Preface

IFAS, one of the finest institutes of India has accumulated the General Aptitude Comprehensive Theory and Practice book. This book prominently focuses on important topics of General Aptitude in the GATE exam.

General Aptitude is an important section for the GATE exam as the weight-age of this subject is **15 marks**. It is the easiest section having **good weightage** in the GATE exam and it can help you to crack the GATE Exam. The general aptitude section can be scored easily in **GATE exam** and it is divided into two portions: **Verbal Ability and Numerical Ability**. Hence, this becomes more pertinent from the exam's point of view and can't be neglected. This book will help you crack your GATE exam and score highest in general aptitude.

There are total 29 chapters in the book, which comprises Verbal ability, logical aptitude, quantitative aptitude and spatial aptitude with each subject containing detailed explanation of the topic, solved Questions, and all questions are sorted and solved. This book contains all sorted questions from renowned exams so it will help the reader to practice questions from a particular topic at one place. This book relates the present study to its wider context, which would serve as a pedestal upon which the remaining part of the study will be built.

This book aims to investigate all the topics that will help you to qualify for the GATE exam for all subjects. It is beneficial for Masters Entrance Examinations like GATE irrespective of your subject stream.

The book has an intricate explanation of general aptitude for each topic which will give you a competitive edge and the much needed skill to ace the race of GATE exam.

Surabhi Sontakke
Souvik Pal Chaudhury

Acknowledgement

We would like to take this opportunity to thank the entire students at Institute for Advanced Studies (IFAS), who give us inspiration to build the rising pillars of tomorrow. We would like to convey our sincere gratitude to Er. Radheshyam Choudhary, Founding CEO, IfAS Edutech Pvt. Ltd. for being a continuous source of inspiration through his positive strokes.

There is a set of people whom we would like to thank for reviewing and helping us for preparing the systematic layout, your comments were invaluable in improving the text. We could not have done this without their help and passion for teaching.

Next, we would like to extend our heartfelt thanks to all the IfAS team for their hard work. With your constant support we were able to further continue our teaching, training, and especially learning the many facets of the process of building these creative questions in books.

We take pride to say that this book is a team effort, and producing it would be impossible without outstanding people of IFAS publication. It was our immense pleasure to work with many other dedicated and creative people of IFAS during the production of this book. Special thanks to Vikendra Mehta and Yogesh Raut who crafted our ideas to the wonderful design of the cover page. Aniket Waghmode for his efforts to draw all the diagrams and Sanjay Kokane, Bhagyashri Gadge for typing and Kuldeep Singh Rathore for formatting.

And finally, we appreciate everyone's significant efforts and gratitude towards those who are unmentioned.

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Souvik Pal Chaudhury

GATE 2022 Exam Pattern

Particulars	Details
Examination Mode	Computer Based Test (Online)
Duration	3 Hours
Number of Papers in GATE 2022	29 Papers
Section	General Aptitude (GA) Candidate Selected Subject
Type of Questions	Multiple Choice Questions (MCQs) Multiple Select Questions (MSQs) Numerical Answer Type (NAT) Questions
Design of Questions	The questions are designed to test the listed abilities Application Analysis Comprehension Recall Synthesis
Number of Questions	65 Questions (including 10 questions from General Aptitude)
Distribution of Questions in all Papers except AR, CY, EY, GG, MA, PH and XL	Engineering Mathematics - 13 Marks Subject Questions - 72 Marks General Aptitude - 15 Marks
Distribution of Questions in AR, CY, EY, GG, MA, PH, XH and XL	Questions from Subject Concerned - 85 Marks General Aptitude - 15 Marks
Total Marks	100 Marks
Marking Scheme	All of the questions will be worth 1 or 2 marks
Negative Marking	Two types of MCQs: MCQs - 1 mark for each correct answer; 1/3 mark will be deducted for every wrong answer. MCQs - 2 marks for each correct answer; 2/3 mark will be deducted for every incorrect response. There are no negative marking for Numerical Answer Type (NAT) questions NO negative marking for MSQ & NAT.

GATE 2022 Exam Pattern - Marking Scheme

GATE Paper Code	General Aptitude (GA) Marks	Subject Marks	Total Marks	Total Time (Minutes)
AE, AG, BM, BT, CE, CH, CS, CY, EC, EE, ES, EY, IN, MA, ME, MN, MT, NM, PE, PH, PI, TF, ST	15	85	100	180
AR [Part A + Part B (B1: Architecture or B2: Planning)]	15	60 + 25	100	180
GE [Part A + Part B (Section I or Section II)	15	55 + 30	100	180
GG [Part A + Part B (Section 1: Geology or Section 2: Geophysics)]	15	25 + 60	100	180
XE (Section A + Any TWO Sections)	15	15 + (2 x 35)	100	180
XH (Section B1 + Any ONE Section)	15	25 + 60	100	180
XL (Section P + Any TWO Sections)	15	25 + (2 x 30)	100	180

Paper Code	Paper GATE 2022
AE	Aerospace Engineering
AG	Agricultural Engineering
AR	Architecture and Planning
BT	Biotechnology
BM	Biomedical Engineering
CE	Civil Engineering
CH	Chemical Engineering
CS	Computer Sc. and Information Technology
CY	Chemistry
EC	Electronics and Communication Engg.
EE	Electrical Engineering
ES	Environmental Science and Engineering
EY	Ecology and Evolution
GG	Geology and Geophysics
IN	Instrumentation Engineering
MA	Mathematics
ME	Mechanical Engineering
MN	Mining Engineering
MT	Metallurgical Engineering
PE	Petroleum Engineering
GE	Geomatics Engineering (New)
NM	Naval Architecture and Marine Engineering (New)
PH	Physics
PI	Production and Industrial Engineering
ST	Statistics
TF	Textile Engineering and Fibre Science
XE-A	Engineering Mathematics
XE-B	Fluid Mechanics
XE-C	Materials Science
XE-D	Solid Mechanics
XE-E	Thermodynamics
XE-F	Polymer Science and Engineering
XE-G	Food Technology
XE-H	Atmospheric and Oceanic Sciences
XH-B1	Reasoning and Comprehension
XH-C1	Economics
XH-C2	English
XH-C3	Linguistics
XH-C4	Philosophy
XH-C5	Psychology
XH-C6	Sociology
XL-P	Chemistry
XL-Q	Biochemistry
XL-R	Botany
XL-S	Microbiology
XL-T	Zoology
XL-U	Food Technology

Why GATE Exam is Important

The purpose of the GATE exam is to test students' knowledge and understanding of their **basic** engineering **and science subjects. Every year thousands of engineering graduates leave engineering schools and universities. In today's** competitive **landscape, measuring** and **testing** the **quality** of engineering students is **only possible** through the GATE exam.

There is a **misunderstanding** among students that the GATE is only for ME. **/M.Tech,** which **ultimately only leads** to a teaching career. **However, this** is not correct. **The candidate's GATE** score is also used by **various Public Enterprises (PSUs)** (i.e., **state-owned** companies **such as Indian** Oil, GAIL, and Hindustan **Petroleum,** etc.) for CSIR **scholarship programs and fellowships at** ME **/ M.Tech** and many more.

- To pursue M.E./ M.Tech./ M.Sc programs in any of the leading institutes in the country
- Master's degree leads to specialization and cultivates and brings out best of your interest in a certain area which may lead to research / Ph.D.,
- More domain specific companies recruit through campus recruitment in leading Institutes.
- Higher salaries are offered for post graduate student when compared to a graduate
- A Masters degree is a must for those wishing to apply for Faculty/Research positions in educational institutes and most of the R&D centers.
- Scholarship of Rs 8000/- is paid during masters course; so no dependency to parents for financial needs.
- GATE qualified candidates are also eligible for the award of Junior Research Fellowship in CSIR Laboratories and CSIR sponsored projects.
- More than 37 PSUs (Public Sector Undertakings-government organizations), like BARC, IOCL etc. prescribe GATE qualification as a requirement.
- Based on the GATE score, some of the foreign universities (Like NTU, Singapore) offer Ph.D. positions without any GRE score.
- Most importantly to get to be a part of any nationally reputed Educational Institute and enjoy learning and research in the conducive ambience.
- One gets intellectual satisfaction from working in the area of interest.
- Last but not the least, Fellowship Program in management (FPM)

Enrolment through GATE score card.

