Computational Thinking and Artificial Intelligence

Class 7

Teacher Handbook

CENTRAL BOARD OF SECONDARY EDUCATION

First Edition: March, 2026
Country of Publication: India
Published by: Central Board of Secondary Education, Integrated Office, Sector 23, Dwarka, New Delhi-110077

PREFACE

The National Education Policy (NEP) aims to position India as a leader in emerging knowledge fields by integrating technologies like AI, Machine Learning, Big Data, and Computational Thinking into school education. It promotes technology-enabled, interactive, and gamified learning using tools such as Augmented Reality (AR), Virtual Reality (VR), and virtual labs to foster creativity, problem-solving, and interdisciplinary exploration. NCFSE 23 carries this recommendation further for implementation.

While Artificial Intelligence (AI) is an important requirement, Computational Thinking (CT) should be a broader skill, developing a foundation for learning AI. It can cover various aspects like Cybersecurity, basic networking, etc. Hence, CBSE approaches this by integrating Computational Thinking with AI and other technological advancements, without dependence on any platform.

The book engages learners with problems involving multi-layered constraints, conditional dependencies, optimisation strategies, data interpretation and structured decision-making across numerical, spatial and real-life contexts. It deepens Artificial Intelligence understanding through concepts such as rule-based classification, data representation, bias and fairness and decision-making systems, enabling students to analyse how data, rules and assumptions influence intelligent behaviour. The document also provides pedagogical guidance, learning resources, assessment support and classroom implementation guidelines to facilitate competency-based learning in alignment with NEP 2020.

TEAM CBSE

ACKNOWLEDGEMENTS

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The efforts of Prof. Manish Jain and his whole team from Centre for Creative Learning, IIT Gandhinagar are also acknowledged and deeply appreciated.

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Introduction

Computational Thinking (CT) is a problem-solving approach that comprises Decomposition, Pattern Recognition, Abstraction, Algorithm Design, Data Analysis and Troubleshooting. Computational Thinking Skills involve solving complex problems that promote thinking skills such as critical & creative thinking, abstraction and pattern recognition, as well as algorithmic thinking. Problem identification and problem solving necessitate the application of multidisciplinary understanding for creating effective solutions.

Artificial intelligence (AI) is a cutting-edge technology that empowers machines and computers to perform tasks that usually require mimicking human intelligence. These machines can perform complex thinking processes such as data analysis, pattern recognition, prediction of trends, solving problems and decision making. Thus, AI involves simulating cognitive processes associated with human intelligence and is widely applicable in various sectors such as banking, healthcare, defence, education, entertainment, agriculture and others for processing information, solving intricate problems and for planning.

The National Education Policy (NEP) aims for India to emerge as a global leader in new emerging knowledge domains such as artificial intelligence, machine learning, data analytics, 3-D machining etc. To realise this goal, the policy suggests teaching students Mathematics and Computational Thinking, along with new subjects like Artificial Intelligence, Machine Learning, and Data Science during their school education. The policy also focuses on technology-enabled learning and classrooms by using tools like artificial intelligence, machine learning, and adaptive testing to create knowledge.

The National Curriculum for School Education draws from this policy aspiration and emphasises the need to introduce these emerging domains of study and technologies in the school curriculum. It recommends inclusion of subjects such as design thinking, augmented reality, virtual reality, artificial intelligence, and computational thinking. Additionally, it promotes the use of gamified content, interactive content, and immersive experiences (such as AR, VR, or virtual labs) to enhance student learning. In a variety of subjects, including design, music, art, and sciences, these resources support students in knowledge creation and exploration, and development of capacities such as problem-solving, critical and creative thinking.

CBSE, under the aegis of the Department of School Education and Literacy, Ministry of Education, Govt. of India, is implementing a Curriculum on Computational Thinking and Artificial Intelligence (CT & AI) to inculcate AI-readiness in school students. This curriculum will be implemented from classes 3rd to 8th, in the session 2026-27, and aims to develop AI-Ready learners, by focussing on Computational Thinking Skills. The AI-readiness, so inculcated through CT Skills, will help develop the capacities of learners to use computational thinking, such as logical thinking, problem solving, pattern recognition, and so on, and understand the role and use of Artificial Intelligence in daily life. The Curriculum aims to build strong foundations in computational thinking, digital literacy, and responsible use of technology, along with nurturing innovation, critical thinking, and ethical decision-making capacities.

1. **Relevance: Importance of introducing Computational Thinking (CT) and Artificial Intelligence (AI)**

- **Preparing for the future:** To contribute to the world of work in modern societies, individuals need capabilities such as problem solving, using data effectively, identifying patterns, and applying AI ethically for various purposes in life.
- **Holistic Development:** Study of CT and AI contributes to development of reasoning, logical thinking, creative problem-solving skills, critical thinking, ethical decision-making abilities, leading to individual flourishing. It leads to creation of responsible digital citizens in society.
- **Interdisciplinary Relevance:** Embedding CT and AI concepts in the school curriculum helps students to develop an integrated view of the world by connecting various disciplines such as Mathematics, Science, Humanities etc.
- **Innovation and Entrepreneurship:** At the core CT and AI is about solving problems, devising innovative solutions and recreating human thinking. This leads to an entrepreneurial and innovative mindset in the learners.
- **Ethical Awareness:** Study of CT & AI will sensitise learners about the misuse and bias, fairness and inclusivity in AI systems.

2. **Objectives (Curricular Goals)**

- **CG-1:** Develops skills and capacities of computational thinking, namely, decomposition, pattern recognition, data representation, generalisation, abstraction, and algorithms to solve problems where such techniques of computational thinking are effective.
- **CG-2:** Develops spatial and visual reasoning.
- **CG-3:** Gain foundational knowledge of AI, its types, and domains.
- **CG-4:** Understand key ethical terms such as bias and fairness in relation to AI.
- **CG-5:** Demonstrates proficiency to use Computer & other devices, computer applications for learning and practical purposes such as data analysis, preparation of visual representations and communication of ideas.

3. **Learning Outcomes**

Computational Thinking (CT) Learning Outcomes

ABSTRACT THINKING

Students will be able to interpret and solve complex, multi-layered problems by:

- Visualising and analysing 3D objects and their transformations, including rotations, reflections, cross-sections, and nets.
- Understanding compound transformations involving multiple flips, turns, folds, and rearrangements.
- Identifying hidden relationships and constraints within incomplete figures, patterns, or logical setups.
- Analysing symmetry, congruence, and proportional reasoning across different representations.
- Interpreting relative positions, orientations, and viewpoints of objects in advanced visual scenarios.

PATTERN RECOGNITION

Students will be able to recognise, extend, and predict complex patterns involving:

- Multi-rule numerical sequences, including alternating, nested, and dependent patterns
- Algebraic patterns using variables, expressions, and functional relationships
- Visual and geometric patterns formed through transformations or growth rules
- Letter and symbol-based patterns involving positional and logical dependencies
- Integrated patterns combining numbers, shapes, symbols, and logical conditions

DECOMPOSITION

Students will be able to break down real-world and abstract problems by:

- Separating interconnected conditions and constraints into manageable components
- Analysing number properties (factors, multiples, ratios, percentages, powers) within layered clues
- Deconstructing problems involving spatial reasoning, measurements, and geometry
- Interpreting tables, grids, charts, and flow-based information with multiple dependencies
- Breaking multi-step logical situations (movement, exchanges, comparisons, scheduling) into ordered steps
- Translating visual or verbal information into structured data for systematic analysis

ALGORITHMIC THINKING

Students will be able to design and follow logical procedures to solve advanced problems involving:

- Rule-based sequences and algorithms with conditional branching
- Grid-based navigation and pathfinding with constraints and decision points
- Step-wise transformations involving calculations, swaps, transfers, or positional changes
- Ordering and arranging elements (people, objects, events) using multiple attributes and logical clues
- Solving problems using if–then reasoning, elimination strategies, and logical consistency checks
- Creating or analysing procedural steps to reach an optimal or valid solution

Artificial Intelligence (AI) Learning Outcomes

Learners will be able to:

- Distinguish key predictive techniques such as:
  - **Regression:** The method of predicting a number based on patterns in past data
  - **Classification:** The process by which a machine arranges things in a group based on what it has learned
  - **Clustering:** The process by which a system automatically puts similar items together
- Explain about the key domains of AI, namely:
  - **Data Science:** learn to manage and extract insights from data
  - **Computer Vision:** learn the basics of how machines understand and respond to visual information
  - **Natural Language Processing:** understand the basics and limitations of how computers process and handle natural language inputs
- Explain what **bias in AI** means, and identify situations where AI can give unfair results
- Demonstrate courteous, safe, and responsible use of technology as part of good digital citizenship

- Use safe practices for maintaining data privacy, including giving informed consent before personal data is collected, used, shared, archived, or deleted
    - Collect and organise simple structured data, interpreting patterns and trends, and create bar charts, line graphs and pie charts
    - Apply basic predictive approaches/techniques to a small dataset
    - Explain uses of AI in healthcare, education, transport, and communication

4. Mapped with NEP and NCF 2023

- The National Education Policy (NEP) aims to position India as a leader in emerging knowledge fields by integrating technologies like AI, Machine Learning, Big Data, and Computational Thinking into school education
- NCFSE 23 carries this recommendation further for implementation
- Learning standards are derived using the approach suggested with and are aligned to NCF SE-2023
- Curricular Goals are derived from the Aims of Education, along with other relevant considerations

5. Time Allocation

The Middle stage (Class 6–8) suggests 100 hours annually, including the time for specific topics on basics of AI and interdisciplinary projects. For Grade 7, the breakdown is:

- **Advanced CT skills:** 40 hrs. per academic year
- **Introductory concepts of AI:** 20 hrs. in an academic year
- **Interdisciplinary projects:** 40 hrs. total (20 hrs. allocated to each of the two required projects)

6. Approach / Pedagogy

- Use hands-on and real-world problems, collaborative and group work to solidify and apply multidisciplinary foundational knowledge on Coding, Data Analysis and Artificial Intelligence tools
- Use complex puzzles, riddles and games to build on the computational thinking abilities taught in the previous stage
- Deliver fundamental concepts of AI through explanations, demonstrations and hands-on experience
- Organise group discussions, design collaborative projects that integrate CT & AI, and offer guidance to students to carry out these projects
- Independent activities for students such as data collection, organisation and analysis created using digital tools or manually
- Discussions, debates and case studies on ethical use of AI

7. Assessment

Assessment approaches move away from traditional summative assessment to continuous, formative, and competency-based assessment. Methods for Class 7 include:

- Written Tests and Practical Examinations
- Project presentations, assignments, and reflective journals

- Interactive Group activities like treasure hunts
- Teacher Observation Journal
- Thematic Projects and Reflections/Group Discussions

CT and AI Transition

- Computational Thinking (CT) forms the basis of learning AI.
- Skills like breaking problems into parts, spotting patterns, filtering essential information, and designing step-wise procedures are the same reasoning processes that power AI and ML systems.
- The curriculum begins with the introduction of CT and deepens it as we move across the stages; AI is introduced later, once pre-requisite knowledge of CT is built for understanding AI.

How to Use This Book?

PART-1 Computational Thinking

Part 1 of this handbook is designed as a companion to the Mathematics textbook and is intended to be used alongside regular classroom teaching. Since it follows the same chapter sequence, the Mathematics teacher can seamlessly integrate it into daily instruction. As concepts are introduced in class, the corresponding questions from this book can be used to deepen understanding and encourage application.

Before beginning a chapter, the teacher is encouraged to read and identify the underlying concepts required for each question and plan how to align them with classroom teaching. As these concepts are taught, the teacher can introduce the related 'thinking questions' to students. It is important to note that the questions in this book are thinking-based and designed to promote analysis, reasoning, and problem-solving.

Teachers should adopt a facilitative approach, guiding students through prompts and discussions rather than directly providing solutions. Students should be given time to think and attempt independently, followed by classroom discussions where different approaches are shared and explored.

Some chapters also include activities that build intuition and engagement. These should be conducted before attempting the questions, as they help students approach the problems with better understanding.

PART-2 Artificial Intelligence

Part 2 of the handbook provides a structured introduction to Artificial Intelligence (AI) as a technology that enables machines to learn from data, recognise patterns, and make decisions. The concepts of AI are presented using simple explanations and real-life examples from areas such as healthcare, education, transport, and communication.

Each chapter includes:

- Foundational understanding of AI concepts
- Real-life examples and applications of AI
- Introduction to key AI domains such as Data Science, Computer Vision, and Natural Language Processing
- Activities and data-based tasks
- Reflection on ethical use of AI

The AI content progresses from introduction to application, including introductory predictive techniques such as regression, classification, and clustering. The book emphasises ethical and responsible use of AI, including introduction to bias, fairness, privacy, and safe use of technology, enabling informed and thoughtful engagement with AI systems.

Teachers should approach the book with the mindset that the process of thinking is more important than arriving at the correct answer. Creating a safe and encouraging environment where students feel comfortable making mistakes, exploring multiple strategies, and expressing their reasoning is essential. The goal is to nurture confident, independent thinkers rather than focus solely on correctness.

PART-1

COMPUTATIONAL THINKING

Chapter 1: Large Numbers Around Us

1. **'X' is a 6-digit number formed using exactly three different digits. One of the digits appears once, another appears twice, and the third appears three times. When 2 lakhs are added to 'X', the resulting number 'Y' is still a 6-digit number. What is the highest possible value of 'Y'?**

   a) 977889 b) 999999 c) 999988 d) 999887

   Answer: c

   Solution:

   Given that X is a 6-digit number, where one digit occurs once, one digit occurs twice, and the other digit occurs thrice.

   Now, when 200000 is added to X, we get Y, which is also a 6-digit number.

   To maximise the value of Y, we have to maximise the value of X.

   Let X = __ __ __ __ __ __.

   The first blank cannot have 8 or more than 8, as adding 200000 + 800000 gives 1000000, which is the smallest 7-digit number. So, X must start with 7.

   X = 7 __ __ __ __ __.

   Also, we know that X is made of 3 different digits, where 1 digit occurs once, one digit occurs twice, and the other digit occurs thrice.

   Again, to maximise its value, the largest digit 9 must occur thrice, and the next largest digit 8 must occur twice.

   Hence, the HIGHEST possible value of X = 799988.

   Therefore, the HIGHEST possible value of Y is 799988 + 200000 = 999988.

   Option c is correct.

---

2. **What is the product of all the numbers on a telephone dial pad?**

   a) 12345 b) 32451 c) 362880 d) None of these

   Answer: d

   Solution:

   A telephone dial pad contains the numbers 0 to 9.
   When finding the product, all numbers are multiplied together.
   0 is included in the dial pad.
   We know that any natural number multiplied by 0 always results in 0.
   So, whatever the product of the other digits be, the total product of the numbers on the dial-pad becomes 0.
   As 0 is not present in the options, option d, 'None of these' is correct.

---

3. **Sam forms two different 6-digit numbers, X and Y, using digits from 0 to 9 (without repetition within a number). Exactly two digits are common between X and Y.**
   - **The digit 9 appears in the same position in both numbers**
   - **Y ends with 0, has only one even digit, and its digits are arranged in descending order**
   - **6 is present in X, and the number of even digits on its left is equal to the number of even digits on its right**

   If X is the largest possible number, what is the difference between X and Y?

   a) 9310 b) 9210 c) 8420 d) 8310

   Answer: a

Solution:

9 appears in the same position in both numbers.

Number Y ends with 0 and has only one even digit. So, the other digits are odd (as 0 is even) and arranged in descending order.

The odd digits in descending order are: 9, 7, 5, 3, 1.

So, **Y = 975310**.

In number X, the digit 9 will also be at the first position from the left (same as in Y).

So, **X = 9 _ _ _ _ _**.

In number X, the digit 6 has an equal number of even digits on both sides, and X must be the largest possible number.

The even digits are: 0, 2, 4, 6, 8.

If 6 has only one even digit on each side, then number X will contain three even digits, and the remaining digits will be odd.

Since number Y contains all the odd digits and zero, three odd digits would be common between X and Y. However, only two common digits are allowed.

Therefore, 6 cannot have only one even digit on each side; it must have more than one.

If 6 has two even digits on both sides, then it must be at the hundreds position.

So, **X = 9 _ _ 6 _ _**.

The remaining even digits are: 8, 4, 2, 0. Arranging them to get the largest possible value of X, we get **984620**.

Now, find the difference:

984620 − 975310 = 9310

Therefore, the difference between the two numbers is **9310**. Hence, the correct answer is **option a**.

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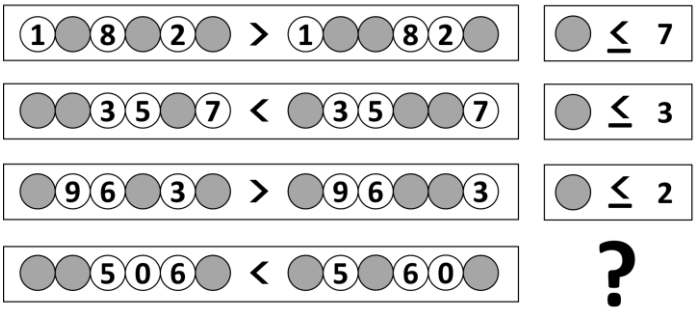
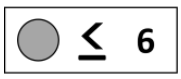
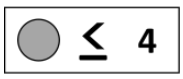
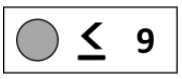
4. If each of the rows follows the same theme, what will come in place of "?"



a) 

b) 

c) 

d) 

Answer: c

Solution:

In each term, two six-digit numbers are formed by replacing the grey circle with a digit. The maximum possible value of the grey circle is given on the right. The comparison remains valid as long as the digit in the grey circle is less than or equal to the digit given on the right. For example, in the first term, the comparison holds when the grey circle is replaced with a digit less than or equal to 7.

178727 > 177827.

The condition is not valid for any number greater than 7.

In the question term, the numbers are: _ _ 506 _ < _ 5 _ 60 _.

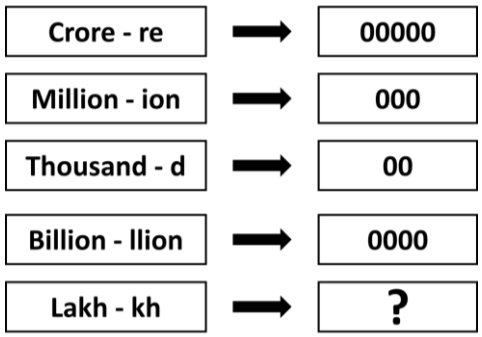
Here, the comparison is valid as long as the grey circle is replaced with a digit less than or equal to 5.

555065 < 555605.

The condition is invalid for any other digit greater than 5. (For example, if the grey circle is replaced with 6, then 665066 < 656606 is invalid)

Hence, the correct answer is **option c**.

5. **What will come in place of "?"**



a) 0 b) 00 c) 000 d) 0000

Answer: c

Solution:

Before the arrow, the **spelling of a number** is written, and a few letters from that spelling are shown after "-".

Rule:

- The **number of letters written after "-"** tells how many zeros are to be removed from that number.
- The **remaining zeros** are shown on the right side of the arrow.

Understanding the example

Crore = 1,00,00,000 : has **7 zeros**

Letters after "-" are **"re"**: 2 letters

Remaining zeros:

7 - 2 = 5: **00000**

Applying the rule to the question

Lakh = 1,00,000 : has **5 zeros**

Letters after "-" are **"kh"**: 2 letters

Remaining zeros:

5 - 2 = 3: **000**

Hence, option c is the correct answer.

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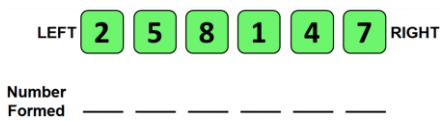
6. **Six number tokens are given. Rearrange them to form a 6-digit number such that:**
   - **The difference between the first and last digits is as small as possible**
   - **The hundreds digit is double the thousands digit**
   - **No consecutive digits appear next to each other**
   - **All given tokens must be used exactly once**

   How many different 6-digit numbers between 2 lakhs and 8 lakhs can be formed under these conditions?



a) 1 b) 2 c) 3 d) More than 3

Answer: b

Solution:

As per the second condition, the hundreds digit is double the thousands digit.

So, there are only three possible cases, as per the available tokens.

Case A: __ __ 1 2 __ __

Case B: __ __ 2 4 __ __

Case C: __ __ 4 8 __ __

However, the third condition states that no consecutive digits of the number series appear next to each other. So, case A is invalid, as 1 and 2 (consecutive digits) are next to each other. Remaining cases:

Case B: __ __ 2 4 __ __

Case C: __ __ 4 8 __ __

Now, as per the first condition, the first and the last digits of the number have the least possible difference between them.

The least possible difference between any two tokens is 1.

From the above tokens, the pairs that have a difference of 1 are: (1, 2), (4, 5), and (7, 8).

As all tokens must appear once in a number, let's fill in cases B and C with the appropriate first and last digits, where the digits are not repeated.

