Physics Fundamentals Cheatsheet

A concise reference guide to fundamental concepts, formulas, and principles in Physics. Ideal for students and professionals seeking a quick review.

Mechanics

Kinematics

Displacement (Δx)	$\Delta x = x_f - x_i$ (final position - initial position)
Average Velocity (v_{avg})	$v_{avg} = \frac{\Delta x}{\Delta t}$ (displacement / time)
Average Acceleration (a_{avg})	$a_{avg} = \frac{\Delta v}{\Delta t}$ (change in velocity / time)
Final Velocity (v_f) (constant acceleration)	$v_f = v_i + at$ (initial velocity + acceleration * time)
Displacement (Δx) (constant acceleration)	$\Delta x = v_i t + \frac{1}{2}at^2$
Final Velocity Squared (v_f^2) (constant acceleration)	$v_f^2 = v_i^2 + 2a\Delta x$
Position (x) as a function of time (t)	$x(t) = x_0 + v_0t + (1/2)at^2$
Average Speed	Total distance traveled / Total time

Dynamics

Newton's First Law (Inertia)	An object at rest stays at rest, and an object in motion stays in motion with the same speed and in the same direction unless acted upon by a force.
Newton's Second Law	$F = ma$ (Force = mass * acceleration)
Newton's Third Law	For every action, there is an equal and opposite reaction.
Weight (W)	$W = mg$ (mass * acceleration due to gravity)
Frictional Force (F_f)	$F_f = \mu F_N$ (coefficient of friction * normal force)
Static Friction	$F_s \le \mu_s F_N$
Kinetic Friction	$F_k = \mu_k F_N$

Work and Energy

Work (W)	$W = Fd \cos(\theta)$ (force * distance * cosine of the angle between them)
Kinetic Energy (KE)	$KE = \frac{1}{2}mv^2$ (1/2 * mass * velocity squared)
Potential Energy (PE) - Gravitational	$PE = mgh$ (mass * gravity * height)
Potential Energy (PE) - Spring	$PE = \frac{1}{2}kx^2$ (1/2 * spring constant * displacement squared)
Power (P)	$P = \frac{W}{\Delta t}$ (work / time)
Work-Energy Theorem	$W_{net} = \Delta KE$
Conservation of Mechanical Energy (no non-conservative forces)	$KE_i + PE_i = KE_f + PE_f$
Efficiency	$\frac{W_{out}}{W_{in}}$

Thermodynamics

Thermodynamic Definitions

Temperature (T)	A measure of the average kinetic energy of the particles in a system.
Heat (Q)	The transfer of energy between objects due to a temperature difference.
Internal Energy (U)	The total energy of all the molecules within a substance.
Specific Heat (c)	The amount of heat required to raise the temperature of 1 gram of a substance by 1 degree Celsius.
Latent Heat (L)	The heat required to cause a phase change (e.g., solid to liquid).

Laws of Thermodynamics

Zeroth Law	If two systems are each in thermal equilibrium with a third system, then they are in thermal equilibrium with each other.
First Law	$\Delta U = Q - W$ (change in internal energy = heat added - work done by the system)
Second Law	The entropy of an isolated system always increases or remains constant. Heat cannot spontaneously flow from a cold body to a hot body.
Third Law	The entropy of a system approaches a constant value as the temperature approaches absolute zero.

Heat Transfer

Conduction	$Q = \frac{kA\Delta T t}{L}$ (heat transfer through a material)
Convection	Heat transfer by the movement of a fluid.
Radiation	$Q = \epsilon \sigma A T^4 t$ (heat transfer by electromagnetic radiation)
Stefan-Boltzmann Constant	$\sigma = 5.67 \times 10^{-8} W/m^2K^4$

Electromagnetism

Electrostatics

Coulomb's Law	$F = k \frac{|q_1 q_2|}{r^2}$ (force between two point charges)
Electric Field (E)	$E = \frac{F}{q}$ (force per unit charge)
Electric Potential (V)	$V = \frac{PE}{q}$ (potential energy per unit charge)
Electric Potential Energy (PE)	$PE = qV$
Capacitance (C)	$C = \frac{Q}{V}$ (charge / voltage)

Magnetism

Magnetic Force on a Moving Charge	$F = qvB \sin(\theta)$ (charge * velocity * magnetic field * sine of the angle)
Magnetic Force on a Current-Carrying Wire	$F = ILB \sin(\theta)$ (current * length * magnetic field * sine of the angle)
Magnetic Field due to a Long Straight Wire	$B = \frac{\mu_0 I}{2 \pi r}$
Permeability of Free Space	$\mu_0 = 4\pi \times 10^{-7} T \cdot m/A$

Electromagnetic Induction

Faraday's Law	$\mathcal{E} = -N \frac{\Delta \Phi_B}{\Delta t}$ (induced emf = - number of turns * change in magnetic flux / time)
Magnetic Flux (Φ_B)	$\Phi_B = BA \cos(\theta)$ (magnetic field * area * cosine of the angle)

Waves and Optics

Wave Properties

Wave Speed (v)	$v = f\lambda$ (frequency * wavelength)
Period (T)	$T = \frac{1}{f}$ (1 / frequency)
Wave Number (k)	$k = \frac{2\pi}{\lambda}$

Optics

Snell's Law	$n_1 \sin(\theta_1) = n_2 \sin(\theta_2)$ (refractive index * sine of the angle)
Index of Refraction (n)	$n = \frac{c}{v}$ (speed of light in vacuum / speed of light in the medium)
Critical Angle (θ_c)	$\sin(\theta_c) = \frac{n_2}{n_1}$ (for total internal reflection, $n_1 > n_2$)
Lens Equation	$\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i}$ (focal length, object distance, image distance)
Magnification (M)	$M = - \frac{d_i}{d_o}$

Interference and Diffraction

Constructive Interference (Double Slit)	$d \sin(\theta) = m \lambda$ (path difference = integer * wavelength)
Destructive Interference (Double Slit)	$d \sin(\theta) = (m + \frac{1}{2}) \lambda$