CHAPTER 1

Physical Entities (Base quantities)	Fundamental Units SI unit-name (symbol)
length	meter (m)
mass	kilogram (Kg)
time	second (s)
electric current	ampere (A)
temperature	Kelvin (K)
Amount of substance	Mole (mol)
luminous intensity	Candela (cd)

Factor	Prefix[a]	Symbol
10^{24}	yotta-	Y
10^{21}	zetta-	Z
10^{18}	exa-	E
10^{15}	peta-	P
10^{12}	tera-	T
10^{9}	**giga-**	**G**
10^{6}	**mega-**	**M**
10^{3}	**kilo-**	**k**
10^{2}	hecto-	h
10^{1}	deka-	da
10^{-1}	deci-	d
10^{-2}	**centi-**	**c**
10^{-3}	**milli-**	**m**
10^{-6}	**micro-**	**μ**
10^{-9}	**nano-**	**n**
10^{-12}	**pico-**	**p**
10^{-15}	femto-	f
10^{-18}	atto-	a
10^{-21}	zepto-	z
10^{-24}	yocto-	y

Significant Figures (有效數字)

- Meaningful digits

Decimal Place (小數數位)

- The position of a digit to the right of the decimal point in a decimal number

Density (密度)

- $\rho = \frac{m}{v}$

Errors Calculations

- $Absolute\ Error\ =\ Measure\ Error - True\ Value$
- $Relative\ Error\ =\ \frac{Absolute\ Error}{True\ Value}$
- $Percentage\ Error\ =\ Relative\ error \times 100\%$

Types of Error

1. Human Error
2. Random Error
3. Systematic Error

Precision (精準度)

- Specifies the repeatability or consistency of successive measurements

Accuracy (準確度)

- Specifies the deviation between the measured and true value

CHAPTER 2

Distance (距離)

- Total length of path

Displacement (位移)

- Change in position
- $\Delta x = x_2 - x_1$

Average Speed (平均速度)

- $s_{avg} = \frac{Total\ Distance}{\Delta t}$

Average Velocity (平均速率)

- $v_{avg} = \frac{\Delta x}{\Delta t}$

Instantaneous Speed (暫態速度)

- Magnitude of instantaneous velocity

Instantaneous Velocity (暫態速率)

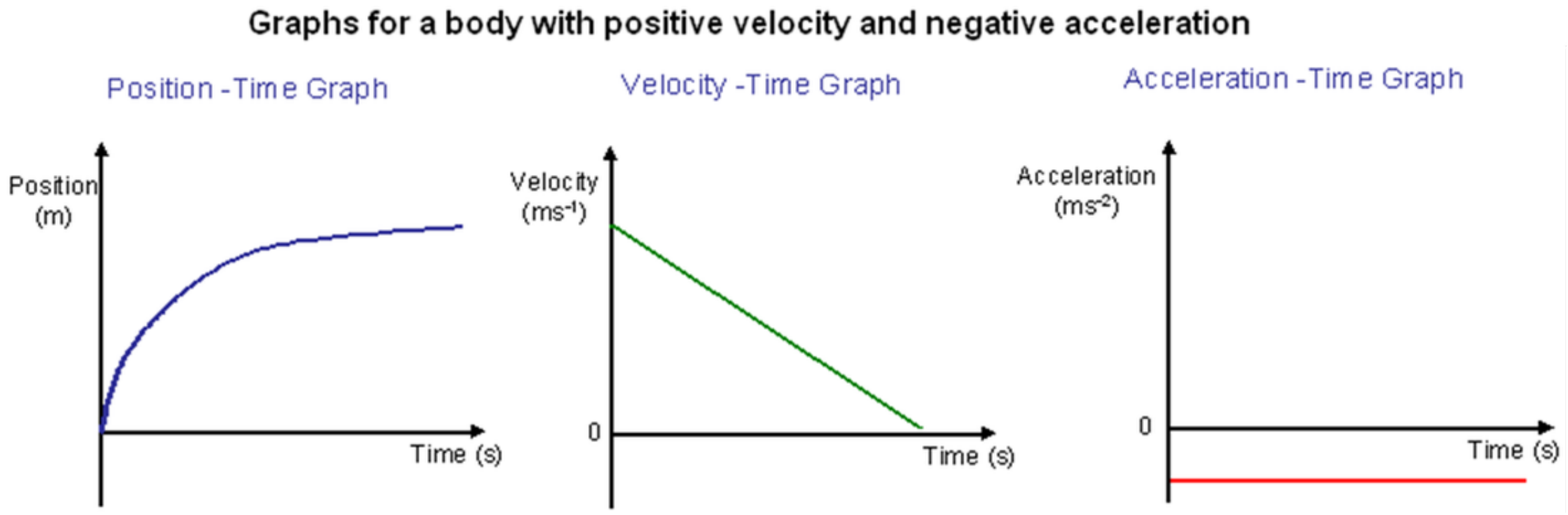
- $v = \lim_{\Delta t \to 0} \frac{\Delta x}{\Delta t} = \frac{dx}{dt}$

