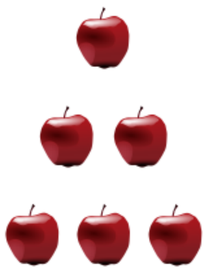
2 Whole Numbers

Whole numbers

Count the number of apples shown below.



When you count, you start counting from one, then go on to two, three, four, etc. This is the natural way of counting any set of objects. Hence, 1, 2, 3, 4, ... are called counting numbers or natural numbers. The number of students in a class, the number of days in a week are all examples of natural numbers.

The natural numbers along with zero form the collection of whole numbers.

Natural Numbers	Whole Numbers
There is no natural number whose successor is 1.	There is no whole number whose successor is 0.
1 is the smallest natural number.	0 is the smallest whole number.
0 is not a natural number.	0 is a whole number.

Building Concepts 1

How many whole numbers are there between 32 and 53?

Explanation

Whole numbers between 32 and 53 = 20 (53 – 32 – 1= 20)

That is 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 52, 52

Successor and Predecessor

Successor

The number which comes immediately after a particular number is called its successor.

The successor of a whole number is the number obtained by adding 1 to it.

Successor of a given number is 1 more than the given number.

We observe that every whole number has its successor.

> Successor is obtained by adding 1 to given whole number. Predecessor is obtained by subtracting 1 from the given whole number.
>
> **SPOT LIGHT**

Number + 1 = Successor

Predecessor

The number which comes just before a particular number is called its predecessor.

The predecessor of a whole number is one less than the given number.

We observe that every whole number, other than zero, has its predecessor.

Number – 1 = Predecessor

Also, if a is the successor of b, then b is the predecessor of a.

Be Alert !

- Whole number 0 has no predecessor.

Building Concepts 2

Find the successor and predecessor of 6199, 8540, 934, 13469.

Explanation

PREDECESSOR		NUMBER		SUCCESSOR
(6199 – 1) = 6198	← Predecessor	6199	Successor →	(6199 + 1) = 6200
(8540 – 1) = 8539	← Predecessor	8540	Successor →	(8540 + 1) = 8541
(934 – 1) = 933	← Predecessor	934	Successor →	(934 + 1) = 935
(13469 – 1) = 13468	← Predecessor	13469	Successor →	(13469 + 1) = 13470

Numerical Ability 1

(i) Write the next three natural numbers after 10999.

(ii) Which is the smallest whole number?

Solution

Next three natural numbers after 10999 are

10999 + 1 = 11000

11000 + 1 = 11001

11001 + 1 = 11002

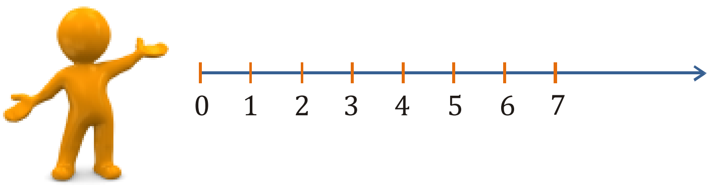
(ii) Smallest whole number is 0.

Number line

You can represent whole numbers on a number line.

Draw a line. Mark a point on it. Label it 0. Mark a second point to the right of 0. Label it 1. The distance between these points labelled as 0 and 1 is called unit distance. On this line, mark a point to the right of 1 and at unit distance from 1 and label it 2. In this way go on labelling points at unit distances as 3, 4, 5,... on the line. You can go to any whole number on the right in this manner.

This is a number line for the whole numbers.



SPOT LIGHT

Between two consecutive whole numbers, there lies no whole number.

Check your Concepts 1

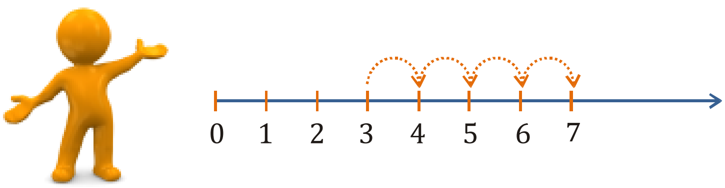
1. Mark 30, 12, 18 on the number line. Which number is at the farthest left?

