OC Test Questions

The N.S.W. Opportunity Class Placement Test ("OC Test" for short) presents challenging questions to primary school students.

A selection of sample questions is discussed below.

NOTE: a wide variety of questions can appear on the OC Test; *the particular types of questions below might not appear at all* — but understanding the solution processes is still useful.

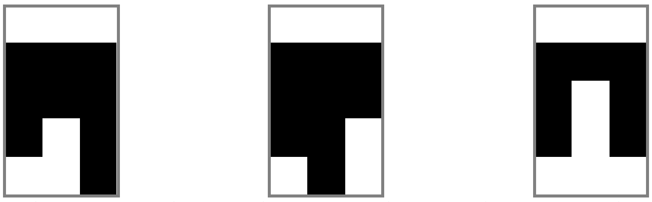
1. Thinking Skills

a) Overlapping cards to make a larger pattern

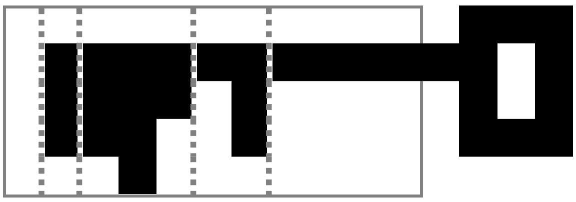
i. Example question

Original problem statement

Question 28 from the 2022 Thinking Skills practice paper presents three cards



which can be rearranged in any order, and can overlap, such as to make the following sample pattern that might correspond to the shape of a key.



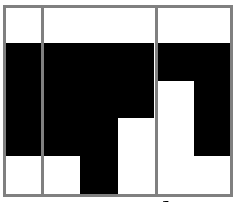
Restated question

Let us ignore the 'head' of the key (*on the right*), and focus on the section that would be inserted into a lock (*on the left*). In other words, let us concentrate on the pattern.

We also need to understand that

- the "cards" are made of paper*, with the pattern printed only on one side;
- the cards cannot be rotated or folded;
- the cards can only be moved horizontally; and
- each card can be used only once.

The sample pattern of just the combined cards is given below.



The question then asks which of four patterns can be made.

* This is indicated by the sample, where the overlapped portions reveal only the pattern on the uppermost card, not any card (or cards) underneath.

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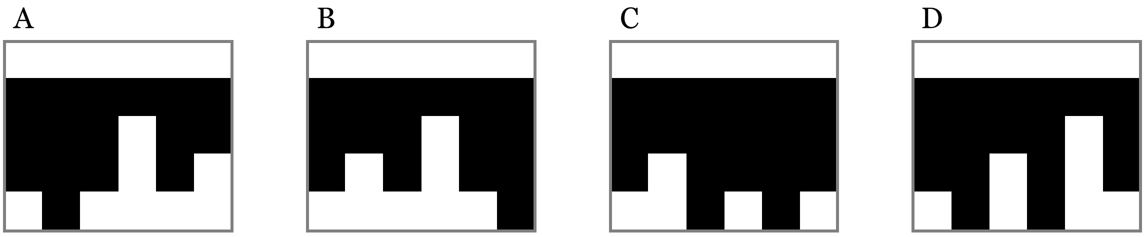
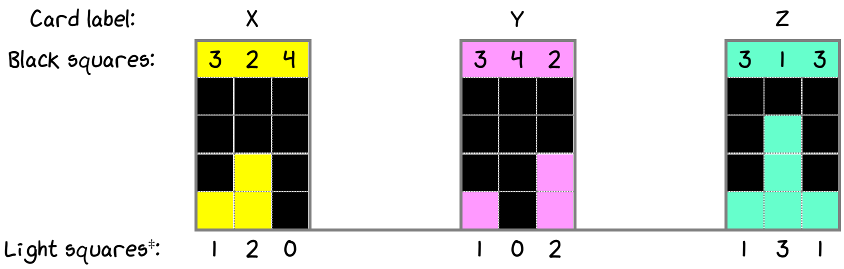


Solution

Understand the question: check the sample pattern

To confirm our understanding of what's involved, let's check how the sample pattern was constructed. To aid in that, let us

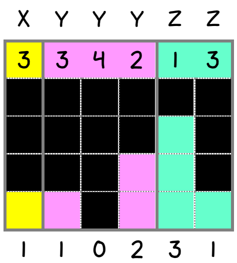
- label each of the three cards*,
- identify the elements† of each pattern (it may help to think of a grid), and
- colour the cards.



The first steps would be useful in a real test, but colouring is not necessary in a real test.

Now consider the sample pattern.

- Only card Z has a column with 1 black square (3 light squares), so card Z must be placed on the right in the sample pattern, with its left column hidden beneath another card.
- The second, third and fourth columns in the sample pattern are from a single card (it must be uppermost), which matches the pattern of card Y.
- The first column of the sample pattern has 3 black squares (1 light square), which could have been the left column of any of the three cards. However, cards Y and Z have already been used, so it must be card X.



We will try to apply these ideas to the four options. This will be a bit more difficult than for the sample pattern, because the edges of the upper card were shown in the sample pattern, but are not shown in options A, B, C & D.

If you have seen this type of problem before, then you might be able to skip over the checking of the sample pattern.

