Chapter 4:
Expressions Using Letter-Numbers

Complete Notes with Step-by-Step Solutions | CBSE | Algebra Basics

📌 Topics: Letter-Numbers • Algebraic Expressions • Simplification • Patterns • Calendar Algebra

4.1 THE NOTION OF LETTER-NUMBERS

▶ What are Letter-Numbers?

In mathematics, we often use LETTERS to represent unknown or changing numbers. These letters are called letter-numbers (also called variables). Using letter-numbers makes it easy to write general rules and formulas.

Letter-Number: A letter (like a, b, x, n) used to represent a number in a mathematical expression.
Algebraic Expression: A mathematical expression that uses letter-numbers along with numbers and operations (+, −, ×, ÷).

▶ Example 1: Aftab and Shabnam — Age Problem

Shabnam is always 3 years older than Aftab. We can write this as a formula:

Shabnam's age = Aftab's age + 3

Let 'a' = Aftab's age, 's' = Shabnam's age. Then:

s = a + 3

Aftab's Age (a)	Expression for Shabnam's Age	Shabnam's Age (s)
4	4 + 3	7
10	10 + 3	13
18	18 + 3	21
23	23 + 3	26
a	a + 3	s = a + 3

If Aftab's age (a) is 23 years, what is Shabnam's age?

Given: a = 23, Expression: s = a + 3
To Find: Shabnam's age (s)
Concept Used: Substitution in algebraic expression
Step 1: Substitute a = 23 in the expression s = a + 3
Step 2: s = 23 + 3 = 26

Final Answer: Shabnam's age = 26 years

Given Shabnam's age (s), write an expression to find Aftab's age.

Since Aftab is 3 years YOUNGER than Shabnam:

a = s − 3

Step 1: If s = 20 (Shabnam's age), substitute in a = s − 3

Step 2: a = 20 − 3 = 17

Final Answer: Aftab's age when Shabnam is 20 = 17 years

▶ Example 2: Matchstick Pattern (L-shapes)

Parthiv makes L-shapes using matchsticks. Each L needs EXACTLY 2 matchsticks.

```
|    |  |    |  |  |   ← Vertical sticks
⌊    ⌊  ⌊    ⌊  ⌊  ⌊   ← Horizontal sticks
1 L   2 Ls    3 Ls   Pattern: 2 sticks per L
```

Number of Ls	Number of Matchsticks	Pattern
1	2	1 × 2
5	10	5 × 2
7	14	7 × 2
45	90	45 × 2
n	2n	n × 2 = 2n

Number of matchsticks = 2 × n = 2n (where n = number of Ls)

▶ Example 3: Ketaki's Laddu Business — Cost Expression

Price of 1 coconut = ₹35 | Price of 1 kg jaggery = ₹60

Let c = number of coconuts, j = number of kg of jaggery

Item	Relationship	Algebraic Expression
Cost of coconuts	No. of coconuts × ₹35	c × 35 = 35c
Cost of jaggery	No. of kg × ₹60	j × 60 = 60j
Total Cost	Cost of coconuts + Cost of jaggery	35c + 60j

Total Cost = 35c + 60j

How much should she pay if she buys 10 coconuts and 5 kg jaggery?

Step 1: Cost of 10 coconuts = 10 × 35 = ₹350

Step 2: Cost of 5 kg jaggery = 5 × 60 = ₹300

Step 3: Total = 350 + 300 = ₹650

Final Answer: Total cost = ₹650

How much should she pay if she buys 8 coconuts and 9 kg jaggery?

Step 1: Cost = 8 × 35 + 9 × 60 = 280 + 540 = ₹820

Final Answer: Total cost = ₹820

Use the expression to find cost for 7 coconuts and 4 kg jaggery.

Step 1: c = 7, j = 4 → 35(7) + 60(4) = 245 + 240 = ₹485

☑ Final Answer: Total cost = ₹485

▶ Example 4: Perimeter of a Square

Perimeter of a square = 4 × side length

Perimeter = 4 × q = 4q (where q = side length)

🔴 What is the perimeter of a square with side length 7 cm?

Step 1: Substitute q = 7 in the formula: Perimeter = 4q = 4 × 7 = 28 cm

☑ Final Answer: Perimeter of square = 28 cm

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🔴 Q1. Write formulas for the perimeter of: (a) equilateral triangle, (b) regular pentagon, (c) regular hexagon

Given: Regular polygons with all sides equal. Let side = a units.

Concept Used: Perimeter = number of sides × side length

Shape	No. of Sides	Perimeter Formula
Equilateral Triangle (all sides equal)	3	Perimeter = 3 × a = 3a units
Regular Pentagon	5	Perimeter = 5 × a = 5a units
Regular Hexagon	6	Perimeter = 6 × a = 6a units

☑ Final Answer: (a) 3a (b) 5a (c) 6a (where a = side length)

🔴 Q2. Munirathna has a 20 m long pipe. He joins another pipe of length 'k' metres. Give expression for combined length.

