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# Fermat's Theorem for CAT





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## Title

### Fermat's little theorem for CAT

## Explanation

Fermat's theorem is an important remainder theorem which can be used to find the remainder easily.

Fermat's theorem states that for any integer 'a' and prime number 'p',  $a^p - a$  is always divisible by 'p'.

Also, if a is not divisible by p, i.e. if a and p are relatively prime, then

$$a^{(p-1)} \text{ mod } p = 1 \text{ mod } p$$

which means the remainder is 1.

The second part of the theorem is very useful in solving problems.

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### Examples

**When  $2^{256}$  is divided by 17, the remainder would be \_: (CAT 2002)**

Here, 17 is a prime number and 2, 17 are relatively prime.

Therefore,  $2^{16} \text{ mod } 17 = 1$ .

$2^{256}$  can be written as  $(2^{16})^{16}$ .

Since,  $2^{16} \text{ mod } 17 = 1$ ,  $(2^{16})^{16} \text{ mod } 17 = 1$ .

Thus, the remainder when  $2^{256}$  is divided by 17 is 1.

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As you can see, if you know the Fermat's theorem such questions can be solved in less than a minute and it will boost your score.

**Find the remainder when  $3^{75}$  is divided by 37.**

Here, 37 is a prime number. Hence, Fermat's theorem can be used. Also, 3 and 37 are relatively prime.

Therefore,

$$3^{36} \text{ mod } 37 = 1$$

$$3^{72} \text{ mod } 37 = (3^{36})^2 \text{ mod } 37 = 1$$

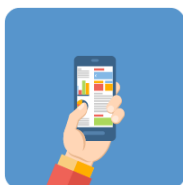
$$3^{75} \text{ mod } 37 = 3^{72} \cdot 3^3 \text{ mod } 37 = 3^3 \text{ mod } 37, 27 \text{ mod } 37 \text{ is equal to } 27.$$

Hence, the remainder when  $3^{75}$  is divided by 37 is 27.

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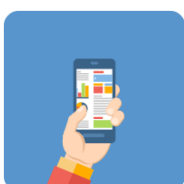
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