CAT Questions based on Number System

Instructions
For the following questions answer them individually

Question 1

How many 4-digit numbers, each greater than 1000 and each having all four digits distinct, are there with 7 coming before 3?

Answer:315

Explanation:
Here there are two cases possible

Case 1: When 7 is at the left extreme

In that case 3 can occupy any of the three remaining places and the remaining two places can be taken by (0,1,2,4,5,6,8,9)

So total ways 3(8)(7)= 168

Case 2: When 7 is not at the extremes

Here there are 3 cases possible. And the remaining two places can be filled in 7(7) ways.(Remember 0 can't come on the extreme left)

Hence in total 3(7)(7)=147 ways

Total ways 168+147=315 ways

Question 2

How many pairs(a, b) of positive integers are there such that $a \leq b$ and $ab = 4^{2017}$?

A 2018

B 2019

C 2017

D 2020

Answer: A

Explanation:
$ab = 4^{2017} = 2^{4034}$

The total number of factors = 4035.

out of these 4035 factors, we can choose two numbers a,b such that a<b in [4035/2] = 2017.

And since the given number is a perfect square we have one set of two equal factors.

.'. many pairs(a, b) of positive integers are there such that $a \leq b$ and $ab = 4^{2017}$ = 2018.

Question 3

How many of the integers 1, 2, … , 120, are divisible by none of 2, 5 and 7?

A 42

B 41

C 40

D 43

Answer: B

Explanation:
The number of multiples of 2 between 1 and 120 = 60

The number of multiples of 5 between 1 and 120 which are not multiples of 2 = 12

The number of multiples of 7 between 1 and 120 which are not multiples of 2 and 5 = 7

Hence, number of the integers 1, 2, ... , 120, are divisible by none of 2, 5 and 7 = 120 - 60 - 12 - 7 = 41

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Question 4

Let N, x and y be positive integers such that $N = x + y, 2 < x < 10$ and $14 < y < 23$. If $N > 25$, then how many distinct values are possible for N?

Answer:6

Explanation:
Possible values of x = 3,4,5,6,7,8,9

When x = 3, there is no possible value of y

When x = 4, the possible values of y = 22

When x = 5, the possible values of y=21,22

When x = 6, the possible values of y = 20.21,22

When x = 7, the possible values of y = 19,20,21,22

When x = 8, the possible values of y=18,19,20,21,22

When x = 9, the possible values of y=17,18,19,20,21,22

The unique values of N = 26,27,28,29,30,31

Question 5

How many integers in the set {100, 101, 102, ..., 999} have at least one digit repeated?

Answer:252

Explanation:
Total number of numbers from 100 to 999 = 900

The number of three digits numbers with unique digits:

_ _ _

The hundredth's place can be filled in 9 ways (Number 0 cannot be selected)

Ten's place can be filled in 9 ways

One's place can be filled in 8 ways

Total number of numbers = 9*9*8 = 648

Number of integers in the set {100, 101, 102, ..., 999} have at least one digit repeated = 900 - 648 = 252

Question 6

Let m and n be natural numbers such that n is even and $0.2 < \frac{m}{20}, \frac{n}{m}, \frac{n}{11} < 0.5$. Then $m - 2n$ equals

A 3

B 1

C 2

D 4

Answer: B

Explanation:
$0.2 < \frac{n}{11} < 0.5$

=> 2.2<n<5.5

Since n is an even natural number, the value of n = 4

$0.2 < \frac{m}{20} < 0.5$ => 4< m<10. Possible values of m = 5,6,7,8,9

Since $0.2 < \frac{n}{m} < 0.5$, the only possible value of m is 9

Hence m-2n = 9-8 = 1

Question 7

If a, b and c are positive integers such that ab = 432, bc = 96 and c < 9, then the smallest possible value of a + b + c is

A 49

B 56

C 59

D 46

Answer: D

Explanation:
Since $c < 9$, we can have the following viable combinations for $b \times c = 96$ (given our objective is to minimize the sum):

$48 \times 2\,; 32 \times 3\,; 24 \times 4\,; 16 \times 6\,; 12 \times 8$

Similarly, we can factorize $a \times b = 432$ into its factors. On close observation, we notice that 18×24 and 24×4 corresponding to $a \times b$ and $b \times c$ respectively together render us with the least value of the sum of $a + b + c = 18 + 24 + 4 = 46$

Hence, Option D is the correct answer.

Question 8

The mean of all 4-digit even natural numbers of the form 'aabb',where $a > 0$, is

A 4466

B 5050

C 4864

D 5544

Answer: D

Explanation:
The four digit even numbers will be of form:

1100,1122,1144...1188,2200,2222,2244....9900,9922,9944,9966,9988

Their sum 'S' will be (1100+1100+22+1100+44+1100+66+1100+88)+(2200+2200+22+2200+44+...)....+(9900+9900+22+9900+44+9900+66+9900+88)

=> S=1100*5+(22+44+66+88)+2200*5+(22+44+66+88)....+9900*5+(22+44+66+88)

=> S=5*1100(1+2+3+...9)+9(22+44+66+88)

=>S=5*1100*9*10/2 + 9*11*20

Total number of numbers are 9*5=45

.'. Mean will be S/45 = 5*1100+44=5544.

Option D

Question 9

How many 3-digit numbers are there, for which the product of their digits is more than 2 but less than 7?

Answer:21

Explanation:
Let the number be 'abc'. Then, $2 < a \times\ b \times\ c < 7$. The product can be 3,4,5,6.

We can obtain each of these as products with the combination 1,1, x where x = 3,4,5,6. Each number can be arranged in 3 ways, and we have 4 such numbers: hence, a total of **12** numbers fulfilling the criteria.

