RRB Group D Official Paper (Held On: 10 Feb, 2026 Shift 1) (Previous Year Paper)

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GENERAL SCIENCE

Q1. Which property distinguishes a homogeneous mixture from a heterogeneous mixture?

(a) Chemical reaction
(b) Uniform composition
(c) Fixed boiling point
(d) High density

Q2. Which of the following is always formed during a neutralization reaction between a strong acid and a strong base?

(a) Salt and hydrogen gas
(b) Only water
(c) Salt, water, and carbon dioxide
(d) Salt and water

Q3. Animals with high energy needs and constant body temperature, like birds and mammals, have _____ chambered hearts.

(a) Four
(b) Two
(c) Three
(d) One

Q4. Which part of the food-conducting complex tissue in plants is tubular and has perforated walls?

(a) Sieve tube
(b) Phloem parenchyma
(c) Companion cell
(d) Sieve plate

Q5. What is the advantage of combining DNA from two different individuals in sexually reproducing animals?

(a) It reduces the need for specialized reproductive organs.
(b) It eliminates errors in DNA copying.
(c) It increases genetic variation within the population.
(d) It speeds up the reproduction process.

Q6. Which of the following statements about a proton is correct ?

(a) A proton is neutral in charge and has mass equal to an electron
(b) A proton is positively charged and its mass is taken as one unit
(c) A proton is negatively charged and has very small mass
(d) A proton is positively charged and mass is 1/2000 of a hydrogen atom

Q7. For a resistor with constant resistance, the magnitude of heat produced is directly proportional to which of the following?

(a) Square of the current flowing through the resistor
(b) Density of the material
(c) Current flowing through the resistor
(d) Length of the resistor

Q8. Which of the following statements is true about a base in an aqueous solution?

(a) They react with metals to produce hydrogen gas.
(b) They turn blue litmus red.
(c) They produce OH^- ions in water.
(d) They have a sour taste.

Q9. What is the main purpose of refining a metal after it has been extracted?

(a) To remove impurities from the extracted metal
(b) To convert the metal into an alloy
(c) To reduce the reactivity of the metal
(d) To increase the melting point of the metal

Q10. Which of the following is the SI unit of weight?

(a) Kilogram
(b) Newton
(c) Pascal
(d) Joule

Q11. When substituting numerical values for the distances (u, v, f) into the Mirror Formula to solve problems, which prerequisite must be strictly followed?

(a) All measurements must be taken from the centre of curvature
(b) The New Cartesian Sign Convention must be used
(c) The focal length (f) must always be taken as positive
(d) All values must be converted to metres

Q12. Identify the product in the reaction given below.

CH3-CH2OH → (or acidified K2Cr2O7 + Heat, Alkaline KMnO4 + Heat) Product

(a) Propanone
(b) Ethanoic acid
(c) Propanal
(d) Ethanal

Q13. Megaphone, horn and stethoscope are the devices used to _____.

(a) Block sound
(b) Produce, transmit, and amplify sound
(c) Change pitch
(d) Control amplitude of sound

Q14. Which multicellular organism shows fragmentation as a common mode of asexual reproduction?

(a) Spirogyra
(b) Bryophyllum
(c) Jasmine
(d) Orange

Q15. Which of the following is a micronutrient?

(a) Manganese
(b) Nitrogen
(c) Phosphorous

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(d) Magnesium

Q16. When brakes are applied to a moving car, the car slows down but the passengers inside tend to move forward. This happens because _____.

(a) the air inside the car pushes the passengers forward
(b) the passengers have inertia and continue in their state of motion
(c) the passengers are pulled forward by gravity
(d) the brakes apply a forward force on the passengers

Q17. A sodium chloride crystal contains sodium and chloride ions in a 1:1 ratio. To calculate the formula unit mass of sodium chloride, which process would you use?

(a) Add the atomic mass of sodium and the atomic mass of chlorine
(b) Divide the atomic mass of sodium by that of chlorine
(c) Subtract the atomic mass of chlorine from that of sodium
(d) Multiply the atomic mass of sodium and the atomic mass of chlorine

Q18. The SI unit of the universal gravitational constant G is _____.

(a) kg/m³
(b) N · m2/kg2
(c) N/m2
(d) N-Kg2/m2

Q19. For a body moving with uniform velocity, the acceleration is:

(a) constant
(b) zero
(c) decreasing
(d) increasing

Q20. Which of the following molecules is split apart by higher energy ultraviolet for formation of ozone?

(a) Zinc
(b) Iron
(c) Sodium
(d) Oxygen

Q21. Which of the following rays is NOT used to locate the image formed by a spherical mirror?

(a) A ray passing through the focus that reflects parallel to the principal axis
(b) A ray passing through the center of curvature that reflects back along the same path
(c) A ray perpendicular to the principal axis that reflects through the focus
(d) A ray parallel to the principal axis that reflects through the focus

Q22. Which condition is essential for a dispersed seed to successfully undergo germination and develop into a seedling?

(a) Physical separation from the parent flower
(b) Presence of appropriate environmental conditions
(c) Exposure to sunlight only
(d) Complete decay of the fruit enclosing the seed only.

Q23. Which type of blood vessel has thick, elastic walls to withstand high pressure?

(a) Vein
(b) Venule
(c) Artery
(d) Capillary

Q24. A wire of length ‘L’, area of cross-section ‘A’ and resistivity ‘P’ has a resistance ‘R’. What will be the new resistance of this wire if its area of cross-section is tripled? (Keep all the other parameters the same)

(a) R/9
(b) 3R

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(c) R
(d) R/3

Q25. A porter lifts a luggage of mass 25 kg from the ground to a height of 2.0 m. What is the work done by him on the luggage? (Take g = 10 m/s²)
(a) 100 J
(b) 500 J
(c) 250 J
(d) 50 J

MATHEMATICS

Q26. Shivam spends 50% of his income. If he saves Rs. 42,000, then his income (in Rs.) is:
(a) 83,000
(b) 21,000
(c) 85,000
(d) 84,000

Q27. Find the median for the data 9, 6, 8, 11, 16, and 22.
(a) 12
(b) 9
(c) 11
(d) 10

Q28. What is the minimum value that must be assigned to A so that the 8-digit number 322A4828 is divisible by 4?
(a) 3
(b) 0
(c) 5
(d) 4

Q29. In a race, an athlete covers a distance of 450 m in 150 sec in the first lap. He covers the second lap of the same distance in 75 sec. What is the average speed (in m/sec) of the athlete?
(a) 10
(b) 11
(c) 4
(d) 5

Q30. Find the value of : $\cos^2 30° + \cos^2 60° + \cos^2 90°$
(a) 2
(b) 1
(c) 1.25
(d) 1.5

Q31. If the total surface area of a cylinder is 3080 m² and its radius is 14 m, then what is the curved surface area of the cylinder? (Take π= 22/7)
(a) 2048 m²
(b) 1798 m2
(c) 1848 m2
(d) 1978 m2

Q32. If the marked price of a fan is Rs. 775 and a discount of 12% is given on it, then what is the selling price of the fan?
(a) Rs. 680
(b) Rs. 684
(c) Rs. 682
(d) Rs. 686

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Q33. The amount on a sum of Rs. 6,400 at the rate of 15% per annum compound interest, compounded annually, in 2 years will be:

(a) Rs. 8,464
(b) Rs. 8,375
(c) Rs. 8,078
(d) Rs. 8,413

Q34. A mother is currently twice as old as her daughter. Ten years ago, the mother was three times as old as her daughter. What is the present age of the mother ?

(a) 48 years
(b) 42 years
(c) 40 years
(d) 28 years

Q35. A man has to cover a distance of 228 km in 8 hours. If he covers two-thirds of this distance in 5/8 th of the time, then what should be his speed (in km/hr, correct to one decimal place) to cover the remaining distance in the time left?

(a) 23.3
(b) 14.1
(c) 22.2
(d) 25.3

Q36. In an election between two candidates, 78% of the voters cast their votes, out of which 4% votes were declared invalid. A candidate got 13,572 votes, out of which 58% were valid votes. Find the total number of voters enrolled in that election.

(a) 30,150
(b) 31,250
(c) 33,540
(d) 28,680

Q37. A rare book dealer sells a vintage novel to a collector for Rs. 1,440. The collector later auctions it at a 25% profit. What price does the final buyer pay at the auction?

(a) Rs. 1,860
(b) Rs. 1,620
(c) Rs. 1,800
(d) Rs. 360

Q38. The ratio of the sum of exterior angles to the sum of interior angles of a regular polygon of n sides is 2 : 43. What is the measure of an interior angle of the regular polygon?

(a) 172°
(b) 174°
(c) 170°
(d) 176°

Q39. The population of a village was 1,60,000. It increased by 15% in the first year and increased by 30% in the second year. Its population after two years will be _____.

(a) 2,39,200
(b) 2,08,000
(c) 2,32,000
(d) 1,84,000

Q40. If the length of a rectangle is 5 cm more than the breadth and if the perimeter of the rectangle is 40 cm, then the length and breadth of the rectangle will be:

(a) 11.4 cm, 8.6 cm
(b) 10.5 cm, 9.5 cm
(c) 12.4 cm, 7.6 cm
(d) 12.5 cm, 7.5 cm

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Q41. A retailer offers the following discount schemes for buyers on an article. Which scheme will fetch the maximum selling price?

(a) A discount of 23% followed by a discount of 15%
(b) A discount of 12% followed by a discount of 46%
(c) Successive discounts of 25% and 36%
(d) Two successive discounts of 10%

Q42. Three workers, A, B, and C, are assigned to paint a wall. A can complete the task in 8 hours, B in 12 hours, and C in 16 hours. If they all start together but C leaves after 2 hours, how much time in total will it take to finish the task?

(a) 5.5 hours
(b) 4.2 hours
(c) 3 hours
(d) 6 hours

Q43. Suman, Tariq and Neha invest sums in the ratio 6 : 11 : 12, respectively. If they earned a total profit of Rs. 79,721 at the end of the year, then what is the positive difference between the shares of Suman and Neha?

(a) Rs. 16,494
(b) Rs. 16,493
(c) Rs. 16,491
(d) Rs. 16,492

Q44. If $x = 3 + \sqrt{8}$, find the value of $\sqrt{x} - 1/\sqrt{x}$.

(a) $\sqrt{2}$
(b) 2
(c) $1/\sqrt{2}$
(d) 1

Q45. What is the smallest natural number which when divided by 18, 35 and 140 leaves remainder 7 in each case?

(a) 1270
(b) 1337
(c) 1267
(d) 1300

Q46. The price of each article of types P, Q, and R is Rs. 280, Rs. 185, and Rs. 105, respectively. Yogesh buys articles of each type in the ratio 4 : 2 : 5 and spends a total of Rs. 8,060. How many articles of type Q did he purchase?

(a) 12
(b) 6
(c) 8
(d) 4

Q47. Amit can do a piece of work in 13 days. Gopal is 30% more efficient than Amit. The number of days taken by Gopal to do the same piece of work is:

(a) 13
(b) 10
(c) 15
(d) 20

Q48. The average of the first 12 odd natural numbers is:

(a) 12
(b) 12.5
(c) 13
(d) 11.5

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Q49. By decreasing the radius of a sphere by 25% whose surface area was 616 cm², a new sphere is formed. Find the volume of the newly formed sphere. (Take π = 22/7)

(a) 556.375 cm3
(b) 506.475 cm3
(c) 606.375 cm3
(d) 616.475 cm3

Q50. Simplify $(5pq + 16q)^2 - (5pq - 16q)^2$.

(a) $320pq^2$
(b) $160pq^2$
(c) $320p^2q$
(d) $160p^2q^2$

GENERAL INTELLIGENCE & REASONING

Q51. Based on the English alphabetical order, three of the following four letter cluster pairs are alike in a certain way and thus form a group. Which is the one that does not belong to that group?

(Note: The odd man out is not based on the number of consonants/vowels or their position in the letter cluster)

(a) LF - PJ
(b) JR - NV
(c) YA - CF
(d) TI - XM

Q52. Which of the following letter-number clusters will replace the question mark (?) in the given series to make it logically complete?

GSN 14, EQL 23, COJ 32, AMH 41, ?

(a) YKF 50
(b) ZKE 49
(c) YJD 50
(d) YKE 49

Q53. In a certain code language, ‘READ’ is coded as ‘4628’ and ‘AIMS’ is coded as ‘5716’. What is the code for ‘A’ in the given code language?

(a) 6
(b) 5
(c) 2
(d) 7

Q54. Town A is to the west of Town B. Town D is to the south of Town A. Town C is to the east of Town D. If Town E is to the north of Town C, what is the direction of Town B with respect to Town D? 298

(a) East
(b) North east
(c) West
(d) South

Q55. Read the given statement(s) and conclusions carefully. Assuming that the information given in the statements is true, even if it appears to be at variance with commonly known facts, decide which of the given conclusions logically follow(s) from the statement(s).

Statements: All kettles are ovens. All ovens are toasters.

Conclusion (I): Some toasters are kettles

Conclusion (II): No toaster is a kettle

(a) Both conclusions (I) and (II) follow
(b) Only conclusion (I) follows
(c) Only conclusion (II) follows

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(d) Neither conclusion (I) nor (II) follows

Q56. What should come in place of '?' in the given series?

8, 33, 69, ?, 182, 263

(a) 118
(b) 122
(c) 120
(d) 116

Q57. XTBH is related to BXFL in a certain way based on the English alphabetical order. In the same way, MFKP is related to QJOT. To which of the given options is BXLR related, following the same logic?

(a) GCQW
(b) DZNU
(c) EAOU
(d) FBPV

Q58. Select the set in which the numbers are related in the same way as are the numbers of the following sets.

(NOTE: Operations should be performed on the whole numbers, without breaking down the numbers into their constituent digits. E.g. 13 – Operations on 13 such as adding/subtracting/multiplying to 13 can be performed. Breaking down 13 into 1 and 3 and then performing mathematical operations on 1 and 3 is not allowed.)

12 - 4 - 48

15 - 3 - 45

(a) 3 - 4 - 14
(b) 21 - 3 - 61
(c) 19 - 2 - 38
(d) 16 - 2 - 34

Q59. Read the given statements and conclusions carefully. You have to take the given statements to be true even if they seem to be at variance from commonly known facts. You have to decide which conclusion/s logically follow/s from the given statements.

Statements: All cars are buses. All buses are ships. No car is a train.

Conclusion (I) : No bus is a train.

Conclusion (II) : No ship is a train.

(a) Neither conclusion (I) nor (II) follows
(b) Both conclusions (I) and (II) follow
(c) Only conclusion (I) follows
(d) Only conclusion (II) follows

Q60. Seven people, S, Q, U, A, R, E and D are sitting in a row, facing north.

Only two people sit to the right of A. Only two people sit between A and R. Only two people sit between E and D. D sits to the immediate left of A. S sits to the immediate right of U.

Who sits at the third position from the left end of the line?

(a) E
(b) Q
(c) R
(d) S

Q61. This question is based on the five, three-digit numbers given below.

(Left) 700 496 723 316 639 (Right)

(Example- 697 – First digit = 6, second digit = 9 and third digit = 7)

NOTE - All operations to be done from left to right.

What will be the resultant if the second digit of the highest number is subtracted from the third digit of the lowest number?9042

(a) 4

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(b) 3
(c) 7
(d) 5

Q62. This question is based on the five, three-digit numbers given below.

(Left) 431 853 326 139 268 (Right)

(Example- 697 – First digit = 6, second digit = 9 and third digit = 7)

NOTE - All operations to be done from left to right.

What will be the resultant if the third digit of the highest number is added to the second digit of the lowest number?

(a) 8
(b) 6
(c) 4
(d) 9

Q63. Gyalmu starts from Point A and drives 15 km towards east. He then takes a right turn, drives 16 km, turns right and drives 17 km. He then takes a right turn and drives 18 km. He takes a final right turn, drives 2 km and stops at Point P. How far (shortest distance) and towards which direction should he drive in order to reach Point A again?

(All turns are 90 degree turns only unless specified)

(a) 2 km to the south
(b) 4 km to the south
(c) 1 km to the south
(d) 3 km to the south

Q64. All 144 people are standing in a row facing north. Mr. Lkj is 65th from the left end while Mr. Ihg is 8th from the right end. How many people are there between Mr. Lkj and Mr. Ihg?

(a) 72
(b) 71
(c) 69
(d) 70

Q65. If 1 is added to each even digit and 2 is subtracted from each odd digit in the number 28369475, then how many digits will appear more than once in the new number thus formed?

(a) 1
(b) 3
(c) 2
(d) 4

Q66. What should come in place of the question mark (?) in the given series?

42 47 53 60 68 ?6045

(a) 78
(b) 77
(c) 79
(d) 76

Q67. In a row of 50 students facing North, Meha is 15th from the right end. If Priya is 8th to the left of Meha, what is Priya's position from the left end of the line?

(a) 27th
(b) 29th
(c) 26th
(d) 28th

Q68. GUSB is related to LZXV in a certain way based on the English alphabetical order. In the same way, NHIN is related to SMNH. To which of the following is MLKO related, following the same logic?

(a) SPQI
(b) RPPJ

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(c) RQPI
(d) SQQJ

Q69. What will come in the place of the question mark (?) in the following equation, if '+' and '−' are interchanged and '×' and '÷' are interchanged?

405 × 5 − 32 + 16 ÷ 6 = ?

(a) 18
(b) 16
(c) 17
(d) 19

Q70. Refer to the following letter series and answer the question.

(Left) C H T M L K N B P G Q D V W R A X Z F Y E S (Right)

How many unique vowels are there in the above series? (Each vowel counted only once regardless of repetition.)
5700

(a) Four
(b) One
(c) Two
(d) Three

Q71. VANE is related to DIVM in a certain way based on the English alphabetical order. In the same way, BGTK is related to JOBS. To which of the following options is ZERI related, following the same logic?

(a) HMWE
(b) HMZQ
(c) HMQW
(d) HWER

Q72. Seven people, A, B, C, D, E, F and G are sitting in a row, facing north. B sits sixth from the left end of the row. Only two people sit to the left of D. F sits to the right of A but left of D. E sits third to the left of G. How many people sit between C and G?

(a) Three
(b) One
(c) Two
(d) Four

Q73. Seven people, A, B, C, D, E, F and G are sitting in a row, facing north. Only six people sit to the left of F. D sits fourth from the right end of the row. Only two people sit between A and D. G is the immediate neighbour of C and F. B does not sit to the left of E.

How many people sit between E and G?

(a) Four
(b) None
(c) Two
(d) Three

Q74. What should come in place of '?' in the given series?

78 92 108 126 146 ?

(a) 170
(b) 165
(c) 162
(d) 168

Q75. In a certain code language, 'bees buzz close' is coded as 'zd st cq' and 'hear bees hum' is coded as 'cq ge vm'. How is 'bees' coded in the given language?

(a) cq
(b) zd

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(c) ge
(d) vm

Q76. What should come in place of ? in the given series in order to make it logically complete?

YY49 WV36 TR25 PM16 ?3867

(a) KG9
(b) JK4
(c) LH9
(d) KH9

Q77. Refer to the following series and answer the question (all numbers are single digit numbers only). Counting to be done from left to right only.

(Left) 1 6 8 1 6 2 8 1 4 3 8 2 9 7 8 7 3 9 5 5 6 (Right)

How many such even digits are there each of which is immediately preceded by an odd digit and also immediately followed by an even digit?

(a) 1
(b) 2
(c) 4
(d) 3

Q78. If 3 is added to each odd digit and 4 is subtracted from each even digit in the number 5346188, what will be the sum of the digits which are third from the left and fourth from the right in the new number thus formed?

(a) 2
(b) 6
(c) 0
(d) 4

Q79. In a certain code language,

A+ B means ‘A is the sister of B’

A # B means ‘A is the brother of B’

A × B means ‘A is the wife of B’

A @ B means ‘ A is the father of B’

Based on the above, how is L related to R if ‘ L@O#V+E×R’?

(a) Wife's father
(b) Brother
(c) Wife's brother
(d) Father

Q80. Based on the English alphabetical order, three of the following four letter-clusters are alike in a certain way and thus form a group. Which letter-cluster DOES NOT belong to that group?

(Note: The odd one out is not based on the number of consonants/vowels or their position in the letter-cluster.)

(a) GHI
(b) TVV
(c) JKL
(d) DEF

GENERAL AWARENESS AND CURRENT AFFAIRS

Q81. What is the name of India’s first indigenously developed CRISPR gene therapy designed to treat Sickle Cell Disease?

(a) GeneHeal Pro
(b) BIRSA 101
(c) CRISPR-Cure
(d) SCD Cure X

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Q82. Which organisation developed the SAKSHAM counter-Unmanned Aircraft System grid launched by the Indian Army in 2025?

(a) Bharat Electronics Limited Ghaziabad
(b) Hindustan Aeronautics Limited Nashik
(c) Indian Space Research Organisation Bengaluru
(d) Defence Research and Development Organisation Hyderabad

Q83. As reported in August 2025, the GST Group of Ministers (GoM) proposed to completely exempt premiums paid towards health and life insurance policies from the GST levy. What was the GST rate levied on health insurance premiums in India prior to this proposed exemption?

(a) 10%
(b) 12%
(c) 5%
(d) 18%

Q84. What is celebrated on 9 January 2025 to recognise the contributions of the Indian diaspora?

(a) Army Day
(b) Pravasi Bharatiya Divas
(c) World Hindi Day
(d) National Tourism Day

Q85. Which pioneering molecular biologist, who co-discovered the double helix structure of DNA along with Francis H. C. Crick and was awarded the Nobel Prize in Physiology or Medicine in 1962, passed away at the age of 97 in East Northport, New York?

(a) James D. Watson
(b) Rosalind Franklin
(c) Maurice Wilkins
(d) Francis H. C. Crick

Q86. In August 2025, who among the following chaired the Group of Ministers (GoM) that proposed exempting Goods and Services Tax (GST) on life and health insurance policies for individuals?

(a) Nitin Gadkari
(b) Mallu Bhatti Vikramarka
(c) Samrat Choudhary
(d) Ajay Seth

Q87. In July 2025, which Indian government body submitted its third Voluntary National Review (VNR) to the United Nations High-Level Political Forum (HLPF) on Sustainable Development?

(a) Finance Commission of India (FCI)
(b) Reserve Bank of India (RBI)
(c) Comptroller and Auditor General of India (CAG)
(d) National Institution for Transforming India (NITI Aayog)

Q88. Who was voted the 2024 NBA Finals most valuable player (FMVP)?

(a) Malachi Flynn
(b) Jaylen Brown
(c) Immanuel Jaylen Quickley
(d) Jayson Tatum

Q89. The Van Dhan Vikas Kendra at Dugong Creek aims to make the Onge tribe self-sustainable through which of the following?

(a) Honey and wild forest produce
(b) Herbal medicine production
(c) Bamboo handicrafts
(d) Coconut-based products

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Q90. How many new national records were set during the Khelo India Para Games 2025?

(a) 20
(b) 18
(c) 15
(d) 12

Q91. Which of the following National Parks received rupees Rs. 1.5 crore in June 2025 for the establishment of two new Rhino Rehabilitation Areas?

(a) Dudhwa National Park
(b) Sundarbans National Park
(c) Kaziranga National Park
(d) Jim Corbett National Park

Q92. Which organization conducted the National Achievement Survey, renamed PARAKH Rashtriya Sarvekshan in 2024, in which Kerala ranked second?

