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1.

{10, 99, 23, 12, 0, 5, 9, 8}
{10,99,23,12} {0,5,9,8}
{10,99} {23,12} {0,5} {9,8}
{10} {99} {23} {12} {0} {5} {9} {8}
{10,99} {12,23} {0,5} {8,9}
{10,12,23,99} {0,5,8,9}
{0,5, 8, 9,10,12,23,99}

2. The running time is O(N). Because if we have a loop to insert same elements, the loop will terminates right at first try . So the running time should be O(N) which depends on how many elements are there to sort.

3. 1)

$F(n)=2F(n/2)+n$
$F(n)=2(2F(n/4) + n/2)) + n = 4F(n/4)+2n$
$F(n)=2^kF(n/2^k)+kn$
when $n/2^k = 1$ $k=\log_2 n$
so $F(n)=2^{\log_2 n} F(n/2^{\log_2 n})+ n\log_2 n$
$= nF(1)+n\log_2 n$
$=n+n\log_2 n$

2)

$T(n)=n\log_2 n+2n-1$ $F(n)= n+n\log_2 n$
proof: need to show: $n+n\log_2 n=O(n\log_2 n+2n-1)$
$n+n\log_2 n=\Omega(n\log_2 n+2n-1)$

Let $C_1 = 2$ when $n \geq 1$ $C_1(n\log_2 n+2n-1) =n\log_2 n+ n\log_2 n+4n-2 > n\log_2 n+n$
Thus, choose $n_0=1$ we have $n\log_2 n+2n-1 \geq n+n\log_2 n$ when $n_0 \geq n$
Let $C_1 = 0.5$ when $n \geq 1$ $C_1(n\log_2 n+2n-1) =0.5n\log_2 n +4n-2 < n\log_2 n+n$
Thus, choose $n_0=1$ we have $n\log_2 n+2n-1 \leq n+n\log_2 n$ when $n_0 \leq n$
Therefore $F(n) =\theta(T(n))$

4. Report

	InsertionSort	QuickSort
10	9.53674e-07	9.53674e-07
20	2.86102e-06	5.00679e-06
100	1.88351e-05	1.19209e-05
200	5.19753e-05	1.78814e-05
400	2.44856e-04	4.57764e-05
800	2.29692e-03	1.60933e-04
1600	3.26395e-03	1.78099e-04
3200	0.0304101	0.000496864
6400	0.0869331	0.00106311