CREST Olympiads

MATHEMATICS WORKBOOK

6

For the preparation of National & International Olympiads

- Chapter-wise practice exercises
- Previous year paper

CREST Mathematics Olympiad (CMO)

Mathematics Olympiad

Exams Preparation Book

CMO | IMO | UMO | iOM | UIMO | HMO

Grade 6

#CRESTInnovator

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CREST Mathematics Olympiad Workbook for Grade 6

Second Edition

Disclaimer: The information in the Workbook is to give you the path to success but it does not guarantee 100% success as the strategy is completely dependent on its execution. And it is based on previous year papers of CMO exam.

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Preface

We are pleased to launch a thoroughly revised edition of this workbook. We welcome feedback from students, teachers, educators and parents. For improvements in the next edition, please send your suggestions at info@crestolympiads.com.

CREST Olympiads is one of the largest Olympiad Exams with students from more than 25 countries. The objective of these exams is to build competitive spirit while evaluating students on conceptual understanding of the concepts.

We strive to provide a superior learning experience, and this workbook is designed to complement the school studies and prepare the students for various competitive exams including the CREST Olympiads. This workbook provides a crisp summary of the topics followed by the practice questions. These questions encourage the students to think analytically, to be creative and to come up with solutions of their own. There's a previous year paper given at the end of this workbook for the students to attempt after completing the syllabus. This paper should be attempted in 1 hour to get an assessment of the student's preparation for the final exam.

Publishers

Chapter 1

Knowing Your Number

Knowing Your Numbers, Whole Numbers and Playing with Numbers

Natural Numbers: Natural numbers are a part of the number system. They include all the counting numbers from 1 till infinity. Natural numbers are also called counting numbers.
Example: 1, 2, 3, 4, 5, 6, …….

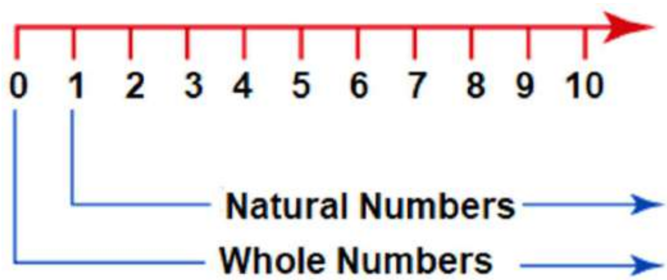
Successor and Predecessor of Numbers

The number which comes immediately after a particular number is called its successor.
In other words, the successor of a given number is 1 more than the given number.
The number which comes just before a particular number is called its predecessor.
In other words, the predecessor of a given number is 1 less than the given number.

Example: 9,999,999 is the predecessor of 10,000,000 or we can also say 10,000,000 is the successor of 9,999,999.

Whole Numbers

All natural numbers including 0 are called whole numbers.
Example: 0, 1, 2, 3, 4, 5, …….



Operations on Whole Numbers

Properties of Addition

i. **Closure property:** If a and b are any two whole numbers, then (a + b) is also a whole number.
Example: 4 + 5 = 9, 22 + 35 = 57 etc.

ii. **Commutative law:** If a and b are any two whole numbers, then (a + b) = (b + a).
Example: 5 + 14 = 14 + 5

iii. **Additive property of zero**: If a is any whole number, then
a + 0 = 0 + a
Example: 320 + 0 = 0 + 320

iv. **Associative law**: For any whole numbers a, b, c we always have (a + b) + c = a + (b + c)
Example: (6 + 3) + 8 = 6 + (3 + 8)
9 + 8 = 6 + 11
17 = 17

Properties of Subtraction

i. **Closure property:** If a and b are two whole numbers such that a > b or a = b then a - b is a whole number, otherwise subtraction is not closed in whole numbers.

ii. **Commutative law:** For any two whole numbers a and b, (a - b) is not equal to (b - a).
Example: (8 - 5) is not equal to (5 - 8)

iii. **Subtracting zero**: For any whole number a, we have (a - 0) = 0 but (0 - a) is not defined in whole numbers.
Example: (9 - 0) = 9 but (0 - 9) is not defined in whole numbers.

iv. **Associative law**: If a, b, c are any three whole numbers, then in general (a - b) - c is not equal to a - (b - c).
Example: (7 - 5) - 3 = 4 - 3 = 1
7 - (5 - 3) = 7 - 2 = 5
1 is not equal to 5