Step 1: Combined length = existing pipe + new pipe = 20 + k

☑ Final Answer: Combined length = (20 + k) metres

🔴 Q3. What is the total amount Krithika has with different notes of ₹100, ₹20, and ₹5? Complete the table.

₹100 notes	₹20 notes	₹5 notes	Expression and Total
3	5	6	3×100 + 5×20 + 6×5 = 300+100+30 = ₹430
6	4	3	6×100 + 4×20 + 3×5 = 600+80+15 = ₹695
8	4	z	8×100 + 4×20 + z×5 = 880 + 5z
x	y	z	100x + 20y + 5z

🔴 Q4. Venkatalakshmi's flour mill: 10 sec to start, 8 sec/kg to grind. Which expression gives time for 'y' kg?

Concept: Time = Start-up time + (grinding time per kg × number of kg)

Step 1: Start-up time = 10 seconds
Step 2: Grinding time = 8 × y seconds
Step 3: Total = 10 + 8y

☑ Final Answer: (d) 10 + 8 × y is correct!

Why others are wrong: (a) 10+8+y adds y directly — wrong. (b) (10+8)×y multiplies startup+grind by y — wrong. (c) 10×8×y — wrong. (e) 10y+8 multiplies startup by y — wrong.

Q5. Write algebraic expressions: (a) 5 more than a number, (b) 4 less than a number, (c) 2 less than 13 times a number, (d) 13 less than 2 times a number

Let the number be 'd'.

Description	Expression
5 more than a number	d + 5
4 less than a number	d − 4
2 less than 13 times a number	13d − 2
13 less than 2 times a number	2d − 13

Q6. Describe situations for: (a) 8×x + 3×y, (b) 15×j − 2×k

(a) 8×x + 3×y:

A shopkeeper sells pens at ₹8 each and notebooks at ₹3 each. Abha buys x pens and y notebooks. Total cost = 8x + 3y.

(b) 15×j − 2×k:

A factory makes 15 chairs per day for j days = 15j chairs. But 2 chairs break per day for k days = 2k chairs broken. Good chairs = 15j − 2k.

Q7. In a 2×3 calendar grid, if the bottom middle cell is date 'w', write expressions for all blank cells.

In a calendar, dates in the SAME row differ by 1. Dates in the NEXT row differ by 7.

Bottom Row →	Left Cell	Middle Cell	Right Cell
Bottom row	w − 1	w	w + 1
Top row (7 days back)	w − 8	w − 7	w − 6

4.2 REVISITING ARITHMETIC EXPRESSIONS

▶ Key Rules for Evaluating Expressions

Rule	Description	Example
BODMAS/Order	Multiplication/Division BEFORE Addition/Subtraction	23 − 10×2 = 23 − 20 = 3
Swapping	Terms can be added in any order (commutative)	83+28−13+32 = (83−13)+(28+32) = 70+60 = 130
Grouping	Group convenient terms to simplify calculation	Group positives and negatives separately

Brackets +ve	Positive sign outside: remove brackets as is	+(18+13) = +18+13
Brackets −ve	Negative sign outside: flip ALL signs inside	−(18+13) = −18−13

Evaluate: 1. 23 − 10 × 2

Concept: Multiplication first (BODMAS)

Step 1: Write as sum of terms: 23 + (−10×2)

Step 2: Calculate −10×2 = −20

Step 3: 23 + (−20) = 23 − 20 = 3

Final Answer: 23 − 10 × 2 = 3

Evaluate: 2. 83 + 28 − 13 + 32

Concept: Swapping and grouping like terms

Step 1: Rewrite: 83 + 28 + (−13) + 32

Step 2: Group conveniently: (83 + (−13)) + (28 + 32)

Step 3: = 70 + 60 = 130

Final Answer: 83 + 28 − 13 + 32 = 130

Evaluate: 3. 34 − 14 + 20

Step 1: = 34 + (−14) + 20 = (34+20) + (−14) = 54 − 14 = 40

Final Answer: 34 − 14 + 20 = 40

Evaluate: 4. 42 + 15 − (8 − 7)

Step 1: Solve bracket first: 8−7 = 1

Step 2: = 42 + 15 − 1 = 56

Final Answer: 42 + 15 − (8 − 7) = 56

Evaluate: 5. 68 − (18 + 13)

Method 1 (Solve bracket first):

Step 1: 18 + 13 = 31

Step 2: 68 − 31 = 37

Method 2 (Remove bracket with negative sign):

Step 1: 68 − (18 + 13) = 68 − 18 − 13

Step 2: = (68−18) − 13 = 50 − 13 = 37

Final Answer: 68 − (18 + 13) = 37

Evaluate: 6. 7 × 4 + 9 × 6

Step 1: 7×4 = 28 and 9×6 = 54

Step 2: 28 + 54 = 82

Final Answer: 7 × 4 + 9 × 6 = 82

Evaluate: 7. 20 + 8 × (16 − 6)

Step 1: Bracket: 16 − 6 = 10

Step 2: 8 × 10 = 80

Step 3: 20 + 80 = 100

Final Answer: 20 + 8 × (16 − 6) = 100

4.3 OMISSION OF THE MULTIPLICATION SYMBOL

▶ The Shorthand Notation

In algebra, when a NUMBER is multiplied by a LETTER-NUMBER, we DROP the multiplication sign.