Stipend of 22,000- 30,000

Preparation Ideas for GA Section in Gate Exam.

The General Aptitude section accounts for 15 marks and consists of 10 questions. Of these, 5 questions carry1 mark each while the other 5 questions fetch you 2 marks each.

The test is broadly classified under two heads; Verbal and Numerical Ability.

Part 1: Verbal Ability: This consists of English Grammar, Verbal Analogies Sentence Completion, Word Groups, Critical Reasoning, Instructions and Verbal Deduction.

Part 2: Numerical Ability: This comprises Numerical Reasoning, Numerical Computation, Numerical Estimation and Data Interpretation.

Tips for Excellence in GA

General aptitude is the easiest section of the GATE test to achieve, but it is important to brush up on the basics and prepare in advance.

Refer to your Class X grammar book (CBSE / NCERT) to improve your grammar skills.

Learn 10 new words and use them every day to improve your vocabulary.

Once a week, practice reading a short passage and try to describe it in a few points; this will help you with reading and understanding.

Try to solve language puzzles and analogies every day.

Since the Number Skills section focuses on approximation skills, practice calculating without a calculator and increase your speed.

Study all the mathematical basics from your textbooks for class X.

Practice sample papers / papers from previous years together with your specialist paper so that you feel comfortable when you answer and rethink from one format to another. This will also help you understand the patterns and style of the questions.

GA| General Aptitude

Verbal Aptitude

Basic English grammar: tenses, articles, adjectives, prepositions, conjunctions, verb-noun agreement, and other parts of speech Basic vocabulary: words, idioms, and phrases in context Reading and comprehension Narrative sequencing

Quantitative Aptitude

Data interpretation: data graphs (bar graphs, pie charts, and other graphs representing data), 2- and 3-dimensional plots, maps, and tables Numerical computation and estimation: ratios, percentages, powers, exponents and logarithms, permutations and combinations, and series Mensuration and geometry Elementary statistics and probability

Analytical Aptitude

Logic: deduction and induction, Analogy, Numerical relations and reasoning

Spatial Aptitude

Transformation of shapes: translation, rotation, scaling, mirroring, assembling, and grouping Paper folding, cutting, and patterns in 2 and 3 dimensions

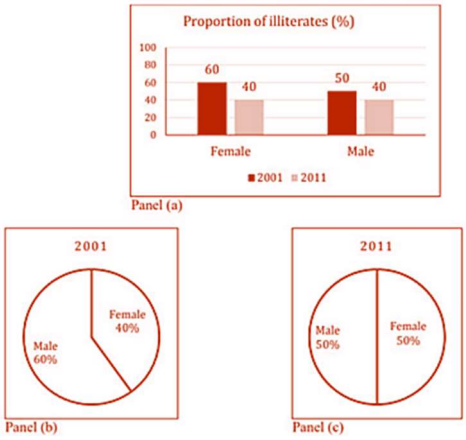
Sample Questions

Verbal Aptitude:

1. Out of the following four sentences, select the most suitable sentence with respect to grammar and usage.
   (A) I will not leave the place until the minister does not meet me.
   (B) I will not leave the place until the minister doesn't meet me.
   (C) I will not leave the place until the minister meet me.
   (D) I will not leave the place until the minister meets me.
   ANSWER: D
2. Indian currency notes show the denomination indicated in at least seventeen languages. If this is not an indication of the nation's diversity, nothing else is. Which of the following can be logically inferred from the above sentences?
   (A) India is a country of exactly seventeen languages.
   (B) Linguistic pluralism is the only indicator of a nation's diversity.
   (C) Indian currency notes have sufficient space for all the Indian languages.
   (D) Linguistic pluralism is strong evidence of India's diversity.
   ANSWER: D
3. The unruly crowd demanded that the accused be _____ without trial.
   (A) hanged (B) hanging
   (C) hankering (D) hung
   ANSWER: A
4. Archimedes said, "Give me a lever long enough and a fulcrum on which to place it, and I will move the world." The sentence above is an example of a _____ statement.
   (A) figurative (B) collateral
   (C) literal (D) figurine
   ANSWER: A

Quantitative Aptitude:

5. The bar graph in Panel (a) shows the proportion of male and female illiterates in 2001 and 2011. The proportions of males and females in 2001 and 2011 are given in panel (b) and (c) respectively. The total population did not change during this period. The percentage increase in the total number of literates from 2001 to 2011 is --------



   (A) 30.43 (B) 33.43
   (C) 34.43 (D) 35.43
   ANSWER: A
6. If pqr ≠ 0 and $p^{-x=\frac{1}{q}}q^{-y=\frac{1}{r}}r^{-z=\frac{1}{p}}$, what is the value of the product xyz?
   (A) -1 (B) $\frac{1}{pqr}$
   (C) 1 (D) pqr
   ANSWER: C
7. An e-mail password must contain three characters. The password has to contain one numeral from 0 to 9, one upper case and one lower case character from the English Alphabet. How many distinct passwords are possible?
   (A) 6,760 (B) 13,520
   (C) 40,560 (D) 1,05,456
   ANSWER: C

8. The area of a square is d. What is the area of the circle which has the diagonal of the square as its diameter?

(A) πd (B) πd^2

(C) $\frac{\pi d^2}{4}$ (D) $\frac{1}{2}\pi d$

ANSWER: D

Analytical Aptitude:

9. Computers were invented for performing only high-end useful computations. However, it is no understatement that they have taken over our world today. The internet, for example, is ubiquitous. Many believe that the internet itself is an unintended consequence of the original invention. With the advent of mobile computing on our phones, a whole new dimension is now enabled. One is left wondering if all these developments are good or, more importantly, required. Which of the statement(s) below is/are logically valid and can be inferred from the above paragraph?

(i) The author believes that computers are not good for us.

(ii) Mobile computers and the internet are both intended inventions.

(A) (i) only (B) (ii) only

(C) both (i) and (ii) (D) neither (i) nor (ii)

Answer D

10. Some students were not involved in the strike

If the above statement is true, which of the following conclusions is/are logically necessary?

(i) Some who were involved in the strike were students.

(ii) No student was involved in the strike

(iii) At least one student was involved in the strike

(iv) Some who were not involved in the strike were students.

(A) (i) and (ii) (B) (iii)

(C) (iv) (D) (ii) and (iii)

Answer C.

Spatial Aptitude:

11. A rectangular sheet of length 6cm and breadth 4cm is coiled to form an open cylinder (say, P) such that the breadth sides meet. The same sheet can also be coiled to form a cylinder (say, Q) such that the length sides meet. Which one of the following statements is FALSE?

(A) Surface area of the open cylinders P and Q are equal.

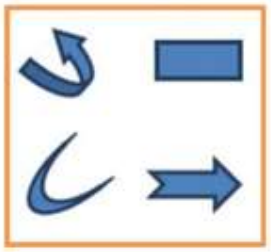
(B) Volume of P and Volume of Q are equal.

(C) Volume of P is greater than that of Q.

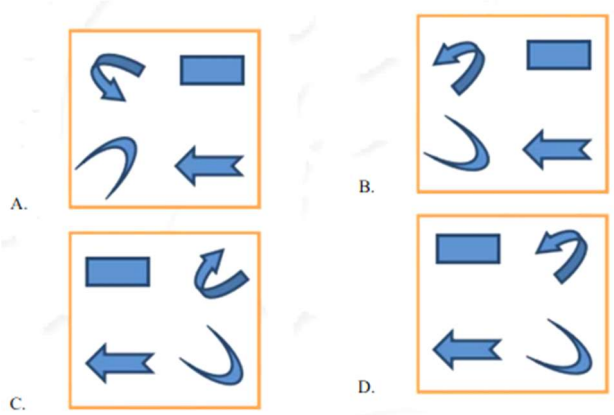
(D) The height of cylinder Q is greater than that of P.