Properties of Multiplication

1. **Closure property:** If a and b are two whole numbers, then (a x b) is also a whole number.
Example: 8 x 6 = 48, 12 x 10 = 120

2. **Commutative law**: If a and b are any two whole numbers then:
(a x b) = (b x a)
Example: 6 x 9 = 9 x 6
54 = 54

3. **Multiplicative property of zero:** For any whole number a, we have:
   (a x 0) = (0 x a) = 0
   Example: 9 x 0 = 0 x 9 = 0

4. **Multiplicative property of 1:** For any whole number a, we have:
   (a x 1) = (1 x a) = a
   Example: 5 x 1 = 1 x 5 = 5

5. **Associative law**: If a, b, c are any whole numbers, then:
   (a x b) x c = a x (b x c)
   Example: (4 x 3) x 5 = 4 x (3 x 5)
   or, 12 x 5 = 4 x 15
   60 = 60

6. **Distributive law of multiplication over addition:** For any whole numbers a, b, c we have:
   a x (b + c) = (a x b) + (a x c)
   Example: 7 x (5 + 3) = (7 x 5) + (7 x 3)
   or, 7 x 8 = 35 + 21
   56 = 56

Properties of Division

1. **Closure property:** If a and b are nonzero whole numbers, then a/b is not always a whole number.
   Example: 7/2 = 3.5, which is not a whole number.

2. **Division by 0:** If a is a whole number, then a/0 is meaningless.

3. **Dividing 0 by any whole number:** If a is a nonzero whole number, then 0/a = 0.

Even and Odd Numbers

If the digit at one's place of the number is 0, 2, 4, 6 or 8, then the number is called an **even number**.
If the digit at one's place of the number is 1, 3, 5, 7 or 9, then the number is called an **odd number**.

Prime Number: The number which has only two factors 1 and itself is called a prime number.
Example: 2, 3, 5, 7, 11, ….

Co-Primes: A pair of numbers having no common factor, other than 1 is called co-primes.
Example: (3, 5), (4, 5), (7, 9) etc.

Twin-Primes: Prime numbers which differ by 2 are called twin primes.
Example: (3, 5), (5, 7), (11, 13) etc.

Prime Triplet: A set of three consecutive primes which differ by 2, is called a prime triplet.
Example:(3, 5, 7), (19, 21, 23) etc.

Composite Numbers: The numbers which have more than two factors are called composite numbers.
Example: 4, 6, 8, 9, 10, …

Perfect Numbers: A number is a perfect number if the sum of all its possible factors including 1 and the number itself is equal to twice that number.
Example: Factors of 6 are 1, 2, 3, 6
1 + 2 + 3 + 6 = 12 = 2 x 6
So, 6 is a perfect number.

Division Algorithm: In a division sum, we have four quantities – Dividend, Divisor, Quotient and Remainder. The relation between them is:
Dividend = Divisor × Quotient + Remainder

