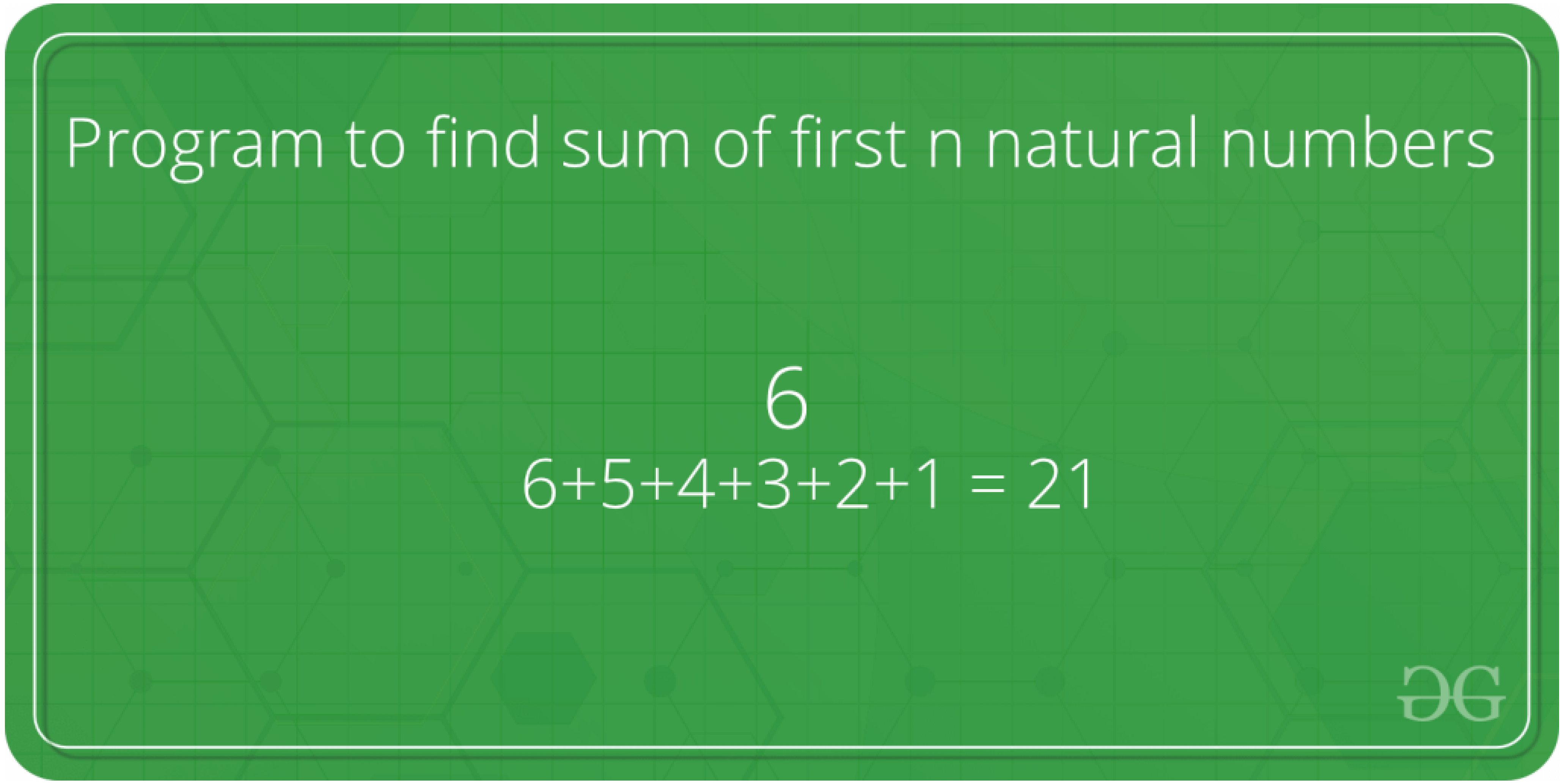
Dash
All
Articles
Videos
Problems
Quiz
« Prev
Next »

Sum of Natural numbers

Given a number n, find the sum of first natural numbers.