Full Form	Shorthand (Algebraic)	Read As
4 × n	4n	Four times n
5 × m + 3	5m + 3	Five m plus three
7 × k	7k	Seven k
2 × a × b	2ab	Two a b

★ RULE: Write the NUMBER first, then the LETTER. Never write n4 — always write 4n.

★ RULE: We CANNOT omit the sign between two numbers: 3 × 4 ≠ 34. Only number × letter allows omission.

▶ Number Sequence: Multiples of 4

Sequence: 4, 8, 12, 16, 20, 24, 28, ... (multiples of 4)

Position (n)	Term	Expression
1	4	4 × 1 = 4n when n=1
3	12	4 × 3
29	116	4 × 29
nth	?	4 × n = 4n

nth term of 4, 8, 12, 16, ... = 4n

Find the value of 7k when k = 4.

Step 1: 7k = 7 × k = 7 × 4 = 28

☑ Final Answer: 7k = 28 when k = 4

Find the value of 5m + 3 when m = 2.

Step 1: 5m = 5 × m = 5 × 2 = 10

Step 2: 5m + 3 = 10 + 3 = 13

☑ Final Answer: 5m + 3 = 13 when m = 2

⚠ MIND THE MISTAKE, MEND THE MISTAKE (Section 4.3)

Find and correct the errors in these substitutions:

#	Expression	Given (Wrong)	Error	Correct Answer
1	If a=−4, then 10−a=?	6 ✗	10−(−4)=10+4=14, not 10−4=6	14
2	If d=6, then 3d=?	36 ✗	3d=3×6=18, not 36	18
3	If s=7, then 3s−2=?	15 ✓	3×7−2=21−2=19... actually check: 3×7=21, 21−2=19	19

4	If r=8, then 2r+1=?	29 ✗	2×8+1=16+1=17, not 29	17
5	If j=5, then 2j=?	10 ✓	2×5=10 ✓ Correct!	10
6	If m=−6, then 3(m+1)=?	19 ✗	3(−6+1)=3(−5)=−15, not 19	−15
7	If f=3,g=1, then 2f−2g=?	2 ✗	2×3−2×1=6−2=4, not 2	4
8	If t=4,b=3, then 2t+b=?	24 ✗	2×4+3=8+3=11, not 24	11
9	If h=5,n=6, then h−(3−n)=?	4 ✗	5−(3−6)=5−(−3)=5+3=8, not 4	8

4.4 SIMPLIFICATION OF ALGEBRAIC EXPRESSIONS

▶ Like Terms vs Unlike Terms

Type	Definition	Examples
Like Terms	Same letter-number(s), possibly different coefficients	5c, 3c, 10c → all have 'c'
Unlike Terms	Different letter-numbers	18c and 11d → different letters
Can Simplify?	ONLY like terms can be combined	5c+3c+10c = 18c BUT 18c+11d CANNOT simplify

★ Like terms can be ADDED or SUBTRACTED. Unlike terms cannot be combined further.

★ When adding like terms: add the COEFFICIENTS (numbers) and keep the letter-number same.

▶ Perimeter of a Rectangle — Simplification

Perimeter = length + breadth + length + breadth = l + b + l + b

Step	Expression	Explanation
Initial	l + b + l + b	Sum of all four sides
Rearrange (swap)	l + l + b + b	Group like terms together
Simplify	2l + 2b	l+l = 2l and b+b = 2b
Verify: l=3,b=4	2(3)+2(4) = 6+8 = 14	Also: 3+4+3+4 = 14 ✓

Perimeter of Rectangle = 2l + 2b

▶ Example 5: Pencil and Eraser Shop

Price per pencil = c, Price per eraser = d

Item	Day 1	Day 2	Day 3	Total Sold
Pencils (price c)	5	3	10	18
Erasers (price d)	4	6	1	11

Find total money earned from pencils.

Step 1: Money from pencils = 5c + 3c + 10c

Step 2: Use distributive property: (5+3+10) × c = 18 × c = 18c

Final Answer: Total from pencils = 18c

If c = ₹50, find the total amount earned by the sale of pencils.

Step 1: Total = 18c = 18 × 50 = ₹900

Final Answer: Total earned from pencils = ₹900

Find total money earned from erasers.

Step 1: Money from erasers = 4d + 6d + 1d = (4+6+1)d = 11d

Final Answer: Total from erasers = 11d

Can 18c + 11d be simplified further?

NO! 18c and 11d are UNLIKE TERMS (different letter-numbers c and d). They cannot be combined.