Answer: B

12.



Which one of the following closely resembles the mirror image of the above figure?



Answer: C

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SECTION – I

QUANTITATIVE APTITUDE

CHAPTER 1

NUMERICAL ABILITY

-: Gate - General Aptitude:-

A number is an arithmetical value, expressed by a symbol or word, representing a particular quantity or amount and used in counting and making calculations.

1.1 Different Types of Numbers

1.1.1 Natural Numbers

The counting numbers are called natural numbers. Natural numbers do not include 0 or any negative numbers.

Example: 1, 2, 3, 4… are all-natural numbers.

1.1.2 Whole Numbers

All counting numbers and 0 (zero) together form the set of whole numbers. They do not include negative numbers.

Example: 0, 1, 2, 3, 4… are whole numbers.

1.1.3 Integers

All counting numbers including 0 and the negatives of the counting numbers form the set of integers.

Example: -3, -2, -1, 0, 1, 2, 3… are all integers.

Set of positive integers = {1, 2, 3, 4, 5, 6…}

Set of negative integers = {-1, -2, -3, -4, -5, -6…}

Set of non-negative integers = {0, 1, 2, 3, 4, 5, 6…}

1.1.4 Even Numbers and Odd Numbers

An integer which is exactly divisible by 2 is called an even number. While an integer which cannot be exactly divisible by 2 is called an odd number.

Example: -6, -4, -2, 0, 2, 4, 6, 8, 10… are all **even numbers**.

Zero is considered an even number.

While an integer which cannot be exactly divisible by 2 is called an odd number.

Example: -5, -3, -1, 1, 3, 5, 7, 9, 11… are all **odd numbers**.

1.1.5 Prime Numbers

A natural number other than 1 is a **prime number** if it is divisible by 1 and itself only.

Example: 2, 3, 5, 7, 11, 13, 17, 19, 23, 29, 31, 37, 41, 43 and 47 are the prime numbers less than 50.

Test to find whether a given number is a prime:

Step 1:

Select a least positive integer n such that n^2> given number

Step 2:

Test the divisibility of a given number by every prime number less than n.

Step 3:

The given number is prime only if it is not divisible by any of these primes.

Example: Check whether 571 is a prime number

Since $(23)^2 = 529 < 571$ and $(24)^2 = 576 > 571$

So, n = 24

Prime numbers less than 24 are 2, 3, 5, 7, 11, 13, 17, 19, 23.

Since 571 is not divisible by any of these primes, therefore 571 is a prime number.

Example: Check whether 923 is a prime number.

Since $30^2 = 900 < 923$ and $31^2 = 961 > 923$

So, n = 31

Prime numbers less than 31 are 2, 3, 5, 7, 11, 13, 17, 19, 23, 29

Since 923 is divisible by 13, 923 is not a prime number

1.1.6 Composite Numbers

Natural numbers greater than 1 which are not prime are known as **composite numbers**.

Example: 9 can be divided by 3 (as well as 1 and 9), so 9 is a composite number similarly 12 can be divided by 2, 3, 4 and 6, so it is also a composite number.

Note:

1. The number 1 is neither a prime number nor a composite number.
2. The number 2 is the only even number which is prime

1.1.7 Rational Numbers

A rational number is a number that can be represented as a ratio or fraction in which both the numerator and the denominator are whole numbers.

The number 18 can be said to a rational number because it can be written as the fraction $\frac{18}{1}$.

Likewise, ¾ is also a rational number because it can be written as a fraction.

Every whole number is a rational number, because any whole number can be written as a fraction.

1.1.8 Irrational Numbers

Any number that is not rational is considered as an irrational number. An irrational number can be written as a decimal, but not as a fraction.

An irrational number has endless non-repeating digits to the right of the decimal point.

Some important examples of irrational numbers include:

π = 3.141592…

$\sqrt{2}$ = 1.414213…

Although irrational numbers are not often used in daily life, they do exist on the number line. In fact, between 0 and 1 on the number line, there are an infinite number of irrational numbers

1.1.9 Decimal Numbers

Not every number we face is a whole number. Our decimal system allows us a flexibility in writing the numbers of different values and sizes, using a symbol called the decimal point.

Example: 32.567, 12.87 23.64

As we move right from the decimal point, each place value is divided by 10. While on moving to the left side from the decimal point each place value is multiplied by 10.

1.1.10 Perfect Number:

A perfect number is a natural number, which when you add up all of the factors less than that number will give you that number.

Example: The factors of 28 are 1, 2, 4, 7, and 14.

1 + 2 + 4 + 7 + 14 = 28.

Thus, 28 is a perfect number.

1.1.11 Perfect Square:

A perfect square is a number that can be written as the product of two equal factors.

Example: 25, 36, 49, 64… are all perfect squares.

Important properties of perfect squares:

I. No perfect square ends with 2, 3, 7, 8.

II. No perfect square ends with an odd number of zeros.

III. Perfect squares can be recognized by the fact that all of their prime factors have even multiplicities.

1.1.12 Fractions:

A fraction is used to represent a part of a whole or any number of equal parts. A fraction (examples: 5/11 and 3/7) consists of an integer numerator, displayed above a line, and a non-zero integer denominator, displayed below that line.

Proper Fraction:

A fraction whose numerator is less than the denominator. The value of such fractions is usually less than 1.

Example $\frac{1}{4}, \frac{2}{7}, \frac{17}{20}$.

Improper Fraction:

A fraction whose numerator is equal to or greater than the denominator.

The value of such fractions is usually more than 1.

E.g. $\frac{5}{3}, \frac{10}{7}, \frac{40}{19}$.

Mixed Fraction:

An improper fraction (fractions having denominator smaller than numerator) can be expressed as a whole number and a proper fraction. Such fractions are then called mixed fraction.

Steps involved in conversion of improper fraction to mixed fraction

Step 1: Divide the numerator by the denominator.

Step 2: Write down the Quotient (whole number) of the division followed by the fraction having the remainder above the denominator.

Example $5\frac{1}{4}, 3\frac{7}{8}, 22\frac{3}{17}$.

Factorization:

The prime numbers that divide an integer exactly are termed as the prime factors of that Integer.

The factorization of a positive integer is the process of listing of the integer's prime factors, together with their multiplicities.

Example 1: Prime factors of 420 $= 2 \times 2 \times 3 \times 5 \times 7$

$= 2^2 \times 3^1 \times 5^1 \times 7^1$

Where, 2, 3, 5 and 7 are factors having multiplicities 2, 1, 1 and 1 respectively.

Example2: Prime factorization of 900 = $2^2 \times 3^2 \times 5^2$

in which multiplicities of the factors 2, 3, 5 are 2, 2, 2 respectively, which are all even. Thus 900 is a perfect square.

IV. Perfect square (unit digit- 0, 1, 4, 5, 6, 9)

Unit's digit	0	1	4	5	6	9
Ten's digit	0	even	even	2	odd	even

1.2 Factors and Multiples

If a number, say, 'x' exactly divides another number 'y', we can say that 'x' is a factor of 'y'. Further, 'y' is called a multiple of 'x'.

For example, 4 is a common factor of 8 and 12.

Example 1: If A and B are two natural numbers such that A *x* B = 84, which of the following cannot be the value of A + B?

(1) 21 (2) 25

(3) 45 (4) 85

Explanation:

Checking only the given answer options,

12 x 7 = 84, 12+7 = 21

21 x 4 = 84, 21+4 = 25

84 x 1 = 84, 84+1 = 85

42 x 2 = 84, 42+2 = 44

Since A and B are natural numbers and we can get 44 by addition of a particular set of values, there can be no way of getting 45 by using natural number for A and B.

Therefore, 45 is the number which cannot be obtained in the above question i.e. option (3)

Answer (3)

1.2.1 GCD - Greatest Common Divisor (Highest Common Factor (HCF)):

The GCD or HCF of two or more than two numbers is the greatest number that divides each one of them exactly.

