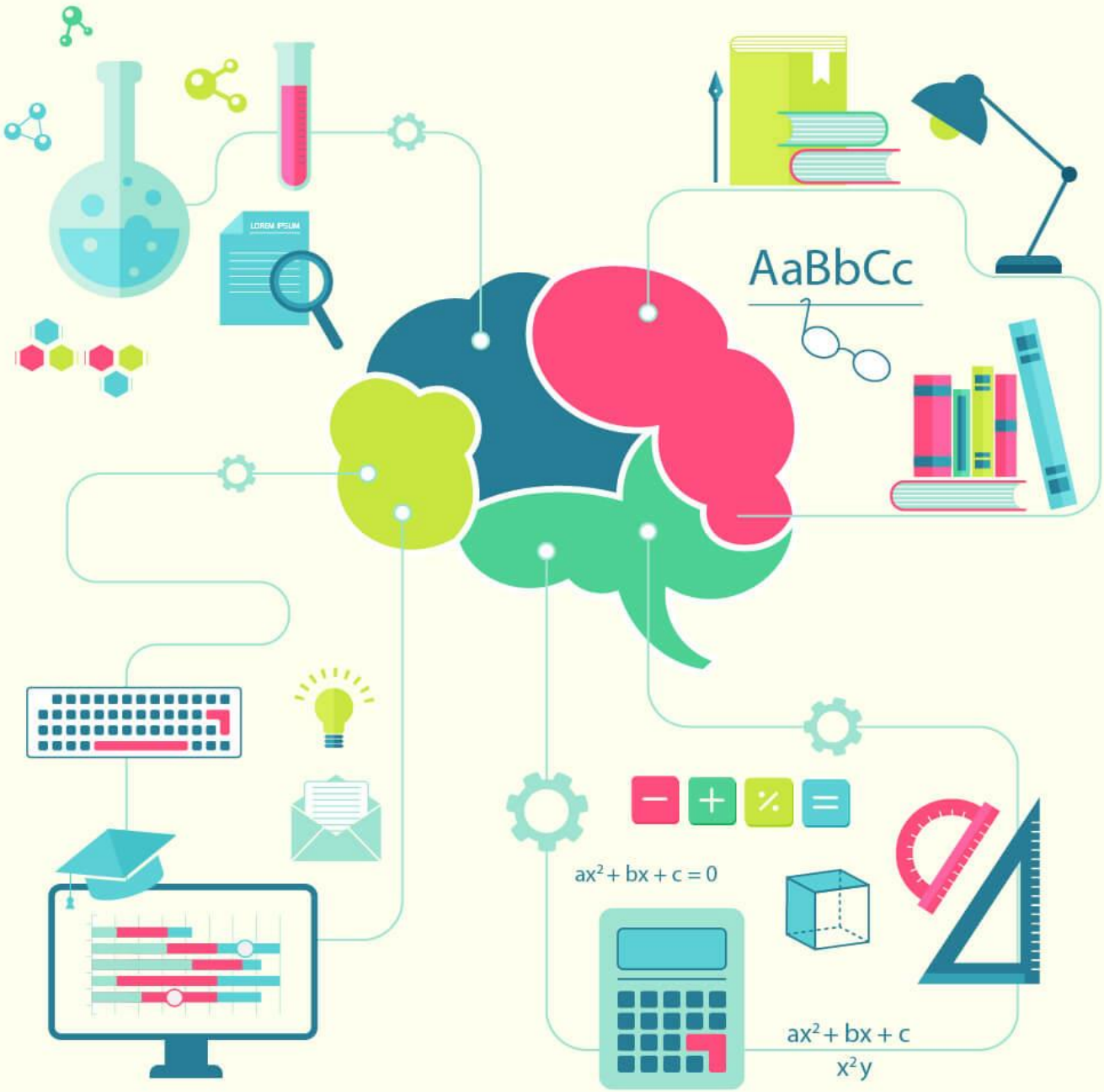
cracku

# Wilson's Theorem for CAT



According to Wilson's theorem for prime number 'p',
[(p-1)! + 1] is divisible by p.

In other words, (p-1)! leaves a remainder of (p-1) when divided by p.

Thus, **(p-1)! mod p = p-1**

For e.g.
4! when divided by 5, we get 4 as a remainder.

6! When divided by 7, we get 6 as a remainder.

10! When divided by 11, we get 10 as a remainder.



If we extend Wilson's theorem further, we get an important corollary
(p-2)! mod p = 1

As from the Wilson's theorem we have, (p-1)! mod p = (p-1)

Thus, [(p-1)(p-2)!] mod p = (p-1)

This will be equal to [(p-1) mod p] * [(p-2)! mod p] = (p-1)

For any prime number 'p', we observe that (p-1) mod p = (p-1).

For e.g. 6 mod 7 will be 6.
Thus, (p-1) * [(p-2)! mod p] = (p-1)
Thus, for RHS to be equal to LHS,

**(p-2)! mod p = 1**
Hence, 5! mod 7 will be 1 and 51! mod 53 will be 1





Examples:

Q.1) What will be the remainder when 568! Is divided by 569?

Solution: According to Wilson's theorem we have,
For prime number 'p', (p-1)! mod p = (p-1)

In this case 569 is a prime number. Thus, 568! mod 569 = 568.
Hence, when 568! is divided by 569 we get 568 as remainder.
Answer: 568

Q.2) What will be the remainder when 225! Is divided by 227?

Solution: We know that for prime number 'p', (p-2)! mod p = 1.
In this case, 227 is a prime number.

Thus, 225! mod 227 will be equal to 1. In other words, when 225! Is divided by 227 we get remainder as 1.
Answer: 1







Q.3) What will be the remainder when 15! is divided by 19?

Solution:19 is a prime number.
From corollary of Wilson's theorem, for prime number 'p',
(p-2)! mod p = 1

Thus, 17! mod 19 = 1
[17*16*15!] mod 19 = 1
[17 mod 19]* [16 mod 19]* [15! mod 19] = 1
[-2]*[-3]* [15! mod 19] = 1
[6 * 15!] mod 19 = 1

Multiplying both sides by 3, we get
[18*15!] mod 19 = 3
[-1*15!] mod 19 = 3

Multiplying both sides by '-1', we get
15! mod 19 = -3

Remainder of '-3' when divided by 19 is same as remainder of '16' when divided by 19.
Thus 15! mod 19 = 16
Answer: 16



Q.4) What will be the remainder when $(23!)^2$ is divided by 47?

Solution: 47 is a prime number.
From corollary of Wilson's theorem, for prime number 'p',
(p-2)! mod p = 1

Thus, 45! mod 47 = 1
[45*44*43*42*...*25*24*23!] mod 47 = 1
[(-2)*(-3)*(-4)*(-5)*...*(-22)*(-23) * 23!] mod 47 = 1

We see that, there are even number of terms from '-2' to '-23'. Thus, negative sign cancels off.

We get,
[23!*23!] mod 47 = 1
Thus, $(23!)^2$ mod 47 =1

Hence, when $(23!)^2$ is divided 47, we get 1 as a remainder.
Answer: 1

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