P3.1.

a) $f(n) = 9n \qquad g(n) = 5n^3$

$\lim_{n\to\infty} \frac{9n}{5n^3} = 0 \qquad \lim \frac{5n^3}{9n} = \infty$

$\downarrow \qquad \downarrow$

$f \in o(g)$ and $f \in O(g) \qquad$ ~~$g \in \omega(f)$~~ $g \in \omega(f)$ and $g \in \Omega(f)$

b) $f(n) = 9n^{0,8} + 2n^{0,3} + 14 \log n \qquad g(n) = \sqrt{n}$

$\lim_{n\to\infty} \frac{9n^{0,8} + 2n^{0,3} + 14 \log n}{\sqrt{n}} = \infty \longrightarrow$ $f \in \omega(g)$, $f \in \Omega(g)$

$\lim_{n\to\infty} \frac{\sqrt{n}}{9n^{0,8} + 2n^{0,3} + 14 \log n} = 0 \longrightarrow g \in o(f), \quad g \in O(f)$

P3.1

(c) $f(n) = \frac{n^2}{\log n}$ $g(n) = n \log n$

$\lim_{n\to\infty} = \frac{\frac{n^2}{\log n}}{n\log n} = \infty$

$\downarrow$

$f \in \Omega(g)$

$f \in \omega(g)$

$\lim_{n\to\infty} \frac{n\log n}{\frac{n^2}{\log n}} = 0$

$\downarrow$

$g \in o(f)$

$g \in O(f)$

(d) $f(n) = (\log(3n))^3$ $g(n) = 9\log n$

$\lim_{n\to\infty} = \frac{(\log(3n))^3}{9\log n} = \infty$

$\downarrow$

$f \in \Omega(g)$

$f \in \omega(g)$

$\lim_{n\to\infty} = \frac{9\log n}{(\log(3n))^3} = 0$

$\downarrow$

$g \in o(f)$

$g \in O(f)$

P 3.2.

a) It has been shown in „a3.2.cpp" file.

b) We must show 3 thing about loop invariant: Initialazation, Maintence and Termination

Initialazation: Initialy sorted array has no element in it, so therefore we can say it is sorted at that time;

Maintence: Here the left part of the subarray ~~array~~ till the „n" element A[0...n] is always sorted and the next element from [n+1 .. n] gets added to the left sub-array so, it maintains the loop invariant.

Termination: The loop invariant gives us a useful property that helps show that algorithm is correct, when the loop terminates. At the end of termination the left subarray will

reach the size of the loop and there will be
no more elements to be sorted.