

- :



(Physical Quantities) : **1-1**

(measured quantities)

(calculated quantities)

2-1

(physical quantity)

4

$$\frac{1}{2} mv^2$$

(basic quantities)

(derived

/

quantities)

$$. (1 \text{ N} = 1 \text{ kg} \cdot \text{m} / \text{s}^2)$$

(SI units)

2-1

(standard unit)

(Systeme SI

(s)

(m)

International)

(kg)

(length)

-1



0 °C

0.023%

" " 1960

-

1,650,763.73

(⁸⁶Kr)

1983

1/299,792,458

1-1

299,792,458

(mass)

-2

.()

¹²C

2-1



1-1

(Time)

-3

(

)



24

86,400

(¹³³CS)

1-1

9,192,631,1770

2-1

3-1

1-1

بعض الفترات الزمنية (s)	بعض الكتل في الطبيعة (kg)	بعض الأطوال في الطبيعة (m)
5×10^{17}	10^{52}	2×10^{16}
1.4×10^{17}	7×10^{41}	4×10^9
1×10^{17}	9×10^{30}	7×10^8
6×10^8	6×10^{24}	6.4×10^6
3×10^7	7×10^{22}	1.7×10^6
9×10^4	7×10^1	9×10^3
3×10^3	1×10^{-5}	1.7×10^0
8×10^{-1}	1×10^{-55}	1×10^{-10}
1×10^{-3}	2×10^{-27}	1×10^{-14}
2×10^{-15}	9×10^{-31}	1×10^{-15}

:

3-1 2-1

$$1 \text{ km/h} = (1 \text{ km} \times 1000 \frac{\text{m}}{\text{km}}) / (1 \text{ h} \times 3600 \frac{\text{s}}{\text{h}}) = 0.278 \text{ m/s}$$

(Dimensions)

3-1

(dimension)

(length)

3-1

[M] (*mass*)

[T] (*time*)

[L]

[]

$$V = \pi r^2 h$$

[L]

[L]²

[V]=[L]²[L]

π

[V]=[L]³

1-1

$$g \quad v \quad m \quad E = \frac{1}{2}mv^2 + mgh$$

h

[M]

[L]/[T]

:

[L]/[T]²

$$[E]=[M]\frac{[L]^2}{[T]^2}+[M]\frac{[L]}{[T]}\quad [L]=[M]\frac{[L]^2}{[T]^2}+[M]\frac{[L]^2}{[T]^2}$$

$\frac{1}{2}$

2-1

:

$$s = \frac{1}{2}v_0 t^2 + vt$$

)

v_0

t

$v \quad s$

$\frac{1}{2}$

(

:

$\frac{1}{2}$

:

$$[L]^2 = \frac{[L]}{[T]}[T]^2 + \frac{[L]}{[T]}[T]$$

:

:

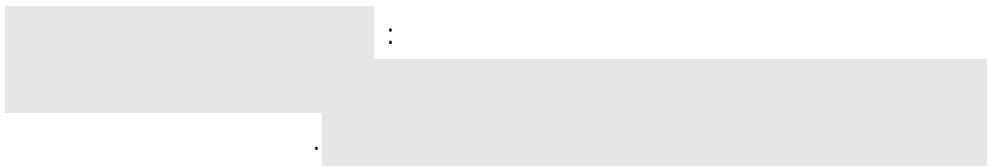
[L]/[T]

$$[L]^2 = [L][T] + [L]$$

(Significant figures)

4-1

16.3 cm ± 0.1 cm
 16.4 cm 16.2 cm
 4.6 cm 4.4 cm 4.5 cm
 5 3
 4.5±0.1 cm 16.3±0.1 cm
 (16.3 cm)(4.5 cm)=73.35 cm²



.7.3×10¹ cm² :

1.5 kg 1500 g

1.50×10⁰ kg

1.5×10⁰ kg

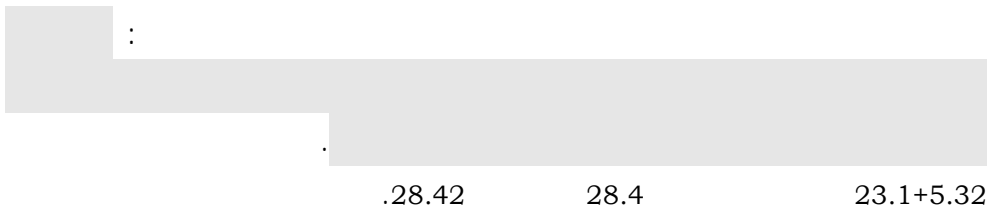
1.5×10⁻³

0.0015

1.50×10⁻³

5-1

105



(Coordinate Systems)