Case B: As the middle digits of case B are 2 and 4, the only possible pair for the first and last digits is (7, 8)

a) 7 __ 2 4 __ 8
b) 8 __ 2 4 __ 7

Case C: As the middle digits of case C are 4 and 8, the only possible pair for the first and last digits is (1, 2)

a) 1 __ 4 8 __ 2
b) 2 __ 4 8 __ 1

Fill in the remaining blanks in such a way that no two consecutive digits of the number series appear next to each other.

Case B:

a) 7 5 2 4 1 8
b) 8 5 2 4 1 7

Case C:

a) 1 7 4 8 5 2
b) 2 7 4 8 5 1

Among all the numbers, the numbers that lie between 2 lakhs and 8 lakhs are 752418 and 274851.

Hence, option b is correct.

---

7. Two five-digit numbers are formed using different digits from 0 to 9. Both numbers have some digits missing, as shown below:

Number 1: _ 1 _ 9 _

Number 2: _ 4 _ 6 _

No two consecutive digits of the number series are present in the same number.

What is the maximum possible difference of the numbers formed?

a) 47525 b) 52663 c) 52429 d) 46733

Answer: b

Solution:

The digits not used in either number are 0, 2, 3, 5, 7, and 8.

No two consecutive digits are present in the same number.

Number 1 already contains 1 and 9. So, it can use 3, 5, and 7 only. (as 0, 2, and 8 are not allowed)

Number 2 already contains 4 and 6. So, it can use 0, 2, and 8 only. (as 3, 5, and 7 are not allowed)

To obtain the maximum difference, one number must be maximized and the other minimized.

We have to logically decide which number has a greater scope to be maximized and which can be minimized.

Clearly, we can see that the largest single digit '9' is already present in the tens place of number 1. So, the largest digit doesn't play any role in our current task.
Let's go to the next largest digit '8'.
We know that 8 belongs to number 2 and the largest place value of this number (the ten thousands) is also empty. So, placing 8 in the ten thousands place will significantly increase the overall value of number 2. (Hence, we get the maximum difference by having number 2 as large as possible and number 1 as small as possible).
Number 1: _ 1 _ 9 _
Number 2: 8 4 _ 6 _
Let's place the other digits (0 and 2) in number 2, accordingly.
Number 1: _ 1 _ 9 _
Number 2: 8 4 2 6 0
Similarly, to minimize number 1, we have to fill in the missing digits (3, 5, and 7) in ascending order.
Number 1: 3 1 5 9 7
Number 2: 8 4 2 6 0
The difference between both the numbers is: 84260 - 31597 = 52663.
Hence, the correct answer is option b.

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8. A, B, C, D, and E each have a different number card among one hundred, one thousand, ten thousand, one lakh, and ten lakhs.
- **C has an even number of zeros in his number**
- **A's number has 2 zeros less than C's number**
- **D's number has 4 zeros more than A's number**
- **The number of zeros in B is more than that of A but less than C**

Which number card does E have?

a) One thousand b) Ten thousand c) One lakh d) Ten lakh

Answer: c

Solution:

Since A has 2 fewer zeros than C, and D has 4 more zeros than A, C must lie between A and D, and must have an even number of zeros.

Therefore, C has ten thousand, A has one hundred, and D has ten lakh.

The number of zeros in B is more than that of A but less than C.

B must fall between A and C. So, B has a thousand.

The only card left for E is one lakh. So, the correct answer is option c.

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9. 4 friends, Alex, Bob, Calvin and David have a different profession – Doctor, Lawyer, Cricketer, and Engineer and earn a different salary – ₹40,000, ₹50,000, ₹60,000 and ₹70,000 per year. (not necessarily in the same order)
- **The cricketer earns the highest**
- **Alex earns more than Bob, while the doctor earns more than David, who is the engineer**
- **Bob is the lawyer, and neither Bob nor David has an exact salary of ₹50,000**

Which of these options shows the correct profession and salary of Calvin?

a) Cricketer - ₹70,000 b) Doctor - ₹60,000 c) Doctor - ₹50,000 d) Doctor - ₹40,000

Answer: c

Solution:

The 4 friends are Alex, Bob (lawyer), Calvin, and David (engineer). This leaves us with two professions, doctor and cricketer (for Calvin and Alex), which have not been fixed. It is mentioned that the Cricketer earns the highest.

Profession	Name	Salary
Cricketer		70,000
		60,000
		50,000
		40,000

Since the lawyer (Bob) and the engineer (David) do not earn ₹50,000 (as given in the statement, neither Bob nor David has an exact salary of ₹50,000), it must be the doctor who earns ₹50,000.

Profession	Name	Salary
Cricketer		70,000
		60,000
Doctor		50,000
		40,000

As "the doctor earns more than David, the engineer", David must earn ₹40,000, as the doctor earns ₹50,000. The only salary remaining for the lawyer is ₹60,000.

Profession	Name	Salary
Cricketer		70,000
Lawyer	Bob	60,000
Doctor		50,000
Engineer	David	40,000

Now, since Alex earns more than Bob, Alex must be the cricketer (₹70,000), and Calvin must be the doctor (₹50,000).

Therefore, Calvin's profession is a Doctor, with a ₹50,000 salary.

Profession	Name	Salary
Cricketer	Alex	70,000
Lawyer	Bob	60,000
Doctor	Calvin	50,000
Engineer	David	40,000

Option c is correct.

---

10. The following are the clues to the 6-digit password of Nisha's laptop:

35 tens
31 thousands
25 ones
423 hundreds
14 ten thousands
What is Nisha's password?

a) 213625 b) 203675 c) 212375 d) 213675

Answer: d

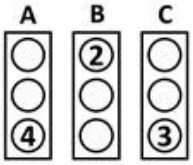
Solution:

To find Nisha's laptop password, add the values represented by each clue.

14 ten thousands = 14 × 10,000 = 1,40,000

31 thousands = 31 × 1,000 = 31,000
423 hundreds = 423 × 100 = 42,300
35 tens = 35 × 10 = 350
25 ones = 25
Now add all the values:
1,40,000 + 31,000 + 42,300 + 350 + 25 = 2,13,675
Therefore, Nisha’s laptop password is 213675.
Hence, the correct answer is option d.

Columns A, B, and C contain 3 numbers each, such that:
- The number of times each number appears in all 3 columns combined, is equal to its value (e.g., 2 appears twice, 3 appears thrice, etc.)
- Each column contains AT LEAST TWO different numbers
If column A is the only column with THREE different numbers, then which column has the highest sum?



(a) Column A
(b) Column B
(c) Column C
(d) Both columns B and C

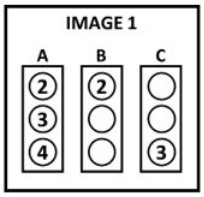
Answer: d

Solution:

From the question, we can say that **4 appears four times, 2 appears twice, and 3 appears thrice.**

It is stated that **Column A is the only column with three different numbers**, meaning Column A contains **2, 3, and 4**.

So, the empty circles of column A will have **2 and 3**.



We already have **two 2's and two 3's placed.**

So, the remaining four circles must be filled with:

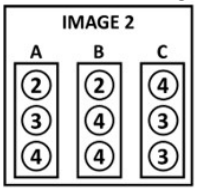
• One 3

• Three 4's

Now, since Column B already contains a 2, we cannot place a 3 and 4 in it - doing so would make three different digits in Column B, which violates the condition that only Column A can have three different numbers.

Therefore, Column B must have **two 4's.**

The remaining 3 and 4 will then go into Column C.



Sum of the digits of column A = 2 + 3 + 4 = 9

Sum of the digits of column B = 2 + 4 + 4 = 10

Sum of the digits of column C = 4 + 3 + 3 = 10

Hence, both columns B and C have the highest sum.

Hence, option d is the correct answer.

Chapter 2: Arithmetic Expressions

1. **Identify the odd one out from the following expressions, after INTERCHANGING their operators.**

   a) 204 + 3 ÷ 29 b) 67 - 2 × 37 c) 48 ÷ 6 × 3 d) 195 × 49 - 2

   Answer: c

   Solution:

   We have to identify the odd one out after interchanging the operators present in the expressions.
   Let us solve each equation one by one:
   Option a: 204 + 3 ÷ 29
   After interchanging the operators, the resultant expression is: 204 ÷ 3 + 29
   = 68 + 29
   = 97
   Option b: 67 - 2 × 37
   After interchanging the operators, the resultant expression is: 67 × 2 - 37
   = 134 - 37
   = 97
   Option c: 48 ÷ 6 × 3
   After interchanging the operators, the resultant expression is: 48 × 6 ÷ 3
   = 288 ÷ 3
   = 96
   Option d: 195 × 49 - 2
   After interchanging the operators, the resultant expression is: 195 - 49 × 2
   = 195 - 98
   = 97
   In every option, the answer is 97 except in option c, where the resultant value is 96.
   Hence, the correct answer is option c.

---

2. **There is a seminar from 11:00 AM to 2:00 PM, where students must spend AT LEAST 1 hour in the seminar. The table displays the number of students entering and exiting the seminar at different times. What is the MAXIMUM possible number of students who spent at least 2 hours in the seminar?**

SR. NO	TIME	IN	OUT
1.	11:00 AM	120	
2.	12:00 PM	40	60
3.	1:00 PM	80	40
4.	2:00 PM		140

   a) 60 b) 80 c) 100 d) 120

   Answer: c

   Solution:

   To maximize the number of students spending at least 2 hours in the seminar, we should aim to retain as many students as possible for that duration.
   1. Initial Entry at 11:00 AM:
   - 120 students entered the seminar
   - 60 students exited at 12:00 PM, meaning these 60 students cannot complete 2 hours
   - At 12:00 PM, the remaining 60 students from the 11:00 AM batch are still in the hall

2. At 12:00 PM:
- 40 new students entered the hall
- The total number of students in the seminar is now 100 (60 from the 11:00 AM batch + 40 new students)
- The 60 students from the 11:00 AM batch have now completed 1 hour

3. At 1:00 PM:
- 80 more students entered
- 40 students left the hall, and to maximize the number staying for 2 hours, we assume these 40 students are from the 11:00 AM batch, meaning they have now completed 2 hours
- The remaining 20 students from the 11:00 AM batch stay in the hall
- The total number of students in the hall is now 140 (20 from 11:00 AM + 40 from 12:00 PM + 80 from 1:00 PM)

4. At 2:00 PM:
- No new students enter, and all 140 students exit
- By this time, the 40 students from the 12:00 PM batch have completed 2 hours

Final Calculation:
- 60 students from the 11:00 AM batch stayed until at least 1:00 PM, and 40 of them left exactly at 1:00 PM after completing 2 hours
- 20 students from the 11:00 AM batch remained until 2:00 PM, so they also completed 2 hours
- 40 students from the 12:00 PM batch stayed until 2:00 PM, completing 2 hours

Thus, the maximum possible number of students who spent at least 2 hours in the seminar is 100.
Option c is correct.

---

3. In the given expression '8 @ 7 - 15 < 4 × 2 × 5', which operator cannot be used in place of '@', such that the condition remains valid?

a) - b) ÷ c) + d) ×

Answer: d

Solution:

8 @ 7 - 15 < 4 × 2 × 5

The left side of the condition has 8 @ 7 - 15 and the right side has 4 × 2 × 5, which is 40.

Let's solve it logically.

The LHS has -15 in it. So, whatever the value of 8 @ 7 be, its value further decreases due to the subtraction of 15 from it.

So, Subtraction (-) and division (÷) reduce the value, and there is already a (-15) in the expression, which decreases the value further.

So, the result will definitely be less than 40, and these operators can be used definitely.

Addition (+) increases the value slightly. Let's check with "+".

8 + 7 - 15 = 0, which is still less than 40. So, addition can be used here.

Multiplication (×) increases the value.

8 × 7 - 15 = 41, which is not less than 40. So, multiplication cannot be used.

Therefore, the operator that cannot be used is multiplication (×). Option d is correct.

4. **A bus has 40 seats, and some seats are already occupied, with one passenger in each seat.**
   - **At the first stop, 5 passengers get off and 8 passengers get in**
   - **At the second stop, 2 passengers get off and 4 passengers get in**
   - **At the third stop, exactly half of the passengers get off**

   After this, half of the bus seats are occupied.

   Which of the following expressions represents the number of passengers on the bus at the beginning?

   a) 5 × 5 + 5 b) 6 × 6 - 4 c) 5 × 5 + 10 d) 6 × 6 - 5

   Answer: c

   Solution:

   This can be solved by moving backwards from the last stop. (reverse deduction)

   Half of the bus seats are occupied at the end.

   Since the bus has 40 seats, 20 passengers remain. (40/2 = 20)

   At the third stop, half of the passengers got down.

   This means before the third stop, there were 40 passengers, because half of 40 is 20.

   At the second stop, 2 passengers got down and 4 got in.

   If there are 'X' number of passengers and 2 got down and 4 got in, the expression for the number of people at that time is:

   X - 2 + 4

   = X + 2

   This means the number of passengers increased by 2 (overall).

   So, before the second stop there were 38 passengers only, which later became 40.

   At the first stop, 5 passengers got down and 8 got in.

   If there are 'Y' number of passengers and 5 passengers got down and 8 got in, the expression for the number of people at that time is:

   Y - 5 + 8

   = Y + 3

   This means the number of passengers increased by 3 (overall), so at the beginning, there were 35 passengers. (35 + 3 = 38)

   Among the given expressions,

   a) 5 × 5 + 5 = 25 + 5 = 30

   b) 6 × 6 - 4 = 36 - 4 = 32

   c) 5 × 5 + 10 = 25 + 10 = 35

   d) 6 × 6 - 5 = 36 - 5 = 31

   Therefore, the correct answer is option c.

---

5. **The following expression has a whole number 'n'. If a blank can either take '×4' or '–12', what is the least possible value of 'n'?**

   Expression: (n ____ ____) ____ = 96

   a) 9 b) 18 c) 4 d) 72

   Answer: a

   Solution:

   Think logically.

   Multiplying by 4 makes the number grow bigger and subtracting 12 makes it smaller.

If we want the smallest starting number ‘n’ and turn it into 96, we should multiply by 4 more times, because even a small number can become big after multiplying. As subtraction decreases a number, let’s try to avoid it as much as possible.

Now, the expression must make n into 96.

Let’s assume that all three operations performed on n are of ‘×4’ only.

So, n × 4 × 4 × 4 = 96

n × 64 = 96.

But, there is no such whole number which when multiplied by 64 gives 96 as the result.

Thus, we can say that not all the three operations are ‘×4’. At least one ‘−12’ must be used.

Now let’s try using two ‘×4’ operations and one ‘−12’ operation, since we want to subtract as little as possible. There are different possible arrangements. Let’s test them carefully:

Case 1: Subtract first, then multiply twice

(n − 12 × 4) × 4 = 96

Divide by 4 on both sides.

(n − 12 × 4) = 24

n – 48 = 24

Add 48 on both sides.

n = 24 + 48

n = 72

This is a whole number.

Case 2: Multiply once, subtract, then multiply

(n × 4 − 12) × 4 = 96

(4n − 12) × 4 = 96

16n − 48 = 96

Add 48 on both sides.

16n = 144

n = 9

This is also a whole number.

Case 3: Multiply twice, then subtract

(n × 4 × 4) − 12 = 96

16n − 12 = 96

Add 12 on both sides.

16n = 108

n = 108/16 = 6.75

n = 6.75

It is not a whole number.

Now, compare the valid whole numbers:

Case 1: n = 72

Case 2: n = 9

The smallest possible whole number is: 9.

Hence, option a is correct.

6. **Which operators should be interchanged to get the minimum value of the given expression?**
8 × 4 + 2 - 1

a) × and + b) + and - c) - and × d) No change

Answer: c

Solution:

Let us solve the current expression: 8 × 4 + 2 - 1 = 32 + 2 - 1 = 33.
To find the minimum value by interchanging the operators, let's analyse the problem logically instead of trying each pair of operators given in the options.
Since we need the least possible result, we should consider changing the multiplication operator because it is placed between two of the highest numbers in the given expression.
By interchanging it with the subtraction operator, which is placed between two of the lowest numbers, we can reduce the overall value.
Let's apply this change to the expression: Original expression: 8 × 4 + 2 - 1
Interchange multiplication with subtraction: New expression: 8 - 4 + 2 × 1
Now, solve the new expression step by step:
2 × 1 = 2
8 - 4 + 2 = 6
Thus, the minimum value is 6.
Option c is the correct choice.

---

7. **In certain code, 1 is coded as 2, 3 is coded as 10, 5 is coded as 26.**
In the same way, 4 is coded as A and 6 is coded as B.
If C is the sum of A and B, which of the following is correct regarding C?

a) C > 55 b) C < 50 c) C = 50 d) C < 55

Answer: d

Solution:

Here, the pattern for coding is to multiply the number by itself and add 1. For example:
1 = (1 × 1) + 1 = 2
3 = (3 × 3) + 1 = 10
So, 4 = (4 × 4) + 1 = 17
A = 17
Also, 6 = (6 × 6) + 1 = 37
B = 37
Now,
C = A + B
C = 17 + 37 = 54
We know that 54 < 55
So, C < 55
Therefore, the correct answer is option d, C < 55.

---

8. **In the following expression, each ball with a mathematical operator is swapped with the ball immediately to its left, to form a new arithmetic expression. What will be the value of NEW EXPRESSION - ORIGINAL EXPRESSION?**

a) 63 b) 73 c) -63 d) -73

Answer: d

Solution:

The value of the original expression is:

87 + 15 - 3

= 102 - 3

= 99

Let's form the new expression, as per the given instructions.

Given that, each ball with an operator is swapped with the ball immediately to its left.

After swapping the balls having mathematical operators with the balls on their immediate left, the resultant expression is:

= 8 + 71 - 53

= 79 - 53

= 26

New expression - Original expression

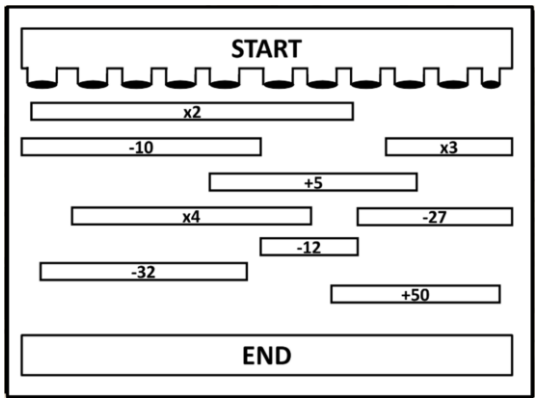
= 26 - 99

= - 73

Thus, the correct answer is option d.

---

9. A stone with an initial value of 10 is dropped through one of the holes at the START and moves in a straight path to reach the END. As it passes each numbered bar along the way, its value changes according to the operation shown on that bar. What is the maximum value the stone can have when it reaches the END?



a) 60 b) 88 c) 53 d) 68

Answer: b

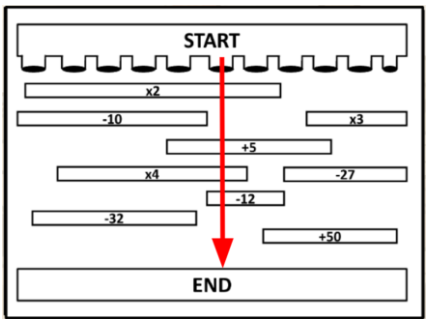
Solution:

As we need the highest possible value, we should try to touch any of these multiplication bars, so that there is a good increase in the stone's value.

However, if we concentrate on bar '×3', we would miss the bars '×2' and '×4', which would be a great loss. So, let's ignore bar '×3'.

We should avoid -32 and -10 as it would decrease the overall value.

Hence, we just take -12 over -32 and -10.



The value we get from the above hole is:

Bar 1: (10 × 2) = 20

Bar 2: 20 + 5 = 25

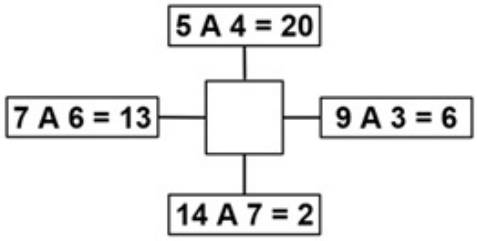
Bar 3: 25 × 4 = 100

Bar 4: 100 - 12 = 88

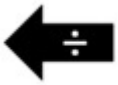
Hence, option b is the correct answer.

---

10. Each arrow has a mathematical operator. When placed in the centre box, its operator replaces the letter A in the equation it points to. Which arrow satisfies an equation based on this rule?



a) 

b) 

c) 

d) 

Answer: d

Solution:

Let us check each option one by one by replacing A with the operator shown on the arrow.

Option a: Operator = '–'

Top equation becomes:

5 – 4 = 1

Since 1 ≠ 20, this option is incorrect.

Option b: Operator = '÷'

Left equation becomes:

7 ÷ 6 = 1.16…

Since 1.16 ≠ 13, this option is incorrect.

Option c: Operator = '+'

Right equation becomes:

9 + 3 = 12

Since 12 ≠ 6, this option is incorrect.

