



# Solution Review: Nested Loop with Multiplication (Basic)

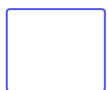
This review provides a detailed analysis of the different ways to solve the nested loop with multiplication problem

We'll cover the following ^

- Solution
  - Time Complexity




## Solution #

```
1 n = 10 # n can be anything, this is just an example
2 sum = 0
3 pie = 3.14
4 var = 1
5 while var < n:
6     print(pie)
7     for j in range(1, n, 2):
8         sum += 1
9     var *= 3
10 print(sum)
11
```



## Time Complexity



The outer loop in this problem, i.e., everything under **line 5**,    runs  $\log_3(n)$  times since **var** will first be equal to 1, then 3, then 9,  $\dots$ , until it is  $3^k$  such that  $3^k \leq n$ . This means that the outer loop runs a total of  $\log_3(n)$  times. The inner loop, on the other hand, runs a total of  $\log_3(n) \times \frac{n}{2}$ . So,

Statement	Number of Executions
<code>n = 10</code>	1
<code>sum = 0</code>	1
<code>pie = 3.14</code>	1
<code>var = 1</code>	1
<code>while var &lt; n:</code>	$\log_3(n)$
<code>    print(pie)</code>	$\log_3(n)$
<code>    j in range(1,n,2):</code>	$\log_3(n) \times \frac{n}{2}$
<code>        sum++;</code>	$\log_3(n) \times \frac{n}{2}$
<code>        var *= 3</code>	$\log_3(n)$
<code>print(sum)</code>	1



**Running Time Complexity =**

$$\begin{aligned}
 & 5 + \log_3(n) + \log_3(n) + (\log_3(n) \times \frac{n}{2}) + (\log_3(n) \times \frac{n}{2}) + \text{[?]} \text{[Clipboard]} \text{[Settings]} \\
 & = 5 + 3\log_3(n) + 2(\frac{n\log_3(n)}{2}) \\
 & = 5 + 3\log_3(n) + n\log_3(n)
 \end{aligned}$$

Now, to find the Big O complexity,

1. Drop the leading constants  $\Rightarrow \log_3(n) + n\log_3(n)$

2. Drop lower order terms  $\Rightarrow n\log_3(n)$

Using  $\log_3(n) = \frac{\log_2(n)}{\log_2(3)} = \frac{\log_2(n)}{1.585}$ , we can turn this into  $\frac{n\log_2(n)}{1.585}$ . Dropping the constants, given us:

Big O Time Complexity  $\Rightarrow O(n\log_2(n))$

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