5-1

()

3 m



(coordinate system)

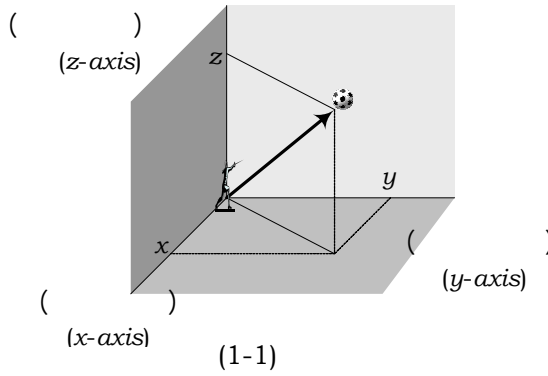
(y-axis)

(x-axis)

(z-axis)

$z=+4$ m $y=-7$ m $x=+3$ m

z y x
 .(1-1) (Cartesian coordinates)



(Vectors & Scalars)

6-1

75 kg

-5 °C

.(scalars)

d A

.(vectors)

.(2-1) \vec{A} \mathbf{A} \overline{PQ}
 : \mathbf{A} Q P

(1-1) $\overline{PQ} = |PQ| = A = \mathbf{A}$

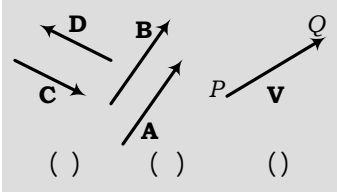
(Vectors Algebra)

7-1

: -1

:

B A



(2-1)

A=B

B A (2-1)

D C

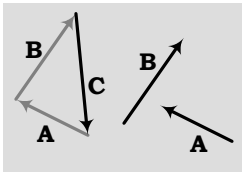
: (2-1)

C=-D

: -2

:()

-



(3-1)

A

B A

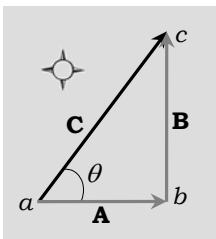
B

A

B

.(3-1)

3-1



(4-1)

40 km 30 km

(4-1)

30 km

3 cm **A**

10 km

.4 cm 40 km

B

C

B

A

A

B

: abc

ac

(4-1)

.**A+B**

$$\overline{ac} = \sqrt{\overline{ab}^2 + \overline{bc}^2} = 5 \text{ cm}$$

A

.50 km

5 cm

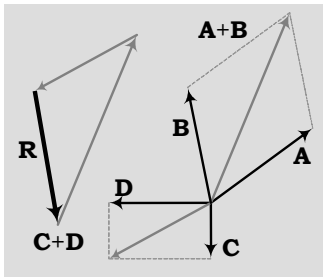
c

: abc

$$\tan \theta = \frac{\overline{bc}}{ab} = 1.33 \Rightarrow \theta = 53^\circ$$

(2-1)

$$\mathbf{A + B = B + A}$$



(5-1)

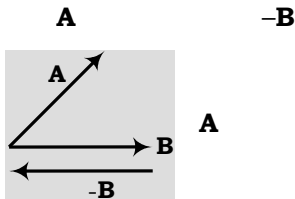
30 km 40 km

(5-1)

(resultant)

(3-1)

$$\mathbf{A - B = A + (-B)}$$



(6-1)

(7-1)

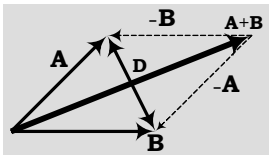
(6-1)

$$\mathbf{C = A + B}$$

B A

B

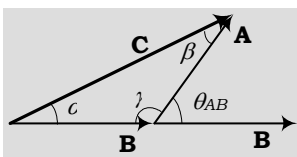
$$\mathbf{-D = B - A \quad D = A - B}$$



(7-1)

B A

(cosine law)



(8-1)