Acceleration (加速度)

- $a_{avg} = \frac{v_2 - v_1}{t_2 - t_1} = \frac{\Delta v}{\Delta t}$

Instantaneous Acceleration (暫態加速度)

- $a = \frac{dv}{dt}$



- $s = \int v dt$
- $v = \int a dt$
- $v = \frac{ds}{dt}$
- $a = \frac{dv}{dt}$

Equation Number	Equation	Missing Quantity
2-11	$v = v_0 + at$	$x - x_0$
2-15	$x - x_0 = v_0 t + \frac{1}{2}at^2$	v
2-16	$v^2 = v_0^2 + 2a(x - x_0)$	t
2-17	$x - x_0 = \frac{1}{2}(v_0 + v)t$	a
2-18	$x - x_0 = vt - \frac{1}{2}at^2$	v_0

CHAPTER 3

Scalar (標量)

- Have magnitude only

Vector (向量)

- Have both magnitude and direction

Properties of Vector

- $\vec{a} + \vec{b} = \vec{b} + \vec{a}$
- $(\vec{a} + \vec{b}) + \vec{c} = \vec{a} + (\vec{b} + \vec{c})$
- $\vec{a} - \vec{b} = \vec{a} + (-\vec{b})$

Unit-Vector Notations

- $a = a_x\vec{\imath} + a_y\vec{\jmath}$

Magnitude-Angle Notations

- $a_x = acos\emptyset$
- $a_y = asin\emptyset$
- $a = \sqrt{a_x{}^2 + a_y{}^2}$
- $tan\emptyset = \frac{a_y}{a_x}$

Unit Vector (單位向量)

- $\hat{A} = \frac{\vec{A}}{|\vec{A}|}$

Scalar Product (標量積)/ Dot Product (點積)

- $\vec{a} \cdot \vec{b} = abcos\emptyset$
- $\vec{a} \cdot \vec{b} = a_x b_x + a_y b_y + a_z b_z$

Vector Product(向量積)/ Cross Product (叉積)

- $\vec{a} \times \vec{b} = \vec{c}$
- $c = absin\emptyset$
- $\vec{a} \times \vec{b} = \left(a_y b_z - b_y a_z\right)\hat{\imath} + (a_z b_x - b_z a_x)\hat{\jmath} + (a_x b_y - b_x a_y)\hat{k}$

•31 SSM Suppose a rocket ship in deep space moves with constant acceleration equal to $9.8\ m/s^2$, which gives the illusion of normal gravity during the flight. (a) If it starts from rest, how long will it take to acquire a speed one-tenth that of light, which travels at $3.0 \times 10^8\ m/s$? (b) How far will it travel in so doing?

ANALYZE (a) Given that $a = 9.8 \text{ m/s}^2$, $v_0 = 0$ and $v = 0.1c = 3.0\times10^7 \text{ m/s}$, we can solve $v = v_0 + at$ for the time:

$$t = \frac{v - v_0}{a} = \frac{3.0\times10^7 \text{ m/s} - 0}{9.8 \text{ m/s}^2} = 3.1\times10^6 \text{ s}$$

which is about 1.2 months. So it takes 1.2 months for the rocket to reach a speed of $0.1c$ starting from rest with a constant acceleration of 9.8 m/s^2.

