Heritage of Humanity by the Intergovernmental Committee for the Safeguarding of the Intangible Cultural Heritage under UNESCO. The walled city of Jaipur, in India’s north-western state of Rajasthan was founded in 1727 by Sawai Jai Singh II. Unlike other cities in the region located in hilly terrain, Jaipur was established on the plain and built according to a grid plan interpreted in the light of Vedic architecture. The streets feature continuous colonnaded businesses that intersect in the centre, creating large public squares called *chaupars*. Markets, shops, residences and temples built along the main streets have uniform facades. The city's urban planning shows an exchange of ideas from ancient Hindu and early modern Mughal as well as Western cultures. The grid plan is a model that prevails in the West, while the organization of the different city sectors (chowkris) refers to traditional Hindu concepts. Designed to be a commercial capital, the city has maintained its local commercial, artisanal, and cooperative traditions to this day.

34. Match the Urban Design Concepts in **Group I** with their corresponding Proponents in **Group II**.

Group I		Group II	
(P)	Vertical theory of Urban Design	(1)	Ian Bentley
(Q)	Theory of Responsive Environments	(2)	Gordon Cullen
(R)	Serial Vision	(3)	Norman Pressman
(S)	Winter Urbanism	(4)	Ken Yeang
		(5)	Paul Oliver

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

Answer: B

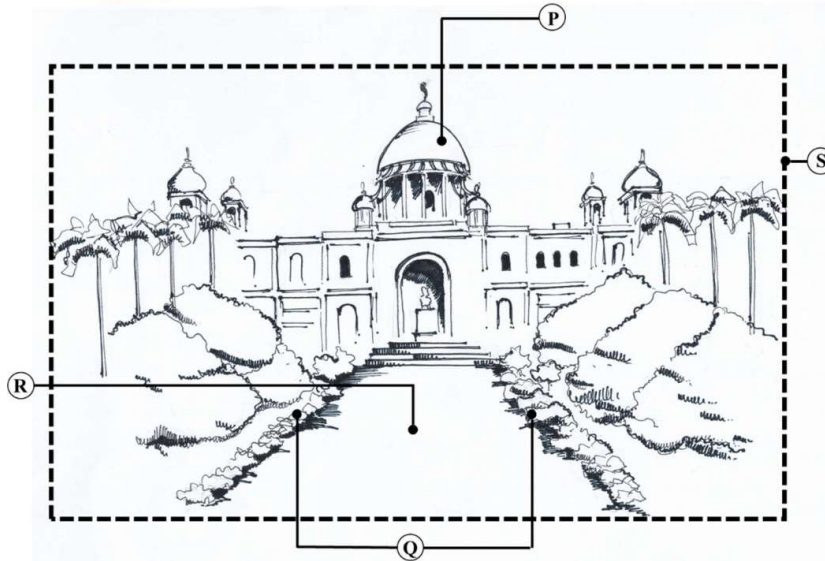
Explanation: Reinventing The Skyscraper: A Vertical Theory Of Urban Design is a book authored by Ken Yeang. The book includes Unique treatment of urban design of skyscrapers. Includes progressive ideas about vertical landscaping. Provides new mapping techniques useful in both conventional and vertical urban design.

Theoretical Framework of the Study Ian Bentley's Responsive Environment (1985) discusses that the built environment should provide freedom of choices to everyone and that planning towards a "responsive" environment should be a "product of progressive social and political attitudes" (Bentley, et.al, 1985).

Serial Vision is a visual approach to urban design first introduced by Gordon Cullen in his 1961 classic Townscape. This method of visual representation can be used as a tool for evaluating current experience in moving around a space, analyzing it, designing alternatives, and presenting a new design.

Notable advocates of climate-sensitive urban design for winter settlements were the Swedish-English architect Ralph Erskine and the Canadian planner Norman Pressman. Pressman published numerous books and articles on winter cities between 1986 and 2004. While his works looked at a range of different ways of making winter cities more livable, his work settled and focused on three climate-sensitive design principles for winter cities. Here his microclimatic design ideas focused on maximizing solar access, minimizing the negative effects of wind, and managing snowfall and gathering.

35. In the following sketch, P, Q, R, and S refer to elements of an urban space. Identify P, Q, R, S.



- P-Path, Q-Vista, R- Edge, S-Landmark
- P-Vista, Q-Edge, R- Landmark, S-Path
- P-Landmark, Q-Vista, R- Path, S-Edge
- P-Landmark, Q-Edge, R- Path, S-Vista

Answer: D

Explanation: Kevin Lynch argues that for any given city, a corresponding set of mental images exist in the minds of the people who experience that city. Contributing to those images are five qualities which Lynch identifies as Paths, Edges, Districts, Nodes, and Landmarks.

Paths

- These are the streets, sidewalks, trails, canals, railroads, and other channels in which people travel
- They arrange space and movement between space

Edges

- Boundaries
- They can be either Real or Perceived
- These are walls, buildings, and shorelines, curbstone, streets, overpasses, etc.

Districts

- Medium to large areas that are two-dimensional
- An individual enters into and out of these areas
- Have common identifying characteristics

Nodes

- Large areas you can enter, serve as the foci of the city, neighborhood, district, etc.
- Offers the person in them multiple perspectives of the other core elements
- "...the most successful node seemed both to be unique in some way and at the same time to intensify some surrounding characteristic"

Landmarks

- Points of reference person cannot enter into
- These are buildings, signs, stores, mountains, public art
- At least one aspect of them is unique or memorable in the context they exist
- Mobile Points (such as Sun) can be used as well

Vista: In urban design, a terminating vista is a building or monument that stands at the end or in the middle of a road, so that when one is looking up the street the view ends with the site.

36. As per the URDPFI Guidelines 2015, match the type of Health Care Facilities in **Group I** to the corresponding population served per unit in **Group II**.

Group I		Group II	
(P)	Multi-Speciality Hospital	(1)	15,000
(Q)	Dispensary	(2)	50,000
(R)	Veterinary Hospital	(3)	1,00,000
(S)	General Hospital	(4)	2,50,000
		(5)	5,00,000


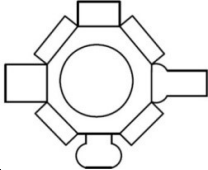

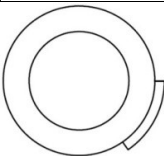
- P-1, Q-2, R-3, S-4
- P-3, Q-1, R-5, S-4
- P-4, Q-3, R-5, S-2
- P-5, Q-1, R-2, S-3

Answer: B

Explanation: Details regarding the requirements of Healthcare Facilities, as per URDPFI Guidelines are shown in the table given below,

Sr. No.	Category	No. of beds	Population served per unit	Area requirement
1.	Dispensary	--	15000	0.08 to 0.12 Ha
2.	Nursing home, child welfare and maternity centre	25 to 30 beds	45000 to 1 lakh	0.20 to 0.30 Ha
3.	Polyclinic	Some observation beds	1 lakh	0.20 to 0.30 Ha
4.	Intermediate Hospital (Category B)	80 beds Initially maybe for 50 beds including 20 maternity beds	1 lakh	Total Area = 1.00 Ha a) Area for Hospital = 0.60 Ha b) Area for residential Accommodation = 0.40 Ha
5.	Intermediate Hospital (Category A)	200 beds Initially the provision maybe for 100 beds	1 lakh	Total Area = 3.70 Ha a) Area for hospital = 2.70 Ha b) Area for residential Accommodation = 1.00 Ha
6.	Multi-Speciality Hospital (NBC)	200 beds Initially the provision may be for 100 beds	1 Lakh	Total Area = 9.00 Ha a) Area for hospital = 6.00 Ha b) Area for residential accommodation = 3.00 Ha
7.	Speciality Hospital (NBC)	200 beds Initially the provision may be for 100 beds	1 Lakh	Total Area = 3.70 Ha a) Area for hospital = 2.70 Ha b) Area for residential accommodation = 1.00 Ha
8.	General Hospital (NBC)	500 Initially the provision maybe for 300 beds	2.5 lakh	Total Area = 6.00 Ha a) Area for hospital = 4.00 Ha b) Area for residential Accommodation = 2.00 Ha
9.	Family Welfare Centre (MPD, pg 134)	As per requirement	50,000	Total area = 500 sqm 800 sqm
10.	Diagnostic centre (MPD, pg 134)	--	50,000	Total area = 500 sqm to 800 sqm
11.	Veterinary Hospital for pets and animals (MPD, pg 134)	--	5 lakh	Total area = 2000 sqm
12.	Dispensary for pet animals and birds (MPD, pg 134)	--	1 lakh	Total area = 300 sqm
13.	Rehabilitation centres			As per requirement