2. From 1005 and 9756, which number would be on the right relative to the other number on number line?

3. Place the successor of 12 and the predecessor of 7 on the number line.

Addition on the number line

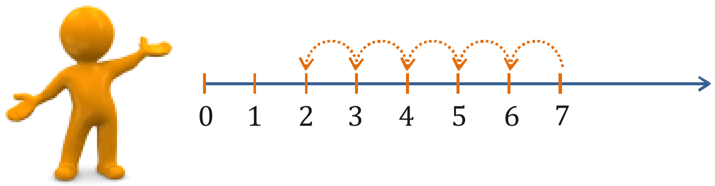
Addition of whole numbers can be shown on the number line. Let us see the addition of 3 and 4.



Start from 3. Since we add 4 to this number so we make 4 jumps to the right; from 3 to 4, 4 to 5, 5 to 6 and 6 to 7 as shown above. The tip of the last arrow in the fourth jump is at 7. The sum of 3 and 4 is 7, i.e. 3 + 4 = 7.

Subtraction on the number line

The subtraction of two whole numbers can also be shown on the number line. Let us find 7 – 5.



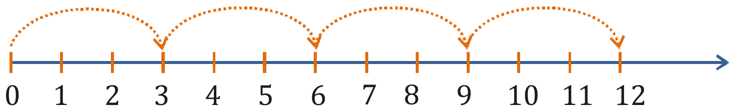
Start from 7. Since 5 is being subtracted, so move towards left with 1 jump of 1 unit. Make 5 such jumps. We reach the point 2. We get

7 – 5 = 2.

Multiplication on the number line

We now see the multiplication of whole numbers on the number line.

Let us find 3 × 4.



Start from 0, move 3 units at a time to the right, make such 4 moves. Where do you reach? You will reach 12.

So, we say, 3 × 4 = 12.

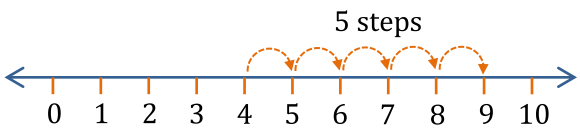
Building Concepts 3

(i) Show addition of 4 and 5 on number line.

(ii) Subtract 3 from 8 using number line.

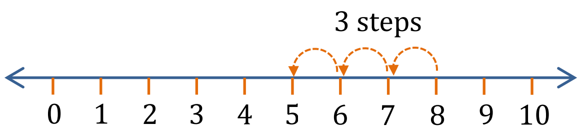
Explanation

(i) Addition of 4 and 5



4 + 5 = 9

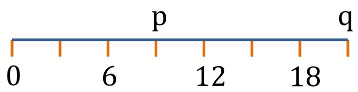
(ii) Subtract 3 from 8



8 – 3 = 5

Numerical Ability 2

What is the value of p + q – 2 in the given number line?



Solution

p = 9 from the number line

q = 21 from the number line

p + q – 2 = 9 + 21 – 2

= 30 – 2

= 28

Properties of whole numbers

Four basic operations - addition, subtraction, multiplication, and division can be performed on whole numbers. You will now learn about some properties of these operations.

Active Maths 1

To check whether whole numbers are closed under addition, subtraction, multiplication and division.

Exploring the Concept

Take four pairs of numbers. Add, subtract, multiply and divide them.

Drawing Conclusions

1. Is the sum always a whole number?

For e.g., 5 + 7= 12 (whole number) ; 6 + 3 = 9 (whole number)

2. Is the difference always a whole number?

For e.g., 7 – 5 = 2 (whole number) ; 3 – 6 = – 3 (not a whole number)

3. Is the product always a whole number?

For e.g., 5 × 7 = 35 (whole number) ; 3 × 6 = 18 (Whole number)

4. Is the quotient always a whole number?

For e.g., 6 ÷ 3 = 2 (whole number) ; 3 ÷ 6 = $\frac{1}{2}$ (Not a whole number)

Closure property

The difference and the quotient of two whole numbers is not always a whole number but the sum and product of two whole numbers is always a whole number. This is the closure property of the whole numbers.

If a and b are two whole numbers, then

(i) a + b = c, then c is also a whole number.

For e.g., 3 + 4 = 7 (whole number)

(ii) a – b = c, then c is not always a whole number.

For e.g., a – b = 7 – 5 = 2 and b – a = 5 – 7 = –2 (not a whole number).

(iii) $a \times b = c$, then c is also a whole number.