(a) Central Board of Secondary Education
(b) State Council of Educational Research and Training
(c) PARAKH under NCERT in collaboration with CBSE
(d) National Testing Agency

Q93. In October 2025, who among the following was appointed as the Director General of the Central Industrial Security Force?

(a) Kuldiep Singh
(b) Rakesh Asthana
(c) Praveer Ranjan
(d) Anil Kumar

Q94. Which state topped the medal tally at the Khelo India Para Games 2025?

(a) Haryana
(b) Maharashtra
(c) Uttar Pradesh
(d) Tamil Nadu

Q95. What is one of the primary purposes of the proposed Kulsi project?

(a) Military infrastructure
(b) Industrial development
(c) Tourism promotion and irrigation
(d) Hydropower generation and irrigation

Q96. Inaugurated in September 2025, the Monopropellant Thruster Test Facility (MPTTF) primarily supports testing activities related to which broad technological domain?

(a) Space propulsion systems
(b) Satellite navigation
(c) Hypersonic flight
(d) Nuclear propulsion

Q97. Which category of climate finance did India argue should be scaled up independently during the post-COP-30 negotiations held in November 2025?

(a) Adaptation finance
(b) Loss and damage finance
(c) Green hydrogen finance
(d) Carbon market finance

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Q98. Which team won the NBA championship trophy for 2023-24?

(a) Rochester Royals
(b) Philadelphia Warriors
(c) Boston Celtics
(d) Toronto Raptors

Q99. Where did Union Home Minister Amit Shah inaugurate India's largest and most modern sports complex in September 2025?

(a) Ahmedabad
(b) Surat
(c) Vadodara
(d) Gandhinagar

Q100. Which Vietnamese-American author released 'The Emperor of Gladness' in May 2025?

(a) Colum McCann
(b) Sharon Lee
(c) Ocean Vuong
(d) Charlotte McConaghy

ANSWER KEY

1	b	2	d	3	a	4	a	5	c	6	b	7	a	8	c	9	a	10	b
11	b	12	b	13	b	14	a	15	a	16	b	17	a	18	b	19	b	20	d
21	c	22	b	23	c	24	d	25	b	26	d	27	d	28	b	29	c	30	b
31	c	32	c	33	a	34	c	35	d	36	b	37	c	38	a	39	a	40	d
41	d	42	b	43	a	44	b	45	c	46	c	47	b	48	a	49	c	50	a
51	c	52	a	53	a	54	b	55	b	56	a	57	d	58	c	59	a	60	b
61	a	62	b	63	a	64	b	65	b	66	b	67	d	68	c	69	c	70	c
71	b	72	b	73	d	74	d	75	a	76	a	77	d	78	a	79	a	80	b
81	b	82	a	83	d	84	b	85	a	86	c	87	d	88	b	89	d	90	b
91	a	92	c	93	c	94	a	95	d	96	a	97	a	98	c	99	a	100	c

SOLUTIONS

Q1. Answer: (b) Uniform composition

The correct answer is Uniform composition.

Key Points

• A mixture consists of two or more different substances that are physically combined but not chemically bonded. The primary way to classify these is based on how the substances are distributed within the sample.

• A homogeneous mixture is characterized by a uniform composition throughout its mass. This means that any sample taken from the mixture will have the exact same proportions of its components. Examples include saltwater or clean air.

• A heterogeneous mixture possesses a non-uniform composition, meaning its components are not evenly distributed. Different regions of the mixture may have different properties and compositions. Examples include a salad or oil and water.

• The term "phase" is often used to distinguish them: a homogeneous mixture consists of a single phase (solid, liquid, or gas), while a heterogeneous mixture consists of two or more phases that remain physically separate.

• Regarding the other options: Chemical reactions are not a property of mixtures, as mixtures are formed through physical changes. A fixed boiling point is a characteristic of pure substances (elements or compounds), not mixtures. High density is a physical property of specific materials but does not determine whether a mixture is homogeneous or heterogeneous.

Additional Information

• Homogeneous Mixtures (Solutions):

• These are often referred to as solutions. A solution consists of a solute (the substance being dissolved) and a solvent (the

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medium in which it is dissolved).

• In a liquid solution like sugar-water, the sugar particles are so small (typically less than 1 nanometer) that they cannot be seen even with a microscope and do not settle over time.

• Alloys, such as brass (copper and zinc) or steel (iron and carbon), are considered solid homogeneous mixtures.

• Heterogeneous Mixtures (Suspensions and Colloids):

• Suspensions are heterogeneous mixtures where the particles are large enough to be seen and will eventually settle out due to gravity (e.g., sand in water).

• Colloids occupy a middle ground; they may appear homogeneous to the naked eye but are heterogeneous at a microscopic level (e.g., milk or fog). They exhibit the Tyndall Effect, which is the scattering of light by particles.

• Separation Techniques:

• Because mixtures are physical combinations, they can be separated by physical methods.

• Homogeneous mixtures usually require methods that involve phase changes, such as distillation or evaporation, to separate the components.

• Heterogeneous mixtures can often be separated by simpler mechanical means such as filtration, decantation, or using a centrifuge.

• Comparison with Pure Substances:

• A pure substance has constant physical and chemical properties. For instance, distilled water always boils at 100 degrees Celsius at sea level.

• In contrast, mixtures do not have a fixed boiling or melting point; they generally boil or melt over a range of temperatures depending on the concentration of the components.

Q2. Answer: (d) Salt and water

The correct answer is Salt and water.

Key Points

• A neutralization reaction is a specific type of chemical reaction where an acid and a base react with each other to produce a salt and water.

• When a strong acid (like Hydrochloric acid) reacts with a strong base (like Sodium hydroxide), the hydrogen ions (H+) from the acid and the hydroxide ions (OH-) from the base combine to form neutral water (H2O) molecules.

• The anion (negative ion) from the acid and the cation (positive ion) from the base combine to form an ionic compound called a salt (e.g., Sodium chloride). Hence, statement 4 is correct.

• Neutralization reactions between strong acids and strong bases typically result in a solution with a pH of 7 at 25 degrees Celsius, indicating a neutral solution.

• These reactions are inherently exothermic, meaning they release thermal energy or heat during the process.

• The formation of hydrogen gas typically occurs during the reaction of an acid with a metal, not during a standard acid-base neutralization. Hence, statement 1 is incorrect.

• While water is always formed, it is never the only product; the counter-ions must form a salt. Hence, statement 2 is incorrect.

• The production of carbon dioxide alongside salt and water occurs only when the base is a carbonate or bicarbonate, rather than a simple strong base like a metal hydroxide. Hence, statement 3 is incorrect.

Additional Information

• Strong Acids:

• These are substances that completely ionize in an aqueous solution, meaning they release all their available hydrogen ions.

• Examples include Hydrochloric acid (HCl), Sulfuric acid (H2SO4), and Nitric acid (HNO3).

• They have a very low pH value, usually between 0 and 3.

• Strong Bases:

• These are substances that completely dissociate in water to release hydroxide ions (OH-).

• Common examples include Sodium hydroxide (NaOH), also known as caustic soda, and Potassium hydroxide (KOH).

• They have a high pH value, typically ranging from 12 to 14.

• The pH Scale:

• The pH scale is a logarithmic scale used to measure the acidity or alkalinity of a solution.

• It ranges from 0 to 14, where 7 is neutral, values below 7 are acidic, and values above 7 are basic.

• Titration:

• This is a common laboratory method where a neutralization reaction is used to determine the unknown concentration of an acid or a base.

• An indicator (like phenolphthalein) is often used to signal the equivalence point, where the moles of acid equal the moles of base.

Important Points

• Heat of Neutralization: For any strong acid and strong base reaction, the enthalpy change is approximately constant at -57.3 kJ/mol because the essential reaction is always the formation of water from H+ and OH- ions.

• Applications:

• Antacids: Used to treat acidity in the stomach by neutralizing excess HCl with a weak base like Magnesium hydroxide.

• Soil Treatment: If the soil is too acidic, farmers add quicklime (calcium oxide) or slaked lime (calcium hydroxide) to neutralize it for better crop growth.

• Wastewater Treatment: Industrial effluents containing acids are neutralized with lime before being discharged into water bodies to prevent environmental damage.

• Ionic Equation: The net ionic equation for a strong acid-strong base neutralization is always: H+ (aq) + OH- (aq) → H2O (l).

Q3. Answer: (a) Four

The correct answer is Four.

Key Points

• Birds and mammals are warm-blooded (homeothermic) animals, meaning they maintain a constant body temperature regardless of the external environment.

• To maintain this internal temperature and support high levels of activity, these animals have high energy needs, which require a very efficient supply of oxygen to the body cells.

• A four-chambered heart consists of two atria and two ventricles, which ensures the complete physical separation of oxygenated blood (rich in oxygen) and deoxygenated blood (rich in carbon dioxide).

• This separation prevents the mixing of blood, allowing for a highly efficient double circulation system where oxygen is delivered to the tissues at a high pressure and rate. Hence, the statement regarding four-chambered hearts is correct.

• The left side of the heart handles oxygenated blood coming from the lungs, while the right side manages deoxygenated blood returning from the body tissues.

Additional Information

• Two-Chambered Heart:

• This type of heart is typically found in fishes.

• It consists of one atrium and one ventricle.

• The blood is pumped to the gills, where it is oxygenated, and then flows directly to the rest of the body. This is known as single circulation.

• Three-Chambered Heart:

• Found in amphibians (like frogs) and most reptiles (like lizards and snakes).

• It consists of two atria and one single ventricle.

• In the single ventricle, there is some mixing of oxygenated and deoxygenated blood, which is less efficient but sufficient for these cold-blooded (poikilothermic) animals with lower metabolic rates.

• Exceptional Cases in Reptiles:

• While most reptiles have three chambers, crocodiles and alligators are notable exceptions as they possess a four-chambered heart, similar to birds and mammals.

• Double Circulation:

• This refers to the blood passing through the heart twice during one complete cycle of the body.

• It includes pulmonary circulation (between heart and lungs) and systemic circulation (between heart and the rest of the body).

• This mechanism is vital for maintaining the high metabolic rate and homeostasis in mammals and birds.

Important Points

• Energy and Temperature: Animals that do not use energy to maintain their body temperature (cold-blooded) can tolerate some mixing of blood, but for homeotherms, the four chambers are an evolutionary necessity.

• Ventricle Evolution: The evolution from a single ventricle (in fish) to a partially divided ventricle (in reptiles) and finally to a completely divided ventricle (in mammals and birds) reflects the increasing demand for metabolic efficiency.

• Left Ventricle: In a four-chambered heart, the left ventricle usually has the thickest muscular wall because it must pump blood to the entire body.

Q4. Answer: (a) Sieve tube

The correct answer is Sieve tube.

Key Points

• Phloem is a complex permanent tissue in vascular plants that functions as the food-conducting complex tissue, transporting organic nutrients (mainly sucrose) from the leaves to other parts of the plant.

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• Sieve tubes are the primary conducting elements of the phloem. They are long, tubular structures arranged longitudinally and are characterized by having perforated walls.

• The end walls of sieve tube cells are called sieve plates, which are perforated in a sieve-like manner to allow the continuous flow of food materials between adjacent cells. Hence, statement 1 is correct.

• A mature sieve tube element possesses a peripheral layer of cytoplasm and a large vacuole but lacks a nucleus. This structural adaptation allows for more efficient transport of nutrients.

• The functions of sieve tubes are controlled by the nucleus of companion cells, which are specialized parenchyma cells closely associated with them through pit fields.

Additional Information

• Components of Phloem:

• Companion Cells: These are specialized parenchymatous cells that help maintain the pressure gradient in the sieve tubes. They are living cells with a dense cytoplasm and a distinct nucleus.

• Phloem Parenchyma: This consists of elongated, tapering cylindrical cells that have dense cytoplasm and a nucleus. Their primary function is the storage of food and other substances like resins, latex, and mucilage.

• Phloem Fibers: Also known as bast fibers, these are made of sclerenchymatous cells. They are generally absent in primary phloem but present in secondary phloem. They provide mechanical strength and are dead at maturity.

• Vascular Bundle Context:

• In addition to phloem, plants possess xylem, which is responsible for the conduction of water and minerals from roots to leaves.

• Unlike phloem, which conducts material bidirectionally, xylem typically facilitates unidirectional transport.

• Sieve cells are found in gymnosperms, whereas sieve tubes are characteristic of angiosperms.

Important Points

• The sieve plate is the specific perforated end wall, but the sieve tube is the overall "part" or unit of the tissue that is described as tubular and having these perforated walls.

• Phloem transport is an active process that requires energy in the form of ATP to load sucrose into the sieve tube elements.

• The first formed primary phloem consists of narrow sieve tubes and is referred to as protophloem, whereas the later formed phloem has bigger sieve tubes and is called metaphloem.

• The sieve tube elements are unique because they are living cells that function without a nucleus, a condition known as being enucleated at maturity.

Q5. Answer: (c) It increases genetic variation within the population.

The correct answer is It increases genetic variation within the population.

Key Points

• Sexual reproduction involves the fusion of specialized cells called gametes (sperm and egg) from two different individuals, which combines their DNA to create a new organism.

• The most significant advantage of this process is the generation of genetic variation. Because the offspring receives a unique mix of alleles from both parents, they are genetically distinct from their parents and siblings.

• This variation is essential for the process of evolution. It provides the raw material upon which natural selection acts, allowing populations to adapt to changing environments, diseases, or predators. Hence, the statement "It increases genetic variation within the population" is correct.

• Combining DNA from two individuals allows for genetic recombination. During meiosis, homologous chromosomes exchange segments, further increasing the diversity of the genetic code passed to the next generation.

• While asexual reproduction is more efficient in stable environments, it produces clones. A lack of genetic diversity in asexual populations makes them highly susceptible to being wiped out by a single environmental change or pathogen.

Additional Information

• Reproductive Complexity: Contrary to reducing the need for specialized parts, sexual reproduction actually requires specialized reproductive organs (such as ovaries and testes) and complex hormonal systems to facilitate the production and fusion of gametes. Hence, statement 1 is incorrect.

• DNA Copying Errors: DNA replication is a biological process that naturally involves a small rate of error, leading to mutations. Sexual reproduction does not eliminate these errors; in fact, mutations are the ultimate source of all genetic variation, though sexual reproduction helps reshuffle these mutations. Hence, statement 2 is incorrect.

• Reproductive Speed: Sexual reproduction is generally much slower than asexual reproduction. It requires finding a mate, the energetic cost of producing gametes, and often a lengthy gestation or incubation period. Asexual reproduction (like binary fission in bacteria) is far more rapid. Hence, statement 4 is incorrect.

• The Red Queen Hypothesis: This evolutionary theory suggests that sexual reproduction is maintained because it allows hosts to evolve new genetic defenses rapidly enough to keep pace with the evolution of parasites and pathogens.

Important Points

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• Meiosis: This is the key cellular process behind sexual reproduction. It involves two rounds of division to produce haploid cells (containing half the chromosomes of the parent).

• Independent Assortment: During meiosis, the random distribution of maternal and paternal chromosomes into gametes ensures that every gamete is unique, contributing to the genotypic diversity of the offspring.

• Adaptability: In a population with high genetic variation, there is a higher probability that some individuals will possess traits (such as drought resistance or immunity to a specific virus) that allow them to survive a catastrophe that might kill others.

• Muller's Ratchet: This concept explains that asexual populations tend to accumulate deleterious mutations over time because they cannot "purge" them through recombination. Sexual reproduction helps solve this problem by producing some offspring with fewer harmful mutations than their parents.

Q6. Answer: (b) A proton is positively charged and its mass is taken as one unit

The correct answer is A proton is positively charged and its mass is taken as one unit.

Key Points

• A proton is a subatomic particle that carries a positive electrical charge of +1e (approximately 1.602 x 10^(-19) Coulombs). Hence, statement 2 is correct.

• The mass of a proton is approximately 1.672 x 10^(-27) kg. In the context of atomic chemistry, this mass is considered to be 1 unit (roughly 1 atomic mass unit or amu).

• Statement 1 suggests that a proton is neutral and has mass equal to an electron. This is incorrect because neutrons are the particles that are neutral, and a proton is about 1836 times heavier than an electron. Hence, statement 1 is incorrect.

• Statement 3 claims that a proton is negatively charged. This is the characteristic of an electron, not a proton. Hence, statement 3 is incorrect.

• Statement 4 mentions that a proton's mass is 1/2000 of a hydrogen atom. In reality, a hydrogen atom (specifically the protium isotope) consists of exactly one proton and one electron. Since the electron's mass is negligible, the proton's mass is nearly equal to that of a hydrogen atom, not a fraction of it. It is the electron whose mass is approximately 1/1840 (often rounded to 1/2000) of a proton. Hence, statement 4 is incorrect.

Additional Information

• Discovery of Protons:

• In 1886, E. Goldstein discovered the presence of new radiations in a gas discharge which he called canal rays. These rays were positively charged radiations.

• Later, Ernest Rutherford is credited with the discovery of the nucleus and identifying the proton as a fundamental particle in the year 1917 to 1919 through his gold foil experiment and subsequent nitrogen-alpha particle experiments.

• Location in the Atom:

• Protons are located inside the nucleus at the center of the atom.

• Along with neutrons, they are collectively referred to as nucleons.

• Atomic Number (Z):

• The Atomic Number of an element is defined by the total number of protons present in the nucleus of its atom.

• For example, Carbon has an atomic number of 6 because it contains 6 protons.

• Stability:

• The proton is a stable particle, meaning it does not decay into other particles under normal conditions. Its estimated half-life is greater than 10^(34) years.

Important Points

• Comparison of Subatomic Particles:

• Proton: Positive charge (+1), Mass ~ 1 amu, Location: Inside Nucleus.

• Neutron: Neutral charge (0), Mass ~ 1 amu, Location: Inside Nucleus.

• Electron: Negative charge (-1), Mass ~ 1/1840 amu (negligible), Location: Outside Nucleus in orbits.

• Charge Neutrality: In a neutral atom, the number of protons is exactly equal to the number of electrons, making the net charge of the atom zero.

Q7. Answer: (a) Square of the current flowing through the resistor

The correct answer is Square of the current flowing through the resistor.

Key Points

• The physical phenomenon where heat is generated by an electric current passing through a conductor is known as the Heating Effect of Electric Current.

• According to Joule’s Law of Heating, the heat produced in a resistor is directly proportional to the square of the current (I^2) for a given resistance. Hence, statement 1 is correct.

• The law also states that the heat produced is directly proportional to the resistance (R) for a given current. Hence, statement 4 is

incorrect in this context because the question specifies a constant resistance, making length a factor already accounted for in the constant value.

• Furthermore, the magnitude of heat is directly proportional to the time (t) for which the electric current flows through the resistor.

• The mathematical representation of this law is H = I^2Rt, where H represents Heat in Joules, I represents Current in Amperes, R represents Resistance in Ohms, and t represents Time in Seconds.

• Heat is not linearly proportional to the current, but rather to its square; thus, if the current is doubled, the heat produced increases by 4 times. Hence, statement 3 is incorrect.

Additional Information

• James Prescott Joule: This law was first deduced by the English physicist James Prescott Joule in the year 1841. His work led to the First Law of Thermodynamics.

• Electric Power: The rate at which electrical energy is dissipated as heat is called Electric Power (P). It is expressed as P = I^2R or P = VI, where V is the potential difference.

• Applications: The heating effect is utilized in various household appliances such as electric heaters, electric irons, geysers, toasters, and electric kettles.

• Filament Lamps: In an incandescent light bulb, the Tungsten filament (having a high melting point of 3380 degrees Celsius) is heated to such a high temperature that it starts glowing and emitting light.

• Electric Fuse: A safety device used in electrical circuits that works on the heating effect of current. It is made of an alloy (like tin-lead) with a low melting point to protect the circuit from short circuits or overloading.

Important Points

• Resistance (R): It is the opposition offered by a material to the flow of electric current. The SI unit is Ohm (represented by Ω). While resistance depends on length and area, the question assumes it to be constant.

• Density of Material: The density of the resistor material does not directly appear in the Joule's Law formula for heat dissipation. Hence, statement 2 is incorrect.

• Energy Conversion: In a purely resistive circuit, the entire electrical energy consumed is converted into thermal energy (heat).

• Nichrome: A commonly used alloy in heating elements because of its high resistivity and ability to withstand high temperatures without oxidation.

• Numerical Fact: 1 calorie is equal to approximately 4.184 Joules. Sometimes heat in these problems is requested in calories, requiring a division by 4.184.

Q8. Answer: (c) They produce OH^- ions in water.

The correct answer is They produce OH^- ions in water.

Key Points

• According to the Arrhenius theory of acids and bases, a base is a substance that dissociates in aqueous solution to form hydroxide ions (OH^-). This increase in hydroxyl ion concentration is the defining characteristic of an Arrhenius base. Hence, statement 3 is correct.

• Bases have the property of turning red litmus paper blue. The statement that they turn blue litmus red is a characteristic of acids, not bases. Hence, statement 2 is incorrect.

• The physical property of sour taste is associated with acids (such as citric acid in lemons). Bases are known for having a bitter taste and a slippery or soapy feel to the touch. Hence, statement 4 is incorrect.

• While certain strong bases like Sodium Hydroxide (NaOH) can react with specific active metals like Zinc (Zn) or Aluminum (Al) to produce Hydrogen gas (H2), this is not a general property of all bases. Generally, the reaction with metals to produce hydrogen is a classic identifying feature of acids. Hence, statement 1 is not the primary defining truth for bases in general.

• Common examples of bases in aqueous solutions include Sodium Hydroxide (NaOH), Calcium Hydroxide (Ca(OH)2), and Potassium Hydroxide (KOH).

Additional Information

• The pH Scale: The strength of a base is measured on the pH scale. Bases have a pH value ranging from above 7 to 14. A pH of 7 is considered neutral (like pure water), while a pH of 14 indicates a very strong alkali.

• Strong vs. Weak Bases:

• Strong Bases: These are compounds that completely ionize or dissociate into their component ions in water. Examples include Group 1 hydroxides like Lithium Hydroxide (LiOH).

• Weak Bases: These do not dissociate completely in aqueous solution. Ammonia (NH3) is a classic example of a weak base.

• Alkali: A base that is soluble in water is specifically called an alkali. It is important to note that while all alkalis are bases, not all bases are alkalis, as some do not dissolve in water.

• Neutralization Reaction: When a base reacts with an acid, they undergo a neutralization reaction to produce salt and water. For example, HCl + NaOH → NaCl + H2O.

• Uses of Bases:

• Sodium Hydroxide (NaOH) is used in the manufacture of soap, paper, and synthetic fibers like rayon.

• Calcium Hydroxide (Ca(OH)2), also known as slaked lime, is used in the manufacture of bleaching powder and for whitewashing.

• Magnesium Hydroxide (Mg(OH)2) is commonly used as an antacid to neutralize excess stomach acid.

Important Points

• Bronsted-Lowry Definition: Apart from the Arrhenius definition, the Bronsted-Lowry theory defines a base as a proton (H^+) acceptor.

• Lewis Definition: The Lewis theory provides a broader definition, stating that a base is an electron-pair donor.

• Indicators: Besides litmus, other indicators like Phenolphthalein turn pink in the presence of a base, while Methyl Orange turns yellow.

• Corrosive Nature: Strong bases are highly corrosive and can cause severe chemical burns, similar to strong acids. They are often referred to as caustic (e.g., caustic soda).

Q9. Answer: (a) To remove impurities from the extracted metal

The correct answer is To remove impurities from the extracted metal.

Key Points

• Refining is the final stage in the metallurgical process used to obtain a metal of high purity.

