Chapter -12
Algebraic Expression

12.1 You have already got the concept of forming algebraic expression combining with variable and constant. Let us recall some concept that we have learnt in class VI.

Variable	:	To donot unknown values we use the english alphabates *a, b, c..... x, y, z* etc. A veriable can take varius values.
Constant	:	A constant has a fixed value. Examples of constant are 2, 50, –5 etc
Algebraic Expression	:	☆ If 3 is added to a number 'x' then the algebric expression will be $x + 3$ ☆ The algebric expression of multiplying x by 3 is $3x$. ☆ The algebraic expression of the square of the product of x and 4 is $(4x)^2$

Activity : Some statements in question card and their algebraic expressions in answer card are given below. Divide yourselves into two groups, one group make separate question cards and other group make separate answer cards. Then match the question card with answer card.

Question card

Q.1	1 added to the quotient when x is divided by 3
Q.2	4 added to the product of x and 3
Q.3	Multiply x by 5 and add the square of x and then add 6.
Q.4	4 is added to the square of x.
Q.5	Add 5 with x and multiply their sum by 3.
Q.6	Square the product of 'n' and 6.
Q.7	Multiply x by 4 and add the product of y and 3.
Q.8	Multiply variable a by 5 and add 8 to the product
Q.9	Add 4 to x and divide the sum by 3.
Q.10	Add 3 to the sum of veriable x and y.

Answer card

A1	$3(x + 5)$
A2	$(4x + 3y)$
A3	$x^2 + 4$
A4	$5a + 8$
A5	$x^2 + 5x + 6$
A6	$\frac{x+4}{3}$
A7	$(x + y + 3)$
A8	$\frac{x}{3}+1$
A9	$(3x + 4)$
A10	$(6n)^2$

Note to the Teacher : The teacher should prepare the cards according to the number of students and encourage the group activity.

12.2 Formation of Algebraic Expression :

In Class VI we formed the algebraic expression with the combination of variable and constant. We can also obtain algebraic expression by combining variables with themselves or with other variables.

With a string, Nomita and Anima shaped out a rectangle and measured its length and breadth –

length = 10 cm

and breadth = 5 cm

∴ the area of the rectangle = (length × breadth)

= 10 × 5 sq. cm = 50 sq. cm

Nomita's college going brother observed their work and asked one question to his sister 'Tell me, if you take x cm and y cm as the length and breadth of the rectangle without measuring then how will you write value the of its area?

Area of rectangle = length × breadth

= $(x \times y)$ sq. cm = xy sq. cm

[that means the algebraic expression xy is formed by multiplying the variable 'x' by variable 'y']

The value of x, y will differ in case of diverse rectangle. We can obtain the area by substituting the value of x and y in the expression xy.

Can we form a square with a string ? What will be its area ?

If the length of the side is x cm then

Area of the square = (side × side) sq. cm

= $(x \times x)$ sq. cm

= x^2 sq. cm

[Upon multiplying a variable x by itself, we get the expression x^2 which is read as x squared]

Thus we need to form algebraic expressions to use them in different practical purposes.

Express the following algebraic expression in statement –

(i) $4xy + 3$ (ii) x^4 (iii) x^3y (iv) $2x^2 - x$ (v) $2x + 3y + 4$ (vi) $x^2 + 5x - 6$

12.3 Terms of Expression and factions of Term :

In the mean time we have learnt about algebraic expression and how to form them. To get a complete idea of an algebraic expression, it is very necessary to understand its terms and factors.

12.3.1 Process to form an algebraic expression :

To form the expresssion $3x + 7$, 7 is added to the product of the variable x by constant 3.

To obtain one expression $5x^2 - 5$, first we multiply 'x' by x itself and then multiply it by 5 and then add (-5).

Thus to obtain $2x - 3y$ also we add the terms $2x$ and $(-3y)$ after framing separately $2x + (-3y) = 2x - 3y$.

So to get a complete algebraic expression, the parts of the expression are form separately and then added them. The parts of an expression which are formed separately are called terms. Notice that the minus sign '–' is included in a term. So $(-3y)$ is added with the term $2x$.

Example :

To form the expression $3x + 7$, $3x$ and 7 are added.

To form the expression $3x^2 - 5$, $3x^2$ and -5 are added.

To form the expression $2x + 3y$, $2x$ and $3y$ are added.

To form the expression $3x^2 - 2xy$, $3x^2$ and $-2xy$ are added.

12.3.2 Factors of terms :

The expression $3x^2 - 2x^2y$ is formed by the terms $3x^2$ and $-2x^2y$.

