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or  $\frac{\infty}{\infty}$ .

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**Example**

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The limit of

### Other types of indeterminants

In the event that the limit produces an indeterminate form, we must convert it into an indeterminate form of type  $\frac{0}{0}$  or  $\frac{\infty}{\infty}$ .

$$f(x)g(x) = \frac{f(x)}{\frac{1}{g(x)}} \text{ or } f(x)g(x) = \frac{f(x)}{g(x)}$$

**Example 7** Find  $\lim_{x \rightarrow 0^+} x \tan x$ .

Since  $\lim_{x \rightarrow 0^+} x = 0$  and  $\lim_{x \rightarrow 0^+} \tan x = \infty$ , we must first convert this product into a quotient.

Using l'Hôpital's Rule, we have:

**Example 8** Find  $\lim_{x \rightarrow \infty} x \tan x$ .

Since  $\lim_{x \rightarrow \infty} x = \infty$  and  $\lim_{x \rightarrow \infty} \tan x = \infty$ , we can easily convert it into the indeterminate form  $\infty \cdot \infty$ .

Using l'Hôpital's Rule, we have:

$$\lim_{x \rightarrow \infty} x \tan x = \lim_{x \rightarrow \infty} \frac{x}{\cot x}$$

**Example 9** Find  $\lim_{x \rightarrow \infty} x^3 e^{-x}$ .

It is not difficult to see that  $x^3$  goes to infinity faster than  $e^{-x}$ . We convert this into the quotient  $\lim_{x \rightarrow \infty} \frac{x^3}{e^x}$ . Using l'Hôpital's Rule, we obtain:

$$\lim_{x \rightarrow \infty} x^3 e^{-x} = \lim_{x \rightarrow \infty} \frac{x^3}{e^x}$$

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**Example 13** Find  $\lim_{x \rightarrow 1} ($

Since  $\lim_{x \rightarrow 1} \frac{x}{x-1} = \infty$  and I must first convert this using a

$$\lim_{x \rightarrow 1} \left( \frac{x}{x-1} - \frac{1}{\ln x} \right)$$

Since  $\lim_{x \rightarrow 1} (x \ln x - x + 1)$  of type  $\frac{0}{0}$ . We can therefore a

$$\lim_{x \rightarrow 1} \left( \frac{x}{x-1} - \frac{1}{\ln x} \right) =$$

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$$\lim_{x \rightarrow 1} \left( \frac{x}{x-1} - \frac{1}{\ln x} \right) =$$

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21.  $\lim_{x \rightarrow \infty} \frac{\ln(x-10)}{\ln(4x+1)}$  (type  $\frac{\infty}{\infty}$ )

$$\begin{aligned} &= \lim_{x \rightarrow \infty} \frac{\left[ \frac{1}{x-10} \right]}{\left[ \frac{4}{4x+1} \right]} \\ &= \lim_{x \rightarrow \infty} \frac{4x+1}{4x-40} \quad (\text{type } \frac{\infty}{\infty}) \\ &= \lim_{x \rightarrow \infty} \frac{4}{4} = \frac{4}{4} = 1 \end{aligned}$$

22.  $\lim_{x \rightarrow 0^+} \frac{\sqrt{x}}{\ln(x+1)}$  (type  $\frac{0}{0}$ )

$$\begin{aligned} &= \lim_{x \rightarrow 0^+} \frac{\left[ \frac{1}{2\sqrt{x}} \right]}{\left[ \frac{1}{x+1} \right]} \\ &= \lim_{x \rightarrow 0^+} \frac{x+1}{2\sqrt{x}} = \infty \end{aligned}$$

23.  $\lim_{x \rightarrow \infty} \frac{e^{4x}}{e^{3x} + x}$  (type  $\frac{\infty}{\infty}$ )

$$\begin{aligned} &= \lim_{x \rightarrow \infty} \frac{4e^{4x}}{3e^{3x} + 1} \quad (\text{type } \frac{\infty}{\infty}) \\ &= \lim_{x \rightarrow \infty} \frac{16e^{4x}}{9e^{3x}} = \lim_{x \rightarrow \infty} \frac{16e^x}{9} = \infty \end{aligned}$$

24.  $\lim_{x \rightarrow 0} \frac{e^{2x}-1}{e^{5x}-1}$  (type  $\frac{0}{0}$ )

$$= \lim_{x \rightarrow 0} \frac{2e^{2x}}{5e^{5x}} = \lim_{x \rightarrow 0} \frac{2}{5e^{3x}} = \frac{2}{5}$$

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$$29. \lim_{x \rightarrow 0^+} \left( \frac{1}{x} \right)$$

$$= \lim_{x \rightarrow 0^+} \frac{1}{x}$$

$$= \lim_{x \rightarrow 0^+} \frac{1}{\cancel{x}}$$

$$= \lim_{x \rightarrow 0^+} \frac{1}{0}$$

$$= \lim_{x \rightarrow 0^+} \infty$$

$$= \lim_{x \rightarrow 0^+} \infty$$

$$30. \lim_{x \rightarrow \infty} (\sqrt{x})$$

$$= \lim_{x \rightarrow \infty} \sqrt{x}$$