# Topic 03: Asymptotic Analysis, Section 1 Group __

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- Name
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**1.** We can extend asymptotic notation to the case of two parameters *n* and *m* that can go to infinity independently at different rates. For example, we denote by **O(g(n,m))** the set of functions:

> O(g(n,m)) = {f(n,m) : there exists positive constants c, $n_0$ **and** $\mathbf{m_0}$ such that $0 \leq f(n,\mathbf{m}) \leq cg(n,\mathbf{m})$ for all $n \geq n_0$ **or** $\mathbf{m \geq m_o}$}

**Give a corresponding definition for Θ(g(n,m)).**

**2.** Indicate, for each pair of expressions $f(n)$ and $g(n)$ in the table below, whether f(n) = __(g(n)), where the __ may be O, o, Ω, ω or Θ. Assume that $k \geq 1$, $c > 1$, and $d > 0$ are constants and we are analyzing growth rates in terms of the variable $n$. "lg" is log base 2. To respond, write "Yes" or "No" in each box. Justifications are also required so we can give better feedback and possibly partial credit in case of wrong answers. Justifications are also required and should give formulas used to transform the expressions and/or refer to statements proven in the text.

| | $f(n)$ | $g(n)$ | O? | o? | Ω? | ω? | Θ? |
|---|---|---|---|---|---|---|---|
| *a.* | $n^{\lg c}$ | $c^{\lg n}$ | | | | | |
| *b.* | $\lg^k n$ | $n^d$ | | | | | |
| *c.* | $2^n$ | $2^{n/2}$ | | | | | |
| *d.* | $\lg(n!)$ | $\lg(n^n)$ | | | | | |

Justifications (required):

a.

b.

c.

d.

**Challenge: Done early? Try these!**

| | $f(n)$ | $g(n)$ | O? | o? | Ω? | ω? | Θ? |
|---|---|---|---|---|---|---|---|
| *e.* | $4n^2$ | $4^{\lg n}$ | | | | | |
| *f.* | $2^{\lg n}$ | $\lg^2 n$ | | | | | |
| *g.* | $\sqrt{n}$ | $n^{\sin n}$ | | | | | |

Justifications:

e.

f.

g.