(4-1)

$$c = \sqrt{A^2 + B^2 + 2AB \cos \theta_{AB}}$$

B A

θ_{AB}

B A

C

(5-1)

$$\frac{A}{\sin \alpha} = \frac{B}{\sin \beta} = \frac{C}{\sin \gamma}$$

: (sine law)

(8-1) $\gamma \quad \beta \quad \alpha$

4-1

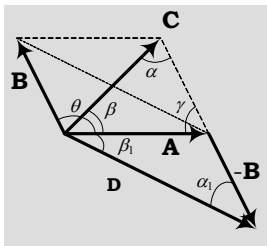
$\theta = 120^\circ \quad B = 6 \quad A = 7$

(9-1)

$D = A - B \quad C = A + B$

C

$C = A + B$



(9-1)

: (4-1)

$$c = \sqrt{(7)^2 + (6)^2 + 2(7)(6)\cos 120^\circ} = 6.6$$

:(5-1)

$$\frac{7}{\sin \alpha} = \frac{6}{\sin \beta} = \frac{6.6}{\sin 60^\circ}$$

$\sin \beta = 0.79 \Rightarrow \beta = 52^\circ$

: (9-1)

$D = A - B$

$$D = \sqrt{(7)^2 + (6)^2 + 2(7)(6)\cos 60^\circ} = 11.3$$

D

$$\frac{7}{\sin \alpha_1} = \frac{6}{\sin \beta_1} = \frac{11.3}{\sin 60^\circ}$$

$\sin \alpha_1 = 0.54 \Rightarrow \alpha_1 = 32^\circ$

:()

: $C_y \quad C_x \quad C$

(6-1)

$C = C_x + C_y$

:

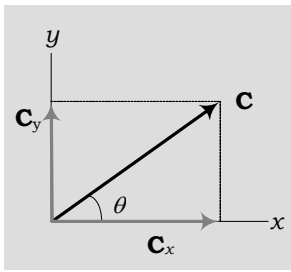
: (10-1) C_y C_x

(7-1)
$$\begin{aligned} C_x &= C \cos \theta \Leftrightarrow \cos \theta = \frac{C_x}{C} \\ C_y &= C \sin \theta \Leftrightarrow \sin \theta = \frac{C_y}{C} \end{aligned}$$

(y-component) C_y *(x-component)* C_x
: (10-1) **C**

(8-1)
$$C = \sqrt{C_x^2 + C_y^2}$$

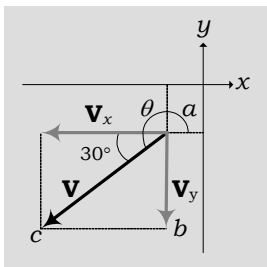
(9-1)
$$\tan \theta = \frac{C_y}{C_x}$$



(10-1)

(8-1) oy ox
(7-1)
(9-1) (8-1)
(orthogonal coordinate system)

5-1



(11-1)

ox (11-1) **V**
 $\theta = 30^\circ$ 7 oy
V : () :
:
 $\theta = 180^\circ + 30^\circ = 210^\circ$
:(7-1)

$V_x = V \cos \theta = 7 \cos 210^\circ = -6.1$
 $V_y = V \sin \theta = 7 \sin 210^\circ = -3.5$

(7-1)

$\mathbf{V} : (\quad)$

$abc \quad ab \quad (11-1)$

$V_x = ab = 7 \cos 30^\circ = 6.1$

$V_x = -6.1$

oy

\mathbf{V}

$: \quad abc \quad bc \quad (11-1)$

$V_y = bc = 7 \sin 30^\circ = 3.5$

$V_y = -3.5$

$\mathbf{B} \quad \mathbf{A}$

$\mathbf{A} = \mathbf{A}_x + \mathbf{A}_y$

$\mathbf{B} = \mathbf{B}_x + \mathbf{B}_y$

\mathbf{C}

$\mathbf{C} = (\mathbf{A}_x + \mathbf{A}_y) + (\mathbf{B}_x + \mathbf{B}_y)$

(10-1)

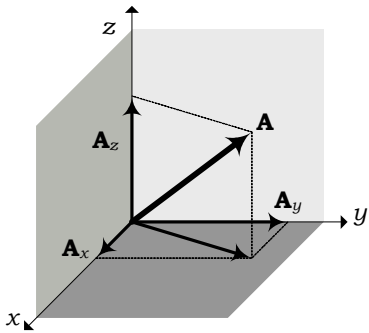
$\mathbf{C} = (\mathbf{A}_x + \mathbf{B}_x) + (\mathbf{A}_y + \mathbf{B}_y)$