Examples :

```
Input : n = 3
Output : 6
Explanation :
Note that 1 + 2 + 3 = 6

Input  : 5
Output : 15
```

```
Explanation :
Note that 1 + 2 + 3 + 4 + 5 = 15
```

Dash
All
Articles
Videos
Problems
Quiz

A **simple solution** is to do the following.

```
1) Initialize : sum = 0
2) Run a loop from x = 1 to n and
   do following in loop.
     sum = sum + x
```

Python3

```
 # PYTHON program to find sum of first
# n natural numbers.

# Returns sum of first n natural
# numbers
def findSum(n) :
    sum = 0
    x = 1
    while x <=n :
        sum = sum + x
        x = x + 1
    return sum


# Driver code

n = 5
print findSum(n)
```

Output

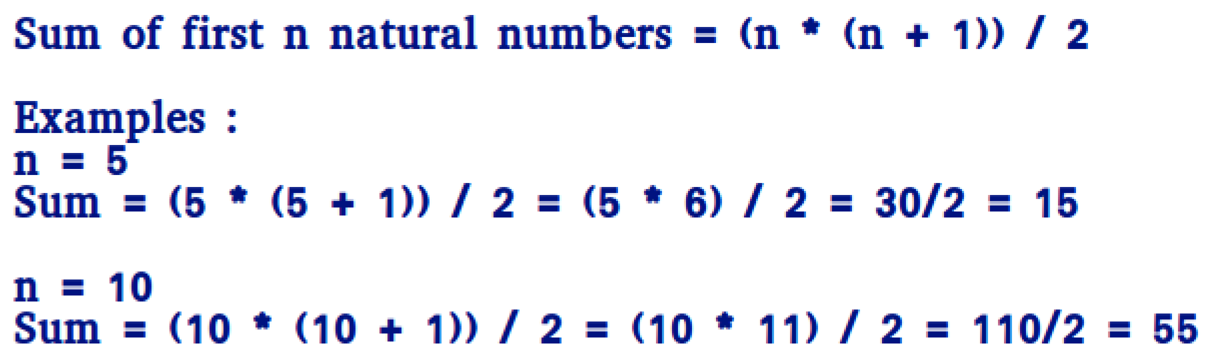
```
15
```

Time Complexity: *O(n)*

Auxiliary Space: *O(1)*

An **efficient solution** is to use the below formula.

Dash
All
Articles
Videos
Problems
Quiz



Sum of first n natural numbers = (n * (n + 1)) / 2

Examples :
n = 5
Sum = (5 * (5 + 1)) / 2 = (5 * 6) / 2 = 30/2 = 15

n = 10
Sum = (10 * (10 + 1)) / 2 = (10 * 11) / 2 = 110/2 = 55

How does this work?

```
We can prove this formula using induction.

It is true for n = 1 and n = 2
For n = 1, sum = 1 * (1 + 1)/2 = 1
For n = 2, sum = 2 * (2 + 1)/2 = 3

Let it be true for k = n-1.

Sum of k numbers = (k * (k+1))/2
Putting k = n-1, we get
Sum of k numbers = ((n-1) * (n-1+1))/2
                 = (n - 1) * n / 2

If we add n, we get,
Sum of n numbers = n + (n - 1) * n / 2
                 = (2n + n^2 - n)/2
                 = n * (n + 1)/2
```

Python3

```
 # Efficient CPP program to find sum
# of first n natural numbers.

# Returns sum of first n natural
# numbers
def findSum(n) :
    return n * (n + 1) / 2

# Driver code
```

```
n = 5
print findSum(n)
```

Dash
All
Articles
Videos
Problems
Quiz

Output

```
15
```

Time Complexity: *O(1)*

Auxiliary Space: *O(1)*

The above program causes overflow, even if the result is not beyond the integer limit. We can avoid overflow up to some extent by dividing first.

Python3

```
 # Efficient Python program to find the sum
# of first n natural numbers that avoid
# overflow if the result is going to be
# within limits.

# Returns sum of first n natural
# numbers
def findSum(n) :
    if (n % 2 == 0) :
        return (n / 2) * (n + 1)

# If n is odd, (n+1) must be even
    else :
    return ((n + 1) / 2) * n

# Driver code
n = 5
print findSum(n)
```

Output

```
15
```

Time Complexity: *O(1)*

Auxiliary Space: *O(1)*

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Dash

All

Articles

Videos

Problems

Quiz

«

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