37. Match the plan forms in **Group I** with their corresponding project names in **Group II**.

Group I		Group II	
(P)		(1)	New Parliament of Egypt, Cairo
(Q)		(2)	Apple Park Campus, California
(R)		(3)	Commerzbank, Frankfurt
(S)		(4)	30 St. Mary Axe, London
		(5)	Parliament Building, Dhaka

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

Answer: D

Explanation: Commerzbank Tower is shaped as a 60-metre (197 ft) wide rounded equilateral triangle with a central, triangular atrium. At nine different levels, the atrium opens up to one of the three sides, forming large sky gardens. These open areas allow more natural light in the building, reducing the need for artificial lighting.

Louis Kahn designed the entire JatiyaSangsad complex, which includes lawns, lake and residences for the Members of the Parliament (MPs). The architect's key design philosophy was to represent Bengali culture and heritage, while at the same time optimizing the use of space. The exterior of the building is striking in its simplicity, with huge walls deeply recessed by porticoes and large openings of regular geometric shapes. The main building, which is at the center of the complex, is divided into three parts – the Main Plaza, South Plaza and Presidential Plaza. An artificial lake surrounds three sides of the main building of JatiyaSangsadBhaban, extending to the Members of Parliament hostel complex. This skillful use of water to portray the riverine beauty of Bengal adds to the aesthetic value of the site.

The Parliament Building in the New Administrative Capital is built upon 126000m, it consists of the main building, the service building and the landscape works includes the fences, internal roads and the green areas.

Apple Park: Located on a suburban site totalling 1.46 km², it houses more than 12,000 employees in one central four-story circular building of approximately 0.26 km². Apple co-founder Steve Jobs wanted the campus to look less like a business park and more like a nature refuge.

38. Match the Biosphere reserves in India in **Group I** with their corresponding locations in **Group II**.

Group I		Group II	
(P)	Agasthyamala Biosphere Reserve	(1)	Western Himalayan region, Himachal Pradesh
(Q)	Nokrek Biosphere Reserve	(2)	Western Ghats, Kerala and Tamil Nadu
(R)	Cold desert Biosphere Reserve	(3)	Tura range, Meghalaya
(S)	Simlipal Biosphere Reserve	(4)	Kachchh, Rajkot, Surendranagar, and Patan districts, Gujarat
		(5)	Mayurbhanj district, Odisha

- P-2, Q-1, R-4, S-3
- P-2, Q-3, R-1, S-5
- P-3, Q-1, R-4, S-5
- P-4, Q-5, R-1, S-3

Answer: B

Explanation: The Agasthyamala Biosphere Reserve is a biosphere reserve in India established in 2001, located in the southernmost end of the Western Ghats and includes 3,500.36 km² of which 1828 km² is in Kerala and 1672.36 km² is in Tamil Nadu.

The Nokrek Biosphere Reserve is located in the northeast of India on the Tura Range, which forms part of the Meghalaya Plateau (average altitude: 600 metres).

Cold Desert Biosphere Reserve is a biosphere reserve located in the Western Himalayas, within Himachal Pradesh in North India. Declared a biosphere reserve in 2009, it comprises the Pin Valley National Park and its surroundings, Kibber Wildlife Sanctuary, Sarchu and Chandratat, etc.

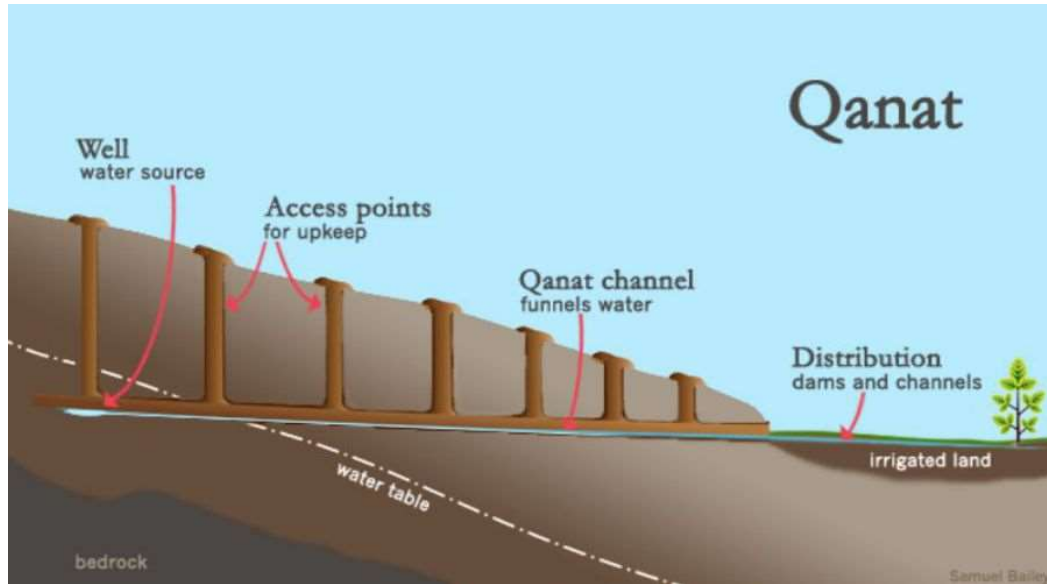
Similipal derives its name from 'Simul' (silk cotton) tree. It was formally designated a tiger reserve in 1956 and brought under Project Tiger in the year 1973. It was declared a biosphere reserve by the Government of India in June 1994. It has been part of the UNESCO World Network of Biosphere Reserve since 2009.

39. In traditional Persian context, qanat system refers to

- An underground water-way, tunnelled and channeled
- A system where water is raised by a series of scoops fixed to a moving belt stretched between two wheels
- A method of conducting water from a source-well rather than raising it
- A system where water is conducted from enclosure to enclosure by straightforward gravity fall

Answer: A, C, D

Explanation: Qanats are underground tunnel systems that bring infiltrated groundwater, surface water, or spring water to the earth's surface using only gravitational force. Qanats have been used for irrigation and drinking water for centuries worldwide, particularly in the Middle East and North Africa and Central and West Asia.



40. Which of the following is/are classified as the Principles of Universal Design?
- Perceptible Information
 - Tolerance for Error
 - Occult Balance
 - Simple and Intuitive Use

Answer: A, B, D

Explanation: The 7 Principles of Universal Design were developed in 1997 by a working group of architects, product designers, engineers, and environmental design researchers, led by the late Ronald Mace in the North Carolina State University. The purpose of the principles is to guide the design of environments, products, and communications. According to the Center for Universal Design in NCSU, the Principles "may be applied to evaluate existing designs, guide the design process and educate both designers and consumers about the characteristics of more usable products and environments."