General concepts to apply

Before examining the four options in detail, it's worth quickly mentioning a few patterns that *clearly* couldn't be made from our three cards, as below.

---

* Here the cards are labelled "X", "Y" & "Z". It is better *not* to choose "A", "B" & "C" to avoid confusion with the multiple-choice options. It is better *not* to choose "1", "2" & "3" to avoid confusion when counting the squares.

† Here, for completeness, dark and light squares in each column have each been counted. In a real test you only need to count one type — whichever you find convenient.

‡ The top row has been *excluded* from the tallies, because there is a light square in *every* column there. Alternatively, it is OK to *include* the top row of light squares in the tallies, as long as it is done consistently for every column.

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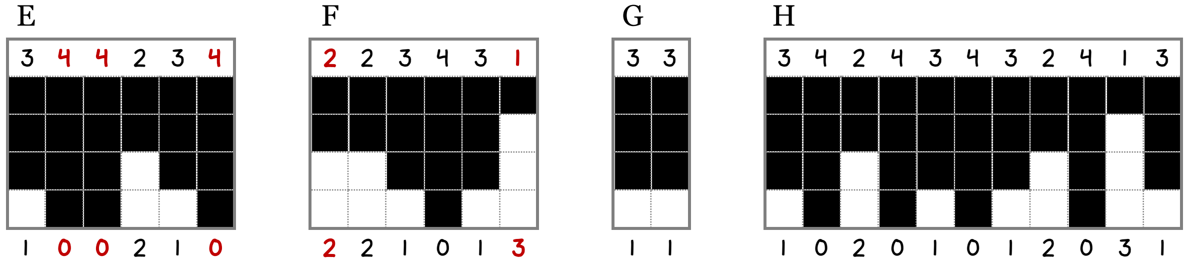
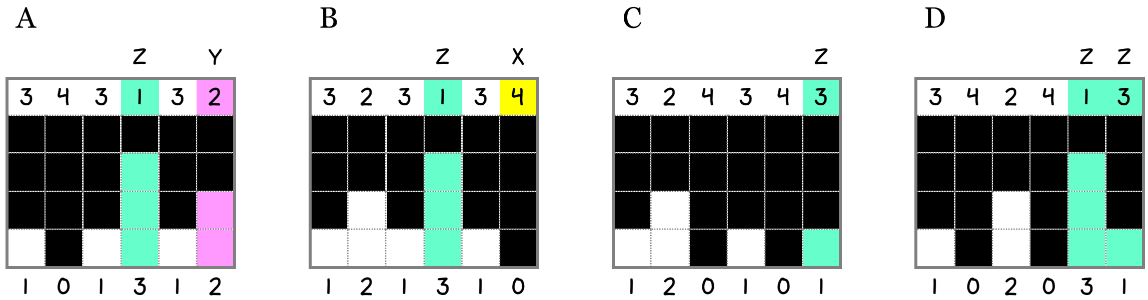


Pattern E cannot be made because it has three columns that have 4 black (0 light) squares, but there are only two such columns amongst the cards[*]. Pattern F cannot be made because none of the cards have 2 black (2 light) squares on the left, and furthermore none of the cards have 1 black (3 light) squares on the right. Pattern G is too short (three columns would be the minimum, if all cards were piled on top of each other). Pattern H is too long (nine columns would be the maximum, if none of the cards were overlapping).

Finding the right option

Now let us turn to options A, B, C & D.

- The patterns in all of the options have six columns, so the cards must overlap to some extent.
- None of the patterns have too many of any type of column.
- The first column of each pattern has 3 black (1 light) squares, which could be card X, Y or Z.
- The last column of each pattern can only be made from one card, which has a matching right column, as indicated below. Caution: we don't yet know how much of that card is exposed.
- Only one of the cards has 1 black (3 light) squares, so we know where that column of card Z is in patterns A, B & D, as indicated below. Caution: again, we don't yet know how much of that card is exposed.



- Two cards have already been identified in patterns A and B, so each of those patterns must start with the remaining card: card X for pattern A, and card Y for pattern B.
- The second column of A can now only be the middle column of card X, but that doesn't have 4 black (0 light) squares. Pattern A cannot be made: **option A is incorrect**.
- The second column of B can now only be the middle column of card Y, but that doesn't have 2 black (2 light) squares. Pattern B cannot be made: **option B is incorrect**.
- The fifth column of pattern C and the fourth column of pattern D can only come from card X, which has 4 black (0 light) squares on the right.

[*] Although pattern E doesn't have any columns with 1 dark (3 light) squares, that is not immediately conclusive, because that particular column of card Z might have been 'hidden' by another card placed on top of it.

