WALL KEY

The Canon Board

Sixty-four formulas · files are domains · ranks origin horizon

FILE DOMAINS

a Number b Structure c Change d Space e Motion f Field g Quantum h World

a1 Number · Arithmetic

$1 + 1 = 2$

The elementary arithmetic identity at the root of counting.

a2 Number · Pythagoras

$a^2 + b^2 = c^2$

Pythagorean theorem relating sides of a right triangle.

a3 Number · Irrational

$\sqrt{2} \notin \mathbb{Q}$

√2 is irrational — not a ratio of integers.

a4 Number · Unique factorization

$n = \prod p_i^{e_i}$

Fundamental theorem of arithmetic: unique prime factorization.

a5 Number · Infinitude of primes

$\forall N \, \exists p > N$

There are infinitely many prime numbers.

a6 Number · Euler identity

$e^{i\pi} + 1 = 0$

Euler’s identity linking e, i, π, 1, and 0.

a7 Number · Prime number theorem

$\pi(x) \sim x/\ln x$

Prime-number theorem: π(x) grows like x / ln x.

a8 Number · Continuum

$2^{\aleph_0} > \aleph_0$

The continuum is strictly larger than the countable infinity.

b1 Structure · Zero

0

Zero — the additive identity and origin of structure.

b2 Structure · Congruence

$a \equiv b \pmod{n}$

Modular congruence: a and b agree modulo n.

b3 Structure · Binomial

$(x + y)^n = \sum \binom{n}{k} x^{n-k} y^k$

Binomial theorem expanding (x + y)^n.

b4 Structure · FTA

$\exists z \in \mathbb{C}, \; p(z) = 0$

Fundamental theorem of algebra: every non-constant polynomial has a complex root.

b5 Structure · Euler formula

$e^{i\theta} = \cos\theta + i\sin\theta$

Euler’s formula relating exponentials and trigonometry.

b6 Structure · Galois

$\mathrm{Gal}(K/F)$

Galois group of a field extension K/F.

b7 Structure · Eigenvalue

$Av = \lambda v$

Eigenvalue equation: A sends v to a scalar multiple.

b8 Structure · Incompleteness

$T \nvdash \mathrm{Con}(T)$

Gödel: a consistent theory cannot prove its own consistency.

c1 Change · Derivative

$\frac{dy}{dx} = f'(x)$

The derivative — instantaneous rate of change.

c2 Change · FTC

$\int_a^b f'(x)\,dx = f(b) - f(a)$

Fundamental theorem of calculus.

c3 Change · Exponential

$e = \sum 1/n!$

Series definition of the base of the natural logarithm.

c4 Change · Fourier

$\hat{f}(\xi) = \int f e^{-2\pi i x \xi}\,dx$

Fourier transform in frequency space.

c5 Change · Basel

$\sum n^{-2} = \pi^2/6$

Basel problem: sum of reciprocal squares.

c6 Change · Residue

$\oint f = 2\pi i \sum \mathrm{Res}$

Cauchy’s residue theorem for contour integrals.

c7 Change · Wave

$\Box u = 0$

Wave / d’Alembert equation □u = 0.

c8 Change · Least action

$\delta S = 0$

Principle of least (stationary) action.

d1 Space · Circumference

$C = 2\pi r$

Circumference of a circle.

d2 Space · Area

$A = \pi r^2$

Area of a disk.

d3 Space · Volume

$V = \frac{4}{3}\pi r^3$

Volume of a ball.

d4 Space · Euclidean metric

$ds^2 = dx^2 + dy^2 + dz^2$

Euclidean line element in three dimensions.

d5 Space · Euler characteristic

$V - E + F = 2$

Euler characteristic of a polyhedron / sphere.

d6 Space · Gauss–Bonnet

$\int K\,dA = 2\pi\chi$

Gauss–Bonnet: curvature integrates to topology.

d7 Space · Riemannian metric

$ds^2 = g_{\mu\nu} dx^\mu dx^\nu$

Riemannian metric as the general line element.

d8 Space · Fundamental group

$\pi_1(S^1) = \mathbb{Z}$

Fundamental group of the circle is the integers.