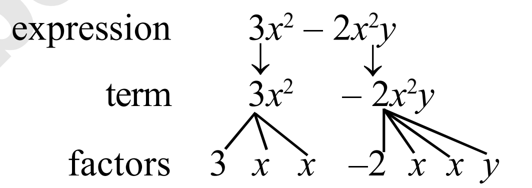
$3x^2 = (3 \times x \times x)$, the factors of the terms are 3, x, x

$-2x^2y = (-2 \times x \times x \times y)$, the factors of the terms are -2, x, x and y

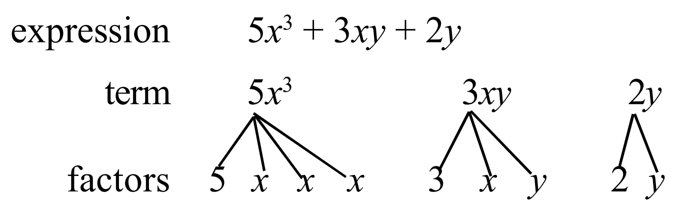
12.3.3 Tree diagram :

We can show the factors and terms of a algebraic expression with the help of Tree diagram, the expression $3x^2 - 2x^2y$ is shown with the help of following tree diagram –

Figure :



Tree diagram of expression $5x^3 + 3xy + 2y$



Let us draw the tree diagram of the following algebraic expression

$2x + 3y$, $10xy - 5$, $4x^3 + 2x^2y$

12.4 Coefficient :

We have learnt to find out the terms and factors of an algebraic expression. Among the factors of an algebraic expression there exists numerical and algebraic factor. For example in the term $2x^2y$; 2 is numerical (coefficient of $2x^2y$) and x,x,y are algebraic (in which term variable exist) factors. (The numerical factor is said to be numerical coefficient or simply coefficient of the term.) So 2 is the coefficient of the term $2x^2y$.

3 is the coefficient of the term $3xy$

3 is also coefficient of xy.

-1 is the coefficient of $-xy^2$; (as $-xy^2 = -1 \times x \times y \times y$)

You have noticed that generally the numerical coefficient is considered as coefficient of the term. Also, sometime we used the term 'coefficient'in a more general way.

In the term $7xy$, 7 is coefficient of xy.

$7y$ is coefficient of x

$7x$ is coefficient of y

But in general 7 is the coefficient of the term 7xy

Observe the following tables :

Table no. -1

	Expression	Term (which are not constant)	Numerical term
1.	$a + 4$	a	1
2.	$xy + 7$	xy	1
3.	$7x - 3y$	$7x, -3y$	7, –3
4.	$xy^2 - y$	$xy^2, -y$	1, –1
5.	$3x^2y - 2xy^2 + 3$	$3x^2y, -2xy^2$	3, –2

Table no. -2

	Expression	Term with factor x	Coenffcient of x
1	$x - y$	x	1
2	$xy^2 + 2y$	xy^2	y^2
3	$-xz + 3xy^2$	$-xz$ $3xy^2$	$-z$ $3y^2$
4	$axy + y^2 + c$	axy	ay

[Notice that each term with x as a factor has the remaining part of the term as the coeficient of x in the table.]

Fill up the following table :

Expression		Term with factor y	Coefficient of y
1	$2x + 7y$		
2	$xy + 2yx^2$		
3	$-yz^3 + 5$		
4	$ax^2 + by + c$		

12.5 Like term and unlike term :

Let us see the following two example :

☆ In the terms $3x^2$ and $5x^2$ the algebraic factors are same that is x and x.

☆ In the terms $2xy$ and $3x^2$ the algebraic factors are not same –

In the term $2xy$ the algebraic factors are x and y ; $(2xy = 2 \times x \times y)$

In the term $3x^2$ the algebraic factors are x and x ; $(3x^2 = 3 \times x \times x)$

From the above two examples it can be seen that the algebraic factors of two or more terms may not be same.

> The terms in which the algebraic factors are same, are called like terms and the terms in which the algebraic factors are not same, are called unlike terms.

The terms $5x^2$, $3x^2$, $7x^2$ are like terms; The terms $2xy$, $3xz$, x^2 are unlike terms.

Observe the following two tables :

Table no. -1

	Terms	Factors	Algebraic factors	pair
1	$2x$ $4y$	$2, x$ $4, y$	Different	Unlike
2	$3xy$ $8xy$ $9xy$	$3, x, y$ $-8, x, y$ $9, x, y$	Same (x, y)	Like

Table no. -2

	Terms	Like	Unlike
1	$4x^2$ $3x^2$	✓	×
2	$3x^2y$ xz 3	×	✓
3	ab 4	×	✓

12.6 Monomials, Binomials, Trinomials and Polynomials :

Monomials : An expression with only one term is called a monomial; for example $5x$, $3xy$, $-y^2$, 6, x^2y^2 etc.

Binomials : An expression which contains two unlike terms is called binomials; for example, $2x + y$, $a + 4$, $xy + 4y$, $x^3 + y^3$ etc.

Trinomials : An expression which contains three terms is called a trinominal; for example $3x + 4y + 7$, $xy + x^2 + y^2$, $x^2 + 3x + 2$ etc.

(Notice that – the expression $3x + 4y + 7x$ is not a trinomal, because $3x$ and $7x$ are like terms)

Polynomials : In general, an expression with one or more terms is called a polynomial. Monomials, Binominals, Trinominals are all polynomials.