For e.g., $10 \times 5 = 50$ (whole number).

(iv) $a \div b$ is not always a whole number.

For e.g., $14 \div 7 = 2$ (whole number) but $7 \div 14 = \frac{1}{2}$ (not a whole number).

Hence, whole numbers are closed under addition and multiplication but are not closed under subtraction and division.

Quick Tips

✸ While doing division and subtraction we can get decimals and negative number respectively. That's why division and subtraction is not closed under closure property.

Commutative property

The order in which we add or multiply two whole numbers does not alter the solution but is not true in case of subtraction and division. This is the Commutative property of the whole numbers.

Let a and b are two whole numbers, then

(i) $a + b = b + a \Rightarrow 12 + 18 = 30 = 18 + 12$.

(ii) $a - b \neq b - a \Rightarrow 3 - 5 = -2 \neq 5 - 3 = 2$

(iii) $a \times b = b \times a \Rightarrow 5 \times 8 = 40 = 9 \times 4$.

(iv) $a \div b \neq b \div a \Rightarrow 6 \div 3 = 2 \neq 3 \div 6 = \frac{1}{2}$

Hence, only addition and multiplication are commutative for whole numbers.

Be Alert !

✸ $4 \div 2 \neq 2 \div 4$

Associative property

The sum and the product of three whole numbers do not change even if the grouping is changed but it is not true in the case of subtraction and division. This is the Associative property of the whole numbers.

Let a, b, and c are three whole numbers, then

(i) $a + (b + c) = (a + b) + c = (a + c) + b$

For e.g., $12 + (15 + 13) = (12 + 15) + 13 = (12 + 13) + 15 = 40$

(ii) $a - (b - c) \neq (a - b) - c$.

For e.g., $8 - (5 - 2) = 5 \neq (8 - 5) - 2 = 1$.

(iii) $a \times (b \times c) = (a \times b) \times c = (a \times c) \times b$.

For e.g., $6 \times (7 \times 2) = (6 \times 7) \times 2 = (6 \times 2) \times 7 = 84$.

(iv) $a \div (b \div c) \neq (a \div b) \div c \Rightarrow 100 \div (25 \div 5) = 20 \neq (100 \div 25) \div 5 = 4 \div 5$.

Hence, addition and multiplication are associative for whole numbers.

Numerical Ability 3

Add the numbers 234, 197 and 103.

Solution

234 + 197 + 103

= 234 + (197 + 103)

= 234 + 300 = 534

Numerical Ability 4

Find 12 × 35.

Solution

12 × 35 = (6 × 2) × 35 = 6 × (2 × 35) = 6 × 70 = 420

In the above example, we have used associativity to get the advantage of multiplying the smallest even number by a multiple of 5.

Distributive property

> a×(b–c)=a×b – a×c is valid for b > c. This is called distribution property of multiplication over subtraction.
>
> SPOT LIGHT

Building Concepts 4

A florist arranges 6 gladioli and 7 roses in a bouquet, Raj buys 5 such bouquets for the school annual function. What is the total number of flowers in these 5 bouquets?

Explanation

Gladioli in 5 bouquets = 5 × 6 flowers = 30 flowers

Roses in 5 bouquets = 5 × 7 flowers = 35 flowers

Total number of flowers in 5 bouquets

= (5 × 6) + (5 × 7) = 65 flowers

Another way of solving the problem is as follows.

Flowers in one bouquet (gladioli + roses) = (6 + 7) flowers

Total number of flowers in 5 bouquets = 5(6 + 7) flowers

= 5 × 13 flowers = 65 flowers

So, 5(6 + 7) = (5 × 6) + (5 × 7)

5 × 13 = 30 + 35

65 = 65

Hence, we can conclude that if a, b and c are whole numbers, then

a × (b + c) = a × b + a × c

This property is called the distributive property of multiplication over addition.

Building Concepts 5

There are 7 plates. Six biscuit are placed on each plate. If 4 biscuits are taken away from each plate, how many biscuits are left on the plates? Write the mathematical statement.