Final Answer: Simplest form = 18c + 11d

▶ Example 6: Rectangle Area — Distributive Property

A big rectangle has a vertical side 'v' and is split horizontally into widths 4 and 3.

```
|←──4──→|←─3─→|
|  Area=4v  |Area=3v|  Height = v
```

Step 1: Area of big rectangle = v × (4+3) = 7v

Step 2: OR: Sum of smaller areas = 4v + 3v = (4+3)v = 7v

4v + 3v = 7v ← This demonstrates the Distributive Property!

▶ Example 7: Chair and Table Rental — Complex Simplification

Item	Rent (₹)	Refund (₹)
Chair	40	6
Table	75	10

Write and simplify the expression for total amount paid for x chairs and y tables.

Step 1: Amount paid at start = 40x + 75y

Step 2: Amount returned = 6x + 10y

Step 3: Net amount paid = (40x + 75y) − (6x + 10y)

Step 4: Open bracket with negative sign: = 40x + 75y − 6x − 10y

Step 5: Group like terms: = (40x − 6x) + (75y − 10y)

Step 6: = (40−6)x + (75−10)y = 34x + 65y

Final Answer: Net amount paid = 34x + 65y

▶ Example 8: Charu's Quiz Scores — Adding Expressions

Round 1 score: 7p − 3q | Round 2: 8p − 4q | Round 3: 6p − 2q

(p = score for correct answer, q = penalty for wrong answer)

If p=4, q=1, find Charu's score in Round 1.

Step 1: Score = 7p − 3q = 7×4 − 3×1 = 28 − 3 = 25

☑ **Final Answer: Round 1 score = 25**

🔴 **Find Charu's TOTAL score after all 3 rounds.**

Step 1: Total = (7p−3q) + (8p−4q) + (6p−2q)
Step 2: Remove brackets: = 7p − 3q + 8p − 4q + 6p − 2q
Step 3: Group like terms: = (7+8+6)p + (−3−4−2)q
Step 4: = 21p + (−9)q = 21p − 9q

☑ **Final Answer: Charu's total score = 21p − 9q**

🔴 **Krishita's score is 23p − 7q. How much more did Krishita score than Charu?**

Step 1: Difference = (23p − 7q) − (21p − 9q)
Step 2: = 23p − 7q − 21p + 9q [note: −(−9q) = +9q]
Step 3: = (23−21)p + (−7+9)q = 2p + 2q

☑ **Final Answer: Krishita scored 2p + 2q more than Charu**

▶ Example 9: Distributive Property in Simplification

🔴 **Simplify: 4(x + y) − y**

Step 1: Apply distributive property: 4(x+y) = 4x + 4y
Step 2: Expression becomes: 4x + 4y − y
Step 3: Group like terms (y terms): 4x + (4−1)y
Step 4: = 4x + 3y

☑ **Final Answer: 4(x + y) − y = 4x + 3y**

▶ Example 10: Are 5u and 5+u Equal?

5u means 5 TIMES u. 5+u means 5 MORE THAN u. These are DIFFERENT operations!

u	5u (= 5 × u)	5+u	Equal?
2	10	7	NO
5	25	10	NO
8	40	13	NO
11	55	16	NO

☑ **Final Answer: 5u and 5+u are NOT equal (they give different values for almost all values of u)**

🔴 **Are the expressions 10y − 3 and 10(y − 3) equal?**

10y − 3 means: 3 less than 10 times y
10(y − 3) means: 10 times (3 less than y)

y	10y − 3	10(y − 3)	Equal?
0	−3	−30	NO
2	17	−10	NO
7	67	40	NO
10	97	70	NO

☑ **Final Answer: 10y − 3 and 10(y − 3) are NOT equal!**

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Q1. Add numbers in the picture grids and write simplified expressions.

▶ Grid 1: 5y, −6, x, x, 2, 5y

Step 1: Total = 5y + (−6) + x + x + 2 + 5y
Step 2: Group: (5y + 5y) + (x + x) + (−6 + 2)
Step 3: = 10y + 2x + (−4) = 10y + 2x − 4

Final Answer: Sum = 10y + 2x − 4

▶ Grid 2: 2p, 3q, −2, 3, 3q, 2p, 3, −2, 2p, 3q, 3q, 2p

Step 1: Count: 2p appears 4 times = 8p; 3q appears 4 times = 12q
Step 2: Numbers: (−2)+3+3+(−2) = 2
Step 3: Total = 8p + 12q + 2

Final Answer: Sum = 8p + 12q + 2

▶ Grid 3: −5g, 5k, 5k, −5g (corners); 5k in all middle spots

Step 1: −5g appears 4 times: −20g; 5k appears 12 times: 60k
Step 2: Total = −20g + 60k

Final Answer: Sum = −20g + 60k

Q2. Simplify each expression:

