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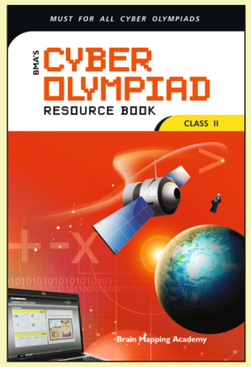

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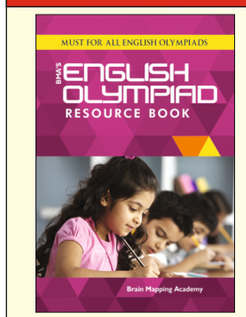

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Publisher's Note

Sometimes the understanding of fundamental concepts alone does not help the students to crack the competitive exams as most of them are objective in structure. Students need rigorous training to familiarize themselves to the style of the exams they are attempting. The board exams which are of qualifying, but not competitive, nature do not completely address the needs of students in testing them in objective type format.

To bridge this gap and to enable the students to face the reality of competitive exams, Brain Mapping Academy, brought out an all-objective questions reference book.

A crisp summary of the topics and useful formulations were provided at the beginning of each chapter so that the students can memorize the important points.

Care has been taken to design thought-provoking questions. These should help students to attain a deeper understanding of principles. The questions have been reviewed to fill the gaps in problem coverage and to build the confidence in the students. They have also been expanded to impart reasoning/logical/analytical skills.

This book will cater all the requirements of the students who are approaching national/ state level talent search examinations and all Olympiad exams. This book also complements the additional preparation needs of the students for the regular board exams.

We took utmost care to make this the best resource book available for the talent / olympiad exams aspirants. We welcome criticism from the students, teacher community and educators, especially concerning any errors and deficiencies which may have remained in this edition and the suggestions for improvement for the next edition.

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UIMO Unified International Mathematics Olympiad

Aim of these examinations

The focus on fundamentals is so important that without a firm understanding of them, a child cannot be expected to face the reality of the competitive world once he/she finishes the formal education. Even while opting for higher studies the student has to go through a complete scan of what he/she knows. Exams like IIT-JEE, AIEEE, AIIMS, AFMC, SAT, SAT, GRE, GMAT, etc. are so designed to test the fundamental strength of a student. Hence the need of the hour is building the fundamental base as strong as possible.

A successful life emerges out from healthy and pure competition. Competition is the only way for the students to shake lethargy. It's the only way to get introduced for manly worthiness. Firm standards in education and competition are the tonic for a promising and talented future.

This exactly is the philosophy behind the Unified Council's **NSTSE**-National Level Science Talent Search Examination & **UIMO**-Unified International Mathematics Olympiad.

Organisation

These exams are conducted by Unified Council. Unified Council is India's first ISO 9001 certified organisation in the educational testing and assessment. Since its inception, Unified Council has put together the best brains in an endeavour to make the younger generation fundamentally stronger and nourish their brains for a bright and enterprising future.

Eligibility: Students of classes 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11 & 12 are eligible to participate in this examination.

Medium & Syllabus: This exam is conducted in only English medium and is suitable for all the students following CBSE/ICSE/State Board Syllabi.

Examination Pattern

There will be a separate question paper for each class. All questions are objective-type multiple choice with no negative marking for wrong answers.

Duration: 60 minutes

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Allocation of Marks

NSTSE

For Class 1

Mathematics	:	15 marks
General Science	:	25 Marks

For Class 2

Mathematics	:	20 marks
General Science	:	30 Marks

For Classes 3 to 5

Mathematics	:	25 marks
General Science	:	30 Marks
Critical Thinking	:	05 Marks

For Classes 6 to 10

Mathematics	:	25 marks
Physics	:	10 marks
Chemistry	:	10 marks
Biology	:	10 marks
Critical Thinking	:	05 marks

For Class 11 & 12

Mathematics/Biology	:	25 marks
Physics	:	15 marks
Chemistry	:	15 marks
Critical Thinking	:	05 marks

UIMO

For Classes 1 & 2

Mathematics	:	0 marks
Logical Reasoning	:	10 Marks

For Classes 3 to 5

Mathematics	:	35 marks
Logical Reasoning	:	10 Marks
Critical Thinking	:	05 Marks

For Classes 6 to 12

Mathematics-1	:	30 marks
Mathematics-2	:	5 marks
Logical Reasoning	:	10 marks
Critical Thinking	:	05 marks

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CHAPTER 02

Factors and Multiples

Synopsis

- **Factors:** The numbers that are multiplied to give a product are called factors.

  e.g., $\underset{\text{Factor}}{43} \times \underset{\text{Factor}}{15} = \underset{\text{Product}}{645}$

  Factors divide the number exactly (i.e., without leaving a remainder.) So factors are also called divisors.