Explanation

Biscuits on 7 plates = 7 × 6 = 42 biscuits

Biscuits taken away from 7 plates = 7 × 4 = 28 biscuits

Biscuits remaining = 7 × 6 – 7 × 4 = 42 – 28 = 14 biscuits

or, Biscuits left on one plate = (6 – 4) biscuits

Biscuits left on 7 plates = 7 (6 – 4) = 7× 2 biscuits = 14 biscuits

So, the mathematical statement 7 × (6 – 4) = 7 × 6 – 7 × 4

So in above case, multiplication is distributive over subtraction also. But if b is greater than c, then (c – b) does not exist in whole numbers.

If a, b and c are whole numbers, then a × (b – c) = a × b – a × c if and only if b is greater than c.

> 0 = additive identity
> 1 = multiplicative Identity.
>
> SPOT LIGHT

Identity (for addition and multiplication)

What happens when you add zero to any whole number?

You get the same whole number again. Hence, zero is called the additive identity of a whole number because it maintains the identity of the number during the operation of addition.

Zero has a special role in multiplication too. Any whole number when multiplied by zero becomes zero.

Now, let's talk about multiplicative identity. Can you think of a whole number which when multiplied by any whole number gives that whole number itself as the answer. Yes, it is one. One is the multiplicative identity for whole numbers.

Note: If zero is divided by a whole number, the result will always be zero.

Be Alert !

Some important rules to learn.

- a + 0 = a
- a × 0 = 0
- a × 1 = a

Patterns in whole numbers

Numbers and elementary shapes can be correlated using patterns. Whole numbers can be arranged in different shapes as:

Every whole number (greater than 1) can be arranged as a line;

2 ⟶

3 ⟶

6 ⟶

Some numbers can be arranged as squares.

4 ⟶ 

9 ⟶ 

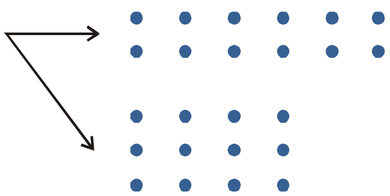
16 ⟶ 

These are also known as perfect squares.

Some numbers can be arranged as rectangles.

6 ⟶ 

8 ⟶ 

12 

Some numbers can be arranged as triangles.

3 ⟶ 

6 ⟶ 

10 ⟶  The triangle should have its two sides equal and always one dot at the top.

Check your Answers 1

1.

0 1 2 3 4...............12.............18............30

12 is at the farthest left.

2. 9756 is on the right relative to 1005.

3.

0 1 2 3 4 5 6 7 12 13

The successor of 12 is 13, the predecessor of 7 is 6.

Check your Concepts 2

1. As shown to you, 12 can be arranged as two rectangles, i.e., 2 × 6 and 3 × 4. Think two more such numbers.

2. Which of the following numbers are triangular numbers?
2, 3, 4, 5, 6, 9, 10, 25, 27, 28, 35, 36

3. Which is the smallest number that can be shown as a line, rectangle and triangle?

4. Which number can be shown both as a square and a triangular number?

> **SPOT LIGHT**
> Division of a whole number by zero is meaningless and is not allowed. E.g. to speak of dividing 10 apples among zero students is meaningless.

Pattern observations

The mathematical operations can be simplified by observing patterns.

Pattern 1

125 + 9 = 125 + (10 – 1) = 135 – 1 = 134
125 + 99 = 125 + (100 – 1) = 225 – 1 = 224
125 + 999 = 125 + (1000 – 1) = 1125 – 1 = 1124
125 + 9999 = 125 + (10000 – 1) = 10125 – 1 = 10124

Pattern 2

65 × 9 = 65 × (10 – 1)
65 × 99 = 65 × (100 – 1)
65 × 999 = 65 × (1000 – 1) and so on.