For example, 6 is the highest common factor of 12, 18 and 24.

Method for finding the GCD of two or more numbers:

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

Step 2: Choose common factors.

Step 3: Find the product of these common factors. This is the required H.C.F. of given numbers.

Example: Find the GCD of 360 and 240?

Prime factors of 360 = 2 × 2 × 2 × 3 × 3 × 5 = $2^3 3^2 5^1$

Prime factors of 240 = 2 × 2 × 2 × 2 × 3 x 5 = $2^4 3^1 5^1$

Prime factors common to 360 and 240= 2 × 2 × 2 × 3 x 5 = 120.

So, the GCD/HCF of 360 and 240 is 120.

1.2.2 Least Common Multiple (LCM):

The LCM of two or more given numbers is the smallest number which is exactly divisible by each one of them.

Method of finding LCM of two or more numbers:

Step 1: Resolve each given number into prime factors.

Step 2: Take out all factors with highest powers that occur in given numbers.

Step 3: Find the product of these factors. This product will be the L.C.M.

Example: Find LCM of 360 and 240

Prime factors of 360 = 2 × 2 × 2 × 3 × 3 × 5 = $2^3 3^2 5^1$.

Prime factors of 240 = 2 × 2 × 2 × 2 x 3 × 5 = $2^4 3^1 5^1$.

Product of highest powers of all prime factors of 360 and 240 = 2^4 x 3^2 × 5^1 = 720.

Thus, the LCM of 360 and 240 is 720.

Important Properties of GCD and LCM

i) Product of two numbers = LCM of the numbers × HCF of the numbers

ii) HCF or GCD of given numbers always divides their LCM

iii) HCF or GCD of given fractions = $\frac{GCD\ of\ Numerators}{LCM\ of\ Denominator}$

iv) LCM of given fractions = $\frac{LCM\ of\ Numerators}{GCD\ of\ Denominator}$

Example 2: The GCD of two numbers is 2 and their LCM is 42. If one of the numbers is 6, find the other number?

(1) 12 (2) 13

(3) 14 (4) 16

Explanation:

Let another number be *y*.

We know that, Product of two numbers = Product of their GCD and LCM

i.e. $6 \times y = 2 \times 42$

i.e. $y = \frac{(2 \times 42)}{6}$

i.e. $y = 14$

Answer (3)

Example 3: Find the H.C.F of 108, 360 and 600.

(1) 12 (2) 13

(3) 14 (4) 15

Explanation:

Upon prime factorization of the given numbers,

108 = 2^2 x 3^3,

360 = (2^3 x 3^2 x 5)

600 = (2^3 x 5^2 x 3)

Taking out the common factors, we can say,

H.C.F = (2^2 x 3)

= (4 x 3)

= 12

Answer (1)

1.3 'BODMAS' Rule

This rule depicts the correct sequence in which the operations are to be executed, so as to find out the value of the given expression.

Here B - Bracket,
O - of,
D - Division,
M - Multiplication,
A - Addition and
S – Subtraction

Thus, in simplifying an expression, first of all the brackets must be removed, strictly in the order (), {} and ||.

After removing the brackets, we must use the following operations strictly in the order: (i) Division (ii) Multiplication (iii) Addition (iv) Subtraction.

Example 4: What will be the value of (48 - 12) ÷ 4 + 6 ÷ 2 × 3?

(1) 18 (2) 9/4

(3) 24 (4) 4.5

Explanation:

(48 - 12) ÷ 4 + 6 ÷ 2 × 3

= 36 ÷ 4 + 6 ÷ 2 × 3 (Solving Bracket)

= 9 + 3 × 3 (Solving Division)

= 9 + 9 (Solving Multiplication)

= 18 (Solving Addition)

Answer (1)

1.4 Test For Divisibility

- A number is **divisible by 2** if its last digit is 0 or divisible by 2 (i.e. 0,2,4,6 or 8).
  Example – 48, 786, 987654 are divisible by 2
- A number is **divisible by 3** if the sum of its digits is divisible by 3.
  Example: 534: 5+3+4=12 and 1+2=3 so 534 is divisible by 3.
- A number is **divisible by 4** if the last two digits of the number are divisible by 4 or both are 0.
  Example – 4224 is divisible by 4 since 24 (last two digits are divisible by 4)
- A number is **divisible by 5** if the last digit is 5 or 0.
  Example – 555, 8870, 745 are divisible by 5
- A number is **divisible by 6** if the number is divisible by both 2 and 3.
  Example –36, 90, 216 are divisible by 2 since they are even and also by 3 (applying divisibility test for 3), therefore this numbers should be divisible by 6.
- A number is **divisible by 7** if the number follows the given condition –
  Double the last digit and subtract it from the remaining leading truncated number. If the result is divisible by 7, then so was the original number.
  Example – Whether 357 is divisible by 7 or not can be checked by taking the unit digit 7, double it to 14, and then subtract it from 35, then 35 – 14 = 21, which is divisible by 7. Therefore, 357 is divisible by 7.
- A number is **divisible by 8** if the number formed by the last three digits is divisible by 8.
  Example – 376, 67192, 1225448 are divisible by 8.
- A number is **divisible by 9** if the sum of the digits is divisible by 9.
  Example – 459, 1242, 6732 are divisible by since their addition is divisible by 9.
- A number is **divisible by 10** if it ends in a 0.
  Example – 340, 5670, 10000 are divisible by 10.
- A number is **divisible by 11** if the difference of the sum of the digits in the even and odd positions gives us a number which is either 0 or divisible by 11.
  Example – 572 is divisible by 11,
  Sum of digits in the even positions (i.e.2^{nd} position) = 7
  Sum of digits in the odd positions (i.e.1^{st} and 3^{rd} position) = 5 + 2 = 7
  Difference = 7 -7 = 0, which is divisible by 11.
  There is an **alternative method for testing the divisibility by 11**.
  Subtract the last digit from the remaining leading truncated number. If the result is divisible by 11, then so was the first number. Apply this rule over and over again as necessary.
  Example – 19151→ 1915-1 =1914 →191-4=187
  →18-7=11,
  so yes, 19151 is divisible by 11
- A number is divisible by 12 if the number is divisible by 2, 3 and 4 as well.
  Example – 108 is divisible by 2(since its even), divisible by 3(since addition of the digits is 9), divisible by 4(since 08 is divisible by 4) and therefore divisible by 12.
- A number is divisible by 13 if it follows the following condition- Add four times the last digit to the remaining leading truncated number. If the result is divisible by 13, then so was the first number. Apply this rule over and over again as necessary.
  Example–50661-->5066+4=5070-->507+0=507-->
  50+28=78 and 78 is 6×13, so 50661 is divisible by 13.

Example 5: The number 333,333,333,333 is divisible by

(1) 9 and 11 (2) 3 and 11

(3) 3 and 9 (4) 3, 9 and 11

Explanation:

The addition of the digits in the number is 36 which is divisible by 3 as well as 9 therefore the number must be divisible by both 3 and 9.

Let us check the divisibility test for 11,

So, the addition of the digits at even places will be

3 +3 +3 +3 +3 +3 = 18,

While the addition of the digits at odd places will be 3 +3 +3 +3 +3 +3 = 18

So, 18-18 = 0, therefore according to the divisibility test of 11, the number should be divisible by 11 as well.

Answer (4)

1.5 Modulus of a Real Number:

Modulus of a real number x is defined as:

$$|x| = \begin{cases} -x, & x < 0 \\ x, & x \geq 0 \end{cases}$$

Thus, |5| = 5 and |-5| = -(-5) = 5.

1.6 Laws of Exponents:

$\boldsymbol{X^a}$: When '*X*' is a natural number, then $\boldsymbol{X^a}$stands for the product of '*a*' factors each equal to '*X*'.