\mathbf{C}

(11-1)

$$\begin{aligned} C_x &= A_x + B_x \\ C_y &= A_y + B_y \end{aligned}$$

oxyz



(12-1)

.()

oz

oy ox

oy ox

90°

90°

90°

(12-1)

A

-3

) ()

15

(

()

()

A

B

n

A

(12-1)

$$\mathbf{B} = n\mathbf{A}$$

n

B A

n

7-1

.oz oy ox

i

(6-1) \mathbf{C}_x

(13-1) $\mathbf{C}_x = C_x \mathbf{i}$

4.5 $\mathbf{C}_x = -4.5 \mathbf{i}$
 (unit vector) **i**

k oy **j**
 oz oy ox **D** oz

(14-1) $\mathbf{D} = D_x \mathbf{i} + D_y \mathbf{j} + D_z \mathbf{k}$

:(scalar or dot product) () -
B A

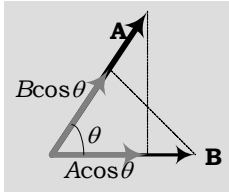
(15-1) $\mathbf{A} \cdot \mathbf{B} = c$

(16-1) $c = AB \cos \theta_{AB}$

$B A \mathbf{B} \mathbf{A} \theta_{AB}$
 : (16-1) (15-1)

(17-1) $\mathbf{A} \cdot \mathbf{B} = AB \cos \theta_{AB}$

$\mathbf{A} \cdot \mathbf{B} = A(B \cos \theta_{AB}) = B(A \cos \theta_{AB})$



$$(13-1)$$

(18-1)

$$\mathbf{A} \cdot \mathbf{B} = A \cos \theta_{AB} B = B \cos \theta_{AB} A$$

$$(13-1)$$

$$\mathbf{A} \cdot \mathbf{B} = \mathbf{B} \cdot \mathbf{A}$$

6-1

$$\mathbf{i} \cdot \mathbf{i} \quad \mathbf{j} \cdot \mathbf{j} \quad \mathbf{k} \cdot \mathbf{k} \quad \mathbf{i} \cdot \mathbf{j} \quad \mathbf{j} \cdot \mathbf{k} \quad \mathbf{k} \cdot \mathbf{i}$$

$$(17-1)$$

$$\mathbf{i} \cdot \mathbf{i} = \cos \theta_{ii}$$

$$\theta_{ii}=0 \quad \cos 0=1$$

$$\mathbf{i} \cdot \mathbf{i} = 1$$

(19-1)

$$\mathbf{i} \cdot \mathbf{i} = \mathbf{j} \cdot \mathbf{j} = \mathbf{k} \cdot \mathbf{k} = 1$$

$$(17-1)$$

$$\mathbf{i} \cdot \mathbf{j} = \cos \theta_{ij} = \cos 90^\circ = 0$$

(20-1)

$$\mathbf{i} \cdot \mathbf{j} = \mathbf{j} \cdot \mathbf{k} = \mathbf{k} \cdot \mathbf{i} = 0$$

7-1

$$\mathbf{R} \cdot \mathbf{R}$$

$$\mathbf{R} = R_x \mathbf{i} + R_y \mathbf{j} + R_z \mathbf{k}$$

$$\mathbf{R}$$

$$\mathbf{R} \cdot \mathbf{R} = (R_x \mathbf{i} + R_y \mathbf{j} + R_z \mathbf{k}) \cdot (R_x \mathbf{i} + R_y \mathbf{j} + R_z \mathbf{k})$$

$$\begin{aligned} \mathbf{R} \cdot \mathbf{R} &= R_x^2(\mathbf{i} \cdot \mathbf{i}) + R_y^2(\mathbf{j} \cdot \mathbf{j}) + R_z^2(\mathbf{k} \cdot \mathbf{k}) \\ &\quad + 2R_x R_y(\mathbf{i} \cdot \mathbf{j}) + 2R_y R_z(\mathbf{j} \cdot \mathbf{k}) + 2R_z R_x(\mathbf{k} \cdot \mathbf{i}) \end{aligned}$$

(20-1) (19-1)

