HINTS AND SOLUTIONS

PART-1

CHAPTER 1 : A SQUARE AND A CUBE

Let's Recall

1. (*a*) Let's look at each pattern carefully and then write the next three terms.

2, 4, 8, 14, 22, 32, …, …, …

Here the differences between consecutive terms are:

4 − 2 = 2; 8 − 4 = 4; 14 − 8 = 6;
22 − 14 = 8; 32 − 22 = 10

The differences increase by 2 each time: 2, 4, 6, 8, 10, …

So the next differences will be 12, 14, 16.

So, 32 + 12 = 44, 44 + 14 = 58 and 58 + 16 = 74

Next three terms: 44, 58, 74

(*b*) 2, 3, 8, 10, 15, 18, 23, … , … , …

Here the differences between consecutive terms are:

3 − 2 = 1; 8 − 3 = 5;10 − 8 = 2;
15 − 10 = 5; 18 − 15 = 3; 23 − 18 = 5

Observe the pattern: +1, +5, +2, +5, +3, +5, …

It alternates between adding 5 and increasing numbers (1, 2, 3, …).

So the next differences will be:
+4, +5, +5

Now continue the sequence:
23 + 4 = 27; 27 + 5 = 32; 32 + 5 = 37

Next three terms: 27, 32, 37

2. This is a standard matchstick–square pattern. Let's make it clear step by step.

Given pattern

4 matchsticks → 1 square (1 × 1 grid)
12 matchsticks → 4 small squares (2 × 2 grid)
24 matchsticks → 9 small squares (3 × 3 grid)

So the pattern is:

Each step forms a larger square grid

Step number = side length of the grid

General pattern: For a grid of size (n times n):

Number of matchsticks = $2n(n + 1)$

Number of small squares = n^2

Total number of squares (all sizes) = $1^2 + 2^2 + 3^2 + 4^2 + ... + n^2$

Continue to the next step,

Next step (4 × 4 grid)

- Number of matchsticks [2 × 4 × 5 = 40]
- Number of small squares [$4^2 = 16$]
- Total number of squares (all sizes) [$1^2 + 2^2 + 3^2 + 4^2 = 1 + 4 + 9 + 16 = 30$]

Summary table

Step	Matchsticks	Small squares	Total squares
1	4	1	1
2	12	4	5
3	24	9	14
4	40	16	30

In the next step, 40 matchsticks are needed and the figure contains 30 squares in total.

3. Given:

- $1^3 = 1$ cube
- $2^3 = 8$ cubes
- $3^3 = 27$ cubes
- $4^3 = 64$ cubes
- and so on ...

We are asked: How many more cubes are added each time to make the next block?

Step 1: Find the increase each time

Block	Total cubes	More cubes added
1^3	1	—
2^3	8	8−1=7
3^3	27	27−8=19
4^3	64	64−27=37

Step 2: Write numbers in the blank boxes

The numbers cubes added each time are:
7, 19, 37.

Fast Check (Page 10)

1. Factors of 60: 1, 2, 3, 4, 5, 6, 10, 12, 15, 20, 30, 60

Since the number of factors is even, 60 is not a perfect square.

2. Factors of 81: 1, 3, 9, 27, 81

Since the number of factors is odd, 81 is a perfect square. ($81 = 9^2$)

3. Factors of 96: 1, 2, 3, 4, 6, 8, 12, 16, 24, 32, 48, 96

Since the number of factors is even, 96 is not a perfect square.

Fast Check (Page 11)

1. Between 20 and 50

$4^2 = 16$ (less than 20)

$5^2 = 25$

$6^2 = 36$

$7^2 = 49$

$8^2 = 64$ (greater than 50)

Perfect squares between 20 and 50: 25, 36, 49

2. Between 70 and 100

$8^2 = 64$ (less than 70)

$9^2 = 81$

$10^2 = 100$

Perfect squares between 70 and 100 : 81

Practice Time 1A

1. (*a*) 243

3	243
3	81
3	27
3	9
3	3
	1

Resolving into prime Factors, we find that

$243 = \underline{3 \times 3} \times \underline{3 \times 3} \times 3$

$= 3^2 \times 3^2 \times 3$

Grouping the factors into pairs of same factors. We find that 3 is left unpaired.

So, 243 is not a perfect square

(*b*) 729

3	729
3	243
3	81
3	27
3	9
3	3
	1

Resolving into prime factors, we find that

$729 = \underline{3 \times 3} \times \underline{3 \times 3} \times \underline{3 \times 3}$

$= 3^2 \times 3^2 \times 3^2$

$= (3 \times 3 \times 3)^2 = 27$

Grouping the factors into pairs of same factors, we find that no factor is unpaired.

Therefore, 729 is a perfect square

(*c*) Same as part (*a*)

(*d*) Same as part (*b*)

2. (*a*) 1444

2	1444
2	722
19	361
19	19
	1

Resolving into prime factors, we find that

$1444 = 2 \times 2 \times 19 \times 19$

$= 2^2 \times 19^2$

After grouping the factors into pair of same factors we find that the prime factors of 1444 can be grouped into pairs and no factors is left unpaired. Therefore, 1444 is a perfect square.

$1444 = 2^2 \times 19^2 = (2 \times 19)^2 = 38^2$

So, the square of 38 is 1444.

(*b*)-(*d*) Same as above

3. Resolving into prime factors.

2	5808
2	2904
2	1452
2	726
3	363
3	121
11	11

We find that

$5808 = \underline{2 \times 2} \times \underline{2 \times 2} \times \underline{11 \times 11} \times 3$

Grouping the factors into pairs of same factors, we find that 3 is left unpaired.

So, to get a perfect square, 5808 should be multiplied by 3.

4. Resolving into Prime Factors

We find that

2	9800
2	4900
2	2450
5	1225
5	245
7	49
7	7
	1

$9800 = \underline{2 \times 2} \times 2 \times \underline{5 \times 5} \times \underline{7 \times 7}$

Grouping the factors into pairs into pairs of same factors. We find that 2 is left unpaired.

So, to get a perfect square, 9800 should be divided by 2.

So, the required number is 2.

5. The LCM of 2, 3, 6 and 10 = 2 × 3 × 5 = 30

2	2, 3, 6, 10
3	1, 3, 3, 5
	1, 1, 1, 5

30 is not a perfect square as 2, 3 and 5 are not in pains.

Thus, to make 90 a perfect square, 30 must be multiplied by 2 × 3 × 5 = 30.

Hence, the smallest square number exactly divisible by 2, 3, 6 and 10 is 30 × 30 = 900.

6. LCM of 8, 15, and 20

$= \underline{2 \times 2} \times 2 \times 3 \times \underline{5 \times 5} = 600$

2	8, 15, 20
2	4, 15, 10
5	2, 15, 5
	2, 3, 1

600 is not perfect square as 2 and 3 are not in pairs.

Thus to make 600 a perfect square, 600 nust be multiplied by 2 × 3 = 6

Hence, the smallest square number exactly divisible by 8, 15, and 20 is 600 × 6 = 3600.

7. To find the total number of tiny squares in the image, we need to count the internal grid of each patterned block and then multiply by the number of blocks.

Blocks in the grid: 9 rows × 9 columns = 81 blocks

Tiny squares per block**:** 5 rows × 5 columns = 25 squares

Total tiny squares: 81 × 25 = 2025

Prime factorisation: $3 \times 3 \times 3 \times 3 \times 5 \times 5 = 3^4 \times 5^2$

Fast Check (Page 14)

(*a*) 24 and 38

24 ends in 4 ⟶ square ends in 6

38 ends in 8 ⟶ square ends in 4

(*b*) 35 and 50

35 ends in 5 ⟶ square ends in 5

50 ends in 0 ⟶ square ends in 0

(*c*) 16 and 24

16 ends in 6 ⟶ square ends in 6

24 ends in 4 ⟶ square ends in 6

Same unit's digit

(*d*) 19 and 23

19 ends in 9 ⟶ square ends in 1

23 ends in 3 ⟶ square ends in 9

Final Answer

(*c*) 16 and 24

Think Tank (Page 18)

Observe the following pattern and find the missing numbers.

1.

$7^2 = 49$

$67^2 = 4489$

$667^2 = 444889$

$6667^2 = 44448889$

$66667^2 = \underline{4444488889}$

$\underline{666667}^2 = 444444888889$

$\underline{6666667}^2 = 44444448888889$

2.

$11^2 = 121$

$101^2 = 10201$

$1001^2 = \underline{1002001}$

$10001^2 = 100020001$

$100001^2 = 10000200001$

$1000001^2 = \underline{1000002000001}$

Practice Time 1B

1. (*a*) The ones digit of 82 is 2, so the ones digit of square of 82 is 4.

(*b*) The ones digit of 93 is 3, so the ones digit of square of 93 is 9.

(*c*) The ones digit of 128 is 8, so the ones digit of square of 128 is 4.

(*d*) The ones digit of 179 is 9, so the ones digit of square of 179 is 1.

2. (*a*) 7921 is a perfect square, as its units or units digit is 1.

Justification: We can also verify this by prime factorisation.

Since 7921 = 89 × 89, we form pairs of its prime factors.

Therefore, 7921 is a perfect square.

(*b*) 33453 is not a perfect square, as its units or units digit is 3.

Justification: We can also verify this by prime factorisation.

Since 33453 = 3 × 3 × 3 × 3 × 7 × 59, we cannot form pairs of its prime factors.

Therefore, 33453 is not a perfect square.

(*c*) – (*d*). Same as part *b*.

3. The square of odd number is always an odd.

(*a*) 61: Since 61 is an odd number, the square of 61 is also an odd.

(*b*) 872: Since 872 is an even number, the square of 872 is not an odd.

(*c*) 499: Since 499 is an odd number, the square of 499 is also an odd.

(*d*) 176: Since 176 is an even number, the square of 176 is not an odd.

4. (*a*) 1 + 3 + 5 + 7 + 9 + 11

These are the first 6 odd numbers.

Since, sum of first n odd numbers = n^2

Sum = $6^2 = 36$

(*b*) 1 + 3 + 5 + 7 + 9 + 11 + 13 + 15 + 17 + 19 + 21

These are the first 11 odd numbers.

∴ Sum = $11^2 = 121$

(*c*) 11 + 13 + 15 + 17 + … + 29 + 31

This is a sequence of consecutive odd numbers.

First odd number = 11 = 6th odd number

Last odd number = 31 = 16th odd number

So the sum is:

$16^2 - 5^2 = 256 - 25 = 231$

∴ Sum = 231

5. (*a*) 16 = 1 + 3 + 5 + 7

(*b*) 36 = 1 + 3 + 5 + 7 + 9 + 11

(*c*) 121 = 1 + 3 + 5 + 7 + 9 + 11 + 13 + 15 + 17 + 19 + 21

(*d*) 144 = 1 + 3 + 5 + 7 + 9 + 11 = 13 + 15 + 17 + 19 + + 21 + 23

6. Any perfect square n^2 can be written as the sum of two consecutive numbers:

$$n^2 = \frac{(n^2-1)}{2} + \frac{(n^2+1)}{2}$$

These two numbers are consecutive.

(*a*) 361:

$361 = 19^2$

$$\frac{(361-1)}{2} = \frac{360}{2} = 180$$

$$\frac{(361+1)}{2} = \frac{362}{2} = 181$$

361 = 180 + 181

(b) 625:

$625 = 25^2$

$$\frac{(625-1)}{2} = \frac{624}{2} = 312$$

$$\frac{(625+1)}{2} = \frac{626}{2} = 313$$

625 = 312 + 313

(*c*) 441:

$441 = 21^2$

$$\frac{(441-1)}{2} = \frac{440}{2} = 220$$

$$\frac{(441+1)}{2} = \frac{442}{2} = 221$$

441 = 220 + 221

(*d*) 529:

$529 = 23^2$

$$\frac{(529-1)}{2} = \frac{528}{2} = 264$$

$$\frac{(529+1)}{2} = \frac{530}{2} = 265$$

529 = 264 + 265

7. **Rule:** The product of two consecutive even or two consecutive odd numbers can be written as:

$n\,(n + 2) = (n + 1)^2 - 1$

(*a*) 15 × 17

15 and 17 are consecutive odd numbers.

15 × 17 = (16 − 1)(16 + 1)

$15 \times 17 = 16^2 - 1$

(*b*) 36 × 38

36 and 38 are consecutive even numbers.

36 × 38 = (37 − 1)(37 + 1)

$36 \times 38 = 37^2 - 1$

(*c*) 43 × 45

43 and 45 are consecutive odd numbers.

43 × 45 = (44 − 1)(44 + 1)

$43 \times 45 = 44^2 - 1$

(*d*) 58 × 60

58 and 60 are consecutive even numbers.

58 × 60 = (59 − 1)(59 + 1)

$58 \times 60 = 59^2 - 1$

8. Using the given pattern, find the missing numbers

Given:

$4^2 + 5^2 + 20^2 = 21^2$

$5^2 + 6^2 + 30^2 = 31^2$

Pattern Explanation

The first two numbers are squares of consecutive natural numbers, that is, n^2 and $(n + 1)^2$.

The third number is the square of the product of these two consecutive numbers, that is, $[n\,(n + 1)]^2$.

The number on the right-hand side is the square of one more than this product, that is, $[n\,(n + 1) + 1]^2$.

Hence, the general pattern is:

$n^2 + (n + 1)^2 + [n\,(n + 1)]^2 = [n(n + 1) + 1]^2$

This explains the following:

$4^2 + 5^2 + 20^2 = 21^2$

$5^2 + 6^2 + 30^2 = 31^2$

$6^2 + 7^2 + 42^2 = 43^2$

$7^2 + 8^2 + 56^2 = 57^2$

$8^2 + 9^2 + 72^2 = 73^2$

9. Since, $(n + 1)^2 = n^2 + 2n + 1$, where, $n = 28$

$28^2 = 784$ (Given)

$29^2 = 28^2 + 2 \times 28 + 1 = 784 + 57 = 841$

10. We know that difference of the squares of any two consecutive natural numbers is equal to their sum. Therefore,

(*a*) $48^2 - 47^2 = 48 + 47 = 95$

(*b*) $25^2 - 24^2 = 25 + 24 = 49$

(*c*) $92^2 - 91^2 = 92 + 91 = 183$

(*d*) $142^2 - 141^2 = 142 + 141 = 283$

(*e*) $180^2 - 179^2 = 100 + 179 = 359$

(*f*) $256^2 - 255^2 = 256 + 255 = 511$

Fast Check (Page 20)

1. $58^2 = 58 \times 58 = 3364$

2. $73^2 = 73 \times 73 = 5329$

Practice Time 1C

1. (*a*) 49

Successively subtract 1, 3, 5, 7, 9, … from 49:

49 − 1 = 48	40 − 7 = 33
48 − 3 = 45	33 − 9 = 24
45 − 5 = 40	24 − 11 = 13
	13 − 13 = 0

Since, the result is 0,

Hence, 49 is a perfect square (7^2).

(*b*) 120

Successively subtract 1, 3, 5, 7, 9, … from 120:

120 − 1 = 119	84 − 13 = 71
119 − 3 = 116	71 − 15 = 56
116 − 5 = 111	56 − 17 = 39
111 − 7 = 104	39 − 19 = 20
104 − 9 = 95	20 − 21 = −1
95 − 11 = 84	

Since, the result is not 0.

Hence, 120 is not a perfect square.

(*c*) 121

Successively subtract 1, 3, 5, 7, 9, … from 121:

121 − 1 = 120	85 − 13 = 72
120 − 3 = 117	72 − 15 = 57
117 − 5 = 112	57 − 17 = 40
112 − 7 = 105	40 − 19 = 21
105 − 9 = 96	21 − 21 = 0
96 − 11 = 85	

Since, the result is not 0.

Hence, 121 is a perfect square (11^2).

(*d*) 136

Successively subtract 1, 3, 5, 7, 9, … from 136:

136 − 1 = 135	100 − 13 = 87
135 − 3 = 132	87 − 15 = 72
132 − 5 = 127	72 − 17 = 55
127 − 7 = 120	55 − 19 = 36
120 − 9 = 111	36 − 21 = 15
111 − 11 = 100	15 − 23 = −8

Since, the result is not 0.

Hence, 136 is not a perfect square.

2. (*a*) $35^2 = (3 \times 4)$ hundreds + 25

= 12 hundreds + 25 = 1200 + 25 = 1225

(*b*) 106: Nearest base = 100 (two 0s)

Difference = 106 – 100 = 6

Hence, $106^2 = 106 + 6 \mid 6^2 = 112 \mid 36 = 11236$.

(*c*) $21^2 = (20 + 1) \times (20 + 1)$

$= 20\,(20 + 1) + 1\,(20 + 1)$

$= 400 + 20 + 20 + 1 = 441$.

(*d*) $75^2 = (7 \times 8)$ hundreds + 25

= 56 hundreds + 25 = 5600 + 25 = 5625.

(*e*) $49^2 = (50 – 1) \times (50 – 1)$

$= 50(50 – 1) – 1(50 – 1)$

$= 2500 – 50 – 50 + 1 = 2401$.

(*f*) 92: Nearest base = 100 (two 0s)

Difference: 100 – 92 = 8

Hence, $92^2 = 92 – 8 \mid 8^2 = 84 \mid 64 = 8464$.

(*g*) 105: Nearest base = 100(two 0s)

Difference: 105 – 100 = 5

Hence, $105^2 = 105 + 5 \mid 5^2 = 110 \mid 25 = 11025$.

(*h*) 98: Nearest base = 100 (two 0s)

Difference: 100 – 98 = 2

Hence, $98^2 = 98 – 2 \mid 2^2 = 96 \mid 02 = 9602$

3. To find the square of a number using distributive property, write it as:

(*a*) 33^2

$33 = 30 + 3$

$(30 + 3)^2 = (30 + 3) \times (30 + 3)$

$= 30^2 + 2 \times 30 \times 3 + 3^2$

$= 900 + 180 + 9 = 1089$

(*b*) 97^2

$97 = 100 - 3$

$(100 - 3)^2 = (100 - 3) \times (100 - 3)$

$= 100^2 - 2 \times 100 \times 3 + 3^2$

$= 10000 - 600 + 9 = 9409$

(*c*) 81^2

$81 = 80 + 1$

$(80 + 1)^2 = (80 + 1) \times (80 + 1)$

$= 80^2 + 2 \times 80 \times 1 + 1^2$

$= 6400 + 160 + 1 = 6561$

(*d*) 63^2

$63 = 60 + 3$

$(60 + 3)^2 = (60 + 3) \times (60 + 3)$

$= 60^2 + 2 \times 60 \times 3 + 3^2$

$= 3600 + 360 + 9 = 3969$

(*e*) 72^2

$72 = 70 + 2$

$(70 + 2)^2 = (70 + 2) \times (70 + 2)$

$= 70^2 + 2 \times 70 \times 2 + 2^2$

$= 4900 + 280 + 4 = 5184$

(*f*) 79^2

$79 = 80 - 1$

$(80 - 1)^2 = (80 - 1) \times (80 - 1)$

$= 80^2 - 2 \times 80 \times 1 + 1^2$

$= 6400 - 160 + 1 = 6241$

(*g*) 45^2

$45 = 40 + 5$

$(40 + 5)^2 = (40 + 5) \times (40 + 5)$

$= 40^2 + 2 \times 40 \times 5 + 5^2$

$= 1600 + 400 + 25 = 2025$

(*h*) 89^2

$89 = 90 - 1$

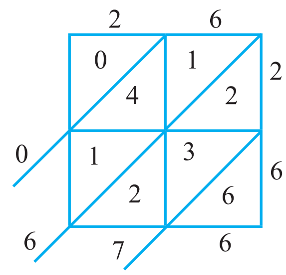
$(90 - 1)^2 = (90 - 1) \times (90 - 1)$

$= 90^2 - 2 \times 90 \times 1 + 1^2$

$= 8100 - 180 + 1 = 7921$

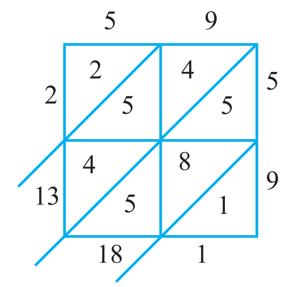
4. Squares using lattice (diagonal) method

(*a*) $26^2 = 676$



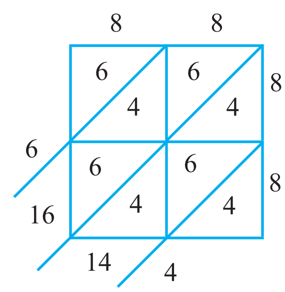
$26^2 = 0 | 6 | 7 | 6 = 676$

(*b*) $59^2 = 3481$



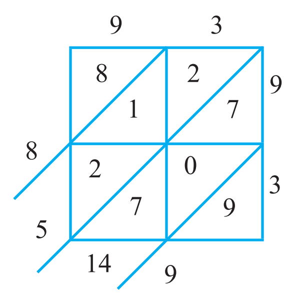
$59^2 = 2 | 13 | 18 | 1 = 2 | 14 | 8 | 1 = 3481$

(*c*) $88^2 = 7744$



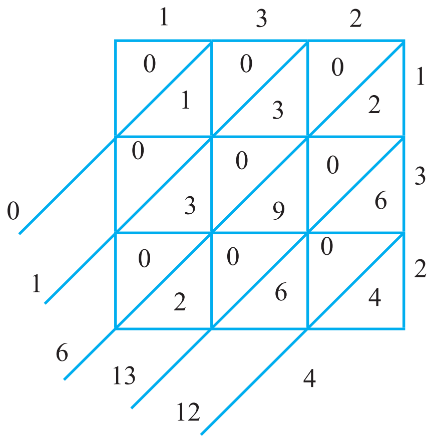
$88^2 = 6 | 16 | 14 | 4 = 6 | 17 | 4 | 4 = 7744$

(*d*) $93^2 = 8649$



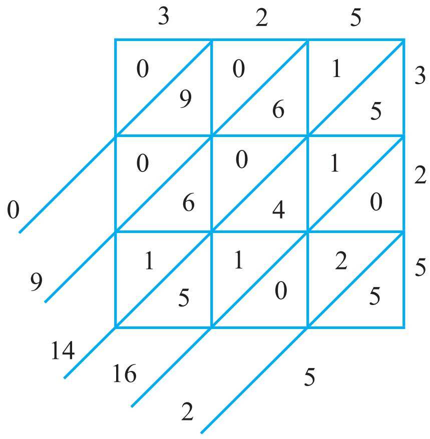
$93^2 = 8 | 5 | 14 | 9 = 8 | 5 + 1 | 4 | 9 = 8649.$

(*e*) $132^2 = 17424$



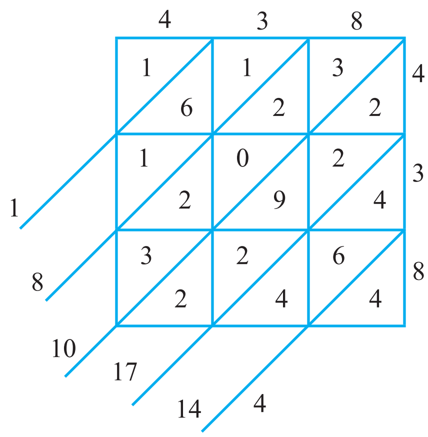
$132^2 = 0 | 1 | 6 | 13 | 12 | 4 = 0 | 1 | 6 | 14 | 2 | 4$
$= 17424$

(*f*) $325^2 = 105625$



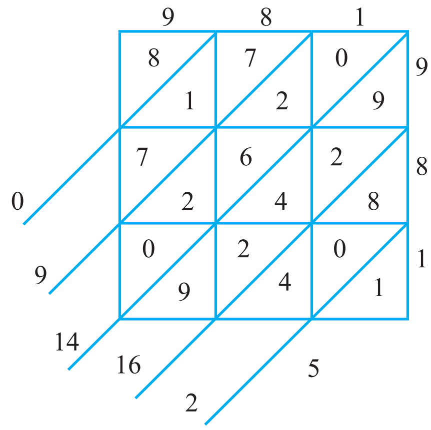
$325^2 = 0 | 9 | 14 | 16 | 2 | 5 = 0 | 9 | 15 | 6 | 2 | 5$
$= 1 | 0 | 5 | 6 | 2 | 5 = 105625$

(*g*) $438^2 = 191844$



$438^2 = 1 | 8 | 10 | 17 | 14 | 4$
$= 1 | 8 | 10 | 18 | 4 | 4$
$= 1 | 8 | 11 | 8 | 4 | 4 = 1 | 9 | 1 | 8 | 4 | 4$
$= 191844$

(*h*) $981^2 = 962361$



$981^2 = 8 | 15 | 10 | 22 | 16 | 1$
$= 8 | 15 | 10 | 23 | 6 | 1$
$= 8 | 15 | 12 | 3 | 6 | 1$
$= 8 | 16 | 2 | 3 | 6 | 1$
$= 9 | 6 | 2 | 3 | 6 | 1 = 962361$

Fast Check (Page 27)

The greatest 4-digit number = 9999

Remainder = 198

$\therefore$ The greatest perfect square of 6-digits

= 9999 – 198 = 9801

	99
9	9999
	– 81
189	1899
	– 1701
	198

Practice Time 1D

1. Rule: If a number has *n* digits, its square root has

- $\frac{n}{2}$ digits (if n is even)
- $\frac{(n+1)}{2}$ digits (if n is odd)

(*a*) $\overline{64}$: Number of digits in the square root 64 is 1

(*b*) $\overline{1}\,\overline{44}$: Number of digits in the square root 144 is 2

(c) $\overline{44}\,\overline{89}$: Number of digits in the square root 4489 is 2

(*d*) $\overline{2}\,\overline{72}\,\overline{25}$: Number of digits in the square root 27225 is 3

(*e*) $\overline{39}\,\overline{06}\,\overline{25}$: Number of digits in the square root 390625 is 3

(*f*) $\overline{19}\,\overline{36}\,\overline{00}$: Number of digits in the square root 193600 is 3 (*g*) $\overline{70}\,\overline{56}$: Number of digits in the square root 7056 is 2.