Option d: Operator = '÷'

Bottom equation becomes:

14 ÷ 7 = 2

Since 2 = 2, this equation holds true.

Therefore, the correct answer is option d.

The Thinking Spot

Tom, Sam, Mariya, John, and Bob each selected a shape. They placed their shapes in the grid below.

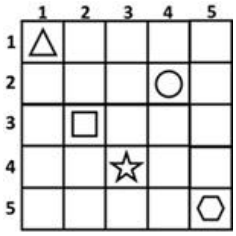
Tom's shape is neither a circle nor a triangle

Sam's shape is in column number 3

Mariya's shape is not in the first three rows

John's shape is neither square nor circle

Which of the following shapes is chosen by Bob?



(a) Square (b) Circle (c) Hexagon (d) Triangle

Answer: b

Solution:

• Sam: The shape in column 3 is a star.

• Mariya: Not in the first three rows, so it must be a hexagon because Sam has a star.

• Tom: Since it's not a circle or a triangle, it is a square because Sam has a star and Mariya has a hexagon.

• John: Since it's neither a square nor a circle, it has to be a triangle, the only shape left.

• Bob has selected a circle, which is the last remaining shape.

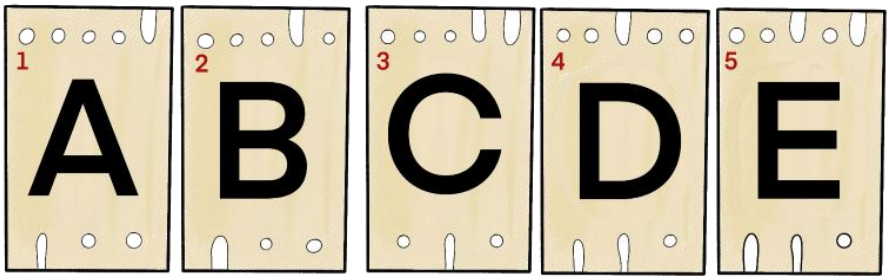
Hence, option b is the correct answer.

Chapter 3: A Peek Beyond the Point

Activity Time

Introduction

We know that numbers can be represented in powers of 10. Though this is not the only way to represent the number. In this activity, we will understand the binary representation and powers of 2, using punched cards. Consider a set of cards with the alphabet written on them, and we shuffle them. Using a stick and holes on the top of the cards, we can magically arrange the cards alphabetically in a few seconds. With this activity, we will discover the patterns in punching & the principle behind the trick.



Activity	Time	Description
Launch	5 min	Teacher demonstrates the activity Supporting Links: Print file: https://drive.google.com/file/d/15IRE5Pr1BrkjBab4oXqoik6rTDeFesbK/view?usp=drive_link Activity Video Link: https://www.youtube.com/watch?si=ggcG_e4GWMByAMBh&v=F3DagixkqsQ&feature=youtu.be Reference: https://docs.google.com/document/d/1jJQmWEnU21zhtMbp3ht_FX_E1HldpVs6iizucnafxEI/edit?tab=t.0
Trial by Students	15 min	Students try out the activity.

		Student Worksheet: https://docs.google.com/document/d/1Sr0B87i2x6a3tvTkcNL0vaHDBz_OhYcDtXKAEYuR_eU/edit?usp=sharing As the teacher progresses through the activities, the students progress along with the worksheet. Students can make their own punch cards using the template after class hours.
Discussions and Explorations	10 min	Attempting the worksheets and the discussion based on the activity

CT Components

Algorithmic Thinking
We used a step-by-step approach to convert a decimal number to binary.

Decomposition
Breaking the conversion of the number to binary into one bit at a time.

Abstraction
Using different types of holes to represent the binary number system.

Logic
Every alphabet can correspond to a number, and every number can be represented in the binary system with a punching pattern.

Generalisation
Recognising a doubling pattern of 1, 2, 4, and so on, and adding different powers thus generated gives us the binary representation, and we conclude that any number can be represented in terms of powers of 2.

Activity Description: Punched Cards

Consider a set of cards with the alphabet written on them, and we shuffle them. The objective now is to arrange them in alphabetical order. One method is to find the card A first, then B, and so on. This might take some time.

Now, notice that the cards have been punched on the top. There are an O-shaped and a U-shaped punch, and using these holes, we can sort the cards in an interesting way. Insert a stick in the set of cards starting from the rightmost hole. Once you lift the stick, some will come along with it. Now, bring them in front & repeat this for all sets of holes. Magically, the cards are sorted.

In our day-to-day life, we use the decimal number system, which uses the numbers 0, 1, 2, 3, 4, 5, 6, 7, 8, and 9. The decimal number system is based on bundles of ten (Powers of 10, which is 1,10,100, 1000,...). Similarly, the binary number system is based on bundles of two (Power of 2, which is 1,2,4,8,...). So, if we compare the two numbering systems for place values, this is what it looks like….

	Decimal (Bundles of Ten)	Binary (Bundles of Two)
Units Place	1	1
First Bundle	10 = 10	2 = 2
Second Bundle	10x10 = 100	2x2 = 4
Third Bundle	10x10x10 = 1000	2x2x2 = 8

The binary number system (popularly known as the language of computers) deals with only two numbers: 0 and 1. We can convert any decimal number to its binary equivalent and vice versa. You can convert any decimal number into a binary representation by writing it with the power of 2.

for example, 23 = 16 + 4 + 2 + 1. Show this to the students.

23 in decimal	$10^1 = 10$	$10^0 = 1$
23	2	3

23 in binary	$2^4 = 16$	$2^3 = 8$	$2^2 = 4$	$2^1 = 2$	$2^0 = 1$
$(10111)_2$	1	0	1	1	1

You can also do this by an algorithm, which is presented below (which you may present to the student):

i. Divide the decimal number by the base (2) of the binary number.
ii. Note the remainder from the first step till the end of the division process.
iii. The remainders obtained as 0 or 1 are written in order from the last step to the first step of division.

Let's find out the binary equivalent of the decimal number 11.

Divisor	Decimal Number	Corresponding Remainder
2	11	1
2	5	1
2	2	0
	1	

The highlighted cells represent the binary representation, written from bottom to top. So, 11 = (1011)2. The binary number 1011 can be changed to its corresponding decimal number as:

A	B	C	D
2^3 x 1	2^2 x 0	2^1 x 1	2^0 x 1

Decimal number = A+B+C+D = 1 x 23 + 0 x 22 + 1 x 21 + 1 x 20
= (1x8)+(0 x 4) + (1 x 2) + (1 x 1) =8+2+1 = 11

1. What will be the binary representation for the decimal number 14?

a) 1010 b) 1100 c) 1110 d) 1111

Explanation

c) 1110
Decimal 14 can be written in power of 2s as 8 + 4 + 2 = 1 x 23 + 1 x 22 + 1 x 21 + 0 x 20 = 1110

CT Competency

Algorithmic Thinking
Decomposition
Generalisation

The number of digits or bits (binary digits) in a binary number depends on the number. For example, numbers up to 7 can be represented in a 3-bit binary number, numbers from 8 to 15 in a 4-bit binary number, numbers from 16 to 31 similarly need an additional bit, hence a 5-bit binary number, and so on. There are 26 letters in English; hence, 5 sets of holes on each card for sorting.

---

2. You want to perform a similar punched card activity with Hindi alphabets. How many holes are needed on each card?

a) 5 b) 6 c) 8 d) 10

Explanation

b) 6
There are 52 Hindi alphabets. Using 6 bits/holes, we can represent numbers from 0 up to 63.

CT Competency

Abstraction
Logic

Punching Pattern on the Card

Every alphabet can correspond to a number, and every number can be represented in the binary system. The following table contains the corresponding conversion from decimal to binary.

Letter	Corresponding Decimal Number	Corresponding Binary Number
A	1	00001

B	2	00010
C	3	00011
D	4	00100
E	5	00101
..	..	..
..	..	..
Y	25	11001
Z	26	11010

These binary numbers indicate to us a unique way to punch. Where there is 0, punch an O-shaped hole, and where there is 1, punch a U-shaped hole. For example: 01010 is the binary equivalent of J, so the holes on card J from left to right will be O U O U O.

---

3. Can you identify which card the binary pattern 10101 belongs to?

a) P b) S c) T d) U

Explanation

c) T

The alphabet T comes 21st in the order starting from A as 1. Therefore, it is represented by the decimal number 21, and that can be written in binary as 10101.

CT Competency

Abstraction

Logic

---

4. The alphabet R comes 18th in the order starting from A as 1. What will be the punching pattern on Card R?

a) U0U0U b) UU0U0 c) U00U0 d) 0UU00

Explanation

c) UOOUO

The alphabet R comes 18th in the order starting from A as 1. Therefore, it is represented by the decimal number 18, and that can be written in binary as 10010.

CT Competency

Abstraction

Logic

Punched cards, utilising binary choices is analogous to their role in powering early computing machines such as IBM sorters and Turing's Bombe. This binary concept has its roots in study of poetry in ancient India, which was well studied by Acharya Pingala's and documented in his work Chandaḥśāstra (~2 BCE).

Questions

1. **Two decimal numbers differ by 3.6. In one of the numbers, the decimal point is moved one place to the right. After this change, both numbers become equal. Which was the smaller of the two original numbers before shifting the decimal point?**

   a) 0.4 b) 0.36 c) 3.6 d) 4

   Answer: a

   Solution:

   Let the **smaller number** be x.

   Since the two numbers differ by **3.6**, the **larger number is: x + 3.6**

   When the decimal point of one number is moved **one place to the right**, that number becomes **10 times** its original value. After this change, both numbers become equal.

   So, 10x = x + 3.6

   Now solve:

   10x − x = 3.6

   9x = 3.6

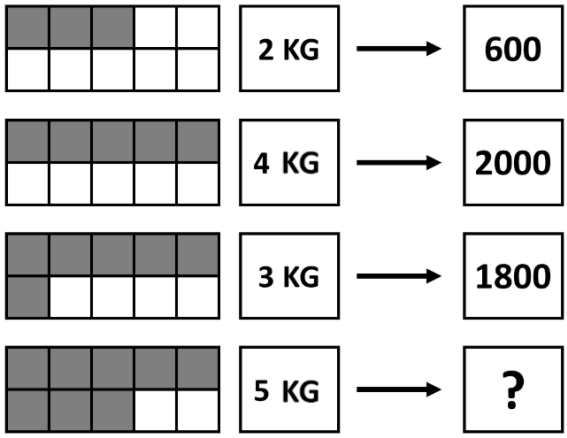
   x = 3.6/9 = 0.4

   So, the smaller original number was **0.4**

   Hence, option a is the correct answer.

---

2. **What will come in place of "?"**



   a) 2000 b) 4000 c) 40000 d) 8000

   Answer: b

   Solution:

   Before the arrow, each term has some shaded blocks and a number next to it, in KG.

   The shaded blocks represent a fraction (out of 10).

   This fraction is multiplied by the given number.

   The result (KG) is converted into grams and written after the arrow.

   For example, in the first pair, the shaded fraction is 3/10, which is 0.3

   0.3 multiplied by 2 kg gives 0.6 kg.

   Now, this 0.6 kg is converted into grams.

   We know that 1 kg = 1000g. So, 0.6 kg = 0.6 x 1000 = 600 g.

   Hence, 600 is given after the arrow.

   Similarly, in the question term, 8 out of 10 blocks are shaded.

So, the fraction is 0.8
Multiplying with 5 kg, we get: 0.8 × 5 = 4 kg
Converting it into grams: 4 kg = 4000 g
Hence, option b, 4000 is the correct choice.

---

3. **Find the next term in the given series below:**
85.41, 88.71, 89.01, 92.31, 92.61, 95.91, 96.21, __

a) 96.51 b) 99.21 c) 99.51 d) None of these

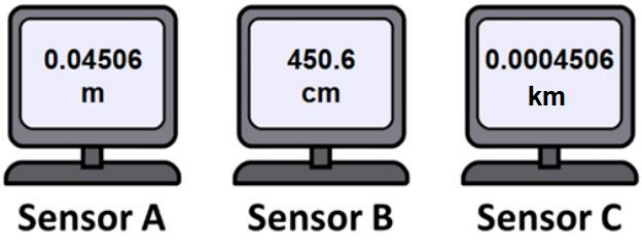
Answer: c

Solution:

Each term in the given series is obtained by adding 3.3 and 0.3 to the previous term alternately.
85.41 + 3.3 = 88.71
88.71 + 0.3 = 89.01
89.01 + 3.3 = 92.31
92.31 + 0.3 = 92.61
As the last given term 96.21 is 0.3 more than its previous term, the next term is obtained by adding 3.3 to 96.21, which gives 99.51.
Hence, the correct answer is option c.

---

4. **There are three sensors - A, B, and C. Each sensor displays the measurement of the length of the same item, but in different units: metres, centimetres, or kilometres. Only one sensor shows the correct length. The other two show values that are 10 times greater and 10 times smaller than the actual length (the units remain unchanged). Based on the readings shown, which sensor displays the correct length?**



a) Sensor A b) Sensor B
c) Sensor C d) Cannot be determined

Answer: c

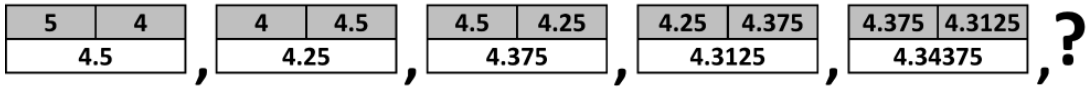
Solution:

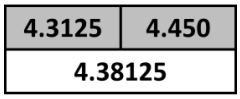
Let's take one sensor to be correct each time. So, the other two sensors will be showing 10 times greater and 10 times smaller than the actual length. (in any order)
Case 1: Let's assume that sensor A is displaying the correct length.
As A = 0.04506 is in metres, let's convert it into cm and km.
0.04506 m = 0.04506 x 100 = 4.506 cm.
However, Sensor B is showing 450.6, which is neither 10 times greater than nor 10 times smaller than 4.506
So, our assumption is incorrect. Sensor A is not displaying the correct value.
Case 2: Let's assume that sensor B is displaying the correct length.
As B = 450.6 is in centimetres, let's convert it into m and km.
450.6 cm = 450.6 ÷ 100 = 4.506 m
However, Sensor A is showing 0.04506, which is neither 10 times greater than nor 10 times smaller than 4.506.

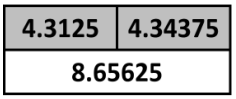
So, our assumption is incorrect. Sensor B is not displaying the correct value.
Case 3: Let's assume that sensor C is displaying the correct length.
As C = 0.0004506 is in kilometres, let's convert it into m and cm.
0.0004506 km = 0.0004506 x 1000 = 0.4506 m
Sensor A is showing 0.04506, which is 10 times smaller than 0.4506
So, when sensor C is correct, sensor A is displaying a value which is 10 times smaller.
Now, let's check if sensor B is showing a value which is 10 times larger.
Convert km to cm.
0.0004506 km = 0.0004506 x 100000 = 45.06
Sensor B is displaying 450.6, which is 10 times larger than 45.06
Hence, both conditions are satisfied.
Therefore, sensor C is displaying the correct value.
Option c is the correct answer.

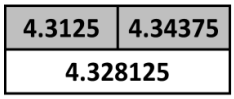
---

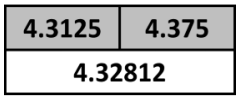
5. What will come in place of "?" in the given series?



a) 

b) 

c) 

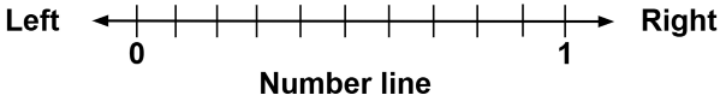
d) 

Answer: c
Solution:
The given series follows these rules:
- In each term, the decimal number at the bottom is the average of the top two numbers in grey blocks.
- The grey blocks in every next term are a combination of the top-right number and the bottom number of its previous term.

For example, in the second term, the numbers in the grey cells are 4 and 4.5
4 is the top-right number of the previous term (the first term)
4.5 is the bottom number of the first term (average of 5 and 4)
Likewise, the terms follow this rule of averages:
(4 + 4.5)/2 = 4.25
(4.5 + 4.25)/2 = 4.375
(4.25 + 4.375)/2 = 4.3125
(4.375 + 4.3125)/2 = 4.34375
Hence, in the next term, both grey blocks must have numbers: 4.3125 and 4.34375, and their average must be written below.
(4.3125 + 4.34375)/2 = 4.328125
As the term in option c follows this rule, option c is the correct choice.

6. **Four friends A, B, C, and D each select a distinct point on the following number line (from 0 to 1) such that:**
   - **A's point is 4th to the right of D's point**
   - **The value of C's point is at least 0.4 and B's point has the highest value among all friends**
   - **No two friends choose adjacent points**

   What is the LEAST possible sum of the points chosen by all of them?



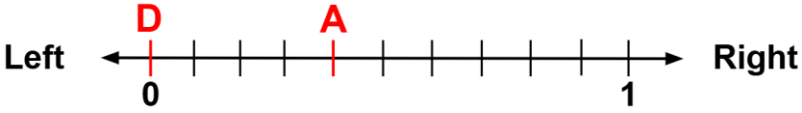
Number line

a) 2.0 b) 1.9 c) 1.8 d) 1.4

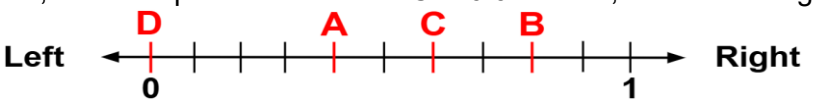
Answer: c

Solution:

Clearly, as there are 9 points between 0 and 1 on the number line, we can say that the value of each point is 0.1 more than the previous value.
We have to minimise the sum of the points chosen by all 4 friends.
So, we must minimise the individual values.
Let's check if the least value 0 can be assigned to any friend.
Given that B's point has the highest value among all. So, B cannot have 0.
A is 4th to the right of D. So, A cannot have 0.
The value of C's point is at least 0.4 and C also cannot have 0.
So, let's take 0 for D. Thus, A and D can be placed as follows:



Now, B and C are remaining.
As the value of C's point is at least 0.4, its value can be anything greater than 0.3
However, as A is already 0.4, we cannot assign any value till 0.5 for C (no two friends chose adjacent points).
So, the least possible value for C is 0.6. Hence, B will further get 0.8 (as 0.7 cannot be assigned).



Hence, the values are: 0, 0.4, 0.6, and 0.8
Therefore, the least possible sum is 0 + 0.4 + 0.6 + 0.8 = 1.8
Hence, option c is the correct choice.

---

7. **Alex has to fill in the blank with a DECIMAL NUMBER formed using every digit among 0, 1, 2, 3, and 4, each exactly once, where:**
   - **The sum of the digits before the decimal point is equal to the sum of the digits after the decimal point**
   - **The digits before the decimal point are in descending order and the digits after the decimal point are in ascending order**
   - **The conditions of "<" are satisfied**

   How many different numbers can be placed in the blank?

34.201 < _____ < 412.03

a) 2 b) 3 c) 4 d) More than 4

Answer: b

Solution:

The digits given are: 0, 1, 2, 3, and 4
The total sum of all digits is 10.
We have to form a decimal number where the sum of the digits before the decimal point is equal to the sum of the digits after the decimal point.
So, the digits must be divided into two groups such that both groups have equal sum, that is, 5 and 5.
So, the groups of numbers before and after the decimal point can be: (1, 4, 0) and (2, 3), OR (1, 4) and (0, 2, 3).
Following the descending order before the decimal point and ascending order after the decimal point, the possible numbers are:
41.023, 32.014, 410.23, 320.14.
Also, it is given that 34.201 < the decimal number < 412.03
Based on this only three numbers are possible from the above list: **41.023, 320.14, and 410.23**
Hence, 3 different numbers can be formed. Thus, the correct answer is **option b.**

---

8. Raj measures the lengths of two objects, Object A and Object B, using a ruler marked in centimetres.

- **On Day 1, Object A measures 5.2 cm. Its length decreases by 1 line on Day 2, 2 lines on Day 3, 3 lines on Day 4, and so on, following the same pattern**
- **On Day 1, Object B measures 1.2 cm. Its length increases by 1 line on Day 2, 2 lines on Day 3, 3 lines on Day 4, and so on, following the same pattern**

On which day will the difference between the lengths of the two objects be the least?
Note: *The scale is in centimetres*

a) Day 3 b) Day 4 c) Day 5 d) Day 6

Answer: c
Solution:
Let's solve it logically.
The length of Object A on Day 1 = 5.2 cm
The length of Object B on Day 1 = 1.2 cm
Difference between their lengths = 5.2 − 1.2 = 4.0 cm
The pattern of increase or decrease in the lengths in each day is 1 line (0.2 cm), 2 lines (0.4 cm), 3 lines (0.6 cm), 4 lines (0.8 cm), and so on.
Hence, the sequence is 0.2, 0.4, 0.6, 0.8, and so on. (in both cases, either + or -)
The lengths of object A from Day 1 are: 5.2, 5, 4.6, 4, **3.2**, 2.2 and so on.
The lengths of object B from Day 1 are: 1.2, 1.4, 1.8, 2.4, **3.2**, 4.2 and so on.
Clearly, the 5th term of the above patterns is the same (3.2)
Hence, the least difference between the lengths of both objects can be seen on the 5th day.
Option c is correct.