Expression	Simplified Form	Working
p+p+p+p	4p	4 times p
p+p+p+q	3p + q	3p and one q
p+q+p−q	2p	p+p=2p, q−q=0
p−q+p−q	2p − 2q	2p and −2q
p+q−p+q	2q	p−p=0, q+q=2q
p+q−(p+q)	0	= p+q−p−q = 0
p−q−p−q	−2q	p−p=0, −q−q=−2q
2d−d−d−d	−d	2d−2d=0, then −d
2d−d−d−c	−c	2d−2d=0, leaves −c
2d−d−(d−c)	c	=2d−d−d+c=0+c=c
2d−(d−d)−c	2d−c	d−d=0, so 2d−0−c=2d−c
2d−d−c−c	d−2c	2d−d=d, then −c−c=−2c

MIND THE MISTAKE, MEND THE MISTAKE — Page 94

#	Expression	Given (Wrong)	Error Explanation	Correct Form
1	3a + 2b	5	Cannot add unlike terms 3a and 2b	3a + 2b
2	3b − 2b − b	0	3b−2b=b, then b−b=0 ✓ Correct!	0

3	6(p + 2)	6p + 8	6×p=6p ✓, but 6×2=12 not 8	6p + 12
4	(4x+3y)−(3x+4y)	x + y	4x−3x=x ✓, but 3y−4y=−y not +y	x − y
5	5−(2−6z)	3 − 6z	−(−6z)=+6z not −6z	3 + 6z
6	2+(x+3)	2x − 6	No multiplication here! Just add. 2+x+3=x+5	x + 5
7	2y+(3y−6)	−y + 6	2y+3y=5y not −y. Brackets have + outside.	5y − 6
8	7p−p+5q−2q	7p + 3q	7p−p=6p not 7p. 5q−2q=3q ✓	6p + 3q
9	5(2w+3x+4w)	10w+15x+20w	5(6w+3x)=30w+15x (combine 2w+4w=6w first)	30w + 15x
10	3j+6k+9h+12	3(j+2k+3h+4)	3×j=3j ✓ 3×2k=6k ✓ 3×3h=9h ✓ 3×4=12 ✓	3j+6k+9h+12
11	4(2r+3s+5)−20	−8r−12s	4×2r=8r, 4×3s=12s, 4×5=20; 20−20=0; so 8r+12s	8r + 12s + 20

4.5 PICK PATTERNS AND REVEAL RELATIONSHIPS

▶ Formula Detective — Number Machines

A number machine takes 2 inputs (top of Y), performs an operation, and outputs a result (bottom).

🔴 Machine 1 (Black): Inputs 5,2→8; 8,1→15; 9,11→7; 10,10→10; a,b→?

Step 1: Try 2×5 − 2 = 8 ✓ | 2×8 − 1 = 15 ✓ | 2×9 − 11 = 7 ✓ | 2×10 − 10 = 10 ✓

Formula: 2a − b (2 times first input minus second input)

☑ Final Answer: Last expression: 2a − b

🔴 Machine 2 (Blue): Inputs 5,2→5; 8,1→7; 9,11→18; 10,10→18; a,b→?

Step 1: Try a+b−2: 5+2−2=5 ✓ | 8+1−2=7 ✓ | 9+11−2=18 ✓ | 10+10−2=18 ✓

Formula: a + b − 2

☑ Final Answer: Last expression: a + b − 2

🔴 Machine 3 (Purple): Inputs 4,1→5; 6,0→1; 3,2→7; 10,3→?; a,b→?

Step 1: Try a×b+1: 4×1+1=5 ✓ | 6×0+1=1 ✓ | 3×2+1=7 ✓ | 10×3+1=31 ✓

Formula: a × b + 1 = ab + 1

☑ Final Answer: 4th expression: 31 | General: ab + 1

▶ Example 12: Saree Design Pattern — Algebra in Art

Pattern A, B, C, A, B, C, A, B, C,... repeats with period 3.

Design	Positions	Formula for nth occurrence
A (position 1 in group)	1, 4, 7, 10, 13, ...	3n − 2
B (position 2 in group)	2, 5, 8, 11, 14, ...	3n − 1

C (position 3 in group)	3, 6, 9, 12, 15, ...	3n

Which design appears at Position 122?

Step 1: Divide 122 by 3: 122 = 3 × 40 + 2 (remainder = 2)

Step 2: Remainder 2 means position is '2 mod 3' → DESIGN B

Final Answer: Design B appears at position 122

What design appears at positions 99, 122, and 148?

Step 1: 99 ÷ 3 = 33 remainder 0 → Remainder 0 means multiple of 3 → Design C

Step 2: 122 ÷ 3 = 40 remainder 2 → Design B

Step 3: 148 ÷ 3 = 49 remainder 1 → Design A

Final Answer: Position 99: Design C | Position 122: Design B | Position 148: Design A

▶ Patterns in a Calendar — Diagonal Sums

In any 2×2 square of calendar dates, the two diagonal sums are ALWAYS EQUAL!

Example from November 2024: Square with 12, 13, 19, 20

Diagonal 1: 12 + 20 = 32 | Diagonal 2: 13 + 19 = 32 → Equal!