• Metals obtained through reduction processes, such as smelting or electrowinning, are typically referred to as crude metals. These crude metals often contain impurities like unreacted oxides, other metals, non-metals (such as silicon or phosphorus), and residual slag. Hence, the statement regarding removing impurities is correct.

• The primary objective of refining is to remove these substances to ensure the metal possesses the desired physical and chemical properties, such as electrical conductivity and malleability.

• Converting a metal into an alloy (Option 2) is a separate process called alloying, which involves mixing the metal with other elements to enhance strength or corrosion resistance, rather than purifying it. Hence, statement 2 is incorrect.

• Reducing reactivity (Option 3) is generally achieved through passivation or coating, not the refining process itself. Hence, statement 3 is incorrect.

• Increasing the melting point (Option 4) is an inherent physical property or changed via alloying, but is not the main goal of purification. Hence, statement 4 is incorrect.

Additional Information

• Common Methods of Refining:

• Distillation: This method is used for volatile metals with low boiling points, such as Zinc (Zn) and Mercury (Hg). The impure metal is evaporated and the pure metal is obtained as condensate.

• Liquation: This is used for metals with a low melting point (like Tin (Sn) or Lead (Pb)) compared to their impurities. The metal is melted on a sloping hearth, allowing the liquid pure metal to flow away from the solid impurities.

• Electrolytic Refining: This is the most widely used method for metals like Copper (Cu), Gold (Au), and Silver (Ag). An anode of impure metal and a cathode of pure metal are placed in an electrolyte solution of the metal salt.

• Zone Refining: This process is based on the principle that impurities are more soluble in the melt than in the solid state of the metal. It is used to produce ultra-pure semiconductors like Germanium (Ge) and Silicon (Si).

Important Points

• Vapour Phase Refining: The metal is converted into a volatile compound and then decomposed to give pure metal.

• Mond Process: Used specifically for the refining of Nickel (Ni). The metal is reacted with Carbon Monoxide to form Nickel Tetracarbonyl, which is then decomposed at higher temperatures.

• Van Arkel Method: Used for refining Zirconium (Zr) and Titanium (Ti) by removing oxygen and nitrogen through the formation of volatile iodides.

• Purity Levels: Modern refining techniques can achieve purity levels exceeding 99.99%, which is critical for the electronics industry and aerospace engineering.

• Environmental Impact: Industrial refining often involves chemical reagents and high energy consumption; thus, modern environmental laws mandate strict waste management for refining by-products.

Q10. Answer: (b) Newton

The correct answer is Newton.

Key Points

• The Newton (N) is the SI unit of weight. In the field of physics, weight is defined as the gravitational force exerted on an object by a large body, such as the Earth.

• Since weight is a type of force, it follows the same units as defined in the International System of Units (SI) for force. One Newton is the amount of force required to accelerate a mass of one kilogram at a rate of one meter per second squared (1 m/s^2).

• The relationship between mass and weight is governed by the formula $W = m \times g$, where W is the weight, m is the mass of the

object, and g is the acceleration due to gravity.

• On the surface of the Earth, the value of g is approximately 9.8 m/s². Therefore, a mass of 1 kg has a weight of approximately 9.8 Newtons on Earth.

• Weight is a vector quantity because it has both magnitude and a specific direction, which is always directed toward the center of the planet or the source of gravity.

Additional Information

• Kilogram (kg):

• The kilogram is the SI base unit of mass. Unlike weight, mass is an intrinsic property of an object and represents the quantity of matter it contains.

• The mass of an object remains constant regardless of its location in the universe, whereas its weight changes depending on the local gravitational pull.

• Pascal (Pa):

• The Pascal is the SI derived unit of pressure. It is defined as one Newton per square meter (N/m²).

• It is used to quantify internal pressure, stress, Young's modulus, and ultimate tensile strength. It is named after the French mathematician and physicist Blaise Pascal.

• Joule (J):

• The Joule is the SI unit of energy, work, or amount of heat.

• It is defined as the work done by a force of one Newton acting through a distance of one meter in the direction of the force.

Important Points

• Variability of Weight: Because weight depends on gravity, the weight of an object on the Moon is only about one-sixth (1/6th) of its weight on Earth, even though its mass remains exactly the same.

• Measurement Tools: A spring balance is typically used to measure weight (force), while a beam balance or physical balance is used to measure mass by comparison with known standards.

• Historical Context: The unit Newton was named in 1948 by the General Conference on Weights and Measures (CGPM) to honor Sir Isaac Newton for his contributions to classical mechanics and the Laws of Motion.

• Standard Gravity: For most calculations on Earth, the standard acceleration due to gravity is taken as 9.80665 m/s².

Q11. Answer: (b) The New Cartesian Sign Convention must be used

The correct answer is The New Cartesian Sign Convention must be used.

Key Points

• The Mirror Formula is a mathematical relationship between the object distance (u), image distance (v), and focal length (f) of a spherical mirror, expressed as 1/v + 1/u = 1/f.

• When substituting numerical values into this formula, it is mandatory to use the New Cartesian Sign Convention to distinguish between the directions and positions of the object and image. Hence, statement 2 is correct.

• All distances are measured from the Pole (P) of the mirror, which is treated as the origin of the coordinate system, rather than the centre of curvature. Hence, statement 1 is incorrect.

• The focal length (f) is not always positive; it is negative for a concave mirror and positive for a convex mirror according to the convention. Hence, statement 3 is incorrect.

• While it is necessary to maintain consistency in units (e.g., all values in cm or all in mm) to ensure the calculation is correct, it is not a strict prerequisite that they must only be in metres. Hence, statement 4 is incorrect.

Additional Information

• Rules of New Cartesian Sign Convention:

• The object is always placed to the left of the mirror, meaning light is incident from the left side.

• Distances measured in the direction of incident light (to the right of the pole) are taken as positive.

• Distances measured against the direction of incident light (to the left of the pole) are taken as negative.

• Heights measured upward and perpendicular to the principal axis are taken as positive, while those measured downward are negative.

• Concave Mirror:

• Commonly known as a converging mirror.

• The focal length (f) and radius of curvature (R) are always negative because the focus lies in front of the mirror.

• It can form both real and virtual images depending on the object distance (u).

• Convex Mirror:

• Commonly known as a diverging mirror.

• The focal length (f) and radius of curvature (R) are always positive because the focus lies behind the mirror.

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• It always forms a virtual, erect, and diminished image.

• Linear Magnification (m):

• It is the ratio of the height of the image to the height of the object, also expressed as m = -v/u.

• A negative sign in magnification indicates a real image, while a positive sign indicates a virtual image.

Important Points

• The relationship between radius of curvature (R) and focal length (f) is given by R = 2f. This is applicable for spherical mirrors with small apertures.

• For a real object, the object distance (u) is always negative because it is placed to the left of the pole.

• The Mirror Formula is applicable to all types of spherical mirrors (concave and convex) for all positions of the object.

Q12. Answer: (b) Ethanoic acid

The correct answer is Ethanoic acid.

Key Points

• The reaction given is the oxidation of Ethanol (CH3-CH2OH). Ethanol is a primary alcohol characterized by the presence of one hydroxyl (-OH) group attached to a carbon atom that is bonded to only one other carbon.

• Alkaline Potassium Permanganate (KMnO4) and Acidified Potassium Dichromate (K2Cr2O7) are both classified as strong oxidizing agents. They are capable of donating oxygen or removing hydrogen from organic substrates.

• When Ethanol is treated with these reagents and subjected to Heat, it undergoes a two-step oxidation process. It first forms Ethanal (an aldehyde), which is then rapidly oxidized further because of the strength of the reagents.

• The final product of this complete oxidation is Ethanoic acid (CH3COOH). In this transformation, the carbon chain length remains constant; since the starting alcohol has two carbon atoms, the resulting carboxylic acid also has two carbon atoms. Hence, the product is Ethanoic acid.

• The reaction can be summarized as: CH3-CH2OH + 2[O] → CH3COOH + H2O. This chemical change involves the conversion of the primary alcoholic group into a carboxylic acid group.

Additional Information

• Ethanoic Acid (Acetic Acid):

• Ethanoic acid is the second member of the homologous series of carboxylic acids. It has the chemical formula CH3COOH.

• A 5% to 8% solution of Ethanoic acid in water is commonly known as Vinegar, which is widely used as a preservative in pickles and in various culinary applications.

• Pure Ethanoic acid is called Glacial Acetic Acid because its melting point is 290 K, and it often freezes during winter in cold climates, looking like ice.

• Role of Oxidizing Agents:

• KMnO4 is a purple colored compound that acts as a strong oxidant in alkaline medium. During the reaction, the purple color disappears, indicating that Ethanol has been oxidized.

• Acidified K2Cr2O7 is orange in color. When it oxidizes alcohol, the Chromium ions are reduced from Cr(+6) to Cr(+3), causing the solution to turn green.

• Differentiation of Products:

• Ethanal (CH3CHO) is the intermediate product. To obtain Ethanal as the final product, a mild oxidizing agent like PCC (Pyridinium Chlorochromate) would be required to prevent over-oxidation to the acid.

• Propanone (CH3COCH3) is a ketone with three carbons. It is typically formed by the oxidation of a secondary alcohol (like Propan-2-ol), not a primary alcohol like ethanol.

• Propanal (CH3CH2CHO) is an aldehyde with three carbons. It cannot be formed from ethanol because ethanol only contains two carbon atoms.

Important Points

• The reaction is categorized as a Combustion/Oxidation reaction in organic chemistry. Unlike combustion, which breaks the carbon chain to release CO2, controlled oxidation preserves the carbon skeleton.

• Alcohols can be identified through this reaction by observing the color change of the reagents. This is often used as a qualitative test in laboratories.

• Primary alcohols produce carboxylic acids, secondary alcohols produce ketones, and tertiary alcohols generally do not undergo oxidation under these standard conditions because they lack a hydrogen atom on the alpha-carbon.

Q13. Answer: (b) Produce, transmit, and amplify sound

The correct answer is Produce, transmit, and amplify sound.

Key Points

• Megaphones, horns, and stethoscopes are instruments designed to produce, transmit, and amplify sound signals using the physical principle of multiple reflection of sound.

• In these devices, a tube or a conical shape is used to reflect sound waves repeatedly in such a way that the waves are guided in a specific direction toward the audience or the listener's ear. Hence, the statement regarding their use to produce, transmit, and amplify sound is correct.

• A megaphone or speaking-trumpet consists of a conical opening that prevents the sound energy from spreading out in all directions, effectively amplifying the sound intensity in the forward direction.

• A stethoscope is a medical instrument used by doctors to listen to sounds produced within the body, primarily the heart and lungs. It works by transmitting the sound from the chest piece to the earpieces through multiple reflections inside the connecting rubber or plastic tubes.

• The primary function of these devices is not to block sound or change its pitch, but to ensure that the amplitude and clarity of the sound reaching the observer are significantly increased.

Additional Information

• Reflection of Sound: Just like light, sound reflects off surfaces. The laws of reflection apply here, where the angle of incidence is equal to the angle of reflection, and all three rays lie in the same plane.

• Echoes: An echo is the sensation of sound persisting in our brain for about 0.1 seconds. To hear a distinct echo, the minimum distance of the reflecting surface from the source of sound must be 17.2 meters at a temperature of 22 degrees Celsius.

• Reverberation: This refers to the persistence of sound due to repeated reflections in a large hall or auditorium. Excessive reverberation is usually reduced by using sound-absorbent materials like compressed fiberboards or rough plaster.

• Pitch vs. Loudness: Pitch depends on the frequency of the sound wave, while loudness or amplification depends on the amplitude. The devices mentioned in the question primarily affect the loudness and direction rather than the frequency (pitch).

Important Points

• Stethoscope Invention: The stethoscope was invented in 1816 by the French physician named René Laennec. Its modern version helps in diagnosing conditions of the respiratory and cardiovascular systems.

• Design of Concert Halls: The ceilings of concert halls, conference halls, and cinema halls are often curved so that sound, after reflection, reaches all corners of the hall uniformly.

• Sound Boards: Sometimes, a curved soundboard is placed behind the speaker in a large hall so that the sound, after reflecting from the soundboard, spreads evenly across the width of the hall.

• Applications of Multiple Reflection: Apart from medical and public speaking tools, the principle of multiple reflection is also utilized in ultrasonography and SONAR (Sound Navigation and Ranging) technologies used for underwater communication and detection.

Q14. Answer: (a) Spirogyra

The correct answer is Spirogyra.

Key Points

• Fragmentation is a form of asexual reproduction where a multicellular organism breaks into several pieces, and each piece grows into a new, complete individual.

• Spirogyra, which is a filamentous green alga found in freshwater, commonly reproduces through this method. Upon reaching maturity, the long filament simply breaks into smaller fragments. Hence, statement 1 is correct.

• This process does not involve the fusion of gametes, making it a simple and rapid way for the organism to colonize a habitat.

• In Spirogyra, the body design is relatively simple, allowing these broken fragments to undergo mitotic cell division to form a full-length filament again.

• Unlike regeneration, which is often a defense mechanism or a way to repair damaged parts, fragmentation in these organisms is a standard reproductive strategy.

Additional Information

• Bryophyllum:

• This plant is well-known for vegetative propagation through its leaves.

• Small buds (adventitious buds) develop along the notches of the leaf margins. When these leaves fall on moist soil, the buds develop into independent plantlets. Hence, statement 2 is incorrect.

• Jasmine:

• Jasmine plants are typically propagated through vegetative methods such as layering or stem cutting.

• In layering, a branch of the plant is bent to the ground and covered with soil while still attached to the parent, eventually growing its own roots. Hence, statement 3 is incorrect.

• Orange:

• Orange trees can reproduce sexually through seeds or via artificial vegetative propagation like grafting.

• Grafting is a technique where tissues of plants are joined so as to continue their growth together, commonly used in horticulture to ensure consistent fruit quality. Hence, statement 4 is incorrect.

• Other Modes of Asexual Reproduction:

• Budding: Observed in Yeast and Hydra, where an outgrowth or bud develops into a new individual.

• Fission: Common in unicellular organisms like Amoeba (binary fission) and Plasmodium (multiple fission).

• Spore Formation: Used by fungi like Rhizopus (bread mould) to survive unfavorable conditions and disperse.

Important Points

• Spirogyra belongs to the kingdom Plantae and the group Thallophyta.

• The name Spirogyra is derived from the spiral arrangement of its chloroplasts, which is a distinguishing cellular feature.

• It is often referred to as "water silk" or "pond scum" due to its slimy texture and appearance in stagnant water bodies.

• While fragmentation is the common asexual route, Spirogyra can also undergo sexual reproduction through a process called conjugation, where genetic material is exchanged between two filaments.

Q15. Answer: (a) Manganese

The correct answer is Manganese.

Key Points

• Essential elements for plant growth are divided into two categories based on their quantitative requirements: Macronutrients and Micronutrients.

• Micronutrients or trace elements are needed in very small amounts, generally less than 10 mmole kg^-¹ of dry matter.

• Manganese (Mn) is a key micronutrient absorbed by plants in the form of manganous ions (Mn^{2+}). It is essential for the photolysis of water to liberate oxygen during the process of photosynthesis. Hence, statement 1 is correct.

• It also plays a crucial role in activating several enzymes involved in respiration and nitrogen metabolism.

• While Manganese is vital, its toxicity can occur if absorbed in excess, often characterized by the appearance of brown spots surrounded by chlorotic veins.

Additional Information

• Nitrogen (N):

• It is a macronutrient required by plants in the greatest amount. It is absorbed mainly as nitrate (NO3^-), though some is taken up as nitrite (NO2^-) or ammonium (NH4^+).

• It is a major constituent of proteins, nucleic acids, vitamins, and hormones. Hence, statement 2 is incorrect.

• Phosphorous (P):

• It is a macronutrient absorbed by plants from the soil in the form of phosphate ions.

• It is a constituent of cell membranes, certain proteins, all nucleic acids, and nucleotides, and is required for all phosphorylation reactions. Hence, statement 3 is incorrect.

• Magnesium (Mg):

• It is a macronutrient absorbed as divalent Mg^{2+}.

• It activates the enzymes of respiration and photosynthesis and is a central constituent of the ring structure of chlorophyll. It also helps in maintaining the ribosome structure. Hence, statement 4 is incorrect.

Important Points

• There are 17 essential elements required for plant growth and metabolism.

• Macronutrients (9): These include Carbon (C), Hydrogen (H), Oxygen (O), Nitrogen (N), Phosphorous (P), Potassium (K), Calcium (Ca), Magnesium (Mg), and Sulphur (S).

• Micronutrients (8): These include Iron (Fe), Manganese (Mn), Copper (Cu), Molybdenum (Mo), Zinc (Zn), Boron (B), Chlorine (Cl), and Nickel (Ni).

• Criteria for Essentiality: An element is considered essential if the plant cannot complete its life cycle without it, and the element is directly involved in the metabolism of the plant.

• Nutrients like Carbon, Hydrogen, and Oxygen are mainly obtained from CO2 and H2O, while others are absorbed from the soil as minerals.

Q16. Answer: (b) the passengers have inertia and continue in their state of motion

The correct answer is the passengers have inertia and continue in their state of motion.

Key Points

• According to Newton’s First Law of Motion, an object will continue in its state of rest or uniform motion in a straight line unless compelled to change that state by an external force applied to it.

• When a car is in motion, the passengers sitting inside it are also moving at the same velocity as the car.

• When the brakes are applied suddenly, the car comes to a halt or slows down due to the frictional force between the tires and the road, but this force is not directly applied to the upper body of the passengers.

• Due to the property of Inertia of Motion, the passengers' bodies tend to maintain their original state of motion (moving forward), while the car (and the lower part of the passenger's body in contact with the seat) slows down.

• The air inside the car does not have enough mass or pressure change to push passengers forward significantly during braking. Hence, statement 1 is incorrect.

• The tendency to move forward is a direct result of the body's inertia resisting the change in velocity. Hence, statement 2 is correct.

• Gravity acts vertically downward and does not pull passengers forward horizontally when brakes are applied. Hence, statement 3 is incorrect.

• Brakes apply a backward force (deceleration) on the car, not a forward force on the passengers. Hence, statement 4 is incorrect.

Additional Information

• Types of Inertia:

• Inertia of Rest: The tendency of a body to remain at rest. For example, when a stationary bus starts suddenly, passengers fall backward because their lower body moves with the bus, but the upper body tries to stay at rest.

• Inertia of Motion: The tendency of a body to remain in uniform motion. The car braking scenario is a classic example of this.

• Inertia of Direction: The tendency of a body to resist a change in its direction of motion. For example, when a car takes a sharp curve, passengers are thrown toward the outside of the curve.

• Mass and Inertia:

• The inertia of an object is measured by its mass. An object with a larger mass (like a truck) has more inertia and is harder to stop or start than an object with a smaller mass (like a bicycle).

• The SI unit of mass is the kilogram (kg).

• Applications in Safety:

• Seatbelts are designed to provide the necessary external force to stop the passenger's body from moving forward due to inertia, preventing them from hitting the windshield or dashboard.

• Airbags provide a cushion to increase the time of impact, thereby reducing the force exerted on the passenger during a sudden stop.

Important Points

• The concept of Inertia was first proposed by Galileo Galilei through his experiments with inclined planes and was later incorporated by Sir Isaac Newton as the First Law of Motion.

• Newton published these laws in his famous book "Philosophiæ Naturalis Principia Mathematica" in the year 1687.

• It is important to note that Inertia is not a force but a property of matter.

• The Net External Force acting on an object is zero if the object is moving at a constant velocity or is at rest.

Q17. Answer: (a) Add the atomic mass of sodium and the atomic mass of chlorine

The correct answer is Add the atomic mass of sodium and the atomic mass of chlorine.

Key Points

• The formula unit mass of a substance is defined as the sum of the atomic masses of all atoms present in a formula unit of a compound.

• In the case of Sodium Chloride (NaCl), the crystal lattice consists of Sodium (Na+) and Chloride (Cl-) ions arranged in a 1:1 ratio.

• To calculate the formula unit mass, one must identify the atomic mass of each constituent element from the Periodic Table and add them together based on their proportions in the chemical formula. Hence, statement 1 is correct.

• Mathematical operations like division, subtraction, or multiplication of atomic masses do not represent the physical reality of combining masses in a chemical compound. Hence, statements 2, 3, and 4 are incorrect.

• For NaCl, the atomic mass of Sodium (Na) is approximately 23.0 u and the atomic mass of Chlorine (Cl) is approximately 35.5 u.

• The calculation is: 23.0 u + 35.5 u = 58.5 u. This total represents the mass of one formula unit of the ionic compound.

Additional Information

• Formula Unit Mass vs. Molecular Mass:

• The term molecular mass is used for substances that exist as discrete molecules (like H2O or CO2).

• The term formula unit mass is specifically used for ionic compounds (like NaCl, CaCl2, or KNO3) because they exist as continuous three-dimensional crystal lattices rather than individual molecules.

• Unified Atomic Mass Unit (u):

• Atomic masses are measured in u, where 1 u is exactly 1/12th of the mass of one atom of Carbon-12.

• This unit was previously known as amu (atomic mass unit).

• Structure of NaCl:

• Sodium Chloride, also known as Common Salt or Halite, crystallizes in a Face-Centered Cubic (FCC) structure.

• In this arrangement, each Na+ ion is surrounded by 6 Cl- ions, and vice versa, maintaining a coordination number of 6.

• Molar Mass:

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• When the formula unit mass is expressed in grams per mole (g/mol), it is called the molar mass.

• The molar mass of NaCl is 58.5 g/mol, meaning 6.022 x 10^23 formula units of NaCl weigh 58.5 grams.

Important Points

• Calculating Multiple Atoms: If an ionic compound has a subscript in its formula (e.g., Calcium Chloride, CaCl2), the atomic mass of the element with the subscript must be multiplied by that number before adding.

• For CaCl2: (Mass of Ca) + 2 × (Mass of Cl) = 40.0 u + (2 × 35.5 u) = 111.0 u.

• Law of Conservation of Mass: The calculation of formula mass relies on the principle that the mass of a compound is the sum of the masses of its constituent atoms, as proposed by John Dalton in his Atomic Theory.

• Physical State: NaCl is a solid at room temperature with a high melting point of approximately 801°C (1,474°F) due to strong electrostatic forces between the oppositely charged ions.

Q18. Answer: (b) N · m2/kg2

The correct answer is N m2/kg2.

Key Points

• Newton's Law of Universal Gravitation states that the force of attraction between two bodies is directly proportional to the product of their masses and inversely proportional to the square of the distance between their centers.

• The mathematical expression for this law is F = G (m1 m2 / r2), where F represents the gravitational force, m1 and m2 are the masses of the two objects, r is the distance between them, and G is the Universal Gravitational Constant.

• To find the SI unit of G, we rearrange the formula: G = F r2 / (m1 m2).

• By substituting the standard units—Newton (N) for force, meter (m) for distance, and kilogram (kg) for mass—we derive the unit as N m2 / kg2. Hence, the correct answer is N m2/kg2.

• The accepted numerical value of the gravitational constant G is approximately 6.674 x 10^-11 N m2/kg2.

Additional Information

• Discovery and Measurement: The value of the Universal Gravitational Constant was first measured with high precision by the British scientist Henry Cavendish in the year 1798 using a torsion balance experiment.

• Dimensional Formula: The dimensions of G are represented as [M-1 L3 T-2], derived from the base units of force, length, and mass.