- Principle 1: Equitable Use
- Principle 2: Flexibility in Use
- Principle 3: Simple and Intuitive Use
- Principle 4: Perceptible Information
- Principle 5: Tolerance for Error
- Principle 6: Low Physical Effort
- Principle 7: Size and Space for Approach and Use

41. As per the URDPFI Guidelines 2015, which of the following Organoleptic and Physical parameters comply with the acceptable limit requirements of drinking water quality?
- Colour: Maximum 5 Hazen units
 - Turbidity: Maximum 1 NTU
 - PH Value: Minimum 10
 - Total Dissolved Solids: Maximum 500 mg/l

Answer: A, B, D

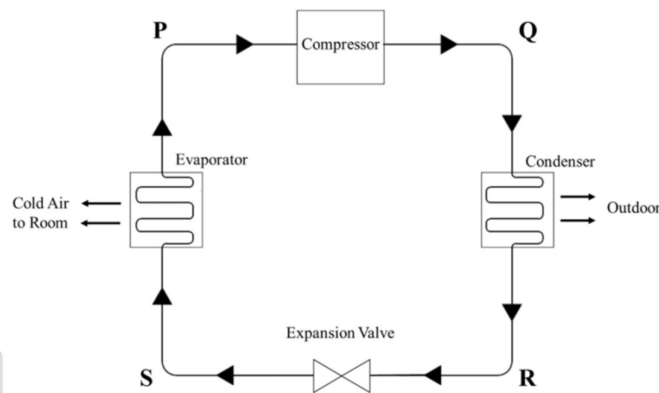
Explanation: The acceptable limits of various parameters for drinking water, as per URDPFI Guidelines 2015 are tabulated below,

Table 8.29: Organoleptic and Physical Parameters of Drinking Water

S. No.	Characteristics	Requirement (Acceptable limit)	Permissible limit in the absence of alternate source	Method of Test, ref. to part of IS 3025	Remarks
1	Colour, Hazen units, Max	5	15	Part 4	Extended to 15 only, if toxic substances are not suspected in absence of alternate sources
2	Odour	Agreeable	Agreeable	Part 5	Test cold and when heated Test at several dilutions
3	pH Value	6.5-8.5	No relaxation	Part II	-
4	Taste	Agreeable	Agreeable	Parts 7 and 8	Test to be conducted only after safety has been established
5	Turbidity, NTU, Max	1	5	Part 10	-
6	Total dissolved solids, mg/l, Max	500	2000	Part 16	-

Source: IS 10500: 2012.

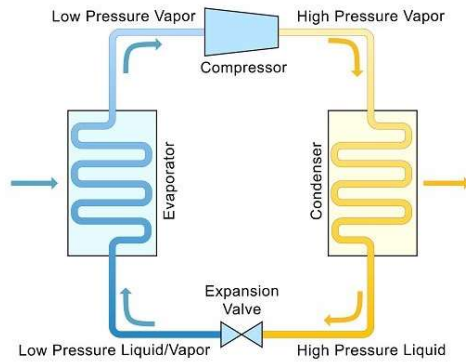
42. In an ideal air-conditioning cycle shown below, which of the following statement(s) is/are true in the segments P, Q, R, S?



- a. P: Vapour at low pressure
- b. Q: Vapour at low pressure
- c. R: Liquid at high pressure
- d. S: Liquid-Vapour mixture at low pressure

Answer: A, C, D

Explanation: The four main components of the refrigeration cycle are shown in the figure given below. Also, the phase and properties of refrigerant flowing among the four components is marked in the figure.



43. Which of the following is/are the characteristic(s) of a Mughal Garden?
- Symmetrical and geometrical
 - Fountain and channelled water
 - Winding road and untrimmed vegetation
 - Vista with terminal building

Answer: A, B, D

Explanation: The gardens built by the Mughal emperors of India are now an integral part of our architectural heritage. Based on the layout of the four gardens of paradise mentioned in the Quran, this Charbagh master plan divides a garden into geometric quadrants using walkways, water pools, running water canals, and linear flower beds.

1: AXIAL GEOMETRY: One of the key features of a Mughal Garden is its highly structural geometry. Respecting the axis is cardinal rule for implementing a Charbagh geometry. The word literally translates to four gardens.

2: CREATE A FOCAL POINT: After intersection of the garden axes, the next point is a focal point. The Shalimar Bagh has a summer pavilion, and the Taj Gardens have the Taj Mahal.

3: RUNNING WATER OR POOLS Flowing water and pools is another common theme of a Mughal Garden with reference to the four rivers that flowed through the Garden of Eden. The joint reflection of the sky and trees in a pool is symbolic of everything man admires in nature, a representation of life. Mughal gardens feature canals and pools along the axes, as well as fountains and waterfalls.

4: ORNAMENTAL DETAILING: The Mughal gardens include symbolic ornamental detailing inspired from the Quran and family history, juxtaposed with more secular references like zodiac symbols, numerology, and local craftsmanship

5: COLOURFUL FLOWER BEDS: The first visual connect you establish with a paradise garden is an expanse of colorful flowers. The gardens are also sprinkled with fruit trees to symbolize life. While some gardens cultivate flowers in beds planned to complement the four-part system, traditionally the flowers were allowed to grow wild and bloom.

44. As per the Central Pollution Control Board's National Air Quality Index (AQI) of India 2014, which of the following statement(s) is/are true?
- AQI is computed considering 8-hourly value of CO
 - AQI is computed considering 2-hourly value of PM_{2.5}
 - AQI considers the O₃ concentrations
 - AQI considers the CO₂ concentrations

Answer: A, C

Explanation: AQI has six categories of air quality. These are: Good, Satisfactory, Moderately Polluted, Poor, Very Poor and Severe. The AQI values and corresponding ambient concentrations (health breakpoints) for the identified eight pollutants are as follows:

Table 3.11 Breakpoints for AQI Scale 0-500 (units: $\mu\text{g}/\text{m}^3$ unless mentioned otherwise)

AQI Category (Range)	PM ₁₀ 24-hr	PM _{2.5} 24-hr	NO ₂ 24-hr	O ₃ 8-hr	CO 8-hr (mg/m ³)	SO ₂ 24-hr	NH ₃ 24-hr	Pb 24-hr
Good (0-50)	0-50	0-30	0-40	0-50	0-1.0	0-40	0-200	0-0.5
Satisfactory (51-100)	51-100	31-60	41-80	51-100	1.1-2.0	41-80	201-400	0.6-1.0
Moderate (101-200)	101-250	61-90	81-180	101-168	2.1- 10	81-380	401-800	1.1-2.0
Poor (201-300)	251-350	91-120	181-280	169-208	10.1-17	381-800	801-1200	2.1-3.0
Very poor (301-400)	351-430	121-250	281-400	209-748*	17.1-34	801-1600	1201-1800	3.1-3.5
Severe (401-500)	430 +	250+	400+	748+*	34+	1600+	1800+	3.5+

**One hourly monitoring (for mathematical calculation only)*

Image credit: National Air Quality Index Report by Central Pollution Control Board

45. The decadal population data of a city are given in the following Table. The domestic water consumption of the city is estimated to be 175 litres per capita per day in the year 2041. Considering 2011 population as the base year and using arithmetic growth method of population forecasting, the daily domestic water demand of the city in the year 2041 (in million litres per day, rounded off to two decimal places) will be _____.

Year	1981	1991	2001	2011
Population	1,80,750	1,95,850	2,15,300	2,45,450

Answer: 53.00 to 56.00

Explanation: The average growth of population per decade is calculated as follows,

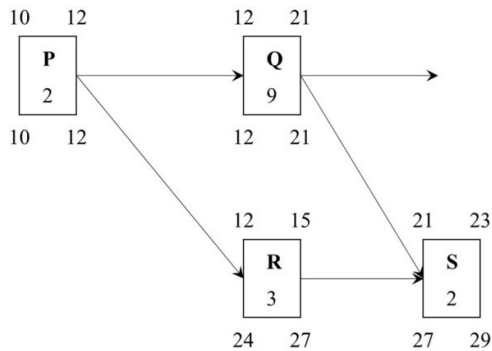
Year	Population	Decadal growth
1981	1,80,750	---
1991	1,95,850	15,100
2001	2,15,300	19,450
2011	2,45,450	30,150

Average growth of population per decade 21,566.67

Population in the year 2041 (using arithmetic growth method of population forecasting) = $2,45,450 + (3 \times 21,566.67) = 3,10,150$

Daily domestic water demand = $3,10,150 \times 175 = 54.28$ million liters

46. The activity duration, early start, early finish, late start, and late finish (in weeks) for activities P, Q, R, and S are shown in the following figure. The interfering float of activity R (in weeks, in integer) is _____.