- $\left(\frac{x}{y}\right)^a = \frac{x^a}{y^a}$
- $x^0 = 1$
- $x^{-a} = \frac{1}{x^a}$
- $x^{\frac{1}{a}} = \sqrt[a]{x}$
- For any natural numbers a, b, c, d, $a^b > a^c > a^d$, if and only if $b > c > d$.
- For three positive real numbers 'a','b','c' with the same positive valued exponent x, $a^x > b^x > c^x$if and only if $a > b > c$.

1.7 Properties of Exponents:

- $x^a \times x^b = x^{a+b}$
- $\frac{x^a}{x^b} = x^{a-b}$
- $(x^a)^b = x^{ab}$
- $(xy)^a = x^a.y^a$.

Example 6

$(32)^{2.6}$ x $(32)^{?} = 32^8$

(1) 2.9 (2) 2.75

(3) 4.5 (4) 5.4

Explanation:

$(32)^{2.6}$ x $(32)^{?} = 32^8$

$(32)^{?} = \frac{32^8}{32^{2.6}}$

$(32)^{?} = 32^{8-2.6}$ (since the numbers (roots) of the power are same)

$(32)^{?} = 32^{5.4}$

Answer (4)

Some Important Expansion Formulae:

i) $(x + y)(x - y) = (x^2 - y^2)$

ii) $(x + y)^2 = (x^2 + y^2 + 2xy)$

iii) $(x - y)^2 = (x^2 + y^2 - 2xy)$

iv) $(x + y + z)^2 = x^2 + y^2 + z^2 + 2(xy + yz + zx)$

v) $(x^3 + y^3) = (x + y)(x^2 - xy + y^2)$

vi) $(x^3 - y^3) = (x - y)(x^2 + xy + y^2)$

vii) $(x^3 + y^3 + z^3 - 3xyz) = (x + y + z)(x^2 + y^2 + z^2 - xy - yz - xz)$

viii) When $x + y + z = 0$, then $x^3 + y^3 + z^3 = 3xyz$.

1.8 Logarithm Functions

If b is any number such that b>0 and b≠1 and x>0 then,

$y=\log_b x$ is equivalent to $b^y = x$

We usually read this as "log base b of x".

In this definition $y=\log_b x$ is called the **logarithm form** and $b^y = x$ is called the **exponential form**.

Properties of Logarithms

1. $\log_b(xy)=\log_b(x)+\log_b(y)$
2. $\log_b(\frac{x}{y}) = \log_b(x) - \log_b(y)$
3. $\log_b(x^r) = r\ \log_b(x)$
4. If $\log_b(x) = \log_b(y), then\ x = y$

1.9 Quadratic Equation

A quadratic equation is an equation of the form $f(x) = ax^2 + bx + c$, where a, b, c are all real and a≠0, and x is an unknown variable.

The values of x satisfying $f(x) = 0$ are called its roots.

- In $ax^2 + bx + c = 0$, the expression $D = b^2 - 4ac$ is called discriminant.
- Let α, β be the roots of the equation, $ax^2 + bx + c = 0$. Then

Sum of roots= $\boldsymbol{\alpha + \beta = \frac{-b}{a}}$

Product of roots= $\boldsymbol{\alpha\beta = \frac{c}{a}}$

- When the roots of quadratic equation are given, the quadratic equation is given by x^2 −(Sum of roots) x + Product of roots= 0

Nature of the roots of $ax^2 + bx + c = 0$

Let $D = b^2 - 4ac$ be the discriminant of the given equation and the nature of two roots depends on this discriminant as follows:

1. **Real and equal if $D = 0$**
2. **Real, unequal and rational, when $D > 0$ and D is a perfect square.**
3. **Real, unequal and irrational, when $D > 0$ but D is not a perfect square**
4. **Imaginary, if $D < 0$**

Example 7: While solving a problem that reduces to a quadratic equation one student makes a mistake only in the constant term of the equation and obtains 8 and 2 for the roots. Another student makes a mistake only in the coefficient of the first-degree term and finds -9 and -1 for the roots. The correct equation was:

(1) $x^2 - 10x + 9 = 0$ (2) $x^2 + 10x + 9 = 0$

(3) $x^2 - 10x + 16 = 0$ (4) $x^2 - 8x - 9 = 0$

Explanation:

For a general quadratic equation, $px^2 + qx + r = 0$,

Sum of roots = $-\frac{q}{p}$,

Product of roots = $\frac{r}{p}$

Here $x^2 + ax + b = 0$

So, $p = 1, q = a, r = b$.

Thus, sum of roots = -a

Product of roots = b

First student took the wrong value of b, but the correct value of a. Therefore, the sum of roots is correct.

Thus, sum of the roots (-a) = 8 + 2 = 10

So, -a = 10

a = -10

Another student took a wrong value of a, but correct value of b.

Therefore, the products of roots are correct.

Thus, product of roots (b) = -9 x -1 = 9

b = 9

Thus, the correct values of a and b are -10 and 9

Therefore, the correct equation becomes $x^2 - 10x + 9 = 0$

Answer (1)

1.10 Power Cycle of Number:

When we multiply any two numbers having more than one digit, the last digit of the product is the result of the last digit of the product of the last digit of the two numbers.

For example, 332 × 332 =110224, the last digit of this product can be simply obtained by multiplying 2 × 2 = 4 and taking the last digit of that product, i.e., 4 itself.

The last digit of a number x^y forms an order which depends on the unit (last) digit of the number (x) and the power of the number i.e. (y).

This order which is followed by a particular number is the power cycle of that number.

Example – The power cycle of 3:

$3^1 = \mathbf{3}$, $3^5 = 24\mathbf{3}$, $3^9 = 1968\mathbf{3}$,

$3^2 = \mathbf{9}$, $3^6 = 72\mathbf{9}$, $3^{10} = 5904\mathbf{9}$,

$3^3 = 2\mathbf{7}$, $3^7 = 218\mathbf{7}$, $3^{11} = 17714\mathbf{7}$,

$3^4 = 8\mathbf{1}$, $3^8 = 656\mathbf{1}$, $3^{12} = 53144\mathbf{1}$

Notice that the unit digit gets repeated after every 4th power of 3.

Therefore, it is said that 3 has a power cycle of 3, 9, 7, 1 with frequency 4.

All the numbers having 3 at their unit place will have the power cycle and its frequency is the same as 3.

The power cycle of the digits from 0-9 is given below:

Last Digit	Power Cycle	Frequency
0	0	1
1	1	1
2	2, 4, 8, 6	4
3	3, 9, 7, 1	4
4	4, 6	2
5	5	1
6	6	1
7	7, 9, 3, 1	4
8	8, 4, 2, 6	4
9	9, 1	2

Power cycle of any given number can be estimated by knowing the power cycle of these 9 digits.

Example 8: What is the last digit of 38^{38}?

(a) 2 (b) 4

(c) 6 (d) 8

Explanation:

The unit place digit of 38 is 8. From the above table we know that power cycle of 8 is {8, 4, 2, 6} with the frequency of 4.

That is, $8^1 = 8$,

$8^2 = 64$,

$8^3 = 512$,

$8^4 = 4096$ and so on.

Since the power of 38 is 38, we can directly divide 38 by 4 and get remainder as 2 which means the last digit of the number we get after raising the power to 38 is same as the last digit of power 2 and i.e.4

Answer (2)

Example 9: What is the last digit of 63^{121}?

(1) 1 (2) 3

(3) 7 (4) 9

Explanation:

To obtain the last digit of 63^2, 63^3… multiply the last digits i.e., 3×3, 9×3, 7×3 etc.

Hence, the last digit is given by,

For 63^1, Last digit = 3, i.e.3

For 63^2, Last digit = 3 × 3 = 9, i.e., 9

For 63^3, Last digit = 9 × 3 = 27, i.e., 7

For 63^4, Last digit = 7 × 3 = 21, i.e., 1.

For 63^5, Last digit = 1 × 3 = 3, i.e., 3

For 63^6, Last digit = 3 × 3 = 9, i.e., 9

For 63^7, Last digit = 9 × 3 = 27, i.e., 7

For 63^8, Last digit = 7 × 3 = 21, i.e., 1.