e1 Motion · Free fall

$s = \frac{1}{2} g t^2$

Galilean free fall under constant gravity.

e2 Motion · Newton II

$F = ma$

Newton’s second law.

e3 Motion · Gravitation

$F = G m_1 m_2 / r^2$

Newton’s law of universal gravitation.

e4 Motion · Kepler III

$T^2/a^3 = 4\pi^2/(GM)$

Kepler’s third law (Newtonian form).

e5 Motion · Momentum

$F = dp/dt$

Force as rate of change of momentum.

e6 Motion · Euler–Lagrange

$\frac{d}{dt}\frac{\partial L}{\partial \dot{q}} = \frac{\partial L}{\partial q}$

Euler–Lagrange equation of classical mechanics.

e7 Motion · Noether

$\text{symmetry} \Rightarrow \partial_\mu j^\mu = 0$

Noether’s theorem: symmetry implies a conserved current.

e8 Motion · Einstein

$G_{\mu\nu} + \Lambda g_{\mu\nu} = \kappa T_{\mu\nu}$

Einstein field equations with cosmological constant.

f1 Field · Ideal gas

$PV = nRT$

Ideal-gas law.

f2 Field · First law

$dU = \delta Q - \delta W$

First law of thermodynamics.

f3 Field · Boltzmann

$S = k \ln W$

Boltzmann’s entropy formula.

f4 Field · Coulomb

$F = k_e q_1 q_2 / r^2$

Coulomb’s law for electrostatic force.

f5 Field · Gauss

$\nabla \cdot E = \rho/\varepsilon_0$

Gauss’s law for electric fields.

f6 Field · No monopoles

$\nabla \cdot B = 0$

No magnetic monopoles (divergence-free B).

f7 Field · Faraday

$\nabla \times E = -\partial_t B$

Faraday’s law of induction.

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f8 Field · Ampère–Maxwell

$$\nabla \times B = \mu_0 J + \mu_0 \varepsilon_0 \partial_t E$$

Ampère–Maxwell law.

g1 Quantum · Planck

$$E = h\nu$$

Planck relation: energy of a quantum.

g2 Quantum · de Broglie

$$\lambda = h/p$$

de Broglie wavelength of matter.

g3 Quantum · Uncertainty

$$\Delta x \, \Delta p \geq \hbar/2$$

Heisenberg uncertainty principle.

g4 Quantum · Schrödinger

$$i\hbar \partial_t \Psi = \hat{H}\Psi$$

Time-dependent Schrödinger equation.

g5 Quantum · Dirac

$$(i\gamma^\mu \partial_\mu - m)\psi = 0$$

Dirac equation for spin-½ fermions.

g6 Quantum · Commutator

$$[x, p] = i\hbar$$

Canonical commutation relation.

g7 Quantum · Mass–energy

$$E = mc^2$$

Mass–energy equivalence.

g8 Quantum · Higgs

$$V = \mu^2|\phi|^2 + \lambda|\phi|^4$$

Higgs potential (Mexican-hat form).

h1 World · Hubble

$$v = H_0 d$$

Hubble–Lemaître law of cosmic expansion.

h2 World · Minkowski

$$ds^2 = -c^2dt^2 + dx^2$$

Minkowski spacetime interval (c-units form).

h3 World · Lorentz

$$\gamma = (1 - v^2/c^2)^{-1/2}$$

Lorentz factor of special relativity.

h4 World · Light

$$c = 1/\sqrt{\mu_0 \varepsilon_0}$$

Speed of light from vacuum permittivity and permeability.

h5 World · Shannon

$$H = -\sum p_i \log p_i$$

Shannon entropy of a discrete distribution.

h6 World · Bell

$$S_{\mathrm{CHSH}} \leq 2$$

CHSH Bell inequality (classical bound).

h7 World · Bekenstein–Hawking

$$S = A/(4\ell_P^2)$$

Bekenstein–Hawking black-hole entropy.

h8 World · Friedmann

$$H^2 = 8\pi G\rho/3 + \Lambda c^2/3$$

Friedmann equation of cosmology.

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