(*h*) $\overline{9}\,\overline{24}\,\overline{16}$: Number of digits in the square root 92416 is 3.

2. Possible unit digit of the square root of

(*a*) 6561: 1 or 9

(*b*) 2159: Not possible because 2159 is not a perfect square

(*c*) 6084: 2 or 8

(*d*) 15625: 5

(*e*) 5445: Not possible because 5445 is not a perfect square

(*f*) 1729: Not possible because 1729 is not a perfect square

(*g*) 2304: 2 or 8

(*h*) 51076: 4 or 6

3. Rule:

Subtract consecutive odd numbers form given number (1, 3, 5, 7, 9, …) until the result becomes 0. The number of subtractions gives the square root.

(*a*) 121:

$121 - 1 = 120$ $\quad$ $96 - 11 = 85$
$120 - 3 = 117$ $\quad$ $85 - 13 = 72$
$117 - 5 = 112$ $\quad$ $72 - 15 = 57$
$112 - 7 = 105$ $\quad$ $57 - 17 = 40$
$105 - 9 = 96$ $\quad$ $40 - 19 = 21$
$21 - 21 = 0$

Number of subtractions = 11

So, $\sqrt{121} = 11$

(*b*) 144:

$144 - 1 = 143$ $\quad$ $108 - 13 = 95$
$143 - 3 = 140$ $\quad$ $95 - 15 = 80$
$140 - 5 = 135$ $\quad$ $80 - 17 = 63$
$135 - 7 = 128$ $\quad$ $63 - 19 = 44$
$128 - 9 = 119$ $\quad$ $44 - 21 = 23$
$119 - 11 = 108$ $\quad$ $23 - 23 = 0$

Number of subtractions = 12

So, $\sqrt{144} = 12$

(*c*) 225:

$225 - 1 = 224$ $\quad$ $176 - 15 = 161$
$224 - 3 = 221$ $\quad$ $161 - 17 = 144$
$221 - 5 = 216$ $\quad$ $144 - 19 = 125$
$216 - 7 = 209$ $\quad$ $125 - 21 = 104$
$209 - 9 = 200$ $\quad$ $104 - 23 = 81$
$200 - 11 = 189$ $\quad$ $81 - 25 = 56$
$189 - 13 = 176$ $\quad$ $56 - 27 = 29$
$29 - 29 = 0$

Number of subtractions = 15

So, $\sqrt{225} = 15$

(*d*) 361:

$361 - 1 = 360$ $\quad$ $280 - 19 = 261$
$360 - 3 = 357$ $\quad$ $261 - 21 = 240$
$357 - 5 = 352$ $\quad$ $240 - 23 = 217$
$352 - 7 = 345$ $\quad$ $217 - 25 = 192$
$345 - 9 = 336$ $\quad$ $192 - 27 = 165$
$336 - 11 = 325$ $\quad$ $165 - 29 = 136$
$325 - 13 = 312$ $\quad$ $136 - 31 = 105$
$312 - 15 = 297$ $\quad$ $105 - 33 = 72$
$297 - 17 = 280$ $\quad$ $72 - 35 = 37$
$37 - 37 = 0$

Number of subtractions = 19

So, $\sqrt{361} = 19$

4. Square root using prime factorisation

(*a*) $5625 = 3 \times 3 \times 5 \times 5 \times 5 \times 5$

$\therefore \sqrt{5625} = 3 \times 5 \times 5$

3	5625
3	1875
5	625
5	125
5	25
5	5
	1

Taking one factor from each pair:

$\sqrt{5625} = 3 \times 5^2 = 75$

(*b*) $7056 = 2 \times 2 \times 2 \times 3 \times 3 \times 7 \times 7$

$\therefore \sqrt{7056} = 2 \times 2 \times 3 \times 7 = 84$

2	7056
2	3528
2	1764
2	882
3	441
3	147
7	49
7	7
	1

(*c*) $2601 = 3 \times 3 \times 17 \times 17$

$\therefore\ \sqrt{2601} = 3 \times 17 = 51$

3	2601
3	867
17	289
17	17
	1

(*d*) $1024 = \underline{2 \times 2} \times \underline{2 \times 2} \times \underline{2 \times 2} \times \underline{2 \times 2} \times \underline{2 \times 2}$

$\therefore\ \sqrt{1024} = 2 \times 2 \times 2 \times 2 \times 2 = 32$

2	1024
2	512
2	256
2	128
2	64
2	32
2	16
2	8
2	4
2	2
	1

5. (*a*) Resolve 768 into prime factors.

$768 = \underline{2 \times 2} \times \underline{2 \times 2} \times \underline{2 \times 2} \times \underline{2 \times 2} \times 3$

A perfect square has pairs of equal factors but here 3 is left unpaired.

Hence, the given number should be multiplied by 3 to get a perfect square.

2	765
2	384
2	192
2	96
2	24
2	12
2	6
3	3
	1

$\therefore\ 768 \times 3 = 2304$

And, $2304 = 2^2 \times 2^2 \times 2^2 \times 2^2 \times 3^2$

$= (2 \times 2 \times 2 \times 2 \times 3)^2$

$= 48^2$

Thus, $\sqrt{2304} = 48$.

(*b*) Resolve 1575 into prime factors.

$1575 = \underline{3 \times 3} \times \underline{5 \times 5} \times 7$

A perfect square has pairs of equal factors but here 7 is left unpaired.

Hence, the given number should be multiplied by 7 to get a perfect square.

3	1575
3	525
5	175
5	35
7	7
	1

$\therefore\ 1575 \times 7 = 11025$

And, $11025 = 3^2 \times 5^2 \times 7^2 = (3 \times 5 \times 7)^2$

$= 105^2$

Thus, $\sqrt{11025} = 105$.

(*c*) Resolve 2028 into prime factors.

$2028 = 2 \times 2 \times 13 \times 13 \times 3$

A perfect square has pairs of equal factors but here 3 is left unpaired.

2	2028
2	1014
3	507
13	169
13	13
	1

Hence, the given number should be multiplied by 3 to get a perfect square.

$\therefore\ 2028 \times 3 = 6084$

And, $6084 = 2^2 \times 13^2 \times 3^2 = (2 \times 3 \times 13)^2$

$= 78^2$

Thus, $\sqrt{6084} = 78$.

(*d*) Resolve 3200 into prime factors.

$3200 = 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 5 \times 5$

A perfect square has pairs of equal factors but here 2 is left unpaired.

Hence, the given number should be multiplied by 2 to get a perfect square.

2	3200
2	1600
2	800
2	400
2	200
2	100
2	50
5	25
5	5
	1

$\therefore\ 3200 \times 2 = 6400$

And, $6400 = 2^2 \times 2^2 \times 2^2 \times 2^2 \times 5^2$

$= (2 \times 2 \times 2 \times 2 \times 5)^2 = 80^2$

Thus, $\sqrt{6400} = 80$.

6.(*a*). Let us find the prime factors of 396.

$396 = 2 \times 2 \times 3 \times 3 \times 11$

A perfect square has pairs of equal factors but here 11 is left unpaired.

Hence, 11 is the smallest number by which 396 can be divided to make it a perfect square.

2	396
2	198
3	99
3	33
11	11
	1

$\therefore\ \dfrac{396}{11} = 36$ and $36 = 6 \times 6$

Thus, $\sqrt{36} = 6$.

(*b*) Let us find the prime factors of 2645.

$2645 = 23 \times 23 \times 5$

A perfect square has pairs of equal factors but here 5 is left unpaired.

5	2645
23	829
23	23
	1

Hence, 5 is the smallest number by which 2645can be divided to make it a perfect square.

$\therefore\ \dfrac{2645}{5} = 529$ and $529 = 23 \times 23$

Thus, $\sqrt{529} = 23$.

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\ 25-Mar-2026 Sandeep Rai Proof-4 Reader's Sign ______________ Date ________

(*c*) Let us find the prime factors of 6480.

6480 = 2 × 2 ×2 × 2 × 3 × 3 × 3 × 3 × 5

2	6480
2	3200
2	1620
2	810
3	405
3	135
3	45
3	15
5	5
	1

A perfect square has pairs of equal factors but here 5 is left unpaired.

Hence, 5 is the smallest number by which 6480 can be divided to make it a perfect square.

$\therefore \frac{6480}{5} = 1296$

and 1296 = 36 × 36

Thus, $\sqrt{1296} = 36$.

(*d*) Let us find the prime factors of 8864.

8864 = 2 × 2 ×2 × 3 × 19 × 19

A perfect square has pairs of equal factors but here 2 and 3 are left unpaired.

Hence, 6 (2 × 3) is the smallest number by which 8864 can be divided to make it a perfect square.

$\therefore \frac{8864}{6}$ and 1444 = 38 × 38

Thus, $\sqrt{1444} = 38$.

7. Area of square field

Side × Side = 7056 m^2

Side = $\sqrt{7056}$ = 84 m

So, dimensions of square field = 84 m × 84 m

8. Square root using long division

(*a*) $\sqrt{9604}$

	9 8
9	$\overline{96}\,\overline{04}$
	−81
188	15 04
	−15 04
	0

(*b*) $\sqrt{7225}$

	85
8	$\overline{72}\,\overline{25}$
	−64
165	8 25
	− 8 25
	0

(*c*) $\sqrt{42849}$

	2 0 7
2	$\overline{4}\,\overline{28}\,\overline{49}$
	−4
40	28
	−0
407	2849
	− 2849
	0

(*d*) $\sqrt{95481}$

	3 0 9
3	$\overline{9}\,\overline{54}\,\overline{81}$
	−9
60	54
	−0
609	5481
	− 5481
	0

9. (*a*) 1750

	41
4	$\overline{17}\,\overline{50}$
	−16
81	1 50
	− 81
	69

We get the reminder 69

∴ By subtracting 69 from 1750,

we get 1681 = $(41)^2$

$\sqrt{1681} = 41$

Hence, the required number is 69

(*b*) 1825

	42
4	$\overline{18}\,\overline{25}$
	−16
82	2 25
	− 1 64
	61

We get the reminder 61

∴ By subtracting 61 from 1825,

we get 1764 = $(42)^2$

$\sqrt{1764} = 42$

Hence, the required number is 61

(*c*) 6412

	80
8	$\overline{64}\,\overline{12}$
	−64
160	12
	− 0
	12

We get the reminder 12

∴ By subtracting 12 from 6412,

we get 6400 = $(80)^2$.

Hence, the required number is 12

$\sqrt{6400} = 80$

(*d*) 390700

	625
6	$\overline{39}\,\overline{07}\,\overline{00}$
	−36
122	307
	−244
1245	6300
	−6225
	75

We get the reminder 75

∴ By subtracting 75 from 390700, we get 390625 = $(625)^2$.

$\sqrt{390625} = 625$

Hence, the required number is 75

10. (*a*) 402

$20^2 = 400$

$21^2 = 441$

Hence the required smallest number that must be added is 441 − 402 = 39 to make 441 a perfect square.

The square root of 441: $\sqrt{441} = 21$

(*b*) 1989

$44^2 = 1936$

$45^2 = 2025$

Hence the required smallest number that must be added is 2025 − 1989 to make 2025 a perfect square.

The square root of 2025 = $\sqrt{2025} = 45$

(*c*) 3250

$57^2 = 3249$

$58^2 = 3364$

Hence the required smallest number that must be added is 3364 − 3250 to make 3364 a perfect square.

Perfect square root of 3364 = $\sqrt{3364} = 58$

(*d*) 9699

$98^2 = 9604$

$99^2 = 9801$

Hence the required smallest number that must be added is 9801 − 9699 to make 9801 a perfect square.

Perfect square root of 9801 = $\sqrt{9801} = 99$

11. Smallest 8-digit number = 10,000,000

$\sqrt{10,000,000} \approx 3162$

Next whole number = 3163

3163^2 = 10,004,569

Greatest 8-digit number = 99,999,999

$\sqrt{99,999,999} \approx 9999$

9999^2 = 99,980,001

∴ Smallest 8-digit perfect square = 10,004,569

Greatest 8-digit perfect square = 99,980,001

12. Greatest five-digit number = 99,999

$\sqrt{99,999} \approx 316$

∴ 316^2 = 99,856

So, greatest five-digit perfect square number = 99,856 and square root of 99856 = 316

13. Total number of soldiers = 8289

8 soldiers left out

Number of soldiers now = 8289 − 8 = 8281

Since the solders are arranged in the form of square so, we need to find square root of 8281 to determine number of solders in each row.

$\sqrt{8281} = 91$

∴ Number of soldiers in each row = 91

14. Largest perfect square less than 500 = 484

So, 484 children can be arranged in rows and column.

The number of children left out is = 500 – 484

= 16

15. Estimate the square root

(*a*) $\sqrt{1000}$

$31^2 = 961, 32^2 = 1024$

$\sqrt{1000} \approx 32$

(*b*) $\sqrt{1550}$

$39^2 = 1521, 40^2 = 1600$

$\sqrt{1550} \approx 39$

(*c*) $\sqrt{2400}$

$48^2 = 2304, 49^2 = 2401$

$\sqrt{2400} \approx 49$

(*d*) $\sqrt{5000}$

$70^2 = 4900, 71^2 = 5041$

$\sqrt{5000} \approx 71$

Think Tank (Page 29)

To find how many small cubes make the bigger cube:

Side of small cube = 2 cm

Side of big cube = 8 cm

Number of small cubes along one edge = 8 ÷ 2 = 4

Total number of cubes = $4^3 = 64$

So, 64 cubes of side 2 cm are required to make a cube of side 8 cm.

Fast Check (Page 30)

12 = 2 × 2 × 3

Hence, 2 × 2 and 3 are not a triplet so, 12 is not perfect cube.

Fast Check (Page 31)

49000 = 2 × 2 × 2 × 5 × 5 × 5 × 7 × 7

Hence 7 × 7 is not a triplet so, 49000 is not perfect cube.

Think Tank (Page 32)

$10^3 = 1000 \Rightarrow n = 10$

Since n is even, take middle numbers as

$n^2 - 1 = 99$ and $n^2 + 1 = 101$

The 10 consecutive odd numbers are:

91, 93, 95, 97, 99, 101, 103, 105, 107, 109

There are 10 consecutive odd numbers are needed to obtain the sum as 10^3.

Practice Time 1E

1. (*a*) $13^3 = 13 \times 13 \times 13 = 2197$

(*b*) $66^3 = 66 \times 66 \times 66 = 287496$

(*c*) $(-15)^3 = (-15) \times (-15) \times (-15) = -3375$

(*d*) $5.8^3 = (5.8) \times (5.8) \times (5.8) = 195.112$

(*e*) $10.1^3 = (10.1) \times (10.1) \times (10.1) = 1030.301$

(*f*) $\left(\frac{3}{14}\right)^2 = \left(\frac{3}{14}\right)\times\left(\frac{3}{14}\right)\times\left(\frac{3}{14}\right) = \frac{27}{2744}$

(*g*) $\left(\frac{5}{11}\right)^3 = \left(\frac{5}{11}\right)\times\left(\frac{5}{11}\right)\times\left(\frac{5}{11}\right) = \frac{125}{1331}$

(*h*) $2^2 = 4$

$(4)^3 = 4 \times 4 \times 4 = 64$

2. (*a*) By prime factorization, $343 = 7 \times 7 \times 7 = 7^3$

The prime factors of 343 can be grouped into triplets of equal factors and no factors are left ungrouped. So, 343 is a perfect cube of 7.

(*b*) By prime factorization, $625 = \underline{5 \times 5 \times 5} \times 5$

$= 5^3 \times 5$

The prime factors of 625 can be grouped into triplets of equal here 5 is not a triplet, so 625 is not a perfect cube.

(*b*) – (*d*) Same as part a.

(*e*) Same as part b.

(*f*) – (*h*) Same as part a.

3. We know that the cube of an even number is even, and the cube of an odd number is odd.

(*a*) 122: Since 122 is an even so cube of 122 is also an even.

(*b*) 525: Since 525 is an odd so cube of 525 is also an odd.

(*c*), (*d*), (*g*)same as part *a*.

(*e*), (*f*), (*h*) Same as part *b*.

4. To find the units digit of a cube, we only need to consider the units digit of the given number and cube it.

(*a*) 55: unit digit of 55 is 5.

53 = 125

So, unit digit of 553 is 5.

(b) – (h) Same as above.

5. $2^3 = 8, 4^3 = 64$

6. $3^3 = 27, 5^3 = 125$

7. (*a*) $432 = \underline{2 \times 2 \times 2} \times \underline{3 \times 3 \times 3} \times 3$

The prime factors of 432 can be grouped into triplets of equal here 3 is not a triplet, so 432 is not a perfect cube.

(*b*) $1000 = \underline{2 \times 2 \times 2} \times \underline{5 \times 5 \times 5}$

The prime factors of 1000 can be grouped into triplets of equal factors and no factors are left ungrouped. So, 1000 is a perfect cube 2×5 *i.e.* 10.

(*c*) – (*f*) and (*h*) part *b*.

(*g*) Same as part a.

8. (*a*) Prime factorisation of $72 = \underline{2 \times 2 \times 2} \times 3 \times 3$

Here, prime factor 2 appear in groups of three, but prime factor 3×3 is left ungrouped, so if we multiply 72 by 3, we will get one more triplet of 3.

$\therefore$ $72 \times 3 = \underline{2 \times 2 \times 2} \times \underline{3 \times 3 \times 3} = 216$, which is a perfect cube.

So, the 3 is smallest natural number by which 72 must be multiplies to make it a perfect cube.

(*b*) – (*d*) Same as above.

9. (*a*) Prime factorisation of $625 = \underline{5 \times 5 \times 5} \times 5$

Here, prime factor 5 appear in groups of three, but prime factor 5 is left ungrouped, so if we divide 625 by 5, we will get triplet of 5.

$\therefore$ $625 \div 5 = \underline{5 \times 5 \times 5} = 125$, which is a perfect cube.

So, the 5 is smallest natural number by which 625 must be divide to make it a perfect cube.

(*b*) – (*d*) Same as above.

10. Here the pattern is: $n^3 - (n-1)^3 = 3n(n-1) + 1$

(*a*) $80^3 - 79^3 = 3 \times 80 \times 79 + 1$

$= 240 \times 79 + 1 = 18961$

(*b*) $101^3 - 100^3 = 3 \times 101 \times 100 + 1$

$= 303 \times 100 + 1 = 30301$

Practice Time 1F

1. (*a*) $2744 = 2 \times 2 \times 2 \times 7 \times 7 \times 7 = 2^3 \times 7^3$

$\Rightarrow \sqrt[3]{2744} = 2 \times 7 = 14$

(*b*) $-6859 = (-19) \times (-19) \times (-19) = -19^3$

$\Rightarrow \sqrt[3]{(-6859)} = -19$

(*c*) $132651 = 3 \times 3 \times 3 \times 17 \times 17 \times 17 = 3^3 \times 17^3$

$\Rightarrow \sqrt[3]{132651} = 3 \times 17 = 51$

2. (*a*) Given number = $\underline{91}\ \underline{125}$

Second group — First group

The unit digit of the first group of the given number is 5. So, the unit digit of the cube root of the given number is 5.

The number formed in second group is 91.

43 = 64 < 91 < 53 = 125

So, the tens digit of the cube root of the given number is 4.

Hence, the cube root of 91125 is 45, *i.e.*,

$\sqrt[3]{91125} = 45$

(*b*) – (*c*) Same as above.