Answer: 6 to 6

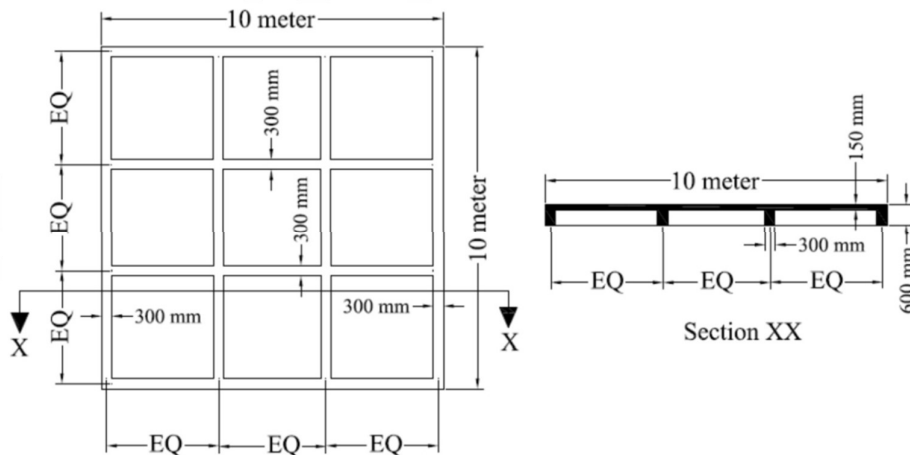
Explanation: Interfering float of R = Total float – Free float = (24 – 12) – (21 – 15) = 12 – 6 = 6 weeks

47. A 230 mm thick brick wall of 10 m length and 3 m height is built using a Flemish bond. The size of the bricks used is 230 mm x 112.5 mm x 70 mm. Assuming a mortar thickness of 5 mm, the number of bricks required (in integer) is ____.

Answer: 3400 to 3500

Explanation: In Flemish bond, length achieved in a course using three bricks (one header and two stretchers) also considering 5 mm of mortar = 117.5 mm + 235 mm = 352.5 mm
 Number of bricks required for the complete course length of 10,000 mm = (3*10,000)/352.5 ≈ 86 bricks
 Number of courses = 3000/75 = 40
 Total number of bricks required = 86*40 = 3440

48. The reflected ceiling plan and section of a reinforced cement concrete roof are shown in the following Figure. All the beams are 300 mm wide, 600 mm deep (including 150 mm slab) equidistantly placed center to center. Assuming 1% of concrete volume is occupied by reinforcement bars, the volume of concrete (in cubic meters, rounded off to two decimal places) is ____.



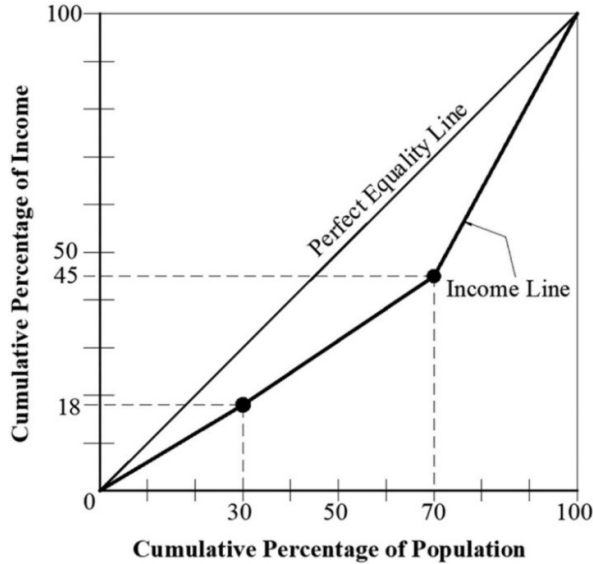
Answer: 24.50 to 25.30

Explanation: Volume of RCC = (10*10*0.6) – [9*(2.9333*2.9333*0.45)] = 60 – 34.8472 = 25.1528 cum

Volume of concrete = 99% of RCC = 0.99*25.1528 = 24.9013

49. The following graph represents the income distribution among the population of a country. The

Gini Coefficient of the country (rounded off to three decimal places) is ____.



Answer: 0.240 to 0.270

Explanation: Total area under perfect equality line, $A = (0.5 \times 100 \times 100) = 5000$
 Area between perfect equality and income distribution, $B = 5000 - (\text{Area below income line})$

$$B = 5000 - \left[\left(\frac{1}{2} \times 30 \times 18 \right) + (40 \times 18) + \left(\frac{1}{2} \times 40 \times 27 \right) + (30 \times 45) + \left(\frac{1}{2} \times 30 \times 55 \right) \right]$$

$$= 5000 - 3705 = 1295$$

Gini coefficient = $B/A = 1295/5000 = 0.259$

PART B1: FOR Architecture CANDIDATES ONLY

Q.50 – Q.56 Carry ONE mark Each

50. Which of the following processes is used for surface treatment of metals?

- Soldering
- Thermoplasting
- Extrusion
- Riveting

Answer: B

Explanation: Electroplating is the process where; electric current is used to plate the object or metal. But Thermoplasting is the process in which the object or the metal to be coated is heated first and then a coating of another molten metal is applied on it. In this process heat is used for coating.

51. Among the following monuments of ancient Greece, the only Octastyle Peripteral temple with eight towering Doric columns lining both east and west facades is ____.

- Temple of Athena
- Temple of Apollo
- The Parthenon
- Temple of Horus

Answer: C

Explanation: The Parthenon is a Doric peripteral temple, which means that it consists of a rectangular floor plan with a series of low steps on every side, and a colonnade (8 x 17) of Doric

columns extending around the periphery of the entire structure. Each entrance has an additional six columns in front of it. The larger of the two interior rooms, the **naos**, housed the cult statue. The smaller room (the **opisthodomos**) was used as a treasury.

52. An Ultrasonic Pulse Velocity (UPV) test was done on a hardened concrete element using a direct transmission method as per IS 516 (Part 5/Section 1): 2018. The distance between the transducer and receiver was 600 mm. The time taken for the induced wave to travel this distance is measured as 0.18 milliseconds. Based on the following Table, the concrete quality grading is ____.

Velocity (km/s) – cross probing	Concrete quality grading
Above 4.4	Excellent
3.75 – 4.4	Good
3.0 – 3.75	Doubtful
Less than 3.0	Poor

- a. Excellent
- b. Good
- c. Doubtful
- d. Poor

Answer: C

Explanation: Velocity of ultrasonic pulse on a hardened concrete element, $V = 600 \text{ mm}/0.18 \text{ milliseconds}$

$$V = \frac{600 * 1000}{1000 * 1000 * 0.18} = \frac{0.6}{0.18} = 3.33 \text{ km/s}$$

As per the given table, concrete quality grading will be 'Doubtful' for velocity of 3.33 km/s

53. Which of the following is/are example(s) of Tomb Architecture of Ancient Egypt?
- a. Step Pyramid of Zoser, Sakkara
 - b. Great Temple of Abu-Simbel
 - c. Temple of Khons, Karnak
 - d. Mastabas of Gizeh

Answer: A, D

Explanation: The Pyramid of Djoser, or Step Pyramid, is an archaeological site in the Saqqara necropolis, Egypt, northwest of the city of Memphis. The 6-tier, 4-sided structure is the earliest colossal stone building in Egypt. It was built in the 27th century BC during the Third Dynasty for the burial of Pharaoh Djoser. The Mastaba of Kaninisut or Mastaba G 2155, is an ancient Egyptian mastaba tomb, located at Giza in the West field of the Great Pyramid of Giza. The cult chamber of the mastaba is now on display in the Kunsthistorisches Museum in Vienna with inventory number 8006.