Clearly, we can observe that the unit digit gets repeated after every 4th power of 3.

Hence, we can say that 3 has a power cycle of 3, 9, 7, 1, with frequency 4.

Therefore, for powers, 1, 5, 9, 13… the last digit will be 3.

For powers, 2, 6, 10, 14…., the last digit will be 9.

For powers, 3, 7, 11, 15…., the last digit will be 7.

For powers, 4, 8, 12, 16…., the last digit will be 1.

In the question, the power is 121.

We have to check, in which series does 121 come.

121 is a number that gives a remainder 1 when divided by 4.

Therefore, 121 is in the series 1, 5, 9, 13, …

Hence, the last digit is 3.

Answer (2)

Example 10: When 2^{33} is divided by 10, the remainder will be

(1) 2 (2) 3

(3) 4 (4) 8

Explanation:

We know that, $2^1 = 2$, $2^2 = 4$, $2^3 = 8$, $2^4 = 16$, $2^5 = 32$….

2 have a power cycle {2, 4, 8, 6} with the frequency of 4. So, dividing 33 by 4 we get 1 as remainder.

So, $2^1 = 2$ should be present on unit place.

The number present on unit place is the remainder when any number is divided by 10.

Answer (1)

1.11 Addition of the sequences

Arithmetic Sequence

In an arithmetic sequence, when each term of a sequence differs from its preceding term by a constant value, the value is called the common difference of that sequence.

The general form of an arithmetic sequence is

a, a+d, a+2d, a+3d and so on.

Three numbers x, y and z are in A.P. if $2y = x + z$

The n^{th} term of an Arithmetic Sequence is can be found by

$t_n = a + (n-1)\, d$

Sum of n terms of an Arithmetic sequence is given by

$S_n = \frac{n}{2}$(first term + last term)

$= \frac{n}{2}[2a + (n-1)\, d]$

Where, a = first term of the sequence,

d = common difference of the sequence = $T_n - T_{n-1}$

Sum of first n consecutive natural numbers

$= (1 + 2 + 3 + \ldots + n) = \frac{n\,(n+1)}{2}$

Sum of first n consecutive square numbers

$= (1^2 + 2^2 + 3^2 + \ldots + n^2) = \frac{n(n+1)\,(2n+1)}{6}$

Sum of first n consecutive cubic numbers

$= (1^3 + 2^3 + 3^3 + \ldots + n^3) = \frac{(n\,(n+1))2}{4}$

1.12 Geometric Sequence

In a geometric sequence, the ratio of a term with its preceding term tends to be constant.

The general form of a G.P. is a, ar, ar^2, ar^3 and so on.

Three numbers a, b, c are in G.P. if $b^2 = ac$

The n^{th} term of a geometric series is $t_n = ar^{n-1}$

Sum of n terms of a Geometric sequence

$$S_n = \frac{a(r^n - 1)}{r - 1}, \quad r > 1$$

Where, a is the first term, r is the common ratio

Sum of terms of an infinite geometric progression,

$$S_\infty = \frac{a}{1-r}, r < 1.$$

Example 11: Which term of the series 2, 5, 8, 11, 14…. is 266?

(1) 66th (2) 89th

(3) 90th (4) 92th

Explanation:

Looking at the sequence, we can find that,

1st term is 2 i.e. 3 x 1 – 1

2nd term is 5 i.e. 3 x 2 – 1

3rd term is 8 i.e. 3 x 3 – 1

So, 266 is $\frac{266+1}{3}$ i.e. 89th term

Or

Use this formula, $t_n = a + (n-1)d$

Where a=2, t_n=266, d=3

266=2+(n-1)3

266-2=3n-3

264+3=3n

267=3n

n=89

Answer (2)

1.13 GATE PREVIOUS YEARS' QUESTIONS

(GATE 2010)

1. Given digit 2, 2, 3,3,3,4,4,4,4. How many distinct 4 digit numbers greater than 3000 can be formed?

   (A) 50 (B) 51

   (C) 52 (D) 54

(GATE 2010)

2. Given the sequence A,B,B,C,C,C,D,D,D,D,…. Etc., that is one A, two Bus, three Cs, Four Ds, five As ND so on, the 240th letter in the sequence will be:

   (A) V (B) U

   (C) T (D) W

(GATE 2010)

3. A positive integer m in base 10 when represented in base 2 has the representation p and in base 3 has the representation$q$. We get $p - q = 990$, where the subtraction is done in base 10. Which of the following is necessarily true :

   (A) $m \geq 14$

   (B) $9 \leq m \leq 13$

   (C) $6 \leq m \leq 8$

   (D) $m < 6$

(GATE 2010)

4. Three friends R, S and T shares toffee from a bowl. R took 1/3rd of the toffees, but returned four to the bowl. S took 1/4th of what was left but returned three toffees to the bowl. T took half of the remainder but turned two back into the bowl. If the bowl had 17 toffees left, how many toffees were originally there in the bowl?

   (A) 38 (B) 31

   (C) 48 (D) 41

(GATE 2010)

5. Raju has 14 currency notes in his pocket consisting of only Rs. 20 notes and Rs. 10 notes. The total money value of the notes is Rs. 230. The number of Rs. 10 notes that Raju has is

   (A) 5 (B) 6

   (C) 9 (D) 10

(GATE 2010)

6. A value of x that satisfies the equation

   $\log x + \log(x-7) = \log(x+11) + \log 2$ is

   (A) 1 (B) 2

   (C) 7 (D) 11

(GATE 2010)

7. If a prime number on division by 4 gives a remainder of 1, then that number can be expressed as

   (A) Sum of squares of two natural numbers

   (B) Sum of cubes of two natural numbers

   (C) Sum of square roots of two natural numbers

   (D) Sum of cube roots of two natural numbers

(GATE 2013)

8. Find the sum to n terms of the series

   $10 + 84 + 734 + \cdots$ ….

   (A) $\frac{9(9^n+1)}{10} + 1$

   (B) $\frac{9(9^n+1)}{8} + 1$

   (C) $\frac{9(9^n-1)}{8} + n$

   (D) $\frac{9(9^n+1)}{8} + n^2$

(GATE 2013)

9. Find the sum of the expression.

   $$\frac{1}{\sqrt{1}+\sqrt{2}} + \frac{1}{\sqrt{2}+\sqrt{3}} + \frac{1}{\sqrt{3}+\sqrt{4}} + \cdots \ldots \frac{1}{\sqrt{80}+\sqrt{81}}$$

   (A) 7 (B) 8

   (C) 9 (D) 10

(GATE 2014)

10. Fill in the missing number in the series.

    2 3 6 15_____157.5 630

(GATE 2014)

11. What is the next number in the series?

    12 35 81 173 357 _____

(GATE 2014)

12. Find the odd one from the following group:

Q, W, Z, B B, H, K, M

W, C, G, J M, S, V, X

(A) Q, W, Z, B (B) B, H, K, M

(C) W, C, G, J (D) M, S, V, X

(GATE 2014)

13. The next term in the series is 81, 54, 36, 24, ___?

(GATE 2014)

14. Find the next term in the sequence:

$7G, 11K, 11M,$ ___ ?

(GATE 2014)

15. Find the next term in the sequence:

$13M, 17Q, 19S,$ _____?