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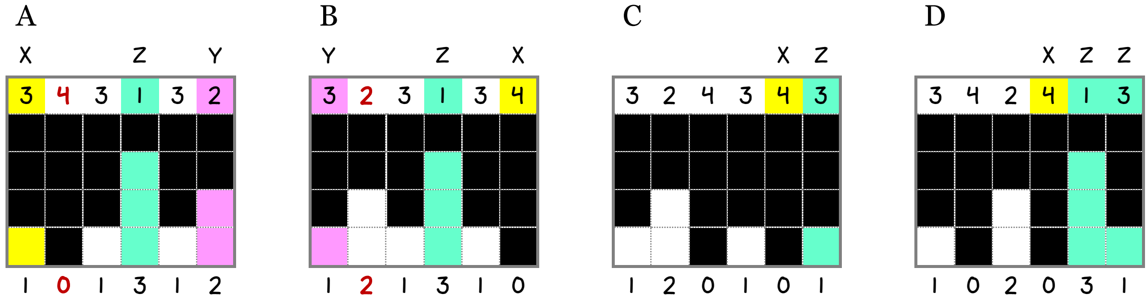
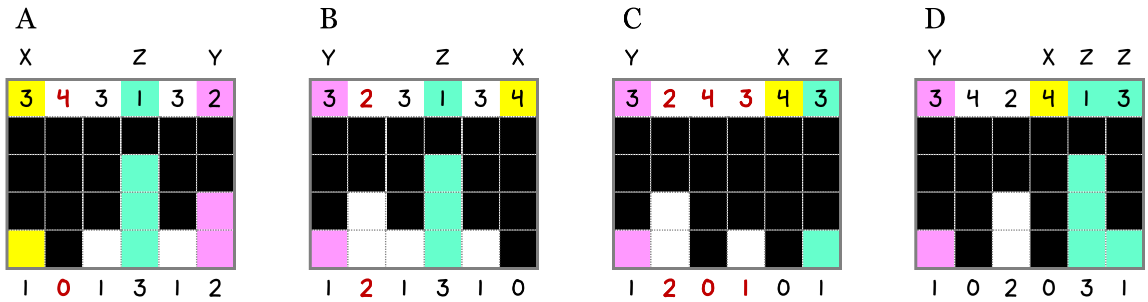


- Two cards have now been identified in patterns C and D, so each of those patterns must start with the remaining card: card Y for both pattern C and pattern D.
- Observe any one of the following.
  - The *second* column of C can now only be the middle column of card Y, but that doesn't have 2 black (2 light) squares.
  - The *third* column of C can now only be the right of card Y or the left of card X, but neither of those have 4 black (0 light) squares.
  - The *fourth* column of C can now only be the middle column of card X, but that doesn't have 3 black (1 light) squares.

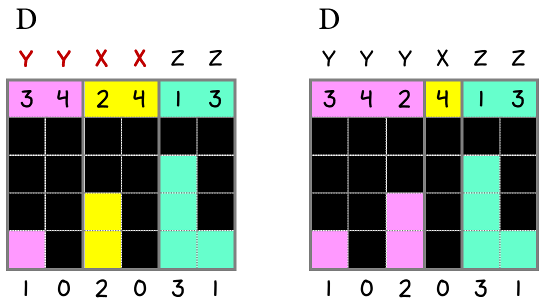
  Pattern C cannot be made: **option C is incorrect**.
- By process of elimination, it appears that **option D must be correct**.



Confirmation

We could simply stop here. Or, if we have spare time, we could confirm the above conclusion.

- The *second* column of D can now only be the middle of card Y or the left of card X. By inspecting the two cards, it must be card Y.
- For the *third* column of D we now consider the right of card Y or the middle of card X.
  - By inspecting the two cards, either card *seems* to work, as below.



  - However, the version on the *left* is impossible: the right column of card Y would have to be hidden under card X, whilst the left column of card X would have to be hidden under card Y!
  - The version on the *right* is possible: card Z is on the bottom, card Y is on the top, and card X is sandwiched between them.

This confirms that **option D is correct**.

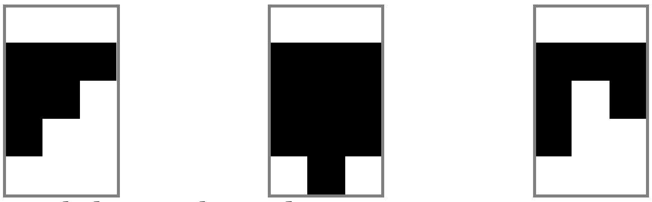
Commentary

This example question might be somewhat challenging at first glance. Focus on understanding the concepts, and try applying them to the practice questions!

ii. Practice questions

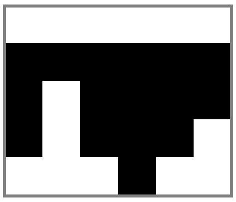
Practice I

By moving the following three cards horizontally (allowing overlap),

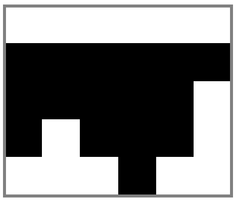


which of the four patterns below <u>can</u> be made?