  1 is a factor of every number, and every number is a factor of itself.

  1 is the smallest factor of a number and the number itself is its greatest factor.

  The factor of a number is less than or equal to the number.

  Every number (except 1) has at least 2 factors – 1 and the number itself.

  The factors or divisors that are common to two or more numbers are called their common factors.

  e.g., Factors of 4 are 1, 2, 4. Factors of 6 are 1, 2, 3, 6.

  ∴ Common factors of 4 and 6 are 1, 2.

- **Highest Common Factor (H.C.F):** The highest of the common factors of two or more numbers is called their Highest Common Factor (H.C.F.) or their Greatest Common Divisor (G.C.D.).

- **Multiples:** The products obtained when a number is multiplied by 1, 2, 3, 4 and so on are called the multiples of that number.

  e.g., 4, 8, 12, 16, 20, ... are the multiples of 4.

  8, 16, 24, 32, 40, ... are the multiples of 8.

  Every number is a multiple of 1.

  A number is the smallest multiple of itself.

  Every multiple of a number is greater than or equal to the number itself.

  Multiples of a number are infinite. There is no largest multiple of a number.

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The multiples that are common to two or more numbers are called their common multiples.

e.g., Multiples of 2 are 2, 4, 6, 8, 10, 12, 14, 16, 18, ...

Multiples of 6 are 6, 12, 18, 24, 30, 36, 42, ...

∴ Common multiples of 2 and 6 are 6, 12, 18,

- **Least Common Multiple (L.C.M.):** The lowest of the common multiples of two or more numbers is called their Lowest (or Least) Common Multiple (L.C.M.).
- **Even numbers:** The numbers which are multiples of 2 are called even numbers.

  e.g., 438, 1450, 7034 etc.,
- **Odd numbers:** The numbers other than the multiples of 2 are called odd numbers.

  e.g., 215, 6013, 897 etc.,
- **Prime numbers:** The numbers which have only 1 and itself as factors are called prime numbers.

  e.g., 3, 11, 23, 47, etc.
- **Composite numbers:** The numbers which have at least 1 factor other than 1 and itself are called composite numbers.

  e.g., 4, 6, 12 etc.,

  a) 1 is neither prime nor composite.

  b) 2 is the smallest and the only even prime number.

  c) 4 is the smallest composite number.

  d) Prime numbers other than 2 are odd.
- **Twin primes:** Two consecutive prime numbers that differ by 2 are called twin primes.

  e.g., (3, 5), (5, 7), (11, 13) etc.,
- **Co-prime numbers:** The numbers which have no common factor except 1 are called co-prime numbers.

  e.g., (4, 15), (11, 17), (18, 37) etc.,
- **Prime factorisation:** The process of splitting a given number into its prime factors is called prime factorisation.

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- **Methods to find the H.C.F. of the given numbers:**

a) Listing the factors:

e.g., Find the H.C.F. of 36 and 72.

Step 1: List all the factors of the given numbers.

Factors of 36: 1, 2, 3, 4, 6, 9, 12, 18, 36

Factors of 72: 1, 2, 3, 4, 6, 8, 9, 12, 18, 24, 36, 72

Step 2: Find the common factors of the given numbers.

The common factors of 36 and 72 are 1, 2, 3, 4, 6, 9, 12, 18 and 36.

Step 3: The greatest of the common factors is the required H.C.F.

36 is the greatest of the common factors of 36 and 72

∴ 36 is the required H. C. F.

b) Prime factorisation:

e.g., Find the H. C. F. of 36 and 72.

Step 1: Express the given numbers as the product of prime numbers.

36 = 2 × 2 × 3 × 3

72 = 2 × 2 × 2 × 3 × 3

Step 2: Circle their common prime factors.

36 = 2 × 2 × 3 × 3

72 = 2 × 2 × 2 × 3 × 3

Step 3: Consider one set of the common factors and find their product.

2 × 2 × 3 × 3 = 36

Step 4: The product obtained in step 3 is the required H. C. F.

