Physics Booklet

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Contents

Classical Mechanics

1.1 Kinematics

1.1.1 Basic concepts

- Velocity

$$\overrightarrow{v}(t) = \frac{d\overrightarrow{r}}{dt}$$

  $\overrightarrow{r}(t)$: position

- Speed

$$v = |\overrightarrow{v}| = \left|\frac{d\overrightarrow{r}}{dt}\right|$$

- Acceleration

$$\overrightarrow{a}(t) = \frac{d\overrightarrow{v}}{dt}$$

- Other rates
  - Jerk

$$\overrightarrow{j}(t) = \frac{d\overrightarrow{a}}{dt}$$

  - Snap

$$\overrightarrow{s}(t) = \frac{d\overrightarrow{j}}{dt}$$

  - Crackle

$$\overrightarrow{c}(t) = \frac{d\overrightarrow{s}}{dt}$$

  - Pop

$$\overrightarrow{p}(t) = \frac{d\overrightarrow{c}}{dt}$$

1.1.2 Constant acceleration cases (theorems)

1. $v(t) = v_0 + at$

$$a = \frac{dv}{dt} \quad \therefore \quad \int_{t_0}^{t} a dt = \int_{t_0}^{t} \frac{dv}{dt} dt$$
$$\therefore \quad a \cdot (t - t_0) = [v(t)]_{t_0}^{t} \quad \therefore \quad v(t) = v_0 + at$$

2. $x(t) = x_0 + v_0 t + \frac{at^2}{2}$

$$v(t) = v_0 + at \quad \therefore \quad \int_{t_0}^{t} v(t) dt = \int_{t_0}^{t} (v_0 + at) dt$$
$$\therefore \quad x(t) = x_0 + v_0 t + \frac{at^2}{2}$$

3. $x(t) = x_0 + vt - \frac{at^2}{2}$

$$v = v_0 + at \quad \therefore \quad v_0 = v - at$$

$$\therefore \quad x(t) = x_0 + (v - at)t + \frac{at^2}{2} \quad \therefore \quad x(t) = x_0 + vt - \frac{at^2}{2}$$

4. $x(t) = x_0 + \frac{(v_0+v)t}{2}$

$$2x = x(t) + x(t) = \left(x_0 + v_0 t + \frac{at^2}{2}\right) + \left(x_0 + vt - \frac{at^2}{2}\right)$$

$$\therefore \quad 2x = 2x_0 + v_0 t + vt \quad \therefore \quad x(t) = x_0 + \frac{(v_0 + v)t}{2}$$

5. $v^2 = v_0^2 + 2a(x - x_0)$

$$\begin{cases} v(t) = v_0 + at \\ x(t) = x_0 + \frac{(v_0+v)t}{2} \end{cases} \quad \therefore \quad \begin{cases} v - v_0 = at \\ v + v_0 = \frac{2(x-x_0)}{t} \end{cases}$$

$$\therefore \quad v^2 = v_0^2 + 2a(x - x_0)$$

1.2 Forces

1.3 Energy

1.4 Momentum

1.5 Angular momentum

1.6 Lagrangian method

Relativistic Mechanics

Electromagnetism

Thermodynamics

Statistical mechanics

Quantum mechanics