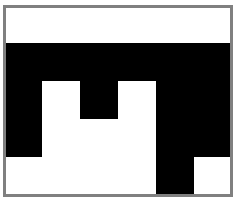
A



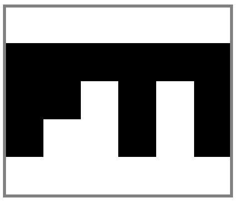
B



C

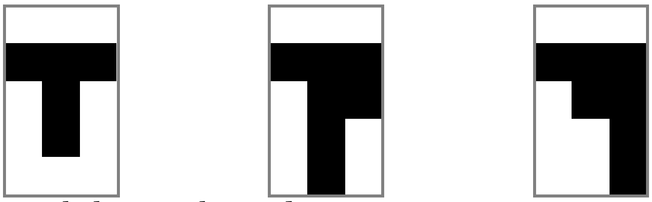


D



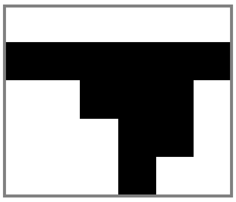
Practice II

By moving the following three cards horizontally (allowing overlap),

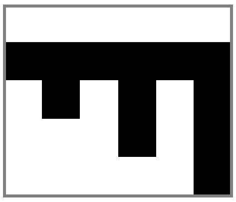


which of the four patterns below <u>can</u> be made?

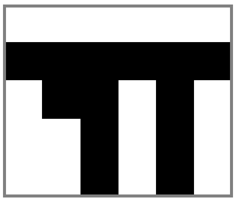
A



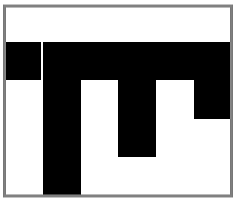
B



C

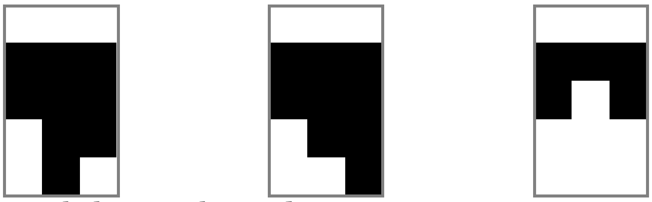


D



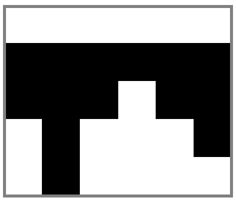
Practice III

By moving the following three cards horizontally (allowing overlap),

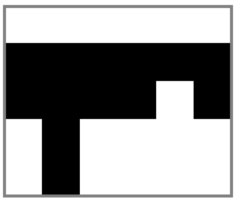


which of the four patterns below <u>can</u> be made?

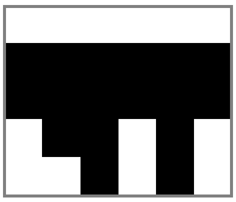
A



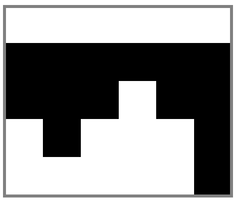
B



C

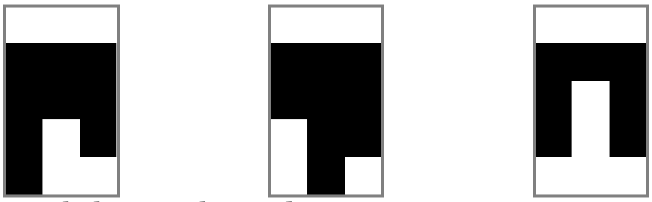


D



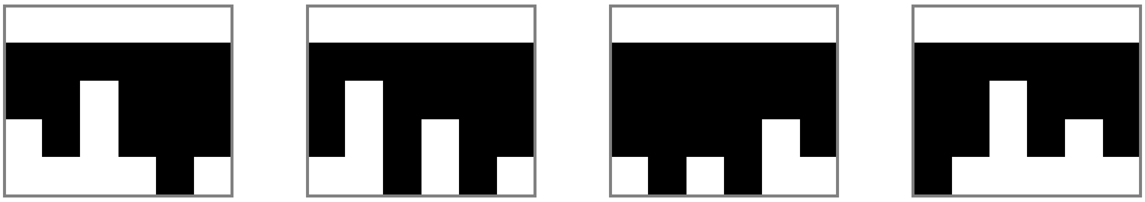
Practice IV

By moving the following three cards horizontally (allowing overlap),



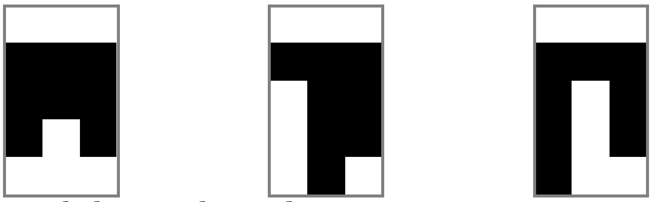
which of the four patterns below can be made?