(21-1) $\mathbf{R} \cdot \mathbf{R} = R_x^2 + R_y^2 + R_z^2 = RR \cos 0^\circ = R^2$

(22-1) $R = \sqrt{R_x^2 + R_y^2 + R_z^2}$

: \mathbf{i} \mathbf{R} ox \mathbf{R}

$$\mathbf{i} \cdot \mathbf{R} = R_x(\mathbf{i} \cdot \mathbf{i}) + R_y(\mathbf{i} \cdot \mathbf{j}) + R_z(\mathbf{i} \cdot \mathbf{k}) = iR \cos \theta_{Rx}$$

: (1-20) (1-19) $i=1$ \mathbf{R} θ_{Rx}

(23-1)
$$\begin{aligned} \cos \theta_{Rx} &= \frac{R_x}{R} \\ \cos \theta_{Ry} &= \frac{R_y}{R} \\ \cos \theta_{Rz} &= \frac{R_z}{R} \end{aligned}$$

: γ β α θ_{Rz} θ_{Ry} θ_{Rx}

(24-1) $\cos^2 \alpha + \cos^2 \beta + \cos^2 \gamma = 1$

(direction cosines)

: \mathbf{B} \mathbf{A} (21-1)

(25-1) $\mathbf{A} \cdot \mathbf{B} = AB \cos \theta_{AB} = A_x B_x + A_y B_y + A_z B_z$

8-1

$$\mathbf{B} = \mathbf{i} - \mathbf{j} + \mathbf{k} \quad \mathbf{A} = 2\mathbf{i} + 6\mathbf{j} - 3\mathbf{k}$$

(25-1) :

$$\mathbf{A} \cdot \mathbf{B} = (2)(1) + (6)(-1) + (-3)(1) = -7 = AB \cos \theta_{AB}$$

$$A = \sqrt{(2)^2 + (6)^2 + (-3)^2} = 7$$

$$B = \sqrt{(1)^2 + (-1)^2 + (1)^2} = 1.7$$

:

$$\cos \theta_{AB} = \frac{\mathbf{A} \cdot \mathbf{B}}{AB} = -0.58 \Rightarrow \theta_{AB} = 125^\circ$$

:(vector or cross product) () -

$$\mathbf{B} \times \mathbf{A}$$

(26-1) $\mathbf{A} \times \mathbf{B} = \mathbf{C}$

C

(27-1) $C = AB \sin \theta_{AB}$

() **A**

)

(

) **B**

C B A

.(14-1)

(

) **C**

(

oz oy ox

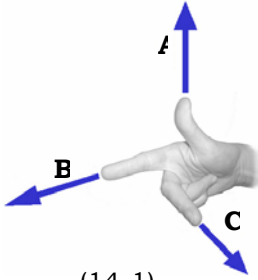
: (27-1) (26-1)

(28-1) $|\mathbf{A} \times \mathbf{B}| = AB \sin \theta_{AB}$

:

(29-1) $\mathbf{A} \times \mathbf{B} = -\mathbf{B} \times \mathbf{A}$

7-1



(14-1)

$\mathbf{A} \times \mathbf{B}$

$\mathbf{B} \times \mathbf{A}$

$$\mathbf{A} = A_x \mathbf{i} + A_y \mathbf{j} + A_z \mathbf{k}$$

$$\mathbf{B} = B_x \mathbf{i} + B_y \mathbf{j} + B_z \mathbf{k}$$

(30-1)

$\mathbf{A} \times \mathbf{B} =$	$\begin{vmatrix} \mathbf{i} & \mathbf{j} & \mathbf{k} \\ A_x & A_y & A_z \\ B_x & B_y & B_z \end{vmatrix}$
----------------------------------	--

(31-1)

$\mathbf{A} \times \mathbf{B} = (A_y B_z - A_z B_y) \mathbf{i} + (A_z B_x - A_x B_z) \mathbf{j} + (A_x B_y - A_y B_x) \mathbf{k}$

9-1

$$\mathbf{k} \times \mathbf{i} () \quad \mathbf{j} \times \mathbf{k} () \quad \mathbf{i} \times \mathbf{j} () \quad \mathbf{k} \times \mathbf{k} () \quad \mathbf{j} \times \mathbf{j} () \quad \mathbf{i} \times \mathbf{i} ()$$