---

9. Some numbers are given in the boxes below. In each number, interchange the digits immediately to the left and right of the decimal point. After making this change, how many boxes will contain a number greater than 498.540?

491.893	497.860	491.855	490.993
A	B	C	D

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

Answer: b

Solution:
The digits on the immediate sides of the decimal point interchange their positions.
Box A: 491.893 becomes 498.193, which is less than 498.540
Box B: 497.860 becomes 498.760, which is greater than 498.540
Box C: 491.855 becomes 498.155, which is less than 498.540
Box D: 490.993 becomes 499.093, which is greater than 498.540
Hence, only two boxes satisfy the condition.
Option b is the correct answer.

---

10. Seven decimal numbers, A-G, are given.

1. **Arrange the numbers in ascending order to form Arrangement 1**
2. **Modify the numbers as follows:**
   - **For numbers in odd positions, move the decimal point one place to the right**
   - **For numbers in even positions, move the decimal point one place to the left**
3. **Arrange the modified numbers again in ascending order to form Arrangement 2**

In Arrangement 2, which pair(s) of numbers have exactly three numbers between them?

0.05, 0.505, 5.05, 5.55, 0.55, 5.005, 0.005

A B C D E F G

a) A and E b) G and D c) C and F d) E and D

Answer: d

Solution:
After arranging the numbers in ascending order, we get:

Arrangement 1	**0.005**	**0.05**	**0.505**	**0.55**	**5.005**	**5.05**	**5.55**
Order	**G**	**A**	**B**	**E**	**F**	**C**	**D**

Now, for odd positions: decimal moves right (×10) and for even positions: decimal moves left (÷10)

Arrangement 1	**00.05** *(=0.05)*	**0.005**	**05.05** *(=5.05)*	**0.055**	**50.05**	**0.505**	**55.5**
Order	**G**	**A**	**B**	**E**	**F**	**C**	**D**

Arranging the above numbers again in ascending order we get:

Arrangement 2	**0.005**	**0.05**	**0.055**	**0.505**	**5.05**	**50.05**	**55.5**
Order	**A**	**G**	**E**	**C**	**B**	**F**	**D**

Among the options given, only E and D have exactly three numbers between them.
Hence, option d is correct.

The Thinking Spot

The numbers given below are to be placed in the grid in such a way that the sum of two adjacent numbers in the grid should be greater than 9 but less than 17. What will come in place of A and B?

Numbers: 2, 3, 5, 11, 15

14			A	8	B	12	1	

(a) A = 5 and B = 2
(b) A = 3 and B = 5
(c) A = 2 and B = 3
(d) A = 5 and B = 3

Answer: d
Solution:
Let us approach the question logically and systematically.

The number after 14 can only be 2, resulting in 16, which is greater than 9 but less than 17.

14	2		A	8	B	12	1	

The number before 12 can only be 3. When you add 3 to 12, you get 15, which is greater than 9 but less than 17. Placing any other number would result in a sum equal to 17 or greater than 17.

14	2		A	8	3	12	1	

The number 11 can be placed after 1 or 2. When 1 or 2 is added to 11, the results are 12 and 13, both of which are greater than 9 and less than 17.

14	2	11	A	8	3	12	1	

OR

14	2		A	8	3	12	1	11

Numbers left with us: **5 and 15**

The number 15 can be placed only after 1. When you add 1 to 15, you get 16, which is greater than 9 but less than 17. Placing it next to any other number would result in a sum equal to 17 or greater than 17. So, we place 15 after 1. We also place 11 after 2.

14	2	11	A	8	3	12	1	15

The only place left for 5 is A. 5 + 11 = 16, and 5 + 8 = 13. Both conditions are satisfied.

Therefore, A = 5.

14	2	11	5	8	3	12	1	15

Therefore, A = 5 and B = 3 as highlighted above.

Hence, option d is the correct answer.

Chapter 4: Expressions using Letter-Numbers

1. **It is given that x means 'greater than', $ means 'equal to', < means 'not less than', A means 'less than' and + means 'not greater than'. Which of the following options has the same meaning as the given expression?**
   a x b A c

   a) a $ c A b b) b < a x c c) c x b A a d) c + b < a

   Answer: c

   Solution:

   Let's replace the symbols of the expression given in the question: a x b A c.

   The resultant statement will be: a > b < c

   a > b < c can be written as a > b, c > b

   Option a: Replacing symbols in option a. The expression becomes:

   a $ c A b: a = c < b.

   We know c > b. Hence, c < b is false.

   Option b: Replacing symbols in option b. The expression becomes:

   b < a x c: b is not less than a > c.

   We know a > b. Hence, b is not less than a is false.

   Option c: Replacing symbols in option c. The expression becomes: c x b A a: c > b < a.

   We know, a > b < c, which is also written in option c. Hence, option c is true.

   Option d: Replacing symbols in option d. The expression becomes:

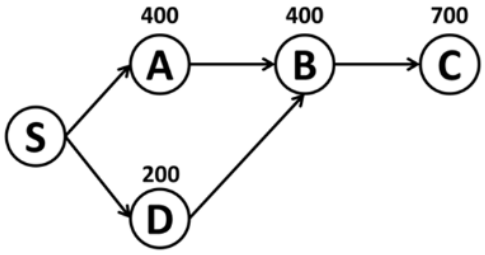
   c + b < a: c is not greater than b is not less than a.

   We know a > b. Hence, b is not less than a is false.

   Only option c is true. Hence, the correct answer is option c.

---

2. **A factory 'S' sends goods to four cities: A, B, C, and D through pipelines (represented by arrows), as shown below. The demand of each city is mentioned above that city** *(for example, the demand at City A is 400 units)***. The demands are satisfied exactly, and no extra units are left in the pipelines. If 300 units are sent through the pipeline from A to B, how many units are sent from D to B?**



   a) 200 b) 600 c) 800 d) 1000

   Answer: c

   Solution:

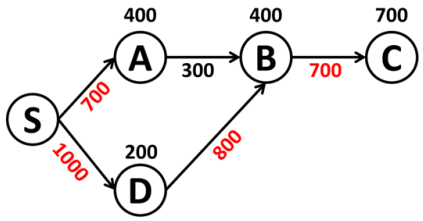
   Assume that 'X' units are sent from D to B.

   Now, the units that travel from A to B (300 units, as given in the question) and those that travel from D to B together satisfy the demand of the cities at the receiving end.

   So, 300 + X must satisfy the demand at city B, which is 400.

   But, if you observe carefully, some units also travel from B to C, to satisfy the demand at city C. So, city B must receive the units equal to its own demand as well as the demand of city C.

Hence, (300 + X) units must travel through both pipelines to satisfy the demand at cities B and C.
Therefore, the equation is:
300 + X = 400 + 700
300 + X = 1100
X = 1100 - 300
X = 800.
Hence, the number of units sent from D to B is 800. Thus, option c is the correct choice.



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3. **Each letter in Set 1 corresponds to exactly one different number from Set 2 (in any order).**
Set 1: A, B, C, P, Q, R
Set 2: 1, 2, 4, 5, 7, 9
The following conditions are given:
- **A and C are consecutive numbers, with A > C**
- **P + Q = R, with P > Q**
- **B is greater than both A and C**

Using this information, find the value of: (4P+3B) − (2P+3C) + (2A−3B)

a) 9 b) 13 c) 15 d) 11

Answer: d

Solution:
A and C are consecutive numbers, and the possible pairs are (2, 1) and (5, 4).
Case 1: If A and C are (5, 4), then the remaining numbers are: 1, 2, 7, 9
Among these, we must have a possible set for P, Q and R, where P + Q = R.
The only possible case will be 7 + 2 = 9.
Hence, the last digit left is 1, which will be assigned to B.
However, it is given that B is greater than both A and C.
Hence, this case is invalid.
Case 2: If A and C are (2, 1), then the remaining numbers are: 4, 5, 7, 9
Among these, we must have a possible set for P, Q and R, where P + Q = R.
The only possible case will be 5 + 4 = 9, where P = 5, Q = 4 and R = 9.
Hence, B = 7 (B > A,C)
Now, we have to find the value of (4P + 3B) − (2P + 3C) + (2A − 3B)
Rather than substituting the values directly, let's write the expression in its simplest form for easier substitution.
(4P + 3B) − (2P + 3C) + (2A − 3B) = 4P + 3B − 2P − 3C + 2A − 3B
= 2P − 3C + 2A
Now, substitute the values: 2(5) − 3(1) + 2(2) = 10 − 3 + 4 = 11
Hence, the correct answer is option d.

4. **The sum of the ages of four people A, B, C, and D is 35. Each one of them is at least 8 years old. What is the MAXIMUM possible age of the oldest person?**

a) 9 years b) 10 years c) 11 years d) 12 years

Answer: c

Solution:

Let the ages of A, B, C, and D be a, b, c, and d respectively.
It is given that:
a + b + c + d = 35
Let the oldest person's age be X.
To get the maximum possible age for the oldest person, we need to minimize the ages of the rest of the people. So, let the rest of the people be 8. (each of them is at least 8 years old)
So, 8 + 8 + 8 + X = 35
24 + X = 35
X = 35 - 24
X = 11
Hence, the MAXIMUM possible age of the oldest person is 11 years.
Hence, option c is the correct answer.

---

5. **3 whole numbers A, B, and C, satisfy the given conditions. At maximum, how many different possible values can C have?**

$$A > B > C \text{ and } A + B = 10$$

a) 4 b) 5 c) 3 d) 2

Answer: a

Solution:

We are given:
• A, B, and C are whole numbers (0 and above)
• The conditions are: A > B > C and A + B = 10
To find how many different values C can take at maximum, we follow these steps:
Step 1: Understanding A and B
Since A + B = 10 and A > B,
we cannot take A = 5 and B = 5 (because A must be strictly greater than B).
Also, we cannot take A < 6, because then B would have to be greater than A to make their sum 10 (which breaks the A > B condition).
So, we start checking from the highest possible A value, working downward, ensuring:
• A > B
• A + B = 10
•Once A and B are fixed, C must be a whole number less than B.
Step 2: Try valid A and B pairs
• A = 9, B = 1: A + B = 10, A > B
  C < 1: Only possible C = 0
• A = 8, B = 2: A + B = 10, A > B
  C < 2: C can be 0 or 1
• A = 7, B = 3
  C < 3: C can be 0, 1, or 2
• A = 6, B = 4
  C < 4: C can be 0, 1, 2, or 3
Now, let's list all possible distinct C values from these cases:
C = 0, 1, 2, 3

Total = 4 values
Values beyond this won't work, as:
• A = 5, B = 5: A is not greater than B
• A < 5: B becomes ≥ A or invalid
Final Answer: 4
C can take four different whole number values: 0, 1, 2, 3.
Option a is the correct answer.

---

6. If the sum of the ages of Shubham and Shivam is 36. What would be the sum of their ages after 36 years?

a) 108 b) 136 c) 72 d) 96

Answer: a

Solution:
Let Shubham's present age be: x
Let Shivam's present age be: y
Given:
x + y = 36
After 36 years:
Shubham's age will be: x + 36
Shivam's age will be: y + 36
So, the sum of their ages after 36 years:
(x + 36) + (y + 36)
= x + y + 72
We know that the sum of the ages of Shubham and Shivam is 36:
x + y = 36
Thus, substituting that in the expression:
36 + 72 = 108
The correct answer is **108**.
Hence after 36 years, both of them would age by 36 years. So, the sum would increase by 72 years.
Hence, the correct answer is option a.

---

7. A, B, and Z are natural numbers such that A + B = Z and:

- **The value of B is twice the value of A**
- **The value of B is greater than 4**
- **The value of Z is less than 10**

What could be the value of A?

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

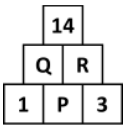
Answer: c

Solution:
Given:
A + B = Z
Also, B = 2A (Since B is twice the value of A)
B > 4
Z < 10
We can substitute B in the first equation with 2A from the second condition:
A + 2A = Z
3A = Z
Now, using the third condition (B > 4), and since (B = 2A), we get:
2A > 4

A > 2
And using the fourth condition (Z < 10), and since (3A = Z), we get:
3A < 10
A < 10/3
Combining the two inequalities for A:
2 < A < 10/3
2 < A < 3.33
The only integer value for A that satisfies all conditions is:
A = 3.
Option c is the correct answer.

---

8. In the given image, each number equals the sum of the two numbers immediately below it. If P, Q, and R are unknown, what is the value of P × Q + R?



a) 42 b) 48 c) 38 d) 36

Answer: c

Solution:
Each number equals the sum of the two numbers directly below it. Thus,
Value of Q would be: Q = 1 + P
Value of R would be: R = P + 3
14 at top is the result of the sum of Q and R:
14 = Q + R
14 = (1 + P) + R (substituting the value of Q in the equation)
14 = 1 + P + (P + 3) (substituting the value of R in the equation)
14 = 4 + 2P
14 – 4 = 2P
10 = 2P
5 = P
Finding the value of Q and R:
Q = 1 + P = 1 + 5
Q = 6
R = P + 3 = 5 + 3
R = 8
Thus, the values of P, Q and R are 5, 6, and 8 respectively.
So, the value of P × Q + R would be:
5 × 6 + 8
= 30 + 8
= 38.
Hence, the correct answer is option c.

---

9. 5A, 5B, and C9 are 2-digit numbers, where A, B, and C represent one of the digits of the respective numbers, and A + B + C = 15. Find the MAXIMUM possible value of 3B + 4C + 8, if:

5A > 5B > C9

a) 43 b) 39 c) 31 d) 36

Answer: b

Solution:

As 5B > C9, C cannot be a value which is 5 or more than 5.

So, to maximize the value of 3B + 4C, we have to assign 4 to C.

We get: 5A > 5B > 49

As A + B + C = 15 and C = 4,

We now have A + B = 11.

If B = 9, (As B must be a single digit only) we have 5A > 59 > 49.

Then, we cannot assign an appropriate value for A.

So, B = 9 is invalid.

Similarly, if B is a value equal to 6 or more than 6, A cannot have an appropriate value that makes 5A > 5B.

So, the maximum possible value of B is 5.

So, 56 > 55 > 49.

Hence, the maximum possible value of 3B + 4C + 8 = 3(5) + 4(4) + 8

= 15 + 16 + 8

= 31 + 8

= 39.

Option b is correct.

---

10. All the cells having 'x' in the given calendar represent dates that are consecutive multiples of a particular number. The first 'x' represents the first Thursday of the month, as shown below. Which of the following is the last day of the month?

November

MON	TUE	WED	THU	FRI	SAT	SUN
			X			
		X				
	X					
X						

a) Monday b) Sunday c) Saturday d) Friday

Answer: b

Solution:

Let the particular number be k.

The four 'x' marked dates are consecutive multiples of k:

k, 2k, 3k, 4k

It is given that each 'x' occurs exactly 6 days after the previous one (as per the image).

Hence,

2k−k = 6

k = 6

Therefore, the dates marked 'x' are:

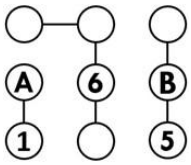
6, 12, 18, 24

(If we consider 12, 18, 24, 30, then 12 would be the first multiple. But it would not match the condition that the first 'x' is the first Thursday of the month. Hence, k = 6 is correct.)

From the calendar, 24th November is a Monday.
Now,
Last date of November = 30
30 − 24 = 6
So, the last day is 6 days after Monday:
Monday + 6 = Sunday
Hence, the last day of the month is Sunday. Thus, the correct answer is option b.

The Thinking Spot

Numbers from 1-9 are to be placed in the grid such that no two consecutive numbers are placed adjacent to each other.
For example, the bottom-left circle has 1, so the circle above it and the circle on the immediate right cannot have the number 2.
Each group of circles which are inter-connected by lines must contain either only odd or only even numbers.
Find the values of A and B.

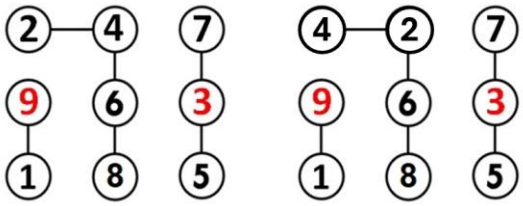


(a) A = 9 and B = 3 (b) A = 3 and B = 9 (c) A = 7 and B = 3 (d) A = 9 and B = 8

Answer: a

Solution:

A and B are connected to circles with odd numbers. Therefore, A and B cannot be an even number. Thus, option d can be eliminated.
Now, the value of A cannot be 7 as it is consecutive to 6 which is in the adjacent circle. So, option c can also be eliminated.
Now, if we keep A = 3, then for the numbers 2 and 4 we will have only one circle left that is above 6. Because if A = 3, then the circle above A cannot have 2 and the circle below 6 also cannot have 2 (as 1 is adjacent to it). The same condition applies for the number 4 as well due to the numbers 3 and 5. So, option B is also eliminated.
Hence, the correct answer is option a.



Chapter 5: Parallel and Intersecting Lines

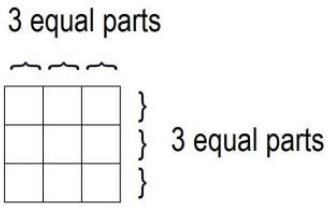
1. **Each side of a square is divided into three equal parts by marking points on it. Using these points as endpoints, line segments are drawn inside the square, such that each line segment is parallel to at least one side of the square. What is the maximum number of squares that can be found in the resulting figure?**

a) 6 b) 9 c) 14 d) 16

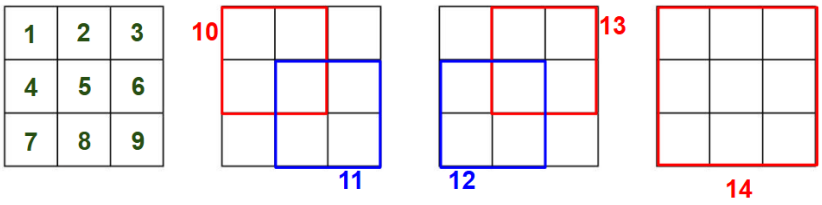
Answer: c

Solution:

As shown below, when each side of the square is divided into three equal parts and line segments are drawn using these dots as endpoints, the resultant figure looks like:



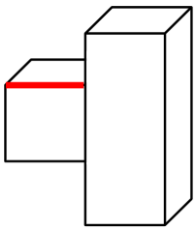
The number of squares seen are 14, as highlighted below:



Option c is the correct answer.

---

2. **The following arrangement is formed using a cube and a cuboid. How many edges are parallel to the edge highlighted by the red line?**

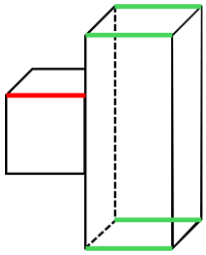


a) 5 b) 6 c) 7 d) 8

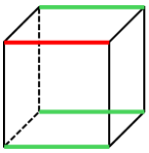
Answer: c

Solution:

There are 4 edges parallel to the red edge in the cuboid as shown below:



There are 3 edges parallel to the red edge in the cube as shown:



Altogether, 4 + 3 = 7 edges are parallel to the edge highlighted by the red line.

Hence, the correct answer is option c.

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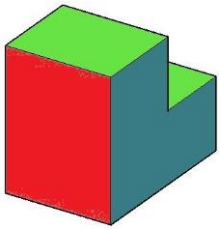
3. In the following solid, every edge has at least one other edge parallel to it. How many different pairs of PARALLEL FACES are present in the solid?

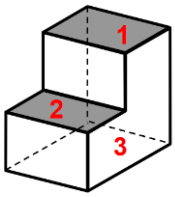


a) 8 b) 7 c) 6 d) 5

Answer: b

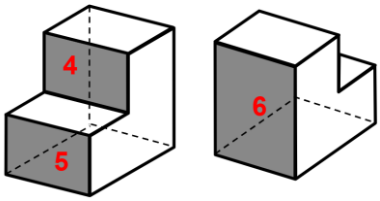
Solution:

The below image shows the three faces which are parallel to each other:



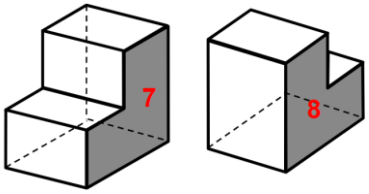
Hence, the pairs of parallel faces would be: (1,2) (1,3) (2,3)

The below images show the three faces that are parallel to each other:



Hence, the pairs of parallel faces would be: (4,5) (4,6) (5,6).

The below images show the two faces that are parallel to each other:



Hence, the pair of parallel faces would be: (7,8)

Since there are a total of 7 parallel pairs, the correct answer is option b.

---

4. In a clock, the hour hand and the minute hand are perpendicular to each other, where the minute hand is at 12. How many different possible positions the hands of the clock can have at this time?