A B C D



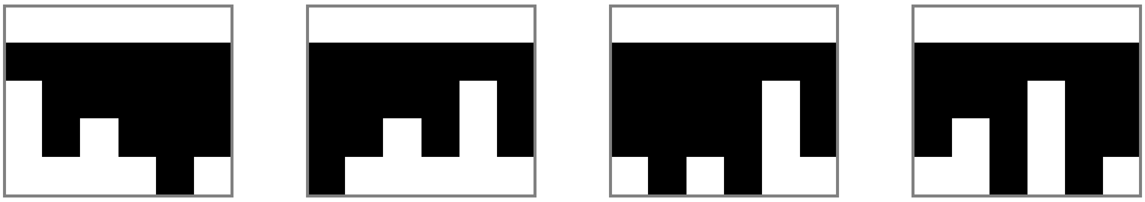
Practice V

By moving the following three cards horizontally (allowing overlap),



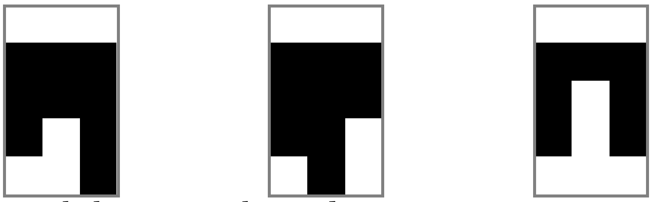
which of the four patterns below can be made?

A B C D



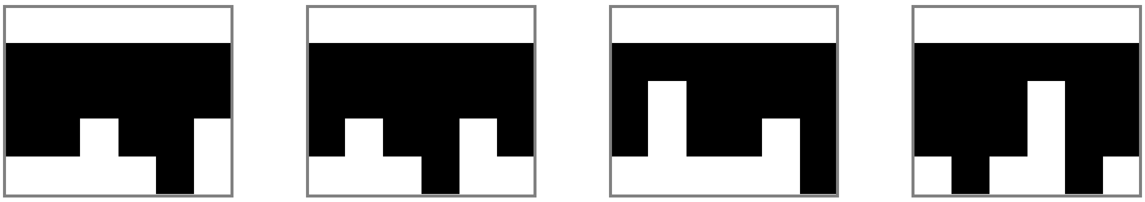
Practice VI

By moving the following three cards horizontally (allowing overlap),



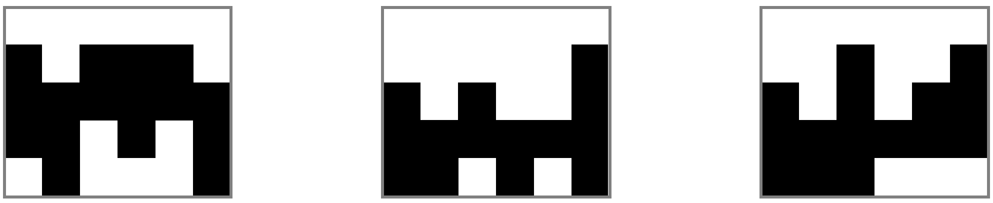
which of the four patterns below cannot be made?

A B C D



Practice VII (*larger cards*)

By moving the following three cards horizontally (allowing overlap),



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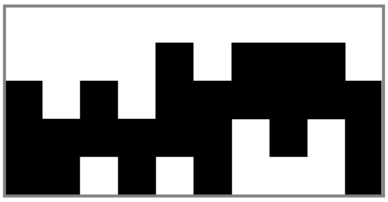
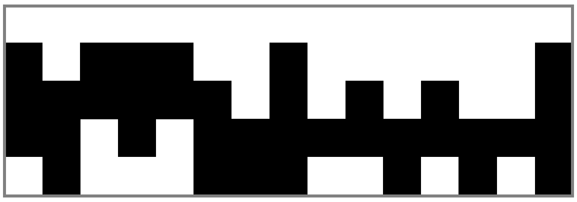
which of the four patterns below <u>cannot</u> be made?

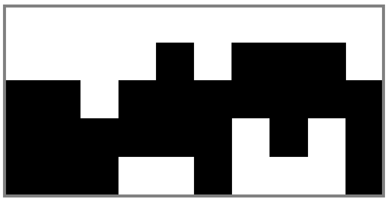
A



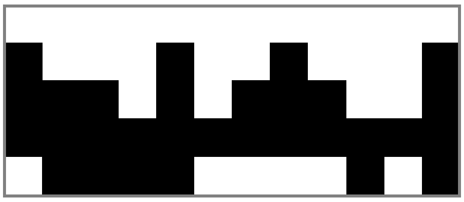
B



C

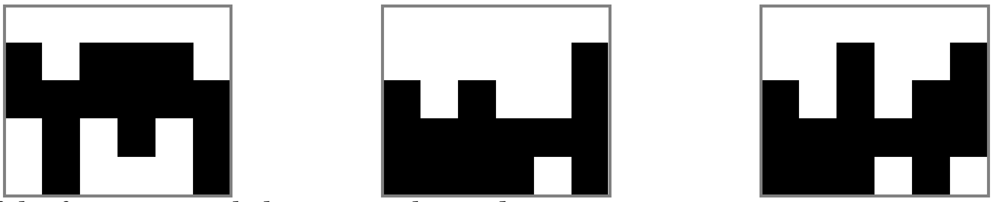


D



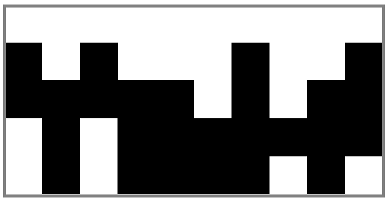
Practice VIII (*larger cards*)

By moving the following three cards horizontally (allowing overlap),

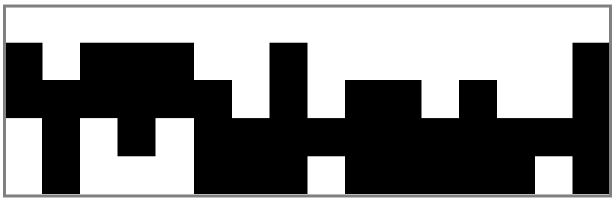


which of the four patterns below <u>cannot</u> be made?