3. (*a*) 216:

216 – 1 = 215; 215 – 7 = 208; 208 – 19 = 189;
189 – 37 = 152; 152 – 61 = 91; 91 – 91 = 0

Number of subtractions = 6

$\sqrt[3]{216} = 6$

(*b*) 729:

729 – 1 = 728; 728 – 7 = 721; 721 – 19 = 702;
702 – 37 = 665; 665 – 61 = 604;
604 – 91 = 513; 513 – 127 = 386;
386 – 169 = 217; 217 – 217 = 0

Number of subtractions = 9

$\sqrt[3]{729} = 9$

(*c*) 1728:

1728 – 1 = 1727; 1727 – 7 = 1720;
1720 – 19 = 1701; 1701 – 37 = 1664;
1664 – 61 = 1603; 1603 – 91 = 1512;
1512 – 127 = 1385; 1385 – 169 = 1216;

1216 – 219 = 997; 997 – 285 = 712;
712 – 371 = 341; 341 – 341 = 0
Number of subtractions = 12

$\therefore \sqrt[3]{1728} = 12$

4. (*a*) $\sqrt[3]{\frac{729}{1000}} = \frac{\sqrt[3]{729}}{\sqrt[3]{1000}} = \frac{\sqrt[3]{\underline{3\times3\times3}\times\underline{3\times3\times3}}}{\sqrt[3]{\underline{2\times2\times2}\times\underline{5\times5\times5}}}$

$= \frac{9}{10} = 0.9$

(*b*) $\sqrt[3]{\frac{125}{512}} = \frac{\sqrt[3]{125}}{\sqrt[3]{512}}$

$= \frac{\sqrt[3]{\underline{5\times5\times5}}}{\sqrt[3]{\underline{2\times2\times2}\times\underline{2\times2\times2}\times\underline{2\times2\times2}}}$

$= \frac{5}{8} = 0.625$

(*c*) $\sqrt[3]{648}\times\sqrt[3]{576}$

$= \sqrt[3]{2\times2\times2\times3\times3\times3\times3} \times\sqrt[3]{2\times2\times2\times2\times2\times2\times3\times3}$

$= \sqrt[3]{\underline{2\times2\times2}\times\underline{2\times2\times2}\times\underline{2\times2\times2}\times\underline{3\times3\times3}\times\underline{3\times3\times3}}$

$= 2 \times 2 \times 2 \times 3 \times 3 = 72$

(*d*) $\sqrt[3]{2197\times5832}$

$= \sqrt[3]{13\times13\times13\times2\times2\times2\times3\times3\times3\times3\times3\times3}$

$= \sqrt[3]{\underline{13\times13\times13}\times\underline{2\times2\times2}\times\underline{3\times3\times3}\times\underline{3\times3\times3}}$

$= 2 \times 3 \times 3 \times 13 = 234$

5. Cube root of products/ratios

(*a*) $\sqrt[3]{(-216\times1728)} = \sqrt[3]{(-6)^3\times12^3} = -72$

(*b*) $\sqrt[3]{\frac{-1331}{4096}} = -\frac{\sqrt[3]{1331}}{\sqrt[3]{4096}}$

$= \frac{\sqrt[3]{11\times11\times11}}{\sqrt[3]{2\times2\times2\times2\times2\times2\times2\times2\times2\times2\times2\times2}}$

$= -\frac{11}{16}$

(*c*) $\sqrt[3]{-\frac{1875}{5145}} = -\sqrt[3]{\frac{1875}{5145}}$

$= -\sqrt[3]{\frac{125}{343}} = -\frac{\sqrt[3]{125}}{\sqrt[3]{343}}$

$= \frac{\sqrt[3]{5\times5\times5}}{\sqrt[3]{7\times7\times7}} = -\frac{5}{7}$

(*d*) $\sqrt[3]{3.375} = \sqrt[3]{\frac{3375}{1000}} = \sqrt[3]{\frac{27}{8}}$

$\frac{\sqrt[3]{3\times3\times3}}{\sqrt[3]{2\times2\times2}} = \frac{3}{2} = 1.5$

6. Volume of a cubical box = 32.768 m^3

Side of cube = $\sqrt[3]{32.768}$

$\sqrt[3]{32.768} = \frac{\sqrt[3]{32768}}{\sqrt[3]{1000}} = \frac{\sqrt[3]{32\times32\times32}}{\sqrt[3]{10\times10\times10}} = \frac{32}{10} = 3.2$

∴ Length of side = 3.2 m

7. Volume of a cube = $\frac{112197}{216}\,m^3$

Side of cube = $\sqrt[3]{\frac{112197}{216}} = \frac{\sqrt[3]{112197}}{\sqrt[3]{216}} = \frac{48}{6}$

∴ Length of side of cube = 8 m

8. Sum of cubes = 98784

Let first number = x

Second number = $2x$

Third number = $3x$

$x^3 + (2x)^3 + (3x)^3 = 98784$

$x^3 + 8x^3 + 27x^3 = 98784$

$36x^3 = 98784$

$x^3 = 2744 = 14\times14\times14 = 14^3$

$x = 14$

∴ The numbers are 14, 28, 42

Challenge Question (Page 40)

1. Adjacent pairs and square numbers

Given arrangement: 8, 1, 3, 6, 10

Adjacent sums:

$8 + 1 = 9 = 3^2$

$1 + 3 = 4 = 2^2$

$3 + 6 = 9 = 3^2$

$6 + 10 = 16 = 4^2$

Here is correct arrangement of numbers from 1 to 17 such that every pair of adjacent numbers has a square sum:

16, 9, 7, 2, 14, 11, 5, 4, 12, 13, 3, 6, 10, 15, 1, 8, 17

Check (adjacent sums):

$16 + 9 = 25$; $9 + 7 = 16$; $7 + 2 = 9$;

$2 + 14 = 16$; $14 + 11 = 25$;

$11 + 5 = 16$; $5 + 4 = 9$; $4 + 12 = 16$; $12 + 13 = 25$;

$13 + 3 = 16$; $3 + 6 = 9$; $6 + 10 = 16$; $10 + 15 = 25$;

$15 + 1 = 16$; $1 + 8 = 9$; $8 + 17 = 25$

(All are perfect squares.)

2. Let $\frac{A}{2} = \frac{B}{3} = \frac{C}{4} = x$

So, $A = 2x$, $B = 3x$, $C = 4x$

Given: $A^3 + B^3 + C^3 = 0.334125$

Substitute:

$$(2x)^3 + (3x)^3 + (4x)^3 = 0.334125$$
$$8x^3 + 27x^3 + 64x^3 = 0.334125$$
$$99x^3 = 0.334125$$
$$x^3 = 0.003375$$
$$x = 0.15$$

Therefore:

$A = 0.3$, $B = 0.45$, $C = 0.6$

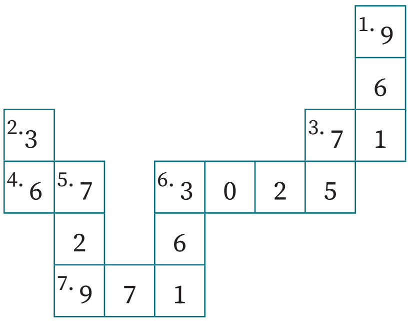
3. Square and cube number diagram

$9 + 16 = 25$

$36 + 49 = 4 + 81$

$1 + 8 + 27 + 64 = 100$

Create and solve (Page 40)



Here are the correct numerical answers for the crossword clues:

Across	**Down**
3. 71	1. 961
4. 67	2. 36
6. 3025	3. 75
7. 951	5. 729
	6. 361

Chapter Assessment

A. 1. $\sqrt{4 \times 25} = \sqrt{100} = 10$

Correct option (*b*) 10

2. $196 = 14^2$, $625 = 25^2$, $1225 = 35^2$

(*d*) 404

Correct option is (*d*)

3. $512 = 8^3$

$9261 = 21^3$ (odd); $4096 = 16^3$; $8000 = 20^3$

Correct option is (*b*)

4. even × even × even = even

Correct option is (*a*)

5. Volume = 729 cm^3

Side = $\sqrt[3]{729} = 9$ cm

Correct option is (*b*)

B. 1. 9000 has 3 zeros ⟶ square has 6 zeros

Both true, R explains A

Correct option is **(*a*)**

2. $7^2 = 49 = 24 + 25$

Both true, and R explains A **(*a*)**

Correct option is (*a*)

3. Ones digit of 364^3 depends on

$4^3 = 64$ ⟶ ones digit 4

Reason true but not explanation

Correct option is (*b*)

4. $50^3 = 125000$ ⟶ 3 zeros

Both true, and R explains A

Correct option is (*a*)

C. 1. negative

2. triplets of prime factors

3. even

4. 2, 3, 7 and 8

5. never end

D. **1.** False ($2^3 = 8$)

2. True (no square ends with 8)

3. False ($12^3 = 1728$)

4. True ($1^3 = 1$)

5. True

6. True (x^3 divides y^3)

E. **1.** $31 \times 2^2 \times 5^3 = 31 \times 4 \times 100$

$= 15500 = 155$ hundreds

2. (*a*) $\dfrac{\sqrt[3]{2197} \times \sqrt[3]{1728}}{\sqrt[3]{1331}}$

$= \dfrac{\sqrt[3]{13\times13\times13} \times \sqrt[3]{12\times12\times12}}{\sqrt[3]{11\times11\times11}}$

$= \dfrac{13\times12}{11} = \dfrac{156}{11}$

(*b*) $\sqrt[3]{0.008} + \sqrt[3]{5832} - \sqrt[3]{729} + \sqrt[3]{4.096}$

$= \sqrt[3]{0.2\times0.2\times0.2} + \sqrt[3]{18\times18\times18}$

$- \sqrt[3]{9\times9\times9} + \sqrt[3]{1.6\times1.6\times1.6}$

$= 0.2 + 18 - 9 + 1.6 = 10.8$

3. Difference of two perfect cubes = 189

Cube root of smaller number = 3

Smaller number = 3 × 3 × 3 = 27

Larger number = 27 + 189 = 216

So, cube root of larger number = 6

4. 1058 = 2 × <u>23 × 23</u>

Smallest number to divide by = 2

Perfect square obtained = 1058 ÷ 2 = 529

Square root of 529 = 23

5. Volume = $52\dfrac{47}{64}$ cubic metres

Convert to improper fraction:

$52\dfrac{47}{64} = \dfrac{3375}{64}$

Let side = *a*

Volume of cube $(a)^3 = \dfrac{3375}{64}$

$a = \sqrt[3]{\dfrac{3375}{64}} = \dfrac{\sqrt[3]{3375}}{\sqrt[3]{64}} = \dfrac{\sqrt[3]{15\times15\times15}}{\sqrt[3]{4\times4\times4}}$

$a = \dfrac{15}{4}$

$a = 3.75$ m

So, the side of cube is 3.75

6. $100 = 10^2$

Next perfect square = $11^2 = 121$

500 lies between 22² and 23²

$22^2 = 484$

$23^2 = 529$ (greater than 500)

Perfect squares between 100 and 500 are from 11^2 to 22^2

Number of perfect squares between 100 and 500

$= 22 - 11 + 1 = 12$

7. From $8a^2b = 216$

$a^2b = 27$ ...(1)

From $27ab^2 = 216$

$ab^2 = 8$ ...(2)

Multiply (1) and (2):

$\sqrt[3]{a^3b^3} = \sqrt[3]{216}$

ab = cube root of 216

$ab = 6$

Therefore, $2ab = 12$

Answer: 12

8. Pair 1: 12 and 21

$12^2 = 144$

$21^2 = 441$

Pair 2: 102 and 201

$102^2 = 10404$

$201^2 = 40401$

∴ (12, 21) and (102, 201) have same property

9. LCM of 3, 4, 5, 6 = 2 × 2 × 3 × 5 = 60

To make it a perfect square: Multiply by 15

Smallest perfect square = 60 × 15 = 900

900

10. Total students = 6250

Students left out = 9

Now number of students arranged = 6250 − 9

= 6241

6241 = 79 × 79

∴ Number of students in each row = 79

11. Smallest number to be added to 6200 to make it a perfect square

$78^2 = 6084$

$79^2 = 6241$

Next perfect square after 6200 is 6241

Required number to be added

= 6241 − 6200 = 41

12. A decimal number is multiplied by itself and the product is 51.84.

Let the number be x

$$x \times x = 51.84$$
$$x^2 = 51.84$$

Square root of 51.84 = 7.2

13. Coins given: 1, 3, 5, 7, … for 30 days

(This is a series of odd numbers)

It is known that: Sum of first n odd numbers $= n^2$

For 30 days: Total coins $= 30^2 = 900$

14. Four-digit perfect square

Digits pattern: even, even, odd, even

No digit is zero

Check perfect squares:

$$94^2 = 8836$$

Digits: 8 (even), 8 (even), 3 (odd), 6 (even)

All conditions satisfied

Therefore the required number is 8836.

Mental Maths (Page 43)

1. $100 = 10^2$

1000 lies between 31^2 (961) and 32^2 (1024)

Perfect squares: 11^2 to 31^2

Number of perfect squares between 100 and 1000 $= 31 - 11 + 1 = 21$

2. $52^2 - 51^2$

So, $52^2 - 51^2 = (52 + 51) = 103$

3. Units digit of 1236 = 6

$$6^2 = 36$$

So, unit digit of 1236^2 is 6

4. Given number = 3×3×3×3×5×3×7×5×5×7

$= 3 \times 3 \times 3 \times 3 \times 3 \times 5 \times 5 \times 5 \times 7 \times 5$

Here prime factors (3 × 3) and (7 × 7) are left ungrouped, so if we multiply the given number by 3 × 7, we will get triple of each number.

So, the smallest number = 3 × 7 = 21

5. $125 \times 512 \times 4 = \underline{5 \times 5 \times 5} \times \underline{2 \times 2 \times 2} \times \underline{2 \times 2 \times 2} \times \underline{2 \times 2 \times 2} \times 2 \times 2$

Here, prime factor 2 × 2 is left ungrouped, so if we divide the given number by 4, we will get triplet each number.

$\therefore$ $125 \times 512 \times 4 \div 4 = \underline{5 \times 5 \times 5} \times \underline{2 \times 2 \times 2} \times \underline{2 \times 2 \times 2} \times \underline{2 \times 2 \times 2}$, which is a perfect cube.

So, the 4 is smallest natural number by which 125 × 512 × 4 must be divide to make it a perfect cube.

6. $\sqrt[3]{-1000 \times 729}$

$$= \sqrt[3]{(-10)\times(-10)\times(-10)\times 9\times 9\times 9}$$
$$= \sqrt[3]{\underline{(-10)\times(-10)\times(-10)}\times\underline{9\times 9\times 9}}$$
$$= (-10) \times 9 = -90$$

7. Unit digit of $\sqrt[3]{50653}$ is 7

CHAPTER 2: POWER PLAY

Let's Recall

1. 1 km = 1000 m

1 m = 100 cm

So,

1 km = 1000 × 100 = 100000 cm

2. (*a*) $15^2 = 15 \times 15 = 225$

(*b*) $21^2 = 21 \times 21 = 441$

(*c*) $27^2 = 27 \times 27 = 729$

(*d*) $39^2 = 39 \times 39 = 1521$

3. (*a*) $11^3 = 11 \times 11 \times 11 = 1331$

(*b*) $21^3 = 21 \times 21 \times 21 = 9261$

(*c*) $16^3 = 16 \times 16 \times 16 = 4096$

(*d*) $12^3 = 12 \times 12 \times 12 = 1728$

4. Area of square = side^2

$\text{Side}^2 = 484$

Side $= \sqrt{484} = 22$

Therefore, length of side of square is 224.

Think Tank (Page 47)

Each time a sheet of paper is folded, its thickness doubles.

Initial thickness = x

After 1 fold → $2x$

After 2 folds → $4x = 2^2x$

After 3 folds → $8x = 2^3x$

So after n folds, thickness = $x \times 2^n$

For 15 folds:

Thickness = $x \times 2^{15}$

So the correct expression is: $2^{15}x$

Practice Time 2A

1. (a) $2 \times 2 \times 2 \times 2 \times 2 \times 2 = 2^6$
   (b) $3 \times b \times 3 \times b \times 3 \times b \times b \times b = 3^3 \times b^5$
   (c) $a \times a \times a \times b \times b \times b \times b = a^3 \times b^4$
   (d) $a \times b \times b \times b \times c \times c \times c \times c = a \times b^3 \times c^4$
   (e) $x \times x \times y \times y \times y \times y \times y = x^2 \times y^5$
   (f) $p \times p \times p \times q \times q \times q \times s \times s \times p = p^4 \times q^3 \times s^2$
   (g) $3 \times 3 \times 5 \times 5 \times 5 \times 5 \times 5 = 3^2 \times 5^5$
   (h) $2 \times 11 \times 5 \times 11 \times 11 \times 11 \times 5 \times 5$
   $= 2 \times 11^4 \times 5^3$
   (i) $3 \times 3 \times 5 \times 2 \times 2 \times 2 \times 5 \times 7$
   $= 3^2 \times 2^3 \times 5^2 \times 7$
   (j) $11 \times 11 \times 11 \times 11 \times 11 \times 11 \times 7 \times 7 = 11^6 \times 7^2$
2. (a) $36 = 2^2 \times 3^2$ (b) $64 = 2^6$
   (c) $625 = 5^4$ (d) $324 = 2^2 \times 3^4$
   (e) $405 = 3^4 \times 5$ (f) $540 = 2^2 \times 3^3 \times 5$
   (g) $3600 = 2^4 \times 3^2 \times 5^2$ (h) $4096 = 2^{12}$
   (i) $400 = 2^4 \times 5^2$ (j) $2025 = 3^4 \times 5^2$
   (k) $3136 = 2^6 \times 7^2$ (l) $3375 = 3^3 \times 5^3$
3. (a) $13^6 \times 13^2 \times 13^4$
   $= (13 \times 13 \times 13 \times 13 \times 13 \times 13) \times (13 \times 13) \times (13 \times 13 \times 13 \times 13)$
   $= 13^{12}$
   (b) $\left(\frac{17}{29}\right)^4 \times \left(\frac{17}{29}\right)^6$
   $= \frac{17}{29} \times \frac{17}{29} \times \frac{17}{29} \times \frac{17}{29} \times \frac{17}{29} \times \frac{17}{29} \times \frac{17}{29} \times \frac{17}{29} \times \frac{17}{29} \times \frac{17}{29}$
   $= \left(\frac{17}{29}\right)^{10}$
   (c) Same as part (b)
   (d) $3^4 \times 3^2 \times 5 = 3 \times 3 \times 3 \times 3 \times 3 \times 3 \times 5$
   $= 36 \times 5.$
   (e) – (d) Same as part (d)
4. (a) $\left(\frac{2}{5}\right)^2 = \frac{2}{5} \times \frac{2}{5} = \frac{4}{25}$
   (b) $\left(\frac{3}{5}\right)^3 = \left(\frac{3}{5}\right) \times \left(\frac{3}{5}\right) \times \left(\frac{3}{5}\right) = \left(\frac{27}{125}\right)$
   (c) $\left(\frac{4}{5}\right)^4 = \frac{4}{5} \times \frac{4}{5} \times \frac{4}{5} \times \frac{4}{5} = \frac{256}{625}$
   (d) $\left(\frac{3}{7}\right)^5 = \frac{3}{7} \times \frac{3}{7} \times \frac{3}{7} \times \frac{3}{7} \times \frac{3}{7} = \frac{243}{16807}$
   (e) $\left(\frac{1}{6}\right)^4 = \frac{1}{6} \times \frac{1}{6} \times \frac{1}{6} \times \frac{1}{6} = \frac{1}{1296}$
   (f) $\left(\frac{2}{5}\right)^3 = \frac{2}{5} \times \frac{2}{5} \times \frac{2}{5} = \frac{8}{125}$
5. (a) $\left(\frac{1}{32}\right) = \frac{1}{2} \times \frac{1}{2} \times \frac{1}{2} \times \frac{1}{2} \times \frac{1}{2} = \left(\frac{1}{2}\right)^5 = 2^{-5}$
   (b) $\frac{27}{125} = \frac{3}{5} \times \frac{3}{5} \times \frac{3}{5} = \left(\frac{3}{5}\right)^3$
   (c) $\frac{1}{1024} = \frac{1}{2} \times \frac{1}{2} \times \frac{1}{2} \times \frac{1}{2} \times \frac{1}{2} \times \frac{1}{2} \times \frac{1}{2} \times \frac{1}{2} \times \frac{1}{2} \times \frac{1}{2}$
   $= \left(\frac{1}{2}\right)^{10}$
   (d) $\frac{16}{625} = \frac{2}{5} \times \frac{2}{5} \times \frac{2}{5} \times \frac{2}{5} = \left(\frac{2}{5}\right)^4$
   (e) $\frac{32}{243} = \frac{2}{3} \times \frac{2}{3} \times \frac{2}{3} \times \frac{2}{3} \times \frac{2}{3} = \left(\frac{2}{3}\right)^5$
   (f) $\frac{1}{4096} = \frac{1}{2} \times \frac{1}{2} \times \frac{1}{2} \times \frac{1}{2} \times \frac{1}{2} \times \frac{1}{2} \times \frac{1}{2} \times \frac{1}{2} \times \frac{1}{2} \times \frac{1}{2} \times \frac{1}{2} \times \frac{1}{2}$
   $= \left(\frac{1}{2}\right)^{12}$
6. $243 = 3 \times 3 \times 3 \times 3 \times 3 = 3^5$
7. $256 = 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 = 2^8$
8. (a) 2^3 and 3^2; $2^3 = 8$ and $3^2 = 9$; Since $9 > 8$, 3^2 is greater than 2^3.
   (b) 2^5 and 5^2; $2^5 = 32$; $5^2 = 25$; Since $32 > 25$, 2^5 is greater than 5^2.
   (c) 2^8 and 8^2; $2^8 = 256$; $8^2 = 64$; Since $256 > 64$, 2^8 is greater than 8^2.
   (d) 5^2 and 3^5; $5^3 = 125$; $3^5 = 243$; Since $243 > 125$, 3^5 is greater than 5^3.

(*e*) 100^2 and 2^{15}; $100^2 = 10000$; $2^{15} = 32768$;
Since $32768 > 10000$, 2^{15} is greater than 100^2.

(*f*) 3^4 and 4^3; $3^4 = 81$; $4^3 = 64$; Since $81 > 64$,
3^4 is greater than 4^3.

9. $a^3b^2 = a \times a \times a \times b \times b$
$a^2b^3 = a \times a \times b \times b \times b$
$b^2a^3 = a \times a \times a \times b \times b$
$b^3a^2 = a \times a \times b \times b \times b$
$a^3b^2 = b^2a^3$ and $a^2b^3 = b^3a^2$
So, all are not the same.

10. (*a*) $2 \times 10^5 = 2 \times 100000 = 200000$
(*b*) $7^2 \times 2^4 = 49 \times 16 = 784$
(*c*) $5 \times 2^3 \times 3^2 = 5 \times 8 \times 9 = 360$
(*d*) $(-2)^3 \times (-5)^3 = (10)^3 = 1000$
(*e*) $(-3)^2 \times (-2)^4 = 9 \times 16 = 144$
(*f*) $3^2 \times 10^3 = 9 \times 1000 = 9000$

Think Tank (Page 51)

Since the number of sunflowers triples every day, we work backwards from the day it is completely full.

On Day 20 → flowerbed is completely full

One day earlier (Day 19) → number of sunflowers is one-third of the full amount

So, the flowerbed was one-third full on Day 19.