Hence, the H. C. F. of 36 and 72 is 36.

c) Division method: e.g., Find the H.C.F of 36, 72 and 144.

Step 1: Divide the larger number by the smallest number.

```
36)72(2
  -72
   0
```

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Step 2: If the remainder is not zero, divide the divisor by the remainder. Continue the procedure until the remainder obtained is 0.

If the remainder obtained is 0, divide the other given number by the divisor.

```
36)144(4
  -144
   ----
     0
```

Step 3: If the remainder is 0, the divisor is the Highest Common Factor or Greatest Common Divisor of the given numbers.

Thus, 36 is the H. C. F. (or G. C. D.) of 36, 72 and 144.

- **Methods to find the L.C.M. of the given numbers:**

a) Listing the multiples:

e.g., Find the L.C.M. of 36 and 72.

Step 1: List the first few multiples of the given numbers.

Multiples of 36: 36, 72, 108, 144, 180, 216,

Multiples of 72: 72, 144, 216, . . .

Step 2: Find the common multiples of the given numbers.

The common multiples of 36 and 72 are 72, 144, 216, . . .

Step 3: The lowest of the common multiples is the required L.C.M.

72 is the lowest of the common multiples of 36 and 72.

Hence, 72 is the required L.C.M.

b) Prime factorisation method:

e.g., Find the L.C.M. of 36 and 72.

Step 1: Express the given numbers as the product of prime numbers.

$36 = 2 \times 2 \times 3 \times 3$

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

Step 2: Circle their common prime factors.

$36 = 2 \times 2 \times 3 \times 3$

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

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Step 3: Consider one set of the common factors and find their product.

$2 \times 2 \times 3 \times 3 = 36$

Step 4: Find the product of the remaining factors (uncircled factors) and the product obtained in step 3.

$36 \times 2 = 72$

Step 5: The product obtained in step 4 is the required L.C.M.

Hence, the L.C.M. of 36 and 72 is 72.

c) Division Method:

e.g., Find the L.C.M. of 36 and 72.

Step 1: Write the given numbers separated by commas between them.

| 36, 72

Step 2: Divide the given numbers by a prime factor common to them.

2 | 36, 72
  18, 36

Note: **Start with the least prime factor common to the given numbers.**

Step 3: Continue the process until all the factors are prime.

2 | 36, 72
2 | 18, 36
3 | 9, 18
3 | 3, 6
  1, 2

Step 4: Find the product of all the prime factors obtained in step 3, which gives the required L.C.M.

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

Therefore, 72 is the L.C.M. of 36 and 72.

- L. C. M. of given numbers = Their H. C. F × The product of the prime factors left uncircled.

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Level - 1

[Each question has only one correct option]

01 **Which type of numbers have more than two factors ?**

(A) Even numbers

(B) Prime numbers

(C) Composite numbers

(D) Odd numbers

02 **Which of the following are not multiples of 2 ?**

(A) Even numbers

(B) Odd numbers

(C) Prime numbers

(D) Composite numbers

03 **Which of the following are two consecutive prime numbers that differ by 2 ?**

(A) Co-primes

(B) Twin primes

(C) Composite numbers

(D) Both (A) and (B)

04 **Identify the numbers with only as their common factor.**

(A) Co-prime numbers

(B) Twin prime numbers

(C) Composite numbers

(D) Prime numbers

05 **What is the L.C.M. of two co-prime numbers ?**

(A) Their sum

(B) Their difference

(C) Their product

(D) Their quotient

06 **Find the smallest whole number that is divisible by 10 and 12.**

(A) 40 (B) 30 (C) 12 (D) 60

07 **Find the L.C.M. of 12, 24 and 36.**

(A) 36 (B) 24

(C) 72 (D) 108

08 **Identify an example for twin primes**

(A) 5, 7 (B) 3, 5

(C) 11, 17 (D) 13, 17

09 **What are the common factors of 9 and 36 ?**

(A) 1, 3, 9 (B) 1, 4, 3, 5, 9

(C) 1, 3, 5 (D) 1, 3, 4, 9

10 **Find three common multiples of 18 and 36.**

(A) 18, 6, 9 (B) 18, 36, 6

(C) 36, 54, 72 (D) 1, 6, 18

11 **How many prime numbers are there from 50 to 100 ?**

(A) 18 (B) 12 (C) 10 (D) 20

12 **How is 20 written as the product of primes ?**

(A) 2×5 (B) $2 \times 2 \times 3 \times 5$

(C) $2 \times 2 \times 5$ (D) $2 \times 2 \times 3$

13 **Identify an example for co-prime numbers.**

(A) 25, 14 (B) 18, 16

(C) 9, 18 (D) 11, 77

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14 **What is the sum of the first five multiples of 8 ?**