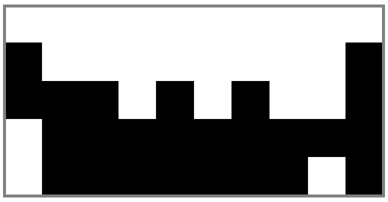
A



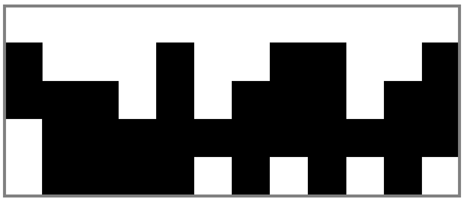
B



C



D



2. Mathematical Reasoning

a) Finding digits in a multiplication

For all of the following questions, the letters differ in value from one another, and can otherwise be any digit from 0 to 9.

i. Example question

Problem statement

Which letter has the smallest value in the following multiplication?

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$$\begin{array}{r} Y\ 2\ Z\ 4 \\ \times \quad\quad W \\ \hline Y\ X\ 3\ V \\ \hline \end{array}$$

(A) V (B) W (C) X (D) Y (E) Z

Solution

The key to solving this question is to identify where we have been given enough information to make progress — which we can do by considering each column in turn. We will work in the traditional way, moving from left to right.

- *Ones column*: **W×4 = V**. W might be any digit. From the "four times" table we notice that W×4 could be 0, 4, 8, 12, 16, 20, 24, 28, 32 or 36. So V must be an even number (0, 2, 4, 6 or 8). Notice that we *might* have to carry a 1, 2 or 3 over into the tens column — which is represented as "carryover" below — but remember that sometimes nothing needs to be carried (so carryover would be zero).
- *Tens column*: **W×Z + carryover = _3**. A blank has been added in front of the "3" to accommodate any digit carried into the hundreds column. There are too many unknowns in this column to figure out any values. (However, we can confirm that W is not 0 — if it were, we wouldn't be able to get a 3 in the bottom line.)
- *Hundreds column*: **W×2 + carryover = _X**. A blank has been added in front of the "X" to accommodate any carryover to the thousands column. Again there are too many unknowns in this column to figure out any values.
- *Thousands column*: **W×Y + carryover = Y**. Note that there cannot be any carryover into the ten-thousands column. Notice that Y appears twice. Let's consider a few examples for various potential values of Y.
  - If Y = 2.
    - **1**×2 + 0 = 2
    - 1×2 + 10 = 12 (not valid: excessive carryover)
    - 2×2 + 8 = 12 (not valid: excessive carryover)
    - 9×2 + 4 = 22 (not valid: excessive carryover)
  - If Y = 5.
    - **1**×5 + 0 = 5
    - 1×5 + 10 = 15 (not valid: excessive carryover)
    - 2×5 + 5 = 15 (not valid: excessive carryover)
  - If Y = 8.
    - **1**×8 + 0 = 8
    - 1×8 + 10 = 18 (not valid: excessive carryover)
    - 2×8 + 5 = 18 (not valid: excessive carryover)

  From those examples it should be apparent that for any value of Y*, **W must be 1**.

Let's review the problem statement: we need to find the letter representing the smallest digit. We know that W is 1, which is quite small — the only smaller digit would be 0†. Can any of the other letters represent 0?

- *Ones column*: **1×4 = V**. Hence **V is 4**, and there is no carryover to the tens column.
- *Tens column*: **1×Z = _3**. Hence **Z is 3**, and there is no carryover to the hundreds column.
- *Hundreds column*: **1×2 = _X**. Hence **X is 2**, and there is no carryover to the tens column.
- *Thousands column*: **1×Y = Y**. We cannot figure out the value of Y, but logically we wouldn't write it down if it were 0, so we can safely assume that **Y is not 0**. Y must be larger than W.

Therefore the **correct option is B**.

* Technically, if Y were 0, then W would not need to be 1. However, when performing multiplication in tabular format we would not write down "0" as the leftmost digit. Therefore we do not need to accommodate the case of Y = 0.

† The solution could have stopped here if the problem statement had said that the letters uniquely represent any digit from 1 to 9 (rather than from 0 to 9).