(b) To calculate the distance traveled during this time interval, we evaluate $x = x_0 + v_0 t + \frac{1}{2}at^2$, with $x_0 = 0$ and $v_0 = 0$. The result is

$$x = \frac{1}{2}\left(9.8 \text{ m/s}^2\right)(3.1\times10^6 \text{s})^2 = 4.6\times10^{13} \text{ m.}$$

•33 SSM ILW A car traveling 56.0 km/h is 24.0 m from a barrier when the driver slams on the brakes. The car hits the barrier 2.00 s later. (a) What is the magnitude of the car's constant acceleration before impact? (b) How fast is the car traveling at impact?

ANALYZE (a) Using Eq. 2-15, we find the acceleration to be

$$a = \frac{2(x - v_0 t)}{t^2} = \frac{2\left[(24.0\text{ m}) - (15.55\text{ m/s})(2.00\text{ s})\right]}{(2.00\text{ s})^2} = -3.56\,\text{m/s}^2,$$

or $|a| = 3.56\text{ m/s}^2$. The negative sign indicates that the acceleration is opposite to the direction of motion of the car; the car is slowing down.

(b) The speed of the car at the instant of impact is

$$v = v_0 + at = 15.55\text{ m/s} + (-3.56\text{ m/s}^2)(2.00\text{ s}) = 8.43\text{ m/s}$$

which can also be converted to 30.3 km/h.

••41 SSM ILW WWW Use the definition of scalar product, $\vec{a} \cdot \vec{b} = ab \cos \theta$, and the fact that $\vec{a} \cdot \vec{b} = a_x b_x + a_y b_y + a_z b_z$ to calculate the angle between the two vectors given by $\vec{a} = 3.0\hat{i} + 3.0\hat{j} + 3.0\hat{k}$ and $\vec{b} = 2.0\hat{i} + 1.0\hat{j} + 3.0\hat{k}$.

ANALYZE Given that $\vec{a} = (3.0)\hat{\mathrm{i}} + (3.0)\hat{\mathrm{j}} + (3.0)\hat{\mathrm{k}}$ and $\vec{b} = (2.0)\hat{\mathrm{i}} + (1.0)\hat{\mathrm{j}} + (3.0)\hat{\mathrm{k}}$, the magnitudes of the vectors are

$$a = |\vec{a}| = \sqrt{a_x^2 + a_y^2 + a_z^2} = \sqrt{(3.0)^2 + (3.0)^2 + (3.0)^2} = 5.20$$

$$b = |\vec{b}| = \sqrt{b_x^2 + b_y^2 + b_z^2} = \sqrt{(2.0)^2 + (1.0)^2 + (3.0)^2} = 3.74.$$

The angle between them is found to be

$$\cos\phi = \frac{(3.0)(2.0) + (3.0)(1.0) + (3.0)(3.0)}{(5.20)(3.74)} = 0.926,$$

or $\phi = 22°$.

53 **SSM** A vector $\vec{a}$ of magnitude 10 units and another vector $\vec{b}$ of magnitude 6.0 units differ in directions by 60°. Find (a) the scalar product of the two vectors and (b) the magnitude of the vector product $\vec{a} \times \vec{b}$.

ANALYZE (a) Given that $a = |\vec{a}| = 10$, $b = |\vec{b}| = 6.0$ and $\phi = 60°$, the scalar (dot) product of $\vec{a}$ and $\vec{b}$ is

$$\vec{a} \cdot \vec{b} = ab \cos\phi = (10)(6.0)\cos 60° = 30.$$

(b) Similarly, the magnitude of the vector (cross) product of the two vectors is

$$|\vec{a} \times \vec{b}| = ab \sin\phi = (10)(6.0)\sin 60° = 52.$$