(A) 90 (B) 60

(C) 30 (D) 120

15 **Find the least 4 - digit number that is divisible by 8.**

(A) 1000 (B) 1008

(C) 4000 (D) 1016

16 **How many factors does 256 have ?**

(A) 9 (B) 8

(C) 10 (D) 12

17 **Which of the following numbers has 8 as factor ?**

(A) 136 (B) 22[illegible]

(C) 842 (D) 748

18 **m is a multiple of [illegible] and [illegible] factor of 48. Find the possible value for m.**

(A) 4 (B) 32

(C) 16 (D) 40

19 **How many twin primes are there between 1 and 100 ?**

(A) 6 (B) 10 (C) 7 (D) 8

20 **What is the sum of the numbers that are multiples of 7 as well as factors of 42 ?**

(A) 84 (B) 42 (C) 14 (D) 7

21 **What is the H.C.F. of two co-prime numbers ?**

(A) 1 (B) 0

(C) 2 (D) Their product

22 **Study the numbers given in the box.**

5760	1080	720
2160		1440

Identify the number that is not a divisor of the given numbers.

(A) [illegible] (B) 24

(C) 36 (D) 12

23 **[illegible] the least common multiple of 45 and 50. What is the value of 10P + 100 ?**

(A) 4500 (B) 4600

(C) 4400 (D) 1000

24 **What is the H.C.F. of 36 and 144 ?**

(A) 36 (B) 144

(C) 4 (D) 2

25 **When a number is increased by 8, it is divisible by 35. What is the remainder when the same number is divided by 5 ?**

(A) 2 (B) 4

(C) 3 (D) 0

26 **The L.C.M. of two numbers is 10 times their H.C.F. Find the numbers.**

(A) 24, 96 (B) 16, 15

(C) 24, 480 (D) 24, 240

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27 **Find the product of all the factors of 40.**

(A) 265 × 100 (B) 256 × 10000

(C) 256 × 1000 (D) 265 × 1000

28 **How many hundreds are there in the sum of the factors of 140 ?**

(A) 300 (B) 30

(C) 336 (D) 3

29 **How many times the H.C.F. of 11, 33 and 88 is their L.C.M. ?**

(A) 11 (B) 24

(C) 22 (D) 3629

30 **Which of the following sets of numbers have the same H.C.F.?**

60		120	135
650	230	180	[illegible]
250	450	240	495
P	Q	R	S

(A) Q and R (B) P and R

(C) R and S (D) P and Q

31 **Identify the correct statement.**

(A) The L.C.M. of two primes is their product.

(B) The H.C.F. of twin primes is their product.

(C) The largest factor of a number is 1.

(D) The smallest factor of a number is the number itself.

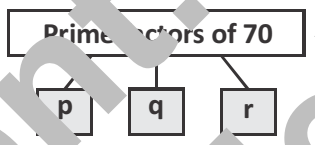
32 **The L.C.M. of 3, 6 and x is 18. What is the possible value of x ?**

(A) 36 (B) 6 (C) 18 (D) 3

33 **Given that (p + 3) is the highest common factor of 81 and 108, find the value of p.**

(A) 6 (B) 12 (C) 9 (D) 24

34 **From the given diagram, what is the value of p + q + r ?**



(A) 7 (B) 2

(C) 9 (D) 14

35 **Two toy trains start at the same time. The first one stops after every 5 seconds and the second one stops after every 4 seconds. How many times do they stop together in 1 minute ?**

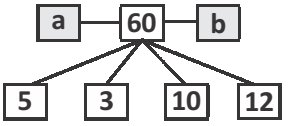
(A) 1 (B) 2 (C) 3 (D) 5

36 **1, 19, p, 29, 31, q, 41 is a list of prime numbers in ascending order. What is the value of q – p ?**

(A) 60 (B) 37

(C) 23 (D) 14

37 **The diagram shows some of the factors of 60.**



What are the possible values of a and b ?