(26-1)

$$|\mathbf{i} \times \mathbf{i}| = \dot{u} \sin 0^\circ = 0$$

$$\mathbf{i} \times \mathbf{i} = \mathbf{j} \times \mathbf{j} = \mathbf{k} \times \mathbf{k} = 0$$

(32-1)

$\mathbf{R} \times \mathbf{R} = 0$

$$|\mathbf{i} \times \mathbf{j}| = \dot{ij} \sin 90^\circ = 1$$

:

$$\begin{array}{ccc}
 & \mathbf{i} \times \mathbf{j} & \\
 \cdot oz & \mathbf{j} \ \mathbf{i} & \mathbf{j} \ \mathbf{i} \\
 oy & & \\
 ox & & \mathbf{k}
 \end{array}$$

(33-1) $\mathbf{k} \times \mathbf{i} = \mathbf{j} \quad \mathbf{j} \times \mathbf{k} = \mathbf{i} \quad \mathbf{i} \times \mathbf{j} = \mathbf{k}$

: (33-1)

(34-1) $\mathbf{i} \times \mathbf{k} = -\mathbf{j} \quad \mathbf{k} \times \mathbf{j} = -\mathbf{i} \quad \mathbf{j} \times \mathbf{i} = -\mathbf{k}$

$$\begin{array}{ccccccc}
 - & \mathbf{i} & \mathbf{j} & \mathbf{k} & \mathbf{i} & \mathbf{j} & \mathbf{k} \\
 \hline
 & & & & & & \rightarrow
 \end{array}$$

(15-1)

(15-1)

(15-1)

10-1

() θ_{RF} () $\boldsymbol{\tau} = \mathbf{R} \times \mathbf{F}$ () $\mathbf{F} = 3\mathbf{i} + \mathbf{j} - 5\mathbf{k} \quad \mathbf{R} = 2\mathbf{i} - 4\mathbf{j} + \mathbf{k}$

(31-1) :

$$\boldsymbol{\tau} = \mathbf{R} \times \mathbf{F} = (20 - 1)\mathbf{i} + (3 - (-10))\mathbf{j} + (2 - (-12))\mathbf{k} = 19\mathbf{i} + 13\mathbf{j} + 14\mathbf{k}$$

$\mathbf{F} \ \mathbf{R}$ ()

$$|\boldsymbol{\tau}| = |\mathbf{R} \times \mathbf{F}| = RF \sin \theta_{RF}$$

$$R = \sqrt{R_x^2 + R_y^2 + R_z^2} = 4.6$$

$$F = \sqrt{F_x^2 + F_y^2 + F_z^2} = 5.9$$

8-1

$$\tau = \sqrt{\tau_x^2 + \tau_y^2 + \tau_z^2} = 26.9$$

$$\sin \theta_{RF} = \frac{\tau}{RF} \approx 0.99 \Rightarrow \theta_{RF} = 82^\circ$$

: (23-1) **R** ()

$$\cos \theta_{Ry} = \frac{R_y}{R} = -0.87 \Rightarrow \theta_{Ry} = 150^\circ$$

(Unit Vector) **8-1**

$$\mathbf{A} = A_x \mathbf{i} + A_y \mathbf{j} + A_z \mathbf{k}$$

(35-1)

$$\mathbf{a} = \frac{\mathbf{A}}{A} = \frac{A_x \mathbf{i} + A_y \mathbf{j} + A_z \mathbf{k}}{\sqrt{A_x^2 + A_y^2 + A_z^2}}$$

a **A a**

11-1

$$\mathbf{R} = 3\mathbf{i} - \mathbf{j} + 4\mathbf{k}$$

: (35-1) :

$$\mathbf{r} = \frac{\mathbf{R}}{R} = \frac{3\mathbf{i} - \mathbf{j} + 4\mathbf{k}}{\sqrt{9+1+16}} = \frac{3}{\sqrt{26}}\mathbf{i} - \frac{1}{\sqrt{26}}\mathbf{j} + \frac{4}{\sqrt{26}}\mathbf{k}$$

R **r**

12-1

: **B A** (cosine law)

$$c = \sqrt{A^2 + B^2 + 2AB \cos \theta_{AB}}$$

B A θ_{AB}

: **C = A + B** :

$$\mathbf{c \cdot c = (A + B) \cdot (A + B) = A \cdot A + A \cdot B + B \cdot A + B \cdot B} \quad : \quad (17-1)$$