Example : Identify the like and unlike ternms and fill up the following table –

Pair		Factor	Algebraic factor same/differet	Like/Unlike term
1	$2xy$ $7yx$			
2	$3x$ $-7x$			
3	xy^2 $2xy^2z$			
4	$2ab^2$ $3a^2b$			
5	$3x^3y^3$ $-4x^3y^3$			

Exercise -12.1

1. Write the algebraic expressions of the following using variable, constant and arithmatic operation

(i) Multiply x by x and add 2.

(ii) Sum of a and b.

(iii) Subtraction of 7 from x.

(iv) Subtraction of z from y.

(v) Multiplication of y to 'square of x' and added to z.

(vi) Half of the product of x and y.

(vii) Sum of y and z subtracted from the product of y and z.

(viii) Addtion of z with the quotient of x divided by y.

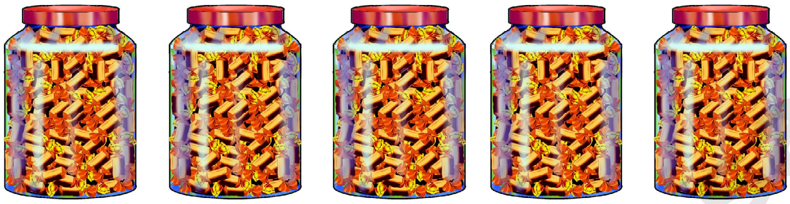
(ix) Addtion of z with three time of x.

(x) Sum of x and 6 is divided by 3.

(xi) Square of the product of x and 5.

(xii) Multiplication of 5 with the square of x.

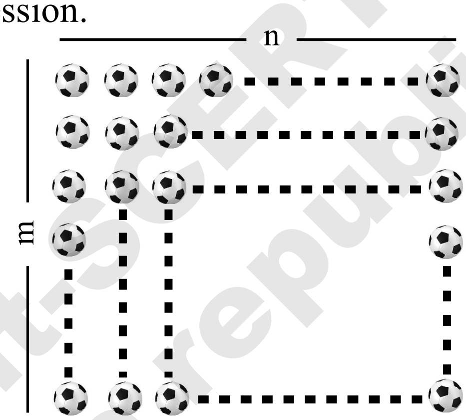
2. There are 'n' nos of chocolates in each of the following 5 containers –



(i) If two more chocolate are added to each container, total how many chocolates will be there?

(ii) If $n = 10$, what will be the total number of chocolate?

3. In the following picture few balls are arranged in raw and column. Express the total no of balls in algebraic expression.



4. Identify the term and factors in the following expressions. Show the terms and factors with the help of tree diagram.

(a) $y + 7$ (b) $x^2 + 2x + 3$ (c) $2x^2 + 3xy + 4y^2$

(d) $7x + 5$ (e) $xy - x + 1$ (f) $3x^2y - 4xy^2$

(g) $3x^3 - x^2 + 1$ (h) $xz + z$ (i) $-2mn + m^2 - 3n^2$

(j) $-7x^2 + 3x^2y^3 + 5x^2y^2 - y$

5. Fill up the following tables –

(a)

	Expression	Term (which is not constant)	Numerical coefficent
i	$2x + 3y$		
ii	$mn + 3$		
iii	$2ab - a + b$		
iv	$2x^2y - 4xy^2 + 7$		
v	$3x^3 - 7x^2 + y$		

(b)

	Expression	Term with factor x	Coefficient of x
i	$xy^3 + 1$		
ii	$2xy + y + 1$		
iii	$3xy^2 - xy + x$		
iv	$7xz - z$		
v	$y - x + 2$		

(c)

	Expression	Term with factor b^2	Coefficent of b^2
i	$ab^2 + 9$		
ii	$ab^2 + a^2b + 3a$		
iii	$-b^3 + 3a2b - 5b^2$		

6. Classify the following expressions as monomials, binomials and trinomials –

(i) $2x + 3$ (ii) y^3 (iii) $3a^2b$ (iv) $3a^2b + 5ab^2 + 3a$

(v) $2m + 3n$ (vi) $x^2 + x$ (vii) $m^2 + n^2$ (viii) $2x^2 + 3x + 1$

(ix) $xy + y$ (x) 34

7. a. Write whether the following pairs of term is like or unlike terms.

(i) $-4x, \frac{1}{2}x$ (ii) $-5x; 7y$ (iii) 9, 20 (iv) $2x^2y, 3xy^2$

(v) $2xy, 3xz$ (vi) $-7xz, 2xz$ (vii) x^2, x^3 (viii) $x^2, 2x^2$

(x) $mn, 3nm$ (x) $\frac{1}{2}z, \frac{3}{4}z$

b. Identify the like terms in the following

$ab^2, a^2, xy^2, y^3, 4xy^2, 7ab^2, -2x, 5y, xy, 3x, -ab^2, a^2b^2, 3ab^2, x^3y^3, 40x$

$-m^2n, 3mn^2, -m^2n, 2a^2b^2, 3y$.

12.7 Addition and Subtraction of algebraic expression :

Let us try to understand the following discussions carefully :

Anita's age = 6 years, Anita's brother Amal's age = 12 years, Anita's mother's age = 36 years, Anita's father's = 41 years, and Antia's grand father's age = 70 years.

