

# Dirac Delta Function

## Summary of Different Forms

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	$\infty$ Volume (No boundary conditions)	<b>Finite Volume</b> (Boundary conditions)
<b>Volume = 4D spacetime <math>V</math></b>	$\delta^{(4)}(x-y) = \frac{1}{(2\pi)^4} \int e^{-i(x-y)p} d^4 p$ <p style="text-align: center;">Continuous momenta <math>p</math>  <math>\infty</math> or finite <math>p</math> volume            See bottom LH or bottom RH block            Continuous <math>x</math> or discrete <math>x_n</math></p>	$\delta^{(4)}(x-y) = \frac{1}{V} \sum_{n=-\infty}^{\infty} e^{-i(x-y)p_n}$ <p style="text-align: center;">Discrete momenta <math>p_n</math>  <math>\infty</math> or finite <math>p</math> volume            See bottom LH or bottom RH block            Continuous <math>x</math> or discrete <math>x_n</math></p>
<b>Volume = 4D momentum space <math>V_p</math></b>	$\delta^{(4)}(p'-p) = \frac{1}{(2\pi)^4} \int e^{-i(p'-p)x} d^4 x$ <p style="text-align: center;">Continuous spacetime <math>x</math>  <math>\infty</math> or finite <math>x</math> volume            See top LH or top RH blocks            Continuous <math>p</math> or discrete <math>p_n</math></p>	$\delta^{(4)}(p'-p) = \frac{1}{V_p} \sum_{n=-\infty}^{\infty} e^{-i(p'-p)x_n}$ <p style="text-align: center;">Discrete spacetime events <math>x_n</math>  <math>\infty</math> or finite <math>x</math> volume            See top LH or top RH blocks            Continuous <math>p</math> or discrete <math>p_n</math></p>

Note: Since integrals and sums are over all negative and positive values, the relations are equally valid with  $-i$  replaced by  $i$  in the exponentials above.