(A) $21W$ (B) $21V$

(C) $23W$ (D) $23V$

(GATE 2014)

16. If $\left(z+\frac{1}{z}\right)^2 = 98$ compute $\left(z^2+\frac{1}{z^2}\right)$. [CS-1, EE-1]

(GATE 2014)

17. The value of $\sqrt{12+\sqrt{12+\sqrt{12+\cdots..}}}$ is

(A) 3.464 (B) 3.932

(C) 4.000 (D) 4.444

(GATE 2014)

18. Consider the equation, $(7526)_8 - (Y)_8 = (4364)_8$ where $(X)_N$ stands for X to the base N. Find Y.

(A) 1634 (B) 1737

(C) 3142 (D) 3162

(GATE 2015)

19. Find the missing sequence in the letter series below:

A, CD, GHI, ? , UVWXY

(A) LMN (B) MNO

(C) NMOP (D) NOPQ

(GATE 2015)

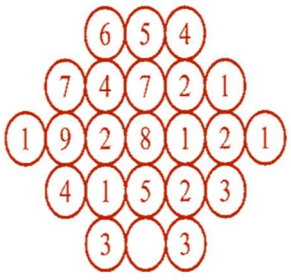
20. If $\log_x(5/7) = -1/3$, then the value of x is

(A) $343/125$ (B) $125/343$

(C) $-25/49$ (D) $-49/25$

(GATE 2015)

21. Fill in the missing value



(GATE 2015)

22. If $x > y > 1$, which of the following must be true ?

(i) ln $x >$ ln y

(ii) $e^x > e^y$

(iii) $y^x > x^y$

(iv) $\cos x > \cos y$

(A) (i) and (ii) (B) (i) and (iii)

(C) (iii) and (iv) (D) (ii) and (iv)

(GATE 2015)

23. How many four digit numbers can be formed with the 10 digits 0, 1, 2,……9 if

No number can be start with 0 and if repetitions are not allowed?

(GATE 2015)

24. Given (9 inches)$^{1/2}$= (0.25 yards)$^{1/2}$. Which one of the following statements is TRUE ?

(A) 3 inches= 0.5 yards

(B) 9 inches = 1.5 yards

(C) 9 inches = 0.25 yards

(D) 81 inches= 0.0625 yards

(GATE 2015)

25. The number that least fits this set: (324, 441, 97 and 64) is

(A) 324 (B) 441

(C) 97 (D) 64

(GATE 2015)

26. If $|9Y-6| = 3, they\ y^2 - 4y/3$ is

(A) 0 (B) $+1/3$

(C) $-1/3$ (D) 53

(GATE 2015)

27. The sum of the digits of a two-digit number is 12. If the new number formed by reversing the digits is greater than the original number by 54, find the original number.

(A) 39 (B) 57

(C) 66 (D) 93

(GATE 2017)

28. Find the smallest number y such that $y \times 162$ is a perfect cube.

(A) 24 (B) 27

(C) 32 (D) 36

(GATE 2017)

29. X is a 30 digit number starting with the digit 4 followed by the digit 7. Then the number X^3 will have,

(A) 90 digit (B) 91 digit

(C) 92 digit (D) 93 digit

(GATE 2017)

30. What is the sum of the missing digits in the subtraction problem below?

(A) 8 (B) 10
(C) 11 (D) cannot be determined

(GATE 2017)

31. The last digit of
$(2171)^7 + (2172)^9 + (2173)^{11} + (2174)^{13}$ is
(A) 2 (B) 4
(C) 6 (D) 8

(GATE 2018)

32. What is the value of $1 + \frac{1}{4} + \frac{1}{16} + \frac{1}{64} + \frac{1}{256} + \cdots$?
(A) 2 (B) $\frac{7}{4}$
(C) $\frac{3}{2}$ (D) $\frac{4}{3}$

(GATE 2018)

33. Given that a and b are integers and $a + a^2b^3$ is odd then, which one of the following statements is correct?
(A) a and b are both odd
(B) a and b are both even
(C) a is even and b is odd
(D) a is odd and b is even

(GATE 2018)

34. Find the missing group of letters in the following series:
BC, FGH, LMNO, _____.
(A) UVWXY (B) TUVWX
(C) STUVW (D) RSTUV

(GATE 2018)

35. For non-negative integers, a, b, c what would be the value of $a + b + c$ if $\log a + \log b + \log c = 0$
(A) 3 (B) 1
(C) 0 (D) -1

(GATE 2018)

36. 'A faulty wall clock is known to gain 15 J minutes every 24 hours. It is synchronized to the correct time at 9 AM on 11th July. What will be the correct time to the nearest minute when the clock shows 2 PM on 15th July of the same year?
(A) 12:45 PM
(B) 12:58 PM
(C) 1:00 PM
(D) 2:00 PM

(GATE 2018)

37. What would be the smallest natural number which when divided either by 20 or by 42 or by 76 leaves a remainder of 7 in each case?
(A) 3047
(B) 6047
(C) 7987
(D) 63847

(GATE 2018)

38. In appreciation of the social improvements completed in a town, a wealthy philanthropist decided to gift Rs 750 to each male senior citizen in the town and Rs 1000 to each female senior citizen. Altogether, there were 300 senior citizens eligible for this gift. However, only 8/9th of the eligible men and 2/3rd of the eligible women claimed the gift. How much money (in Rupees) did the philanthropist give away in total?
(A) 1,50,000 (B) 2,00,000
(C) 1,75,000 (D) 1,51,000

(GATE 2019)

39. Two design consultants, P and Q, started working from 8 AM for a client. The client budgeted a total of USD 3000 for the consultants. P stopped working when hour hand moved by 210 degrees on the clock. Q stopped working when the hour hand moved by 240 degrees. P took two tea breaks of 15 minutes each during her shift, but took no lunch break. Q took only one lunch break for 20 minutes, but no tea breaks. The market rate for consultants is USD 200 per hour and breaks are not paid. After paying the consultants, the client shall have USD ____ remaining in the budget.
(A) 000.00 (B) 300.00
(C) 166.67 (D) 433.33

(GATE 2019)

40. The missing number in the given sequence 343, 1331,_____,4913 is
(A) 4096 (B) 2744
(C) 2197 (D) 3375

(GATE 2019)

41. Five number 10, 7, 5, 4 and 2 are to be arranged in a sequence from left to right following the directions given below:
1. No two odd or even numbers are next to each other.
2. The second number from the left is exactly half of the left-most number.
3. The middle number is exactly twice the right-most number

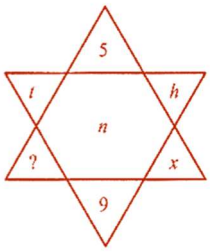
Which is the second number from the right?
(A) 2 (B) 4
(C) 7 (D) 10

(GATE 2020)

42. In four-digit integer numbers from 1001 to 9999, the digit group "37" (in the same sequence) appears _____ times.
(A) 270 (B) 299
(C) 279 (D) 280

(GATE 2020)

43. Find the missing element in the following figure.



(A) e (B) y

(C) d (D) w

(GATE 2020)

44. The difference between the sum of the first 2n natural numbers and the sum of the first n odd numbers is

(A) $2^n - n$ (B) $n^n - n$

(C) $2^n + n$ (D) $n^n + n$

(GATE 2020)

45. Which of the following numbers is exactly divisible by $(11^{13} + 1)$?

(A) $11^{26} + 1$ (B) $11^{52} - 1$

(c) $11^{39} - 1$ (D) $11^{33} + 1$

(GATE 2020)

46. $\oplus$ and $\odot$ are two operators on numbers p and q such that $p \odot q = p - q$ and $p \oplus q = p \times q$. Then $(9 \odot (6 \oplus 7)) \odot (7 \oplus (6 \odot 5)) =$

(A) 40 (B) -40

(C) -33 (D) -26

(GATE 2020)

47. If $\oplus \div \odot = 2$, $\oplus \div \Delta = 3$, $\odot + \Delta = 5$, $\Delta \times \otimes = 10$ then, the value of $(\otimes - \otimes)^2$ is

(A) 4 (B) 1

(C) 0 (D) 16

(GATE 2020)

48. If $\left(x - \frac{1}{2}\right)^2 - \left(x - \frac{3}{2}\right)^2 = x + 2$, then the value of x is

[CS-2, XE, XL]

(A) 6 (B) 4

(C) 8 (D) 2

ANSWER KEY									
1	B	2	A	3	B	4	C	5	A
6	D	7	A	8	D	9	B	10	45
11	725	12	C	13	16	14	B	15	C
16	96	17	C	18	C	19	C	20	A
21	3	22	A	23	4536	24	C	25	C
26	B	27	A	28	D	29	A	30	D
31	B	32	D	33	D	34	B	35	A
36	B	37	C	38	B	39	C	40	C
41	C	42	D	43	C	44	D	45	B
46	B	47	B	48	B				

:: Explanations ::

1. Explanation: Answer (B)

Given: Digits are 2,2,3,3,3,4,4,4,4

As the number is greater than 3000. So thousand's place can be either 3 or 4.

