Compute the run time of the algorithm given below as a function of input size ‘n’.

1. **Algorithm insertionSort(A, n)**
2. **Input** array A of n integers
3. **Output** sorted array A
4. for $i \leftarrow 1$ to $n - 1$ do
   5. key $\leftarrow A[i]$
   6. $j \leftarrow i - 1$
   7. while $j \geq 0$ and $A[j] > key$ do
      9. $j \leftarrow j - 1$
   10. $A[j+1] \leftarrow key$
11. return A

Assume that each of the following basis operations:
   - Evaluating an expression
   - Assigning a value to a variable
   - Indexing into an array
   - Calling a method
   - Returning from a method
   takes a unit amount of time to execute.

Ans:
Line 4: 2n + 1 Ops  
   (1 evaluation, 1 assignment, (n-1) increments of index, n comparisons)
Line 5: 2(n-1) Ops  
   (1 array indexing, 1 assignment for each i.)
Line 6: 2(n-1) Ops  
   (1 evaluation, 1 assignment for each i)
Line 7: \[
\sum_{i=1}^{n-1} (3i + 1) = \frac{3n(n-1)}{2} + (n-1) = \frac{3}{2}n^2 - \frac{1}{2}n - 1
\]
   (i+1 comparisons, i array indexing, and i comparisons for each i)
Line 8: \[
\sum_{i=1}^{n-1} 3i = \frac{3n(n-1)}{2} = \frac{3}{2}n^2 - \frac{3}{2}n
\]
   (2i array indexing, i assignments for each i)
Line 9: \[
\sum_{i=1}^{n-1} 2i = n(n-1) = n^2 - n
\]
   (i evaluations, i assignments for each i) or (only i decrements for each i)
Line 10: 2(n-1) Ops  
   (1 array indexing, 1 assignment for each i.)
Line 11: 1

Run time = $4n^2 + 5n - 5$