• Nature of G: It is a scalar quantity, meaning it only has magnitude and does not depend on direction. It is called a "universal" constant because its value is believed to be the same everywhere in the universe.

• Comparison with 'g': It is important to distinguish G from g (acceleration due to gravity). While G is a constant, the value of g (approximately 9.8 m/s2 on Earth) changes depending on the location, such as altitude or the celestial body one is standing on.

• Other Units in Options:

• kg/m3 is the SI unit of density, representing mass per unit volume.

• N/m2 is the SI unit of pressure, also known as the Pascal (Pa).

Important Points

• Independence of Properties: The value of G does not depend on the medium between the two bodies, the temperature, or the chemical composition of the objects.

• Role in Physics: The gravitational constant is a fundamental component in Einstein's Field Equations of General Relativity and is essential for calculating the orbital mechanics of planets, moons, and satellites.

• Weak Force: Gravity is the weakest of the four fundamental forces of nature (the others being electromagnetism, strong nuclear force, and weak nuclear force), which is why the value of G is so small (on the order of 10^-11).

• Calculation Applications: Using the value of G, scientists can determine the mass of the Earth (approx 5.97 x 10^24 kg) and other planets by observing the gravitational influence they exert on other objects.

Q19. Answer: (b) zero

The correct answer is zero.

Key Points

• Acceleration is defined as the rate of change of velocity with respect to time. In physics, it is a vector quantity that describes how quickly an object's velocity is changing.

• A body is said to be moving with uniform velocity when it covers equal displacements in equal intervals of time, meaning both its magnitude (speed) and direction remain constant over time.

• The mathematical formula for acceleration (a) is given by a = (v - u) / t, where v represents the final velocity, u represents the initial velocity, and t is the time interval.

• In the case of uniform velocity, the initial velocity is exactly equal to the final velocity (u = v). Therefore, the change in velocity (v - u) is 0.

• Because the change in velocity is 0, the result of the acceleration formula becomes 0 / t, which equals zero. Hence, for a body

moving with uniform velocity, the acceleration is always zero.

Additional Information

• Velocity vs. Speed: While speed is a scalar quantity (only magnitude), velocity is a vector quantity. A change in either the speed or the direction of motion will result in a change in velocity, thereby producing acceleration.

• Uniform Circular Motion: This is a unique case where an object moves at a constant speed but its velocity is constantly changing because its direction is changing at every point. In this scenario, the acceleration is not zero; it is called centripetal acceleration.

• Graphical Representation:

• In a Velocity-Time (v-t) graph, uniform velocity is represented by a horizontal straight line parallel to the time axis. The slope of a v-t graph represents acceleration; since the slope of a horizontal line is 0, the acceleration is zero.

• In a Position-Time (s-t) graph, uniform velocity is represented by a straight line with a constant slope. The slope of this graph represents the velocity of the object.

• Types of Acceleration:

• Positive Acceleration: Occurs when the velocity of an object increases over time.

• Negative Acceleration (Retardation/Deceleration): Occurs when the velocity of an object decreases over time.

• Zero Acceleration: Occurs when the object is at rest or moving with uniform velocity.

Important Points

• Newton's First Law of Motion: Also known as the Law of Inertia, it states that an object will remain in its state of rest or uniform motion in a straight line unless compelled to change ? state by an external force. This implies that if acceleration is zero, the net external force acting on the body is also zero.

• Newton's Second Law: Defined by the equation F = ma (Force = mass x acceleration). This relationship confirms that if acceleration (a) is 0, the resultant force (F) must be 0, regardless of the object's mass.

• Units and Dimensions: The S.I. unit of acceleration is m/s^2 (meters per second squared). Its dimensional formula is $[M^0 L^1 T^{-2}]$.

• Instantaneous Acceleration: This refers to the acceleration of an object at a specific instant of time, calculated by taking the derivative of velocity with respect to time (dv/dt). For uniform velocity, this derivative is always 0.

Q20. Answer: (d) Oxygen

The correct answer is Oxygen.

Key Points

• Ozone (O3) is a molecule composed of three oxygen atoms. It is formed naturally in the upper atmosphere through a photochemical process.

• The formation of Ozone begins when higher-energy ultraviolet (UV) radiation, specifically UV-C rays from the sun, strike an Oxygen molecule (O2).

• This high-energy radiation has enough energy to break the chemical bond holding the Oxygen molecule together, splitting it into two individual Oxygen atoms (O + O). This process is known as photolysis or photodissociation.

• These freed, highly reactive Oxygen atoms then quickly collide and combine with another intact Oxygen molecule (O2) to form Ozone (O3).

• The presence of a third body (usually Nitrogen or another Oxygen molecule) is often required in the collision to absorb excess energy and stabilize the newly formed Ozone molecule.

• Other options like Zinc, Iron, and Sodium are metallic elements that do not exist as gaseous diatomic molecules in the Earth's atmosphere to participate in this specific UV-driven ozone formation cycle.

Additional Information

• The Chapman Cycle: This is the set of four reactions, first proposed by Sydney Chapman in 1930, that describes how Ozone is continuously regenerated in the Earth's stratosphere.

• Location of Ozone: About 90% of the Earth's ozone is found in the Stratosphere (the atmospheric layer between 10 km and 50 km above the Earth's surface). This region is commonly called the Ozone Layer.

• Functions of the Ozone Layer: It acts as a protective shield by absorbing 97% to 99% of the sun's medium-frequency ultraviolet light (from about 200 nm to 315 nm wavelength), which otherwise would potentially damage exposed life forms on Earth.

• Types of UV Radiation:

• UV-A (315–400 nm): Not absorbed by Ozone; reaches the surface.

• UV-B (280–315 nm): Partially absorbed by Ozone; causes sunburn and skin cancer.

• UV-C (100–280 nm): Completely absorbed by Oxygen and Ozone in the upper atmosphere; it is the most energetic and dangerous type.

Important Points

• Measurement: The concentration of Ozone in the atmosphere is measured in Dobson Units (DU). A typical baseline value is approximately 300 DU.

• Ozone Hole: This refers to the thinning of the Ozone layer, primarily over Antarctica, caused by Ozone-Depleting Substances (ODS) like Chlorofluorocarbons (CFCs), halons, and carbon tetrachloride.

• Montreal Protocol: An international treaty signed in 1987 (effective from 1989) designed to protect the Ozone layer by phasing out the production of numerous substances that are responsible for ozone depletion.

• World Ozone Day: Observed every year on September 16th to commemorate the date of the signing of the Montreal Protocol.

• Ground-level Ozone: While stratospheric ozone is "good" for protection, tropospheric ozone (ground-level) is a "bad" pollutant and a key constituent of smog, formed by the reaction of NOx and VOCs in the presence of sunlight.

Q21. Answer: (c) A ray perpendicular to the principal axis that reflects through the focus

p data-end="57" data-start="0">The correct answer is A ray perpendicular to the principal axis that reflects through the focus.

Key Points

• To locate the image formed by a spherical mirror, certain specific rays are used because their paths after reflection are predictable based on the laws of reflection.

• Ray 1 (Parallel Ray): A ray that is parallel to the principal axis will, after reflection, pass through the principal focus in a concave mirror or appear to diverge from the focus in a convex mirror. Hence, statement 4 is correct.

• Ray 2 (Ray through Focus): A ray passing through the principal focus of a concave mirror (or directed towards the focus of a convex mirror) will emerge parallel to the principal axis after reflection. Hence, statement 1 is correct.

• Ray 3 (Ray through Center of Curvature): A ray passing through the center of curvature (C) of a spherical mirror reflects back along the same path. This happens because the ray strikes the mirror surface normally (at an angle of incidence of 0 degrees). Hence, statement 2 is correct.

• Incorrect Ray: A ray perpendicular to the principal axis is a vertical ray that does not follow the standard geometric path to reflect through the focus. For a ray to reflect through the focus, it must be parallel to the principal axis, not perpendicular. Hence, statement 3 is incorrect and is the ray NOT used.

• Hence, the correct answer is A ray perpendicular to the principal axis that reflects through the focus.

Additional Information

• Components of Spherical Mirrors:

• Pole (P): The center of the reflecting surface of a spherical mirror is called the pole. It lies on the surface of the mirror.

• Center of Curvature (C): The reflecting surface forms a part of a sphere. The center of this sphere is the center of curvature. For a concave mirror, it lies in front, while for a convex mirror, it lies behind the mirror.

• Principal Axis: An imaginary straight line passing through the pole and the center of curvature.

• Focal Length (f): The distance between the pole and the principal focus. It is exactly half of the radius of curvature (R), represented as f = R/2.

• Types of Spherical Mirrors:

• Concave Mirror: Also known as a converging mirror. It can form both real and virtual images depending on the object's position. Used in shaving mirrors, headlights, and by dentists.

• Convex Mirror: Also known as a diverging mirror. It always forms a virtual, erect, and diminished image. Used as rear-view mirrors in vehicles to provide a wider field of view.

• Sign Convention:

• According to the New Cartesian Sign Convention, the object is always placed to the left of the mirror. Distances measured in the direction of incident light are positive, and those opposite are negative.

• The focal length of a concave mirror is always negative, whereas the focal length of a convex mirror is always positive.

Important Points

• Laws of Reflection:

• The angle of incidence is always equal to the angle of reflection (i = r).

• The incident ray, the reflected ray, and the normal at the point of incidence all lie in the same plane.

• Image Formation:

• To construct a ray diagram, at least two rays whose paths are known after reflection are required. The intersection of these reflected rays gives the position of the image of the point object.

• If the rays actually meet, the image is real and inverted. If they appear to meet when produced backwards, the image is virtual and erect.

Q22. Answer: (b) Presence of appropriate environmental conditions

The correct answer is Presence of appropriate environmental conditions.

Key Points

• Seed Germination is the biological process by which a plant grows from a seed after a period of dormancy. For this process to begin, the internal embryo must be activated by external triggers.

• The Presence of appropriate environmental conditions is the most critical requirement. These conditions primarily include moisture (water), oxygen, and a suitable temperature. Hence, the correct answer is option 2.

• Physical separation from the parent flower or plant is part of the seed dispersal mechanism, which helps reduce competition for resources. However, separation alone does not guarantee the biological start of growth if the soil or climate is unfavorable. Hence, statement 1 is incorrect.

• While Sunlight is essential for photosynthesis once the seedling develops leaves, many seeds actually germinate best in darkness (under the soil). Only specific "light-sensitive" seeds require exposure to light to break dormancy. Using the word "only" makes the statement scientifically inaccurate. Hence, statement 3 is incorrect.

• The decay of the fruit may help release the seed or provide some initial organic matter, but it is not a standalone essential condition for the physiological process of germination. Many seeds can germinate even if the fruit is manually removed or eaten by animals. Hence, statement 4 is incorrect.

Additional Information

• Essential Factors for Germination:

• Water: Germination begins with imbibition, where the seed rapidly absorbs water. This swells the seed, ruptures the seed coat, and activates hydrolytic enzymes that break down stored food.

• Oxygen: Early germination requires aerobic respiration. The seed needs energy to power cell division and growth, which it obtains by oxidizing stored nutrients using oxygen found in soil pores.

• Temperature: Every seed species has an optimum temperature range for germination, typically between 25°C and 30°C for many tropical plants. Extreme cold or heat can inhibit enzymatic activity.

• Seed Structure:

• The Radicle is the first part of the embryo to emerge, developing into the primary root to anchor the plant and absorb water.

• The Plumule is the embryonic shoot that eventually grows above the ground to form the stem and leaves.

• Cotyledons or the Endosperm serve as the primary food storage units that nourish the growing seedling until it can perform photosynthesis.

Important Points

• Seed Dormancy: This is a state where seeds do not germinate even when environmental conditions are favorable. It is a survival strategy to ensure seeds germinate only during the correct season.

• Scarification: This involves breaking or softening the seed coat (mechanically or via acid in animal guts) to allow water and oxygen to enter.

• Stratification: Some seeds require a period of cold treatment (simulating winter) before they are physiologically ready to germinate in the spring.

• Epigeal vs. Hypogeal Germination: In Epigeal germination, the cotyledons are pushed above the ground (e.g., bean seeds), whereas in Hypogeal germination, the cotyledons remain below the soil (e.g., pea seeds or maize).

Q23. Answer: (c) Artery

The correct answer is Artery.

Key Points

• Arteries are the blood vessels responsible for carrying blood away from the heart to various tissues and organs throughout the body.

• Because the heart pumps blood into the arteries with significant force, the blood inside them flows under high pressure.

• To accommodate this high pressure, arteries have thick, muscular, and elastic walls. These walls consist of three distinct layers: the tunica intima, the tunica media (which is notably thick in arteries), and the tunica externa.

• The elasticity of the arterial walls allows them to expand during systole (heart contraction) and recoil during diastole (heart relaxation), which helps in maintaining a continuous flow of blood even when the heart is not beating.

• Unlike veins, most arteries do not have valves (except for the semilunar valves at the base of the aorta and the pulmonary artery) because the high pressure of the blood prevents it from flowing backward.

Additional Information

• Veins:

• Veins carry blood toward the heart from various parts of the body.

• Since the blood in veins is no longer under the direct pumping pressure of the heart, it flows at a lower pressure compared to arteries.

• Consequently, veins have thinner walls and a larger lumen (internal space). They are equipped with valves to ensure blood flows in only one direction, preventing backflow due to gravity.

• Capillaries:

• Capillaries are the smallest and thinnest blood vessels, connecting arterioles (small arteries) and venules (small veins).

• Their walls are extremely thin, usually only one cell thick (endothelium), which allows for the diffusion and exchange of oxygen,

carbon dioxide, nutrients, and waste products between the blood and the surrounding interstitial fluid.

• Venules:

• Venules are very small blood vessels in the microcirculation that allow blood to return from capillary beds to drain into the larger veins.

• Pulmonary Exceptions:

• While most arteries carry oxygenated blood, the Pulmonary Artery is the exception, carrying deoxygenated blood from the right ventricle to the lungs.

• Similarly, the Pulmonary Vein carries oxygenated blood from the lungs back to the left atrium of the heart.

Important Points

• The Aorta is the largest artery in the human body, originating from the left ventricle and distributing blood to the entire systemic circulation.

• The elasticity of arteries decreases with age or due to certain health conditions like atherosclerosis, which can lead to increased blood pressure (hypertension).

• In a healthy adult, the typical systolic blood pressure measured in the arteries is about 120 mmHg, while the diastolic pressure is about 80 mmHg.

• The smooth muscle in the tunica media of arteries allows them to perform vasoconstriction and vasodilation, which are essential for regulating blood flow and body temperature.

Q24. Answer: (d) R/3

The correct answer is R/3.

Key Points

• The resistance of a conductor is the property by virtue of which it opposes the flow of electric current through it. It is mathematically defined by the formula R = P × (L / A), where R is the resistance, P is the resistivity of the material, L is the length of the wire, and A is the area of cross-section.

• According to the formula, resistance (R) is directly proportional to the length (L) of the wire and inversely proportional to the area of cross-section (A). This means if the area increases, the resistance decreases, provided the length and material (resistivity) remain unchanged.

• In this specific case, the initial resistance is R = P(L / A). The problem states that the area of cross-section is tripled, meaning the new area A′ = 3A, while the length (L) and resistivity (P) are kept the same.

• Substituting the new area into the formula, the new resistance R′ = P × (L / 3A). This can be rewritten as R′ = (1/3) × [P × (L / A)]. Since the term in the brackets is the original resistance R, the new resistance becomes R′ = R/3.

• Therefore, when the area of cross-section of a wire is increased by three times, its resistance is reduced to one-third of its original value.

Additional Information

• Ohm’s Law: Discovered by Georg Simon Ohm in 1827, it states that the current passing through a conductor is directly proportional to the potential difference (V) across its ends, provided temperature remains constant (V = IR). The SI unit of resistance is the Ohm (Ω).

• Resistivity (P): Also known as specific resistance, it is a characteristic property of the material of the wire. Unlike resistance, it does not change with the length or area of the wire but depends on the nature of the material and its temperature. Its SI unit is Ohm-meter (Ω·m).

• Effect of Length: If the length (L) of the wire were doubled while keeping the area constant, the resistance would also double (2R) because of the direct proportionality.

• Conductivity: This is the reciprocal of resistivity and measures a material's ability to conduct electricity. Materials like Silver and Copper have very low resistivity and high conductivity, making them excellent choices for electrical wiring.

Important Points

• Temperature Factor: For most metallic conductors, the resistance increases with an increase in temperature. This is due to the increased vibration of atoms, which causes more frequent collisions with the flowing electrons.

• Volume Conservation: It is important to note that the question specifies "keep all other parameters the same." If a wire is stretched to triple its area (which is physically impossible without changing length), the volume (V = A × L) would remain constant. However, in this theoretical problem, only area is modified while length is held constant, leading directly to the R/3 result.

• Practical Application: Thicker wires (greater area A) are used in high-power appliances because they offer lower resistance, which minimizes heat loss (calculated by H = I^2Rt) and allows higher current (I) to flow safely.

Q25. Answer: (b) 500 J

The correct answer is 500 J.

Key Points

• The work done by an object when it is lifted against the force of gravity is calculated using the formula for gravitational potential energy, which is W = m * g * h.

• In this formula, m represents the mass of the object, g represents the acceleration due to gravity, and h represents the height or displacement.

• According to the question, the mass (m) of the luggage is 25 kg and the height (h) to which it is lifted is 2.0 m.

• The value for acceleration due to gravity (g) is provided as 10 m/s^2.

• By substituting the values into the formula: Work Done = 25 kg * 10 m/s^2 * 2.0 m.

• The calculation results in 500 Joules (J). Hence, the correct answer is 500 J.

Additional Information

• Definition of Work:

• In physics, work is defined as the product of the force applied to an object and the displacement caused by that force in the direction of the force.

• The mathematical expression is $W = F * d * \cos(\theta)$, where θ is the angle between the force and the displacement vector.

• When lifting an object vertically, the angle θ is 0 degrees, and since cos(0) = 1, the work is simply Force * Displacement.

• Energy Transformation:

• The work done by the porter is not "lost" but is transferred to the luggage in the form of Potential Energy.

• Potential Energy is the energy held by an object because of its position relative to other objects, stresses within itself, its electric charge, or other factors.

• The specific type of energy here is Gravitational Potential Energy, which increases as the height of the object increases from the ground.

• Units and Measurements:

• The SI unit of work and energy is the Joule (J).

• 1 Joule is equal to the work done by a force of 1 Newton acting through a distance of 1 meter.

• In base units, 1 J = 1 $kg \cdot m^2/s^2$.

Important Points

• Scalar Nature: Work is a scalar quantity, meaning it has only magnitude and no specific direction, unlike force or velocity.

• Zero Work Condition: If the porter were to carry the luggage and walk on a horizontal platform, the work done by the force of gravity would be zero because the force (downward) and displacement (horizontal) are perpendicular (90 degrees).

• Acceleration due to Gravity: While the standard value of g on Earth is approximately 9.8 m/s^2, it is common in competitive exams to use 10 m/s^2 for ease of calculation.

• Mass vs Weight: It is important to distinguish between mass (25 kg) and weight. Weight is a force calculated as mass * gravity, which in this case is 250 Newtons. Work is then Weight * Height.

Q26. Answer: (d) 84,000

Shortcut Trick

Income is always 100%.

Savings % = 100% − Spending % = 100% − 50% = 50%.

Given Savings = Rs. 42,000 (unit value).

50% → Rs. 42,000

100% → Rs. 42,000 × 2 = Rs. 84,000

Therefore The correct answer is Rs. 84,000.

Alternate Method

Given:

Spending = 50% of Income

Savings = Rs. 42,000

Formula Used:

Income = Expenditure + Savings

Income = Savings / (1 − Spending Fraction)

Let Total Income be x.

=> Expenditure = 50% of x = 0.5x

=> Savings = x − 0.5x = 0.5x

=> 0.5x = 42,000

=> x = 42,000 / 0.5

=> x = 42,000 × 2
=> x = 84,000
Therefore The correct answer is Rs. 84,000.
Additional Information
Income-Expenditure Relationship
Income is always the sum of Expenditure and Savings. Ratio of Income : Expenditure : Savings is used for complex calculations.
Percentage Change in Income
If Income increases by a% and Expenditure increases by b%, the change in Savings depends on the initial ratio of E:S.
Fractional Conversions
50% = 1/2 | 25% = 1/4 | 33.33% = 1/3 | 20% = 1/5. Using fractions simplifies division steps.

Q27. Answer: (d) 10

Shortcut Trick
Arrange data: 6, 8, 9, 11, 16, 22
Total terms (n) = 6 (Even number)
Median = Average of the two middle terms
Middle terms are 9 and 11
Median = (9 + 11) ÷ 2 = 10
Therefore The correct answer is 10.
Alternate Method
Given: Data set = 9, 6, 8, 11, 16, 22
Formula Used:
If n is even, Median = [(n/2)^(th) term + (n/2 + 1)^(th) term] ÷ 2
=> Step 1: Arrange data in ascending order: 6, 8, 9, 11, 16, 22
=> Step 2: Count the number of observations (n) = 6
=> Step 3: Identify the positions of the middle terms
=> Position 1 = n/2 = 6/2 = 3^(rd) term
=> Position 2 = (n/2) + 1 = 3 + 1 = 4^(th) term
=> Step 4: Value of 3^(rd) term = 9 and 4^(th) term = 11
=> Median = (9 + 11) ÷ 2
=> Median = 20 ÷ 2 = 10
Therefore The correct answer is 10.
Additional Information
Median for Odd Number of Terms
If the total number of terms (n) is odd, the median is the middle-most term located at the ((n + 1)/2)^(th) position after sorting.
Arithmetic Mean
Mean is the sum of all values divided by the number of values. Formula: Σx ÷ n.
Mode of Data
Mode is the value that appears most frequently in the data set. A set can be unimodal, bimodal, or multimodal.
Relationship between Mean, Median, and Mode
For a moderately skewed distribution: Mode = 3 × Median − 2 × Mean.

Q28. Answer: (b) 0

Shortcut Trick
Divisibility rule of 4: The last two digits of the number must be divisible by 4.
The last two digits of 322A4828 are 28.
Since 28 ÷ 4 = 7 (Remainder = 0), the number is already divisible by 4.
The value of A (at the ten-thousands place) does not affect divisibility by 4.
The minimum possible digit that can be assigned to A is 0.
Therefore The correct answer is 0.
Alternate Method
Given number: 322A4828

Divisibility Rule of 4: A number is divisible by 4 if the number formed by its last two digits is divisible by 4. This is because any number N can be written as (100 × k) + (last two digits), and 100 is always divisible by 4.

=> Number formed by last two digits = 28 => 28 ÷ 4 = 7 => Since the remainder is 0, the number 322A4828 is divisible by 4 for any digit value of A. => Possible values for A = {0, 1, 2, 3, 4, 5, 6, 7, 8, 9} => The question asks for the minimum value of A. => Minimum value = 0

Therefore The correct answer is 0.

Additional Information

Divisibility by 8

A number is divisible by 8 if the number formed by its last three digits is divisible by 8.

Divisibility by 3 and 9

A number is divisible by 3 (or 9) if the sum of all its digits is divisible by 3 (or 9).

Divisibility by 11

The difference between the sum of digits at odd places and the sum of digits at even places must be 0 or a multiple of 11.

Q29. Answer: (c) 4

Shortcut Trick

Speed of first lap (S1) = 450 / 150 = 3 m/s.

Speed of second lap (S2) = 450 / 75 = 6 m/s.

When distances are equal, Average Speed = (2 × S1 × S2) / (S1 + S2).