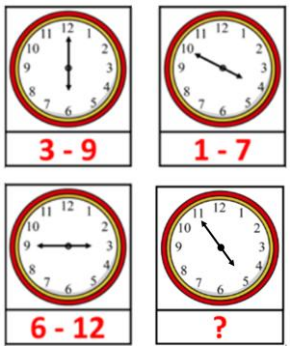
a) 1 b) 2 c) 3 d) 4

Answer: b

Solution:
If the minute hand is at 12, the hour hand can be at 3 or 9, so that the hands are perpendicular.
Hence, option b, 2 is the answer.

---

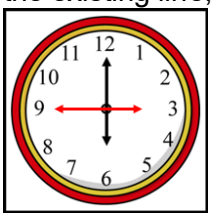
5. If each of the given terms follows the same theme, what will come in place of "?"



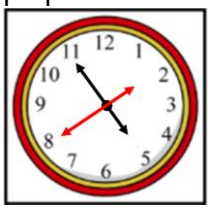
a) 7 - 1 b) 2 - 8 c) 1 - 8 d) 5 - 11

Answer: b

Solution:
In each term, the hands of the clock form a straight line (180°). The pair of numbers written below the clock represent the two positions the hands should point to, in order to form a line that is perpendicular (90°) to the existing straight line.
Also, the numbers listed below are in the order: Smaller number - Larger number
For example, in the first term, when the hands point towards 3 and 9, the new line is perpendicular to the existing line, as shown below:



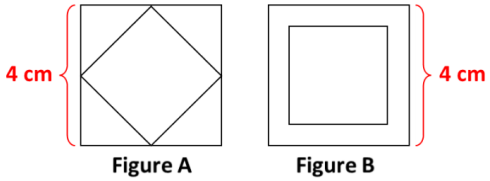
Following this rule, in the question term, we must choose appropriate positions that form a perpendicular line to the one formed by 5 and 11. As shown below, it is formed by 2 and 8.



Hence, the correct answer is **option b**.

---

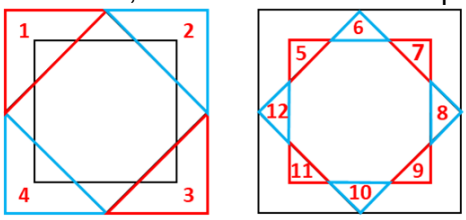
6. Figures A and B are formed using two transparent squares, each. If figure A is placed on top of figure B (without rotation), such that it completely overlaps figure B, how many right-angled triangles can be seen in the resultant image?



a) 10 b) 12 c) 13 d) 14

Answer: b

Solution:
Both Figure A and Figure B are squares of the same dimensions, 4 cm × 4 cm.
Figure A is placed on Figure B without rotation.
As it is given that the figures are made using squares, all the angles of each square will be 90°. So, the triangles formed at these corners are right angled triangles.
As shown in the given figure, a total of 12 right-angled triangles are formed when the two figures are overlapped.
Therefore, the correct answer is option b.



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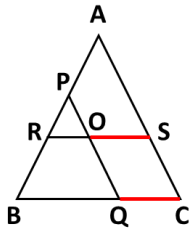
7. In triangle ABC, BC is the base.
Point P lies on AB and point Q lies on BC such that PQ is parallel to AC.
Point R lies on AB and point S lies on AC such that RS is parallel to BC.
Lines PQ and RS intersect at a point O inside the triangle.
Which of the following quadrilaterals must be a parallelogram?

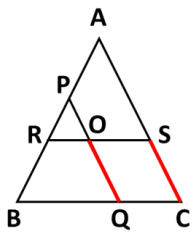
a) QPAC b) ORBQ c) QOSC d) SAPO

Answer: c

Solution:
Since RS ∥ BC (RS is parallel to BC; ∥ means parallel to), any segment on RS is parallel to BC.
So, OS ∥ BC
Now look at QC.
Q lies on BC, so QC is part of BC.
Therefore, OS ∥ QC
First pair of opposite sides parallel.

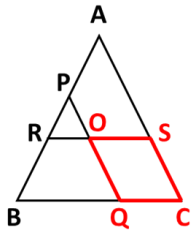


Since PQ ∥ AC, any segment on PQ is parallel to AC.
So, OQ ∥ AC
Now look at SC.
S lies on AC, so SC is part of AC.
Therefore, OQ ∥ SC
Second pair of opposite sides parallel.



A quadrilateral is a parallelogram if both pairs of opposite sides are parallel.

In quadrilateral QOSC:
OS ∥ QC
OQ ∥ SC
So, both pairs of opposite sides are parallel.
Therefore, QOSC is a parallelogram. Hence, the correct answer is option c.



[Please note that the above triangle is taken as a reference. This case is applicable to any type of triangle ABC].

---

8. Two lines intersect at point K.
One angle is (ax − 10)° and its vertically opposite angle is (bx + 20)°.
Which of the following is DEFINITELY true?

a) a = b b) a ≠ b c) x = 10 d) a + b = 0

Answer: b

Solution:

Since the given angles are vertically opposite, they must be equal.
So, ax − 10 = bx + 20
a x − b x = 30
(a − b)x = 30
So, x = 30 / (a − b)
Now check each option.

Option a: a = b

If a = b, then (a − b) = 0.
But then (a − b)x = 0, which cannot equal 30.
So, this is impossible.

Option b: a ≠ b

For (a − b)x to equal 30, (a − b) must not be zero.
So, a and b must be different.
This must always be true.

Option c: x = 10

If x = 10, then:
30/(a − b) = 10
So, a − b = 3.
This is possible for some values of a and b. But x could also be 30, 15, 6, etc., depending on (a − b).
So, x = 10 is possible, but not necessary.

Option d: a + b = 0

Since a and b are positive integers, their sum cannot be zero.
So, this is impossible.
Hence, option b is the correct answer.

9. **A computer draws two intersecting lines. One angle formed at the intersection is 70°, but originally, it was intended to be 40°. Which of the following options shows the respective 'Expected and Resultant' measures of one of the other angles?**

a) 140 degrees and 110 degrees
b) 110 degrees and 140 degrees
c) 140 degrees and 170 degrees
d) 170 degrees and 140 degrees

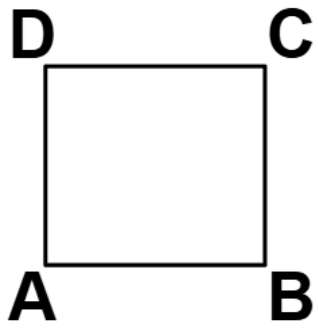
Answer: a

Solution:

One angle formed at the intersection is 70°, but originally, it was intended to be 40°.
So, Expected angle = 40 degrees and Resultant angle = 70 degrees.
Now, if an angle of 40 degrees was expected, the other angle would be 180 - 40 = 140 degrees.
Hence, the other expected angle = 140 degrees.
However, as the original angle resulted in 70 degrees, this makes the other angle 180 - 70 = 110 degrees.
So, Expected vs Resultant = 140 degrees - 110 degrees
Option a is the correct choice.

---

10. **ABCD is a square of side length 4 m. Raj starts from point A and walks North to reach point D. From point D, he further walks 4 m without taking any turns and reaches point P. At P, he turns 135° clockwise and walks a certain distance and stops only when he reaches a point on the square. Which of the following statements is INCORRECT with respect to the boundary of the square and the path taken?**

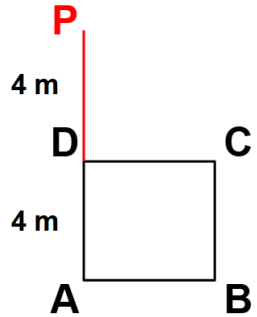


a) PC ∥ DB
b) ∠PCD = ∠DCA
c) PC ≠ AC
d) ∠DPC = ∠DCP

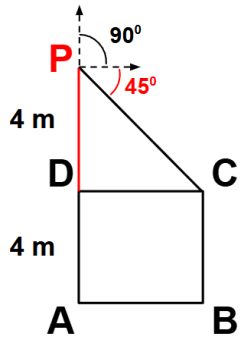
Answer: c

Solution:

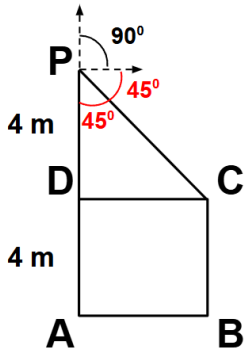
Given that Raj walks from A to D and then walks 4 m from D to reach P.



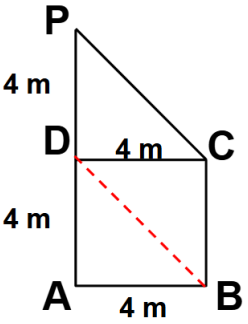
At P, he takes 135° clockwise turn.
A 90° clockwise turn from D makes him face towards East. As he turned 135° (90° + 45°) in clockwise direction, he starts walking towards C, as shown.



Hence, he stops when he reaches point C.
From the image, we can say that ∠DPC is 45°. (∠DPC = 180° - (90° + 45°))



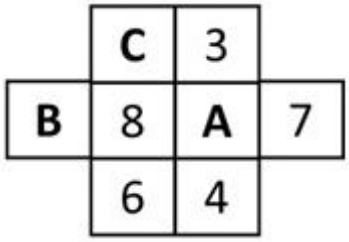
Also, triangle PDC is a right angled triangle.
All three angles of this triangle add up to 180°.
∠DPC + ∠PDC + ∠PCD = 180°.
45° + 90° + ∠PCD = 180°.
∠PCD = 180° - 45° - 90°
∠PCD = 45°.
Therefore, ∠PCD = ∠DPC = 45°
Option d is true.
Let's have a line joining points B and D.



Both PC and DB are the hypotenuses of congruent right-angled triangles (triangle PDC and triangle DAB of sides 4m.)
Here, PC is parallel to DB and is of the same length as DB.
Option a is true.
Also, in the above case, we have seen that PC is of the same length as DB, which is also the diagonal of the square ABCD.
So, PC should also be equal to another diagonal of the square, which is AC.
PC ≠ AC is false
Option c is INCORRECT.

As AC is the diagonal of the square ABCD, it bisects the angle of the square.
$\angle DCA = 90°/2 = 45°$
We already know that $\angle PCD = 45°$.
Thus, $\angle DCA = \angle PCD$
Option b is true.
Hence, option c is incorrect.
Thus, option c is the right answer.

A, B, and C are all different numbers having any value among 1, 2, and 5. What will come in place of C so that no two consecutive numbers are placed next to each other in any direction (vertically, horizontally, or diagonally)?



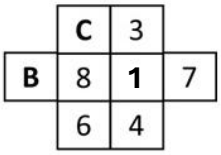
(a) 2 (b) 1 (c) 5 (d) None

Answer: c

Solution:

To solve the question, we start by finding the value of A:
A is adjacent to 3 and 4. Since no two consecutive numbers can be adjacent, A cannot be 2 (because 2 and 3 are consecutive) and A cannot be 5 (because 5 and 4 are consecutive).

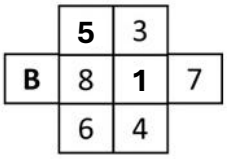
Therefore, the only possible value for A is 1.



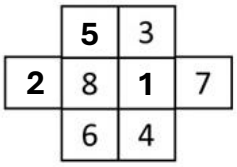
Now, the remaining numbers for B and C are 2 and 5.

Next, we check the value of C:

C is adjacent to 3, and since 2 and 3 are consecutive numbers, C cannot be 2.
Hence, C must be 5.



Finally, the remaining number for B will be 2.



Hence, the correct answer is option c.

Chapter 6: Number Play

Activity Time

Introduction

Solving puzzles always seems complex. But have you wondered how computers solve puzzles? We will see a simplified way to solve some puzzles by following simple instructions and using the binary computer language. This will give us insight into how we can break complex problems into smaller pieces that can be easily solved. By combining smaller problems, computers can solve a larger one.

Activity	Time	Description
Launch	5 min	The teacher will demonstrate by solving a puzzle quickly using the cards, then ask students how it worked. Template: https://drive.google.com/file/d/10sRoRMg0KRobPqwhkrUasJX9Ekvwnsz3/view
Exploring Logic punch card by Students	25 min	Students spend time understanding the cards. Then they start solving basic logical statements using the cards. They will then solve some puzzles with multiple statements using the cards. Students can make their own punch cards using the template after class hours. Student Worksheet: https://docs.google.com/document/d/1RxupyjbvHrgOy26a48e8cUMihTm5Ri46BFfxaSTt9IA/edit?tab=t.0
Discussions & Conclusion	10 min	Discussing the worksheets. The students will continue their discussion of binary numbers from the previous activity. They discuss their understanding of the logical statements and how to deduce from given informations They can also discuss how a complex problem is broken down into individual logical steps and combined to solve a larger problem.

CT Components

Algorithmic Thinking
We follow a step-by-step process to search for the required card using the statements given in the puzzle.

Decomposition
We break the task of solving a logic puzzle into solving individual steps using the binary logic of true or false.

Pattern Recognition
They observe that the number of cards possible is related to the number of holes at the top. They see how true and false, on and off, and U-shaped and O-shaped holes are identical.

Generalisation
From solving a puzzle in 3-holed cards, they see the extension to 5-holed cards.

Logic
These puzzles require solving each step logically.

Activity: Logical puzzle punch cards

In this activity, you will use punched cards to solve logical puzzles. By stacking, aligning, and filtering the cards, we will see how complex reasoning can be built from simple decisions - **True** or **False**, mirroring how binary logic works inside a computer.

The scenario is that you have the following lights in the room: **Yellow Y**, **Pink P**, **Red R**, **Green G**, and **Blue B**. By following the clues given in the **Case Cards**, you have to figure out which lights are **ON** in the given Puzzle. To solve these puzzles, we have a deck of cards representing all possible combinations of these lights being **ON** or **OFF**.

Understanding the cards

To solve these puzzles, we have a deck of cards representing all possible combinations of these lights being **ON** or **OFF**. Each card has five positions for holes on the top, and each position corresponds to a coloured light mentioned above in the given order.

Each position has two possible hole types: **U-shaped** or **O-shaped**. Each card represents one possible combination. If a light is **ON** in a card, then the hole corresponding to it is **U-shaped**. If a light is **OFF** in a card, then the hole corresponding to it is **O-shaped**.

Eg: **Yellow Y** is **OFF**, **Pink P** is **ON**, **Red R** is **ON**, **Green G** is **OFF**, **Blue B** is **OFF** is the card where the holes are **O U U O O**.

Each hole, thus, has 2 possible states. If we have two holes, then we have $2 \times 2 = 4$ possible states. Likewise, if we have 3 holes, we have $2 \times 2 \times 2 = 8$ states. Therefore, if we have 5 holes, we will have $2 \times 2 \times 2 \times 2 \times 2 = 32$ states. That is the number of distinct cards we have.

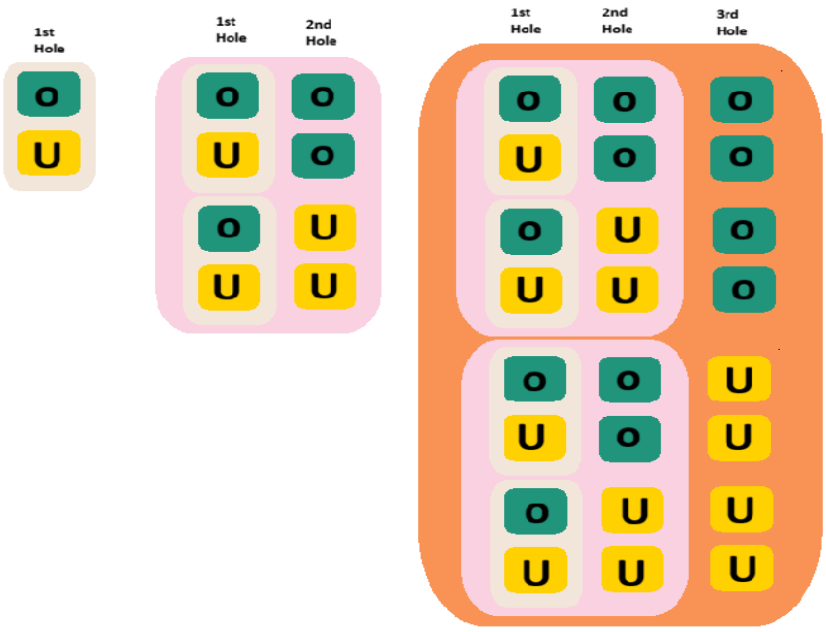


Figure: All the possible three-hole states and how they come from the two-hole states

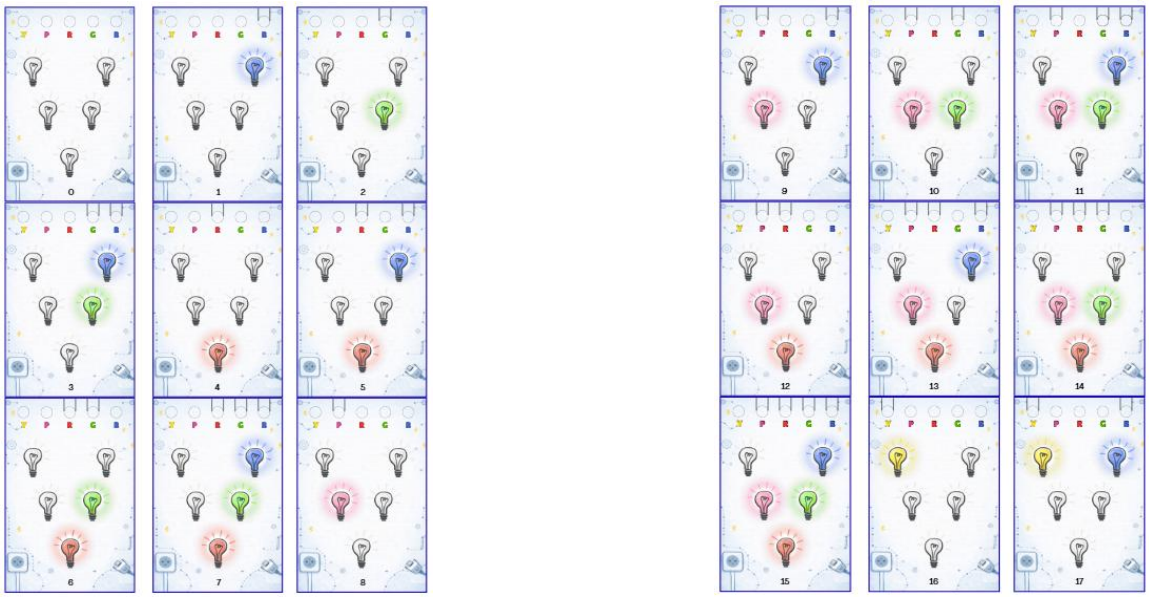


Figure: Some possible cards with 5 binary digits

Procedure

If the puzzle says a light is **ON**, we need to remove all cards where that light is **OFF**. For that, we put the stick into the deck of cards through the hole corresponding to that light and pull out all the cards that get stuck to it. We remove these cards because they got stuck due to **O-shaped** holes that indicate the light is **OFF**.

If we know some light is **OFF** in the puzzle, we remove all the cards that do not come out with the stick; these are the cards with **U-shaped** holes in positions corresponding to the given colour, which indicate that the light is **ON**.

Ensuring the above helps us solve the logical puzzles through punch cards.

Let's get familiar with the cards and the rules.

1. **Can you identify which bulbs are 'OFF' based on the card?**

a) **Blue B** and **Yellow Y** bulbs

b) **Green G** and **Red R** bulbs

c) **Red R** and **Yellow Y** bulbs

d) All bulbs are OFF

Correct answer: c. **Red R** and **Yellow Y** bulbs

Explanation: The Red R and **Yellow Y** bulbs' positions have **O-shaped** holes. The other bulbs can be seen shining in the image of the card.

Competencies: Logic, Pattern recognition

Understanding using a case

The operation of the cards is explained by showing how they can be used for solving a problem in two-valued logic.

We can start by taking **Case 1**, which contains the first 8 cards from 0 to 7, and focus only on the **Red R, Green G,** and **Blue B** lights. Three statements are given containing simple assertions and negation statements. The aim is to determine which bulbs are on or off among these.

To solve this problem, let's establish some notation. Only three terms are involved, so we shall be concerned with only the **Red R, Green G,** and **Blue B** holes.

