

# Physics Booklet

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# Classical Mechanics

## 1.1 Kinematics

### 1.1.1 Basic concepts

- Velocity

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

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

- Speed

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

- Acceleration

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

- Other rates

– Jerk

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

– Snap

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

– Crackle

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

– Pop

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

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

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

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

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

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

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

$$2x = x(t) + x(t) = \left(x_0 + v_0t + \frac{at^2}{2}\right) + \left(x_0 + vt - \frac{at^2}{2}\right)$$

$$\therefore \quad 2x = 2x_0 + v_0t + vt \quad \therefore \quad x(t) = x_0 + \frac{(v_0+v)t}{2}$$

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

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

## 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