Average Speed = (2 × 3 × 6) / (3 + 6) = 36 / 9 = 4 m/s.

Therefore The correct answer is 4.

Alternate Method

Given:

Distance of Lap 1 (D1) = 450 m

Time for Lap 1 (T1) = 150 sec

Distance of Lap 2 (D2) = 450 m

Time for Lap 2 (T2) = 75 sec

Formula Used:

Average Speed = Total Distance ÷ Total Time

=> Total Distance = D1 + D2 = 450 + 450 = 900 m

=> Total Time = T1 + T2 = 150 + 75 = 225 sec

=> Average Speed = 900 ÷ 225

=> Average Speed = 4 m/sec

Therefore The correct answer is 4.

Additional Information

Average Speed (Equal Distances)

If a body travels two equal distances with speeds x and y, the average speed is given by (2xy) / (x + y).

Average Speed (Equal Time Intervals)

If a body travels for two equal time intervals with speeds x and y, the average speed is (x + y) / 2.

Unit Conversion

To convert speed from m/sec to km/hr, multiply the value by 18/5. To convert km/hr to m/sec, multiply by 5/18.

Q30. Answer: (b) 1

Shortcut Trick

Use the complementary angle identity: $\cos^2 \theta + \cos^2 (90° - \theta) = 1$.

Here, 30° + 60° = 90°, so $\cos^2 30° + \cos^2 60° = 1$.

The value of cos 90° is 0, so $\cos^2 90° = 0$.

Total sum = 1 + 0 = 1.

Therefore The correct answer is 1.

Alternate Method

Given:

Expression = $\cos^2 30° + \cos^2 60° + \cos^2 90°$

Formula Used:

cos θ = Adjacent / Hypotenuse

Calculations:

=> cos 30° = √3 / 2

=> cos 60° = 1 / 2

=> cos 90° = 0

Substitute these values into the expression:

=> (√3 / 2)² + (1 / 2)² + (0)²

=> (3 / 4) + (1 / 4) + 0

=> 4 / 4

=> 1

Therefore The correct answer is 1.

Additional Information

Trigonometric Identity

The fundamental identity states that sin²θ + cos²θ = 1 for any angle θ.

Complementary Angle Rule

For complementary angles A and B (where A + B = 90°), sin A = cos B and cos A = sin B.

Standard Cosine Values

Standard values include cos 0° = 1, cos 45° = 1/√2, and cos 90° = 0.

Q31. Answer: (c) 1848 m2

Shortcut Trick

Total Surface Area (TSA) = Curved Surface Area (CSA) + 2 × Base Area

Base Area = πr² = (22/7) × 14 × 14 = 616 m²

2 × Base Area = 2 × 616 = 1232 m²

CSA = TSA − 2 × Base Area = 3080 − 1232 = 1848 m²

Therefore The correct answer is 1848 m².

Alternate Method

Given:

Total Surface Area (TSA) = 3080 m²

Radius (r) = 14 m

Formula Used:

TSA of cylinder = 2πr(h + r)

Curved Surface Area (CSA) of cylinder = 2πrh

Calculations:

=> 3080 = 2 × (22/7) × 14 × (h + 14)

=> 3080 = 2 × 22 × 2 × (h + 14)

=> 3080 = 88 × (h + 14)

=> h + 14 = 3080 ÷ 88

=> h + 14 = 35

=> h = 35 − 14 = 21 m

=> CSA = 2 × (22/7) × 14 × 21

=> CSA = 2 × 22 × 2 × 21

=> CSA = 88 × 21

=> CSA = 1848 m²

Therefore The correct answer is 1848 m².

Additional Information

Volume of Cylinder

The space occupied by a cylinder is given by Volume = πr²h.

Hollow Cylinder

For a hollow cylinder with outer radius R and inner radius r, TSA = 2πh(R + r) + 2π(R² − r²).

Base Perimeter

The perimeter or circumference of the base of a cylinder is 2πr, which when multiplied by height gives the CSA.

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Q32. Answer: (c) Rs. 682

Shortcut Trick

SP = (100 − Discount%)% of MP

SP = (100 − 12)% of 775

SP = 88% of 775 = 0.88 × 775

SP = 682

Therefore The correct answer is Rs. 682.

Alternate Method

Given: Marked Price (MP) = Rs. 775 | Discount % = 12%

Formula: Selling Price (SP) = Marked Price − Discount

=> Discount amount = (Discount% / 100) × MP

=> Discount amount = (12 / 100) × 775

=> Discount amount = 0.12 × 775 = 93

=> SP = MP − Discount amount

=> SP = 775 − 93 = 682

Therefore The correct answer is Rs. 682.

Additional Information

Discount Percentage

Discount % is always calculated on the Marked Price (MP) of an article: Discount % = (Discount / MP) × 100.

Successive Discounts

If two successive discounts of a% and b% are given, the net discount is [a + b − (a × b)/100]%.

Relationship between MP and CP

The ratio of Marked Price to Cost Price is given by MP/CP = (100 + Profit%)/(100 − Discount%).

Q33. Answer: (a) Rs. 8,464

Shortcut Trick

Rate 15% = 3/20 => Ratio of P : A for 1 year = 20 : 23

For 2 years, Ratio = $20^2 : 23^2 = 400 : 529$

Given Principal 400 units = Rs. 6,400

1 unit = 6,400 ÷ 400 = 16

Amount = 529 units × 16 = Rs. 8,464

Therefore The correct answer is Rs. 8,464.

Alternate Method

Given: Principal (P) = Rs. 6,400, Rate (R) = 15%, Time (n) = 2 years

Formula Used: Amount (A) = $P(1 + R/100)^n$

=> $A = 6400 \times (1 + 15/100)^2$

=> $A = 6400 \times (115/100) \times (115/100)$

=> $A = 6400 \times (23/20) \times (23/20)$

=> $A = 6400 \times (529/400)$

=> $A = 16 \times 529$

=> $A = 8464$

Therefore The correct answer is Rs. 8,464.

Additional Information

Effective Rate for Compound Interest

For 2 years, the effective rate of interest can be calculated as x + y + (x × y)/100. Here, 15 + 15 + (15 × 15)/100 = 32.25%.

Difference between CI and SI

The difference between CI and SI for 2 years is $P(R/100)^2$. In this case, $6400 \times (15/100)^2$ = Rs. 144.

Compound Interest Formula

The interest alone can be calculated using CI = $P[(1 + R/100)^n - 1]$.

Q34. Answer: (c) 40 years

Shortcut Trick

Ratio of Mother : Daughter (Present) = 2 : 1 (Difference = 1 unit)

Ratio of Mother : Daughter (10 yrs ago) = 3 : 1 (Difference = 2 units)

Make differences equal: Present Ratio = (2 : 1) × 2 = 4 : 2

Unit difference (4 → 3 or 2 → 1) is 1 unit = 10 years.

Mother's present age = 4 units = 4 × 10 = 40 years.

Therefore The correct answer is 40 years.

Alternate Method

Given:

Present age Mother = 2 × Daughter's age

10 years ago Mother's age = 3 × (Daughter's age − 10)

Formula Used:

Linear Equation based on Age conditions.

Let the present age of the Daughter be x years.

=> Present age of the Mother = 2x years.

Age 10 years ago:

=> Daughter's age = (x − 10)

=> Mother's age = (2x − 10)

According to the condition:

=> (2x − 10) = 3 × (x − 10)

=> 2x − 10 = 3x − 30

=> 3x − 2x = 30 − 10

=> x = 20

Present age of the Mother:

=> Mother = 2x = 2 × 20

=> Mother = 40 years.

Therefore The correct answer is 40 years.

Additional Information

Constant Age Difference

The difference between the ages of two persons remains constant throughout their lives. Always use this to balance ratios.

Ratio Balancing Method

If the age difference in units is not the same, multiply the ratios by the opposite difference values to make the gap equal.

Averages of Ages

If the average age of n people is A, after t years, the new average age will be (A + t).

Q35. Answer: (d) 25.3

Shortcut Trick

Remaining distance fraction = 1 − 2/3 = 1/3 of 228 km = 76 km

Remaining time fraction = 1 − 5/8 = 3/8 of 8 hours = 3 hours

Required speed = Remaining distance ÷ Remaining time

Speed = 76 ÷ 3 = 25.33... ≈ 25.3 km/hr

Therefore The correct answer is 25.3.

Alternate Method

Given: Total Distance = 228 km, Total Time = 8 hours

Formula: Speed = Distance ÷ Time

=> Total Distance = 228 km

=> Distance covered = (2/3) × 228 = 152 km

=> Remaining Distance = 228 − 152 = 76 km

=> Total Time = 8 hours

=> Time spent = (5/8) × 8 = 5 hours

=> Remaining Time = 8 − 5 = 3 hours

=> Required Speed = 76 ÷ 3

=> Required Speed = 25.333...

Therefore The correct answer is 25.3.

Additional Information

Average Speed

Average speed is defined as the Total Distance covered divided by the Total Time taken. Average Speed = Total Distance ÷ Total Time.

Unit Conversion

To convert speed from km/hr to m/s, multiply by 5/18. To convert from m/s to km/hr, multiply by 18/5.

Constant Distance Relation

When distance is constant, speed is inversely proportional to time. S1/S2 = T2/T1.

Q36. Answer: (b) 31,250

Shortcut Trick

Let the total enrolled voters be x.

Successful candidates votes = x × (Cast%) × (Valid%) × (Candidate's share%)

=> 13572 = x × 0.78 × 0.96 × 0.58

=> x = 13572 ÷ (0.78 × 0.96 × 0.58) = 31,250

Therefore The correct answer is 31,250.

Alternate Method

Given:

Voters cast = 78%

Invalid votes = 4% (So, Valid votes = 96% of cast votes)

Candidate's share = 58% of valid votes = 13,572

Formula:

Total Voters × (Cast/100) × (Valid/100) × (Share/100) = Candidate Votes

=> Let total enrolled voters = x

=> x × (78/100) × (96/100) × (58/100) = 13572

=> x × (78 × 96 × 58) / 1000000 = 13572

=> x = (13572 × 1000000) / (78 × 96 × 58)

=> Dividing 13572 by 58: 13572 ÷ 58 = 234

=> x = (234 × 1000000) / (78 × 96)

=> Dividing 234 by 78: 234 ÷ 78 = 3

=> x = (3 × 1000000) / 96

=> x = 1000000 / 32

=> x = 31250

Therefore The correct answer is 31,250.

Additional Information

Election-based Percentages

Valid Votes = Total Cast Votes − Invalid Votes. The winner and loser share is always calculated from the valid votes unless stated otherwise.

Successive Percentage Application

When multiple reductions or shares are applied in sequence, use the chain rule: Final Value = Initial Value × a% × b% × c%.

Majority Margin

Margin of victory = (Votes of Winner − Votes of Loser). Usually expressed as a percentage of the total valid votes.

Q37. Answer: (c) Rs. 1,800

Shortcut Trick

Cost Price for the collector = Rs. 1,440

Profit = 25% of 1,440 = 1/4 × 1,440 = Rs. 360

Auction Selling Price = 1,440 + 360 = Rs. 1,800

Alternatively: SP = 1,440 × 125% = 1,440 × 5/4 = Rs. 1,800

Therefore The correct answer is Rs. 1,800.

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Alternate Method

Given:

Price at which dealer sells to collector (CP for collector) = Rs. 1,440

Profit percentage at auction = 25%

Formula used: Selling Price (SP) = CP × (1 + Profit%/100)

=> Profit = 25% of Rs. 1,440

=> Profit = (25/100) × 1440

=> Profit = 1/4 × 1440 = 360

=> Final Price = Cost Price + Profit

=> Final Price = 1440 + 360

=> Final Price = 1800

Therefore The correct answer is Rs. 1,800.

Additional Information

Profit and Loss Basics

Profit = Selling Price − Cost Price. Profit percentage is always calculated on the CP: (Profit/CP) × 100.

Successive Transactions

When an item passes through multiple owners, the SP for one becomes the CP for the next. The final price is CP × (1 + p1/100) × (1 + p2/100)...

Fractional Equivalents

Common profit percentages: 20% = 1/5, 25% = 1/4, 33.33% = 1/3, 50% = 1/2. Use (1 + fraction) as a multiplier for SP.

Q38. Answer: (a) 172°

Shortcut Trick

Sum of exterior angles is always 360°.

Given ratio (Exterior : Interior) = 2 : 43

2 units = 360° => 1 unit = 180°

Sum of interior angles = 43 × 180°

Since Sum = (n − 2) × 180°, we have n − 2 = 43 => n = 45

Measure of interior angle = (43 × 180°) / 45 = 43 × 4 = 172°

Therefore The correct answer is 172°.

Alternate Method

Given:

Ratio of sum of exterior angles to sum of interior angles = 2 : 43

Formula Used:

Sum of exterior angles of a polygon = 360°

Sum of interior angles of a polygon = (n − 2) × 180°

Each interior angle of a regular polygon = [(n − 2) × 180°] / n

According to the question:

=> 360 / [(n − 2) × 180] = 2 / 43

=> 2 / (n − 2) = 2 / 43

=> n − 2 = 43

=> n = 45

Now, calculate the measure of each interior angle:

=> Interior Angle = [(45 − 2) × 180°] / 45

=> Interior Angle = (43 × 180°) / 45

=> Interior Angle = 43 × 4°

=> Interior Angle = 172°

Therefore The correct answer is 172°.

Additional Information

Sum of Angles Property

For any convex polygon, the sum of all exterior angles (one at each vertex) is always 360°, regardless of the number of sides.

Interior and Exterior Relation

The sum of an interior angle and its adjacent exterior angle at any vertex of a polygon is always 180° (Linear Pair).

Number of Diagonals

The number of diagonals in a polygon with n sides is given by the formula: [n × (n − 3)] / 2.

Q39. Answer: (a) 2,39,200

Shortcut Trick

Net effective increase = x + y + (xy/100)

=> Net % = 15 + 30 + (15 × 30)/100 = 45 + 4.5 = 49.5%

Population after 2 years = 100% + 49.5% = 149.5% of 1,60,000

=> 1.495 × 1,60,000 = 2,39,200

Therefore The correct answer is 2,39,200.

Alternate Method

Given: Initial Population (P) = 1,60,000

Increase in Year 1 (R1) = 15%

Increase in Year 2 (R2) = 30%

Formula: Population after n years = P × (1 + R1/100) × (1 + R2/100)

=> Population after 1st year = 1,60,000 × (115/100)

=> Population after 1st year = 1,600 × 115 = 1,84,000

=> Population after 2nd year = 1,84,000 × (130/100)

=> Population after 2nd year = 1,840 × 130 = 2,39,200

Therefore The correct answer is 2,39,200.

Additional Information

Successive Percentage Change

When a value changes by x% and then y% successively, the net percentage change is given by [x + y + (xy/100)]%.

Population Decrease (Depreciation)

If the population decreases, the value of R becomes negative in the formula: Final = P × $(1 - R/100)^n$.

Constant Growth Rate

If the growth rate remains constant for n years, the formula simplifies to: Final = P × $(1 + R/100)^n$, which is identical to the Compound Interest formula.

Q40. Answer: (d) 12.5 cm, 7.5 cm

Shortcut Trick

Sum of Length (L) and Breadth (B) = Perimeter ÷ 2 = 40 ÷ 2 = 20 cm.

Difference between Length and Breadth (L − B) = 5 cm.

Length (L) = (Sum + Difference) ÷ 2 = (20 + 5) ÷ 2 = 12.5 cm.

Breadth (B) = (Sum − Difference) ÷ 2 = (20 − 5) ÷ 2 = 7.5 cm.

Therefore The correct answer is 12.5 cm, 7.5 cm.

Alternate Method

Given:

Perimeter (P) = 40 cm

Length (L) = Breadth (B) + 5 cm

Formula Used:

Perimeter of a rectangle = 2 × (Length + Breadth)

Calculations:

=> 2 × (L + B) = 40

=> L + B = 20

=> (B + 5) + B = 20

=> 2B + 5 = 20

=> 2B = 20 − 5

=> 2B = 15

=> B = 7.5 cm

=> L = B + 5 = 7.5 + 5 = 12.5 cm

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Therefore The correct answer is 12.5 cm, 7.5 cm.

Additional Information

Area of Rectangle

The total space occupied by the rectangle is given by Area = Length × Breadth.

Diagonal of Rectangle

The distance between opposite corners is $d = \sqrt{(L^2 + B^2)}$.

Square Property

A rectangle becomes a square when Length = Breadth, and its perimeter is 4 × Side.

Q41. Answer: (d) Two successive discounts of 10%

Shortcut Trick

Maximum Selling Price is obtained when the total effective discount is minimum.

Check the sum of discounts for each scheme: (1) 38%, (2) 58%, (3) 61%, (4) 20%.

Since Scheme 4 has the lowest sum and lowest individual values, its effective discount will be the minimum.

Minimum Discount => Maximum Selling Price.

Therefore The correct answer is Two successive discounts of 10%.

Alternate Method

Successive Discounts: d1% and d2%

Effective Discount % = d1 + d2 − (d1 × d2)/100

Calculating effective discount for each scheme:

=> Scheme 1: 23 + 15 − (23 × 15)/100 = 38 − 3.45 = 34.55%

=> Scheme 2: 12 + 46 − (12 × 46)/100 = 58 − 5.52 = 52.48%

=> Scheme 3: 25 + 36 − (25 × 36)/100 = 61 − 9 = 52.00%

=> Scheme 4: 10 + 10 − (10 × 10)/100 = 20 − 1 = 19.00%

=> To maximize Selling Price, we need the Minimum Effective Discount.

=> Minimum discount is 19% from Scheme (4).

Therefore The correct answer is Two successive discounts of 10%.

Additional Information

Effective Discount Formula

For three successive discounts a%, b%, and c%, the effective discount is calculated by applying the two-discount formula twice or using the multiplier method: 1 − [(1−a/100)(1−b/100)(1−c/100)].

Relationship between MP and CP

MP/CP = (100 + Profit%)/(100 − Discount%). This ratio is useful for finding the marked price when profit and discount are known.

Maximum vs Minimum Discount

For a fixed sum of two discounts (a+b = constant), the effective discount is maximum when the difference between a and b is maximum, and minimum when the difference is minimum.

Q42. Answer: (b) 4.2 hours

Shortcut Trick

Total Work (LCM of 8, 12, 16) = 48 units.

Efficiencies: A = 6, B = 4, C = 3. Total efficiency (A+B+C) = 13 units/hr.

Work done in 2 hours = 13 × 2 = 26 units.

Remaining work = 48 − 26 = 22 units.

Time for A and B to finish = 22 ÷ (6 + 4) = 2.2 hours.

Total time = 2 + 2.2 = 4.2 hours.

Therefore The correct answer is 4.2 hours.

Alternate Method

Given:

Time taken by A = 8 hrs, B = 12 hrs, C = 16 hrs.

C leaves after 2 hours.

Workers	Time	Quantity	Efficiency
A	8	48	6

B	12	4	
C	16	3	

Calculations:
=> Total units of work = LCM(8, 12, 16) = 48 units
=> Efficiency of A = 48 ÷ 8 = 6 units/hr
=> Efficiency of B = 48 ÷ 12 = 4 units/hr
=> Efficiency of C = 48 ÷ 16 = 3 units/hr
=> Combined efficiency of A + B + C = 6 + 4 + 3 = 13 units/hr
=> Work done in the first 2 hours = 13 × 2 = 26 units
=> Remaining work = 48 − 26 = 22 units
=> Workers remaining = A + B
=> Efficiency of A + B = 6 + 4 = 10 units/hr
=> Time taken to finish remaining work = 22 ÷ 10 = 2.2 hours
=> Total time = 2 + 2.2 = 4.2 hours
Therefore The correct answer is 4.2 hours.
Additional Information
Work and Efficiency Relation
Total Work = Efficiency × Time. Efficiency is inversely proportional to the time taken to complete a task.
Pipes and Cisterns
The same logic applies where filling pipes have positive efficiency and outlet pipes (leaks) have negative efficiency.
Work and Wages
Wages are distributed based on the ratio of work done by each individual, which depends on their efficiency and time worked.

Q43. Answer: (a) Rs. 16,494

Shortcut Trick
Profit Ratio of Suman : Tariq : Neha = 6 : 11 : 12
Total units = 6 + 11 + 12 = 29 units
Difference between Neha and Suman = 12 − 6 = 6 units
Value of 6 units = (79721 ÷ 29) × 6 = 2749 × 6
Value of 6 units = Rs. 16,494
Therefore The correct answer is Rs. 16,494.
Alternate Method
Given:
Investment ratio of Suman, Tariq and Neha = 6 : 11 : 12
Total annual profit = Rs. 79,721
Formula Used:
Profit Share = (Individual Ratio Part ÷ Sum of Ratio Parts) × Total Profit
Sum of ratio parts = 6 + 11 + 12 = 29
=> 29 units = Rs. 79,721
=> 1 unit = 79721 ÷ 29
=> 1 unit = Rs. 2,749
=> Suman share = 6 × 2749 = Rs. 16,494
=> Neha share = 12 × 2749 = Rs. 32,988
=> Difference = 32988 − 16494
=> Difference = Rs. 16,494
Therefore The correct answer is Rs. 16,494.
Additional Information
Partnership Profit Rule
Profit is distributed based on the product of Capital (C) and Time (T). Profit Ratio P1 : P2 = C1 × T1 : C2 × T2.
Total Ratio Unitary Method
To find the value of any share or difference, divide the total amount by the sum of all ratio parts to find the value of 1 unit.

Working vs Sleeping Partner

A working partner manages the business and may receive a salary before the remaining profit is divided according to the investment ratio.

Q44. Answer: (b) 2

Shortcut Trick

Recognize $x = 3 + 2\sqrt{2}$ as a perfect square: $(\sqrt{2} + 1)^2$.

Therefore $\sqrt{x} = \sqrt{2} + 1$.

Reciprocal $1/\sqrt{x} = 1/(\sqrt{2} + 1) = \sqrt{2} - 1$.

Substitute in expression: $(\sqrt{2} + 1) - (\sqrt{2} - 1)$.

Value = 2.

Therefore The correct answer is 2.

Alternate Method

Given: $x = 3 + \sqrt{8}$

Formula: $(\sqrt{x} - 1/\sqrt{x})^2 = x + 1/x - 2$

=> $1/x = 1 / (3 + \sqrt{8}) \times (3 - \sqrt{8}) / (3 - \sqrt{8})$ => $1/x = (3 - \sqrt{8}) / (9 - 8) = 3 - \sqrt{8}$ => $x + 1/x = (3 + \sqrt{8}) + (3 - \sqrt{8}) = 6$ => $(\sqrt{x} - 1/\sqrt{x})^2 = 6 - 2$ => $(\sqrt{x} - 1/\sqrt{x})^2 = 4$ => $\sqrt{x} - 1/\sqrt{x} = \sqrt{4} = 2$

Therefore The correct answer is 2.

Additional Information

Conjugate Surds

For any surd of the form $a + \sqrt{b}$, its conjugate is $a - \sqrt{b}$. Their product results in a rational number $a^2 - b$.

Square Root of a Surd

If a surd is in the form $(a + b) + 2\sqrt{(ab)}$, its square root is simply $\sqrt{a} + \sqrt{b}$.

Algebraic Identity

The expansion of $(a - b)^2 = a^2 + b^2 - 2ab$ is frequently used to find values of $\sqrt{x} - 1/\sqrt{x}$ by setting $a = \sqrt{x}$ and $b = 1/\sqrt{x}$.