Red bulb '**ON**', 1st position will be **U**	**Red** bulb '**OFF**', 1st position will be **O**
Green bulb '**ON**', 2nd position will be **U**	**Green** bulb '**OFF**', 2nd position will be **O**
Blue bulb '**ON**', 3rd position will be **U**	**Blue** bulb '**OFF**', 3rd position will be **O**

If all lights are **ON**, then **RGB = U U U**
If all lights are **OFF**, then **RGB = O O O**
If **Red** is **OFF**, **Green** is **ON**, **Blue** is **OFF**, then **RGB = O U O**
If **Red** and **Green** are **ON,** but **Blue** can be anything, then **RGB = U U X**

2. **Can you identify which bulb is OFF based on this pattern: RGB = U U O?**

a) **Red** bulb b) **Blue** Bulb c) **Blue** Bulb d) All bulbs are OFF

Correct answer: b. **Blue** Bulb
Explanation: The **O-shaped** hole is in the **Blue** bulbs' position
Competencies: Logic, Pattern recognition, Abstraction

Case 1: Focusing on RGB cards only (with 8 cards only)

Statements
I. The **Red** light is **ON**
II. The **Blue** light is **OFF**
III. **ON** light only has **OFF** Neighbour
The problem has three statements.

- *The statement **I**: "The **Red** light is **ON**"*

Insert the stick in the **R** position and lift.
The stick will raise all **RGB = O X X** cards: All cards where **Red** is **OFF**.
RGB = O X X cards are discarded.

All remaining cards are assembled into a pack once more (in any order), and we are ready for the second statement.

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3. **After performing an action using Statement I, how many cards are left in the pack?**

a) 8 b) 4 c) 2 d) 1

Correct answer: b. 4
Explanation: There are 4 cards with the Red light on and 4 cards with the Red light off. We are keeping the cards which have the light on. The 4 cards with the red light off are removed.
Competencies: Decomposition, Logic, pattern recognition

- *The second statement, **II**, "The **Blue** light is **OFF**"*

Put the stick in the hole corresponding to **Blue** and lift. Cards with **RGB = X X O** will come out. Remaining cards will be **RGB = X X U**

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4. **After performing the action using Statement II, among these, which card will not be discarded?**

a) **RGB = X X O** b) **RGB = U O U** c) **RGB = X X U** d) All will be eliminated

Correct answer: a. **RGB = X X O**
Explanation: We discard all the cards where **Blue** light is **ON**, **RGB = X X U,** and keep those cards where **RGB = X X O.**
Competencies: Algorithmic thinking, decomposition, pattern recognition

All remaining cards are assembled into a pack once more (in any order), and we are ready for the third statement.

- *The third statement, **III**, "**ON** light only has **OFF** Neighbour"*

Recall the first statement, “The **Red** light is **ON**”.
The **Green** bulb neighbours the **Red** bulb. It should be **OFF**.
Insert the stick in the **Green** position and lift. The stick will raise **RGB = X O X** cards.

After this action, only one card will be left, and that will be the solution to the logical puzzle.

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5. What is the pattern of the last card (solution)?

a) **RGB = U U O** b) **RGB = U O U** c) **RGB = O U U** d) **RGB = U O O**

Correct answer: d. **RGB = U O O**
Explanation: After the first statement, cards with **RGB = U X X** holes remained. From these, those cards with **RGB = X X O** holes remained after the second statement. Finally, we need the cards with **RGB = X O X** holes. If we put together all this information, we get **RGB = U O O.**
Competencies: Algorithmic thinking, decomposition.

Case 2: Focusing on RGB cards only (with 8 cards only)

Statements
I. The **Red** light is **ON**
II. The Lights are either all **ON** or all **OFF**

The first statement is identical to **Case 1**.
The second statement, **II**, "The Lights are either all **ON** or all **OFF**".

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6. Among these, what would be the pattern of the solution?

a) **RGB = U O O** b) **RGB = O O O** c) **RGB = U O U** d) **RGB = U U U**

Correct answer: d. **RGB = U U U**
Explanation: The second statement says either all are **ON** or all are **OFF**, but we know from the first statement that **Red** is **ON**. So, all the lights must be **ON.**
Competencies: Logical reasoning, Algorithmic thinking, decomposition

More Puzzles

Below are three progressively harder cases. They introduce additional logic and multi-step filtering to mimic advanced truth-table-based reasoning. Each ends with one solution card.


CASE 3
(Take cards from 0 to 15)
The Red light is 'ON'
'ON' light only has 'OFF' Neighbours
Exactly Even Lights are 'ON'


CASE 4
(Take cards from 0 to 31)
The Yellow light is 'ON'
The Pink light is 'OFF'
If Yellow light is 'ON', then Blue light is 'ON'
Red and Green are either both are 'ON' or 'OFF'
If Blue light is 'ON', then Red light is 'OFF'


CASE 5
(Take cards from 0 to 31)
If Yellow light is 'ON', so is Pink light
Either Green light or Blue light, or both of them, is 'ON'
If Yellow light is 'ON', then Blue light is 'ON'
Red and Green are either both are 'ON' or 'OFF'
If Blue light is 'ON', then Red light is 'OFF'

Questions

1. **Form the largest four-digit odd number by selecting exactly one digit from each row and each column. What is the sum of the digits?**

7	4	5	3
6	9	2	6
5	1	3	2
8	9	7	4

a) 21 b) 22 c) 23 d) 24

Answer: c

Solution:

We must select one digit from each row and each column, and form the largest four-digit odd number.

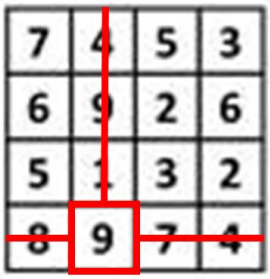
Step 1: Choose the largest possible digit for the thousands place.

The largest digit in the grid is 9.

There are two 9s in the grid, but we must choose the one that allows the remaining digits to still form the largest possible number.

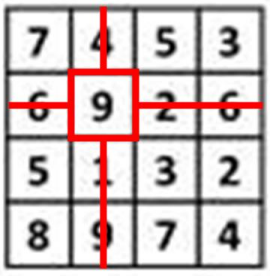
If we select 9 from Row 4, Column 2, then we cannot select the other highest digits (9, 8, and 7) from that same row and column as shown below.

This will not allow us to form the largest 4-digit odd number.



So, select 9 from Row 2, Column 2.

Then we can still choose the other highest digits like 8 or 7.

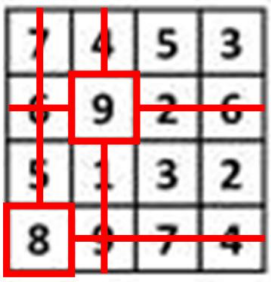


Step 2: Choose the next largest digit for the hundreds place

After selecting 9, we cannot use Row 2 or Column 2.

The largest remaining digit is 8 (Row 4, Column 1).

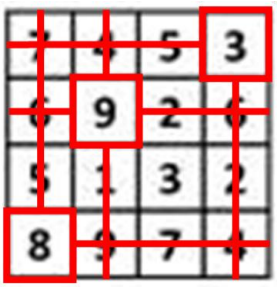
So, select 8.



Step 3: Choose the next digit while ensuring the number remains odd.

The remaining digits available are 5, 3, 3, and 2.
Since the number must be odd, the last digit must be odd (3 or 5).

To keep the number as large as possible, select 3 in Row 1, Column 4. (Because, if 5 is selected, then the other digit we get will be 2. This forms number 9825, but it is not the largest possible number, as we have a scope for the tens digit being 3)



Step 4: Select the last remaining digit.

Now only one valid digit remains, which is 3 (Row 3, Column 3).

Step 5: Form the number and find the sum

The largest four-digit odd number formed is: 9833

Sum of the digits: 9 + 8 + 3 + 3 = 23

Therefore, the sum of the digits is 23.

Option c is the correct answer.

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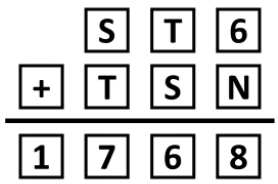
2. In the given image, S, T, and N represent distinct single-digit numbers, where T > S. What is the value of N + S?



a) 13 b) 12 c) 9 d) 11

Answer: c

Solution:

First, look at the unit's place.
We are given that **6 + N = 8**.
So, **N = 2**.
There is **no carry forward** from the unit's place. (since no single digit number added to 6 can give 18)
Now, look at the addition of **ST + TS = 176**.
Since the sum is a three-digit number, there must be **one carry forward** from the tens place.
This means the sum of **S + T** must be **16**. The possible pairs that add up to 16 are:

- 8 + 8
- 9 + 7

Since all digits are **distinct**, **8 + 8 is not possible**. So, the only valid pair is **9 and 7**.
Given that **T > S**,

- **S = 7**
- **T = 9**

Finally,
N + S = 2 + 7 = 9
Hence, **option c is the correct answer.**

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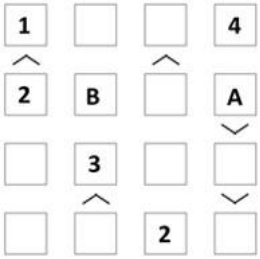
3. Each square of the given puzzle must be filled with a single-digit natural number such that:
- **The sum of all four different digits in each row and each column is 10**
- **All the inequality signs (< and >) between the boxes must be followed**

Find the correct values of A and B.



a) A = 3, B = 4 b) A = 2, B = 1 c) A = 1, B = 4 d) A = 3, B = 1

Answer: d

Solution:

Each square of the given puzzle must be filled with a single-digit natural number.

The sum of all four different digits in each row and column is 10.

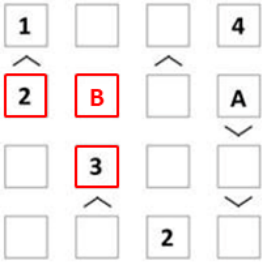
The only set of four digits whose sum is 10 is: 1 + 2 + 3 + 4 = 10

Therefore, only digits 1, 2, 3, and 4 can be used. (No digit greater than 4 can be used, because if we include 5 or any larger digit, the sum would become greater than 10, which is not allowed.)

Find the value of B:

In the same row as B, the digit 2 is present. So, B cannot be 2.

In the same column as B, the digit 3 is present. So, B cannot be 3.

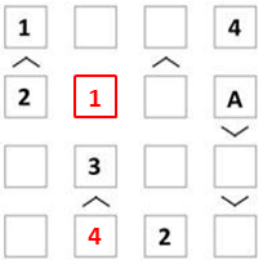


The remaining possible digits are 1 and 4.

Now, look at the inequality in the same column as B. The number in the last row must be greater than 3. So, it must be 4. This means B cannot be 4.

Therefore, the only remaining possible value is 1.

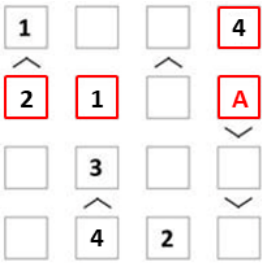
So, the value of B = 1.



Find the value of A:

In the same row as A, digits 2 and 1 are already present. So, A cannot be 1 or 2.

In the same column as A, digit 4 is present. So, A cannot be 4.



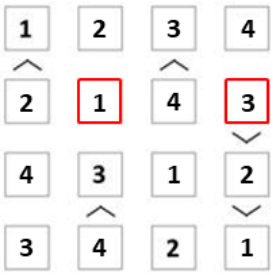
Therefore, the only remaining possible value is 3.

So, the value of A = 3.

Therefore, the values of A and B are A = 3 and B = 1.

Hence, the correct answer is **option d.**

The complete grid can be seen below:



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4. How many cells contain a digit equal to the sum of all the other digits in its corresponding row and column combined?

3			6
1	2	3	
	4		2
5			1

a) 2 b) 3 c) 4 d) 5

Answer: c

Solution:

As per the question, we need to consider those cells whose digit is equal to the sum of the other numbers in its corresponding row and column.

For example, here**, for 3,** the numbers in its corresponding row and column are 1, 5, and 6. Their sum is greater than 3, so this cell cannot be considered, as shown in the image.

3			6
1	2	3	
	4		2
5			1

Similarly, **for 1 and 2**, the numbers present in their corresponding rows and columns are greater than 1 and 2. (3, 4, 5, and so on).
So, their sum will anyways be greater than the number itself.
Hence, these cells need not be checked.

3			6
1	2	3	
	4		2
5			1

For 6, the numbers in its corresponding row and column are 3, 2, and 1, and their sum is 3 + 2 + 1 = 6. So, we will consider this cell.

3			6
1	2	3	
	4		2
5			1

For the highlighted 3, the numbers in its corresponding row and column are 1 and 2, and their sum is 1 + 2 = 3. So, we will consider this cell.

3			6
1	2	3	
	4		2
5			1

For 4, the numbers in its corresponding row and column are 2 and 2, and their sum is 2 + 2 = 4. So, we will consider this cell.

3			6
1	2	3	
	4		2
5			1

For 5, the numbers in its corresponding row and column are 3, 1, and 1, and their sum is 3 + 1 + 1 = 5. So, we will consider this cell.

3			6
1	2	3	
	4		2
5			1

Hence, there are only four such cells that satisfy the given condition.
Therefore, the correct answer is option c.

5. **Using the digits 1, 2, 3, and 4, form the highest and the smallest three-digit numbers such that each number contains exactly two different digits. What is the sum of the two numbers formed?**

a) 545 b) 555 c) 565 d) 575

Answer: b

Solution:

The number must have exactly two different digits and is formed using the digits 1, 2, 3, and 4.
To form the highest three-digit number under this condition, we use the largest unique digits, 4 and 3.
The greatest number formed is 443.
To form the smallest three-digit number under this condition, we use the smallest unique digits, 1 and 2.
The smallest number formed is 112.
Now, adding these two numbers, we get 443 + 112 = 555. So, the sum is 555.
Option b is correct.

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6. **A 2-digit number is formed using two different digits, and the digits are reversed to create another 2-digit number. The difference between these 2 numbers CANNOT be:**

a) An even number b) An odd number c) A prime number d) An integer

Answer: c

Solution:

Let the two-digit number be formed by two different digits **X** and **Y**.

- Since **X** is in the tens place and **Y** is in the ones place, the number can be written as **10X + Y**
- When the digits are reversed, **Y** comes to the tens place and **X** to the ones place. The new number becomes **10Y + X**

Now, find the difference between the two numbers:
Difference = (10X + Y) − (10Y + X)
Difference = 10X + Y − 10Y − X
Difference = 9X − 9Y
Difference = 9(X − Y)
This shows that the difference is always a **multiple of 9**.
A **prime number** is a number greater than 1 that has exactly two factors: 1 and itself.
Since multiples of 9 are not prime, the difference **cannot** be a prime number.
The multiples of 9 are integers and they can be even numbers and odd numbers too.
Hence, the correct answer is option c.

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7. **A four-digit number has the same number of even and odd digits. Which of the following could possibly be the sum of the digits of this number?**

a) 11 b) 15 c) 20 d) All of these

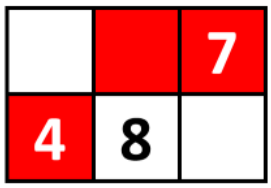
Answer: c

Solution:

It is given that the 4-digit number has the same number of even and odd digits. Thus the number will have 2 even digits and 2 odd digits.
Now, we know that
Even + Even = Even
Odd + Odd = Even
Again, Even + Even = Even
Thus, the sum of the digits of this number will be an even number, which can possibly be 20.
Option c is correct.

8. **The given grid is to be filled with distinct single-digit natural numbers such that:**
   - **The sum of each row is the same and is an even number**
   - **The larger number in each column is placed in the red block**

   What is the sum of the numbers in the white blocks?

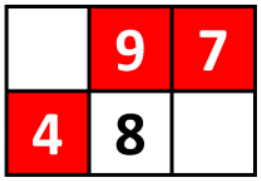


a) 16 b) 17 c) 15 d) 20

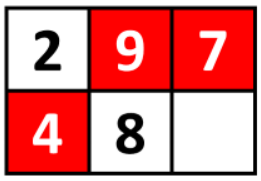
Answer: a

Solution:

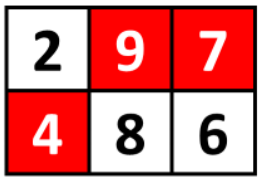
Let us first analyse the grid. Since the red block contains the larger number in each column, the second column must have 9, as it is the only single-digit number greater than 8.



In the first column, the white block must contain a number less than 4. So, the possible values are 1, 2, or 3. Since the row sum is even and 7 + 9 = 16, only 2 can be added to keep the total even.
Therefore, 2 is placed in the first column of the first row.



The total of the first row is:
2 + 9 + 7 = 18.
Let the last number in the second row be x. So, the equation becomes:
4 + 8 + x = 18
x = 18 - 12
x = 6.
Hence, the last number in the second row is 6.



The numbers in the white blocks are 2, 8, and 6.
Hence, their sum is 16. Thus, option a is the correct answer.

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9. **A computer generates rectangles where the length and breadth (dimensions) follow a series. If the pattern continues, what will be the area of the next rectangle the computer should draw?**

   $2 \times 3, 3 \times 5, 5 \times 8, 8 \times 13, 13 \times 21, ?$

a) 693 sq. units b) 2210 sq. units c) 442 sq. units d) 714 sq. units

Answer: d

Solution:
The series begins with 2 × 3.
In each term, the second number of the previous term becomes the first number of the current term, and the new second number is the sum of the two numbers in the previous term. (This rule can be seen from 3 × 5 onwards)
Since the fifth term is 13 × 21, the sixth term will have 21 as the first number and 13 + 21 = 34 as the second number.
Therefore, the sixth term is 21 × 34, and the dimensions of the sixth rectangle are 21 × 34.
Area of a rectangle = length × breadth.
21 × 34 = 714.
Thus, the area of the rectangle will be 714 sq. units.
Hence, option d is the correct answer.

---

10. Given below is a 3 × 3 grid to be filled by numbers from 1 to 9 such that:

- **Every pair of adjacent digits in a row should have a difference of three**
- **Some of the numbers have already been placed**

Based on the given conditions, choose the correct option.

1		
	5	
		9

a) A row can have all numbers as even
b) A row can have all numbers as odd
c) A row can have 2 even and 1 odd number
d) All of these

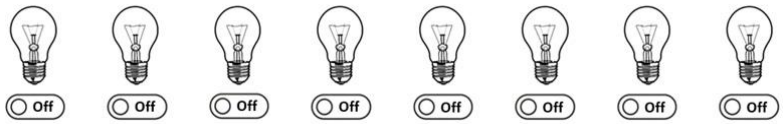
Answer: c

Solution:
Given that every pair of adjacent digits in a row should have a difference of three.
So, each number entered in a row is either 3 more or 3 less than the existing adjacent numbers.
The completed grid is as shown below. We see that options a and b are not true.
However, option c is satisfied (In the middle row, 2 and 8 are even, and 5 is odd).
Option c is the correct choice.

1	4	7
2	5	8
3	6	9

The Thinking Spot

Given below are bulbs, each with a switch beneath it. When you press a switch, it lights up ONLY the adjacent bulbs and not the bulb above the switch. What is the minimum number of switches you need to press to light up all the bulbs?



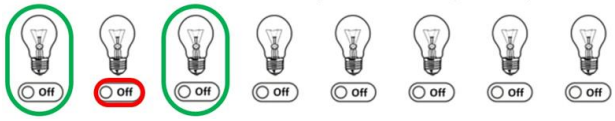
(a) 2 (b) 3 (c) 4 (d) 5

Answer: c

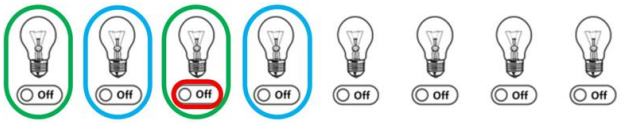
Solution:

In order to light all the bulbs by using minimum switches, we need to switch on the bulb that has bulbs on both its adjacent sides.

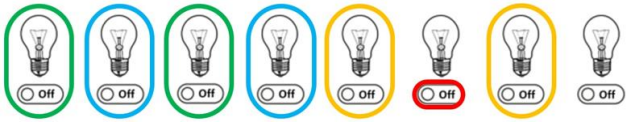
So, we turn on the 2nd bulb. Hence, its adjacent bulbs will light up.



Next, if we switch on the 3rd bulb, its adjacent bulbs will light up.



Now if we switch on the 6th bulb, its adjacent bulbs will light up.



On switching on the 7th bulb, its adjacent bulbs will light up.

So, at least 4 switches must be pressed to light up all the bulbs.
Hence, option c is the correct answer.

Chapter 7: A Tale of Three Intersecting Lines

1. **If the sides of an equilateral triangle and that of a square are of equal length, what can you say about the area of both the shapes?**

   a) The area of the square is the same as that of the triangle
   b) The area of the triangle is greater than that of the square
   c) The area of the square is greater than that of the triangle
   d) None of these

   Answer: c

   Solution:

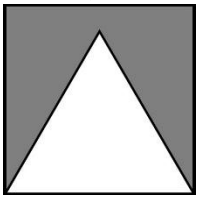
   Both shapes are made using sides of the **same length**.

   - A **square** has **four sides**. Because of the extra side, the shape can open out more and spread wider before closing. This allows it to enclose **more space**
   - An **equilateral triangle** has **only three sides**. The shape closes sooner, making it narrower and shorter in height compared to the square

   If you form both shapes using sticks of equal length:

   - The square has a constant width through the top and bottom as opposed to the triangle that has a decreasing width from bottom to top
   - The triangle's height is smaller. So, it covers **less area**

   Hence, even though the sides are equal, the **square encloses more space** than the triangle.