PROVE that diagonal sums are always equal for any 2×2 calendar square.

Let top-left number = a. In a standard 7-day week calendar:

Position	Value	Reason
Top-left	a	Given
Top-right	a + 1	Next day (1 more)
Bottom-left	a + 7	Next week (7 more)
Bottom-right	a + 8	7+1 more

```
a     |  a+1
a+7   |  a+8
```

Step 1: Diagonal 1 sum: a + (a+8) = a + a + 8 = 2a + 8

Step 2: Diagonal 2 sum: (a+1) + (a+7) = a + 1 + a + 7 = 2a + 8

Step 3: Both diagonals give 2a + 8 → They are always EQUAL!

Both diagonal sums = 2a + 8 (8 more than twice the top-left number)

Final Answer: Proved! Diagonal sums are ALWAYS equal for any 2×2 calendar square.

▶ Plus-Sign Pattern in Calendar

Consider the + shape: centre = 15, with 8 above, 22 below, 14 left, 16 right.

Step 1: Sum = 8 + 14 + 15 + 16 + 22 = 75

Step 2: 75 = 5 × 15 (5 times the centre)

PROOF: Let centre = a. Then: above = a−7, below = a+7, left = a−1, right = a+1

Step 1: Sum = (a−7) + (a−1) + a + (a+1) + (a+7)

Step 2: = a−7+a−1+a+a+1+a+7

Step 3: = 5a + (−7−1+0+1+7) = 5a + 0 = 5a

Sum of + shape = 5 × (centre number) — ALWAYS!

▶ Matchstick Pattern — Triangles

Pattern: 1 triangle = 3 sticks, 2 triangles = 5 sticks, 3 triangles = 7 sticks...

Step (y)	Triangles	Matchsticks	Pattern
1	1	3	3
2	2	5	3+2
3	3	7	3+2+2
4	4	9	3+2+2+2
5	5	11	3+2+2+2+2
y	y	2y + 1	3 + 2(y−1)

Number of matchsticks in Step y = 2y + 1

Verification: 3 + 2(y−1) = 3 + 2y − 2 = 2y + 1 ✓

How many matchsticks in Step 33, Step 84, Step 108?

Step 1: Step 33: 2(33) + 1 = 66 + 1 = 67 matchsticks

Step 2: Step 84: 2(84) + 1 = 168 + 1 = 169 matchsticks

Step 3: Step 108: 2(108) + 1 = 216 + 1 = 217 matchsticks

Final Answer: Step 33: 67 | Step 84: 169 | Step 108: 217 matchsticks

FIGURE IT OUT — Pages 102–105

Q1. One plate of Jowar roti costs ₹30 and Pulao costs ₹20. x plates roti and y plates pulao ordered. Which expression gives total?

Step 1: Total = (cost per roti × no. of roti plates) + (cost per pulao × no. of pulao plates)

Step 2: = 30 × x + 20 × y = 30x + 20y

Final Answer: (a) 30x + 20y is correct!

Why others are wrong: (b) (30+20)×(x+y) = 50(x+y) adds both prices per item — wrong. (c) 20x+30y swaps prices. (d) and (e) are wrong operations.

Q2. Pushpita gives flags: p customers bought champak only, q bought marigold only, r bought both. How many flags?

Step 1: Each of the p+q+r customers gets exactly 1 flag

Step 2: Total customers = p + q + r (r customers bought BOTH but are still COUNTED ONCE)

Final Answer: (a) p + q + r flags

Q3. A snail climbs 'u' cm/day and slips 'd' cm/night for 10 days and 10 nights. (a) Expression for distance from start, (b) What if d > u?

Step 1: Net movement per day = climb up − slip down = u − d

Step 2: For 10 days: total net movement = 10(u − d)

Final Answer: (a) Distance from start = 10(u − d) cm

(b) If d > u, then u − d is NEGATIVE, meaning the snail slides DOWN overall. The snail will NEVER reach the top.

Q4. Radha cycles 5 km/day in Week 1. Each week she increases by 'z' km/day. How many km after 3 weeks?

Step 1: Week 1: 5 km/day for 7 days = 5 × 7 = 35 km

Step 2: Week 2: (5+z) km/day for 7 days = 7(5+z) = 35+7z km

Step 3: Week 3: (5+2z) km/day for 7 days = 7(5+2z) = 35+14z km

Step 4: Total = 35 + (35+7z) + (35+14z) = 105 + 21z km

Final Answer: Total distance after 3 weeks = 105 + 21z km

Q5. Fill in the missing blanks on the expression transformer paths.