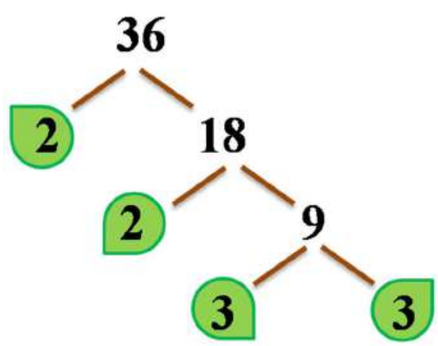
Divisibility Tests

a. **Divisibility by 2:** A number is divisible by 2, **i**f its unit digit is even. Example: 220, 356, 1168 are divisible by 2 as their unit digit is even.
b. **Divisibility by 3:** A number is divisible by 3, if the sum of its digits is divisible by 3. Example: 6315 is divisible by 3 as the sum of its digits = 6 + 3 + 1 + 5 = 15, which is divisible by 3.
c. **Divisibility by 4:** A number is divisible by 4, if the number formed by the last two digits is divisible by 4. Example: 89248 is divisible by 4 since the number 48 formed by the last two digits is divisible by 4.
d. **Divisibility by 5:** A number is divisible by 5, if its last digit is 5 or 0. Example: 565, 620.
e. **Divisibility by 6:** A number is divisible by 6, if it is even and divisible by 3. Example: 8034 is divisible by 6 since it is an even number and sum of its digits = 8 + 0 + 3 + 4 = 15, which is divisible by 3.
f. **Divisibility by 7:** Take the last digit of the number, double it, and then subtract the result from the rest of the number. If the resulting number is exactly divisible by 7, then the original number is divisible by 7.
   Example: 154 = 15 - 4 x 2 = 7
   672 = 67 - 2 x 2 = 63
g. **Divisibility by 8:** A number is divisible by 8, if the number formed by the last three digits of the given number is divisible by 8. Example: 89736 is divisible by 8 since the number formed by the last three digits is 736 which is divisible by 8.
h. **Divisibility by 9:** A number is divisible by 9, if the sum of its digits is divisible by 9. Example: 61128 is divisible by 9 since the sum of its digits = 6 + 1 + 1 + 2 + 8 = 18, which is divisible by 9.

i. **Divisibility by 10:** A number is divisible by 10, if it ends in 0. Example: 46890, 67800 etc.
j. **Divisibility by 11:** A number is divisible by 11, if the difference between the sum of the digits in odd places and the sum of its digits in even places starting from the unit's place is 0 or divisible by 11. Example: 41679 is divisible by 11 since, sum of the digits at even places = 7 + 1 = 8
sum of the digits at odd places = 9 + 6 + 4 = 19
Difference = 19 - 8 = 11, which is divisible by 11.

Prime Factor: A factor of a given number is called a prime factor if this factor is a prime number.
Example: 2 and 3 are prime factors of 12.

Prime Factorization: Expressing a given number as the product of its prime factors is called prime factorization of the given number.
Example: The prime factorisation of 36 = 2 × 2 × 3 × 3



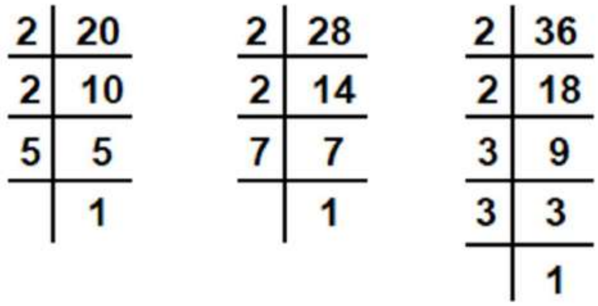
Highest Common Factor (HCF)

The greatest number which is a common factor of two or more given numbers, is called the **highest common factor** or **greatest common divisor**.

Highest Common Factor (HCF) by Prime Factorization

The prime factors of 20, 28 and 36 are:
20 = 2 × 2 × 5
28 = 2 × 2 × 7
36 = 2 × 2 × 3 × 3
Common prime factors = 2, 2

HCF = 2 × 2 = 4

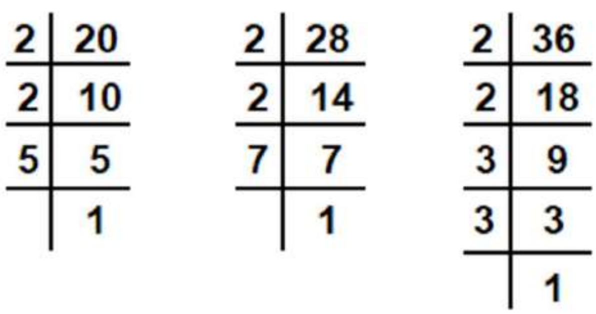


Lowest Common Multiple (LCM)

The lowest common multiple of two or more numbers is the smallest number which is a multiple of each of the numbers.

Lowest Common Multiple by Prime Factorization

The prime factors of 20, 28 and 36 are:
20 = 2 × 2 × 5
28 = 2 × 2 × 7
36 = 2 × 2 × 3 × 3
LCM = 2 × 2 × 3 × 3 × 5 × 7 = 1260
(2 × 2 is common in the factors of all the three numbers)



Highest Common Factor (HCF) by Division Method

Suppose two numbers are given.

- Divide the greater number by a smaller one.
- Next, divide the divisor by the remainder.
- Go on repeating the process of dividing the preceding divisor by the remainder last obtained till the remainder zero is obtained.
- Then the last divisor is the required HCF of the given number.