54. If Aluminium : Anodisation :: Glazing : X, which of the following choices represent X?
- a. Hard coating
 - b. External cement plastering
 - c. Tempering
 - d. Free-standing vertical greening

Answer: A, C

Explanation: Hard coated or pyrolytic coated reflective glasses are those in which the coating is applied when the glass is manufactured, i.e., it is an online coating process. In this process of coating, the glass is fused into the glass at 650 to 700 degrees Celsius, and on cooling, the coating becomes a part of the glass. The tempering process puts the outer surfaces of the glass into compression and the inner surfaces of the glass into tension. This stress causes the glass when broken to crumble into small granular chunks vs. jagged shards preventing possible injury.

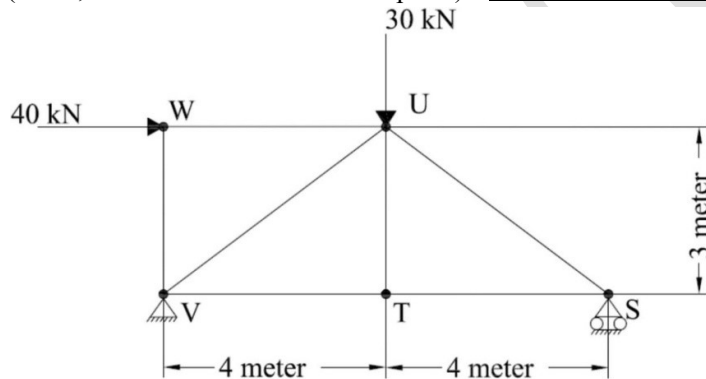
55. A blackbody radiant heating panel of 5 m² surface area at 35 °C surface temperature is located 1 m away from a 1 m² surface at 20 °C. The Stefan-Boltzmann constant is 5.6703 × 10⁻⁸ W m⁻² K⁻⁴. The rate of radiant heat emission by the radiant heating panel (in W, rounded off to two decimal places) is__.

Answer: 2550.00 to 2560.00

Explanation: For black body, e = 1
 Stephan-Boltzmann constant, $\sigma = 5.6703 \times 10^{-8}$
 A = 5 sqm and T = 273 + 35 = 308 kelvin
 Rate of radiant heat emission will be:

$$\frac{Q}{t} \text{ (in watts)} = e * \sigma * A * T^4 = 1 * 5.6703 * 10^{-8} * 5 * 308^4 = 2551.4 \text{ Watts}$$

56. A hypothetical truss comprising of weightless members is shown in the following Figure. Assuming tension to be positive and compression to be negative, the value of force in member TU (in kN, rounded off to one decimal place) is_____.


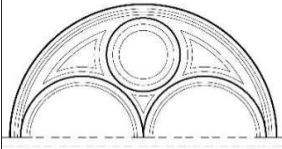
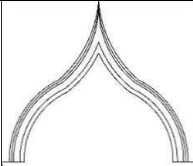
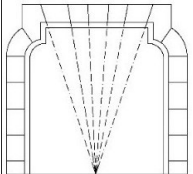


Answer: 0.0 to 0.0

Explanation: If three members meet in an unloaded joint of which two are collinear, then the third member is a zero-force member. Considering that joint T is unloaded, the member UT is a zero-force member.

Q.57 – Q .65 Carry TWO marks Each

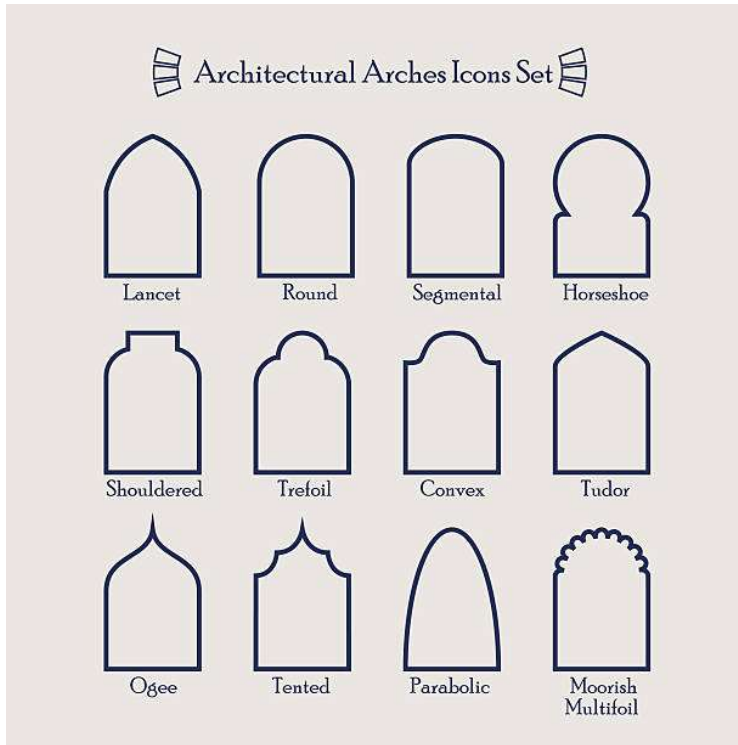
57. Match the illustrations of Arch Types in **Group I** with their corresponding names in **Group II**.

Group I		Group II	
(P)		(1)	Venetian Arch
(Q)		(2)	Ogee Arch
(R)		(3)	Moorish Multifoil Arch
(S)		(4)	Corbelled Arch
		(5)	Shouldered Arch

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

Answer: B

Explanation: illustrations of arch types are shown in the image given below:



58. Match the architectural projects in **Group I** with their corresponding architects in **Group II**.

Group I		Group II	
(P)	Indian Institute of Management Bangalore	(1)	Revathi Kamath
(Q)	Osho International Meditation Resort, Pune	(2)	Brinda Somaya
(R)	Nalanda International School, Vadodara	(3)	Roger Anger
(S)	Matrimandir, Auroville	(4)	B. V. Doshi
		(5)	Hafeez Contractor

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

Answer: A

Explanation: The architect of the iconic and award-winning IIM Bangalore campus is Pritzker Laureate Dr. Balkrishna Doshi, Fellow of the Royal Institute of British Architects and Fellow of the Indian Institute of Architects.

Popularly known as Osho Ashram and formally known as Osho International Meditation Resort, this spiritual centre was established in 1974 by Acharya Rajneesh/Bhagwan Shree Rajneesh, who came

to be known as Osho. The Bhagwan Rajneesh Ashram, as it was originally known, was designed by architect Hafeez Contractor, and is surrounded by bamboo trees and lush greenery.

Nalanda International School, Vadodara, has been awarded a LEAF, (Leading European Architects' Forum) Award in 2006 in the Environmentally Friendly Category. Nationally renowned Architect, Mrs. Brinda Somaya (the architect of Nalanda International School) who designed all the school buildings and campus received the Award.

Designed by French architect Roger Anger, Matrimandir - literally, "the dwelling place of the Mother" - is situated in the heart of a universal city - Auroville, about 12 kilometres from Pondicherry in India. It was designed in 1968, the construction started in 1971 and completed in 2008 after a protracted period of 37 years.

59. Match the structural joining systems in **Group I** with the corresponding materials for which they are commonly used in **Group II**.

Group I		Group II	
(P)	Welding	(1)	Glass
(Q)	Spider Connector	(2)	Plastic
(R)	Mortise and Tenon	(3)	Brick
(S)	Mortar	(4)	Steel
		(5)	Timber

- P-4, Q-1, R-2, S-5
- P-3, Q-5, R-1, S-2
- P-2, Q-3, R-5, S-1
- P-4, Q-1, R-5, S-3

Answer: D

Explanation: Methods used for steel welding include stick welding, flux wire welding, gas metal arc welding, resistance spot welding, and DC-TIG welding. AC-TIG welding is not typically used with steel parts.

Glass spider fitting is an important link component in glass curtain building, which transfers the load to steel structure or other main structures through glass spider joint, its mechanical property plays an important role.

Mortise & Tenon is the fundamental joint in all timber framing. Other joinery is generally a variation of the mortise & tenon. With mortise & tenon joinery, the mortise pocket accepts the tenon tongue and is secured with an oak peg.

Mortar is a workable paste used to bind bricks and other masonry units together. A mortar joint acts as a sealant, a bearing pad, the glue that sticks the units together yet keeps them apart and, in this sense, performs as a gap-filling adhesive.