Starting expression: w + 2

Path	Step 1	After Step 1	Step 2	Final Result
Top path (given)	×3 → 3(w+2)=3w+6	w+5 [wrong, look again]	+3 then ×4	4w+20
Top: w+2 → −5 → w−3 → (×3) →	w+2−5=w−3	×3 = 3w−9	←	3w−9
Bottom: w+2 → −4 → w−2 → ×3 →	w+2−4=w−2	×3 = 3w−6	←	3w−6

Final Answer: Top path back: 3w − 9 | Bottom path: 3w − 6

Q6. Train Yahapur to Vahapur: stops at 3 stations. Travel time between stations = t min. Stop time = 2 min each. (a) If t=4, total time? (b) Expression?

Step 1: Diagram: Yahapur → Station1 → Station2 → Station3 → Vahapur

Step 2: There are 4 intervals of travel, each t minutes

Step 3: There are 3 stops, each 2 minutes

Step 4: Total time = 4t + 3 × 2 = 4t + 6 minutes

Step 5: If t = 4: Total = 4(4) + 6 = 16 + 6 = 22 minutes

Final Answer: (a) 22 minutes | (b) 4t + 6 minutes

Q7. Simplify the following expressions:

Expression	Simplified Step-by-Step	Final Answer
(a) 3a+9b−6+8a−4b−7a+16	Group: (3a+8a−7a)+(9b−4b)+(−6+16) = 4a+5b+10	4a + 5b + 10
(b) 3(3a−3b)−8a−4b−16	9a−9b−8a−4b−16 = (9a−8a)+(−9b−4b)−16 = a−13b−16	a − 13b − 16
(c) 2(2x−3)+8x+12	4x−6+8x+12 = (4x+8x)+(−6+12) = 12x+6	12x + 6
(d) 8x−(2x−3)+12	8x−2x+3+12 = 6x+15	6x + 15
(e) 8h−(5+7h)+9	8h−5−7h+9 = (8h−7h)+(−5+9) = h+4	h + 4
(f) 23+4(6m−3n)−8n−3m−18	23+24m−12n−8n−3m−18 = (24m−3m)+(−12n−8n)+(23−18) = 21m−20n+5	5 + 21m − 20n

Q8. Add the expressions:

Pair	Expression 1 + Expression 2	Sum
(a)	(4d−7c+9) + (8c−11+9d)	13d + c − 2
(b)	(−6f+19−8s) + (−23+13f+12s)	7f + 4s − 4
(c)	(8d−14c+9) + (16c−11−9d)	2c − d − 2

(d)	(6f−20+8s) + (23−13f−12s)	−7f − 4s + 3
(e)	(13m−12n) + (12n−13m)	0
(f)	(−26m+24n) + (26m−24n)	0

Q9. Subtract the expressions:

Problem	Calculation	Answer
(a) 9a−6b+14 FROM 6a+9b−18	(6a+9b−18)−(9a−6b+14) = 6a+9b−18−9a+6b−14 = −3a+15b−32	−3a + 15b − 32
(b) −15x+13−9y FROM 7y−10+3x	(7y−10+3x)−(−15x+13−9y) = 7y−10+3x+15x−13+9y = 16y+18x−23	16y + 18x − 23
(c) 17g+9−7h FROM 11−10g+3h	(11−10g+3h)−(17g+9−7h) = 11−10g+3h−17g−9+7h = 10h−27g+2	10h − 27g + 2
(d) 9a−6b+14 FROM 6a−(9b+18)	(6a−9b−18)−(9a−6b+14) = 6a−9b−18−9a+6b−14 = −3a−3b−32	−(3a+3b+32)
(e) 10x+2+10y FROM −3y+8−3x	(−3y+8−3x)−(10x+2+10y) = −3y+8−3x−10x−2−10y = −13y−13x+6	−13y − 13x + 6
(f) 8g+4h−10 FROM 7h−8g+20	(7h−8g+20)−(8g+4h−10) = 7h−8g+20−8g−4h+10 = 3h−16g+30	3h − 16g + 30

Q10. Describe situations for: (a) 8x + 3y, (b) 15x − 2x

(a) 8x + 3y:

A fruit seller sells mangoes at ₹8 each and bananas at ₹3 each. If a customer buys x mangoes and y bananas, total cost = 8x + 3y.

(b) 15x − 2x:

A shopkeeper has 15 pencils, each costing ₹x. Two pencils are returned/unsold. Amount received = 15x − 2x = 13x.

Q11. Rope folding: 0 folds→2 pieces, 1 fold→3 pieces, 2 folds→? Find pattern and expression for r folds.

Folds (r)	Pieces	Pattern
0	2	2
1	3	2+1
2	4	2+2
3	5	2+3
10	12	2+10
r	r+2	r+2

Number of pieces when folded r times = r + 2

☑ **Final Answer: 10 folds → 12 pieces | r folds → r + 2 pieces**

Q12. Matchstick squares pattern (connected squares): How many matchsticks for 10 squares? For w squares?

Step 1: 1 square = 4 matchsticks. Each new square adds 3 matchsticks (shares 1 side).