Think Tank (Page 53)

We know that

$a^n \div a^n = a^{n-n} = a^0$

Also, $a^n \div a^n = 1$ (because any non-zero number divided by itself is 1)

So, $a^0 = 1$, only when $a \neq 0$

If $a = 0$, then $0^n \div 0^n = 0 \div 0$

But $0 \div 0$ is not defined (it has no fixed value).

Therefore, $a^0 = 1$ is true only when a is not 0.

Conclusion: Zero cannot be the base because division by zero is not defined.

Fast Check (Page 55)

The Pattern (divide by 5 each step)

$5^4 = 625$
$5^3 = 125$
$5^2 = 25$
$5^1 = 5$
$5^0 = 1$
$5^{-1} = \frac{1}{5}$
$5^{-2} = \frac{1}{25}$
$5^{-3} = \frac{1}{125}$
$5^{-4} = \frac{1}{625}$

Practice Time 2B

1. To create a 3-digit password, each digit can be any of the 10 digits (0-9).

- The first digit can be any of the 10 digits, so there are 10 choices.
- The second digit can also be any of the 10 digits, so there are 10 choices.
- The third digit can also be any of the 10 digits, so there are 10 choices.

Thus, the total number of possible combinations is: $10 \times 10 \times 10 = 1000$

Therefore, 1000 different combinations can be created.

2. To generate a signal with 2 flags arranged one below the other:

- The first flag (top) can be any of the 4 flags, so there are 4 choices.
- The second flag (bottom) must be different from the first, so there are 3 remaining flags to choose from.

Thus, the total number of different signals that can be generated is: $4 \times 3 = 12$

Therefore, 12 different signals can be created.

3. To form a 2-digit even number:

- The first digit (tens place) can be any of the 5 digits (1, 2, 3, 4, 5), so there are 5 choices.
- The second digit (ones place) must be even. The even digits available are 2 and 4, so there are 2 choices for the second digit.

Thus, the total number of 2-digit even numbers that can be formed is: $5 \times 2 = 10$

Therefore, 10 different 2-digit even numbers can be formed.

4. To form a 3-digit even number:

- The first digit (hundreds place) can be any of the 6 digits (1, 2, 3, 4, 5, 6), so there are 6 choices.
- The second digit (tens place) can also be any of the 6 digits (1, 2, 3, 4, 5, 6), so there are 6 choices.
- The third digit (ones place) must be even. The even digits available are 2, 4, and 6, so there are 3 choices for the third digit.

Thus, the total number of 3-digit even numbers that can be formed is: $6 \times 6 \times 3 = 108$

Therefore, 108 different 3-digit even numbers can be formed.

5. To generate a signal with 2 flags arranged one below the other:

- The first flag (top) can be any of the 5 flags, so there are 5 choices.
- The second flag (bottom) must be different from the first, so there are 4 remaining flags to choose from.

Thus, the total number of different signals that can be generated is: $5 \times 4 = 20$

Therefore, 20 different signals can be created.

6. Complete the statements

(*a*) $\dfrac{10^{25}+10^{29}}{10^{20}} = \dfrac{10^{25}(1+10^4)}{10^{20}} = \dfrac{10^{25}}{10^{20}}[1+10000]$

$= 10^{25-20}\,[10001] = 10^5 \times 10001$

$= 1000100000$

(*b*) Reciprocal of $\left(\dfrac{2}{3}\right)^3 = \dfrac{1}{\left(\dfrac{2}{3}\right)^3} = \left(\dfrac{3}{2}\right)^3 = \dfrac{27}{8}$

(*c*) $9 \times 3^n = 3^6$

$9 = 3^6 \div 3^n$

$9 = 3^{6-n}$

$3^2 = 3^{6-n}$

$\Rightarrow 6 - n = 2 \Rightarrow n = 6 - 2 = 4$

(*d*) $(6^{-1} + 8^{-1})^{-1} + (2^{-1} + 3^{-1} - 4^{-1})^{-1}$

$6^{-1} = \dfrac{1}{6},\ 8^{-1} = \dfrac{1}{8}$

$(6^{-1} + 8^{-1}) = \dfrac{1}{6}+\dfrac{1}{8} = \dfrac{8+6}{48} = \dfrac{14}{48} = \dfrac{7}{24}$

$2^{-1} = \dfrac{1}{2},\ 3^{-1} = \dfrac{1}{3},\ 4^{-1} = \dfrac{1}{4}$

$(2^{-1} + 3^{-1} - 4^{-1}) = \dfrac{1}{2}+\dfrac{1}{3}-\dfrac{1}{4} = \dfrac{6+4-3}{12} = \dfrac{7}{12}$

$(6^{-1} + 8^{-1})^{-1} + (2^{-1} + 3^{-1} - 4^{-1})^{-1}$

$= \dfrac{24}{7}+\dfrac{12}{7} = \dfrac{36}{7}$

7. (*a*) T: Reciprocal of 7^{49} is $\dfrac{1}{7^{49}}$, same as $\left\{\left(\dfrac{1}{7}\right)^7\right\}^7$

(*b*) F: $\left[\left(\dfrac{-1}{3}\right)^2\right]^{-2} = \left[\dfrac{-1}{3}\right]^{-4} \neq \left(\dfrac{1}{3}\right)^4$

(*c*) F: $\left(-\dfrac{3}{5}\right)^{100} = \dfrac{(-3)^{100}}{5^{100}} = \dfrac{3^{100}}{5^{100}} + \dfrac{-3^{100}}{5^{100}}$

(*d*) $(a \times b)^n = a^n \times b^n$ but F: $(a + b)^3 \neq a^3 + b^3$

(e) F: Base and exponent are wrongly identified

Base $= \dfrac{1}{9}$, Exponent $= -4$

(*f*) T: Using the property of exponent, $a^m \times a^n = a^{m+n}$ the expression of $\left(\dfrac{1}{2}\right)^6 \times \left(\dfrac{1}{2}\right)^{-4} \times \left(\dfrac{1}{2}\right)^5$ is $\left(\dfrac{1}{2}\right)^{6\times(-4)+5}$

8. (*a*) $\dfrac{7^8 \times a^{10} b^7 c^{12}}{7^6 \times a^8 b^4 c^{12}} = 7^{(8-6)} \times a^{10-8} \times b^{7-4} \times c^{12-12}$

$= 7^2 \times a^2 \times b^3 \times c^0 = 49\, a^2 b^3$

(*b*) $\dfrac{5^4 \times 7^4 \times 2^7}{84 \times 49 \times 5^3} = \dfrac{5^4 \times 7^4 \times 2^7}{(2\times2\times3\times7)\times 7^2 \times 5^3}$

$= \dfrac{5^4 \times 7^4 \times 2^7}{2^2 \times 3 \times 7^3 \times 5^3}$

$= 5^{4-3} \times 7^{4-3} \times 2^{7-2} \times 3^{-1}$

$= 5 \times 7 \times 2^5 \times 3^{-1}$

$= \dfrac{35 \times 32}{3} = \dfrac{1120}{3}$

(c) $\dfrac{3^4 \times 12^3 \times 36}{2^5 \times 6^3}$

$= \dfrac{3^4 \times (2\times2\times3)^3 \times (2\times2\times3\times3)}{2^5 \times (2\times3)^3}$

$= \dfrac{3^4 \times (2^2\times3)^3 \times (2^2\times3^2)}{2^5 \times 2^3 \times 3^3}$

$= \dfrac{3^4 \times 2^6 \times 3^3 \times 2^2 \times 3^2}{2^5 \times 2^3 \times 3^3}$

$= 3^{(4+3+2-3)} \times 2^{(6+2-5-3)}$

$= 3^6 \times 2^0 = 729$

(d) $\dfrac{6^2 \times 10^2 \times 5^2}{2^4 \times 5^6 \times 27} = \dfrac{(2\times3)^2 \times (2\times5)^2 \times 5^2}{2^4 \times 5^6 \times 3^3}$

$= \dfrac{2^2 \times 3^2 \times 2^2 \times 5^2 \times 5^2}{2^4 \times 5^6 \times 3^3}$

$= 2^{(2+2-4)} \times 3^{(2-3)} \times 5^{(2+2-6)}$

$= 2^0 \times 3^{-1} \times 5^{-2}$

$= \dfrac{1}{3\times25} = \dfrac{1}{75}$

(e) $\dfrac{6^4 \times 9^2 \times 25^2}{3^4 \times 4^6 \times 15^6} = \dfrac{(2\times3)^4 \times (3\times3)^2 \times (5\times5)^2}{3^4 \times (2\times2)^6 \times (3\times5)^6}$

$= \dfrac{2^4 \times 3^4 \times 3^4 \times 5^4}{3^4 \times 2^{12} \times 3^6 \times 5^6}$

$= 2^{4-12} \times 3^{4+4-4-6} \times 5^{4-6}$

$= 2^{-8} \times 3^{-2} \times 5^{-2}$

$= \dfrac{1}{57600}$

(f) $(729)^0 \times \left(\dfrac{9}{4}\right)^{-2} \times \left(\dfrac{2}{3}\right)^{-3}$

$= 1 \times \left(\dfrac{4}{9}\right)^2 \times \left(\dfrac{3}{2}\right)^3 = 1 \times \dfrac{16}{81} \times \dfrac{27}{8}$

$= \dfrac{54}{81} = \dfrac{2}{3}$

(g) $\dfrac{27 \times a^{-4}}{12 \times 4^{-3} \times a^{-5}} = \dfrac{3^3 \times a^{-4}}{3\times2\times2\times4^{-3} \times a^{-5}}$

$= 3^2 \times 4^2 \times a^{5-4}$

$= 144\,a$

(h) $\left(\dfrac{5}{6}\right)^9 \times \left(\dfrac{6}{5}\right)^5 \times \dfrac{25}{36} = \dfrac{5^9}{6^9} \times \dfrac{6^5}{5^5} \times \dfrac{25}{36}$

$= \dfrac{5^4}{6^4} \times \dfrac{5^2}{6^2} = \dfrac{625}{1296} \times \dfrac{5^2}{6^2}$

$= \dfrac{15625}{46656}$

9. $(-8)^{-1} = -\dfrac{1}{8}$

Let required number $= x$

$x \times \left(-\dfrac{1}{8}\right) = \dfrac{1}{12}$

$x = -\dfrac{2}{3}$

10. $\dfrac{x}{y} = \left(\dfrac{2}{5}\right)^{-2} \times \left(\dfrac{15}{8}\right)^{-3} = \left(\dfrac{5}{2}\right)^3 \times \left(\dfrac{8}{15}\right)^3$

$= \dfrac{125\times8\times8\times8}{8\times15\times15\times15} = \dfrac{125\times64}{15\times15\times15}$

$= \dfrac{25\times64}{3\times225} = \dfrac{64}{3\times9} = \dfrac{64}{27}$

$\left(\dfrac{x}{y}\right)^{-1} = \left(\dfrac{64}{27}\right)^{-1} = \dfrac{27}{64} = \left(\dfrac{3}{4}\right)^3$

11. $5^m \div 5^5 = 5^3 \Rightarrow 5^{m-3} = 5^5 \Rightarrow m - 3 = 5$

$\Rightarrow m = 8$

12. (a) $(-1)^2 + (2)^{-1} = 1 + \dfrac{1}{2} = \dfrac{3}{2}$

(b) $(-1)^2 - (2)^{-1} = 1 - \dfrac{1}{2} = \dfrac{1}{2}$

(c) $(-1)^2 \times (2)^{-1} = 1 \times \dfrac{1}{2} = \dfrac{1}{2}$

(d) $(-1)^2 \div (2)^{-1} = 1 \div \dfrac{1}{2} = 1 \times 2 = 2$

13. (a) $\left(\dfrac{5}{3}\right)^{-5} \times \left(\dfrac{5}{3}\right)^{-11} = \left(\dfrac{5}{3}\right)^{8x}$

$\Rightarrow \left(\dfrac{5}{3}\right)^{-16} = \left(\dfrac{5}{3}\right)^{8x}$

$\Rightarrow 8x = -16 \Rightarrow x = -2$

(*b*) $\left(\frac{2}{7}\right)^{-3} \times \left(\frac{2}{7}\right)^{8} = \left(\frac{7}{2}\right)^{-(2x+1)}$

$\Rightarrow \quad \left(\frac{2}{7}\right)^{5} = \left(\frac{2}{7}\right)^{2x+1}$

$\Rightarrow 2x + 1 = 5 \Rightarrow x = 2$

(*c*) $2^{x-1} \times 2^{x+1} = 32 \Rightarrow 2^{x-1+x+1} = 2^5$

$\Rightarrow 2^{2x} = 2^5 \Rightarrow 2x = 5$

$\Rightarrow x = \frac{5}{2}$

Practice Time 2C

1. Power line for 5

Powers of 5:

$5^7 = 78125$

$5^6 = 15625$

$5^5 = 3125$

$5^4 = 625$

$5^3 = 125$

$5^2 = 25$

$5^1 = 5$

$5^0 = 1$

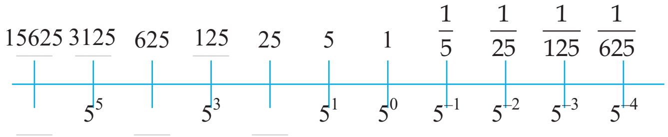
$5^{-1} = \frac{1}{5}$

$5^{-2} = \frac{1}{5^2} = \frac{1}{25}$

$5^{-3} = \frac{1}{5^3} = \frac{1}{125}$

$5{-}4 = \frac{1}{5^4} = \frac{1}{625}$

So the completed power line is:



(*a*) $625 \times 25 = 5^4 \times 5^2 = 5^6$

(*b*) $3125 \div 25 = 5^5 \div 5^2 = 5^3$

(*c*) $15625 \div 125 = 5^6 \div 5^3 = 5^3$

(*d*) $125 \times 625 = 5^3 \times 5^4 = 5^7$

(*e*) $78125 \div 3125 = 5^7 \div 5^5 = 5^2$

(*f*) $125 \times 625 = 5^3 \times 5^4 = 5^7$

(*g*) $15625 \div 78125 = 5^6 \div 5^7 = 5^{-1}$

(*h*) $3125 \div 25 \div 625 = 5^5 \div 5^2 \div 5^4 = 5^{-1}$

(*i*) $3125 \times 125 \div 625 = 5^5 \times 5^3 \div 5^4 = 5^4$

(*j*) $3125 \div 78125 = 5^5 \div 5^7 = 5^{-2}$

2. Standard form: $m \times 10^n$, where $1 \leq m < 10$ and n is an integer

(*a*) $57.36 = 5.736 \times 10^1$

(*b*) $3458000 = 3.458 \times 10^6$

(*c*) $27300 = 2.73 \times 10^4$

(*d*) $168000 = 1.68 \times 10^5$

(*e*) $30269 = 3.0269 \times 10^4$

(*f*) $0.00267 = 2.67 \times 10^{-3}$

(*g*) $234.789 = 2.34789 \times 10^2$

(*h*) $0.000000892 = 8.92 \times 10^{-7}$

(*i*) $0.2349 = 2.349 \times 10^{-1}$

(*j*) $303.882 = 3.03882 \times 10^2$

3. (*a*) $2.089 \times 10^{-5} = 0.00002089$

(*b*) $6.823 \times 10^{-13} = 0.0000000000006823$

(*c*) $4.1278 \times 10^{-5} = 0.000041278$

(*d*) $1.87 \times 10^{-7} = 0.000000187$

(*e*) $5.673 \times 10^{-5} = 0.00005673$

(*f*) $5.32 \times 10^{-7} = 0.000000532$

(*g*) $2.389 \times 10^6 = 2389000$

(*h*) $4.654 \times 10^3 = 4654$

(*i*) $7.89 \times 10^{-3} = 0.00789$

4. 5913000000000:

Move the decimal point 12 places to the left:

$5913000000000 = 5.913 \times 10^{12}$ m

5. 0.00000001:

Move the decimal point 8 places to the right:

$0.00000001 = 1 \times 10^{-8}$ g

6. Red blood cells per mm^3 = 5.5 million = 5.5×10^6

Blood in body = 5 litres

1 litre = 10,00,000 mm^3 = 10^6 mm^3

Total blood in body = 5×10^6 mm^3

Total red blood cells in 5×10^6 mm^3

$= 5.5 \times 10^6 \times 5 \times 10^6$

$= 27.5 \times 10^{12} = 2.75 \times 10^{13}$

7. Diameter of Uranus and Earth are

5.1118×10^7 m and

1.2756×10^7 m respectively.

Now, $\frac{5.1118 \times 10^7}{1.2756 \times 10^7} = \frac{51118}{12756} \approx 4$

So, diameter of Earth is on-fourth of diameter of Uranus.

8. Distance between Sun and Earth = 1.496×10^8 km

Convert km to m = 1.496×10^{11} m

Distance between Earth to Moon = 3.84×10^8 m

Distance between Moon to Sun = $1.496 \times 10^{11} - 3.84 \times 10^8$

$= 1.496 \times 10^{11} - 0.00384 \times 10^{11}$

$= 1.49216 \times 10^{11}$ m

9. Total thickness of 5 books:

5 books × 20 mm = 100 mm

Thickness of 5 paper sheets

5 × 0.0016 mm = 0.008 mm

Total thickness = 100 + 0.008

= 100.008 mm

10. Mass of proton and electron

1.67262×10^{-27} kg and respectively,

9.10938×10^{-31} kg

$\frac{1.57262 \times 10^{-27}}{9.10938 \times 10^{-31}} \approx 1836$

This is close to 2000.

Hence, the mass of a proton is nearly 2000 times the mass of an electron.

11. Given:

1 arab = 10^9

1 padma = 10^{15}

(*a*) Standard form

Starlings population = 1.3 arab = 1.3×10^9

Humans population = 8.2 arab = 8.2×10^9

Ants population = 20 padma 20×10^{15}

$= 2 \times 10^{16}$

(*b*) Ants per human

Ants population ÷ humans population

$= (2 \times 10^{16}) \div (8.2 \times 10^9) \approx 2.44 \times 10^6$

(*c*) Number of flocks of starlings

Total starlings = 1.3×10^9

Birds per flock = 10^4

Number of flocks = $1.3 \times 10^9 \div 10^4$

$= 1.3 \times 10^5 = 1{,}30{,}000$

12. Number of stars in the universe

$= 2 \times 10^{23}$

Counting rate = 1 per second

Seconds = 2×10^{23}

1 year = 365 × 24 × 60 × 60 = 31536000 seconds

$\approx 3.153 \times 10^7$ seconds

Years = $(2 \times 10^{23}) \div (3.153 \times 10^7)$

$\approx 6.34 \times 10^{15}$ years

13. There are an estimated 2×10^{25} drops of water on Earth.

Assume: 1 mL = 16 drops

Volume of one glass = 200 mL

Time to drink one glass = 10 seconds

Step 1: Convert drops to volume (in mL)

Total volume = $(2 \times 10^{25}) \div 16$

$= 1.25 \times 10^{24}$ mL

Step 2: Convert volume to number of glasses

Number of glasses

$= (1.25 \times 10^{24}) \div 200$

$= 6.25 \times 10^{21}$ glasses

Step 3: Calculate total time in seconds

Total time

$= 6.25 \times 10^{21} \times 10$

$= 6.25 \times 10^{22}$ seconds

Step 4: Convert seconds into years

1 year = 3.1536×10^7 seconds

Time in years

$= (6.25 \times 10^{22}) \div (3.1536 \times 10^7)$

$\approx 1.98 \times 10^{15}$ years

It would take approximately 1.98×10^{15} years.

14. Cost of paper per kg = ₹20, Aarti's weight = 35 kg

(*a*) Cost of paper 35 kg × 20 = ₹700

(*b*) 40 kg × 20 = ₹800

(*c*) 35 kg × 25 = ₹875

(*d*) Increase in weight = 45 − 35 = 10 kg

Extra cost = 10 × 20 = ₹200

Mental Maths (Page 65)

1. $\frac{6^7-6^9}{6^5} = \frac{6^7(1-6^2)}{6^5} = 6^{7-5}(1-6^2) = 6^2(1-36)$

$= 6^2(-35) = 36 \times (-35)$

$= -1260$

2. $2^5 = 32, 5^2 = 25, 3^2 = 9$

So, $2^5 + 5^2 - 3^2 = 32 + 25 - 9 = 48$

3. $64 = 2^6$

So,

$2^{3x} = 2^6$

$\Rightarrow 3x = 6$

$\Rightarrow x = 2$

4. $5^2 + x^2 = 13^2$

$\Rightarrow x^2 = 13^2 - 5^2 = 169 - 25$

$\Rightarrow x^2 = 144$

$\Rightarrow x = 12$

5. $41856 = 4.1856 \times 10^4$

6. $2^x \times 5^x = 10000$

$2^x \times 5^x = (2 \times 5)^x = 10^x$

So,

$10^x = 10000$

$10^x = 10^4$

Therefore, $x = 4$

Challenge Question (Page 66)

1. $\frac{1}{216^{-\left(\frac{2}{3}\right)}} + \frac{1}{256^{-\left(\frac{3}{4}\right)}} + \frac{1}{243^{-\left(\frac{1}{5}\right)}} = 216^{\frac{2}{3}} + 256^{\frac{3}{4}} + 243^{\frac{1}{5}}$

$= 6^{3\times\frac{2}{3}} + 2^{8\times\frac{3}{4}} + 3^{5\times\frac{1}{5}}$

$= 6^2 + 2^6 + 3$

$= 36 + 64 + 3$

$= 103$

2. $\frac{5^m \times 5^3 \times 5^{-2}}{5^{-5}} = 5^{12}$

$\Rightarrow 5^m \times 5^3 \times 5^{-2} \times 5^5 = 5^{12}$

$\Rightarrow 5^{(m+3-2+5)} = 5^{12}$

$\Rightarrow 5^{(m+6)} = 5^{12}$

So, $m + 6 = 12 \Rightarrow m = 6$

3. $\frac{16\times 2^{n+1} - 4\times 2^n}{16\times 2^{n+1} - 2\times 2^{n+2}} = \frac{2^4\times 2^{n+1} - 2^2\times 2^n}{2^4\times 2^{n+1} - 2^1\times 2^{n+2}}$

$= \frac{2^{n+5} - 2^{n+2}}{2^{n+5} - 2^{n+3}}$

$= \frac{2^{n+2}(2^3-1)}{2^{n+3}(2^2-1)} = \frac{2^{n+2}\times 7}{2^{n+3}\times 3}$

$= \frac{7}{2\times 3} = \frac{7}{6}$

4. Based on the given examples (e.g., "G89P0" or "003AZ"), it seems we need to form a 5-character passcode where:

3 characters are digits (0-9), 2 characters are uppercase alphabets (A-Z).

- For the 3 digits: Each of the 3 positions can be any digit from 0 to 9, so there are 10 choices for each digit.
- For the 2 letters: Each of the 2 positions can be any uppercase letter from A to Z, so there are 26 choices for each letter.