   Thus, option c is correct.

---

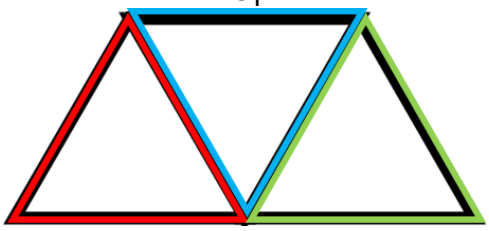
2. **Three identical pieces of paper, each in the shape of an equilateral triangle, are joined together edge to edge, with no gaps or overlaps. Which of the following figures can be formed by joining them?**

   a) Rhombus b) Trapezium c) Hexagon d) Triangle

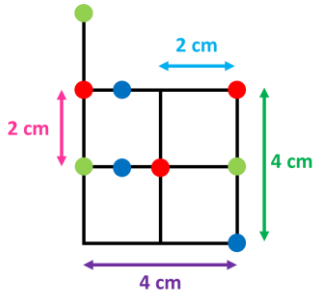
   Answer: b

   Solution:

   As shown below, using three equilateral triangle pieces, only a trapezium can be formed. Hence, the correct answer is Option b.

3. **If dots of the same colour are connected to form triangles, which triangle is not formed by any coloured dots?**



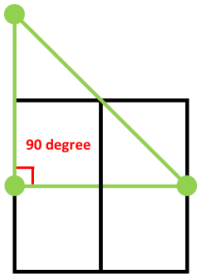
a) Right-angled triangle
b) Obtuse angled triangle
c) Equilateral triangle
d) Isosceles triangle

Answer: c

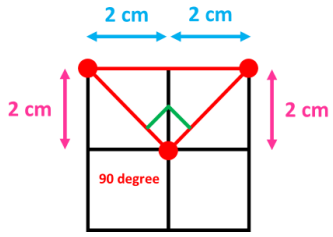
Solution:

Let us make each triangle by joining all the dots of the same colour:

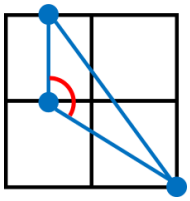
Green dot: A right-angled triangle is formed by joining all the green dots together.



Red dot: The red dot in the middle is equidistant from both vertices because each smaller shape is a 2 × 2 cm square. Since the diagonals of both squares are equal, two sides of the triangle are equal, making it an isosceles right-angled triangle.



Blue dot: The triangle formed by blue dots is a scalene obtuse angled triangle.



Since the equilateral triangle is not formed, the correct answer is option c.

4. **Is the given triangle isosceles, scalene, or equilateral?**
Information 1: The given triangle is similar to a right-angled triangle
Information 2: The given triangle is not a scalene triangle
To answer the given question, which of the given information is/are sufficient?

a) Only 1
b) Only 2
c) Both 1 and 2 together
d) Question cannot be answered even if both pieces of information are used

Answer: c

Solution:

Using information 1, a triangle similar to a right-angled triangle will also be right-angled. Now a right-angled triangle cannot be equilateral. So, information 1 alone is insufficient to answer the question.

Using statement 2, we can only say that the triangle is not scalene. So, information 2 alone is insufficient to answer the question.

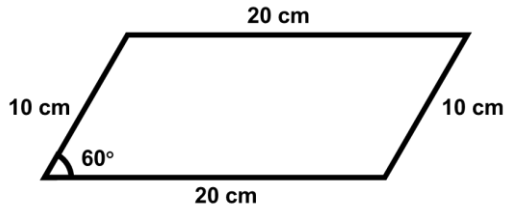
Using information 1 and 2 together, we can know that the triangle is right-angled and is not a scalene triangle.

So, the only possibility is that the triangle is isosceles. Hence, the question can be answered using both information.

Thus, option c is the correct answer.

---

5. **At least how many folds are required to convert the given paper sheet into an equilateral triangle?**



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

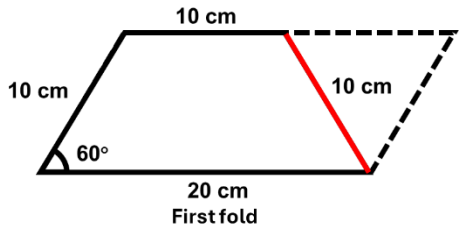
Answer: c

Solution:

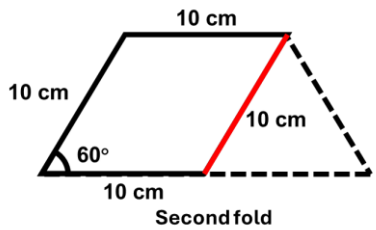
We can see that the given sheet of paper is a parallelogram with parallel sides having the following lengths: 20 cm and 10 cm.

We should try to fold the given sheet such that an equilateral triangle of side length 10 cm is formed.

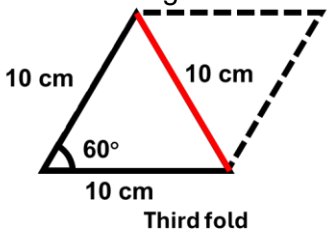
As shown below, we cannot form a triangle in one fold.

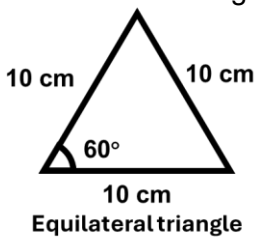


We get a trapezium shape. We must make more folds.



We can see that the result image is a rhombus with side length 10 cm.
One fold along the short diagonal of the rhombus will give us an equilateral triangle.



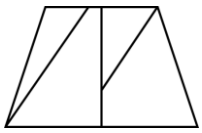


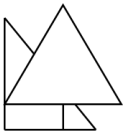
Thus, at least three folds are required to turn the given paper sheet into an equilateral triangle.
Hence, option c is the correct answer.

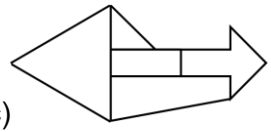
---

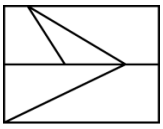
6. Each option contains exactly two types of triangles from the following: a right-angled triangle, an equilateral triangle, and a scalene triangle. Which option contains both a right-angled triangle and an equilateral triangle?

Note: *Consider only those triangles whose all three sides are clearly visible*

a) 

b) 

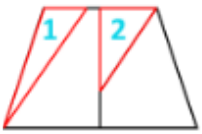
c) 

d) 

Answer: c

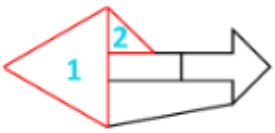
Solution:

As it is mentioned in the question that each option presents exactly two triangles among a right-angled triangle, an equilateral triangle, and a scalene triangle, we have to find the option that contains both a right-angled triangle and an equilateral triangle.
As shown in the image below, we identify the types of triangles in each option:
Option a: Triangle 1 is a scalene triangle, and Triangle 2 is a right-angled scalene triangle.
Option b: Triangle 1 is a scalene triangle, and Triangle 2 is an equilateral triangle.
Option c: Triangle 1 is an equilateral triangle, and Triangle 2 is a right-angled triangle.
Option d: Triangle 1 is a scalene triangle, and Triangle 2 is a right-angled scalene triangle.
Therefore, option c is the correct answer, as it contains both a right-angled triangle and an equilateral triangle.

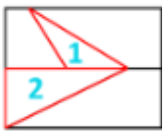


Option a

Option b



Option c



Option d

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7. An isosceles triangle has a perimeter of 23 cm and all its side lengths are whole numbers. The two equal sides are multiples of 3. How many different possible lengths can the third side have?

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

Answer: b

Solution:

If side lengths of two equal sides are multiples of 3, and perimeter is 23 cm, possible combinations of side lengths are (3,3,17), (6,6,11), (9,9,5).

Out of these (3,3,17) is not possible as 3 + 3 = 6 and in any triangle sum of any 2 sides can never be less than the third side.

So, option b is the correct answer.

8. **Two triangles, triangle X and triangle Y, are given. Only partial information about their corresponding sides and angles is provided below.**
Question: Are triangles X and Y similar?
Information 1: Two pairs of corresponding sides of triangle X and triangle Y are proportional, but no information is given about the third pair of corresponding sides.
Information 2: Two pairs of corresponding angles of triangle X and triangle Y are equal, but no information is given about the third pair of corresponding angles.
To answer the given question, which of the given information is/are sufficient?

a) Only 1
b) Only 2
c) Both 1 and 2 together
d) Question cannot be answered even if both information are used

Answer: b

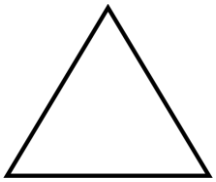
Solution:

It is given that two pairs of corresponding sides of triangle X and triangle Y are proportional, but there is no information about the third pair of sides.
For triangles to be similar using sides, either all three pairs of sides must be proportional, or two pairs of sides must be proportional along with the included angle being equal.
Since neither the third pair of sides nor the included angle is given, we cannot confirm similarity using Information 1 alone.
It is given that two pairs of corresponding angles of triangle X and triangle Y are equal.
If two angles of one triangle are equal to two angles of another triangle, then third pair of corresponding angles will also be equal because the sum of the angles in a triangle is 180°
Thus, the triangles will have the same shape. So, the triangles are similar.
Since Information 2 alone is sufficient to determine similarity, option b is the correct answer.

---

9. **An equilateral triangle is given. Inside it, two straight lines are drawn in any direction. If the triangle is cut along these two lines, what is the maximum number of right-angled triangles that can be formed?**

Note: *You cannot form a triangle by joining two or more pieces.*



a) 2 b) 3 c) 4 d) 5

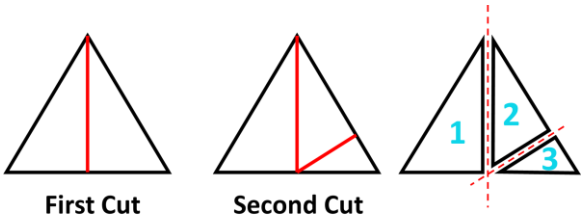
Answer: b

Solution:

To form right-angled triangles inside an equilateral triangle, we must create **perpendicular lines**, since a right angle is formed only when two lines meet at 90 degrees.

1. Draw a **perpendicular** from the **top vertex** of the equilateral triangle to the **base**.
   - This line meets the base at 90 degrees
   - It divides the triangle into **two right-angled triangles**
2. Next, draw a **second straight line** from a point on the base such that it is **perpendicular to the first line** and meets one side of the triangle.
   - This creates **one additional right-angled triangle** in the remaining region

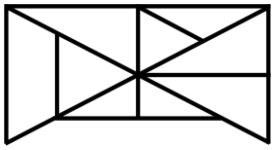
No further right-angled triangles can be formed using only **two straight lines**.



Thus, the correct answer is option b.

---

10. How many right-angled triangles are there in the given figure?

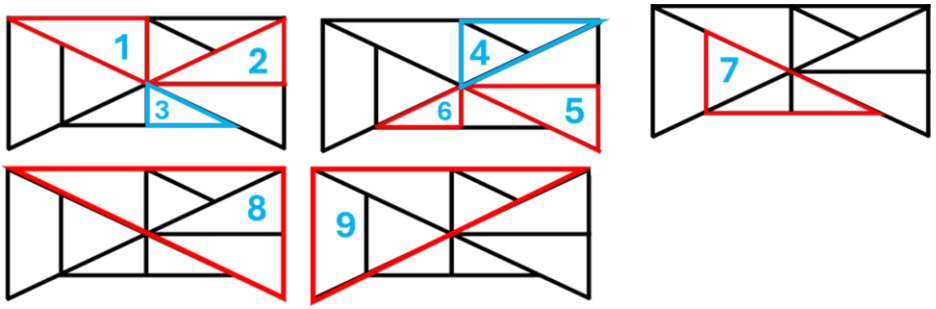


a) 7 b) 8 c) 9 d) 10

Answer: c

Solution:

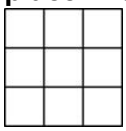
Please refer to the solution image below.



Therefore, the total number of right-angled triangles are 9.

Option c is correct.

A 3 x 3 grid is shown below. You need to place some circles in the cells without making three in a row, column, and diagonal. How many circles at maximum can you place in the grid?

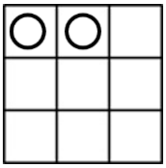


(a) 5 (b) 4 (c) 6 (d) 7

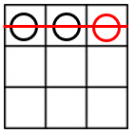
Answer: c

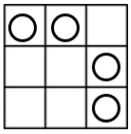
Solution:

We start with the first row. Since we cannot place 3 circles in a row, we place the maximum possible, i.e., 2 circles in the first row (in column 1 and column 2, leaving column 3 empty).

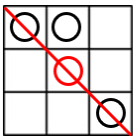


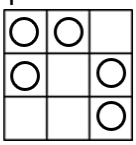
Next, observe the 3rd column. In the first row, column 3 is empty. To maximize the number of circles, we can place circles in the 3rd column, but we must ensure no column has 3 circles. So, we place circles in the 2nd row and 3rd row of column 3.



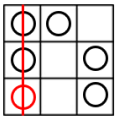


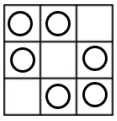
Now, move to the second row. One circle is already placed in column 3.
Since we can place at most 2 circles in a row, we need to place one more circle.
We can choose either column 1 or column 2. However, if we place a circle in column 2 of the second row, it will form a diagonal of 3 circles, which is not allowed.
Therefore, we place the circle in the first column of the second row.





Finally, consider the third row. One circle is already placed in column 3. Also, column 1 already has 2 circles (from row 1 and row 2). So, we cannot place another there.
Hence, we place the remaining circle in the second column of the third row.





Hence, option c is the correct answer.

Chapter 8: Working with Fractions

1. **Samuel received chocolates for his birthday. He decided to share it with his family.**
   - He keeps 1/3rd of the chocolates for himself
   - He gives 1/4th of what is left to his sister Sarah
   - He gives the remaining 12 chocolates (except the ones which he kept for himself) to his brother
   How many chocolates had Samuel received in total before he shared it?

   a) 20 b) 22 c) 24 d) None of these

   Answer: c

   Solution:

   Samuel keeps **one-third** of the chocolates for himself.
   So, the chocolates left = **two-thirds** of the total.
   From this remaining amount of chocolates, he gives **one-fourth** to his sister.
   The fraction of chocolates left after giving to his sister is:
   Three-fourths of two-thirds
   That is:
   (3/4) × (2/3) = **1/2**
   So, the remaining chocolates are **half of the total chocolates**.
   It is given that the remaining amount is **12 chocolates**.
   If **half** of the chocolates is 12, then the **total number of chocolates** must be:
   12 × 2 = **24**
   Samuel received **24 chocolates** in total.
   Hence, option c is the correct answer.

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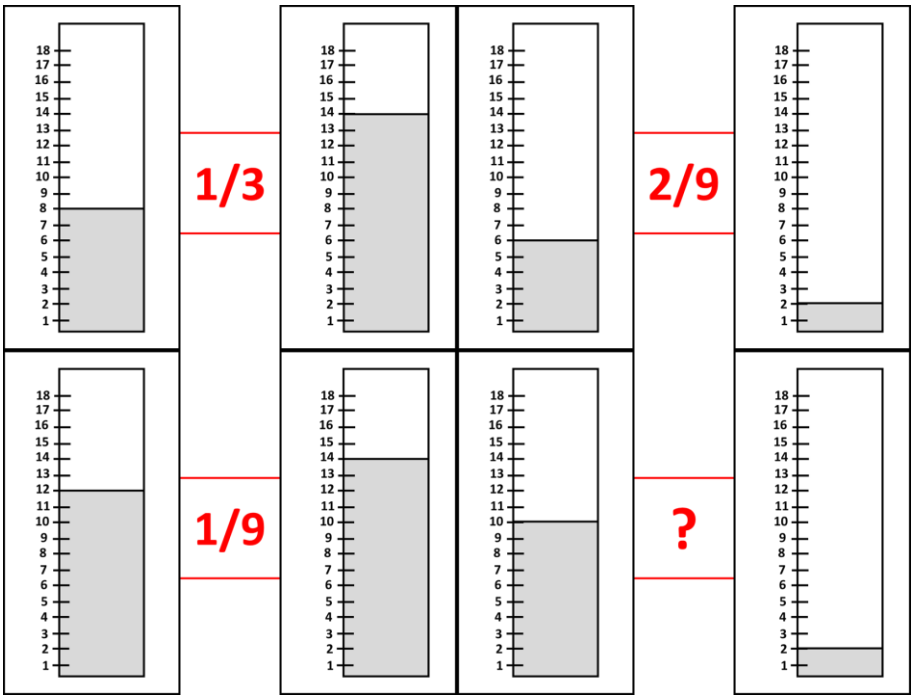
2. **If each of the given terms follows the same theme, what will come in place of "?"**



   a) 2/9 b) 2/3 c) 4/9 d) 1/9

   Answer: c

Solution:

In each group, we observe two measuring cylinders.

Each cylinder represents a fraction out of 18 (since the scale goes up to 18).

The number written between the groups shows the difference between the larger fraction and the smaller fraction, written in simplified form.

First Term:

The left cylinder shows 8/18.

The right cylinder shows 14/18.

Now find the difference:

14/18 − 8/18 = 6/18

6/18 = 1/3

That matches the given value in the middle term.

Question Term:

The left cylinder shows 10/18.

The right cylinder shows 2/18.

Now, find the difference:

10/18 − 2/18 = 8/18

8/18 = 4/9

Hence, the correct answer is option c.

---

3. A bus started its journey from Mumbai.

- 1/4th of the passengers got off the bus in Pune and 35 new passengers got on the bus

- Half of the passengers got off the bus in Goa with no new passengers getting on the bus

When the bus left from Goa, the total number of passengers was 85. How many passengers boarded the bus from Mumbai?

a) 135 b) 170

c) 180 d) Cannot be Determined

Answer: c

Solution:

Let's assume P as the number of passengers who boarded the bus from Mumbai.

1/4th of the passengers got off the bus in Pune and 35 new passengers got on the bus.

Thus, the total number of passengers at Pune is 0.75P + 35

Half of the passengers got off the bus in Goa. Thus, the total number of passengers at Goa is (0.75P + 35) / 2 = 85.

Thus, 0.75P + 35 = 85 x 2

0.75P = 170 - 35

3/4 (P) = 135

P = 135 x (4 / 3)

P = 180.

Thus, 180 passengers boarded from Mumbai.

Hence, option c is the correct answer.

4. **Which of the following statements is/are sufficient to answer the given question?**
Question: What fraction of the initial liquid remains in the vessel after Day 2?
Statement 1: The vessel originally contained 100 litres of liquid
Statement 2: On Day 1, the amount of liquid that evaporates is equal to half of the quantity that would remain if one-third of the initial liquid were removed
Statement 3: On Day 2, the liquid left in the vessel becomes one-fourth of the quantity that was present at the beginning of Day 2

a) Statement 3 alone is sufficient
b) Both Statement 1 and Statement 2 are necessarily required
c) Both Statement 2 and Statement 3 are necessarily required
d) Question cannot be answered even if all the Statements are used

Answer: c

Solution:

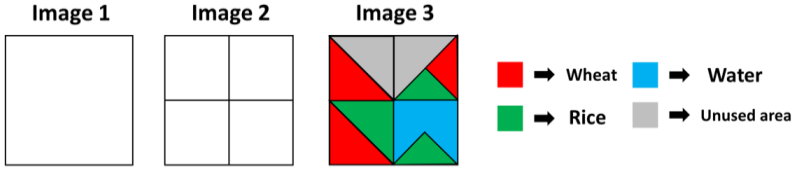
Statement 1:
It only tells us the starting quantity.
It does not tell us how much evaporates.
Statement 1 alone is insufficient.

Statement 2:
If one-third is removed, then two-thirds remains.
Half of that two-thirds is equal to one-third.
So, on Day 1, one-third of the initial liquid evaporates.
After Day 1, two-thirds remains.
But we still don't know what happens on Day 2.
Statement 2 alone is insufficient.

Statement 3:
After Day 2, only one-fourth of the Day 1 quantity remains.
But we don't know how much was left after Day 1.
Statement 3 alone is insufficient.
Now, combine Statement 2 and 3
After Day 1: two-thirds remains.
After Day 2: one-fourth of that remains.
So, final fraction = 2/3 × 1/4 = 2/12 = 1/6.
Both Statement 2 and Statement 3 are necessarily required to answer the question.
Hence, the correct answer is option c.

---

5. **A farmer has a square farm as shown in Image 1. He divides it into 4 equal parts as shown in Image 2. Now, he allotted certain portions of land for specific purposes (Rice crop, Wheat crop, Water) and some part of the farm is unused, as shown in Image 3. What fraction of the new farm is occupied by wheat?**



a) 3/16 b) 1/4 c) 5/16 d) 6/16

Answer: c

Solution:
The whole farm is first divided into 4 equal large squares.