Sum of Anita's father's age and grand father's age = 41 + 70 = 111

Now we shall construct the algebraic expression of Anita's father and grand father's age, then add the two algebraic expressions.

Suppose that Anita's age = x years

So Amal's age = $2x$ years ($\because 2 \times 6 = 12$)

Anita's Mother's age = $6x$ ($\because 6 \times 6 = 36$)

Anita's father's age = $6x + 5 \because (41 = 6 \times 6 + 5)$

Anita's grand father's age = $10x + 10$ (because, $70 = 10 \times 6 + 10$)

(Is it possible to form the algebraic expression of Anita's grand father age in other way?)

Yes, it is possible ; for example $12x - 2$ (because, $70 = 12 \times 6 - 2$)

Now we shall add the two algebraic expression of the age of Anita's father and grand father's –

Anita's father's age = $6x + 5$

Anita's grand father's age = $10x + 10$

Which are like terms of the above algebraic expression ?

$6x$ and $10x$; 5 and 10 is not it ?

Now we shall add the like terms,

Hence, $6x + 10x = (6 + 10)x = 16x$ (obsreve that only the numerical coefficients are added of the like terms)

Therefore do notice that when we add the like terms, their sum is equal to sum of numerical coefficient.

Same way the sum of 5 and 10 is15

$\therefore$ The sum of the like terms $(6x + 5)$ and $(10x + 10)$ is $16x + 15$. (We shall always add the like terms only.)

It would be better if we add the expression in the following way

$$\begin{aligned}(6x + 5) + (10x + 10) &= (6x + 10x) + (5 + 10)\\ &= (6 + 10)x + 15\\ &= 16x + 15\end{aligned}$$

Since we expressed the Anita's grand fathers's age in two ways, so let us add the age of Anita's father $(6x + 5)$ and her grand father's age expressed differently $(12x - 2)$

$$\begin{aligned}(6x + 5) + (12x - 2) &= (6x + 12x) + 5 + (-2)\\ &= (6 + 12)x + 3\\ &= 18x + 3\end{aligned}$$

Do notice that the sum of the above two expressions is $6x + 5$, $10x + 10$ and $6x + 5$, $12x - 2$ which denotes the age of Anita's father and grand father's are different.

Will the sum of their ages different ? If this thought in agitating in mind, let us examine.

Sum of the age of Anita's father's and grand father = $16x + 15$

The value of x is 6, is not it ? Because we assumed Anita's age (6 years) as x.

So if we substitute $x = 6$

in $16x + 15$

Then $16 \times 6 + 15 = 96 + 15 = 111$ (sum of the numerical value of Anita's father and grand father)

Agian if $x = 6$ is substituted in $18 \times 6 + 3$, than

$$18x + 3 = 18 \times 6 + 3$$
$$= 108 + 3 = 111$$

So it is necessary to put the value of variable in a algebraic expression to find the value of the expression.

Now we shall add the expressions $10x + y$ and $2x + 5$. The like terms in the expressions are $2x$ and $10x$; Unlike terms are y and 5.

It is mentioned above that while we add the algebraic expressions we add the like terms only. Then what will happen in case of unlike terms?

The unlike terms will be remain same, that means the unlike terms y and 5 will be reamins as $y + 5$.

$$\therefore (10x + y) + (2x + 5) = (10x + 2x) + y + 5$$
$$= (10 + 2)x + y + 5$$
$$= 12x + y + 5$$

While subtracting an algebraic expression from another algebraic expression we subtract the similar terms, like what we did in addtion. So, the difference between two like term is equal to the difference between the numerical coeficient of the two like terms.

Let us find out the difference of Anita's grand father and father's age from the previous discussion–

Anita's grand father's age $= 10x + 10$

father's age $= 6x + 5$

difference of age $= (10x + 10) – (6x + 5)$

$= (10 – 6)x + (10 – 5)$

$= 4x + 5$

Now let us put $x = 6$ in the expression $4x + 5$

$$4 \times 6 + 5 = 29$$

☆ To find out the difference between $10x + y$ and $2x + 5$, the like terms need to be deducted and the unlike terms will be remain same.

$$(10x + y) – (2x + 5) = (10 – 2)x + y + (–5)$$
$$= 8x + y – 5$$

Let us try to add and subtract some algebraic expressions in the following examples–

Example 1 : Add $4x + 9$ and $3x – 1$

Solution : $4x$ and $3x$ are like terms of the expression

Same way 9 and (–1) are like terms

$\therefore$ Sum of the two espressions $= 4x + 9 + 3x - 1$

$= (4x + 3x) + 9 + (-1)$

$= 7x + 8$

Example 2 : Add $3x + 4y + 5$ and $7x + 2y + 2$

Solution : $(3x + 4y + 5) + (7x + 2y + 2)$

$= 3x + 4y + 5 + 7x + 2y + 2$

$= 3x + 7x + 4y + 2y + 5 + 2$

$= 10x + 6y + 7$

Like terms $3x$ and $7x$; $4y$ and $2y$; 5 and 2 are arranged

Example 3 : $3xy + 4y^2 + z$ and $7xy + 2y^2 + 9$

Solution : $(3xy + 4y^2 + z) + (7xy + 2y^2 + 9)$

$= 3xy + 4y^2 + z + 7xy + 2y^2 + 9$

$= 3xy + 7xy + 4y^2 + 2y^2 + z + 9$

$= 10xy + 6y^2 + z + 9$

Like terms $3xy$ and $7xy$; $4y^2$ and $2y^2$ are rearranged, here z and 9 will be added and sum will be $z + 9$