Now, let's calculate the total number of possible passcodes:

$10 \times 10 \times 10 \times 26 \times 26$

$= 103 \times 262 = 103 \times 676 = 676000$

So, the total number of passcodes is: 676000

Assessment

A. 1. (*c*) exponent

2. (*b*) $5^{-2} = \frac{1}{5^2}$

3. (*d*) $2^5 \div 2^{-6} = 2^{(5-(-6))} = 2^{11}$

4. (*b*) $\left(\frac{1}{2}\right)^{-1} = 2$

Reciprocal of $2 = \frac{1}{2}$

(*b*) $\frac{1}{2}$

5. (*c*) $x^4 \div x^{12} = x^{4-12} = x^{-8}$

(Subtracting exponents)

6. (*d*) $\left(\frac{1}{2}\right)^{-3} = 2^3 = 8$

Let number = k

$8 \div k = \frac{1}{60} \Rightarrow k = 480$

7. (*d*) $(2^4)^m = 16^m$

Solving all options

(*a*) $2^{4m} = (2^4)^m = 16^m$

(*b*) $4^{2m} = (4^2)^m = 16^m$

(*c*) $(2^m)(2^{3m}) = (2^m)(8^m) = 16^m$

(*d*) $4m^{2m}$

Only $4m^{2m}$ is not equal to $(2^4)^m$

8. (*d*) $9^{8.6} \times 8^{3.9} \times 72^{4.4} \times 9^{3.9} \times 8^{8.6} = 72^x$

$\Rightarrow 9^{8.6} \times 8^{3.9} \times (8 \times 9)^{4.4} \times 9^{3.9} \times 8^{8.6} = (8 \times 9)^x$

$\Rightarrow 9^{8.6+3.9} \times 8^{3.9+8.6} \times (8 \times 9)^{4.4} = (8 \times 9)^x$

$\Rightarrow (9 \times 8)^{8.6+3.9} \times (8 \times 9)^{4.4} = (8 \times 9)^x$

$\Rightarrow (9 \times 8)^{8.6+3.9+4.4} = (8 \times 9)^x$

Comparing powers

$\Rightarrow x = 8.6 + 3.9 + 4.4 = 16.9$

9. (*d*) $800 = 2^5 \times 5^2 = m^n \times n^m$

on comparing $m = 2, n = 5$

$$\frac{n}{m} = \frac{5}{2}$$

B. 1. (*a*) **Assertion:** True

Reason: True and correct explanation of Assertion (A)

2. (*b*) $3.5 \times 10^7 = 35000000 \rightarrow$ True

Reason is true but not explanation of Assertion (A)

C. 1. $2^{3x+9} = 2^{-x} \Rightarrow 3x + 4 = -x \Rightarrow x = -1$

2. $\left(\frac{1}{2}\right)^4 = \frac{1}{2\times2\times2\times2} = \frac{1}{16}$

3. $\left(\frac{1}{4}\right)^{-3} = 4^3 = 64$

4. $\frac{1}{2^6} = \frac{1}{64}$

5. $0.00000064 = \frac{64}{10^8} = 6.4 \times 10^{-7}$

6. 5.05×10^{-5} is $= 0.0000505$

D. 1. False: If a is any integer, then $a^0 = 1$.

2. True: Fourth powers are also square numbers.

3. True: $2^0 > (-1)^{135}$

$1 > -1$

4. False

5. False: $(2^3 \times 2^2)^{-2} = 2^{-12}$

$(2^5)^{-2} = 2^{-10} \neq 2^{-12}$

E. 1. $\frac{1}{1+p+q^{-1}} + \frac{1}{[1+q+r^{-1}]} + \frac{1}{[1+r+p^{-1}]}$

$$= \frac{1}{1+p+\frac{1}{q}} + \frac{1}{1+q+\frac{1}{r}} + \frac{1}{1+r+\frac{1}{p}}$$

$$= \frac{q}{q+pq+1} + \frac{r}{r+qr+1} + \frac{p}{p+rp+1}$$

$$= \frac{q}{q+\frac{1}{r}+1} + \frac{r}{r+\frac{1}{p}+1} + \frac{p}{p+rp+1} \quad [\because pqr = 1]$$

$$= \frac{qr}{qr+1+r} + \frac{pr}{pr+1+p} + \frac{p}{p+pr+1}$$

$$= \frac{qr}{\frac{1}{p}+1+r} + \frac{pr}{pr+1+p} + \frac{p}{p+pr+1}$$

$$= \frac{pqr}{1+p+pr} + \frac{pr}{pr+1+p} + \frac{p}{p+pr+1}$$

$$= \frac{pqr+pr+p}{1+p+pr} = \frac{1+pr+p}{1+p+pr} = 1$$

2. $\left(\frac{1}{2}\right)^{-2} + \left(\frac{1}{3}\right)^{-2} + \left(\frac{1}{4}\right)^{-2}$

$= 2^2 + 3^2 + 4^2 = 4 + 9 + 16 = 29$

3. $(3)^{2m+1} \times 3^3 = (-3)^{12}$

LHS: $3^{2m+1} \times 3^3 = 3^{2m+1+3} = 3^{2m+4}$

RHS: 3^{12}

$3^{2m+4} = 3^{12}$

Comparing exponents

$2m + 4 = 12 \Rightarrow 2m = 8 \Rightarrow m = 4$

4. $\frac{2^m \times 3^m + 2^{m+1} \times 3^{m+1}}{2^{m+2} \times 3^{m+2} + 2^{m+3} \times 3^{m+3}}$

$$= \frac{2^m \times 3^m[1+6]}{2^{m+2} \times 3^{m+2}[1+6]} = \frac{2^m \times 3^m \times 7}{2^{m+2} \times 3^{m+2} \times 7}$$

$$= \frac{1}{2^{m+2-m} \times 3^{m+2-m} \times 1} = \frac{1}{4 \times 9} = \frac{1}{36}$$

5. $\dfrac{25^n \times 5 \times 5^n - 125^n}{125^m \times 2^2} = \dfrac{1}{25}$

$\Rightarrow$ $[25^n \times 5^n \times 5 - 125^n] \times 25 = 125^m \times 2^2$

$\Rightarrow$ $[(5^2)^n \times 5^n \times 5 - (5^3)^n] \times 5^2 = [(5^3)^m \times 2^2]$

$\Rightarrow$ $[5^{2n} \times 5^n \times 5 - 5^{3n}] \times 5^2 = 5^{3m} \times 2^2$

$\Rightarrow$ $[5^{3n} \times 5 - 5^{3n}] \times 25 = 5^{3m} \times 4$

$\Rightarrow$ $5^{3n}[4] \times 25 = 5^{3m} \times 4$

$\Rightarrow$ $5^{3n} = 5^{3m} \times 5^{-2}$

$\Rightarrow$ $5^{3n} = 5^{3m-2}$

on comparing exponents

$\Rightarrow$ $3n = 3m - 2$

$\Rightarrow$ $3m - 3n = 2$

6. (*a*) $2^8 \times 5^3 = (2^3 \times 5^3) \times 2^5 = 10^3 \times 32$

(*b*) $5^4 \times 2^6 = (5^3 \times 2^3) \times (5 \times 2^3) = 10^3 \times 40$

(*c*) $10^3 \times 2^5 = 10^3 \times 32$

(*d*) $4^4 \times 5^3 = (2^8 \times 5^3) = 10^3 \times 32$

Same numbers: (*a*), (*c*) and (*d*)

7. Mass of Earth and Jupiter

Earth = 5.97×10^{24} kg

Jupiter = 1.90×10^{27} kg

Total mass = $5.97 \times 10^{24} + 1.90 \times 10^{27}$

= $5.97 \times 10^{24} + 1900 \times 10^{24}$

= 1905.97×10^{24}

= 1.90597×10^{27} kg

8. 4-letter codes using first 10 letters (no repetition)

= $10 \times 9 \times 8 \times 7 = 5040$

9. 5-digit telephone numbers starting with 67 (no repetition)

Digits used: 6, 7 fixed

Remaining digits = 8

Remaining places = 3

= $8 \times 7 \times 6 = 336$

10. Coin tossed 3 times

Number of outcomes = $2^3 = 8$

11. Signals using 2 flags (order matters)

= $6 \times 5 = 30$

12. Let the number be x.

$7^{-5} \times x = 7 \Rightarrow x = 7 \times 7^5 = 7^6$

Required number = 7^6

13. Difference in population (scientific notation)

Difference

= 623700000 − 586500000 = 37200000

= 3.72×10^7

14. (*a*) Distance from Sun to venus (standard form)

108,200,000 km = 1.082×10^8 km

(*b*) Radius of venus (in metres) (standard form)

6051.8 km = 6,051,800 m

= 6.0518×10^6 m

(*c*) Time to reach Sun at 20,000 km/h

Time = Distance ÷ Speed

= 108,200,000 ÷ 20,000

= 5410 hours = 5.41×10^3 hours

(*d*) Time for light to reach Venus

Speed of light = 3×10^5 km/s

Distance = 1.082×10^8 km

Time = Distance ÷ Speed

= $(1.082 \times 10^8) \div (3 \times 10^5)$

= 0.3607×10^3

= 3.607×10^2 seconds

CHAPTER 3: A STORY OF NUMBERS

Let's Recall

1. (*a*) Indian number system

2. (*d*) XL = 40, IX = 9 ⟶ 40 + 9 = 49

3. (*a*) M = 1000 (largest among the options)

4. (*a*) Aryabhata

Fast Check (Page 76)

1. LXXVIII + XLV

LXXVIII = 78

XLV = 45

78 + 45 = 123

123 in Roman numerals = CXXIII

2. DCLXXX − CXLIV

DCLXXX = 680

CXLIV = 144

680 − 144 = 536

536 in Roman numerals = DXXXVI

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\ 25-Mar-2026 Sandeep Rai Proof-4 Reader's Sign ____________ Date ________

Practice Time 3A

1. • In this system:

urapon = 1

ukasar = 2

(*a*) 7: *ukasar - ukasar - ukasar - urapon*

(*b*) 12: *ukasar - ukasar - ukasar - ukasar - ukasar - ukasar*

(*c*) 11: *ukasar - ukasar - ukasar - ukasar - ukasar - urapon*

(*d*) 9: *ukasar - ukasar - ukasar - ukasar - urapon*

2. (*a*) (*ukasar-ukasar-ukasar*) + (*ukasar-ukasar-ukasar-urapon*)

= 6 + 7 = 13

= *ukasar-ukasar-ukasar-ukasar-ukasar-ukasar-urapon*

(*b*) (*ukasar-ukasar-ukasar-ukasar-urapon*) + (*ukasar-ukasar-urapon*)

= 9 + 5 = 14

= *ukasar-ukasar-ukasar-ukasar-ukasar-ukasar-ukasar*

(*c*) (*ukasar-ukasar-ukasar-ukasar-urapon*) − (*ukasar-ukasar-ukasar*)

= 9 − 6 = 3

= *ukasar-urapon*

(*d*) (*ukasar-ukasar-ukasar-ukasar-urapon*) × (*ukasar-ukasar*)

= 9 × 4 = 36

= *ukasar* + *ukasar* + … + *ukasar*, 18 times

(*e*) (*ukasar-ukasar-ukasar-ukasar-ukasar-ukasar-ukasar-ukasar*) ÷ (*ukasar-ukasar*)

= 16 ÷ 4 = 4

= *ukasar-ukasar*

(*f*) (*ukasar-ukasar-ukasar*) × (*ukasar-ukasar-ukasar*) ÷ (*ukasar-ukasar-ukasar*)

= (6 × 6) ÷ 6 = 6

= *ukasar-ukasar-ukasar*

(*g*) *urapon* + *urapon* − *urapon* ÷ *urapon* × *urapon* + *ukasar*

= 1 + 1 − 1 ÷ 1 × 1 + 2 = 3

= *ukasar - urapon*

3. (*a*) *okosa-okosa-okosa-okosa-okosa-urapun*

(*b*) *okosa-okosa-okosa-okosa-okosa-okosa-urapun*

(*c*) *okosa-okosa-okosa*

(*d*) 5 – 3 = 2 → (*okosa-okosa-urapun*) – (*okosa-urapun*)

4. (*a*) 2345 = 2000 + 300 + 40 + 5

= MM + CCC + XL +V = MMCCCXLV

(*b*) 7809 = 7000 + 800 + 9

= 5000 + 2000 + 800 + 9

= $\overline{\text{V}}$ + MM + DCCC + IX = $\overline{\text{V}}$MM DCCCIX

(*c*) 6549= 6000 + 500 + 40 +9

= 5000 + 1000 + 500 + 40 + 9

= $\overline{\text{V}}$ + M + D + XL + IX = $\overline{\text{V}}$MDXLIX

(*d*) 3409 = 3000 + 400 + 9

= MMM + CD + IX = MMMCCCIX

5. (*a*) XLV = (50 – 10) + 5 = 45

(*b*) LXIII = 50 + 10 + 3 = 63

(*c*) LXXVI = 50 + 20 + 6 = 76

(*d*) XCII = (100 – 10) + 2 = 92

(*e*) MDCLXVI = 1000 + 500 + 100 + 50 + 10 + 6 = 1666

(*f*) CCLX = 200 + 50 + 10 = 260

(*g*) DCCVIII = 500 + 200 + 8 = 708

(*h*) CCCXL = 300 + (50 – 10) = 340

6. (*a*) XIX (19) < XX (20)

(*b*) MDC (1600) > MCD (1400)

(*c*) CM (900) > DCCCL (850)

(*d*) XXI (21) > 19

(*e*) 120 < CC (200)

(*f*) C (100) > XCIX (99)

(*g*) MM (2000) > CC (200)

(*h*) DCC (700) < M (1000)

7. Numbers: CM (900), MCD (1400), MDC (1600), XXVII (27), DCCLIX (759)

Ascending order: XXVII (27), DCCLIX (759), CM (900), MCD (1400), MDC (1600)

8. (*a*) XXI (21) + VI (6) = 27 → XXVII

(*b*) CLVII (157) + XXIV (24) = 181 → CLXXXI

(*c*) XXXVIII (38) + XXV (25) = 63 → LXIII

(*d*) XC (90) + CD (400) = 490 → CDXC

(*e*) CD (400) + M (1000) = 1400 → MCD

(*f*) CXX (120) + XC (90) = 210 → CCX

9. • X → 10 • XLI → 41
• XXIX → 29 • C → 100

10. (*a*) CML ÷ XXXVIII – XV = 950 ÷ 38 – 15
= 25 – 15 = 10 → X

(*b*) XLV ÷ V × XVIII = 45 ÷ 5 × 18 = 9 × 18
= 162 → CLXII

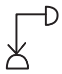
(*c*) VII + XXVIII × XIV = 7 + 28 × 14 = 7 + 392
= 399 → CCCXCIX

(*d*) LVII + XXXVIII × V = 57 + (38 × 5)
= 57 + 190 = 247 → CCXLVII

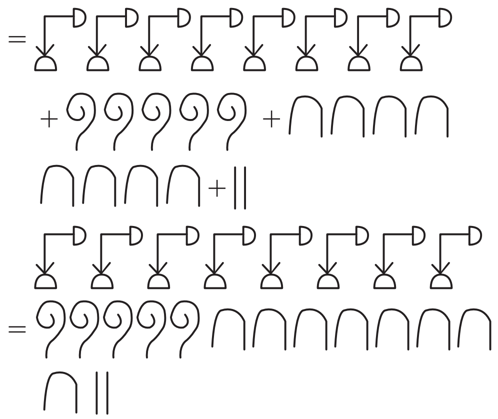
(*e*) IX × VI ÷ II = 9 × 6 ÷ 2 = 54 ÷ 2 = 27 → XXVII

(*f*) XV ÷ III × IV + XL = (15 ÷ 3 × 4) + 40
= (5 × 4) + 40 = 20 + 40 = 60 → LX

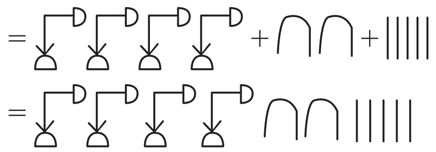
Practice Time 3B

1. Since  = 100000,  = 10000,  = 1000,  = 100,  = 10 and | = 1

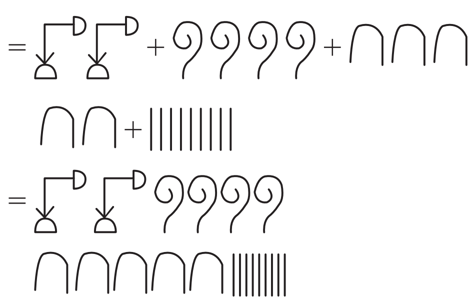
(*a*) 8582 = 8000 + 500 + 80 + 2



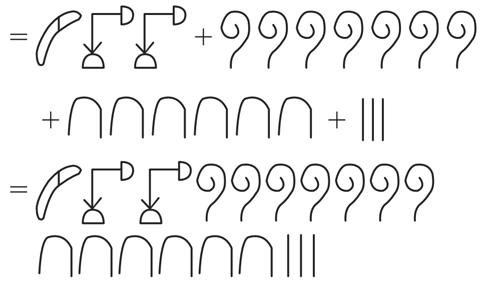
(*b*) 4025 = 4000 + 20 + 5



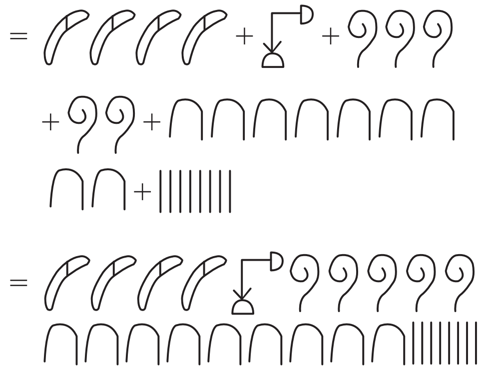
(*c*) 2459 = 2000 + 400 + 50 + 9



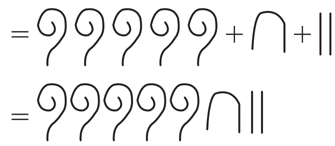
(*d*) 12763 = 10000 + 2000 + 700 + 60 + 3



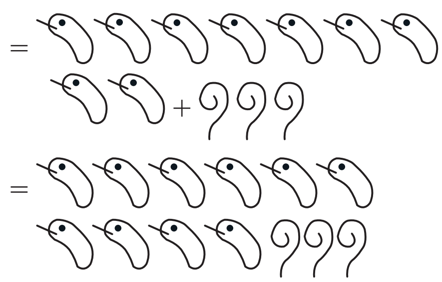
(*e*) 41598 = 40000 + 1000 + 500 + 90 + 8



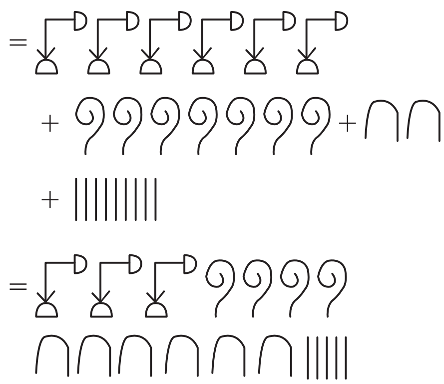
(*f*) 512 = 500 + 10 + 2

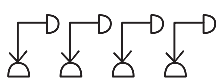


(*g*) 900300 = 900000 + 300



(*h*) 6729 = 6000 + 700 + 20 + 9



(*i*) 4000 = 

(*j*) 5028 = 5000 + 20 + 8

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(*k*) 3465 = 3000 + 400 + 60 + 5

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(*l*) 2065 = 2000 + 60 + 5

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3. (*a*) 𓍢𓍢 ∩∩∩ ∩∩∩ ||||| − ∩∩∩∩ ∩∩∩ ||||||

Here 7 heel bones (∩) cannot be subtracted from 6 heel bones (∩) so we will break 1 coil of rope (𓍢) into 10 heel bones (∩) also 6 single strokes (|) cannot be subtracted from 5 single strokes (|) so further we will break 1 heel bone (∩)into 10 single strokes (|).

