Tables

Fundamental constants

Name	Symbol	Approximate value	Unit
Speed of light in vacuum	c	2.998×10^{8}	m/s
Planck's constant	h	6.626×10^{-34}	Js
Reduced Planck's constant	$\hbar$	1.055×10^{-34}	Js
Permittivity of vacuum	ε_0	8.854×10^{-12}	C^2/Jm
Electron rest mass	m_e	9.109×10^{-31}	kg
Proton rest mass	m_p	1.673×10^{-27}	kg
Proton charge	e	1.602×10^{-19}	C
Atomic mass unit	amu	1.661×10^{-27}	kg
Bohr raduis	a_0	5.292×10^{-11}	m
Bolzmann's constant	k_B	1.381×10^{-23}	J/K
Avogadro's constant	N_A	6.022×10^{23}	1/mol
Rydberg's constant for hydrogen	R_H	109677.581	cm^{-1}

Quantities

Symbol	Quantity	Unit
λ	Wave length	m
f	Frequency	$\mathrm{Hz} = 1/\mathrm{s}$
ν	Frequency	$\mathrm{Hz} = 1/\mathrm{s}$
$\tilde{\nu}$	Wavenumber	$1/\mathrm{cm}$
v	Velocity	$\mathrm{m/s}$
a	Acceleration	$\mathrm{m/s^2}$
m	Mass	kg
μ	Reduced mass	kg
p	Momentum	$\mathrm{kgm/s}$
F	Force	$\mathrm{N} = \mathrm{kgm/s^2}$
E	Energy	$\mathrm{J} = \mathrm{kgm^2/s^2}$
ω	Angular velocity	$\mathrm{rad/s}$
α	Angular acceleration	$\mathrm{rad/s^2}$
l	Angular momentum	$\mathrm{Js} = \mathrm{kgm^2/s}$
I	Moment of inertia	$\mathrm{kgm^2}$

Derivatives

$$\frac{\mathrm{d}}{\mathrm{d}x} e^x = e^x$$

$$\frac{\mathrm{d}}{\mathrm{d}x} ax^n = anx^{n-1}$$

$$\frac{\mathrm{d}}{\mathrm{d}x} ae^{bx} = abe^{bx}$$

$$\frac{\mathrm{d}}{\mathrm{d}x} e^{ax^2} = 2axe^{ax^2}$$

$$\frac{\mathrm{d}^2}{\mathrm{d}x^2} f(x) = \frac{\mathrm{d}}{\mathrm{d}x} \frac{\mathrm{d}}{\mathrm{d}x} f(x)$$

$$\frac{\mathrm{d}}{\mathrm{d}x} \Big(f(x) + g(x) \Big) = \frac{\mathrm{d}f(x)}{\mathrm{d}x} + \frac{\mathrm{d}g(x)}{\mathrm{d}x}$$

$$\frac{\mathrm{d}}{\mathrm{d}x} \Big(f(x)g(x) \Big) = g(x)\frac{\mathrm{d}f(x)}{\mathrm{d}x} + f(x)\frac{\mathrm{d}g(x)}{\mathrm{d}x}$$

$$\frac{\mathrm{d}}{\mathrm{d}x} \left(\frac{f(x)}{g(x)} \right) = \frac{g(x)\frac{\mathrm{d}f(x)}{\mathrm{d}x} - f(x)\frac{\mathrm{d}g(x)}{\mathrm{d}x}}{(g(x))^2}$$

$$\frac{\mathrm{d}}{\mathrm{d}x} \left(\frac{1}{f(x)} \right) = -\frac{1}{(f(x))^2} \frac{\mathrm{d}f(x)}{\mathrm{d}x}$$

$$\frac{\mathrm{d}f(u)}{\mathrm{d}x} = \frac{\mathrm{d}f(u)}{\mathrm{d}u} \frac{\mathrm{d}u}{\mathrm{d}x}$$

$$\frac{\mathrm{d}(\sin(x)\cos(x))}{\mathrm{d}x} = \cos x \frac{\mathrm{d}\sin(x)}{\mathrm{d}x} + \sin(x)\frac{\mathrm{d}\cos(x)}{\mathrm{d}x} = \cos^2(x) - \sin^2(x)$$

$$\frac{\mathrm{d}\ln\left(x^2\right)}{\mathrm{d}x} = \frac{\mathrm{d}\ln\left(x^2\right)}{\mathrm{d}\left(x^2\right)} \frac{\mathrm{d}\left(x^2\right)}{\mathrm{d}x} = \frac{2x}{x^2} = \frac{2}{x}$$

Integrals

$$\int f(x)\mathrm{d}x = F(x) + C$$

$$\int x^n \mathrm{d}x = \frac{x^{n+1}}{n+1} + C, n \neq -1$$

$$\int \frac{dx}{x}\mathrm{d}x = \ln x + C$$

$$\int e^{ax}\mathrm{d}x = \frac{e^{ax}}{a} + C$$

$$\int\limits_0^\infty x^n e^{-ax}\mathrm{d}x = \frac{n!}{a^{n+1}}$$

$$\int\limits_0^\infty e^{-ax^2}\mathrm{d}x = \frac{1}{2}\sqrt{\frac{\pi}{a}}$$

$$\int\limits_0^\infty xe^{-ax^2}\mathrm{d}x = \frac{1}{2a}$$

$$\int\limits_0^\infty x^2 e^{-ax^2}\mathrm{d}x = \frac{1}{4}\sqrt{\frac{\pi}{a^3}}$$

$$\int\limits_0^\infty x^3 e^{-ax^2}\mathrm{d}x = \frac{1}{2a^3}$$

$$\int \sin(ax)\,\mathrm{d}x = -\frac{1}{a}\cos(ax) + C$$

$$\int \sin^2(ax)\,\mathrm{d}x = \frac{1}{2}x - \frac{\sin(2ax)}{4a} + C$$

$$\int x\sin^2(ax)\,\mathrm{d}x = \frac{x^2}{4} - \frac{x\sin(2ax)}{4a} - \frac{\cos(2ax)}{8a^2} + C$$

$$\int_0^a x^2\sin^2(kx)\,\mathrm{d}x = \frac{a^3}{6} - \left(\frac{a^2}{4k} - \frac{1}{8k^3}\right)\sin(2ka) - \frac{a}{4k^2}\cos(2ka)$$

Trigonometrics

$$\begin{aligned}
e^{ix} &= \cos x + i \sin x \quad \text{(Euler's formula)} \\
\sin x &= \frac{e^{ix} - e^{-ix}}{2i} \\
\cos x &= \frac{e^{ix} + e^{-ix}}{2} \\
\sin^2 x + \cos^2 x &= 1 \\
\sin^2 x - \cos^2 x &= -\cos(2x) \\
\sin(2x) &= 2 \sin x \cos x \\
\cos(2x) &= \cos^2 x - \sin^2 x = 2\cos^2 x - 1 = 1 - 2\sin^2 x \\
\sin^2 x &= \frac{1}{2}(1 - \cos(2x)) \\
\cos^2 x &= \frac{1}{2}(1 + \cos(2x))
\end{aligned}$$