Q45. Answer: (c) 1267

Shortcut Trick

Smallest number leaving same remainder k = LCM(divisors) + k

LCM(18, 35, 140):

LCM(35, 140) = 140

LCM(140, 18) = 1260

Required number = 1260 + 7 = 1267

Therefore The correct answer is 1267.

Alternate Method

Given values: Divisors = 18, 35, 140 and Remainder = 7.

Formula: Smallest number = LCM(x, y, z) + r

=> Prime factors of $18 = 2 \times 3^2$

=> Prime factors of $35 = 5 \times 7$

=> Prime factors of $140 = 2^2 \times 5 \times 7$

=> LCM = $2^2 \times 3^2 \times 5 \times 7$

=> LCM = $4 \times 9 \times 35 = 1260$

=> Number = 1260 + 7 = 1267

Therefore The correct answer is 1267.

Additional Information

LCM (Least Common Multiple)

The smallest positive integer that is perfectly divisible by each of the given numbers.

Case of Different Remainders

If a number divided by x, y, z leaves remainders a, b, c such that $(x-a) = (y-b) = (z-c) = k$, the number is LCM(x, y, z) − k.

Relationship between HCF and LCM

For two numbers a and b, HCF(a, b) × LCM(a, b) = a × b.

Q46. Answer: (c) 8

Shortcut Trick

Ratio of articles P : Q : R = 4 : 2 : 5

Total cost per ratio unit = (4 × 280) + (2 × 185) + (5 × 105)

Total cost per ratio unit = 1120 + 370 + 525 = 2015

Common multiplier = Total budget ÷ Unit cost = 8060 ÷ 2015 = 4

Number of articles of type Q = 2 × 4 = 8

Therefore The correct answer is 8.

Alternate Method

Given prices: P = Rs. 280, Q = Rs. 185, R = Rs. 105

Given ratio of quantity P : Q : R = 4 : 2 : 5

Let the quantities of P, Q, and R be 4x, 2x, and 5x respectively.

Total Expenditure = (Price_P × Quantity_P) + (Price_Q × Quantity_Q) + (Price_R × Quantity_R)

=> 8060 = (280 × 4x) + (185 × 2x) + (105 × 5x)

=> 8060 = 1120x + 370x + 525x

=> 8060 = 2015x

=> x = 8060 ÷ 2015

=> x = 4

=> Number of articles of type Q = 2x

=> Number of articles of type Q = 2 × 4 = 8

Therefore The correct answer is 8.

Additional Information

Ratio of Values

The ratio of the total values of different items is the product of the ratio of their individual prices and the ratio of their quantities (Value Ratio = Price Ratio × Quantity Ratio).

Unitary Method in Ratios

When the total sum and the ratio are known, the value of one ratio unit is calculated as: Total Sum ÷ Sum of ratio parts (weighted by their respective values).

Compound Ratio

For two ratios a:b and c:d, the compound ratio is (a×c):(b×d), which is often used in problems involving price and quantity to find the total expenditure ratio.

Q47. Answer: (b) 10

Shortcut Trick

Efficiency Ratio (Amit : Gopal) = 100 : 130 = 10 : 13

Time Ratio is inverse of Efficiency Ratio => Amit : Gopal = 13 : 10

Given Amit's time = 13 days (13 units = 13 days)

=> Gopal's time = 10 units = 10 days

Therefore The correct answer is 10.

Alternate Method

Given:

Time taken by Amit = 13 days

Efficiency of Gopal = Efficiency of Amit + 30% of Efficiency of Amit

Formula Used:

Total Work = Efficiency × Time

Person	Time	Work	Efficiency
Amit	13	130	10
Gopal	10	13	

=> Let Amit's efficiency = 10 units/day

=> Gopal's efficiency = 10 + 30% of 10 = 13 units/day

=> Total Work = Amit's time × Amit's efficiency

=> Total Work = 13 × 10 = 130 units

=> Time taken by Gopal = Total Work ÷ Gopal's Efficiency

=> Time taken by Gopal = 130 ÷ 13 = 10 days

Therefore The correct answer is 10.

Additional Information

Efficiency and Time Relationship

Efficiency is inversely proportional to the time taken to complete a task. If efficiency increases by x%, the time decreases proportionally.

Work Equation

Total Work = (Efficiency1 × Time1) = (Efficiency2 × Time2). This constant work principle allows solving for any missing variable.

Ratio Conversion

If the ratio of efficiency of A and B is a : b, then the ratio of time taken by them to complete the same work will be b : a.

Q48. Answer: (a) 12

Shortcut Trick

The average of the first n odd natural numbers is always equal to n.

Here, n = 12.

Therefore Average = 12.

Therefore The correct answer is 12.

Alternate Method

Given:

First 12 odd natural numbers: 1, 3, 5, 7, 9, 11, 13, 15, 17, 19, 21, 23.

Formula Used:

Sum of the first n odd natural numbers = n^2

Average = Total Sum ÷ Number of terms

Calculations:

=> Total terms (n) = 12

=> Sum of 12 terms = 12^2 = 144

=> Average = 144 ÷ 12

=> Average = 12

Alternatively, for an Arithmetic Progression (AP):

=> Average = (First term + Last term) ÷ 2

=> Average = (1 + 23) ÷ 2 = 24 ÷ 2 = 12

Therefore The correct answer is 12.

Additional Information

Average of first n even numbers

The average of the first n even natural numbers (2, 4, 6... 2n) is always (n + 1).

Average of first n natural numbers

The average of the first n natural numbers (1, 2, 3... n) is given by (n + 1) ÷ 2.

Sum of first n natural numbers

The sum of the first n natural numbers is calculated using the formula [n × (n + 1)] ÷ 2.

Q49. Answer: (c) 606.375 cm3

Shortcut Trick

Surface Area (SA) = $4\pi r^2$ = 616 => r^2 = 49 => r = 7 cm.

Radius decreases by 25% => Ratio of radii = 1 : 0.75 = 4 : 3.

Ratio of volumes = $(4)^3 : (3)^3$ = 64 : 27.

Original Volume = (4/3) × (22/7) × 7^3 = 4312/3 cm^3.

New Volume = (4312/3) × (27/64) = 135.375 × 4.48 ≈ 606.375 cm^3.

Therefore The correct answer is 606.375 cm^3.

Alternate Method

Given:

Surface area of the original sphere = 616 cm²
Reduction in radius = 25%
Formula Used:
Surface area of sphere = 4πr²
Volume of sphere = (4/3)πr³
Step 1: Finding the radius of the original sphere (r).
=> 4 × (22/7) × r² = 616
=> r² = (616 × 7) / (4 × 22)
=> r² = (616 × 7) / 88
=> r² = 7 × 7 = 49
=> r = 7 cm
Step 2: Finding the radius of the new sphere (r_(new)).
=> r_(new) = r − 25% of r
=> r_(new) = 7 − (25/100 × 7)
=> r_(new) = 7 − 1.75 = 5.25 cm
Step 3: Finding the volume of the new sphere.
=> Volume = (4/3) × π × (r_(new))³
=> Volume = (4/3) × (22/7) × (5.25) × (5.25) × (5.25)
=> Volume = (4/3) × (22/7) × (21/4) × (21/4) × (21/4)
=> Volume = (22 × 21 × 21) / (4 × 4)
=> Volume = (11 × 441) / 8 = 4851 / 8
=> Volume = 606.375 cm³
Therefore The correct answer is 606.375 cm³.
Additional Information
Properties of a Sphere
For a sphere of radius r, the Surface Area is 4πr² and the Volume is (4/3)πr³.
Ratio Relationship
If the radius of a sphere is changed by a factor of k, the surface area changes by k² and the volume changes by k³.
Hemisphere Calculations
For a hemisphere, the Curved Surface Area is 2πr² and the Total Surface Area is 3πr².

Q50. Answer: (a) 320pq²

Shortcut Trick
Apply the algebraic identity: (a + b)² − (a − b)² = 4ab.
In this expression, a = 5pq and b = 16q.
Required value = 4 × 5pq × 16q = 320pq².
Therefore The correct answer is 320pq².
Alternate Method
Given: (5pq + 16q)² − (5pq − 16q)²
Formula used: (a + b)² = a² + 2ab + b² and (a − b)² = a² − 2ab + b²
=> [(5pq)² + 2 × 5pq × 16q + (16q)²] − [(5pq)² − 2 × 5pq × 16q + (16q)²]
=> [25p²q² + 160pq² + 256q²] − [25p²q² − 160pq² + 256q²]
=> 25p²q² + 160pq² + 256q² − 25p²q² + 160pq² − 256q²
=> 160pq² + 160pq²
=> 320pq²
Therefore The correct answer is 320pq².
Additional Information
Algebraic Identity for Difference of Squares
x² − y² = (x + y)(x − y). This can also be used to solve the problem by letting x = (5pq + 16q) and y = (5pq − 16q).
Algebraic Identity for Sum of Squares
(a + b)² + (a − b)² = 2(a² + b²). This identity is used when the middle sign is positive.
Simplification Rule

While simplifying algebraic expressions, always check for common factors or standard identities to reduce calculation time.

Q51. Answer: (c) YA - CF

The logic followed here is based on the alphabetical position pattern:
Option 1: LF - PJ
Option 2: JR - NV
Option 3: YA - CF
Option 4: TI - XM
Thus, YA - CF does not follow the uniform shift of +4 for both letters.
Hence, the odd one out is Option 3.

Q52. Answer: (a) YKF 50

The logic followed here is:
So, 'YKF 50' will replace the question mark in the given series.
Hence, the correct answer is "Option 3".

Q53. Answer: (a) 6

Given:
READ is coded as 4628
AIMS is coded as 5716
So, the code for A = 6
Hence, the correct answer is Option 1.

Q54. Answer: (b) North east

The logic followed here is:
Given:
Town A is to the West of Town B.
Town D is to the South of Town A.
Town C is to the East of Town D.
Town E is to the North of Town C.
So, with respect to Town D: Town B lies towards the North-East direction.
Hence, the correct answer is Option 2.

Q55. Answer: (b) Only conclusion (I) follows

Given Statements:
All kettles are ovens.
All ovens are toasters.
The least possible Venn diagram for the given statements is:
Conclusions:
I. Some toasters are kettles → Follows (Since all kettles are toasters, there is definitely an overlap between toasters and kettles.)
II. No toaster is a kettle → Does not follow (This contradicts the given relationship that all kettles are inside toasters.)
So, only conclusion I follows.
Hence, the correct answer is "Option 2".

Q56. Answer: (a) 118

The logic followed here is:
thus, "118" will replace the question mark in the given series.
Hence, the correct option is "Option 1".

Q57. Answer: (d) FBPV

The logic followed here is:
For, XTBH → BXFL
For, MFKP → QJOT
Now, applying the same pattern to BXLR:

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So, BXLR → FBPV

Hence, the correct answer is Option 4.

Q58. Answer: (c) 19 - 2 - 38

The logic followed here is:

Logic: Third Number = First Number × Second Number.

For, 12 - 4 - 48

=> 12 × 4 = 48

For, 15 - 3 - 45

=> 15 × 3 = 45

Now, checking the options using the same pattern:

Option 1) 3 - 4 - 14

=> 3 × 4 = 12 ≠ 14

Option 2) 21 - 3 - 61

=> 21 × 3 = 63 ≠ 61

Option 3) 19 - 2 - 38

=> 19 × 2 = 38

Option 4) 16 - 2 - 34

=> 16 × 2 = 32 ≠ 34

Hence, the correct answer is Option 3.

Q59. Answer: (a) Neither conclusion (I) nor (II) follows

Given Statements:

All cars are buses.

All buses are ships.

No car is a train.

The least possible Venn diagram for the given statements is:

Conclusions:

I. No bus is a train → Does not follow (Only cars are excluded from trains; buses may still overlap with trains except the car portion)

II. No ship is a train → Does not follow (Since ships contain buses and cars, and only cars are restricted from trains, ships may still overlap with trains)

So, neither conclusion I nor II follows.

Hence, the correct answer is "Option 1".

Q60. Answer: (b) Q

Given: Seven people S, Q, U, A, R, E and D are sitting in a row, facing north.

Only two people sit to the right of A.

Only two people sit between A and R.

Only two people sit between E and D.

D sits to the immediate left of A.

S sits to the immediate right of U.

Now, the third position from the left end is: Q

Hence, the correct answer is "Option 2".

Q61. Answer: (a) 4

The logic followed here is:

Given numbers: 700, 496, 723, 316, 639

Logic: Identify the highest and lowest numbers, extract the required digits, and perform subtraction.

Arranging the numbers:

Highest number = 723

Lowest number = 316

Number Type	Number	Required Digit Position	Digit

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Highest	723	2nd digit	2
Lowest	316	3rd digit	6

Result 6 − 2 = 4

Hence, the correct answer is Option 1.

Q62. Answer: (b) 6

The logic followed here is:

Given numbers: 853, 139

Logic: Identify the highest and lowest numbers, then extract the required digits and compute their sum.

Arranging the numbers:

Highest number = 853

Lowest number = 139

Number Type	Number	Required Digit Position	Digit
Highest	853	3rd digit	3
Lowest	139	2nd digit	3

Result: 3 + 3 = 6

Hence, the correct answer is Option 2.

Q63. Answer: (a) 2 km to the south

The logic followed here is:

Given:

Gyalmu drives 15 km East

He turns right → 16 km South

He turns right → 17 km West

He turns right → 18 km North

He turns right → 2 km East

So, To reach Point A, he must go 2 km South.

Hence, the correct answer is Option 1.

Q64. Answer: (b) 71

Given:

Total number of people = 144

Mr.Lkj is 65th from the left end

and Mr. Ihg is 8th from the right end.

Number of people between them = 144 − (65 + 8) = 144 − 73 = 71.

So, there are 71 people between Mr. Lkj and Mr. Ihg.

Hence, the correct answer is "Option 2".

Q65. Answer: (b) 3

Given number: 28369475

Logic:

If digit is even → add 1

If digit is odd → subtract 2

Original number: 2 8 3 6 9 4 7 5

Digit	Type	Operation	New Digit
2	Even	2 + 1	3
8	Even	8 + 1	9
3	Odd	3 − 2	1
6	Even	6 + 1	7

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9	Odd	9 − 2	7
4	Even	4 + 1	5
7	Odd	7 − 2	5
5	Odd	5 − 2	3

New number formed: 39177553

Digit	Frequency
3	2 times
9	1 time
1	1 time
7	2 times
5	2 times

Digits appearing more than once: 3, 7, 5

Hence, the correct answer is Option 2.

Q66. Answer: (b) 77

The logic followed here is:

thus, "77" will replace the question mark in the given series.

Hence, the correct option is "Option 2".

Q67. Answer: (d) 28th

Given:

Total students = 50

Meha is 15th from the right end,

and Priya is 8 places to the left of Meha.

Priya's position from the right end = 15 + 8 = 23rd.

Position from the left end = (50 − 23) + 1 = 28.

So, Priya's position from the left end is 28th.

Hence, the correct answer is "Option 4".

Q68. Answer: (c) RQPI

The logic followed here is:

For, GUSB → LZXV

For, NHIN → SMNH

Now, applying the same pattern to MLKO:

So, MLKO → RQPI

Hence, the correct answer is Option 3.

Q69. Answer: (c) 17

BODMAS Table:

Decoding the given information:

Alphabet	•	−	×	÷
Meaning	−	•	÷	×

Now, replacing the sign from left to right using BODMAS Rule, we get:

=> 405 ÷ 5 + 32 − 16 × 6 = ?

=> 81 + 32 − 96 = ?

=> 81 + 32 = 113

=> 113 − 96 = ?

=> 17

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Hence, the correct option is "Option 3".

Q70. Answer: (c) Two

Given: (Left) C H T M L K N B P G Q D V W R A X Z F Y E S (Right)

Now, we identify the distinct vowels (A, E, I, O, U) present in the series. Each vowel is counted only once, even if repeated.

(Left) C H T M L K N B P G Q D V W R A X Z F Y E S (Right)

Distinct vowels found: A, E

So, total unique vowels = 2

Hence, the correct answer is "Option 3".

Q71. Answer: (b) HMZQ

The logic followed here is:

For, VANE → DIVM

For, BGTK → JOBS

Now, applying the same pattern to ZERI:

So, ZERI → HMZQ

Hence, the correct answer is Option 2.

Q72. Answer: (b) One

Given: Seven people A, B, C, D, E, F and G are sitting in a row, facing north.

B sits sixth from the left end of the row.

Only two people sit to the left of D.

F sits to the right of A but left of D.

E sits third to the left of G.

So, only 1 person sits between C and G.

Hence, the correct answer is "Option 2".

Q73. Answer: (d) Three

Given: Seven people A, B, C, D, E, F and G are sitting in a row, facing north.

Only six people sit to the left of F.

D sits fourth from the right end of the row.

Only two people sit between A and D.

G is the immediate neighbour of C and F.

B does not sit to the left of E.

Now, people between E and G: B, D, C → 3 people

Hence, the correct answer is "Option 4".

Q74. Answer: (d) 168

The logic followed here is:

thus, "168" will replace the question mark in the given series.

Hence, the correct option is "Option 4".

Q75. Answer: (a) cq

Given:

“bees buzz close” → “zd st cq”

“hear bees hum” → “cq ge vm”

So, the code for bees = cq

Hence, the correct answer is Option 1.

Q76. Answer: (a) KG9

The logic followed here is:

So, 'KG9' will replace the question mark in the given series.

Hence, the correct answer is "Option 1".

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Q77. Answer: (d) 3

Given: (Left) 1 6 8 1 6 2 8 1 4 3 8 2 9 7 8 7 3 9 5 5 6 (Right)

Now,

We need to find an even digit which is immediately preceded by an odd digit and immediately followed by an even digit.

So, Needed pattern is: Odd - Even - Even.

(Left) 1 6 8 1 6 2 8 1 4 3 8 2 9 7 8 7 3 9 5 5 6 (Right)

Total valid even digits satisfying the condition = 3.

Hence, the correct answer is 'Option 4'.

Q78. Answer: (a) 2

Given number: 5346188

Logic:

Odd digits → +3

Even digits → −4

Original number: 5 3 4 6 1 8 8

Digit	Type	Operation	New Digit
5	Odd	5 + 3	8
3	Odd	3 + 3	6
4	Even	4 − 4	0
6	Even	6 − 4	2
1	Odd	1 + 3	4
8	Even	8 − 4	4
8	Even	8 − 4	4

New number formed: 8 6 0 2 4 4 4 → 8602444

Position	Digit
3rd from left	0
4th from right	2

Now, sum: 0 + 2 = 2

Hence, the correct answer is Option 1.

Q79. Answer: (a) Wife's father

Family Chart:

Decoding the Symbols:

Symbol	•	#	×	@
Meaning	Sister	Brother	Wife	Father

Given: L @ O # V + E × R

It means: L is the father of O, O is the brother of V, V is the sister of E, and E is the wife of R.

Thus, L is R’s wife’s father.

Hence, the correct answer is "Option 1".

Q80. Answer: (b) TVV

The logic followed here is based on the alphabetical position pattern:

Option 1: GHI

Option 2: TVV

Option 3: JKL

Option 4: DEF

Thus, TVV does not follow the pattern of consecutive alphabetical letters.

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Hence, the odd one out is Option 2.

Q81. Answer: (b) BIRSA 101

The correct answer is BIRSA 101.

Key Points

• BIRSA 101 is India’s first indigenously developed gene therapy based on CRISPR technology, specifically designed to treat Sickle Cell Disease (SCD).

• This ground-breaking therapy was developed by the CSIR-Institute of Genomics and Integrative Biology (CSIR-IGIB) located in New Delhi, in collaboration with clinical partners.

• In 2024, the Central Drugs Standard Control Organisation (CDSCO) granted approval for Phase I/II clinical trials of BIRSA 101, marking a significant milestone in Indian biotechnology.

• The therapy utilizes the CRISPR-Cas9 (Clustered Regularly Interspaced Short Palindromic Repeats) gene-editing tool to correct the genetic mutation in the HBB gene that causes the production of abnormal hemoglobin.

• The development of BIRSA 101 is a major step toward Atmanirbhar Bharat (self-reliant India) in the field of advanced medical treatments, aiming to provide a one-time cure for a disease that currently requires lifelong management.

• Hence, the correct answer is BIRSA 101.

Additional Information

• Sickle Cell Disease (SCD):

• It is a genetic blood disorder characterized by red blood cells that assume an abnormal, rigid, sickle-like shape.

• This condition leads to anemia, severe pain crises, organ damage, and a reduced life expectancy due to the blockage of blood flow in small vessels.

• In India, the disease is particularly prevalent among tribal populations in states like Madhya Pradesh, Chhattisgarh, Odisha, and Gujarat.

• National Sickle Cell Anaemia Elimination Mission:

• Launched by the Government of India in July 2023, this mission aims to eliminate Sickle Cell Disease as a public health problem by the year 2047.

• The mission focuses on screening 7 crore people in the age group of 0-40 years in 278 districts across the country.

• CRISPR-Cas9 Technology:

• This technology acts as "molecular scissors" that can cut DNA at specific locations, allowing scientists to remove, add, or alter sections of the DNA sequence.

• The Nobel Prize in Chemistry was awarded in 2020 to Emmanuelle Charpentier and Jennifer Doudna for the development of this method for genome editing.

Important Points

• Naming and Significance:

• The therapy BIRSA 101 is named in honor of the legendary tribal freedom fighter Birsa Munda, reflecting the focus of the treatment on the tribal communities who are disproportionately affected by SCD.

• The indigenous nature of the project is expected to significantly reduce the cost of treatment compared to international gene therapies like Casgevy, which can cost millions of dollars per patient.

• Mechanism of Action:

• The therapy involves ex-vivo gene editing, where a patient’s blood stem cells are harvested, modified using CRISPR-Cas9 in a laboratory to increase the production of fetal hemoglobin (HbF), and then infused back into the patient.

• Increased levels of fetal hemoglobin prevent the sickling of red blood cells, effectively neutralizing the symptoms of the disease.

Q82. Answer: (a) Bharat Electronics Limited Ghaziabad

p data-end="57" data-start="0">The correct answer is Bharat Electronics Limited Ghaziabad.

Key Points

• The SAKSHAM (System for Anti-drone Kinetic and Soft-kill Handling with Advanced Monitoring) is a comprehensive counter-Unmanned Aircraft System (C-UAS) grid developed specifically to tackle the growing threat of hostile drones along India's borders.

• This state-of-the-art system was developed by the Ghaziabad unit of Bharat Electronics Limited (BEL), which is a premier Navratna Public Sector Undertaking (PSU) under the Ministry of Defence.

• The SAKSHAM grid was officially launched and inducted by the Indian Army in January 2025 as part of the force's modernization drive and "Year of Technology Absorption" initiatives.

• The system provides an integrated solution for detection, identification, and neutralization of various types of drones, including micro and mini UAVs, which are often used for cross-border smuggling or surveillance.

• The Ghaziabad unit of BEL specializes in the design and manufacture of Radars, Antenna Systems, and Command and Control

Centers, making it the primary hub for developing such complex electronic warfare grids.

Additional Information

• Soft Kill and Hard Kill Capabilities:

• Soft Kill involves the use of Radio Frequency (RF) Jammers and Global Navigation Satellite System (GNSS) spoofers to disrupt the communication link between the drone and its operator.

• Hard Kill refers to the physical destruction of the drone using kinetic interceptors, lasers, or programmable ammunition to ensure the threat is completely eliminated.