(A) a = 2, b = 16 (B) a = 4, b = 20

(C) a = 6, b = 25 (D) a = 8, b = 30

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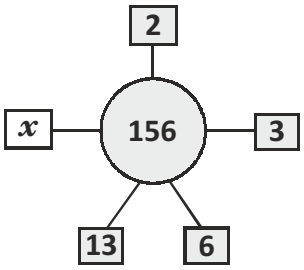
38 **The given figure shows some of the factors of 156.**

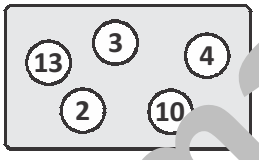


What is the value of x ?

(A) 16 (B) 8

(C) 15 (D) 39

39 **The figure given shows 5 numbers.**



Which of the 5 numbers are the prime factors of 30 ?

(A) 2 and 3 (B) 10 and 13

(C) 2 and 13 (D) 3 and 10

40 **When a number X is added to 8, the sum is divisible by 14. What could the number X be ?**

(A) 48 (B) [illegible]

(C) 78 (D) 68

41 **The quotient when a number is divided by 5 is 6. What is the quotient when the same number is divided by 30 ?**

(A) 1 (B) 100

(C) 10 (D) 1000

42 **Which of these numbers has 2, 3, and 10 as factors ?**

(A) 20709 (B) 10824

(C) 18045 (D) 20[illegible]

43 **Study the following.**

★ M is the least common multiple of 18, 24 and 40.

★ N is the highest common factor of 60, 180 and 30[illegible].

Which digit in the number 2[illegible]15N is in the thousands place ?

(A) 0 (B) 1 (C) [illegible] (D) 6

44 **A and B are two-digit numbers such that A × A × B × B = 2025. What are the respective values of A and B ?**

(A) 5 [illegible] (B) 5, 3

(C) [illegible] (D) 2, 5

45 **Observe the twin primes in the table.**

(3, 5)	(5, 7)	(11,13)	(17,19)
P	Q	R	S

Which of the given twin primes are present in the prime factorisation of 2145 ?

(A) Q and R (B) P and S

(C) P and Q (D) P and R

46 **Identify the number whose prime factorisation has three 2's, four 3's and a 5.**

(A) 3240 (B) 2430

(C) 3420 (D) 2304

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47 **Study the information given in the box.**

> ★ X is a multiple of 6.
> ★ X is a factor of 84.

What is the value of X ?

(A) 42 (B) 26

(C) 21 (D) 14

48 **P is a 2 - digit common factor of 36 and 24. Q is a number that is both a factor and multiple of 28. What is the value of P + Q ?**

(A) 24 (B) 28

(C) 12 (D) 40

49 **X is the sum of the factors of 84. Which of the following is a correct statement ?**

(A) The digit in hundreds and tens place of the sum are the same.

(B) The digit in ones place is the same as the digit in tens place.

(C) The digit in hundreds place is the same as the digit in ones place.

(D) The digit in ones place is the least.

50 **The largest number less than 100 divisible by 15 is decreased by 5. Which of these is a factor of the resultant number ?**

(A) 23 (B) 17

(C) 25 (D) 19

51 **A box had some pens in it. When the pens are distributed equally to 18 children, none remained but while distributing to 19 children 5 children got 1 pen less than the others. How many pens were there in the box ?**

(A) 70 (B) 76

(C) 80 (D) 85

52 **Aakash's age is a factor of 14. Next year his age will be a multiple of 5. How old will he be in years' time ?**

(A) 15 years (B) 21 years

(C) 14 years (D) 20 years

53 **Stamps in an album can be arranged as 12 per page or 18 per page exactly. What is the greatest number of stamps one can have if they are fewer than 500 ?**

(A) 468 (B) 540

(C) 504 (D) 432

54 **Sravan's present age is a multiple of 4. Next year, his age will be a multiple of 7. If his present age is between 30 and 50 years old, what is his age next year ?**

(A) 48 (B) 49

(C) 50 (D) 51

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Stimulating Questions

55 Last year, Kriti's age was a multiple of 7. This year, Kritis age is a multiple of 5. In how many years will Kriti be 26 years old ?

(A) 11 (B) 21

(C) 4 (D) 18

56 A certain number has exactly 3 different factors. If the second greatest factor is 7, what is the sum of the digits of the number ?