Pattern 3

1 × 1 = 1
11 × 11 = 121
111 × 111 = 12321
1111 × 1111 = 1234321

Pattern 4

1 × 9 + 1 = 10
12 × 9 + 2 = 110
123 × 9 + 3 = 1110

Check your Answers 2

1. 18 = 3 × 6 = 9 × 2

and 20 = 10 × 2 = 5 × 4

2. 3,6,10,28,36

3. 6

4. 36

Check your Concepts 3

1. Write the next two steps of each of the given patterns. Can you say how the pattern works?

(i) 1 × 8 = 8

12 × 8 = 88 + 8

123 × 8 = 888 + 88 + 8

1234 × 8 = 8888 + 888 + 88 + 8

(ii) 7 × 11 = 77

63 × 101 = 6363

234 × 1001 = 234234

4189 × 10001 = 41894189

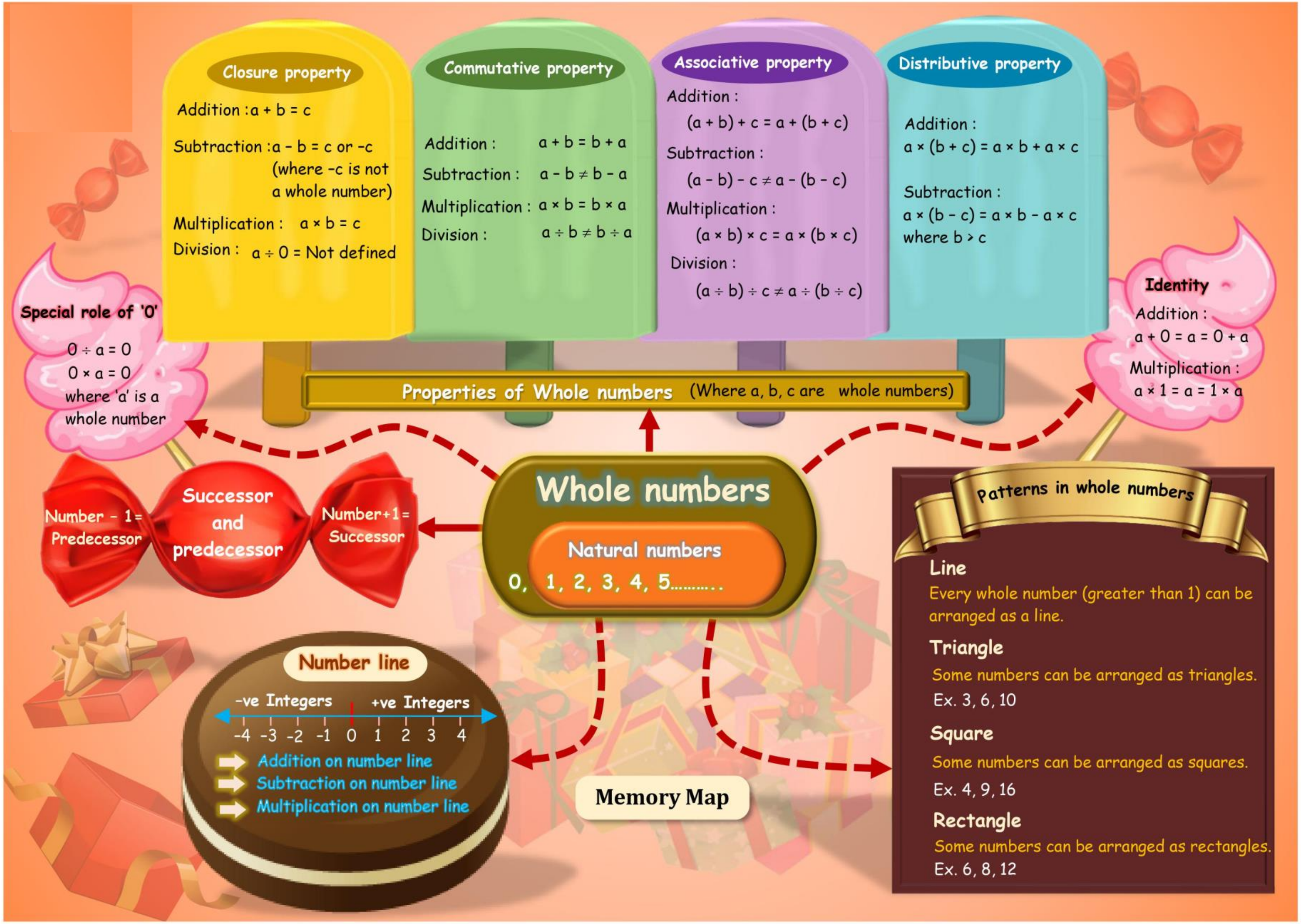
Check your Answers 3

(i) 12345 × 8 = 88888 + 8888 + 888 + 88 + 8

123456 × 8 = 888888 + 88888 + 8888 + 888 + 88 + 8

(ii) 51356 × 100001 = 5135651356

789456 × 1000001 = 789456789456



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