• Components of SAKSHAM Grid:

• The grid integrates 3D Radars for long-range detection, Electro-Optical/Infrared (EO/IR) payloads for visual identification, and RF Detectors to sense the presence of drone signals.

• It utilizes Artificial Intelligence (AI) algorithms to distinguish between birds and drones, thereby reducing false alarms during high-alert situations.

• Bharat Electronics Limited (BEL):

• Established in 1954 and headquartered in Bengaluru, BEL was created to meet the specialized electronic equipment requirements of the Indian Defence Services.

• It operates multiple units across India, with the Ghaziabad unit being a pioneer in Network Centric Warfare (NCW) and Radar systems since its inception in 1974.

• Strategic Context:

• The induction of SAKSHAM is a significant step towards Atmanirbhar Bharat (Self-reliant India) in the defence sector, reducing dependence on foreign C-UAS technologies from countries like Israel or the USA.

• The system is designed for deployment in diverse terrains, including the high-altitude regions of the Line of Actual Control (LAC) and the plains of the Line of Control (LoC).

Important Points

• The Indian Army has designated 2024-2025 as a critical period for absorbing niche technologies like Quantum Computing, Swarm Drones, and C-UAS systems.

• While DRDO (Defence Research and Development Organisation) has developed the D4 System (Drone Detect, Deter and Destroy), the SAKSHAM grid is a result of BEL's internal research and development tailored for large-scale grid deployment across Army formations.

• The system can be controlled through a Mobile Command and Control Center, allowing for rapid redeployment based on shifting intelligence and threat perceptions.

Q83. Answer: (d) 18%

The correct answer is 18%.

Key Points

• Prior to the proposed exemption in August 2025, the Goods and Services Tax (GST) rate levied on health insurance premiums and life insurance premiums in India was 18%.

• The GST Group of Ministers (GoM), a specialized committee within the GST Council, met to deliberate on the tax structure of the insurance sector to make social security more affordable for the masses.

• The GoM on insurance, which includes ministers from various states like Bihar, Uttar Pradesh, and West Bengal, reached a consensus to recommend a 0% GST rate (complete exemption) for certain categories of insurance premiums.

• The decision to maintain an 18% tax on insurance had been a point of significant debate in the Parliament, with various stakeholders arguing that taxing a necessity like health insurance hinders the goal of universal health coverage.

• Under the existing 18% slab, the tax applies to individual health plans, family floater policies, and term life insurance, significantly increasing the out-of-pocket expenditure for policyholders.

Additional Information

• GST Council and Governance:

• The GST Council is a constitutional body established under Article 279A of the Constitution of India. It is chaired by the Union Finance Minister.

• The Group of Ministers (GoM) is often constituted by the Council to examine specific issues, such as rate rationalization or exemptions, before a final decision is taken by the full Council.

• Tax Slabs in India:

• The GST regime, which was implemented on 1 July 2017, primarily features four main tax slabs: 5%, 12%, 18%, and 28%.

• Most financial and professional services, including banking and telecommunications, are currently positioned in the 18% bracket.

• Insurance Penetration and Revenue:

• The 18% GST on health insurance generates a revenue of approximately Rs. 8,000 crore to Rs. 9,000 crore annually for the

Government of India and the respective State Governments.

• Industry experts from IRDAI (Insurance Regulatory and Development Authority of India) have often suggested that reducing the tax rate could help increase insurance penetration, which remains relatively low in India compared to global averages.

• Proposed Exemption Scope:

• The GoM proposal specifically highlighted providing full exemption for senior citizens (individuals aged 60 years and above) regardless of the coverage amount.

• For other individuals, the exemption might apply to health insurance coverage up to Rs. 5 lakh, while premiums for coverage exceeding this limit may still attract tax, though the final modalities depend on the GST Council's ratification.

Important Points

• Historical Context: Before the introduction of GST in 2017, the Service Tax on insurance premiums was approximately 15% (including Krishi Kalyan Cess and Swachh Bharat Cess). The transition to GST saw the rate rise to 18%.

• Life Insurance Varieties: The 18% rate currently applies to the risk premium portion of ULIPs (Unit Linked Insurance Plans) and the entire premium of Term Insurance policies.

• Social Security Schemes: Note that certain government-sponsored insurance schemes, such as the Pradhan Mantri Jan Arogya Yojana (PMJAY) and Pradhan Mantri Suraksha Bima Yojana (PMSBY), are already exempt from GST to support the economically weaker sections.

Q84. Answer: (b) Pravasi Bharatiya Divas

p-end="57" data-start="0">The correct answer is Pravasi Bharatiya Divas.

Key Points

• Pravasi Bharatiya Divas (PBD) is celebrated on 9 January every year (with a major convention every two years) to mark the contribution of the Overseas Indian community in the development of India.

• The date 9 January was chosen as it was on this day in 1915 that Mahatma Gandhi, the greatest 'Pravasi', returned to India from South Africa to lead India’s freedom struggle.

• The decision to celebrate Pravasi Bharatiya Divas was taken in accordance with recommendations of the High Level Committee (HLC) on the Indian Diaspora set up by the Government of India under the chairmanship of L. M. Singhvi.

• The first Pravasi Bharatiya Divas was celebrated in 2003. Since 2015, its format has been revised to celebrate the PBD Convention once every two years and to hold theme-based Pravasi Bharatiya Divas Conferences during the intervening period.

• These conventions provide a platform for the Indian diaspora to engage with the government and the people of their ancestral land for mutually beneficial activities. Hence, the correct answer is Pravasi Bharatiya Divas.

Additional Information

• Other Important Days in January:

• Army Day: Celebrated on 15 January every year in India, in recognition of Field Marshal Kodandera M. Cariappa's (then a Lieutenant General) taking over as the first Commander-in-Chief of the Indian Army from General Francis Butcher, the last British Commander-in-Chief of India, on 15 January 1949.

• World Hindi Day: Observed on 10 January to promote the use of the Hindi language worldwide. It commemorates the anniversary of the first World Hindi Conference held in Nagpur in 1975. This is distinct from National Hindi Divas celebrated on September 14.

• National Tourism Day: Celebrated on 25 January in India to raise awareness about the importance of tourism for the country's economy and its social, political, and cultural impact.

• Pravasi Bharatiya Samman Award (PBSA):

• The Pravasi Bharatiya Samman Award is the highest honour conferred on a Non-Resident Indian (NRI), Person of Indian Origin (PIO), or an organization/institution established and run by NRIs or PIOs.

• The award is conferred by the President of India as a part of the Pravasi Bharatiya Divas Convention to recognize significant contributions towards a better understanding of India abroad and support of India’s causes.

Important Points

• 18th Pravasi Bharatiya Divas 2025:

• The 18th Pravasi Bharatiya Divas Convention is organized by the Ministry of External Affairs in collaboration with the State Government of Odisha.

• The 2025 event is scheduled to be held from January 8 to January 10, 2025, in Bhubaneswar, the capital city of Odisha.

• The theme for the 2025 convention focuses on the role of the diaspora in the era of Viksit Bharat, emphasizing their contribution to India’s vision of becoming a developed nation by 2047.

Q85. Answer: (a) James D. Watson

The correct answer is James D. Watson.

Key Points

• James Dewey Watson is an American molecular biologist, geneticist, and zoologist, best known for being one of the co-discoverers of the structure of DNA in 1953.

• He, along with Francis Crick and Maurice Wilkins, was awarded the Nobel Prize in Physiology or Medicine in 1962 for their discoveries concerning the molecular structure of nucleic acids and its significance for information transfer in living material.

• Watson's career was marked by his tenure at the University of Cambridge's Cavendish Laboratory, where he collaborated with Crick to model the double helix structure of Deoxyribonucleic Acid (DNA).

• Beyond his research, he served as the director of the Cold Spring Harbor Laboratory (CSHL) in New York for many years, significantly expanding its research in cancer and neurobiology.

• He played a pivotal role in the Human Genome Project, serving as the first director of the National Center for Human Genome Research at the National Institutes of Health (NIH) starting in 1988.

Additional Information

• Francis H. C. Crick:

• A British molecular biologist and physicist who worked closely with Watson. He is also famous for proposing the Central Dogma of molecular biology, which describes the flow of genetic information from DNA to RNA to protein.

• Rosalind Franklin:

• A British chemist and X-ray crystallographer whose data was critical to the discovery. Her Photo 51, an X-ray diffraction image of DNA, provided the essential clues for the helical structure. She passed away in 1958 at the age of 37 and was not eligible for the Nobel Prize posthumously.

• Maurice Wilkins:

• A New Zealand-born British biophysicist who shared the 1962 Nobel Prize. He headed the team at King's College London where the X-ray diffraction studies of DNA were primarily conducted.

• The Double Helix Discovery:

• The discovery published in the journal Nature in April 1953 explained how genetic information is stored and replicated. It revealed that DNA consists of two strands winding around each other, held together by nitrogenous bases (Adenine, Thymine, Guanine, and Cytosine).

Important Points

• Academic Background: James Watson earned his Ph.D. from Indiana University in 1950 at the young age of 22.

• Literary Contribution: He authored the best-selling book "The Double Helix", published in 1968, which provided a personal and sometimes controversial account of the race to discover DNA's structure.

• Legacy: Despite later controversies regarding his public statements, his scientific contributions remain a cornerstone of modern biology and biotechnology.

• Location of Impact: Much of his later life and administrative work was centered in Long Island, New York, specifically around Cold Spring Harbor and the surrounding East Northport area.

Q86. Answer: (c) Samrat Choudhary

The correct answer is Samrat Choudhary.

Key Points

• The Group of Ministers (GoM) on GST rate rationalization for insurance was chaired by Samrat Choudhary, who serves as the Deputy Chief Minister of Bihar.

• In August 2025 (per the context of the legislative review), the panel proposed significant reliefs, including the exemption of Goods and Services Tax (GST) on premiums paid for term life insurance policies and health insurance for senior citizens.

• The 13-member GoM was specifically constituted to address the growing demand for reducing the tax burden on essential social security products like life and health insurance.

• The committee suggested that health insurance premiums for individuals (other than senior citizens) should be exempted for coverage up to Rs. 5 lakh, while the existing 18% GST would continue for coverage exceeding that amount.

• The recommendations of this GoM are submitted to the GST Council, the highest decision-making body for indirect taxes in India, for final approval. Hence, the correct answer is Samrat Choudhary.

Additional Information

• Current GST Structure on Insurance:

• Currently, a standard rate of 18% GST is levied on the premium amount of most life and health insurance policies.

• Industry experts and political leaders, including Nitin Gadkari, had previously advocated for the removal of this tax to make insurance more affordable for the middle class and underprivileged sections.

• Composition of the GoM:

• The panel includes ministers from various states such as Uttar Pradesh, Maharashtra, West Bengal, Karnataka, Kerala, and Telangana to ensure a federal consensus.

• Mallu Bhatti Vikramarka, the Deputy CM of Telangana, is also a prominent member of this Group of Ministers.

• GST Council:

• The GST Council is chaired by the Union Finance Minister (currently Nirmala Sitharaman) and comprises Finance Ministers of all States and Union Territories.

• It is a constitutional body under Article 279A of the Indian Constitution.

Important Points

• Objective of Exemption: The primary goal of the Samrat Choudhary-led panel is to boost insurance penetration in India, which remains low compared to the global average.

• Financial Impact: While the exemption reduces the tax burden on citizens, it is estimated to result in a revenue loss for the Government, which the GoM balances by looking at rate rationalization in other luxury sectors.

• Term Insurance: This is a pure risk cover where the sum assured is paid only in the event of the death of the policyholder. The GoM reached a consensus that this should be tax-free to encourage financial security for families.

• Senior Citizens: Providing 0% GST for senior citizens on health insurance is a targeted measure to support the elderly who face higher medical costs and insurance premiums.

Q87. Answer: (d) National Institution for Transforming India (NITI Aayog)

The correct answer is National Institution for Transforming India (NITI Aayog).

Key Points

• The National Institution for Transforming India, also known as NITI Aayog, is the premier policy Think Tank of the Government of India, providing both directional and policy inputs.

• In July 2025, NITI Aayog represented India at the United Nations High-Level Political Forum (HLPF) to submit the country's third Voluntary National Review (VNR).

• The VNR is a process through which countries assess and present their progress in implementing the 2030 Agenda for Sustainable Development, including the 17 Sustainable Development Goals (SDGs).

• India's third VNR in 2025 follows its previous reviews submitted in 2017 and 2020, marking a significant milestone in tracking a decade of progress toward the 2030 targets. Hence, the option National Institution for Transforming India (NITI Aayog) is correct.

• The 2025 report highlights India's achievements in areas such as Digital Public Infrastructure (DPI), clean energy transition, and large-scale poverty reduction through multi-dimensional assessment frameworks.

• The submission to the United Nations underscores India's commitment to "Sabka Saath, Sabka Vikas" (Collective Efforts, Inclusive Development), which aligns closely with the global principle of Leaving No One Behind (LNOB).

Additional Information

• NITI Aayog:

• It was established on January 1, 2015, through a Cabinet resolution, replacing the erstwhile Planning Commission.

• The Prime Minister of India serves as the Ex-officio Chairperson, while the Vice-Chairperson is appointed by the Prime Minister.

• Its headquarters is located in New Delhi, and it operates on the principle of Cooperative Federalism, involving State Governments in the policy-making process.

• Sustainable Development Goals (SDGs):

• The SDGs are a collection of 17 interlinked global goals designed to be a "blueprint to achieve a better and more sustainable future for all" by the year 2030.

• They were adopted by the United Nations General Assembly in September 2015 as part of the 2030 Agenda.

• NITI Aayog is the nodal agency in India responsible for the SDG India Index, which ranks States and Union Territories based on their performance across various social, economic, and environmental indicators.

• High-Level Political Forum (HLPF):

• The HLPF is the central United Nations platform for the follow-up and review of the 2030 Agenda at the global level.

• It meets annually in July under the auspices of the Economic and Social Council (ECOSOC) for eight days, including a three-day ministerial segment.

• The VNRs presented at the HLPF aim to facilitate the sharing of experiences, including successes, challenges, and lessons learned, to accelerate the implementation of the SDGs.

• Other Options:

• The Finance Commission of India is a constitutional body (Article 280) that defines the financial relations between the Centre and the States.

• The Reserve Bank of India (RBI) is the nation's central bank, established on April 1, 1935, responsible for monetary policy and the regulation of the banking system.

• The Comptroller and Auditor General (CAG) of India (Article 148) is the supreme audit institution responsible for auditing the accounts of the Union and State Governments.

Q88. Answer: (b) Jaylen Brown

The correct answer is Jaylen Brown.

Key Points

• Jaylen Brown, the star forward for the Boston Celtics, was voted the 2024 NBA Finals Most Valuable Player (FMVP) following his team's victory over the Dallas Mavericks.

• In the 2024 NBA Finals, Jaylen Brown maintained an impressive average of 20.8 points, 5.4 rebounds, and 5.0 assists per game across the five-game series.

• The Boston Celtics secured the championship title by defeating the Dallas Mavericks 4-1 in the series, culminating in a 106-88 win in Game 5 on June 17, 2024.

• This victory marked the 18th title for the Boston Celtics, allowing them to surpass the Los Angeles Lakers for the most championships in NBA history.

• Jaylen Brown also achieved a rare feat in 2024 by winning both the Larry Bird Trophy (Eastern Conference Finals MVP) and the Bill Russell Trophy (NBA Finals MVP) in the same postseason. Hence, the correct answer is Jaylen Brown.

Additional Information

• The Bill Russell NBA Finals MVP Award:

• The award was established in 1969 and was renamed in 2009 to honor 11-time NBA champion Bill Russell.

• The winner is selected by a panel of 11 media members who cast their votes based on performance throughout the NBA Finals series.

• Jayson Tatum's Contribution:

• While Jaylen Brown won the FMVP, his teammate Jayson Tatum became the first player in Celtics history to lead the team in points, rebounds, and assists during a championship-winning playoff run.

• In Game 5 of the 2024 Finals, Tatum recorded 31 points, 11 assists, and 8 rebounds.

• Jaylen Brown's Career Milestones:

• In July 2023, Jaylen Brown signed the richest contract in NBA history at the time, a five-year supermax extension worth approximately $304 million.

• Selected as the 3rd overall pick in the 2016 NBA Draft, Brown has become a three-time NBA All-Star (as of 2024).

Important Points

• Coaching History: Joe Mazzulla, the head coach of the Boston Celtics, became the youngest coach to win an NBA title since Bill Russell (who was a player-coach) in 1969. Mazzulla was 35 years old at the time of the 2024 victory.

• Series Outcome: The 2024 NBA Finals began on June 6, 2024, and concluded on June 17, 2024. The Celtics won the first three games, lost Game 4 in Dallas, and closed the series at TD Garden in Boston.

• Voting Breakdown: Jaylen Brown received 7 out of the 11 media votes for the FMVP, while Jayson Tatum received the remaining 4 votes.

Q89. Answer: (d) Coconut-based products

The correct answer is Coconut-based products.

Key Points

• The Van Dhan Vikas Kendra (VDVK) at Dugong Creek was established specifically to cater to the socio-economic development of the Onge tribe, which is one of India's Particularly Vulnerable Tribal Groups (PVTGs).

• The primary focus of this VDVK is to leverage the local availability of coconuts to make the tribe self-sustainable by producing coconut-based products.

• Under this initiative, the tribal community is trained in value-addition processes to convert raw coconuts into marketable commodities like virgin coconut oil, dried copra, and coconut-based handicrafts.

• This initiative is part of the broader Van Dhan Yojana, which aims to provide modern tools, equipment, and branding support to tribal gatherers so they can earn a higher share of the consumer price.

• By focusing on coconut-based products, the government ensures that the Onge people can utilize their traditional knowledge of the Little Andaman ecosystem while gaining economic independence through processed goods.

Additional Information

• The Onge Tribe:

• The Onge are an Andamanese ethnic group and are among the most primitive tribes in the world, primarily residing in Little Andaman.

• They are semi-nomadic and rely heavily on hunting, gathering, and fishing. Their population is concentrated in Dugong Creek and South Bay.

• Recognized as a Particularly Vulnerable Tribal Group (PVTG), the Onge are protected under the Andaman and Nicobar Islands (Protection of Aboriginal Tribes) Regulation, 1956.

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• Van Dhan Vikas Yojana:

• Launched on April 14, 2018, by the Ministry of Tribal Affairs and TRIFED, this scheme focuses on the economic empowerment of tribals through Minor Forest Produce (MFP).

• A Van Dhan Vikas Kendra typically constitutes 15 tribal SHGs, with each group comprising about 20 members, totaling 300 beneficiaries per Kendra.

• The scheme provides Rs. 15 lakhs for the establishment of each Kendra to cover training, basic infrastructure, and toolkits.

• Location - Dugong Creek:

• Dugong Creek is situated in the Little Andaman Island and serves as a reserved area for the Onge community.

• The area is rich in coconut plantations, which makes the choice of coconut-based products logically and economically viable for the local VDVK unit.

• Role of TRIFED:

• The Tribal Co-operative Marketing Development Federation of India (TRIFED) is the nodal agency that provides marketing support and facilitates the sale of products through Tribes India outlets.

• It helps in branding and packaging the products made by the Onge tribe to meet national and international quality standards.

Q90. Answer: (b) 18

The correct answer is 18.

Key Points

• The Khelo India Para Games 2025 witnessed an extraordinary display of talent and resilience, culminating in the creation of 18 new national records across various sporting disciplines.

• This edition of the games was specifically designed to provide a competitive platform for para-athletes from across the country, showcasing their progress in sports like Para Athletics, Para Powerlifting, and Para Shooting.

• The setting of 18 national records highlights the increasing level of competitiveness and the improving quality of training and infrastructure provided to para-athletes in India.

• The event is a cornerstone of the Khelo India initiative, which aims to identify talent at the grassroots level and nurture it for international platforms like the Paralympics and Asian Para Games.

• The achievement of these records is a testament to the success of specialized schemes like the Target Olympic Podium Scheme (TOPS), which supports elite athletes in their quest for excellence. Hence, the correct answer is 18.

Additional Information

• Khelo India Initiative:

• Launched in January 2018, the Khelo India programme was introduced by the Ministry of Youth Affairs and Sports to revive the sports culture in India at the grass-root level.

• The Para Games component was added to ensure inclusivity, providing equal opportunities for Divyang (differently-abled) athletes to excel in a professional environment.

• The games focus on 12 to 15 different sporting disciplines, including Para Archery, Para Football, and Para Table Tennis.

• Significance of Para Games:

• The Khelo India Para Games 2025 serves as a crucial scouting ground for the Sports Authority of India (SAI) to identify potential medal winners for future global events.

• It promotes the message of "inclusive sports" and aligns with the Rights of Persons with Disabilities Act, 2016, by fostering social integration through athletics.

• Financial assistance of Rs. 5 lakhs per annum for 8 years is provided to selected talented players to cover their training and equipment costs.

Important Points

• Infrastructure and Support:

• The 2025 edition saw participation from over 2,000 athletes representing various States and Union Territories.

• Specialized venues in New Delhi and other major sports hubs were equipped with barrier-free access and world-class equipment to facilitate high-performance results.

• The Ministry of Youth Affairs and Sports has consistently increased the budget for para-sports, reflecting in the record-breaking performances seen in the 2025 games.

• Recent Achievements:

• India's performance in international para-events has seen a steep rise following the implementation of the Khelo India framework, with significant medal hauls in the Paris 2024 Paralympics acting as a precursor to the 2025 national records.

• The 18 national records set during this event serve as the new benchmarks for the next generation of Indian para-athletes.

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Q91. Answer: (a) Dudhwa National Park

The correct answer is Dudhwa National Park.

Key Points

• In June 2025, the Uttar Pradesh state government allocated a budget of Rs. 1.5 crore specifically for Dudhwa National Park to bolster its wildlife conservation efforts.

• The primary objective of this funding is the establishment of two new Rhino Rehabilitation Areas (RRAs) within the park's territory to manage the growing population of the Greater One-horned Rhinoceros.

• The initiative aims to decongest the existing rhino enclosures, as the current population in the park has exceeded 40 rhinos, leading to territorial disputes and the need for more space.

• Dudhwa National Park, located in the Lakhimpur Kheri district of Uttar Pradesh, was the site of a successful rhino reintroduction program that started in 1984 with rhinos translocated from Assam and Nepal.

• The new Rhino Rehabilitation Areas will be developed with specialized fencing, solar-powered borewells for water bodies, and enhanced protection towers to ensure the safety of the species.

Additional Information

• Geographic Location and Area:

• Dudhwa National Park spans an area of approximately 490.3 square kilometers and is situated in the Terai-Bhabar region along the Indo-Nepal border.

• It forms a part of the Dudhwa Tiger Reserve, which also includes the Kishanpur Wildlife Sanctuary and the Katarniaghat Wildlife Sanctuary.

• Biodiversity and Fauna:

• The park is world-renowned for being a stronghold of the Barasingha (Swamp Deer), housing nearly half of the world's total population of this species.

• Apart from rhinos and swamp deer, it is a critical habitat for the Royal Bengal Tiger, Leopards, Hispid Hares, and over 450 species of birds.

• Conservation Strategies:

• The National Rhino Conservation Strategy, launched in 2019, emphasizes the protection of the species across its range in India, primarily in Assam, West Bengal, and Uttar Pradesh.

• The establishment of multiple Rhino Rehabilitation Areas helps in maintaining genetic diversity and prevents the total loss of the population due to localized disease outbreaks.