(A) 5 (B) 7

(C) 12 (D) 13

57 Of the following numbers, which has an odd number of even factors ?

(A) 4 (B) 80

(C) 100 (D) 128

58 The least common multiple of 10 and 24 plus the greatest common factor of 10 and 24 equals.

(A) [illegible] (B) 1[illegible]

(C) 241 (D) 242

59 I wrote down every whole number less than 25 that is also 1 less than a prime. How many of these numbers are multiples of 4 ?

(A) 0 (B) 1

(C) 2 (D) 3

Previous Contest Questions

[Each question has only one correct option]

60 A is the smallest 4 digit number which is a multiple of 3. P is the biggest number which when rounded off to the nearest hundred gives 9000 as the answer. Find the difference between A and P.

(A) 8047 (B) 8049

(C) 7997 (D) 7999

61 I am thinking of a prime number less than 40. When reverse its digits, I get another prime number. When I multiply these two prime numbers together, get 2701. What prime number did I think of ?

(A) 23 (B) 37

(C) 31 (D) 29

62 The LCM of two numbers is x and their HCF is y. Which option represents the product of the two numbers ?

(A) $\frac{x}{y}$ (B) $\frac{y}{x}$

(C) x + y (D) xy

63 A number is bigger than 12, but smaller than 25. It is a common multiple of 3, 4 and 6. Find the number.

(A) 12 (B) 18

(C) 24 (D) 72

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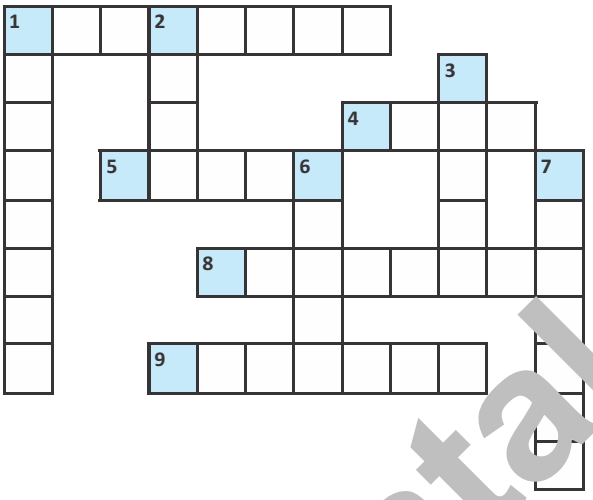
CROSSWORDS

1. Large Numbers



ACROSS

1 The place at which a 7-digit number begins.

4 The number not present in the Roman system.

5 The maximum number of times any roman number can be repeated.

8 The number of thousands when 17695 is rounded to the nearest thousand.

9 The ninth triangular number.

DOWN

1 The Hindu-Arabic numeral corresponding to the roman numeral M.

2 The place in the indian system corresponding to hundred thousands in the international system.

3 A number with 3 zeros.

6 The number of digits in a crore.

7 Number of lakhs in a crore.

2. Factors and Multiples

ACROSS

3 The factor of a number the sum of whose digits is divisible by 9.

4 The smallest factor of any number.

7 The factor of a number ending in zero.

9 The method of breaking up of composite number into their factors.

10 The highest common factor of 1 and

DOWN

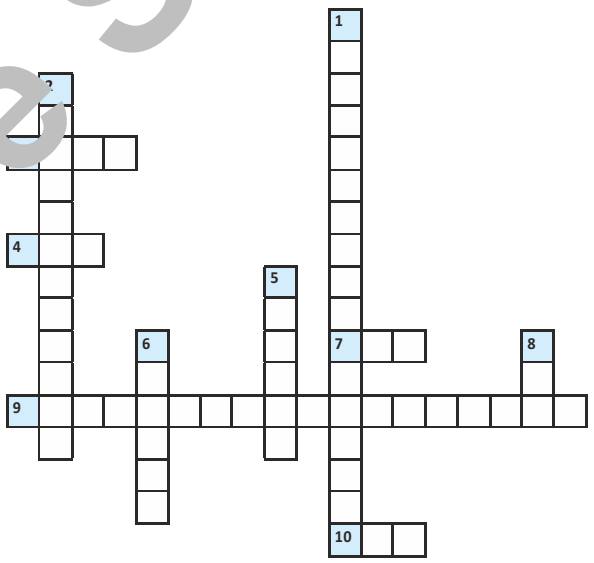
1 The rules that helps to find the numbers that divide a given number exactly.

2 The numbers (except 1), that have only two factors.

5 The lowest common multiple of 10 and 20.

6 The largest factor of 20.

8 The least prime number.



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