Thus we get,

𓍢𓍢 ∩∩∩ ∩∩∩ ||||| = 𓍢 ∩∩∩∩∩∩∩∩ ∩∩∩∩∩∩∩∩ || |||

= 𓍢 ∩ ∩∩∩∩∩∩∩ ∩∩∩∩∩∩∩∩ || |||||||||||||

Now, 𓍢 ∩ ∩∩∩∩∩∩∩∩∩∩ ∩∩∩∩ ||||||||||||||| − ∩∩∩∩ ∩∩∩ ||||||

𓍢 ∩∩∩

= ∩∩∩∩

∩ |||||||||

∩∩∩∩∩∩∩∩∩∩ ||||||||||

𓍢~~𓍢~~ ∩∩∩∩∩~~∩~~ |||||

− ∩∩∩∩∩∩

𓍢 ∩∩∩∩∩∩ |||||||||

{Since 1 𓍢 = 10 ∩ and 1 ∩ = 10 |}

(*b*) 𓆼𓆼𓆼𓆼 𓆼𓆼𓆼 − 𓍢𓍢𓍢𓍢𓎆𓎆 𓎆𓎆𓎆𓏺𓏺𓏺𓏺𓏺 .... (1)

∵ 𓆼𓆼𓆼𓆼𓆼𓆼𓆼

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Put above value in equation (1)

Now, 𓆼𓆼𓆼𓆼𓆼𓆼 𓍢𓍢𓍢𓍢𓍢𓍢𓍢𓍢 𓍢𓎆𓎆𓎆𓎆𓎆𓎆 𓎆𓎆𓎆𓏺𓏺𓏺𓏺𓏺𓏺𓏺𓏺𓏺𓏺 − 𓍢𓍢𓍢𓍢 𓎆𓎆𓎆𓎆𓎆 𓏺𓏺𓏺𓏺𓏺

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(*c*) 𓂭𓂭𓂭𓂭𓆼𓆼𓆼 𓆼𓆼𓆼𓍢𓍢 𓏺𓏺𓏺𓏺𓏺𓏺 − 𓍢𓍢𓍢𓍢𓍢 𓎆𓎆𓏺𓏺𓏺

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(*d*) 𓍢𓍢𓍢𓍢𓎆𓎆 𓎆𓎆𓎆𓏺𓏺𓏺𓏺𓏺𓏺 − 𓎆𓎆𓎆 𓎆𓎆

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4. (*a*) 234 × 12 = 234 × (10 + 2)
= 234 × 10 + 234 × 2
= 2340 + 468 = 2808
= 2000 + 800 + 8
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(*b*) 45 × 19 = 45 × (20 − 1)
= 45 × 20 − 45 × 1
= 900 – 45
= 855
= 800 + 50 + 5
= 𓍢𓍢𓍢𓍢𓍢𓍢𓍢𓍢 𓎆𓎆𓎆𓎆𓎆𓏺𓏺𓏺𓏺𓏺

(*c*) 67 × 38 = 67 × (40 − 2)
= 67 × 40 − 67 × 2
= 2680 − 134
= 2546
= 2000 + 500 + 40 + 6
= 𓆼𓆼 𓍢𓍢𓍢𓍢𓍢 𓎆𓎆𓎆𓎆 𓏺𓏺𓏺𓏺𓏺𓏺

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\ 25-Mar-2026 Sandeep Rai Proof-4 Reader's Sign ____________ Date ________

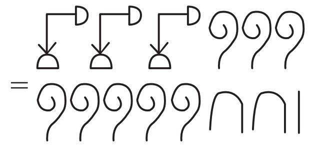
(*d*) 78×49

$78 \times 49 = 78 \times (50 - 1)$

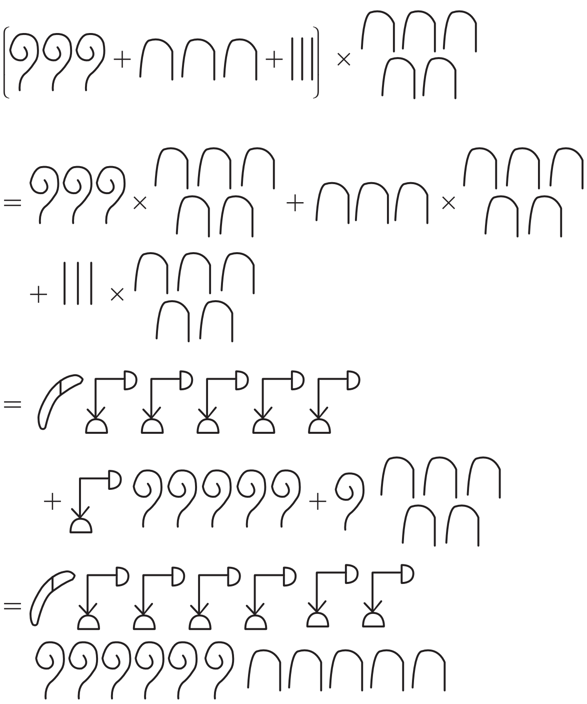
$= 78 \times 50 - 78 \times 1$

$= 3900 - 78$

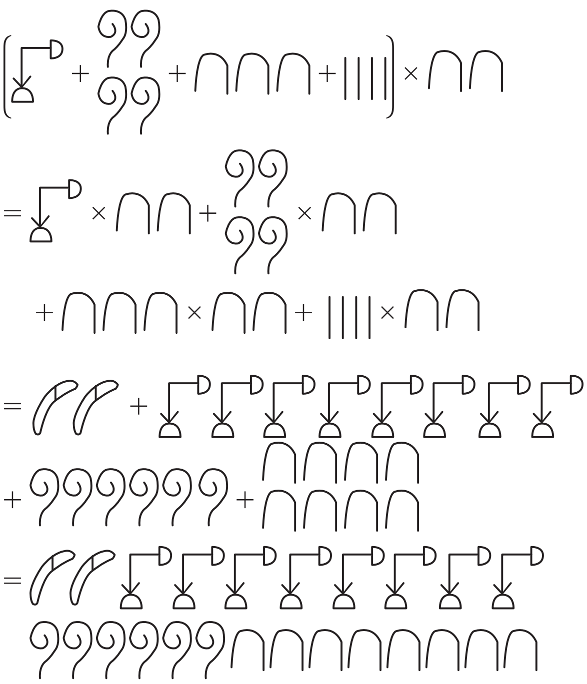
$= 3822$



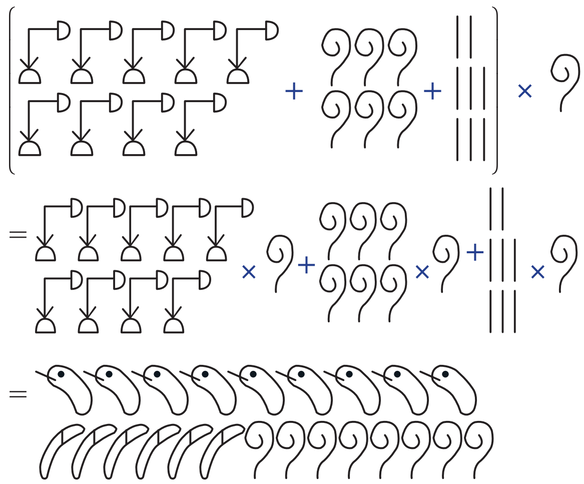
5. (*a*)



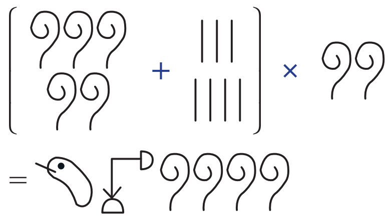
(*b*)



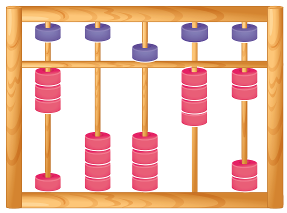
(*c*)



(*d*)



6. (*a*)



Here, 2 beads are at the ones place, 4 beads at the tens place, 5 beads at the hundreds place, and 3 beads at the ten-thousands place.

So,

Ten-thousands = 3 → 30,000

Thousands = 0 → 0

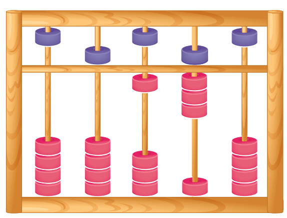
Hundreds = 5 → 500

Tens = 4 → 40

Ones = 2 → 2

Therefore, the number formed is 30,542.

(*b*)



Here, 0 beads are at the ones place, 8 beads at the tens place, 1 bead at the hundreds place, and 5 beads at the thousands place.

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\ 25-Mar-2026 Sandeep Rai Proof-4 Reader's Sign ____________ Date ________

So,

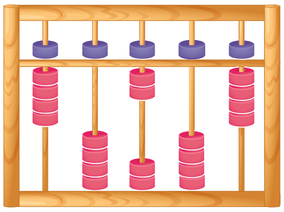
Thousands = 5

Hundreds = 1

Tens = 8

Ones = 0

Therefore, the number formed is 5,180.

(*c*) 

Here, 9 beads are at the ten-thousands place, 5 beads at the thousands place, 7 beads at the hundreds place, 5 beads at the tens place, and 9 beads at the ones place.

So,

Ten-thousands = 9

Thousands = 5

Hundreds = 7

Tens = 5

Ones = 9

Therefore, the number formed is 95,759.

Think Tank (Page 91)

Devanagari digits:

0 = ०, 1 = १, 2 = २, 3 = ३, 4 = ४, 5 = ५, 6 = ६, 7 = ७, 8 = ८, 9 = ९

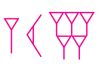
1. 8765 ⟶ ८७६५

2. 4091 ⟶ ४०९१

3. 702 ⟶ ७०२

4. 9181 ⟶ ९१८१

Practice Time 3C

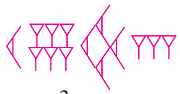
1. (*a*) 

$(60)^2 \times 1 + 60 \times 10 + 1 \times 5$

$= 3600 + 600 + 5 = 4205$

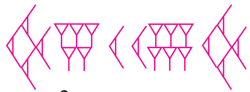
(*b*) 

$60 \times 1 + 1 \times 40 = 100$

(*c*) 

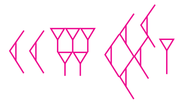
$(60)^3 \times 10 + (60)^2 \times 6 + 60 \times 40 + 1 \times 3$

$= 2160000 + 21600 + 2400 + 3 = 2184003$

(*d*) 

$(60)^2 \times 45 + 60 \times 26 + 1 \times 40$

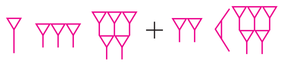
$= 162000 + 1560 + 40 = 163600$

(*e*) 

$60 \times 25 + 1 \times 51 = 1551$

(*f*) 

$(60)^2 \times 1 + 60 \times 3 + 1 \times 5 = 3785$

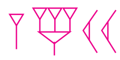
2. (*a*) 

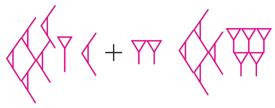
$= (3600 \times 1 + 60 \times 3 + 5) + (1 \times 60 + 15)$

$= (3600 + 180 + 5) + (75) = 3785 + 75 = 3860$

$= 3600 + 240 + 20 = 3600 + 60 \times 4 + 20$

$= (60)^2 \times 1 + 4 \times 60 + 20$

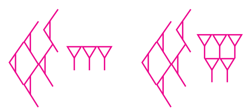
= 

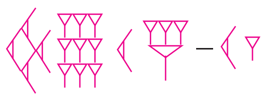
(*b*) 

$51 \times 60 + 10 + 2 \times 60 + 45 \times 1$

$= 3060 + 10 + 120 + 45 = 3235$

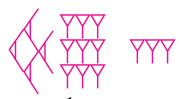
$= 3180 + 55 = 53 \times 60 + 55$

= 

(*c*) 

$= 49 \times 60 + 14 - 11$

$= 2954 - 11 = 2943 = 49 \times 60 + 3$

= 

3. (*a*) $3 \times 20^1 + 13 \times 20^0 = 60 + 13 = 73$

(*b*) $18 \times 360 + 0 \times 20^1 + 12 \times 20^0$

$= 6480 + 0 \times 20 + 12 = 6492$

(*c*) $3 \times 360 + 18 \times 20^1 + 2 \times 20^0$

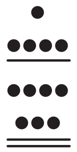
$= 1080 + 360 + 2 = 1442$

(*d*) $8 \times 360 + 18 \times 20^1 + 15 \times 20^0$

$= 2880 + 360 + 15 = 3255$

4. (*a*) 10533

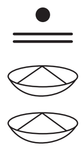
$= 1 \times 7200 + 9 \times 360 + 4 \times 20^1 + 13 \times 20^0$

= 

(*b*) $4560 = 12 \times 360 + 12 \times 20^1 + 0 \times 20^0$

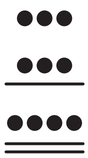
= 

(*c*) 3960

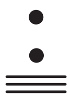
$= 11 \times 360 + 0 \times 20^1 + 0 \times 20^0 =$ 

(*d*) 1254

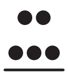
$= 3 \times 360 + 8 \times 20^1 + 14 \times 20^0$

= 

(*e*) $36 = 1 \times 20^1 + 16 \times 20^0$

= 

(*f*) $48 = 2 \times 20^1 + 8 \times 20^0$

= 

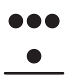
(*g*) $12 = 0 \times 20^1 + 12 \times 20^0$

= 

(*h*) $102 = 5 \times 20^1 + 2 \times 20^0$

= 

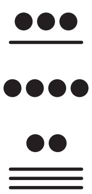
5. (*a*) $(1 \times 20^1 + 17 \times 20^0) + (1 \times 20^1 + 9 \times 20^0)$

$= 37 + 29 = 66 = 3 \times 20^1 \times 6 \times 20^0 =$ 

(*b*) $(3 \times 360 + 19 \times 20^1 + 0 \times 20^0) + (4 \times 360 + 3 \times 20^1 + 17 \times 20^0)$

$= 1080 + 380 + 0 + 1440 + 60 + 17$

$= 1460 + 1517 = 2977$

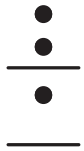
$= 8 \times 360 + 4 \times 20 + 17 \times 20^0 =$ 

(*c*) $(13 \times 360 + 15 \times 20^1 + 6 \times 20^0) + 12 \times 360 + 3 \times 20^1 + 19 \times 20^0$

$= (4680 + 300 + 6) + (4320 + 60 + 19)$

$= 4986 + 4399 = 9385$

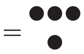
$= 1 \times 7200 + 6 \times 360 + 1 \times 20^1 + 5 \times 20^0$

= 

6. (*a*) $(18 \times 20 + 19 \times 1) - (17 \times 20 + 18 \times 1)$

$= 379 - 358 = 21 = 1 \times 20^1 + 1 \times 20^0 =$ 

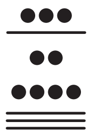
(*b*) $(17 \times 20 + 17 \times 1) - (14 \times 20^1 + 16)$

$= 357 - 296 = 61 = 3 \times 20^1 + 1 \times 20^0 =$ 

(*c*) $(12 \times 360 + 3 \times 20 + 19 \times 1) - (3 \times 360 + 19 \times 20 + 0)$

$= (4320 + 60 + 19) - (1080 + 380 + 0)$

$= (4399) - (1460) = 2939$

$= 8 \times 360 + 2 \times 20^1 + 19 \times 20^0 =$ 

7. (*a*) $7 \times 10000 + 5 \times 1000 + 1 \times 100 + 6 \times 10 + 9 \times 1$

$= 70000 + 5000 + 100 + 60 + 9$

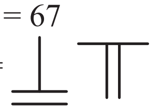
$= 75169$

(*b*) $7 \times 10000 + 6 \times 1000 + 5 \times 100 + 2 \times 10 + 8 \times 1$

$= 70000 + 6000 + 200 + 20 + 8$

$= 76528$

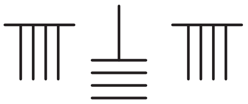
(*c*) $6 \times 10 + 7 \times 1 = 60 + 7 = 67$

8. (*a*) $12 + 65 = 77 = 70 + 7 =$ 

(*b*) $92 + 81 = 173 = 100 + 70 + 3 =$ 

(*c*) $27 + 68 = 95 = 90 + 5 =$ 

(*d*) $654 + 345 = 999 = 900 + 90 + 9$

= 

9. (*a*) $54 - 23 = 31 = 30 + 1 =$ 

(*b*) $98 - 37 = 61 = 60 + 1 =$ 

(*c*) $354 - 235 = 119 = 100 + 10 + 9 =$ 

(*d*) $2456 - 1191 = 1265 = 1000 + 20 + 45$

= 

D:\Sandeep Rai\Maths_Genius-8_TRM\Open_File\Detailed Answers\Detailed Answers \ 25-Mar-2026 Sandeep Rai Proof-4 Reader's Sign ____________ Date ________

Challenge Question (Page 92)

(*a*) REGISTRATION
(*b*) CAR
(*c*) FAR
(*d*) HIM
(*e*) OVER

Mental Maths (Page 94)

1. (*a*) $360 \times 2 + 0 + 3 = 723$
(*b*) $6000 + 500 + 60 + 1 = 6561$
(*c*) $360 + 320 + 1 = 681$
(*d*) $3600 \times 30 + 9 \times 60 + 5$
$= 108000 + 540 + 5 = 108545$

2. (*a*) $18 + 9 = 27 = 1 \times 20 + 7 \times 20^0 =$ 
(*b*) $89 + 11 = 100 = C$
(*c*) $18 \times 9 = 162 = 100 + 60 + 2$
$= 1 \times 100 + 6 \times 10 + 2 \times 1 =$ 

Maths Fun (Page 94)

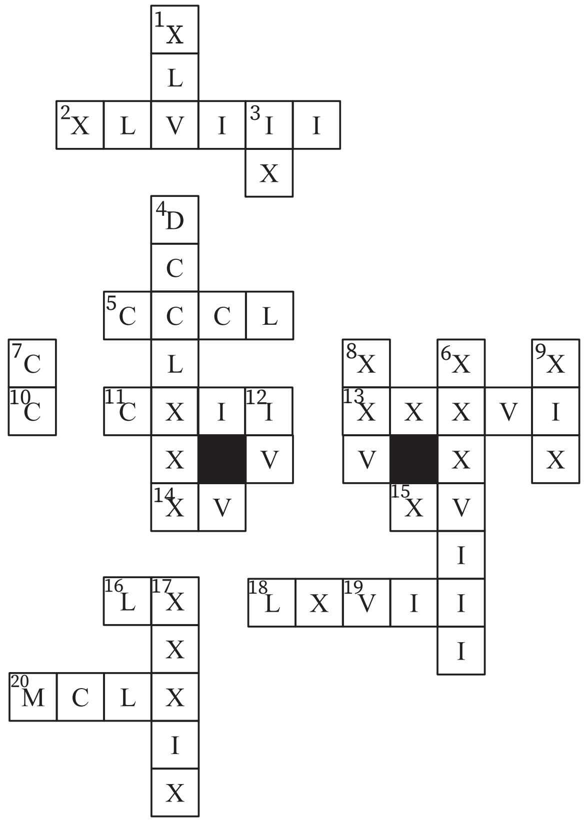
Across

2. L − II = 50 − 2 = 48 = XLVIII
5. L (VII) = 50 × 7 = 350 = CCCL
10. LXXXIX + XI = 89 + 11 = 100 = C
11. MCDLVI ÷ XIII = 1456 ÷ 13 = 112 = CXII
13. VI (VI) = 6 × 6 = 36 = XXXVI
14. L − XXXV = 50 − 35 = 15 = XV
15. XII + III = 12 + 3 = 15 = XV
16. XXX + XXX = 30 + 30 = 60 = LX
18. LXII + V = 62 + 5 = 67 = LXVII
20. XL (XXIX) = 40 × 29 = 1160 = MCLX

Down

1. XXV + XX = 25 + 20 = 45 = XLV
3. XLV ÷ V = 45 ÷ 5 = 9 = IX
4. LX (XIII) = 60 × 13 = 780 = DCCLXXX
6. LXXXVIII − L = 88 − 50 = 38 = XXXVIII
7. X (XX) = 10 × 20 = 200 = CC
8. XL − XV = 40 − 15 = 25 = XXV
9. XXXVIII ÷ II = 38 ÷ 2 = 19 = XIX
12. C ÷ XXV = 100 ÷ 25 = 4 = IV
17. MMMLXXXI ÷ LXXIX = 3081 ÷ 79 = 39
= XXXIX

19. XVI − XI = 16 − 11 = 5 = V



Chapter Assessment

A. **1.** (*a*) 10
2. (*d*) 2
3. (*a*) They are both base-10 systems.
4. (*b*) 1000

B. **1.** **Assertion (A):** True
Reason (R): True and correctly explains the assertion
(*a*)
2. **Assertion (A):** False
Reason (R): True
(*c*)
3. **Assertion (A):** False
Reason (R): True
(*d*)

C. **1.** zero
2. Liber Abaci
3. One Parardha is equal to 1 followed by 12 zeros.
4. tally.
5. two.

D. **1.** True

2. False

Reason: The Babylonian number system is base 60 but it does not use 59 different symbols. It main by uses two basic symbols (1 and 10)

3. False

Reason: The Egyptian number system is a base-10 number system, not base - 20.

4. False

Reason: In Chinese rod numerals:

- Hengs (horizontal rods) represent tens, thousands, and hundred-thousands
- Zongs (vertical rods) represent unit, hundreds, and ten-thousands

E. **1.** = 19

2.

= 100 + 200 + 50 + 6 = 1258

3. = 58

4. MMMDXL = 3000 + 500 + 40 = 3540

1.-(*iii*) **2.**-(*iv*) **3.**-(*i*) **4.**-(*ii*)

F. **1.** (*a*) 63 = 60 + 3 =

(*b*) 132 = 60 × 2 + 12 =

(*c*) 200 = 60 × 3 + 2 × 10 =

(*d*) 1615 = 26 × 60 + 55 =

2. (*a*) 77 = 20 × 3 + 17 =

(*b*) 100 = 5 × 20 + 0 =

(*c*) 721 = 2 × 360 + 0 + 1 =

(*d*) 235 = 11 × 20 + 15 =

3. (*a*) 200 + 30 + 6 = 236 = 236

(*b*) 3000 + 40 = 3040

(*c*) 7000 + 500 + 70 + 7 = 7577

(*d*) 10000 + 500 + 70 + 7 = 10577

4. (*a*) MCCXXII

(*b*) MMMCDLVI

(*c*) MMMXXIX

(*d*) DCCXV

5. (*a*) 1000 + 100 + 10 + 1 =

(*b*) 2000 + 600 + 60 =

(*c*) 700 + 80 + 4 =

(*d*) 70000 + 700 + 7 =

6. (*a*) 10 × 10 = 100 =

(*b*) 100 × 10 = 1000 =

(*c*) 1000 × 10 = 10000 =

(*d*) 10000 × 10 = 100000 =

7. (*a*) 10 × 100 = 1000 =

(*b*) 100 × 100 = 10000 =

(*c*) 1000 × 100 = 100000 =

(*d*) 10000 × 100 = 10^6 = 1000000 =

8. (*a*) 10 × 10^5 = 10^6 = 1000000 =

(*b*) 100 × 1000 = 100000 =

(*c*) 1000 × 1000 = 1000000 =

(*d*) 10 × 10^6 = 10^7 =

9. (*a*) 1 × 60 + 4 =

(*b*) 2 × 60 + 12 =

(*c*) 2677 = 44 × 60 + 37 =

(*d*) 3600 × 1 + 900 + 9 = 3600 + 60 × 15 + 9

=

10. (*a*) (*i*) 1234 + 5678 – 3980 = 2932

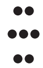
= 2880 + 40 + 12

= 8 × 360 + 2 × 20 + 12 =

(*ii*) 9397 = 7200 + 6 × 360 + 1 × 20 + 17

× 1 =

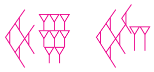
(*iii*) 46 = 20 × 2 + 6 =

(*iv*) 782 = 360 × 2 + 3 × 20 + 2 × 1 = 

(*v*) 5 =

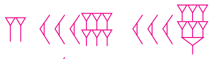
(*vi*) 875 = 360 × 2 + 7 × 20 + 15 = 

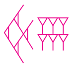
(*b*) (*i*) 2932 = 2880 + 52

= 48 × 60 + 52 = 

(*ii*) 9397 = 7200 + 2160 + 37

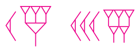
= 2 × 3600 + 36 × 60 + 37

= 

(*iii*) 46 = 

(*iv*) 782 = 780 + 2 = 

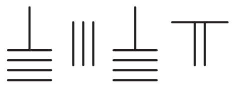
(*v*) 5 = 

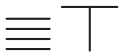
(*vi*) 875 = 14 × 60 + 35 = 

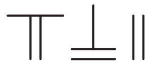
(*c*) (*i*) 2932 = 2000 + 900 + 30 + 2

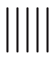
= 

(*ii*) 9397 = 9000 + 300 + 90 + 7

= 

(*iii*) 46 = 4 × 10 + 6 × 1 = 

(*iv*) 782 = 700 + 80 + 2 = 

(*v*) 5 = 

(*vi*) 875 = 800 + 70 + 5 = 

(*d*) (*i*) MMCMXXXII

(*ii*) $\overline{\text{IX}}$CCCXCVII

(*iii*) XLVI

(*iv*) DCCLXXXII

(*v*) v

(*vi*) DCCCLXXV

CHAPTER 4: QUADRILATERALS

Lets Recall

1. Open curve: A curve whose starting point and ending point do not meet.

Closed curve: A curve whose starting point and ending point meet to form a complete loop.

So,

(*a*) Open curve (*b*) Closed curve

(*c*) Open curve (*d*) Closed curve

(*e*) Closed curve

2. (*a*) All sides are 4.5 cm

→ Equilateral triangle

(*b*) Two sides are 4 cm and one side is different

→ Isosceles triangle

(*c*) All sides are of different lengths (4 cm, 10 cm, 12 cm)

→ Scalene triangle

3. (*a*) All angles are same and each one is less than 90°

→ Acute-angled triangle

(*b*) One angle is 90°

→ Right-angled triangle

(*c*) One angle is greater than 90°

→ Obtuse-angled triangle

Fast Check (Page 102)

Given: ABCD is a rectangle. Diagonals AC and BD intersect at O.