60. Match the Instruments in **Group I** with the corresponding climate parameters in **Group II**.

Group I		Group II	
(P)	Pyranometer	(1)	Humidity

(Q)	Disdrometer	(2)	Wind
(R)	Hygrometer	(3)	Solar Radiation
(S)	Anemometer	(4)	Pressure
		(5)	Precipitation

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

Answer: A

Explanation: Simply said a pyranometer is a device that measures solar irradiance from a hemispherical field of view incident on a flat surface. The SI units of irradiance are watts per square metre (W/m^2).

A disdrometer is an optical device situated on a stationary ground station platform that measures properties of different hydrometeor (precipitation) types such as raindrops, snowflakes, and hail.

A hygrometer is an instrument used to measure the amount of water vapor in air, in soil, or in confined spaces. Humidity measurement instruments usually rely on measurements of some other quantities such as temperature, pressure, mass, a mechanical or electrical change in a substance as moisture is absorbed.

An anemometer is an instrument that measures wind speed. This type of anemometer has a spinning wheel. The stronger the wind blows, the faster the wheel rotates. The anemometer counts the number of rotations, which is used to calculate wind speed.

- 61.** In traditional Indian temple architecture, which of the following statement(s) is/are true?
- a. Jagamohana refers to a dancing hall
 - b. Gopuram refers to an entrance tower
 - c. Char-chala refers to a roof composed of four triangular segments
 - d. Vimana refers to the structure over the Garbhagriha

Answer: B, C, D

Explanation: In Kalinga Architecture, basically a temple is made in two parts, a tower and a hall. The tower is called deul and the hall is called jagmohan. The walls of both the deul and the jagmohan are lavishly sculpted with architectural motifs and a profusion of figures.

A gopuram or gopura is a monumental tower, usually ornate, at the entrance of any temple, especially in Southern India. They are a prominent feature of koils, Hindu temples built in the Dravidian style. They are topped by the kalasam, a bulbous stone finial.

Vimana is the structure over the garbhagriha or inner sanctum in the Hindu temples of South India.

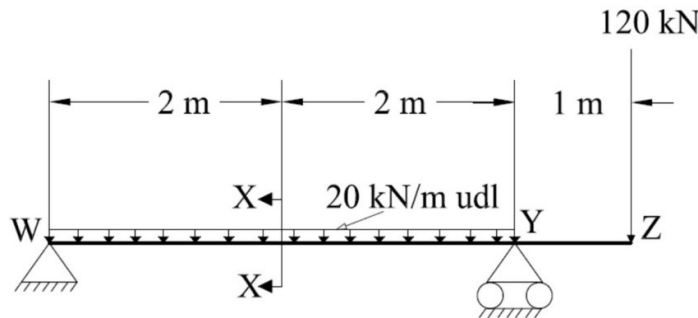
The Char-chala temples have four rectangular roofs meeting at one point. The edges of the chala, along with the cornices, are carved. It is quite a rare roofing style as far as the temples of Bengal are concerned, and you will only find a few structures with this roofing style in Nadia, Murshidabad, and Birbhum districts.

- 62.** Which of the following factors impact Daylight Autonomy of a built space?
- a. Orientation of building
 - b. Glare caused by daylight
 - c. Latitude and longitude of building location
 - d. Fenestration size

Answer: A, C, D

Explanation: In mathematical terms, daylight autonomy is the percentage of annual work hours during which all or part of a building's lighting needs can be met through daylighting alone. It is affected by orientation of the building, fenestration size, latitude and longitude of building location.

63. For the beam shown in the following Figure, assuming a sagging moment (generating tensile stresses at the bottom fibre) as positive and a hogging moment (generating tensile stresses at the top fibre) as negative, the bending moment (in kN.m, rounded off to one decimal place) at section X-X is ___.



Answer: -20.0 to -20.0

Explanation: Calculation of support reactions at W and Y:

Balancing the vertical orientation forces, we get,

$$R_W + R_Y = 120 + (4 * 20) = 200 \text{ kN}$$

$$\sum M_W = 0$$

$$(80 * 2) - (R_Y * 4) + (120 * 5) = 0$$

$$\Rightarrow 4R_Y = 760$$

$$\Rightarrow R_Y = 190 \text{ kN}$$

$$\Rightarrow R_W = 10 \text{ kN}$$

Bending moment at section X-X will be,

$$BM_X = (10 * 2) - (40 * 1) = 20 - 40 = -20 \text{ kNm}$$

64. The acoustical absorption of a wall panel in each octave band is tabulated below. The Noise Reduction Coefficient of the wall panel (rounded off to two decimal places) is _____.

63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	16000 Hz
0.1	0.2	0.5	0.5	0.7	0.8	0.8	0.9	0.9

Answer: 0.60 to 0.65

Explanation: The noise reduction coefficient is the arithmetic average, rounded to the nearest multiple of 0.05, of the absorption coefficients for a specific material and mounting condition determined at the octave band center frequencies of 250, 500, 1000 and 2000 Hz.

$$NRC = \frac{0.5 + 0.5 + 0.7 + 0.8}{4} = 0.625$$

65. A room is maintained at a wet bulb temperature of 25 °C, globe temperature of 30 °C, and air velocity of 0.5 m/s. The decrease in Tropical Summer Index when the air velocity is increased to 3 m/s (in °C, rounded off to two decimal places) is _____.

Answer: -2.20 to -1.50 OR 1.50 to 2.20

Explanation: Tropical summer index (TSI) is given by,

$$TSI = 0.745t_g + 0.308t_w - 2.06\sqrt{v+0.841}$$

where

- t_w = wet bulb temperature, in °C;
- t_g = globe temperature, in °C; and
- V = air speed, in m/s.

Decrease in TSI when air velocity increases from 0.5 m/s to 3 m/s will be,

$$\Delta TSI = 2.06(\sqrt{3 + 0.841} - \sqrt{0.5 + 0.841})$$

$$\Delta TSI = 2.06(\sqrt{3.841} - \sqrt{1.341}) = 1.65^\circ\text{C}$$

PART B2: FOR Planning CANDIDATES ONLY

Q.66 – Q.72 Carry ONE mark Each

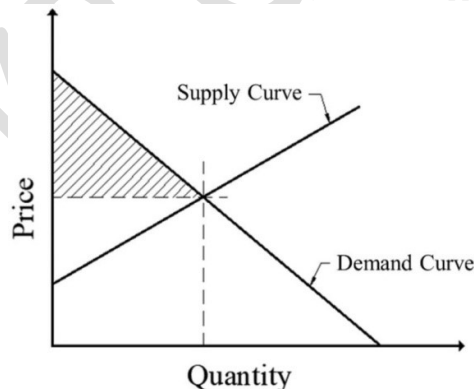
66. Which of the following is the National Electronic Toll Collection System implemented by the National Payment Corporation of India?
- a. e-Pass
 - b. E-ZPass
 - c. HashTag
 - d. FASTag

Answer: D

Explanation: FASTag is a device that employs Radio Frequency Identification (RFID) technology for making toll payments directly while the vehicle is in motion. FASTag (RFID Tag) is affixed on the windscreen of the vehicle and enables a customer to make the toll payments directly from the account which is linked to FASTag.

National Payments Corporation of India (NPCI) has developed the National Electronic Toll Collection (NETC) program to meet the electronic tolling requirements of the Indian market.