Example 4 : Rearrange the like terms and simplify

$2x^2 - 4xy + 7x + 3x^2 + 6x - 2xy - 2x + 3$

Solution : Rearranging the terms,

$2x^2 - 4xy + 7x + 3x^2 + 6x - 2xy - 2x + 3$

$= (2 + 3)x^2 + (-4 - 2)xy + (7 + 6 - 2)x + 3$

$= 5x^2 - 6xy + 11x + 3$

Example 5 : Subtract $2x + 3$ from $7x + 5$

Solution : $(7x + 5) - (2x + 3)$

$= 7x + 5 - 2x - 3$

$= (7x - 2x) + (5-3)$

$= 5x + 2$

Example 6 : Subtract $2xy - 2x - y$ from $6xy + 7x + 5y$

Solution : $(6xy + 7x + 5y) - (2xy - 2x - y)$

$= 6xy + 7x + 5y - 2xy + 2x + y$

$= (6xy - 2xy) + (7x + 2x) + (5y + y)$

$= 4xy + 9x + 6y$

[Notice that we kept $2xy - 2x - y$ between brackets and importance was given on sign while we remove the bracket then]

Give Attention : Subtracting $-2x$ and adding $+2x$ and subtracting $-y$ and adding y gives the same result.

Exercise - 12.2

1. Rearrange the like terms and simplify

   (i) $2x + 3y - 45 + 6y - 7x + 5$

   (ii) $x^2 - 2x + y^2 + 2x^2 + 4x + y^3$

   (iii) $a - (2a - 3b) - b - (3b - 4a)$

   (iv) $x^2y + 3xy^2 + y^3 - 3x^2y + 2xy^2 - 3y^3 + 5$

   (v) $(2z^2 + 3y + 7) - (3y - 8z^2 + 1)$

2. Add

   (i) $3x^2y, -2x^2y, 7x^2y, 2x^2y$

   (ii) $x + xy, 3xy + x, x - 1$

   (iii) $2x^2 + 3xy + y^2, -3x^2 + 5xy + 2y^2, x^2 - 8xy - 3y^2$

   (iv) $3x + 4y, -7x + 5y + 2, 2x + 5xy + 7$

   (v) $6xy, 7yx, 3xz, 5yz$

   (vi) $2x^2 - y^2 + 5, y^2 + 3 - x^2, x^2 + y^2 + 1$

   (vii) $x^2y^2 + xy + 1, -2x^2y^2 + 3xy - 2, 3x^2y^2 - 5xy + x$

   (viii) $3y^2 + yz, -y^2 + 2yz + z^2, z^2 + 1$

3. Subtract

   (i) $-7x^2y$ from $5x^2y$

   (ii) $2xy$ from $7xy$

   (iii) $-x^2 - 2xy + y^2$ from $2x^2 + 3xy + 4y^2$

   (iv) $-2x^2y^2 + 2xy + 5$ from $5x^2y^2 + xy + 7$

   (v) $2m^2 - 3m + 1$from $2m + 3n$

   (vi) $2pq + p^2 + q^2$ from $6pq - p^2 - q^2$

   (vii) $p^2 + 1$ from $2p - 7$

   (viii) $-4x^2 + 5x + 3$ from $3x^2 - 2x + 1$

4. Sum of two algebraic expressions is $5x^2 + 2x + 1$, if one expression is $x^2 + 5x + 7$ find the other.

5. To get $7x + 3y + 1$ how much needs to be subtracted from $2x + 4y + 7$.

6. Anima, Mamoni, Rita and Purabi's marks of their mathematics examination are as follows –

   Mamoni has obtained double the marks of more than Anima.

   Rita has got four marks less than Anima

   Purabi has got two marks more than Mamoni

   Now find out the sum of their marks in algebraic expression.
7. Subtract $2x^2 + y^2 + 7x + 3$ from the sum of $3x^2 + 2x + 1$ and $y^2 - 4x - 2$.
8. Subtract the sum of $2x^2 - x$ and $x^2 + 6x + 2$ from the sum of $2x^2 + 7x$ and $3x - 7$.
9. The measure of the boundary of a paddy field is $x, \frac{x}{2}, y$ and $\frac{y}{2}$ respectively. What is the perimeter of the land ?
10. Nabin has some marbles. Bijay has 4 marbles less than the square of the numbers of marbles with Nabin, Anup has 4 more marbles than the marbles with Bijay, Prakash has said that he has 6 more marbles than the sum of the marbles with Nabin, Bijay and Anup. Express the total number of the marbles with Nabin, Bijay, Anup and Prakash in algebraic expression.