Commentary

This example question might be somewhat challenging at first glance. Focus on understanding the concepts, and try applying them to the practice questions!

ii. Practice questions

Practice I (*easier*)

What digit does K represent in the following multiplication?

$$\begin{array}{r} J\ J \\ \times \quad 3 \\ \hline 1\ K\ J \end{array}$$

(A) 3 (B) 4 (C) 5 (D) 6 (E) 9

Practice II (*easier*)

What digit does Q represent in the following multiplication?

$$\begin{array}{r} P\ 0\ 6 \\ \times \quad Q \\ \hline 8\ 1\ Q \end{array}$$

(A) 1 (B) 2 (C) 4 (D) 6 (E) 8

Practice III

What digit does P represent in the following multiplication?

$$\begin{array}{r} 1\ 3\ 6 \\ \times \quad P \\ \hline 1\ 0\ P\ P \end{array}$$

(A) 2 (B) 3 (C) 4 (D) 6 (E) 8

Practice IV

What digit does G represent in the following multiplication?

$$\begin{array}{r} 2\ 5\ 8 \\ \times \quad G \\ \hline 1\ J\ H\ 8 \end{array}$$

(A) 1 (B) 2 (C) 4 (D) 6 (E) 8

Practice V

What digit does L represent in the following multiplication?

$$\begin{array}{r} K\ K \\ \times \quad L \\ \hline 3\ 8\ L \end{array}$$

(A) 1 (B) 3 (C) 5 (D) 7 (E) 9

Practice VI (*harder*)

What digit does T represent in the following multiplication?

$$\begin{array}{r} T\ T \\ \times \quad U \\ \hline 4\ T\ U \end{array}$$

(A) 1 (B) 3 (C) 5 (D) 7 (E) 9

Practice VII (*harder*)

What digit does M represent in the following multiplication?

$$\begin{array}{r} Q\ N\ R \\ \times \quad 2 \\ \hline M\ R\ Q \end{array}$$

(A) 2 (B) 4 (C) 6 (D) 8 (E) 9

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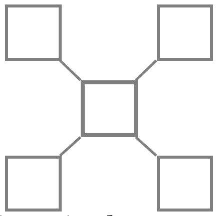
b) Arranging numbers to make a consistent sum

i. Example question

Problem statement

Question 7 from the [2021 Mathematical Reasoning sample test] requires five numbers — 1, 2, 3, 4 & 5 — to be arranged in the boxes below so that the sum along each of the two diagonals is 8, using each number once only.



Which of the five numbers must be written in the central box?

(A) 1 (B) 2 (C) 3 (D) 4 (E) 5

Solution

Comment

A solution is provided online by the NSW Department of Education. However, the official solution does not mention some tips that can be used to solve this — and other, similar, problems — more efficiently.

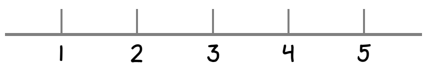
Concept

One of the numbers must be written in the central box, and the *remaining numbers* (to be written in the outer boxes) must be paired up. The each of the pairs must also have a consistent sum.

- This can only occur when the largest of the remaining numbers is paired up with the smallest of the remaining numbers!
    - Then the second-largest is paired with the second-smallest, and so on[*].
- The sums of the various pairs will only be consistent if the remaining numbers can be arranged symmetrically on a number line!
    - When beginning with a set of consecutive numbers[†], the remaining numbers will only have that characteristic if the number placed in the central box is either the first, middle or last value in the original set.
    - If the original set of numbers is *not* uniformly spaced on a number line, then any of them could be the number in the central box[‡].

Solution

Looking at the five original numbers on a number line

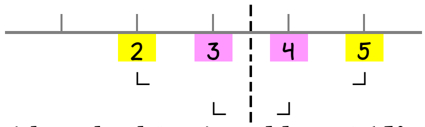


the remaining numbers will be symmetrical if we remove the first, middle or last value. Notice that we can immediately identify that **only three of the options are viable (A, C & E)**.

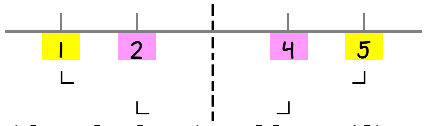
The three viable alternatives are examined below. The symmetry is marked with a dashed line (¦).

Remove 1

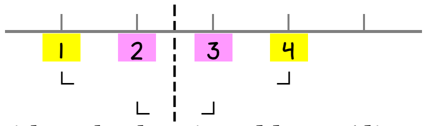
[*] Students might be familiar with this type of pairing of the numbers on opposite sides of a die (1 is opposite 6, 2 is opposite 5, and 3 is opposite 4; each pair adds to 7).
[†] The strategy still works well even if the numbers are not consecutive! Try the practice questions marked "*extension 1*" on page 12 onwards.
[‡] Try the practice questions marked "*harder extension 1*" on page 13.



then pair 2 with 5, and pair 3 with 4: both[*] pairs add to 7[†] (**diagonals will add to 8**).
Remove 3



then pair 1 with 5, and pair 2 with 4: both pairs add to 6 (diagonals will add to 9[‡]).
Remove 5



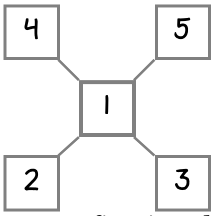
then pair 1 with 4, and pair 2 with 3: both pairs add to 5 (diagonals will add to 10).

As mentioned, removing 2 or 4 will not yield four remaining numbers that can be arranged symmetrically on a number line. (Check this for yourself!)

Among the three viable alternatives, placing 1 in the central box yields the correct sum on both diagonals; therefore the **correct option is A**.

Confirmation

We could stop here and move on. Or, if we have spare time, we could confirm the above conclusion by writing the proposed values into the boxes.



As expected, the diagonals each sum to 8, confirming that **option A is correct**.