Let us consider the following two cases.

Case 1:

When thousand's place is 3

3 a b c

If there is no restriction on number of two's, three's and four's. Then each of a, b, c can be filled with 2 or 3 or 4 each in 3 ways. So, $3 \times 3 \times 3 = 27$ numbers are there. Out of which 3222, 3333 are invalid as 2 can be used twice and 3 thrice only. So number of such valid numbers beginning with 3 are $27 - 2 = 25$

Case 2:

When thousand's place is 4 a b c - - - - Without restriction on number of2's, 3's and 4's a, b, c can be filled in 27 ways (as explained in case 1) Out of these 27 numbers, 4222 is only invalid as two have to be used twice only. So valid numbers are 27-1 =26 Total numbers from case 1 and case 2 is 25 + 26 = 51

Hence, the correct option is (B).

2. Explanation: Answer (A)

Given: A,B,B,C,C,C,D,D,D,D…etc. Here, each alphabets is repeated as many times as its position in the alphabetical order.

Alphabet	Position in alphabetical order	Position in the given sequence
A	1	1st
B	2	2nd and 3rd
C	3	4th , 5th and 6th
D	4	7th, 8th, 9th, and 10th
…	…	….
Some alphabet	n	$\left(\frac{n(n+1)}{2}n-1\right)$, $\left(\frac{n(n+1)}{2}n-2\right)$ ……, 240th ,……, $\left(\frac{n(n+1)}{2}n-n\right)$

Here, $\frac{n(n+1)}{2}$ is the last position in the given sequence for an alphabet whose position is n in the alphabetical order.

So, if we have to find an alphabet whose position is i^{th} in the given sequence and whose position is n in the alphabetical order then we have to find smallest integer value of n such that $\frac{n(n+1)}{2} \geq i$ 2 For example, if $i = 5$, it means we have to find alphabet whose position is 5th in the given sequence, then we have to find minimum value of n such that $\frac{n(n+1)}{2} \geq 5$, So, minimum value 2 of $n = 3$ means it will be alphabet C.

Similarly, if $i = 8$ means we hve to find alphabet whose position is 8th in the given sequence, then we have to find minimum value of n such that $\frac{n(n+1)}{2} \geq 8$. So, minimum value of $n = 4$ means it will be alphabet D.

Now, in this question, we have to find smallest integer value of n such that

$$\frac{n(n+1)}{2} \geq 240$$

$$\left\{\begin{matrix} sum\ of\ forst\ n\ natural\ numbers = \frac{n(+1)}{2} \\ n(n+1) \geq 480 \end{matrix}\right\}$$

Option given are $V, U, T, W. So$, value of n can be 22, 21, 20, 23.

For $V, n = 22 \Rightarrow n(n+1) = 506 \geq 480$

For $U, n = 21 \Rightarrow n(n+1) = 462 \leq 480$

For $T, n = 20 \Rightarrow n(n+1) = 420 \leq 480$

For $W, n = 23 \Rightarrow n(n+1) = 552 \geq 480$

Smallest value of n for $\frac{n(n+1)}{2} \geq 240\ is\ 22$

For $n = 22$, alphabet is V

Hence, the correct option is (A).

3. Explanation: Answer (B)

Given: $p - q = 990$

Hence, $p = 1100, q = 110$

In base 10 subtraction, we are getting result 990. Since, p is in base 2, it can have digits 0 or 1 only. And since q is in base 3, it can have digits 0, 1, 2, only.

We can get result digit '0' by

Either '0-0' or '1-1'

We can get result digit '9' by

Either' 10-2' or '11-2'

So, possible value of p and q can be (their decimal values must be same too)

$(1100)_2$ and $(110)_3 = (12)_{10}$

$(1101)_2$ and $(111)_3 = (13)_{10}$

So, only option (B) is matching the answer.

Hence, the correct option is (B)

4. Explanation: Answer (C)

Given: Three friends R, S and T share toffees as below,

Firstly, R took 1/3rd and returned 4.

Then , S took 1/4th returned 3

Then, T took 1/2nd and returned 2.

Now, the bowl has 17 toffees left.

Method 1:-

The question can be done orally as *R* took 113rd of toffees initially. So, the total number of toffees have to be a multiple of 3. Only the number 48 is multiple of 3, from the options. Hence, the correct option is (C).

Method 2:-

Let x be the total number of toffees in bowl initially.

And *r, s* and t are toffees taken by *R, S* and *T* respectively.

According to question,

$$r = \frac{x}{3} - 4$$

Number of toffees left,

$$y = x\left(\frac{x}{3} - 4\right) = \frac{2x}{3} + 4 \dots\dots\dots\dots (i)$$

s took 1/4th of y and returned 3

So, $s = \frac{y}{4} - 3$

Number of toffees left,

$z = y - \left(\frac{y}{4} - 3\right) = \frac{3y}{4} + 3$

$z = \frac{3}{4}y + 3$

From equation (i)

$z = \frac{3}{4}\left(\frac{2x}{3} + 4\right) + 3$

$z = \frac{x}{2} + 6 \dots\dots\dots\dots\dots (ii)$

T took ½ of z and returned 2 back,

Finally, number of toffees left

$17 = z - \left(\frac{z}{2} - 2\right) = \frac{z}{2} + 2$

$17 = \frac{1}{2}\left(\frac{x}{2} + 6\right) + 2$ [From equation (ii)]

$17 = \frac{x}{4} + 5$

$x = 48$

Hence, the correct option is (C)

5. Explanation: Answer (A)

Let Number of Rs. 20 notes be x

Number of Rs. Notes be y.

$20x + 10y = 230$

$2x + y = 23 \dots\dots\dots (i)$

And $x + y = 14 \dots\dots\dots (ii)$

From equation (i) and (ii),

$x = 9$ and $y = 5$

Thus, the number of 10 rupees notes are

Hence, the correct option is (A)

6. Explanation: Answer (D)

Given:

As we know that, $\log x + \log(x - 7) = \log(x + 11) + \log 2$

So, $\log x\,(x - 7) = \log 2\,(x + 11)$

$x(x - 7) = 2(x + 11)$

$x^2 - 9x - 22 = 0$

$x^2 - 11x + 2x - 22 = 0$

$x(x - 11)(x + 2) = 0$

$x = 11$

$x \neq -2$, log is undefined for negative number.

Hence, the correct option is (D)

7. Explanation: Answer (A)

Theorem: If p is a prime number which has remainder 1 when divided by 4, then p can b

Written as a sum of two squares.

Example:

- $5 = 1 + 4$
- $13 = 9 + 4$
- $17 = 16 + 1$
- $29 = 25 + 4$
- $37 = 36 + 1$
- $41 = 25 + 16$
- And so on.

Hence, option (A) is correct.

From option (B): Sum of cubes of two natural numbers.

Counter example: 5 cannot be represented as cubes of two natural numbers.

$$(1^3 = 1, 2^3 = 8 \Rightarrow 1 + 8 = 9 \neq 5)$$

Hence, option (B) is not correct.

From option (C): Sum of square roots of two natural numbers.

Let, $p = 4n + 1, n \geq 0$ and p is a prime number.

The smallest value of p is5.

So, any p can be written as $p = p_1 + p_2$ where p_1 and $p_2$are natural numbers. Now existence of p_1^2 and p_2^2 makes the option (C) correct.

From option (D): Sum of cube roots instead of p_1^2 and p_2^2 in above explanation we just need to change to p_1^3 andp_2^3.

Hence, the correct options are (A), (C) and (D). It is better to pick option (A) here, because Options (C) and (D) seem to be given by mistake. This question can also be asked in MSQ type. Hence, the correct option is (A).

8. Explanation: Answer (D)

Given: Series is $10 + 84 + 734 + \cdots$ ....