12.8 Finding the value of an Algebraic Expression :

In various situations we need to find one value of an algebraic expression, in such situation we can find the value of the expression by subsituting the value of variable.

The value of an expression depends upon the value of variable.

So we want to say that, value of algebraic expression should be determined by substituting the value of the variable.

Example : Find the values of $7x - 3$ and $x^2 + 5x + 9$ for $x = 4$.

Solution : For $x = 4$, $7x - 3 = 7 \times 4 - 3 = 28 - 3 = 25$

For $x = 4$, $x^2 + 5x + 19 = (4)^2 + 5 \times 4 + 9 = 45$

12.9 Formulas -Rules and Pattern :

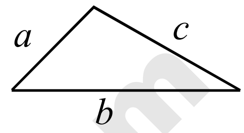
We can form algebraic expression with the help of different formulas and rules in mathematics and can write in general form. Moreover by using algebraic expressions we can form examples which help us to solve many mathematical problems and puzzles.

12.9.1 Perimeter Formulas :

1. If the length of the sides of a triangle are ***a*, *b*** and ***c*** Unit respectively then the perimeter of the triangle $= (a + b + c)$ unit.

Perimeter in case of equilateral triangle $= a + a + a$

$= 3a$ unit



(The length of the equilateral triangle is equal. So $a = b = c$)

2. Perimeter and area of a Rectangle :

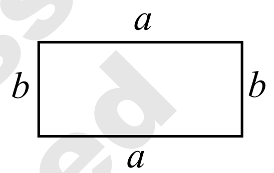
The length of a rectangle $= a$ unit

and breadth $= b$ unit

Perimeter of a rectangle = 2(length + breadth)

$= 2(a + b)$ unit

area of the rectangle = length ×breadth $= a \times b = ab$ sq.unit

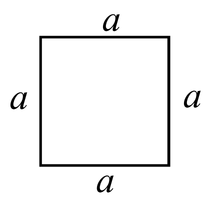


3. The Perimeter and area of a Square : (Do yourself)

If the length of a square is *'a'* then

Perimeter of square = ?

Area of square = ?



If we know value of the variable of an algebraic expression then we can find the value of the expression. For example, if we put the value of *'a'* and *'b'* in the formula of area and perimeter of a rectangle then we will get the value of area or perimeter.

Example :

Sl. No.	Expression	Value of variable	Value of expression
1	$2x^2 + 4$	$x = 3$	$2 \times 3^2 + 4 = 22$
2	$4x + 3y$	$x = 3$ $y = 2$	$4 \times 3 + 3 \times 2 = 18$
3	$x^2 + 4x + 3$	$x = -2$	$(-2)^2 + 4 \times (-2) + 3 = -1$
4	$pq^2 + p^2q + 2p + 4$	$p = 1$ $q = 2$	$1 \times (2)^2 + (1)^2 \times 2 + 2 \times 1 + 4$ $= 4 + 2 + 2 + 4 = 12$
5	$a^2 - b^2$	$a = 4$ $b = 3$	$4^2 - 3^2 = 16 - 9 = 7$

If the length of a rectangle, $a = 4$ cm and breadth $b = 3$ cm

Then the area of the rectangle $= a \times b$

$= 4 \times 3$ sq.cm

$= 12$ sq.cm

12.9.2 Number Pattern :

Let us begin with odd natural number

1st odd natural number $= 1$

2nd odd natural number $= 3$

3rd odd natural number $= 5$

4th odd natural number $= 7$

Now if you ask to write the 50th odd natural number within a very short time, can you write?

For the purpose we shall write the odd natural numbers in another way

1st odd natural number $= 1 = 2 \times \textcircled{1} - 1$

2nd odd natural number $= 3 = 2 \times \textcircled{2} - 1$

3rd odd natural number $= 5 = 2 \times \textcircled{3} - 1$

4th odd natural number $= 7 = 2 \times \textcircled{4} - 1$

Why the sign '◯' is given, observed minutely

5th odd natural number $2 \times \textcircled{5} - 1$ is not it?

Now $2 \times \textcircled{5} - 1 = 10 - 1 = 9$ (5th odd natural number)

So, when we shall write 50th odd natural number

We shall write $= 2 \times 50 - 1$

$= 100 - 1 = 99$

nth odd natural number $= 2 \times n - 1 = 2n - 1$ (Algebraic expression)

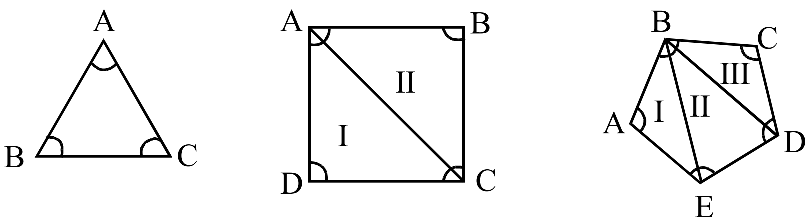
Thus we can arrange pattern of the first nth odd natural number.

So, the algebraic expression of first nth odd natural number is $2n - 1$.

