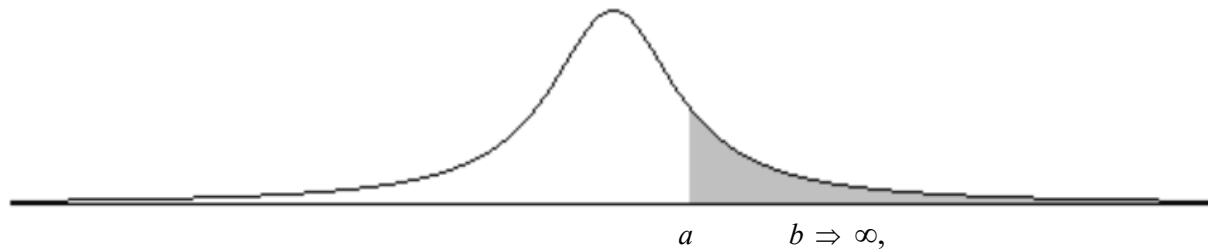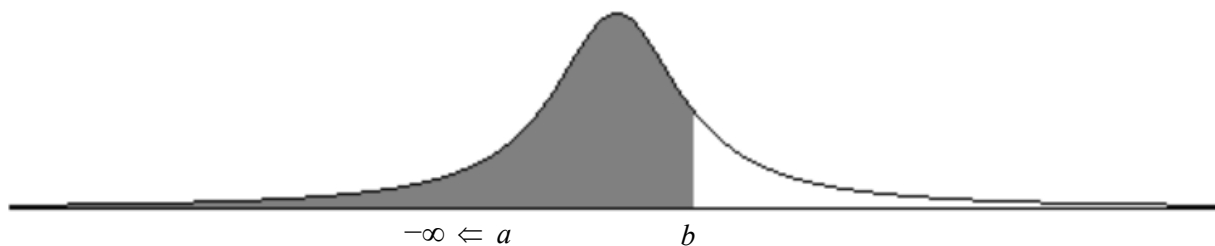# Two Types of Improper Integrals

8.9 *Calculus with Early Transcendentals* by Briggs, et al

6.5 *Active Calculus* by Matthew Boelkins (free digital in the Brightspace Course Support module)
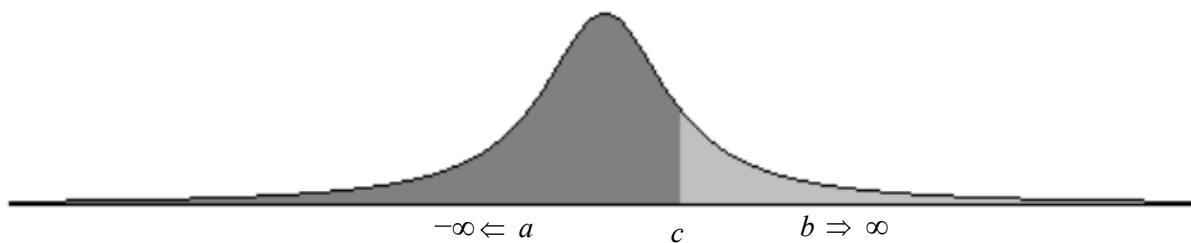
1. **Infinite Intervals**: We have an upper limit of ∞, we have a lower limit of −∞, or we have both. Complete the boxes.

$a \qquad b \Rightarrow \infty,$

$$\int_{\square}^{\square} f(x)\,dx$$

$-\infty \Leftarrow a \qquad b$

$$\int_{\square}^{\square} f(x)\,dx$$

$-\infty \Leftarrow a \qquad c \qquad b \Rightarrow \infty$
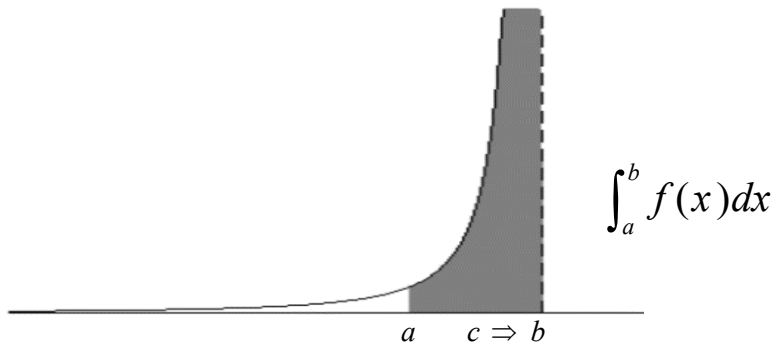
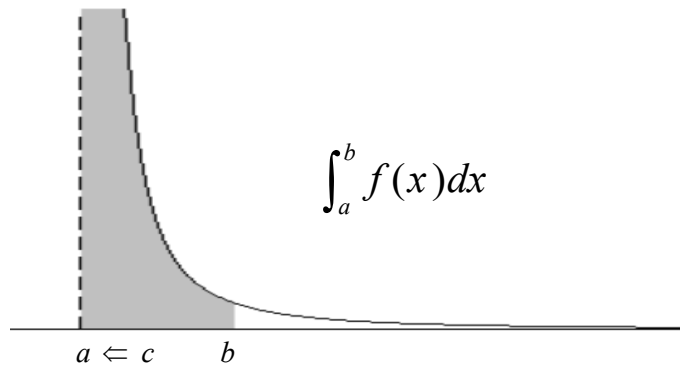$$\int_{\square}^{\square} f(x)\,dx$$

2. **Unbounded Integrands**: An infinite discontinuity (vertical asymptote) exists at a, b or in between.

$$\int_a^b f(x)dx$$

$$a \qquad c \Rightarrow b$$

Here $f(x)$ has a vertical asymptote at $x = b$, where b is the upper limit of integration.

$$\int_a^b f(x)dx$$

$$a \Leftarrow c \qquad b$$

Here $f(x)$ has a vertical asymptote at $x = a$, where a is the lower limit of integration.

$$a \qquad c \Rightarrow p \Leftarrow d \qquad b$$
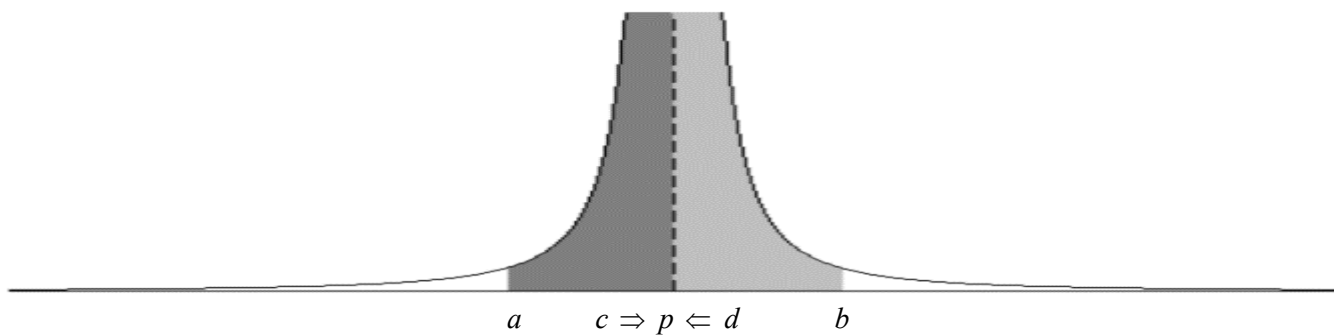
Here $f(x)$ has a vertical asymptote at $x = p$, where $a < p < b$. This case can be like a snake in the grass.

$$\int_a^b f(x)dx$$