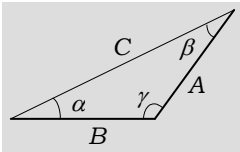
$$c^2 = A^2 + B^2 + 2AB \cos \theta_{AB}$$

$$c = \sqrt{A^2 + B^2 + 2AB \cos \theta_{AB}}$$

13-1

:

(sine law)



(15-1)

$$\frac{A}{\sin \alpha} = \frac{B}{\sin \beta} = \frac{C}{\sin \gamma}$$

(15-1) $\gamma \quad \beta \quad \alpha$

B

C = A + B

:

:

$$CB \sin \alpha = AB \sin \gamma$$

:

$$\frac{A}{\sin \alpha} = \frac{C}{\sin \gamma}$$

A

C = A + B



2-1(m) *(Length)* :

1 Fermi	1 F	10^{-15} m	
1 Angstrom	1 A	10^{-10} m	
1 nanometer	1 nm	10^{-9} m	
1 micrometer	1 μ m	10^{-6} m	
1 millimeter	1 mm	10^{-3} m	
1 centimeter	1 cm	10^{-2} m	
1 kilometer	1 km	10^{+3} m	

(kg) *(Mass)* :

1 microgram	1 μ g	10^{-9} kg	
1 milligram	1 mg	10^{-6} kg	
1 gram	1 g	10^{-3} kg	
1 ton	1 t	10^{+3} kg	

(s) *(Time)* :

1 picosecond	1 ps	10^{-12}	
1 nanosecond	1 ns	10^{-9}	
1 microsecond	1 μ s	10^{-6}	
1 millisecond	1 ms	10^{-3}	
1 minute	1 min	60	
1 hour	1 h	3600	

3-1

10^{+15}	10^{+9}	10^{+6}	10^{+3}	10^{-2}	10^3	10^{-9}	10^{-6}	10^{-3}	10^{-2}	10^{-15}	
T	G	M	k	d	c	m	μ	n	p	F	

$$\mathbf{A} + \mathbf{B} = \mathbf{B} + \mathbf{A}$$

$$c = \sqrt{A^2 + B^2 + 2AB \cos \theta_{AB}}$$

$$\frac{A}{\sin \alpha} = \frac{B}{\sin \beta} = \frac{C}{\sin \gamma}$$

$$\mathbf{A} = A_x \mathbf{i} + A_y \mathbf{j} + A_z \mathbf{k} \quad A$$

$$A = \sqrt{A_x^2 + A_y^2 + A_z^2}$$

$$\cos \theta_n = A_n / A \quad n$$

$$\mathbf{A} \cdot \mathbf{B} = AB \cos \theta_{AB}$$

$$|\mathbf{A} \times \mathbf{B}| = AB \sin \theta_{AB}$$

$$\mathbf{a} = \mathbf{A} / A \quad \mathbf{A} \quad \mathbf{a}$$

$$.1 \text{ g/cm}^3 \quad \mathbf{1-1}$$

$$.70 \text{ km/h} \quad \mathbf{2-1}$$

$$b \quad a \quad x = at^2 - bt^3 \quad \mathbf{3-1}$$

$$.b \quad a$$

$$\mathbf{C} = -2\mathbf{i} + 3\mathbf{j} \quad \mathbf{B} = -5\mathbf{i} - 12\mathbf{j} \quad \mathbf{A} = 3\mathbf{i} - 4\mathbf{j} \quad \mathbf{4-1}$$