Do Yourself : 1. Find the algebraic expression of first nth even natural number.

2. In the number pattern 4, 8, 12..... find the nth term.

Geometrical Pattern :



Sum of the three angle of the triangle ABC = 180^o

Sum of the four angle of the triangle ABCD = Sum of the angle of triangle I + Sum of the angle of triangle II = $180^o + 180^o = 360^o$

Sum of the angle of the Pentagon ABCDE = Sum of the angle of triangle I + Sum of the angle of triangle II + Sum of the angle of triangle III = $180^o + 180^o + 180^o = 540^o$

Now observed the following patterns –

Sum of the angles of a triangle = $180^o = (3 - 2)\times180^0$

Sum of the angles of a qudrilateral = $360^0 = (4 - 2)\times180^0$

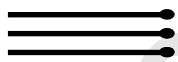
Sum of the angles of a pentagon = $540^o = (5-2)\times180^0$

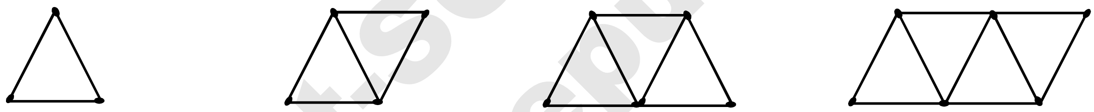
Observe that above 3, 4, 5 etc. are the number of sides of the polygon.

$\therefore$ Sum of the angles of a polygon with n side = $(n-2)\times180^0$

= $2(n-2)90^0 = (2n\text{-}4)90^0$

Game of Stick :





(i) No. of stick = 3 (ii) No. of stick = 5 (iii) No. of stick = 7 (iv) No. of stick = 9

Rita and Tapan will make triangle with stick (as in figure)

(i) Rita made triangle with 3 stick (ii) Tapan made two triangle with 5 sticks

(iii) Rita made 3 triangle with 7 sticks (iv) Tapan made 4 triangle with 9 sticks.

Q. How many sticks will be needed to make *'n'* numbers of triangles ?

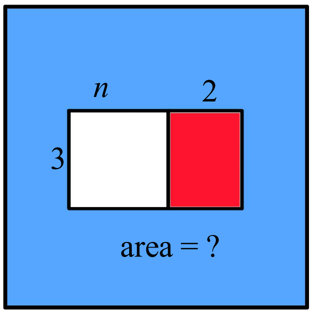
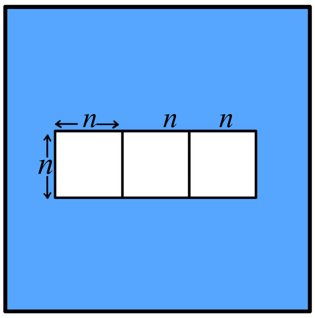
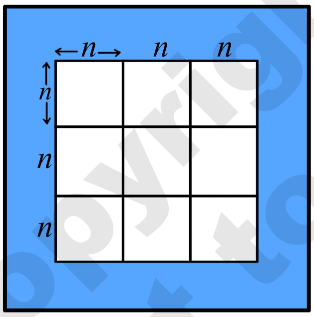
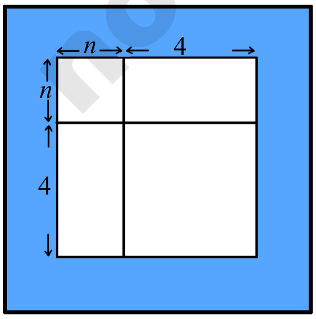
To get the answer of the above question we need to arrange the pattern of the numbers 3, 5, 7, 9

No of triangle	No. of Stick	Pattern
1	3	$2\times1 + 1$
2	5	$2\times2 + 1$
3	7	$2\times3 + 1$
4	9	$2\times4 + 1$
n		$2n + 1$

So, to get ‘***n***’ numbers of triangle the number of stickes will be **2*n* + 1**

Activity : Card Game

Teacher should make card for the game and she should instruct the children accordingly (student will match the answer card with the question card)

<table>
<tr><th></th><th>Question card</th><th colspan="2">Answer Card (area, perimeter)</th></tr>
<tr><td>1.</td><td></td><td>$3n^2$
Card no.1</td><td>$12n$
Card no. 2</td></tr>
<tr><td>2.</td><td></td><td>$n^2 + 8n + 16$
Card no. 3</td><td>$2n + 10$
Card no. 4</td></tr>
<tr><td>3.</td><td></td><td>$3n + 6$
Card no. 5</td><td>$4n + 16$
Card no. 6</td></tr>
<tr><td>4.</td><td></td><td>$9n^2$
Card no. 7</td><td>$8n$
Card no. 8</td></tr>
</table>

Exercise - 12.3

1. Find the value of the following algebraic expressions, if $a = 1$

   (i) $2a + 1$ (ii) $a^2 - 2a + 1$ (iii) $\frac{a+3}{4}$ (iv) $\frac{1}{2}a - 4$

   (v) $a^3 + a^2 + a - 1$

2. If $x = -3$, then find the value of the following algebraic expressions.

   (i) $-x^2 + 4x + 3$ (ii) $2x^2 + x + 3$ (iii) $x^3 - x^2 + 1$ (iv) $3x + 1$ (v) $\frac{x}{3} + \frac{2}{3}$