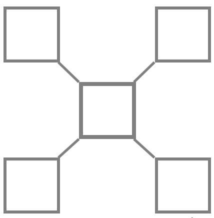
Commentary

This more sophisticated understanding can save a bit of time, and can even allow extension to larger problems without much extra difficulty!

ii. Practice questions

Practice I (*easier*)

Arrange 11, 12, 13, 14 & 15 in the boxes below, using each number once only, so that each diagonal sums to 38. Which number must be written in the central box?



(A) 11 (B) 12 (C) 13 (D) 14 (E) 15

[*] Using the pairing strategy described here yields the same sum for both pairs, as expected. Therefore, in principle it is only necessary to find the sum of one pair (and assume that the other will be identical). On the other hand, checking both pairs minimises the risk of overlooking an arithmetic error. Note that if the five numbers in the original set are *not* uniformly spaced on a number line, then the two pairs are only guaranteed to have identical sums when the correct number is reserved for the central box (see the practice questions marked "*extension 1*" on page 12 onwards).

[†] This is twice the *average* of the four remaining numbers (3½); the dashed line of symmetry is located at that average value.

[‡] Of course, if we had already found that putting 1 in the central box yields the correct sums on the diagonals, then we would not need to check the other two alternatives! Here it is presented for completeness, and to confirm the solution.

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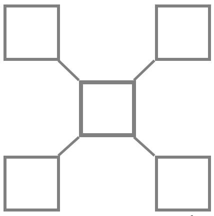
Practice II

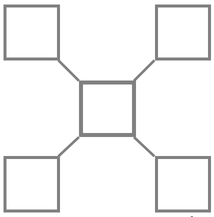
Arrange 5, 6, 7, 8 & 9 in the boxes below, using each number once only, so that each diagonal sums to 22. Which number must be written in the central box?



(A) 5 (B) 6 (C) 7 (D) 8 (E) 9

Practice III

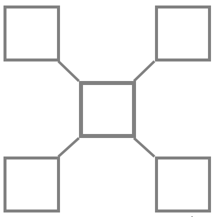
Arrange 63, 64, 65, 66 & 67 in the boxes below, using each number once only, so that each diagonal sums to 195. Which number must be written in the central box?



(A) 63 (B) 64 (C) 65 (D) 66 (E) 67

Practice IV

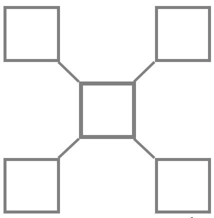
Arrange 3, 6, 9, 12 & 15 in the boxes below, using each number once only, so that each diagonal sums to 30. Which number must be written in the central box?



(A) 3 (B) 6 (C) 9 (D) 12 (E) 15

Practice V (*extension 1*)

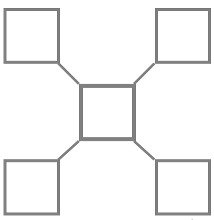
Arrange 22, 29, 31, 38 & 40 in the boxes below, using each number once only, so that each diagonal sums to 100. Which number must be written in the central box?



(A) 22 (B) 29 (C) 31 (D) 38 (E) 40

Practice VI (*harder extension 1*)

Arrange 5, 12, 19, 26 & 33 in the boxes below, using each number once only, so that each diagonal sums to 57. Which number must be written in the central box?



(A) 5 (B) 12 (C) 19 (D) 26 (E) 33

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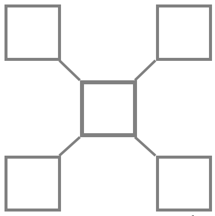
Practice VII (*harder extension 1*)

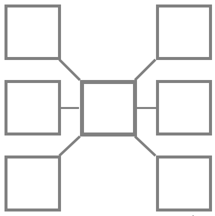
Arrange 20, 35, 55, 61 & 70 in the boxes below, using each number once only, so that each diagonal sums to 151. Which number must be written in the central box?



(A) 20 (B) 35 (C) 55 (D) 61 (E) 70

Practice VIII (*extension 2*)

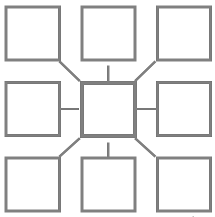
Arrange 1, 2, 3, 4, 5, 6 & 7 in the boxes below, using each number once only, so that the two diagonals and the middle row each sum to 12. Which number must be written in the central box?



(A) 1 (B) 3 (C) 4 (D) 6 (E) 7

Practice IX (*extensions 1 & 2*)

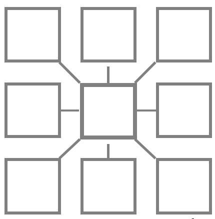
Arrange 4, 6, 8, 10, 12, 14, 16, 18 & 20 in the boxes below, using each number once only, so that the two diagonals, the middle row and the middle column each sum to 30. Which number must be written in the central box?



(A) 4 (B) 10 (C) 12 (D) 16 (E) 20

Practice X (*harder extensions 1 & 2*)

Arrange 1, 8, 15, 22, 29, 36, 43, 49 & 50 in the boxes below, using each number once only, so that the two diagonals, the middle row and the middle column each sum to 100. Which number must be written in the central box?



(A) 1 (B) 8 (C) 29 (D) 49 (E) 50

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