We can factories 4 as 2*2 and the combination 2,2,1 can be used to form **3** more distinct numbers.

We can factorize 6 as 2*3 and the combination 1,2,3 can be used to form **6** additional distinct numbers.

Thus a total of 12 + 3 + 6 = **21** such numbers can be formed.

Question 10

In a row at a bus stop, A is 7th from the left and B is 9th from the right. They both interchange their positions. A becomes 11th from the left. How many people are there in the row?

A 18

B 19

C 20

D 21

Answer: B

Explanation:
After interchanging the positions, A becomes 11th from the left. So B must have been 11th from the left and 9th from the right before the interchange. Hence the total number of people = 11+9-1=19

Question 11

The product of two positive numbers is 616. If the ratio of the difference of their cubes to the cube of their difference is 157:3, then the sum of the two numbers is

A 58

B 85

C 50

D 95

Answer: C

Explanation:
Assume the numbers are a and b, then ab=616

We have, $\frac{a^3-b^3}{(a-b)^3}$ = $\frac{157}{3}$

=> $3\left(a^3-b^3\right)\ =\ 157\left(a^3-b^3+3ab\left(b-a\right)\right)$

=> $154\left(a^3-b^3\right)+3*157*ab\left(b-a\right)$ = 0

=> $154\left(a^3-b^3\right)+3*616*157\left(b-a\right)$ = 0 (ab=616)

=>$a^3-b^3+\left(3\times\ 4\times\ 157\left(b-a\right)\right)$ (154*4=616)

=> $\left(a-b\right)\left(a^2+b^2+ab\right)\ =\ 3\times\ 4\times\ 157\left(a-b\right)$

=> $a^2+b^2+ab\ =\ 3\times\ 4\times\ 157$

Adding ab=616 on both sides, we get

$a^2+b^2+ab\ +ab=\ 3\times\ 4\times\ 157+616$

=> $\left(a+b\right)^2=\ 3\times\ 4\times\ 157+616$ = 2500

=> a+b=50

Question 12

In Roman Numerals, a number has been written as MMXVIII. In Arabic numbers it will be .... (Note:- DO NOT include spaces in your answer)

Answer:2018

Explanation:
In Roman numerals,

The values of M = 1000, D = 500, C = 100, L=50, X = 10, V = 5, 1 = 1.

The value of MMXVIII = 1000+1000+10+5+1+1+1 = 2018

2018 is the correct answer.

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Question 13

The number $37^{371}-26^{371}$ is divisible by:

A 10

B 11

C 12

D 15

Answer: B

Explanation:
Option A:

$37^{371}-26^{371}$ mod 10

=$7^{371}-6^{371}$

Since 7 and 10 are co-prime to each other

E(10) = 10*($\left(1-\ \frac{1}{2}\right)\left(1-\ \frac{1}{5}\right)$

=4

7^4 mod 10 = 1

$7^{4*92}*7^3$ mod 10 = $1*7^3$ mod 10 =3

6^{371} mod 10 = 0

Hence $37^{371}-26^{371}$ is not divisible by 10

Option B:

$37^{371}-26^{371}$ mod 11

$4^{371}-4^{371}$ mod 11

Hence $37^{371}-26^{371}$ is divisible by 11

Option C:

$37^{371}-26^{371}$ mod 12

$1^{371} - 2^{371}$ mod 12

Hence $37^{371} - 26^{371}$ is not divisible by 12

Option D:

$37^{371} - 26^{371}$ mod 15

$7^{371} - 11^{371}$ mod 15

$37^{371} - 26^{371}$ is not divisible by 15

B is the correct answer.

Question 14

The average of 4 distinct prime numbers a, b, c, d is 35, where a < b < c < d. a and d are equidistant from 36 and b and c are equidistant from 34 and a, b are equidistant from 30 and c and d are equidistant from 40. The difference between a and d is:

A 30

B 14

C 21

D Cannot be determined

Answer: B

Explanation:
Given,

The average of the four prime numbers = 35.

a + b + c + d = 35 * 4 = 140.

Since a and d are equidistant from 36.

a + d = 72 --- Eq (1)

b + c = 68 --- Eq (2)

a + b = 60 --- Eq (3) and c + d = 80 --- Eq (4)

Using the equation (3) let us look for the prime values of a and b and the corresponding values of c and d using Eq 2 and 1.

Also given that a < b < c < d.

a	b	c	d	Note
7	53	15	65	c,d are not prime
13	47	21	59	c is not prime
17	43	25	55	c,d are not prime
23	37	31	49	d is not prime
29	31	37	43	Possible

(a, b, c, d) = 29, 31, 37, 43

d - a = 43 - 29 = 14

B is the correct answer.

Question 15

A number G236G0 can be divided by 36 if G is:

A 8

B 6

C 1

D More than one values are possible.

Answer: A

Explanation:
36 = 9*4 Since 9 and 4 are co-prime to each other, we can say that for a number to be divisible by 36 it must be divisible by both 9 and 4.

For G236G0, to be divisible by 4, last two digits should be divisible by 4.

Hence G0 should be a multiple of 4.

Possible values of G are 2, 4, 6, 8, 0

For the number to be divisible by 9, the sum of the digits should be a multiple of 9

G+2+3+6+G+0 = 11+2G should be multiple of 9

If G = 0, 11+2G is not a multiple of 9

If G = 2, 11+2G is not a multiple of 9

If G = 4, 11+2G is not a multiple of 9

If G = 6, 11+2G is not a multiple of 9

If G = 8, 11+2G is a multiple of 9.

Hence 8 is the correct answer.

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