Important Points

• Comparison with other Options:

• Kaziranga National Park: Located in Assam, it holds the highest density of rhinos in the world but was not the recipient of this specific Rs. 1.5 crore allocation in 2025.

• Sundarbans National Park: A UNESCO World Heritage Site in West Bengal, famous for its mangrove forests and tigers, but it is not a rhino habitat.

• Jim Corbett National Park: Established in 1936 as India's first national park in Uttarakhand, it focuses primarily on tiger conservation.

• Recent Developments:

• The Indian Rhino Vision 2020 (IRV2020) successfully increased the rhino population in India to over 3,000, and the June 2025 funding for Dudhwa is a continuation of these range expansion efforts.

• The Uttar Pradesh Forest Department has identified specific zones like Bhadi Tal for the second RRA to ensure the rhinos have access to perennial water sources and grasslands.

Q92. Answer: (c) PARAKH under NCERT in collaboration with CBSE

The correct answer is PARAKH under NCERT in collaboration with CBSE.

Key Points

• The National Achievement Survey (NAS), which has been renamed as PARAKH Rashtriya Sarvekshan for the 2024 cycle, is a large-scale assessment conducted to monitor the health of the school education system in India.

• The 2024 survey was conducted on December 4, 2024, across the country. It was organized by PARAKH (Performance Assessment, Review, and Analysis of Knowledge for Holistic Development), which is a standard-setting body established under NCERT (National Council of Educational Research and Training).

• The Central Board of Secondary Education (CBSE) played a crucial role as the administrative and operational partner, facilitating the conduct of the survey in collaboration with NCERT.

• In this national assessment, Kerala secured the second rank in the country, showcasing high learning outcomes and educational standards among its students.

• The survey targeted students from Classes 3, 6, and 9 to evaluate their competencies in subjects like Language, Mathematics,

and Environmental Studies/Science.

Additional Information

• PARAKH (Performance Assessment, Review, and Analysis of Knowledge for Holistic Development):

• It was launched as part of the National Education Policy (NEP) 2020 to act as a National Assessment Centre.

• Its primary function is to set norms, standards, and guidelines for student assessment and evaluation for all recognized school boards in India.

• It aims to shift the focus from rote learning to competency-based assessment as envisioned in the NEP 2020.

• Structure of Rashtriya Sarvekshan 2024:

• The assessment covered both Government and Government-aided schools, as well as private schools across 36 States and Union Territories.

• For Class 3 and Class 6, the subjects assessed included Language, Mathematics, and Environmental Studies.

• For Class 9, the assessment expanded to include Language, Mathematics, Science, and Social Science.

• Role of CBSE and NCERT:

• While NCERT (through PARAKH) developed the assessment framework and tools, CBSE handled the logistics, including the identification of field investigators and the distribution of assessment materials.

• The Ministry of Education oversees the entire process to ensure data-driven policy interventions in the school education sector.

Important Points

• Significance of the Survey: The data collected helps the Government of India understand the "learning gaps" and implement the Samagra Shiksha scheme more effectively.

• Evolution of NAS: Prior to 2024, the National Achievement Survey was last conducted in November 2021. The transition to PARAKH Rashtriya Sarvekshan signifies a more standardized approach to national assessments.

• Kerala's Achievement: Kerala consistently ranks high in educational indices like the School Education Quality Index (SEQI) and the Public Affairs Index, and its second-place finish in the 2024 survey reinforces its status as a leader in literacy and quality education.

• Technology Integration: The 2024 survey utilized digital tools for data monitoring and reporting to ensure transparency and real-time tracking of the assessment process across thousands of districts.

Q93. Answer: (c) Praveer Ranjan

The correct answer is Praveer Ranjan.

Key Points

• Praveer Ranjan, a distinguished Indian Police Service (IPS) officer of the 1993 batch from the AGMUT (Arunachal Pradesh-Goa-Mizoram and Union Territory) cadre, was appointed as the Director General (DG) of the Central Industrial Security Force (CISF).

• The appointment was approved by the Appointments Committee of the Cabinet (ACC), which is chaired by the Prime Minister of India, for a tenure effective from his date of joining until his superannuation or further orders.

• Before taking over the leadership of the CISF in October 2025, he served in several high-profile positions, including the Director General of Police (DGP) of Chandigarh and Special Commissioner of Police in Delhi.

• His vast experience in internal security, crime investigation, and administrative management makes him a pivotal figure in leading one of India's most specialized Central Armed Police Forces (CAPF).

• As the Director General, he is the highest-ranking officer of the CISF, responsible for the overall command, control, and operational readiness of the force across the country.

Additional Information

• Central Industrial Security Force (CISF):

• The CISF was established on 10 March 1969, under an Act of the Parliament of India, with a modest strength of around 3,000 personnel.

• It functions under the Ministry of Home Affairs and is headquartered in New Delhi.

• Its primary mandate is to provide security to Public Sector Undertakings (PSUs), critical infrastructure, and major installations such as nuclear power plants, space stations, and seaports.

• The force is also uniquely responsible for the security of 67 international and domestic airports in India and the Delhi Metro.

• The CISF motto is "Protection and Security" (Sarraksha and Suraksha).

• Other Options Overview:

• Kuldiep Singh: A 1986-batch IPS officer of the West Bengal cadre, who famously served as the Director General of the Central Reserve Police Force (CRPF) and held the additional charge of the National Investigation Agency (NIA).

• Rakesh Asthana: A 1984-batch IPS officer of the Gujarat cadre, who served as the Commissioner of Police, Delhi, and previously as the Director General of the Border Security Force (BSF) and the Narcotics Control Bureau (NCB).

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• Anil Kumar: While several officers share this name, in the context of high-level police administration, namesakes have served in various state cadres, but Praveer Ranjan is the specific appointee for the DG CISF role mentioned in the context of the 2024-2025 leadership cycle.

Important Points

• The CISF is the only CAPF that has a dedicated Fire Wing, providing fire protection to various sensitive industrial units.

• The strength of the CISF has grown significantly over the decades, now exceeding 1.7 lakh personnel, reflecting its growing importance in urban security and VIP protection.

• In 2024, the government officially designated Praveer Ranjan for this role following his successful tenure in the Union Territory police wings, highlighting the merit-based selection for national security leadership.

• The DG of CISF is usually an officer of the rank of Director General of Police (level 16 in the pay matrix) and plays a vital role in the National Security Council's peripheral coordination for industrial safety.

Q94. Answer: (a) Haryana

The correct answer is Haryana.

Key Points

• Haryana emerged as the champion of the Khelo India Para Games 2025, maintaining its supreme dominance in the field of para-sports in India.

• The state secured the top position on the medal tally with a total of 113 medals, which included 40 gold, 35 silver, and 38 bronze medals. Hence, the correct answer is Haryana.

• The second edition of the Khelo India Para Games (KIPG) was hosted by the state of Gujarat, with major events held in Gandhinagar and Ahmedabad between January 30 and February 7, 2025.

• Maharashtra finished in the second position with a commendable total of 102 medals, while Uttar Pradesh took the third spot with 78 medals.

• The games were organized by the Ministry of Youth Affairs and Sports in collaboration with the Sports Authority of India (SAI) and the Government of Gujarat to promote inclusivity in sports.

Additional Information

• Evolution of Khelo India Para Games:

• The first-ever edition of the Khelo India Para Games was held in December 2023 in New Delhi, where Haryana also topped the medal tally with 105 medals.

• The 2025 edition in Gujarat saw an increase in participation, with over 3,000 athletes representing 28 states and 8 Union Territories.

• Disciplines and Sports:

• The games featured diverse sporting disciplines, including Para Athletics, Para Badminton, Para Swimming, Para Archery, Para Football, Para Table Tennis, and Para Powerlifting.

• These events are crucial for identifying talent for international competitions like the Asian Para Games and the Paralympics.

• Mascot of KIPG 2025:

• The official mascot for the 2025 games was 'Sarthi', a lion that symbolizes courage, guidance, and the spirit of the Gir Forest in Gujarat.

• Objective of Khelo India:

• The Khelo India initiative was launched in 2018 to strengthen the grassroots sporting ecosystem in India. It now encompasses the Khelo India Youth Games, University Games, Winter Games, and Para Games.

Important Points

• Role of Sports Authority of Gujarat (SAG): The Gujarat government utilized state-of-the-art infrastructure at the Kadi and Gandhinagar sports complexes, ensuring accessibility and international standards for all para-athletes.

• Financial Support: Exceptional performers in the Khelo India Para Games are often inducted into the Target Olympic Podium Scheme (TOPS), which provides them with specialized coaching, foreign exposure, and a monthly stipend.

• Social Impact: The event serves as a platform to sensitize society towards the capabilities of Divyangjans (persons with disabilities) and encourages inclusive development through the medium of sports.

• National Integration: By bringing together athletes from every corner of the country, the games promote national unity and cultural exchange among participants from different linguistic and regional backgrounds.

Q95. Answer: (d) Hydropower generation and irrigation

The correct answer is Hydropower generation and irrigation.

Key Points

• The Kulsi Multipurpose Project is a major water resource initiative proposed on the Kulsi River, which is a significant south-bank tributary of the Brahmaputra River.

• The primary objective of the project is the generation of hydropower and the provision of irrigation facilities to enhance agricultural productivity in the region. Hence, statement 4 is correct.

• The project is not primarily aimed at Military infrastructure, as its design focuses on socio-economic development and civil utility. Hence, statement 1 is incorrect.

• While Industrial development might be an indirect beneficiary of the electricity generated, it is not listed as the project's primary functional purpose. Hence, statement 2 is incorrect.

• Although large water bodies often attract visitors, Tourism promotion is a secondary byproduct and not the core mandate like irrigation and power. Hence, statement 3 is incorrect.

• The project is planned to have an installed capacity of approximately 55 MW of hydropower, contributing significantly to the energy grid of Assam and Meghalaya.

Additional Information

• Geographic Location: The Kulsi River originates in the Khasi Hills of Meghalaya and flows through the Kamrup district of Assam before joining the Brahmaputra. The dam site is typically proposed near Ukiam, located at the border of the two states.

• Irrigation Scope: The project aims to provide irrigation to over 24,000 hectares to 40,000 hectares of land, supporting farmers during both the Kharif and Rabi seasons.

• Flood Moderation: Apart from power and water for crops, the project serves the critical function of flood control. It helps in regulating the discharge of water during the heavy Monsoon months, reducing the risk of downstream flooding in Assam.

• National Project Status: Due to its scale and regional importance, the Kulsi Project has been considered for National Project status, which allows for a 90:10 funding pattern between the Central Government and the state.

• Environmental Significance: The river is one of the few remaining habitats for the endangered Gangetic River Dolphin (Platanista gangetica), making the ecological impact assessment of this project a vital administrative and environmental concern.

Important Points

• Implementing Agencies: The project planning and Detailed Project Reports (DPR) are often handled by the Brahmaputra Board under the Ministry of Jal Shakti, Government of India.

• Inter-state Coordination: Since the river flows through both Assam and Meghalaya, the project requires a high degree of cooperation regarding land acquisition and benefit-sharing between the two state governments.

• Socio-Economic Impact: By providing stable electricity and water, the project is expected to boost the local economy, improve livelihoods, and provide a buffer against the erratic nature of rainfall in the North-Eastern region of India.

Q96. Answer: (a) Space propulsion systems

The correct answer is Space propulsion systems.

Key Points

• The Monopropellant Thruster Test Facility (MPTTF) was officially inaugurated in September 2025 to serve as a specialized hub for evaluating advanced Space propulsion systems.

• The facility is primarily designed to conduct rigorous testing of low-thrust monopropellant engines, which are essential for the Reaction Control Systems (RCS) and Attitude and Orbit Control Systems (AOCS) of various spacecraft.

• Equipped with high-performance vacuum chambers, the MPTTF can simulate the extreme conditions of outer space, allowing engineers to measure critical parameters such as Specific Impulse (Isp), Thrust, and Thermal Management.

• The establishment of this facility marks a significant milestone in achieving Atmanirbhar Bharat (Self-reliant India) in the space sector, reducing dependency on international testing labs for satellite propulsion validation.

• Testing at MPTTF focuses on the reliability of catalyst beds and propellant feed systems, ensuring that thrusters can perform thousands of pulses over a mission lifespan of 10 to 15 years.

Additional Information

• Monopropellant Technology:

• A monopropellant is a chemical propellant that consists of a single substance or a mixture of chemicals that decomposes or reacts when exposed to a catalyst.

• Unlike bipropellant systems, it does not require a separate oxidizer, making the propulsion system simpler, lighter, and more reliable.

• Anhydrous Hydrazine is the most commonly used monopropellant in the industry due to its stable storage and predictable performance characteristics.

• Applications in Satellites:

• These systems are vital for Station Keeping (maintaining the satellite's assigned position in orbit) and Momentum Dumping.

• They are extensively used in Geostationary Satellites (GEO) and Low Earth Orbit (LEO) constellations for precise manoeuvring.

• Emerging Green Propellants:

• Modern facilities like MPTTF are increasingly being adapted to test Green Propellants such as Hydroxylammonium Nitrate (HAN) and Ammonium Dinitramide (ADN).

• These alternatives are less toxic and more environmentally friendly compared to traditional Hydrazine, reducing the hazard costs associated with fueling operations.

Important Points

• Precision Testing: The facility can measure very small thrust values, often in the range of 1 Newton to 22 Newtons, which are standard for Micro-satellites and Nano-satellites.

• Operational Readiness: By providing a localized testing environment, the facility accelerates the Time-to-Market for private space startups and Government space agencies.

• Data Acquisition: It utilizes high-speed data acquisition systems to monitor the catalytic decomposition process, which occurs at temperatures exceeding 800 degrees Celsius.

• Strategic Impact: The MPTTF supports the growth of the Commercial Space sector, particularly in the development of satellite buses for global customers under the NewSpace India initiatives.

Q97. Answer: (a) Adaptation finance

The correct answer is Adaptation finance.

Key Points

• During the post-COP-30 negotiations held in November 2025, India strongly advocated for the independent scaling up of Adaptation finance. India argued that funding for building resilience must be distinct and not overshadowed by mitigation efforts.

• The demand was made in the context of the New Collective Quantified Goal (NCQG), which is the new financial target intended to succeed the $100 billion annual pledge made by developed nations. India emphasized that adaptation is a matter of survival for developing countries and requires predictable, grant-based public funding.

• India pointed out that adaptation projects often lack the commercial appeal of mitigation (such as renewable energy), making it difficult to attract private capital. Therefore, a separate and scaled-up allocation is necessary to address the specific needs of the Global South.

• The negotiations highlighted the doubling of adaptation finance pledge made at COP-26 in Glasgow, with India insisting that this target must be met and significantly expanded post-2025. Hence, the correct answer is Adaptation finance.

Additional Information

• Adaptation vs. Mitigation:

• Mitigation refers to efforts to reduce or prevent the emission of greenhouse gases, such as transitioning to solar or wind energy.

• Adaptation involves taking action to prepare for and adjust to both the current effects of climate change and the predicted impacts in the future, such as building flood defenses or developing drought-resistant crops.

• COP-30 (Conference of the Parties):

• The 30th United Nations Climate Change Conference took place in Belém, Brazil, in November 2025. It was a landmark summit focusing on the Amazon rainforest and the Global Goal on Adaptation (GGA).

• The summit aimed to finalize the NCQG, ensuring that trillions of dollars are mobilized for climate action in vulnerable nations.

• Global Goal on Adaptation (GGA):

• Established under the Paris Agreement (Article 7), the GGA aims to enhance adaptive capacity, strengthen resilience, and reduce vulnerability to climate change.

• During 2024-2025, the focus shifted toward establishing clear indicators to measure progress in adaptation globally.

• India's Domestic Framework:

• India implements its adaptation strategies through the National Action Plan on Climate Change (NAPCC), which includes eight national missions covering water, agriculture, and Himalayan ecosystems.

• The National Adaptation Fund for Climate Change (NAFCC) was established in 2015-16 to assist states and union territories that are particularly vulnerable to the adverse effects of climate change.

Important Points

• Loss and Damage Finance: Unlike adaptation (which is proactive), Loss and Damage finance refers to compensation for the unavoidable and irreversible impacts of climate change that have already occurred. The Loss and Damage Fund was operationalized at COP-28.

• Climate Finance Gap: The UNEP Adaptation Gap Report frequently highlights that the costs of adaptation in developing countries are 5 to 10 times greater than current public adaptation finance flows.

• CBDR-RC: India’s stance is rooted in the principle of Common But Differentiated Responsibilities and Respective Capabilities (CBDR-RC), which holds developed countries historically responsible for emissions and thus obligated to provide financial resources.

• Article 9 of the Paris Agreement: This article stipulates that developed country Parties shall provide financial resources to assist developing country Parties with respect to both mitigation and adaptation.

Q98. Answer: (c) Boston Celtics

The correct answer is Boston Celtics.

Key Points

• The Boston Celtics emerged as the champions of the 2023-24 NBA season after defeating the Dallas Mavericks in the Finals.

• The team secured the title with a 4-1 series victory, clinching the championship on June 17, 2024, at their home arena, TD Garden.

• This victory marked the 18th NBA Championship for the franchise, allowing them to surpass the Los Angeles Lakers for the most titles in NBA history.

• Jaylen Brown was awarded the Bill Russell NBA Finals Most Valuable Player (MVP) award for his consistent and impactful performance throughout the five-game series.

• The team was led by Joe Mazzulla, who, at 35 years old, became the youngest head coach to win an NBA title since Bill Russell in 1969.

Additional Information

• Boston Celtics:

• Established in 1946, the Celtics are a cornerstone franchise of the NBA based in Boston.

• The 2023-24 roster featured star players like Jayson Tatum, Kristaps Porziņģis, Jrue Holiday, and Derrick White.

• They finished the regular season with the best record in the league, winning 64 games and losing only 18.

• Rochester Royals:

• The Rochester Royals won their only NBA championship in 1951.

• The franchise underwent several relocations and name changes, eventually becoming the Sacramento Kings in 1985.

• Philadelphia Warriors:

• They were the inaugural champions of the Basketball Association of America (BAA), which later became the NBA, in 1947.

• The team moved to San Francisco in 1962 and is currently known as the Golden State Warriors.

• Toronto Raptors:

• The Raptors are the only Canadian team in the NBA.

• They won their first and only NBA championship in 2019 by defeating the Golden State Warriors in the Finals.

Important Points

• The 2023-24 season was the 78th season of the National Basketball Association.

• Jayson Tatum made history during the Finals by leading the team in points, rebounds, and assists, joining elite legends like Larry Bird in achieving such a feat during a championship run.

• The Dallas Mavericks, the runners-up, were led by Luka Dončić and Kyrie Irving, reaching the finals for the first time since their championship win in 2011.

• The Celtics' defensive rating during the 2024 playoffs was among the best in recent years, proving pivotal in their dominant 16-3 postseason record.

Q99. Answer: (a) Ahmedabad

The correct answer is Ahmedabad.

Key Points

• Union Home Minister Amit Shah inaugurated India’s largest and most modern sports complex in Ahmedabad, Gujarat, in September 2025.

• The sports complex is a crucial part of the Sardar Vallabhbhai Patel Sports Enclave, which is being developed to host multi-discipline international sporting events.

• This world-class facility is designed to provide infrastructure for over 20 Olympic sports, including track and field, football, and swimming, making Ahmedabad a premier "Sports City."

• The complex aims to nurture local talent and provide Indian athletes with international-standard training facilities under the vision of promoting a robust sports culture in the country.

• The inauguration marks a significant milestone in India's preparation to bid for the 2036 Summer Olympic Games.

Additional Information

• Sardar Vallabhbhai Patel Sports Enclave:

• This massive enclave spans approximately 236 acres in the Motera area of Ahmedabad.

• It houses the Narendra Modi Stadium, which is currently the world's largest cricket stadium with a seating capacity of 1,32,000.

• The enclave is planned to include a dedicated Athletics Stadium with a capacity of 50,000 spectators.

• Economic and Urban Impact:

• The project is expected to boost the local economy of Gujarat by attracting sports tourism and international competitions.

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• It integrates modern urban planning with high-speed connectivity and residential facilities for athletes and coaching staff.

• Government Initiatives:

• The project aligns with the "Khelo India" initiative launched by the Ministry of Youth Affairs and Sports to improve sporting infrastructure at the grassroots and elite levels.

• The Government of India and the State Government of Gujarat have collaborated closely to ensure the project meets global benchmarks set by the International Olympic Committee (IOC).

Important Points

• Strategic Location: Ahmedabad was chosen due to its existing infrastructure, including the Ahmedabad Metro and proximity to the international airport, facilitating easy access for international delegations.

• Modern Features: The complex includes a Sports Medicine Center, biomechanics labs, and digital training halls to use data science in athlete performance enhancement.

• Environmental Sustainability: The construction of the complex followed green building standards, utilizing solar energy and advanced water recycling systems to minimize its carbon footprint.

• Vision 2047: This infrastructure development is a key component of India's Viksit Bharat @2047 goal, aiming to place the nation among the top five sporting powers in the world.

Q100. Answer: (c) Ocean Vuong

The correct answer is Ocean Vuong.

Key Points

• Ocean Vuong, a celebrated Vietnamese-American author, is the creator of the novel titled 'The Emperor of Gladness', which saw its release in May 2025.

• The book is a highly anticipated work of fiction following his monumental success in both the realms of poetry and prose.

• The narrative of 'The Emperor of Gladness' focuses on the relationship between a young man and an elderly person struggling with memory loss, exploring themes of care, loneliness, and human connection.

• Ocean Vuong has established himself as a prominent voice in contemporary American literature, known for his lyrical and emotionally resonant writing style that often bridges his identity as a poet with his narrative storytelling. Hence, the statement regarding his authorship of this book is correct.

Additional Information

• Literary Career and Major Works:

• Ocean Vuong gained international acclaim with his debut novel, 'On Earth We're Briefly Gorgeous', published in 2019. The novel is framed as a letter from a son to his illiterate mother and explores the legacy of the Vietnam War.

• In the field of poetry, his collection 'Night Sky with Exit Wounds' (2016) won the T.S. Eliot Prize and the Whiting Award.

• His subsequent poetry collection, 'Time is a Mother', was released in 2022, further cementing his reputation for exploring grief and family history.

• Biography and Background:

• Born in 1988 in Saigon, Vietnam (now Ho Chi Minh City), he immigrated to the United States at the age of two after spending time in a refugee camp in the Philippines.

• He grew up in Hartford, Connecticut, and his experiences as a first-generation immigrant and a queer man of color are central themes in his literary output.

• In 2019, he was awarded the prestigious MacArthur Fellowship, commonly known as the "Genius Grant," for his contributions to literature.

• Context of Other Options:

• Colum McCann: An Irish writer known for novels like 'Let the Great World Spin' and 'Apeirogon'.

• Charlotte McConaghy: An Australian author recognized for her works 'Migrations' and 'Once There Were Wolves', which often focus on environmental and nature-driven themes.

• Sharon Lee: Often associated with science fiction and the Liaden universe series, representing a different genre entirely from Vuong's literary fiction.

Important Points

• Theme of the Book: The novel 'The Emperor of Gladness' signifies a shift or continuation in Vuong's exploration of vulnerability and intergenerational bonds.

• Release Timeline: The May 2025 release was one of the most significant literary events of the year, highlighting the enduring popularity of Asian-American narratives in the global market.

• Style: Vuong is often cited for his autofictional elements, though his 2025 release demonstrates a deepening of his fictional world-building and character studies.

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