$$oz \quad oy \quad ox \quad (2, -2, 4) \quad \mathbf{5-1}$$

$$30^\circ \quad 100 \text{ m} \quad 50 \text{ m} \quad \mathbf{6-1}$$

$$150 \text{ m}$$

$$.(16-1) \quad \mathbf{7-1}$$

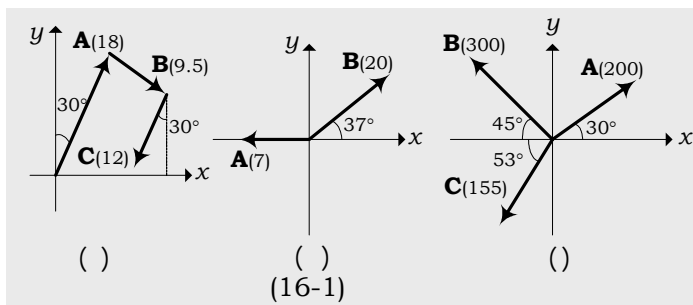
8-1

(16-1) **B A**

9-1

(16-1) **C B A**

10-1

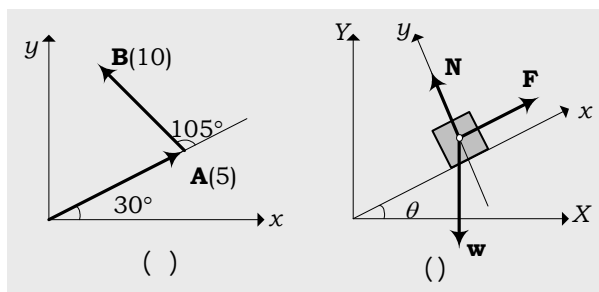


()

m (17-1)

11-1

oy ox



(17-1)

(17-1)

B A

12-1

$\mathbf{B} = \mathbf{i} - 2\mathbf{j}$ $\mathbf{A} = 2\mathbf{i} + 3\mathbf{j}$

D C

$\mathbf{D} = \mathbf{A} - \mathbf{B}$ $\mathbf{C} = \mathbf{A} + \mathbf{B}$

13-1

10 km

30 km

20 km

14-1

(37°

5) **M**

15-1

53°

5

N

N

B		60°	2	A	16-1
A-B	A+B		60°		4
	<i>oy ox</i>	B = -4i + 3j	A = 3i + 4j		B-A
			A-B	A+B	17-1
	6	10			18-1
					30°
		B = -i + 3j - 2k	A = 3i + 4j		19-1
		B = 0.5i + 4.5j	A = 3.2i + 1.6j		20-1
			<i>xy</i>	A	C
A = 3i - 2j + k		A × (B × C)	A · (B × C)	A × (B + C)	A · (B + C)
				C = 2i - 3j	B = 4k
A = 5i + 4j - 6k	<i>oz</i>			A - B + C	22-1
				C = 4i + 3j + 2k	B = -2i + 2j + 3k
()		()	B = i - 2j	A = 2i + 3j	23-1
				A - B	A + B
		A × B	()	A · B	()
	B	A			24-1
			A × B		
				A	25-1
A × B			30°		B
	<i>oz</i>		A = 3i + j - 4k		26-1
		B = i + 2j - 3k	A = i + 2j + 3k		27-1
		B = i - 2j + 3k	A = 2i + 3j + 4k		28-1
60°	6	B	10	A	B × A
				A · B	29-1
			(i × j) × k	i × (j × k)	30-1

$$\mathbf{A} \cdot (\mathbf{A} \times \mathbf{B}) = 0 \quad \mathbf{B} \cdot \mathbf{A} \quad \mathbf{31-1}$$

32-1

$$\mathbf{A} \cdot (\mathbf{B} \times \mathbf{C}) = (\mathbf{A} \cdot \mathbf{B}) \times \mathbf{C} \quad \mathbf{33-1}$$

$$\mathbf{B} = 6\mathbf{i} \quad \mathbf{A} = 3\mathbf{i} + 3\mathbf{j} \quad \mathbf{34-1}$$

$\mathbf{A} \cdot \mathbf{B}$

$$oy \quad 63^\circ \quad yz \quad \mathbf{A} \quad \mathbf{35-1}$$

$$ox \quad 48^\circ \quad xz \quad \mathbf{B}$$

$$.1.4 \quad 3.2 \quad \mathbf{A} \times \mathbf{B} \quad \mathbf{A} \cdot \mathbf{B}$$

$$\mathbf{A} \times \mathbf{B} \quad \mathbf{B} \cdot \mathbf{A} \quad \mathbf{36-1}$$

$$\mathbf{B} = \mathbf{C} \quad \mathbf{A} \times \mathbf{B} = \mathbf{A} \times \mathbf{C} \quad \mathbf{A} \cdot \mathbf{B} = \mathbf{A} \cdot \mathbf{C} \quad \mathbf{37-1}$$

$$\mathbf{A} \times \mathbf{B} = \mathbf{A} \times \mathbf{C} \quad \mathbf{A} \cdot \mathbf{B} = \mathbf{A} \cdot \mathbf{C}$$

من علماء الإسلام

(850 236)
 " " () "algorism"
 ()
 ()