Assume that each square is further divided into 4 equal triangles. So, the farm in Image 3 can be considered as:

So, total number of equal small triangles in the farm: 4 × 4 = 16 triangles
(This will make our calculation easier, as every portion has an equal area)
Now, count the triangles that are shaded to represent wheat.
We can see that 5 small triangles are shaded red.
Since each small triangle represents one equal part of the farm,
Fraction of the farm occupied by wheat = Number of wheat triangles / Total number of triangles = 5 / 16
Therefore, the fraction of the farm occupied by wheat is 5/16.
Hence, option c is the correct answer.

---

6. A wire is bent to form a rectangle with length L and breadth B. After some time, the length is increased by one-fifth of its original value, and the breadth is decreased by one-fifth of its original value. After this change:

- **The perimeter of the rectangle remains the same**
- **The area of the rectangle decreases by 100 sq. cm**

What was the original length of the rectangle?

a) 25 cm b) 40 cm c) 45 cm d) 50 cm

Answer: d

Solution:

Let the original length be L and the original breadth be B.
The new length becomes:
$L + (1/5)L = 6L/5$
The new breadth becomes:
$B - (1/5)B = 4B/5$
Since the wire is not cut or stretched, the perimeter remains the same.
So, $2(L + B) = 2(6L/5 + 4B/5)$
Divide both sides by 2:
$L + B = 6L/5 + 4B/5$
Multiply the entire equation by 5:
$5L + 5B = 6L + 4B$
Rearranging:
$5L - 6L = 4B - 5B$
$-L = -B$
So, L = B (multiply by '-' on both the sides)
This means the original rectangle was actually a **square**.
Original area = L × B
Since L = B,
Original area = L^2
New area = $(6L/5) \times (4L/5) = 24L^2/25$

Decrease in area = $L^2 - 24L^2/25 = L^2/25$

Given decrease is of 100 cm^2

So, $L^2/25 = 100$

Multiply both sides by 25:

$L^2 = 2500$

$L = 50$

The original length of the rectangle was 50 cm.

So, the correct answer is option d.

---

7. A number sequence is mentioned below:
19/2,38/6,76/18,152/54,…
Which will be the first term of the series that will be less than 1?

a) 7th term of the series
b) 8th term of the series
c) 10th term of the series
d) None of these

Answer: a

Solution:

The next term in the given series is obtained by multiplying the numerator of the current term by 2 and the denominator of the current term by 3.

In this way, the subsequent terms are as follows:

304/162, 608/486, 1216/1458.

Since 1216/1458 will be less than 1, the 7th term is the first term in the given series to be less than 1.

Hence, option a is the correct answer.

---

8. A box has 98 chalks. Each day, a teacher picks up a chalk to write.
When a chalk becomes 1/7 of its original size, she sets it aside.
Whenever she collects enough such small pieces to make one full chalk, she joins them and uses it. For how many days will the 98 chalks last?

a) 84
b) 98
c) 112
d) 114

Answer: d

Solution:

It is clear that 98 chalks would last 98 days. Each chalk leaves a fraction of 1/7 its size.

So, 98 such fractions remain, which would give 14 more chalks. So, 98 + 14 = 112 days.

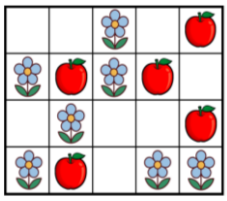
Now, the 14 chalks also leave a fraction of 1/7 its size.

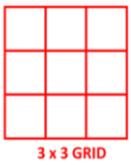
14 fractions can give two more chalks.

Hence, these chalks can last 2 more days, i.e. 112 + 2 = 114 days.

Hence, the correct answer is option d.

9. **A grid contains apples and flowers in some of its cells. A 3 × 3 square frame can be placed on the grid without rotating and without extending outside the grid, covering exactly 9 cells. In how many different positions can the frame be placed so that at least one-third of the covered cells contain flowers?**





a) 3 b) 5 c) 4 d) 6

Answer: b

Solution:

The small frame is a 3 × 3 grid, so it always covers 3 × 3 = 9 squares

The condition says at least one-third of the covered squares must contain flowers.

Now, 1/3 of 9 = 3

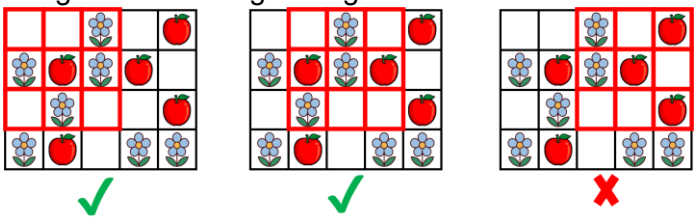
So, the frame must contain 3 or more flowers.

Any placement with fewer than 3 flowers is not allowed.

We will check the grid **column-wise**, starting from columns 1 to 3.

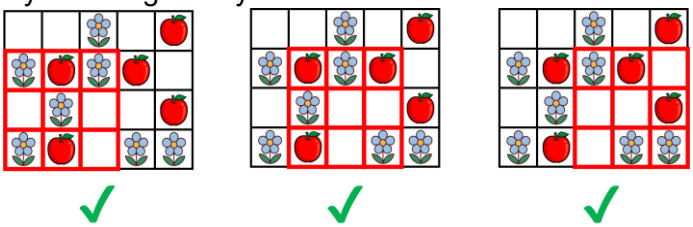
For each starting column, we place the frame over rows 1 to 3, then slide the frame to the right.

We get the following arrangements when we follow this:



Then, we move to Row 2 and repeat the same process, sliding the frame across from the first possible column to the last column of the grid.

By following this systematic row-wise and column-wise approach, we obtain these arrangements:



After checking all the possible placements, we observe that **5 arrangements** satisfy the condition of having AT LEAST one-third of the covered cells containing flowers, as indicated by the tick marks in the solution image.

Hence, the correct answer is option b.

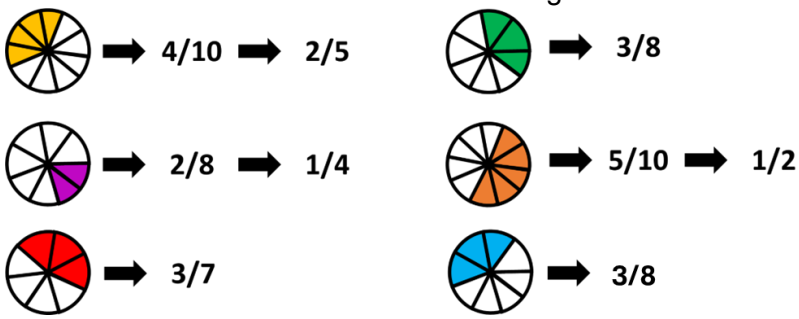
10. Each circle is divided into equal parts, with some parts shaded. A fraction is written to the right of each circle. How many of these fractions correctly represent the shaded part of their corresponding circles?

a) 4 b) 3 c) 2 d) 5

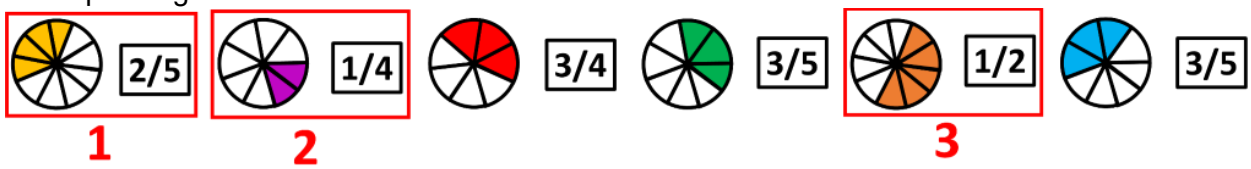
Answer: b

Solution:

The fractions of all the shaded circles are given below:



Now, we have to count the number of fractions that are correctly written to the right of their corresponding shaded circles:



As shown in the above image, a total of 3 fractions are correctly written to the right of their corresponding shaded circles.

Hence, the correct answer is option b.

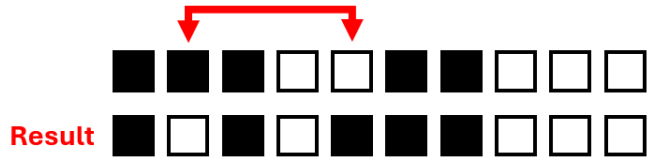
The Thinking Spot

You have a collection of 10 different squares arranged as shown below. What is the minimum number of pairs of squares you need to interchange to ensure that white and black squares are arranged alternately?
Note: *If you swap 1 black square with 1 white square, it is counted as 1 PAIR OF SQUARES being swapped*

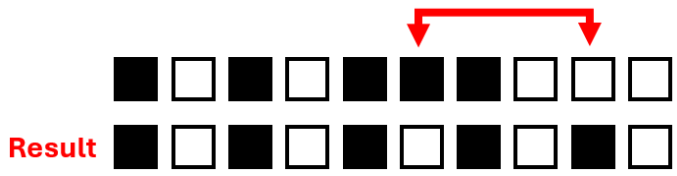
(a) 1 (b) 2 (c) 3 (d) 5
Answer: b

Solution:
We need to rearrange the given squares so that black and white squares are placed alternately, using the minimum number of pairwise interchanges.

The first three squares are black, followed by two white squares.
For an alternating pattern (B, W, B, W, B, W…), the 2nd position should be White, but it is Black. Similarly, position 5 should be black, but it is white.
So, we interchange 2nd Black square with the 2nd White square (position 5)



Now, the first five positions follow the alternating pattern.
Now, look at the position 5, 6, and 7. All are Black, and positions 8, 9, and 10, are all White.
For alternation:
Position 6 should be White, but it is Black.
Position 9 should be Black, but it is White.
So, we interchange 6th Black square with the 9th White square.



Now, all squares are arranged alternately.

So, we required a minimum of 2 pairs of squares to be interchanged to arrange the black and white squares alternately.
Hence, option b is the correct answer.

PART 2

ARTIFICIAL INTELLIGENCE

Chapter: 1 AI Domains and Applications

Exercise

A. Multiple Choice Questions.

1. Which AI technique predicts numerical values?
   a) Classification b) Clustering
   c) Regression d) Detection
2. Which AI domain works with images and videos?
   a) NLP b) Data Science
   c) Computer Vision d) Science
3. Clustering is mainly used to:
   a) Predict marks b) Group similar data
   c) Translate language d) Detect spam
4. In classification, the output is:
   a) A continuous value b) A predefined category
   c) A random number d) A chart
5. In dataset division, which data is used for final evaluation?
   a) Training b) Validation
   c) Test d) Raw data

B. Fill in the Blanks.

1. Regression predicts _____ values.
2. Clustering does not require _____data.
3. Computer Vision works mainly with _____ and videos.
4. NLP helps machines understand _____.
5. A dataset is divided into training, validation, and _____sets.

C. Short Answer Questions.

1. Differentiate between classification and regression.
2. What is clustering? Give one example.
3. Explain the importance of datasets in AI.
4. List the steps involved in Computer Vision.
5. How does NLP help in communication systems?

D. True or False.

1. Regression predicts categories.
2. Clustering is a supervised learning method.
3. Test data is used to evaluate model performance.
4. Computer Vision can detect object locations.
5. NLP can analyse sentiment in text.

E. Identify the AI Domain.

AI Application	Identify the term
Analysing MRI scans	
Text summarization of long articles	
Recommending products based on past purchases	
Grouping customers by buying behaviour	
Chatbots answering customer queries	

Solutions

1. Multiple Choice Questions.

1. c) Regression
2. c) Computer Vision
3. b) Group similar data
4. b) A predefined category
5. c) Test

2. Fill in the Blanks.

1. continuous
2. labelled
3. images
4. language
5. test

3. Short Answer Questions.

1. Classification predicts categories (spam / not spam); Regression predicts numerical values (price, marks)
2. Clustering is grouping similar data without labels.
   Example: Grouping customers based on shopping habits.
3. Datasets help AI systems learn patterns and make predictions.
   Better datasets improve model accuracy.
4. List the steps of Computer Vision:
   - Image collection
   - Image pre-processing
   - Feature extraction
   - Model training
   - Prediction
6. NLP helps machines understand human language.
   Examples:
   - Chatbots
   - Translation
   - Voice assistants

5. True or False.

I. False
II. False
III. True
IV. True
V. True

6. Identify the AI Domain.

AI Application	Identify the term
Analysing MRI scans	Computer Vision
Text summarization of long articles	NLP
Recommending products based on past purchases	Data Science
Grouping customers by buying behaviour	Data Science (Clustering)
Chatbots answering customer queries	NLP

Chapter 2: AI in Industries

Exercise

A. Multiple Choice Questions.

1. Artificial Intelligence mainly helps industries to become:
   a) Traditional b) Efficient
   c) Slow d) Manual
2. In healthcare, AI mainly helps in:
   a) Diagnosis b) Advertising
   c) Packaging d) Decoration
3. In education, AI provides:
   a) Cancelling classes b) Personalised learning
   c) Reducing learning d) Extra homework
4. In transport systems, AI is used to:
   a) Manage traffic b) Increase traffic congestion
   c) Stop route planning d) Remove public transport
5. AI supports better decision-making by:
   a) Ignoring available data b) Analysing large amounts of data
   c) Making random guesses d) Avoiding pattern recognition

B. Fill in the blanks.

1. AI-powered machines help doctors detect diseases at an _____stage.
2. Robotic surgery can make complex operations _____and reduce recovery time.
3. AI learning programs can understand how each student_____ best.
4. Traffic control systems use _____and cameras to monitor vehicles on roads.
5. AI translation tools help people understand different_____.

C. Short answer questions.

1. How does AI help in healthcare?
2. Explain how AI supports personalised learning in education.
3. How does AI improve transport systems?
4. Mention two advantages of using AI in industries.
5. How does AI improve customer service?

D. True or False:

1. AI can help doctors detect diseases at an early stage.
2. AI completely replaces teachers in classrooms.
3. AI helps traffic systems manage congestion.
4. AI cannot analyse large amounts of data quickly.
5. AI improves communication by reducing background noise in online meetings.

E. Identify the AI Applications.

AI Application	Field
Analysing MRI scans	
Giving instant quiz feedback	
Controlling traffic lights	
Blocking spam emails	
Managing inventory and energy use	

Solutions

A. Multiple Choice Questions.

1. b) Efficient
2. a) Diagnosis
3. b) Personalised learning
4. a) Manage traffic
5. b) Analysing large amounts of data

B. Fill in the blanks.

1. early
2. precise
3. learn
4. sensors
5. languages

C. Short answer questions.

1. AI helps doctors detect diseases early, analyse medical images, and assist in robotic surgery.
2. AI tracks student performance and adjusts lessons based on individual learning speed.
3. AI manages traffic signals, predicts congestion, and suggests best routes.
4. Improves efficiency and reduces human error
5. AI chatbots answer questions instantly and provide 24/7 support.

D. True or False.

1. True
2. False
3. True
4. False
5. True

E. Identify the AI Applications.

AI Application	Field
Analysing MRI scans	Healthcare
Giving instant quiz feedback	Education
Controlling traffic lights	Transport
Blocking spam emails	Communication/ Email filtering
Managing inventory and energy use	Business automation

Chapter 3: Data Visualisation and Analysis

Exercise

A. Multiple Choice Questions.

1. Which of the following is an example of structured data?
   a) Social media posts b) Audio recordings
   c) Student marks in a table d) Videos
2. Which method of data collection involves carefully watching and recording information?
   a) Survey b) Measurement
   c) Observation d) Digital collection
3. Which type of graph is best used to show changes over time?
   a) Pie chart b) Line graph
   c) Bar chart d) Table
4. Before creating charts, data should first be:
   a) Deleted b) Randomly arranged
   c) Cleaned and organised d) Converted into videos
5. Which of the following is an example of unstructured data?
   a) Student marks in a table b) Attendance record
   c) Audio recording d) Sales data in a spreadsheet

B. Fill in the Blanks.

1. Data visualization transforms data into a _____ form such as charts or graphs.
2. A database stores data in _____ and columns.
3. Unstructured data includes _____ and videos.
4. Accuracy refers to how close a measurement is to the_____ value.
5. A pattern is something that appears _____ in the data.

C. Short Answer Questions.

1. What is data? Give two examples.
2. Differentiate between structured and unstructured data.
3. Why is data format important?
4. What steps are involved in preparing data for visualization?
5. Explain the difference between precision and accuracy with an example.

D. True or False.

1. Pie charts show how data changes over time.
2. Structured data is easy to search and analyse.
3. Valid data must be both accurate and precise.
4. Observation is a method of data collection.
5. Extra digits added during processing may reduce meaningful precision.

E. Identify the Skill Used.

Situation	Skills used
A student counts how many classmates come to school by bus.	
The cricket team captain arranges match scores in rows and columns.	
A student studies a line graph and concludes that marks improved over time.	
A pie chart is created to show favourite sports in the class.	
Duplicate entries are removed before preparing a chart.	

Solutions

A. Multiple Choice Questions.

1. c) Student marks in a table
2. c) Observation
3. b) Line graph
4. c) Cleaned and organised
5. c) Audio recording

B. Fill in the Blanks.

1. visual
2. rows
3. images
4. true
5. repeatedly

C. Short Answer Questions.

1. Data is raw facts or information. Examples:
    - Student marks
    - Temperature readings
2. Structured Data:
    - Organized in rows and columns
    - Easy to analyse
    - Example: marks table

    Unstructured Data:
    - Not organised
    - Harder to analyse
    - Example: videos, audio
3. Data format helps organise information properly and makes analysis easier.
4. Steps involved in preparing data for visualization:
    - Collect data
    - Clean data
    - Organise data
    - Remove duplicates
    - Create chart
5. Accuracy: close to true value; Precision: repeated values close to each other
   Example:
   Actual value = 50
   Accuracy: 49, 50, 51
   Precision: 45, 45, 45

D. True or False.

1. False
2. True
3. True
4. True
5. True

E. Identify the Skill Used.

Situation	Skills used
A student counts how many classmates come to school by bus.	Data Collection
The cricket team captain arranges match scores in rows and columns.	Data Organisation
A student studies a line graph and concludes that marks improved over time.	Data Analysis
A pie chart is created to show favourite sports in the class.	Data Visualization
Duplicate entries are removed before preparing a chart.	Data Cleaning

Chapters 4: Ethics and AI Bias Awareness

Exercise

A. Multiple Choice Questions.

1. Which of the following is an example of structured data?
   a) Video footage b) A table of student marks in a spreadsheet
   c) A written paragraph d) A collection of photos in a gallery
2. AI bias mainly comes from:
   a) Equal results for all b) Wrong math answer
   c) Fast internet d) Facial recognition errors for darker skin
3. Human-in-the-Loop (HITL) means:
   a) AI decides alone b) Humans check final decisions
   c) No monitoring d) AI ignores humans
4. Which principle protects personal data?
   a) Fairness b) Transparency
   c) Privacy d) Speed
5. Which is a responsibility of a digital citizen?
   a) Spread rumours b) Share passwords
   c) Verify information d) Hack accounts

B. Fill in the Blanks.

1. Ethics guide us to be fair and _____.
2. AI systems learn patterns from _____.
3. Using _____ and balanced data helps reduce bias.
4. Digital users have the right to _____.
5. Human-in-the-Loop keeps _____in final control.

C. Very Short Answer (2–3 lines)

1. What is AI ethics?
2. Give one example of historical bias.
3. Why is transparency important in AI?
4. Name two rights of digital users.
5. What is data bias?

D. Case-Based Questions

1. A hiring system prefers male candidates because past data mostly included men.
   - What type of bias is this?
2. A health AI diagnosis illness based only on money spent on treatment.
   - What type of bias is this?
3. A loan application is rejected by AI.
   - Why should a human review the decision?
4. A student shares false news online.
   - Which responsibility is not followed?

E. One-Word Challenge

Write one word that matches the description:

Description	One word
Repeating past unfair patterns	
Missing groups in training data	
Final decision taken by humans	
Moral rules that guide decisions	
Responsible use of technology	

Solutions

1. Multiple Choice Questions.

1. b) A table of student marks in a spreadsheet
2. d) Facial recognition errors for darker skin
3. b) Humans check final decisions
4. c) Privacy
5. c) Verify information

2. Fill in the Blanks.

1. responsible
2. data
3. diverse
4. privacy
5. humans

3. Very Short Answer (2–3 lines)

1. AI ethics are rules that ensure AI systems are fair, safe and responsible.
2. Hiring AI preferring men because past hiring data mostly included men.
3. Transparency helps users understand how AI makes decisions and builds trust.
4. Two rights of digital users:
    - Right to privacy
    - Right to safety
5. Data bias occurs when training data is unfair or unbalanced, leading to unfair AI decisions.

4. Case-Based Questions

1. Historical bias
2. Measurement bias
3. To ensure fairness and check for errors or bias
4. Verify information / responsible use not followed

5. One-Word Challenge

Write one word that matches the description:

Description	One word
Repeating past unfair patterns	Bias
Missing groups in training data	Underrepresentation
Final decision taken by humans	Human-in-the-loop
Moral rules that guide decisions	Ethics
Responsible use of technology	Digital citizenship

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