To prove: ΔAOD ≅ ΔCOB

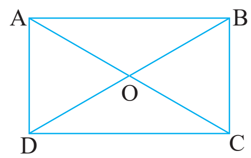
Proof:

In a rectangle, diagonals bisect each other.

∴ OA = OC and OB = OD

∠AOD = ∠COB (vertically opposite angles)

Thus, in ΔAOD and ΔCOB:



- OA = OC
- OD = OB
- ∠AOD = ∠COB

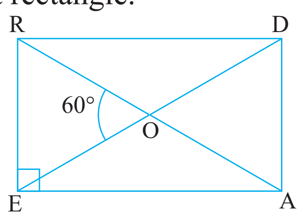
∴ ΔAOD ≅ ΔCOB by SAS congruence rule.

Hence proved.

Practice Time 4A

1. Given:

READ is a rectangle.



ED and RA are diagonals intersecting at point O.

∠ROE = 60°.

To find: ∠EAR and ∠RAD.

In a rectangle, diagonals are equal and bisect each other.

So, OE = OA ⇒ ΔOEA is an isosceles triangle.

Therefore, ∠OEA = ∠OAE = ∠EAR. ……(*i*)

∠ROE is an exterior angle of ΔOEA.

Exterior angle

By theorem: Exterior angle = sum of two opposite interior angles.

So, ∠ROE = ∠OEA + ∠OAE.

60° = ∠EAR + ∠EAR. ……….using (*i*)

60° = 2∠EAR ⇒ ∠EAR = 30°.

In rectangle READ.

∠EAD = 90°.

So, ∠EAD = ∠EAR + ∠RAD.

90° = 30° + ∠RAD.

∠RAD = 60°.

So, ∠EAR = 30°, ∠RAD = 60°

2. (*a*) Since OA = OB

⇒ ∠OAB = ∠OBA

(angles opposite to equal sides are equal)

⇒ ∠OBA = 30°

Since DC || AB and DC = AB and AC is a transversal so

∠ACD = ∠CAB

(Alternate angles are equal)

⇒ ∠ACD = 30°

Now again OD = OC

⇒ ∠ODC = ∠OCD = 30°

Again ∠AOB = 180° – ∠OAB – ∠OBA

= 180° – 30° – 30° = 120°

Since vertically opposite angles are equal

So, ∠DOA = ∠COB and

∠AOB = ∠COD = 120°

Since,

∠DOA + ∠AOB + ∠BOC + ∠COD = 360°

⇒ ∠DOA + ∠BOC

= 360° – 120° – 120°

= 360° – 240° = 120°

⇒ 2∠DOA = 120°

⇒ ∠DOA = 60° = ∠BOC

In ΔAOD,

∠OAD = 90° – 30° = 60° and

∠DOA = 60°

⇒ ΔADO is an equilateral triangle.

⇒ ∠ODA = 60°

Similarly, ΔOCB is an equilateral triangle

So, ∠BOC = ∠BCO = ∠COB = 60°

So, ∠OBA = ∠OCD = ∠ODC = 30°,

∠BOC = ∠OBC = ∠OCB = ∠AOD = ∠OAD = 60°,

∠COD = 120°

(*b*) Given: In a rectangle PQRS, ∠ROQ = 110°, OR = OQ = OP = OS

To find: other angles

Since OR = OQ

∠ORQ = ∠OQR (angles opposite to equal side are equal)

⇒ ΔROQ is an isoscales triangle.

∠ORQ + ∠OQR + ∠ROQ = 180° (angle sum property)

⇒ 2∠ORQ + 110° = 180°

⇒ ∠ORQ = (180° – 110°) ÷ 2 = 35°

∠ORQ = ∠OQR = 35°

Since vertically opposite angles are equal.

⇒ ∠ROQ = ∠POS = 110°

Similarly ΔPOS is an isosceles triangle.

⇒ ∠OPS = ∠OSP = 35°

Since POR is straight line.

∠POQ + ∠QOR = 180° (Linear pair)

⇒ ∠POQ + 110° = 180°

⇒ ∠POQ = 180° – 110° = 70°

Since OR = OQ

⇒ ∠OQP = ∠OPQ (angles opposite to equal side are equal)

⇒ ΔOQP is an isosceles triangle.

∠OQP + ∠QOP + ∠OPQ = 180° (angle sum property)

⇒ ∠OPQ + 70° + ∠OPQ = 180°

⇒ ∠OPQ = (180° – 70°) ÷ 2 = 55°

⇒ ∠OPQ = ∠OQP = 55°

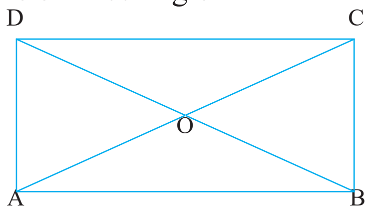
Similarly, ∠ORS = ∠OSR = 55°

So, ∠OQR = ∠ORQ = ∠OPS = ∠OSP = 35°,

∠OPQ = ∠OQP = ∠OSR = ∠ORS = 55°,

∠POQ = ∠SOR = 70°, ∠POS = 110°.

3. Diagonals of a rectangle



In rectangle ABCD, diagonals intersect at O.

Property used:

Diagonals of a rectangle bisect each other, so

OA = OC

Given: $OA = y + 2$

$OC = 2y - 1$

So, $y + 2 = 2y - 1$

$\Rightarrow y = 3$

4. Given: PQRS is a square and PQ = $(5a - 17)$ cm, QR = $(2a + 4)$ cm

Since, all sides of a square are equal.

So, $5a - 17 = 2a + 4$

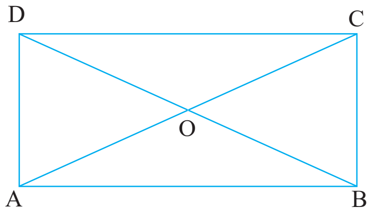
$\Rightarrow 3a = 21$

$\Rightarrow a = 7$

Length of PS = $(5a - 17)$ cm

$= 5(7) - 17 = 18$ cm

5. Given: A diagonal makes an angle of 25° with one side.



Let diagonal AC of the rectangle ABCD is inclined to the side AB at 25°. Since diagonals are equal and they bisect each other,

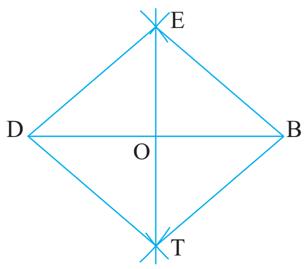
OA = OB

$\Rightarrow \Delta OAB$ is an isosceles triangle.

Also $\angle OAB = 25°$. $\angle COB$ is the exterior angle of the ΔAOB.

So, $\angle COB = \angle OAB + \angle ABO = 25° + 25° = 50°$

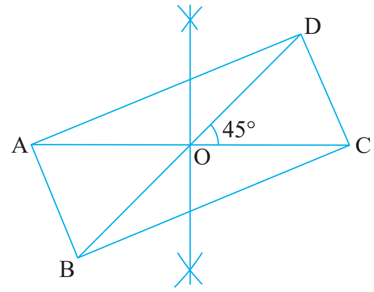
6.



Steps:

1. Draw diagonal DB = 8 cm.
2. Find the midpoint O of DB.
3. Draw a perpendicular line through O.
4. With O as centre and radius OB, cut the perpendicular at E and T.
5. Join D-E-B-T-D.

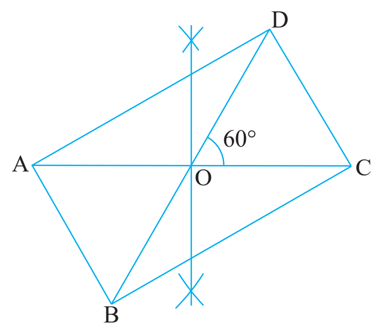
7. *a.* 45°



Steps:

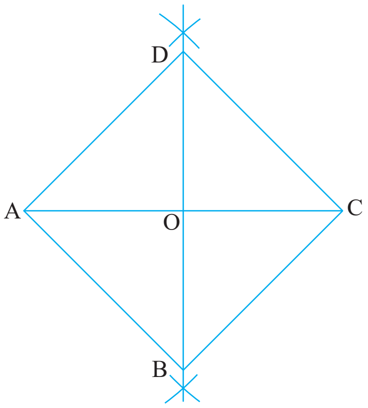
1. Draw a line segment AC = 10 cm.
2. Find the midpoint O of AC using a compass (draw perpendicular bisector).
3. At point O, construct an angle of 45° with AC as one arm.
4. On this new line, mark points B and D such that OB = OD = 5 cm on opposite sides of O.
5. Join A to B, B to C, C to D, and D to A.

(*b*) 60°



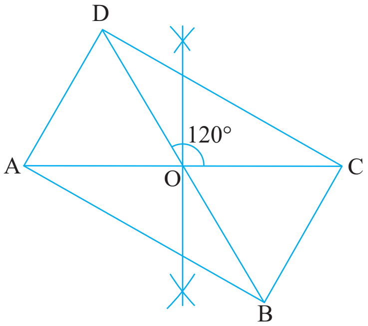
1. Draw a line segment AC = 10 cm.
2. Construct the perpendicular bisector of AC to locate the midpoint O.
3. At point O, construct an angle of 60° with AC as one arm.
4. On this ray, mark points B and D such that OB = OD = 5 cm, on opposite sides of O.
5. Join A–B, B–C, C–D, and D–A.

(*c*) 90°



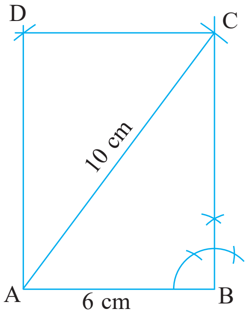
1. Draw a line segment AC = 10 cm.
2. Find the midpoint O of AC.
3. Through O, draw a line perpendicular to AC (this gives a 90° angle).
4. On this perpendicular line, mark B and D such that
   OB = OD = 5 cm.
5. Join A–B, B–C, C–D, and D–A.

(*d*) 120°



1. Draw a line segment AC = 10 cm.
2. Construct the midpoint O of AC.
3. At O, construct an angle of 120° with AC as one arm.
4. On this line, mark B and D such that
   OB = OD = 5 cm, on opposite sides of O.
5. Join A–B, B–C, C–D, and D–A.

8.

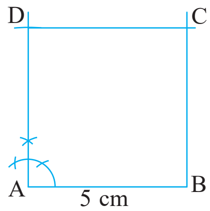


Steps of Construction:

1. Draw a line segment AB = 6 cm.
2. At point B, draw a perpendicular line to AB.
3. With A as centre and radius 10 cm, draw an arc cutting the perpendicular at C.
4. Through point C, draw a line parallel to AB.
5. Through point A, draw a line parallel to BC meeting the previous line at D.
6. Join BC, CD, and DA.

Thus, ABCD is the required rectangle.

8.



Steps of Construction:

1. Draw a line segment AB = 5 cm.
2. At point A, draw a perpendicular line to AB.
3. On this perpendicular line, mark point D such that AD = 5 cm.
4. Through D, draw a line parallel to AB.
5. Through B, draw a line parallel to AD, and mark the intersection of these lines as point C.
6. Join BC and CD.

Thus, ABCD is the required square.

Think Tank (Page 108)

No, a quadrilateral cannot have three right angles if its fourth angle is not a right angle.

Reason:

The sum of interior angles of a quadrilateral is 360°.

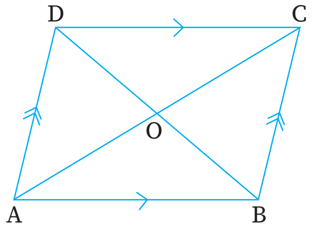
Three right angles = (3 × 90° = 270°).

So, the fourth angle must be (360° – 270° = 90°).

Hence, if three angles are right angles, the fourth angle must also be a right angle.

Think Tank (Page 109)

1. No



Reason:

- In a general parallelogram, diagonals bisect each other but are not equal.
- For congruence, we would need AO = OC and DO = OB, plus an included angle.
- This only holds in special cases like a rectangle or square.
- In a general parallelogram, the triangles ΔAOD and ΔBOC are not congruent.

2. No

Reason:

- For these triangles, we would need AO = OB and AD = BC, with equal included angles.
- Again, this is true in rectangles (where diagonals are equal and angles are right), but not in all parallelograms.
- So in a general parallelogram, ΔOAD and ΔOBC are not congruent.

3. Yes

Reason:

- A rectangle has opposite sides equal and parallel, which satisfies the definition of a parallelogram.
- Therefore, every rectangle is a parallelogram, but the reverse is not true: not every parallelogram is a rectangle (since parallelograms don't always have right angles).

4. No

Reason:

- Diagonals of a parallelogram always bisect each other, but the angle of intersection depends on the shape.
- In a square or rhombus, they intersect at 90°.
- In other parallelograms, the angle can be acute or obtuse.
- So there is no fixed angle for all parallelograms.

Fast Check (Page 110)

1. In a parallelogram, opposite angles are equal.

$\angle H = 60° \Rightarrow \angle F = 60°.$

Adjacent angles are supplementary (sum = 180°).

$\angle H + \angle G = 180° \Rightarrow 60° + \angle G = 180°$

$\Rightarrow \quad \angle G = 120°.$

$\angle E = \angle G = 120°.$

So,

$\angle E = 120°, \angle F = 60°, \angle G = 120°, \angle H = 60°.$

2. Adjacent angles in a parallelogram are supplementary.

$(2x) + (3x) = 180° \Rightarrow 5x = 180° \Rightarrow x = 36°.$

First angle = $2x = 72°$.

Second angle = $3x = 108°$.

Let us assume ABCD is a parallelogram.

Opposite angles are equal:

$\angle A = 72°, \angle C = 72°.$

$\angle B = 108°, \angle D = 108°.$

So, angles are 72°, 108°, 72°, 108°.

Think Tank (Page 110)

In a parallelogram, interior angle + exterior angle = 180°.

If one external angle = x, then the corresponding internal angle = 180° – x.

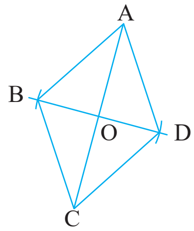
Opposite angles are equal, and adjacent angles are supplementary.

So the four interior angles of the parallelogram are: $(180° - x), x, (180° - x), x$

So, yes we can find all four angles of parallelogram.

Fast Check (Page 113)

To construct a rhombus with diagonals 4 cm and 6 cm



Step 1: Draw a line segment AC = 6 cm (one diagonal).

Step 2: Find the midpoint O of AC by drawing its perpendicular bisector.

Step 3: Through point O, draw a line perpendicular to AC.

Step 4: On this perpendicular line, mark points B and D such that OB = OD = 2 cm (half of the other diagonal).

Step 5: Join A to B, B to C, C to D, and D to A.

ABCD is the required rhombus with diagonals:

- AC = 6 cm
- BD = 4 cm

Practice Time 4B

1. Given ABCD is a square ∠EBC = ∠ECB = 60° and EC = 8 cm.

∠BEC + ∠EBC + ∠BCF = 180°

⇒ ∠BEC + 60° + 60° = 180°

⇒ ∠BEC = 60°

In ΔEBC, all angles are equal to 60°

⇒ ΔEBC is an equaliteral triangle.

All sides are equal.

So, BE = CE = BC.

Since CE = 8 cm, we get BE = BC = 8 cm.

In square ABCD, all sides are equal.

Therefore, side of square = BC = 8 cm.

The side of the square ABCD is 8 cm.

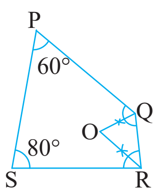
2. Given: In a quadrilateral PQRS, the bisectors of ∠Q and ∠R meet at point O. ∠P = 60°, ∠S = 80°.

Using Angle sum property of quadrilateral,

$$\angle P + \angle Q + \angle R + \angle S = 360°$$

$$\Rightarrow 60° + \angle Q + \angle R + 80° = 360°$$

$$\Rightarrow \angle Q + \angle R = 220°$$



In ΔORQ,

∠OQR + ∠QOR + ∠ORQ = 180°

$$\Rightarrow \frac{1}{2}\angle Q + \angle QOR + \frac{1}{2}\angle R = 180°$$

(∵ the bisecors of ∠Q and ∠R meet at point O)

$$\angle QOR = 180° - \frac{1}{2}(\angle Q + \angle R)$$

$$\angle QOR = 180° - \frac{1}{2}(220°) = 180° - 110° = 70°$$

∠QOR = 70°

3. Given: In rhombus ABCD, diagonals intersect at O, 2∠OAB = 3∠OBA. We need to find the angles of triangle AOD.

Step 1: Let ∠OAB = x.

Then $\angle OBA = \frac{2}{3}x.$

In ΔAOB, ∠OAB + ∠OBA + ∠AOB = 180°.

$$x + \frac{2}{3}x + \angle AOB = 180°.$$

$$\frac{5}{3}x + \angle AOB = 180°. \quad (1)$$

In a rhombus, diagonals bisect each other at right angles.

So, ∠AOB = 90°.

$$\frac{5}{3}x + 90° = 180°. \quad \text{form (1)}$$

$$\frac{5}{3}x = 90°.$$

$$x = \frac{90° \times 3}{5} = 54°.$$

So, $\angle OAB = 54°, \angle OBA = \frac{2}{3}(54) = 36°.$

Step 5: Now consider triangle AOD.

Since diagonals of a rhombus are perpendicular, ∠AOD = 90°.

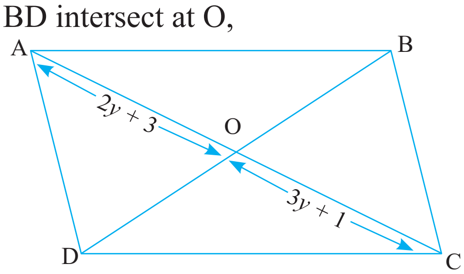
Also, diagonals bisect angles at vertices.

So, ∠OAD = ∠OAB = 54°.

And ∠ODA = ∠OBA = 36°.

Angles of triangle AOD are 54°, 36°, and 90°.

4. Given: In a parallelogram ABCD, diagonals AC and BD intersect at O,



AO = $(2y + 3)$ units and CO = $(3y + 1)$ units.

Since, diagonals of a parallelogram bisect each other.

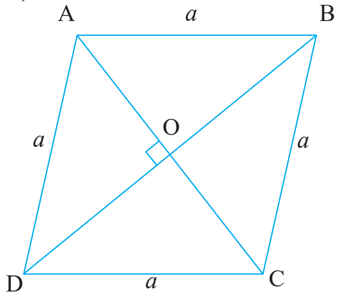
$$\Rightarrow AO = CO.$$

$$\Rightarrow 2y + 3 = 3y + 1$$

$$\Rightarrow 3 - 1 = 3y - 2y$$

$$\Rightarrow 2 = y \quad \Rightarrow y = 2$$

5. In a rhombus, one of the diagonals is equal to one of its sides,



We need to find the angles of the rhombus.

Let each side of the rhombus = a.

Suppose diagonal AC = a.

Now in Δ ABC, AB = BC = CA

$\Rightarrow$ ΔABC is an equilateral triangle.

So, $\angle ABC = 60°$, $\angle BCA = 60°$ and $\angle CAB = 60°$.

Since opposite angles in a rhombus are equal, $\Rightarrow$

$\angle ABC = \angle ADC = 60°$

Since diagonals of a rhombus bisect the angles

$\Rightarrow$ $\angle CAB = 60° \Rightarrow \angle BAD = 120°$

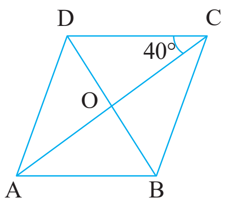
Also $\angle BAD = \angle BCD = 120°$

Opposite angles are equal in a rhombus.

$\angle A = \angle C = 120°$, $\angle B = \angle D = 60°$.

The rhombus has angles 120°, 60°, 120°, 60°.

6. Given: ABCD is a rhombus and its diagonals intersect at O, $\angle ACD = 40°$



We need to find $\angle ADB$.

Since, diagonals of a rhombus bisect the angles.

So, diagonal AC bisects $\angle C$.

$$\Rightarrow \qquad \angle ACD = \frac{1}{2}\angle C.$$

$\Rightarrow \angle C = 2 \times \angle ACD = 2 \times 40° = 80°$.

Since, opposite angles in rhombus are equal.

$\Rightarrow \angle A = \angle C = 80°$.

Also, sum of angles in quadrilateral = 360°.

$\Rightarrow \angle A + \angle B + \angle C + \angle D = 360°$.

$\Rightarrow 80° + \angle B + 80° + \angle D = 360°$.

$\Rightarrow \angle B + \angle D = 200°$.

In rhombus, $\angle B = \angle D$.

$\Rightarrow \angle B = \angle D = 100°$

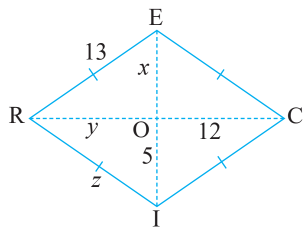
$\Rightarrow \angle ABC = \angle ADC = 100°$

Diagonals of a rhombus bisect the angles.

$\Rightarrow \angle ADC = 2\angle ADB = 100°$

$$\Rightarrow \angle ADB = \frac{100°}{2} = 50°$$

7. Given: RICE be a rhombus RO = y, OC = 12, OE = x, OI = 5, RE = 13, RI = z.



Since, diagonals bisect each other at right angles.

So, O is the midpoint of both diagonals.

From diagonal RC,

OC = OR = 12.

So, y = 12.

From diagonal IE,

OI = OE = 5.

So, x = 5.

Since all the side of rhombus equal. RI = RE = IC = CE = 13

So, z = 13.

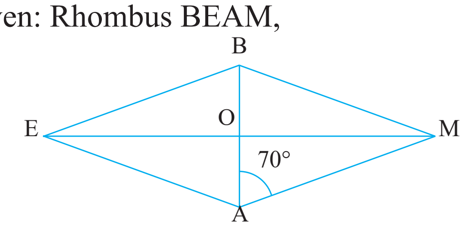
Perimeter of rhombus = 4 × side

= 4 × 13 = 52 units.

Therefore,

x = 12, y = 5, z = 13, Perimeter = 52 units

8. Given: Rhombus BEAM,



$\angle MAO = 70°$.

We need to find $\angle AME$ and $\angle AEM$.

Since diagonals of a rhombus bisect the angles.

Diagonal BA bisects $\angle A$.

$\Rightarrow \angle MAO = \frac{1}{2}\angle A.$

$\Rightarrow \angle A = 2 \times \angle MAO = 2 \times 70° = 140°.$

Since opposite angles in a rhombus are equal.

So, $\angle EAM = \angle EBM = 140°.$

In Rhombus, all sides are equal.