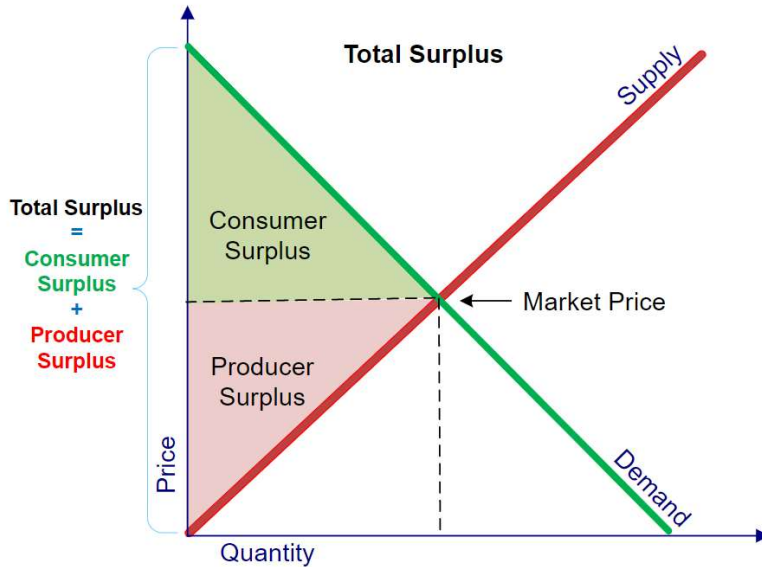
67. The shaded area in the following demand-supply graph is known as__.



- a. Consumer Surplus
- b. Consumer Deficit
- c. Producer Surplus
- d. Producer Deficit

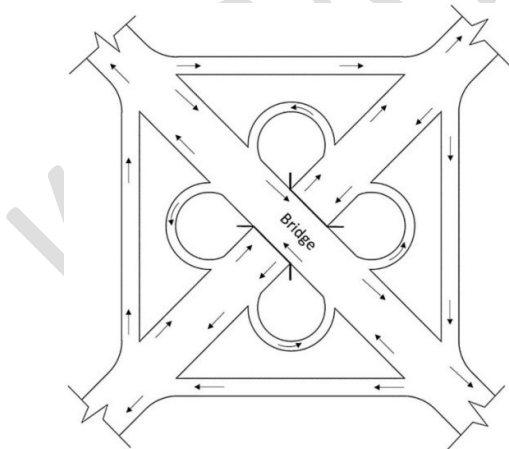
Answer: A

Explanation: Consumer surplus is the monetary gain obtained by consumers because they are able to purchase a product for a price that is less than the highest price that they would be willing to pay. Producer surplus is the amount that producers benefit by selling at a market price that is higher than the least that they would be willing to sell for; this is roughly equal to profit (since producers are not normally willing to sell at a loss and are normally indifferent to selling at a break-even price)



Example of a good with generally high consumer surplus is drinking water. People would pay very high prices for drinking water, as they need it to survive. The difference in the price that they would pay, if they had to, and the amount that they pay now is their consumer surplus. The utility of the first few litres of drinking water is very high (as it prevents death), so the first few litres would likely have more consumer surplus than subsequent litres.

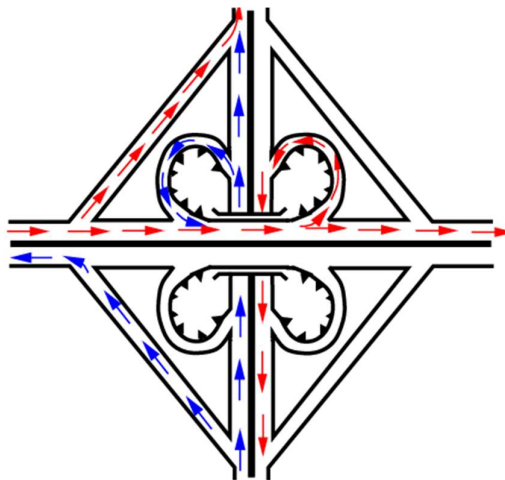
68. Identify the following traffic interchange.



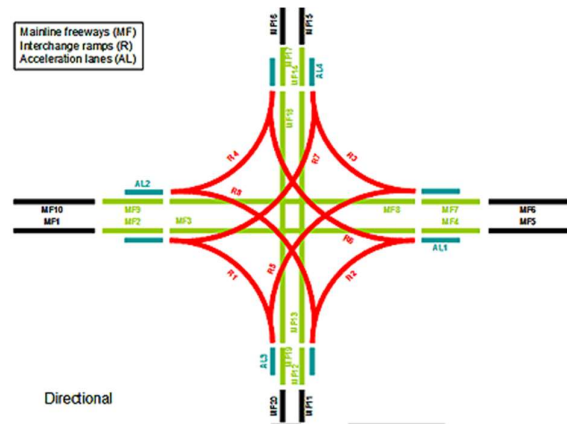
- a. Directional
- b. Trumpet
- c. Clover-Leaf
- d. Diamond

Answer: C

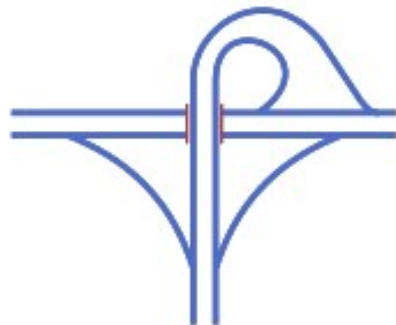
Explanation:



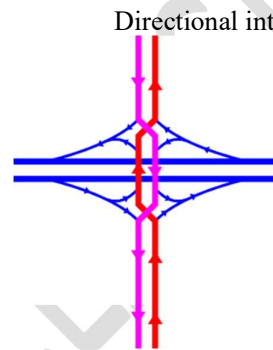
Clover-leaf interchange



Directional



Trumpet



Diamond

69. Which of the following is/are Value Capture Method(s)?

- Building construction fees
- Fees for changing agricultural to non-agricultural land use
- User charge
- Premium on additional FSI/FAR

Answer: B, D

Explanation: Value capture is a type of public financing that recovers some or all of the value that public infrastructure generates for private landowners.

Value capture methods are 'land value tax', 'fees for changing land use', 'Betterment levy', 'premium on additional FAR/FSI' etc.

User charge is not a value capture method as they depend on the quantity actually consumed. User charges differ from taxes, in that users pay charges for benefits they receive specifically, whereas taxes are general charges for services that benefit everyone.

70. Which among the following is/are model(s) of Public-Private Partnership (PPP) used for infrastructure projects?

- BOLD
- BOLT
- BOOT
- BPOT

Answer: B, C

Explanation: BOLT (Build-Own-Lease-Transfer): In this approach, the government gives a concession to a private entity to build a facility (and possibly design it as well), own the facility, lease the facility to the public sector and then at the end of the lease period transfer the ownership of the facility to the government.

BOOT (Build-Own-Operate-Transfer): BOOT is based on the granting of a concession by the Union/ Government/ local authority to the concessionaire, who is responsible for the construction, financing, operation and maintenance of a facility over the period of the concession before finally transferring the fully operational facility.

71. The measured spot speeds (in km/h) of 10 vehicles from a traffic stream are 45, 35, 25, 51, 45, 38, 61, 42, 47, and 49. The Time Mean Speed of the traffic stream (in km/h, rounded off to one decimal place) is ____.

Answer: 43.0 to 44.0

Explanation: Mean of all the spot speeds is time mean speed
 Time mean speed = $438 / 10 = 43.8$

72. In a township, the price of each house was 25,00,000 (in Indian Rupees) last month. The number of houses sold in a month (Q in thousands) is sensitive to the price of the house (P in Indian Rupees) and establishes a relationship as $Q = 6685 - 0.00158P$. If the price of each house increases by 20% in the current month, then the decrease in sale of the houses (in percentage, rounded off to two decimal places) compared to last month will be ____.

