

OKABE-ITO Full Palette Showcase

Colorblind-Safe Scientific Colors

9 distinct colors optimized for accessibility

Palette (7 punchy colors):

- Orange Sky Blue Bluish Green
- Blue Vermillion Reddish Purple Black

Semantic Color Mapping

KINEMATICS

- d = displacement
- v = velocity
- a = acceleration
- t = time
- g = gravity

THERMODYNAMICS

- P = pressure
- V = volume
- T, Q = temperature, heat
- N = particles
- W = work
- U = internal energy
- k, g = constants

Kinematics: Definition of Acceleration

Nature's Rule for Acceleration

$$\bar{a} = \frac{\Delta v}{\Delta t} = \frac{v_f - v_0}{t_f - t_0}$$

Acceleration equals change in velocity divided by change in time.

- \bar{a} = average acceleration (m/s^2)
- v_f, v_0 = final and initial velocity (m/s)
- t_f, t_0 = final and initial time (s)

Kinematics: The Five Equations

For constant **acceleration** only:

$$d = d_0 + \bar{v}t \quad (1)$$

$$\bar{v} = \frac{v_0 + v_f}{2} \quad (2)$$

$$v = v_0 + at \quad (3)$$

$$d = d_0 + v_0t + \frac{1}{2}at^2 \quad (4)$$

$$v^2 = v_0^2 + 2a(d - d_0) \quad (5)$$

Kinematics: Gravitational Acceleration

Nature's Constant

$$g = 9.80 \text{ m/s}^2$$

Near Earth's surface, all objects fall with this **acceleration**.

Free fall equations:

$$y = y_0 + v_0 t + \frac{1}{2}(-g)t^2 \quad (6)$$

$$v = v_0 - g t \quad (7)$$

Every second, **velocity** increases by 9.80 m/s downward.

Thermodynamics: Pressure Definition

Definition: Pressure

$$P = \frac{F}{A}$$

Pressure is force per unit area perpendicular to surface.

- P = pressure (Pa)
- F = force (N)
- A = area (m^2)
- SI unit: Pascal (Pa), where $1 \text{ Pa} = 1 \text{ N/m}^2$

Thermodynamics: Ideal Gas Law

Universal Law: Gas Behavior

$$PV = NkT$$

Pressure \times volume = particles \times Boltzmann constant \times temperature

- P = pressure (Pa)
- V = volume (m^3)
- N = number of particles
- $k = 1.38 \times 10^{-23}$ J/K (Boltzmann constant)
- T = absolute temperature (K)

Thermodynamics: Pressure-Volume Work

Nature's Rule for Gases

$$W = P\Delta V$$

Work equals pressure times change in volume.

- W = work done by gas (J)
- P = pressure (Pa)
- ΔV = change in volume (m^3)

Gas expands \rightarrow positive work done BY system

Thermodynamics: First Law (Energy Conservation)

Universal Law: Energy Conservation

$$\Delta U = Q - W$$

Change in **internal energy** = **heat** added – **work** done by system

- ΔU = change in **internal energy** (J)
- Q = net **heat** into system (J)
- W = net **work** by system (J)

Signs: + Q adds energy, + W removes energy

Thermodynamics: Entropy (Second Law)

Definition: Entropy

$$\Delta S = \frac{Q}{T}$$

Change in **entropy** = **heat** transfer $\nabla \cdot$ **absolute temperature**

- ΔS = change in **entropy** (J/K)
- Q = **heat** transfer (J)
- T = **absolute temperature** (K)

Second Law: $\Delta S_{\text{total}} \geq 0$ (entropy always increases)

Thermodynamics: Heat Engine Efficiency

Definition: Efficiency

$$\text{Eff} = \frac{W}{Q_h}$$

Efficiency = useful **work** output $\nabla \cdot$ **heat** input

- W = **work** output (J)
- Q_h = **heat** from hot reservoir (J)
- $W = Q_h - Q_c$

Second Law limit: 100% efficiency impossible!

Cross-Domain Color Consistency

Semantic Mapping Rationale

Colors map to conceptual roles across physics domains:

Role	Kinematics	Thermodynamics
Space/Position	displacement d	volume V
Flow/Transfer	velocity v	work W
Intensity	acceleration a	temperature T , heat Q
Count/Progress	time t	particles N
Distribution	—	pressure P
Stored	—	energy U