3. Find the value of the algebraic expressions when $x = 1$ and $y = -1$

   (i) $x^2 + xy + y^2$ (ii) $x^2 + y^2$ (iii) $x^2 - y^2$ (iv) $x^2 + y + 1$

   (v) $3x + y$ (vi) $x^2y + xy^2 + x$

4. Simplify the following expression and find values for $x = -2$

   (i) $x^2 + x + 7 + x + x^2 - 1$ (ii) $3(x + 4) + 2x + 1$

   (iii) $3x - (2x - 1)$ (iv) $(x^2 + x) - (2x^2 - x + 1)$

   (v) $x^3 + 2x^2 - x + 2x^2 + 2x + 1$ (vi) $x^3 - 4(x - 5)$

5. Simplify the expression given below and find the value for $x = 2$, $y = -3$ and $z = -1$.

   (i) $2x + y - z + 3x - 2y + z$ (ii) $xy + yz + 2x$

   (iii) $2x^2y + xy^2z + 3xyz + 6x^2y - 2xy^2z - 6xyz$

   (iv) $5 - 3x + 2y - 7x + 6y + 2 + z$

   (v) $(2x + y + z) - (z - 3y) + (2 + x) - (5 - z)$

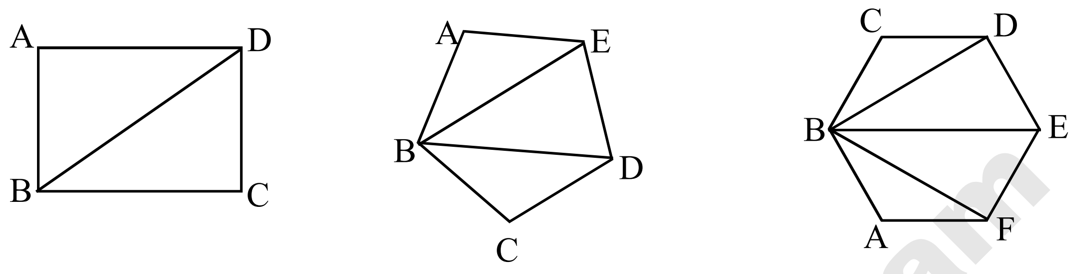
6. For $x = 0$ if the value of the expession $x^2 + 2x - p + 1$ is 6 then find the value of p.

Exercise -12.4

1. Fill the table with the values of the following algebraic expressions [use 1, 2, 3, ... in place of the unknown variables]

	Expression	Terms							
		1st	2nd	3rd	4th	5th	50th	......	100th
(i)	$5n + 1$	6	11						
(ii)	$3n - 1$	2		8					
(iii)	$x^2 + 1$	2			17				
(iv)	$2x + 3$	5		9		13			203
(v)	$4n - 1$	3					199		

2. Observe the following diagram :



(i) (ii) (iii)

In the quadrilateral ABCD only one diagonal can be drawn from the vertex B. (Fig. i)

In the pentagon ABCDE only 2 diagonal can be drawn from one vertex B. (Fig. ii)

In the hexagon ABCDEF only 3 diagonal can be drawn from the vertex B. (Fig. iii)

$\therefore$ number of diagonal can be drawn from a vertex of a quadrilateral = 1

number of diagonal can be drawn from a vertex of a pentagon = 2

number of diagonal can be drawn from a vertex of a hexagon = 3

How many diagonals can be drawn from a vertex of a heptagon ?

How many diagonals can be drawn from a vertex of a polygon of side '*n*' ?

3. In the table given below one value of '*n*' is given for *n* = 1, 2, 3, 4, 5 and some has to find. Fill up the gaps.

(a)

n	1	2	3	4	5
term	1	4	9	16	?

What is the n^{th} term = ?

(b)

n	1	2	3	4	5	–	n
term	4	7	10	13	?		?

(c)

n	1	2	3	4	5	6
term	8	10	12	14	16	?

What is the n^{th} term = ?

Algebraic Expression

What we have learnt

1. Algebraic expressions are formed with addition-subtraction-multiplication-division process of variables and constants.
2. An algebraic expression is formed with one-two or more terms.
3. The coefficient is the numerical factor in the term.
4. An expression with one term is called monomial, an expression with two terms is called binomial and an expression with three term is called trinomial. Collectively expression with one or more term is called a polynomial.
5. Terms which have the same algebraic factors are called like terms. Terms which have different algebraic factors are called unlike terms.
6. We can add or subtract the like terms only.
7. The sum (or difference) of two like terms is a like term.
8. When we add (or subtract) of two albebraic expressions, the like terms are added (subtracted); the unlike terms are left as they are.
9. The value of an algebraic expression is determined with the value of the variable.
10. Rules and formulas in mathematics can be written in concise and general form using algebraic expressions. The general (n^{th}) term of a number pattern is an algebraic expression involving n.