Step 2: Pattern: 4, 7, 10, 13, ... (starts at 4, adds 3 each time)

Step 3: For 10 squares: $4 + 3 \times 9 = 4 + 27 = 31$ matchsticks

Step 4: For w squares: $4 + 3(w-1) = 4 + 3w - 3 = 3w + 1$

Number of matchsticks for w squares = 3w + 1

☑ Final Answer: 10 squares: 31 matchsticks | w squares: 3w + 1

Q13. Traffic signal colours: Red(1), Yellow(2), Green(3), Yellow(4), Red(5)... Pattern repeats every 4. Find colours at positions 90, 190, 343.

Position	÷4 remainder	Colour
90	90÷4 = 22 R 2 → remainder 2	Yellow
190	190÷4 = 47 R 2 → remainder 2	Yellow
343	343÷4 = 85 R 3 → remainder 3	Green

Colour	Expression for positions	Examples
Red	$4n - 3$ ($n = 1, 2, 3, ...$)	1, 5, 9, 13, ...
Yellow	$4n - 2$ and $4n$ (two yellow per cycle)	2, 4, 6, 8, ...even positions
Green	$4n - 1$ ($n = 1, 2, 3, ...$)	3, 7, 11, 15, ...

☑ Final Answer: Position 90: Yellow | Position 190: Yellow | Position 343: Green

Q14. Square pattern: Step 1=5, Step 2=9, Step 3=13 squares. Find formula. How many squares in Step 4, 10, 50?

Step 1: Pattern: 5, 9, 13, 17, ... (starts at 5, adds 4 each time)

Step 2: General formula: $5 + (n-1) \times 4 = 5 + 4n - 4 = 4n + 1$

Step 3: Step 4: $4(4)+1 = 17$ | Step 10: $4(10)+1 = 41$ | Step 50: $4(50)+1 = 201$

Number of squares in Step n = 4n + 1

Step 4: Each square has 4 vertices, so vertices = $4 \times (4n+1) = 16n + 4$

☑ Final Answer: Step 4: 17 | Step 10: 41 | Step 50: 201 | General: 4n+1 | Vertices: 16n+4

Q15. Numbers in a 4-column endless grid: 1,2,3,4; 5,6,7,8; 9,10,11,12... Find expressions for each column, locate numbers.

Step 1: Pattern: Row 1 has 1−4, Row 2 has 5−8, Row r has (4r−3) to 4r

Step 2: General: Number in row r, column c = $4(r-1) + c$

Column	Expression for rth row
1	$4(r-1)+1 = 4r-3$
2	$4(r-1)+2 = 4r-2$
3	$4(r-1)+3 = 4r-1$
4	$4(r-1)+4 = 4r$

(b) Finding row and column of 124, 147, 201:

Step 1: 124: 124÷4 = 31 R 0 → 4×30+4 → row 31, column 4

Step 2: 147: 147÷4 = 36 R 3 → row 37, column 3

Step 3: 201: 201÷4 = 50 R 1 → row 51, column 1

☑ Final Answer: 124: Row 31, Col 4 | 147: Row 37, Col 3 | 201: Row 51, Col 1

(c) Number in row r, column c = 4(r−1) + c

(d) Multiples of 3 pattern:

Multiples of 3 appear in columns in pattern: 3, 2, 1, 4, 3, 2, 1, 4, ... (repeating cycle of 4)

Also: Even numbers always in columns 2 and 4. Odd numbers always in columns 1 and 3.

CHAPTER SUMMARY

▶ Key Vocabulary

Term	Meaning	Example
Letter-Number (Variable)	A letter used to represent a number	a, b, x, n, p
Algebraic Expression	Expression using numbers and letter-numbers	3a + 2b, 4x − 5
Coefficient	The number multiplying a letter-number	In 5x, coefficient = 5
Like Terms	Terms with same letter-numbers	3x, 5x, −2x (all have x)
Unlike Terms	Terms with different letter-numbers	3x and 5y
Simplification	Combining like terms to reduce expression	3x+5x+2x = 10x
Formula	An algebraic expression for a general relationship	Perimeter = 2l+2b

▶ Key Formulas

Perimeter of Equilateral Triangle = 3a

Perimeter of Square = 4q

Perimeter of Rectangle = 2l + 2b

Perimeter of Regular Pentagon = 5a

Perimeter of Regular Hexagon = 6a

nth term of 4, 8, 12, 16, ... = 4n

Matchstick triangles at step y = 2y + 1

Matchstick squares for w squares = 3w + 1

Rope pieces after r folds = r + 2

▶ Important Rules

★ **BODMAS: Brackets → Orders → Division → Multiplication → Addition → Subtraction**

★ **Like terms can be combined; unlike terms CANNOT**

★ **Negative sign outside bracket: FLIP all signs inside: −(a+b) = −a−b**

★ **Positive sign outside bracket: keep signs same: +(a+b) = a+b**

★ **Distributive property: a(b+c) = ab + ac**

★ **Multiplication of number × letter: write number first → 4×n = 4n**

★ **Minimum terms in simplified form ≥ Number of different letter-numbers**

Keep Practicing, Keep Growing!