Consider 20 and 28:

$$
\begin{array}{l}
20\,)\,28\,(1 \\
\quad -20 \\
\hline
\qquad 8\,)\,20\,(2 \\
\qquad\quad -16 \\
\hline
\qquad\qquad 4\,)\,8\,(2 \\
\qquad\qquad\quad -8 \\
\hline
\qquad\qquad\quad 0
\end{array}
$$

HCF = 4

Lowest Common Multiple (LCM) by Division Method

- In this method, we arrange the given numbers in a line in any order.
- We divide by a number that divides exactly at least two of the given numbers and carries forward the numbers which are not divisible.
- This process is repeated till no two of the given numbers are divisible by a common number.
- The product of divisors and the undivided numbers is the required LCM of the given numbers.

Consider 20 and 28:

$$
\begin{array}{r|l}
4 & 20, 28 \\
\hline
 & 5, 7 \\
\hline
\end{array}
$$

LCM = 4 x 5 x 7 = 140

Practice Questions

1. The reciprocal of the smallest composite number is:

   a. 1
   b. 1/2
   c. 1/4
   d. 1/3

2. Which of the following numbers is a perfect square?

   a. 35
   b. 63
   c. 64
   d. 48

3. Prime factorization of 10846 is equal to:

   a. 2 x 11 x 17 x 29
   b. 2 x 13 x 17 x 23
   c. 2 x 7 x 23 x 29
   d. 2 x 5 x 13 x 29

4. The HCF and LCM of the two numbers are 7 and 294 respectively. If one of the numbers is 42, then the other number is:

   a. 56
   b. 72
   c. 49
   d. 63

5. Which of the following options divides 21024 completely?

   a. 2
   b. 3
   c. 4
   d. All of the above

6. Which of the following pairs is a set of co-prime numbers?

   a. 8, 44
   b. 12, 69
   c. 17, 35
   d. 93, 81

7. A number, when divided by 12, leaves the remainder 4 and when divided by 9 leaves the remainder 1. What is the number?

   a. 88
   b. 109
   c. 56
   d. 100

8. 424284 is divisible by:

   a. 7
   b. 8
   c. 9
   d. 11

9. How many prime numbers are there between 25 and 75?

a. 10 b. 15
c. 17 d. 12

10. Add the number obtained by reversing the digits of the number 25,416 to the number obtained by interchanging the digits in the ten's place and the thousand's place of the original number, and choose the correct option:

a. 82908 b. 82098
c. 28089 d. 82809

11. In a five-digit number, the digit at thousand's place is twice the digit at ten's place. The digit at ten thousand's place is 5 more than the digit at unit's place and the digit at hundred's place is the largest one-digit composite number. If the digit at ten's place is the smallest odd prime number and the digit at the unit's place is the even prime number, then the required number is equal to:

a. 67392 b. 76932
c. 96723 d. 79326

12. The numbers (11, 15) are:

a. Prime numbers b. Composite numbers
c. Co-prime numbers d. Twin-prime numbers

13. Which of the following options completely divides (451,107 + 30,216)?

a. 2 b. 3
c. 4 d. 5

14. The smallest value of 'a' in the number 523a52 so that it is divisible by 8 is:

a. 6 b. 2
c. 7 d. 8

15. There are 140 pencils and 196 pens. These pens and pencils are to be arranged in bags containing the same number of pens and pencils, then the greatest number of pens and pencils in each bag is equal to:

a. 35 b. 28
c. 21 d. 42

16. Find the least number which when divided by 12, 20 and 32 leaves the remainder 2 in each case.

a. 362 b. 328
c. 482 d. 456

17. The least number which when decreased by 9 is exactly divisible by 7, 8, 14 and 56 is equal to:

a. 63 b. 65
c. 78 d. 81

18. Find the smallest number which will divide the smallest 5-digit number and the smallest 7-digit number exactly.

a. 2 b. 4
c. 5 d. 10

19. The circumference of the four wheels is 30 cm, 60 cm, 75 cm, and 120 cm. They start moving simultaneously. What least distance they should cover so that each wheel makes a complete number of revolutions?

a. 600 m b. 600 cm
c. 60 cm d. 60 m

20. The length, breadth and height of a huge swimming pool are 875 cm, 650 cm, and 425 cm respectively. Find the longest measuring tape which can measure all the three dimensions of the pool exactly.

a. 20 b. 30
c. 35 d. 25