$\Rightarrow AE = AM$

$\Rightarrow \angle AEM$ is isosceles triangle

$\Rightarrow \angle AME = \angle AEM$ (base angles are equal)

In ΔAEM,

$\angle AME + \angle AEM + \angle EAM = 180°$ (angle sum property)

$\Rightarrow \angle AME + \angle AEM + 140° = 180°$

$\Rightarrow \angle AME + \angle AEM = 40°$

Since both angles are equal

$\Rightarrow \angle AME = \angle AEM = 20°$

9. (*a*) Given: Parallelogram BUNS, SN = 26 cm, BU = $3y - 1$, SB = $3x$, NU = 18 cm

In a parallelogram, opposite sides are equal.

$\Rightarrow SB = NU$

$\Rightarrow 3x = 18$

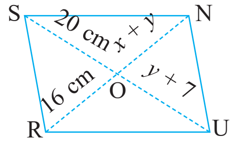
$\Rightarrow x = \frac{18}{3} \quad \Rightarrow x = 6$

and SN = BU

$\Rightarrow 26 = 3y - 1 \Rightarrow y = \frac{27}{3} = 9.$

(*b*) Parallelogram RUNS,

Let RO and SU intersect at O.



Since, diagonals of a parallelogram bisect each other.

$\Rightarrow RO = ON$ and $SO = UO$.

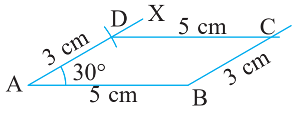
$\Rightarrow 16 = x + y$ and $20 = y + 7$

$\Rightarrow y = 20 - 7 = 13$ cm and so, $16 = x + 13$

$\Rightarrow x = 16 - 13 = 3$ cm

$x = 3$ cm, $y = 13$ cm

10. We know that in a parallelogram, opposite sides are equal and parallel.



Steps of Construction:

Step 1: Draw a line segment AB = 5 cm.

Step 2: At point A, construct an angle of 30° with AB and draw a ray AX.

Step 3: On ray AX, cut off AD = 3 cm.

Step 4: Through point B, draw a line parallel to AD.

Step 5: Through point D, draw a line parallel to AB.

Let these two lines meet at point C.

Thus, ABCD is the required parallelogram.

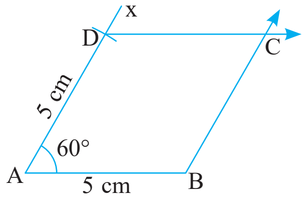
Perimeter:

Perimeter = 2 × (sum of adjacent sides)

= 2 × (5 + 3)

= 16 cm

11. We know that all sides of a rhombus are equal and opposite sides are parallel.



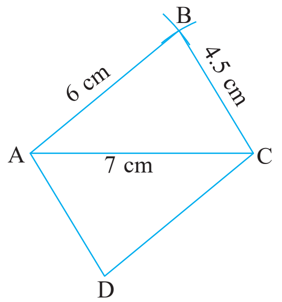
Steps of Construction:

1. Draw a line segment AB = 5 cm.
2. At point A, construct an angle of 60° and draw a ray AX.
3. On ray AX, cut off AD = 5 cm.
4. Through point B, draw a line parallel to AD.
5. Through point D, draw a line parallel to AB.

Let these two lines meet at point C.

Thus, ABCD is the required rhombus.

12.



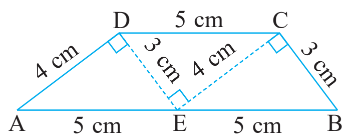
Steps of Construction:

1. Draw a line segments AC = 7 cm (diagonal)
2. With A as centre and radius 6 cm, draw an arc
3. With C as centre and radius 4.5 cm, draw an other arc cutting the previous arc at B
4. Join AB and BC.
5. Through A, draw a line parallel to BC.
6. Through C, draw a line parallel to AB.
7. These two lines meet at D

   Thus, ABCD is required parallelogram where AB = 6 cm, BC = 4.5 cm, AC = 7 cm.

Practice Time 4C

1. Given:



ΔDEC is a right triangle with DE = 3 cm, EC = 4 cm, DC = 5 cm.

Two identical cutouts ADE and EBC are made from ΔDEC.

AE = 5 cm, EB = 5 cm, AD = 4 cm, BC = 3 cm.

ΔADE and ΔECB are congruent right triangles.

When placed on opposite sides of ΔDEC, they extend into quadrilateral ABCD.

In quadrilateral AECD,

AE = CD = 5 cm, AD = EC = 4 cm

$\Rightarrow$ AE CD is parallelogram.

$\Rightarrow$ AE || CD (Opposite side of parallelogram are parallel)

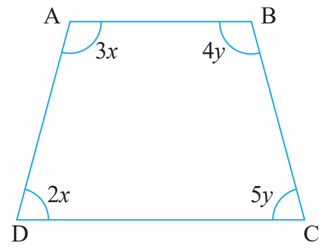
EB extended line of AE.

$\Rightarrow$ AB || CD

This satisfies the property of a trapezium (a quadrilateral with one pair of opposite sides parallel).

The arrangement of congruent right triangles forces AB || CD, making ABCD a trapezium.

2.



Given: Trapezium ABCD,

AB || CD, $\angle A = 3x$, $\angle B = 4y$, $\angle C = 5y$, $\angle D = 2x$.

In a trapezium with AB || CD,

$\angle A + \angle D = 180°$ and $\angle B + \angle C = 180°$.

Consider $\angle A + \angle D = 180°$

$\Rightarrow$ $3x + 2x = 180°$

$\Rightarrow$ $5x = 180° \Rightarrow x = 36°$.

So, $\angle A = 108°$, $\angle D = 72°$.

Now, consider, $\angle B + \angle C = 180°$

$\Rightarrow$ $4y + 5y = 180°$

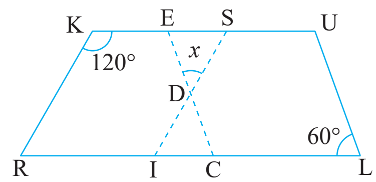
$\Rightarrow$ $9y = 180°$ $\Rightarrow$ $y = 20°$.

So, $\angle B = 80°$, $\angle C = 100°$.

So, $\angle A = 108°$, $\angle B = 80°$, $\angle C = 100°$, $\angle D = 72°$.

3. Given: In a parallelograms KRIS and CLUE

$\angle RKU = 120°$, $\angle ULR = 60°$



In a parallelogram, opposite angles are equal and adjacent angels are supplementary.

In parallelogram KRIS,

$\angle RKS + \angle KSI = 180°$

$\Rightarrow$ $120° + \angle KSI = 180°$

$\Rightarrow$ $120° + \angle KSI = 180°$

$\Rightarrow$ $\angle KSI = 60°$

In parallelogram CLUE,

$\angle ULC = 60° = \angle CEU$

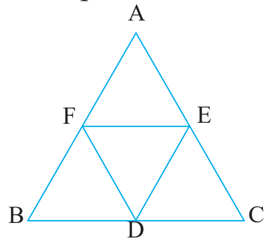
In ΔDES

$\Rightarrow$ $\angle DES + \angle ESD + \angle SDE = 180°$

$\Rightarrow$ $60° + 60° + x = 180°$

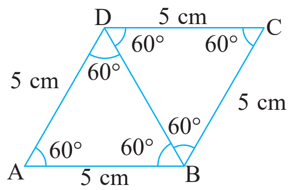
$\Rightarrow$ $x = 60°$

4. In a parallelogram,
Opposite sides of a parallelogram are equal and, opposite sides are parallel.



In parallelogram BDFE, We have FE || BD and FE = BD.
In parallelogram FEDC, We have FE || DC and FE = DC.
So, FE = BD and FE = DC ⇒ BD = DC.

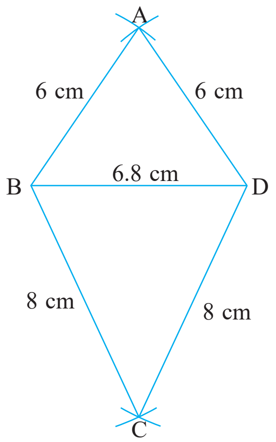
5. Quadrilateral from two equilateral triangles (side 5 cm)



Joining two equilateral triangles side by side gives a rhombus.
All sides = 5 cm, Opposite angles = 60° and 120°.
So quadrilateral is a rhombus with sides 5 cm each.

6. Do it yourself

7.

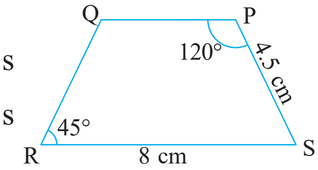


Steps of Construction

1. Draw a line segment BD = 6.8 cm.
   (This represents the given diagonal of the kite.)
2. With B as centre and radius 6 cm, draw an arc on one side of BD.
3. With D as centre and radius 6 cm, draw another arc cutting the previous arc at point A.
4. With B as centre and radius 8 cm, draw an arc on the other side of BD.
5. With D as centre and radius 8 cm, draw another arc cutting this arc at point C.
6. Join AB, AD, BC, and CD.

Thus, ABCD is the required kite.

8. First we draw a rough figure to find other angles of a trapezium PQRS.

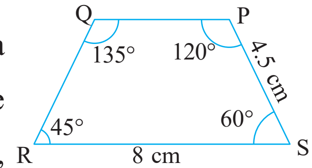


Since PQ || RS, QR is transversal, and PS is transversal

$\angle PQR + \angle QRS = 180°$ and $\angle PSR + \angle SPQ = 180°$

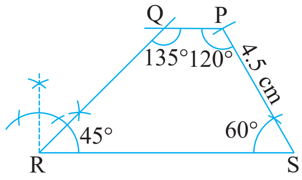
$\Rightarrow \angle PQR + 45° = 180°$ and $120° + \angle PSR = 180°$

$\Rightarrow \angle PQR = 135°$ and $\angle PSR = 60°$



Now we construct a trapezium PQRS where PQ || RS, RS = 4.5 cm, RS = 3 cm,

$\angle P = 120°$, $\angle R = 45°$, $\angle Q = 135°$ and $\angle S = 60°$



Steps of Construction:

1. Draw a line segment RS = 8 cm
2. At point R, construct angle $\angle R = 45°$ and draw a ray PQ.
3. At point S, construct angle $\angle S = 60°$ draw a ray SP.
4. With S as centre and radius 4.5 cm, cut this arm at point P.
5. At point P, construct angle $\angle 120°$ and draw a ray PQ.

Chapter Assessment

A. **1.** (*a*): Square

2. (*a*): Perimeter of parallelogram = 2 × (12 + 7)
= 38 cm

3. (*b*): In a parallelogram, adjacent angles are supplementary. ∠B = 180 − 70 = 110°

4. (*d*): Rhombus

5. (*a*): A pair of opposite sides is parallel

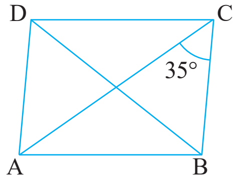
6. (*a*): Rectangle

7. (*a*): Rectangle

8. (*d*): Angles: $3x + 7x + 6x + 4x = 20x = 360°$
⇒ $x = 18$. Angles = 54°, 126°, 108°, 72°.
So, quadrilateral is trapezium

9. (*a*): In square, diagonals are equal and bisect each other at 90°.
ΔAOB has AO = BO and ∠AOB = 90°.
So it is an isosceles right triangle.

10. (*c*): In a rhombus ABCD,



Diagonal AC bisect angle A,
∠ACB = 35°
In a Rhombus, diagonals bisect the opposite angles.
⇒ ∠C = 2 × 35° = 70°
Opposite angels of a rhombus arc equal.
⇒ ∠A = 70°
In rhombus, adjacent angles are supplementary
∠D = 180° – 70 = 110°
Diagonal BD bisect angle D,

$$\angle ADB = \frac{110}{2} = 55°$$

B. **1.** (*a*) Both the assertion and the reason are true and reason is correct explanation of assertion.

2. (*d*) Assertion is false, Reason is true

3. (*a*) Both assertion and reason are true and reason is correct explanation of assertion.

C. **1.** False (F), since all angles of rectangles are right angles but not all have equal sides

2. True (T)

3. True (T)

4. False (F), since square is parallelogram, as it satisfies the properties of a parallelogram (opposite sides equal and parallel)

5. False (F), which both kites and rhombus have equal adjacent sides, a kite does not necessarily have all sides equal like a rhombus.

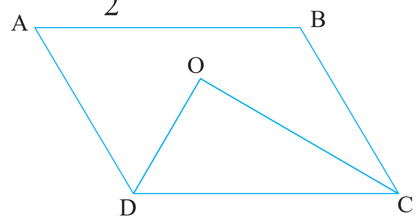
6. True (T)

7. False (F), parallelogram have two pairs of parallel sides, while trapezium have only one pair of parallel sides.

8. True (T)

D. **1.** Given in quadrilateral ABCD, DO and CO are bisectors of ∠D and ∠C.
To prove:

$$\angle COD = \frac{1}{2}(\angle A + \angle B).$$



Proof:
In any quadrilateral, sum of angles = 360°.
So ∠A + ∠B + ∠C + ∠D = 360° (*i*)
⇒ ∠C + ∠D = 360° − (∠A + ∠B).
Since DO and CO are bisectors:
∠ADO = ∠ODC and ∠BCO = ∠OCO

$$\Rightarrow \angle CDO = \frac{1}{2}\angle D \text{ and } \angle DCO = \frac{1}{2}\angle C \quad (ii)$$

In ΔCOD, using angle sum property

$$\angle COD = 180 – (\angle CDO + \angle DCO)$$

$$= 180 – (\frac{1}{2}\angle D + \frac{1}{2}\angle C) \quad \text{(using } (ii))$$

$$= 180 – \frac{1}{2}(\angle C + \angle D) \quad \text{(using } (ii))$$

$$= 180 – \frac{1}{2}[360 – (\angle A + \angle B)]$$

$$= 180 – 180 + \frac{1}{2}(\angle A + \angle B)$$

$$\therefore \angle COD = \frac{1}{2}(\angle A + \angle B) \quad \text{Hence Proved.}$$

2. Given: AB = 7 cm, AD = BC = 5 cm, perimeter = 30 cm.

Perimeter = AB + BC + CD + DA = 30.

So 7 + 5 + CD + 5 = 30 → CD = 13 cm.

Now AL ⊥ DL and MB ⊥ MC.

Since isosceles trapezium ABCD

(∵ AD = BC = 5 cm)

Now in ΔDLA and in Δ BMC,

DA=BC = 5 cm

AL=MB (Since AL and MB are perpendiculars from same parallel DC and AB)

∠ALD = ∠BMC = 90°

ΔDAL ≅ ΔBNC (by RHS congruence rule)

⇒ DL = CM

⇒ DC = DL + LM + MC = 13 cm

⇒ 7 + DL + MC = 13 cm

⇒ 7 + 2DL = 13 ⇒ DL = 3

Then, DL = 3 cm, MC = 3 cm.

3. Given: $x = \frac{3}{5}y$ and $y = \frac{5}{7}z$.

So, $x = \frac{3}{5} \times \frac{5}{7}z = \frac{3}{7}z$

Hence relation: $x : y : z = \frac{3}{7} : \frac{5}{7} : 1 = 3 : 5 : 7$.

$x = 3k$, $y = 5k$, $z = 7k$ (for some constant k).

∵ SL || PQ,

∴ $\angle z + (\angle x + \angle y) = 180°$ (Adjoint angles)

⇒ $7k + (3k + 5k) = 180°$ ⇒ $15k = 180°$

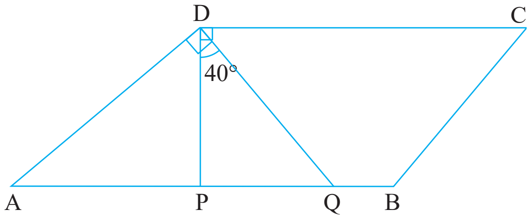
So, $15k = 180°$

⇒ $k = 12°$

∴ $3k = 36°$, $5k = 60°$, $7k = 84°$

Thus, $x = 36°$, $y = 60°$, $z = 84°$

4.



Since PD is perpendicular to CD

⇒ ∠PDC = 90°

But ∠PDQ = 40°

⇒ ∠QDC = 90° – 40° = 50°

Also QD ⊥ AD

⇒ ∠QDA = 90°

⇒ ∠ADP = 90° – ∠PDQ = 90° – 40° = 50°

∴ ∠ADC = ∠ADP + ∠PDQ + ∠QDC

= 50° + 40° + 50° = 140°

∴ ∠B = 140°

(∵ Opposite angles of parallelogram are equal)

Also ∠C = ∠A

Since, sum of all angels of parallelogram is 360°

⇒ ∠A + ∠B + ∠C + ∠D = 360°

⇒ ∠C + ∠D + ∠C + ∠D = 360°

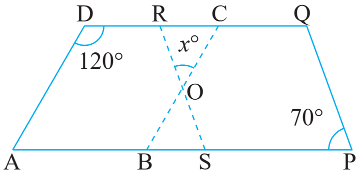
⇒ 2∠C = 360° – 2∠D = 360° – 2 × 140°

⇒ 2∠C = 80°

∠C = 40° = ∠A

Smaller angle of the parallelogram ABCD is ∠C and ∠A which is 40°.

5. (*a*) Given : Parallelograms ABCD and PQRS and ∠D = 120°, ∠P = 70°.



In parallelogram, opposite angles are equal.

So, ∠ABC = 120°, ∠SRC = 70°.

Also, ∠BCR = 180° – ∠B = 180° – 120° = 60°

(∵ Angle sum of property of triangle in ΔOCR

Now, x = 180° – ∠BCR – ∠SRC

= 180° – 60° – 70°

= 180° – 130° = 50° .

Thus, x = 50°.

(*b*) Diagonals of a rectangle are equal and also bisect each other.

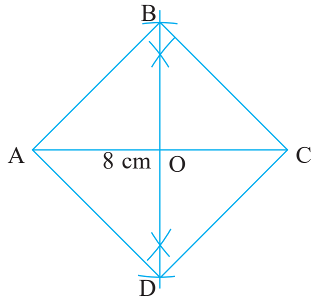
So, OR = OQ

⇒ $2x + 4 = 3x + 1$

⇒ $3x – 2x = 4 – 1$

⇒ $x = 3$

6.

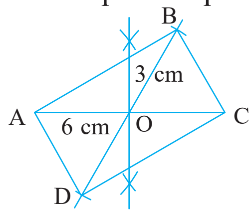


Steps of Construction

1. Draw a line segment AC = 8 cm. (This represents one diagonal of the square.)
2. Construct the perpendicular bisector of AC and mark the point of intersection as O. (Diagonals of a square bisect each other at right angles.)
3. With O as centre and radius 4 cm, draw arcs on the perpendicular bisector on both sides of O.
4. Mark the intersection points as B and D.
5. Join AB, BC, CD, and DA.

Thus, ABCD is the required square.

7.



Steps of Construction

1. Draw a line segment AC = 6 cm (one diagonal).
2. Construct the perpendicular bisector of AC and mark the midpoint as O.
3. At point O, construct an angle of 60° with respect to diagonal AC, and draw a straight line along this direction.
4. With O as centre and radius 3 cm (half of the diagonal), mark points B and D on the newly drawn line.
5. Join AB, BC, CD, and DA.

Thus, ABCD is the required rectangle.

8. (*a*) Types of Quadrilaterals

With two pairs of equal length straws, the twins can form different quadrilaterals depending on arrangement:

- Parallelogram: Equal sides placed opposite each other.
- Rectangle: A special parallelogram where all angles are 90° and opposite sides are equal.
- Kite: Equal sides placed adjacent to each other.

(*b*) Quadrilateral 'COLD'

Sides: OC = DL = 11 cm, CD = OL = 8 cm

⇒ Opposite sides are equal.

Angles: ∠C = ∠L, ∠O = ∠D → opposite angles equal.

Since opposite sides and opposite angles are equal.

COLD is a Parallelogram.

(*c*) Quadrilateral 'SNOW'

Sides: SN = NO = 11 cm, SW = WO = 8 cm

⇒ adjacent sides are equal.

Angles: ∠S = ∠O, ∠N = ∠W.

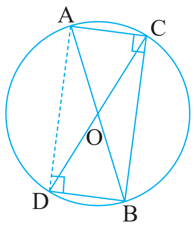
Because adjacent sides are equal (sharing a vertex).

SNOW is a Kite.

Challenge Question (Page 121)

1. Circle with centre O, AB and CD are diameters.

Figure ACBD is a rectangle because AB and CD are equal diagonals of same quadrilateral ACBD. (Since AB and CD are diameters of the same circle.)



- Diameters bisect each other at centre O.
- AC ⊥ BD (perpendicular diameters).
- AC = BD and BC = AD (opposite sides are equal).

So, ACBD is a rectangle.

2. Quadrilateral PQRS with angles:

∠P = $2x + 10°$, ∠Q = $3x - 20°$, ∠R = $3x - 20°$, ∠S = $2x + 10°$.

$(2x + 10) + (3x - 20) + (3x - 20) + (2x + 10) = 360$.

$10x - 20 = 360 \Rightarrow 10x = 380 \Rightarrow x = 38$.

∠P = 2(38) + 10 = 76 + 10 = 86°.

∠Q = 3(38) − 20 = 114 − 20 = 94°.

∠R = 94°.

∠S = 86°.

Since opposite angles are equal (∠P = ∠S, ∠Q = ∠R).

So, PQRS is a parallelogram.

Puzzle (Page 122)

1. Kite

   Explanation: A kite is a quadrilateral with two pairs of adjacent equal sides. The riddle plays on the word "kite" — the flying toy — and the geometric shape.

2. Square

   Explanation: A square has all sides equal and all angles equal to 90°. It's the most "perfect" quadrilateral.

3. Parallelogram

   Explanation: A parallelogram has opposite sides parallel and equal. It looks like a "slanted rectangle," hence the "cousin" clue.

4. Trapezium (Trapezoid)

   Explanation: A trapezium has exactly one pair of parallel sides. That makes it unique among quadrilaterals.

Mental Maths (Page 122)

1. Maximum Obtuse Angles in a Quadrilateral

   In a quadrilateral, the sum of all interior angle is 360°.

   An obtuse angle is one that is greater than 90° but less than 180°

   If 3 are obtuse, e.g. 120° + 120° + 120° = 360°, leaving 0° for the fourth, impossible.

   The maximum number of obtuse angle a quadrilateral can have is 3.

2. A trapezium is a quadrilateral with one pair of opposite sides parallel.

   The sum of the interior angles of any quadrilateral is always 360°.

   Thus, the sum of all the interior angles of a trapezium is 360°.

3. Quadrilaterals with equal side lengths
   - Square: 4 equal sides, all angles 90°.
   - Rhombus: 4 equal sides, opposite angles equal but not necessarily 90°.

     Therefore, squares are not the only quadrilaterals with equal sides; rhombuses also qualify.

4. One diagonal bisecting the other
   - In a parallelogram, both diagonals bisect each other.
   - In a kite, one diagonal bisects the other at right angles, but is not itself bisected.
   - Therefore, the quadrilateral is a kite.