Answer: 27.00 to 30.00

Explanation: Price = 25,00,000
 $Q = 6685 - 0.00158P$
 So with $P = 25,00,000$, $Q = 6685 - (0.00158 \times 25,00,000) = 2735$
 Now price increases 20%, so new price = $25,00,000 \times 1.2 = 30,00,000$
 So, new quantity = $6685 - (0.00158 \times 30,00,000) = 1945$
 Decrease in sale in percentage = $(2735 - 1945) / 2735 \times 100 = 28.88$

Q.73 – Q.81 Carry TWO marks Each

73. Match the models in **Group I** with their corresponding applications in **Group II**.

Group I		Group II	
(P)	Logit model	(1)	Trip assignment
(Q)	Greenshield model	(2)	Modal split
(R)	Gravity model	(3)	Traffic flow
(S)	Multiple regression model	(4)	Trip generation
		(5)	Trip distribution

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

Answer: C

Explanation: Logit model = Modal split

Greenshield Model = Traffic Flow (represent how the behaviour of one parameter of traffic flow changes with respect to another like the relation between speed and density)

Gravity model = Trip distribution

Multiple regression model = Trip generation

74. Match the proponents in **Group I** with the corresponding theories in **Group II**.

Group I		Group II	
(P)	James Q Wilson and George K. Kelling	(1)	Creative Class
(Q)	Sherry Arnstein	(2)	Right to City
(R)	Henry Lefebvre	(3)	Drive-in Culture
(S)	Richard Florida	(4)	Ladder of Citizen Participation
		(5)	Broken Window

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

Answer: C

Explanation: Broken windows theory, academic theory proposed by James Q. Wilson and George Kelling in 1982 that used broken windows as a metaphor for disorder within neighbourhoods. Their theory links disorder and incivility within a community to subsequent occurrences of serious crime. Ladder of Citizen Participation is given by Sherry Arnstein is about citizen involvement in planning processes in the United States, described a “ladder of citizen participation” that showed participation ranging from high to low. The ladder is a guide to seeing who has power when important decisions are being made.

Right to City is given by Henry Lefebvre. He defines the Right to the city as a right of no exclusion of urban society from qualities and benefits of urban life

Creative Class is given by Richard Florida. Florida says that the creative class is a class of workers whose job is to create meaningful new forms

75. Match the Artists/Scientists in **Group I** with their corresponding contributions in **Group II**.

Group I		Group II	
(P)	Robert Park and Louis Wirth	(1)	Poverty Map
(Q)	Jacob August Riis	(2)	Cholera Map
(R)	Charles Booth	(3)	Tenement Shelter Photography

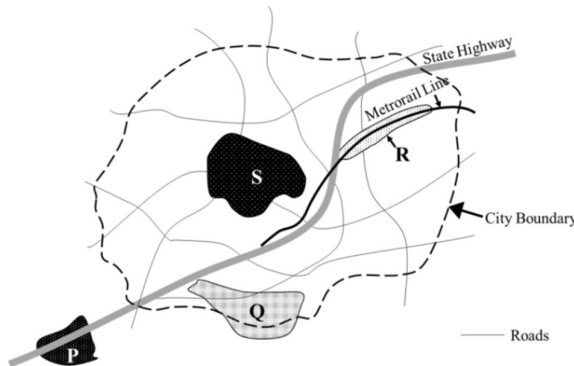
(S)	John Snow	(4)	Urban Ethnography
		(5)	Underground Sewerage Systems

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

Answer: A

Explanation: Poverty Map is by Charles Booth
 Cholera Map is by John Snow Urban ethnography by Robert Park and Louis Wirth Tenement Shelter Photography by Jacob August Riis

76. In the conceptual diagram of the city given below, P, Q, R, and S refer to urban patterns. Among the choices given below, the correct association is



- a. P-Satellite town, Q-Urban fringe, R-TOD, S-Central Business District
- b. P-Central Business District, Q-Satellite town, R-TOD, S-Urban fringe
- c. P-Urban fringe, Q-TOD, R-Satellite town, S-Central Business District
- d. P-Satellite town, Q-Central Business District, R-TOD, S-Urban fringe

Answer: A

Explanation: Satellite town: They are cities that have been established independent of the nearby large metropolitan areas. (P in the given diagram)

Urban Fringe: Rural-Urban fringe is the boundary zone outside the urban area proper where rural and urban land uses intermixed. It is the area where the city meets the countryside. It is an area of transition from agriculture and other rural land use to urban use. Located well within the urban sphere of influence (Q in the given diagram)

Transit-oriented development, or TOD, includes a mix of commercial, residential, office and entertainment centred around or located near a transit station. (R in the given diagram, around the metro line)

A central business district (CBD) is the commercial and business center of a city. It contains commercial space and offices. (S in the given diagram)

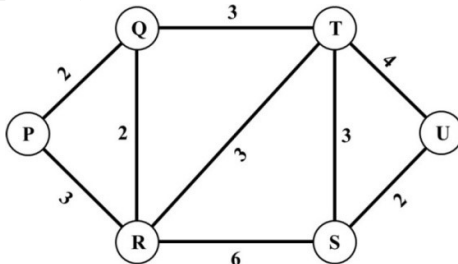
77. Which among the following is/are the component(s) of the assimilative carrying capacity of urban environment?

- a. Air
- b. Water
- c. Economy
- d. Soil

Answer: A, B, D

Explanation: An urban environment needs to have capacities to assimilative i.e manage and recycle various wastes and pollution like air, water, land etc. generated by its population.

78. In the transportation network given below, P, Q, R, S, T, and U are the nodes and values mentioned on the links denote time in minutes. Which of the following options represent the minimum spanning tree?



- a. PQ, QR, QT, TS, SU
- b. PR, QR, RT, TU, SU
- c. PQ, QR, RT, TS, SU
- d. PQ, QR, RS, ST, TU

Answer: A, C

Explanation: Minimum spanning tree connects all the vertices together, without any cycles and with the minimum possible total edge weight

So a graph can have multiple spanning trees

Option A weight = $2+2+3+3+2 = 12$

Option B weight = 14

Option C weight = 12

Option D weight = 17

79. A vehicle count survey (in Passenger Car Unit) is conducted on a mid-block section of a road at regular intervals of 15 minutes from 8:00 AM to 10:00 AM. Based on the data given in Table below, the Peak Hour Factor (rounded off to two decimal places) for the given survey duration is _____.

Time Interval	Passenger Car Unit
8:00 AM – 8:15 AM	212
8:15 AM – 8:30 AM	248
8:30 AM – 8:45 AM	272
8:45 AM – 9:00 AM	315
9:00 AM – 9:15 AM	337

9:15 AM – 9:30 AM	405
9:30 AM – 9:45 AM	320
9:45 AM – 10:00 AM	267

Answer: 0.83 to 0.87

Explanation: Here peak hour traffic is between 08:45 to 9:45 which is 1377
 Peak 15 minute = 405
 So PHF = $1377 / (4 \times 405) = 0.85$

80. A land owner has shown interest in a Town Planning Scheme. Based on the details of the scheme given in the following Table, the estimated Net Benefit to the land owner after land development (in Indian Rupees, in integer) is _____.

Original plot size	500 Sq. m
Original land value	1200 Indian Rupees per Sq.m
Plot deduction for development	40%
Developed land value	2800 Indian Rupees per Sq.m
Total betterment cost to be paid by the land owner	50% of the increased total land value

Answer: 1,18,000 to 1,22,000

Explanation: Plot size = 500
 Value = $1200 \times 500 = 6,00,000$
 Plot deduction = 40% of 500 = 200 sqm
 New plot = 300 sqm
 New value = $2800 \times 300 = 8,40,000$
 Increase = 2,40,000
 Betterment cost = 50% of 2,40,000 = 1,20,000
 Net benefit = 1,20,000

81. The year-wise cash flows (in Indian Rupees) of a construction project are given in the following Table. If the annual discount rate for the project is assumed to be 12%, the Net Present Value (in Indian Rupees, rounded off to two decimal places) for the project will be _____.

Year	Annual Cash Outflow	Annual Cash Inflow
0	5,00,000	0
1	0	0
2	0	0
3	50,000	1,80,000
4	50,000	2,20,000

5	50,000	2,90,000
6	0	3,30,000

Answer: 3800.00 to 5020.00

Explanation: Cash outflow and cash inflow is given

$$PV = \frac{FV}{(1+k)^n}$$

$$NPV = \frac{-5,00,000}{(1.12)^0} + 0 + 0 + \frac{1,30,000}{(1.12)^3} + \frac{1,70,000}{(1.12)^4} + \frac{2,40,000}{(1.12)^5} + \frac{3,30,000}{(1.12)^6}$$

After solving

$$NPV = 4133.16$$