Lecture 1

Monday, May 8, 2023 8:38 AM

Aristotle (384-322BC)

natural phylosophy of nonliving nature

Physics φυσικη

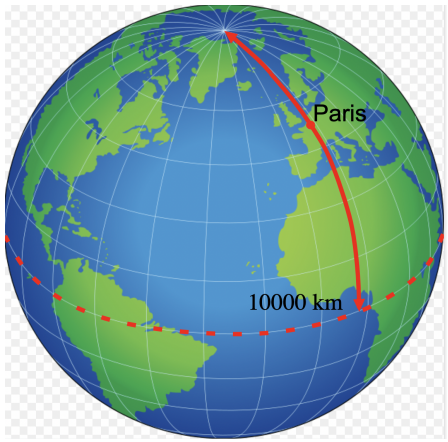
- 2345 year → May 8, CP15)
- Agora:
- Greeks: Logics:

— Units: French Revolution 1789 – 1794

1m – $\frac{1}{10000000}$ – Equator to North pole 1791

1kg – weight of 1L water 1793

SI – units



Physical Quantity

Physical Quantity

Numerical Value + Units

SI - units:

Fundamental Units:

	SI	
Lenght,	m,	meter
Time,	s	Day / 24x60x60
Mass,	Kg,	Kilogram
Temperature,	T,	Kelvin
Electrical Current,	A,	Ampere
Amount of Substance,	mole ~	6.022×10^{23} entities
Luminous,	cd,	candela

Derived Units:

- Speed - $\frac{\text{distance}}{\text{time}}$, $\frac{m}{s}$
- Force - $N = Kg \cdot \frac{m}{s^2}$
- Acceleration $\frac{m}{s^2}$
- Energe $J = Kg \frac{m^2}{s^2}$ - joule

- cgs - units - centimeter, gram, second
- U.S. customary system - British system

Pound - Weight

1 foot = 0.3048 m

1 mile = 1.6 0937 km

1 inch = 2.54 cm

1 pound = 4.48 N

Rules applied to physical quantities with units

R1. $[LHS] = [RHS]$

RHS LHS

$[Q] = \text{const}$

$[5s] = s$

$\left[\frac{2M}{s}\right] = \frac{M}{s}$

R2: Sum and subtract only the quantities of same unity

R3: Multiply / divide units as any algebraic quantities

$10\frac{m}{s} \cdot 5s = = 50m$

R3 $\sin(arg)$ $\exp(arg)$ $\cos(arg)$ $\log(arg)$

arg – unitless

$[arg] = 1$

$[5] = 1$

Conversion of units

$10\frac{mi}{h} \overset{SI}{=} 10 \cdot \frac{1\,mi}{1h} = 10 \cdot \frac{1600\,m}{3600s} = 4.4\frac{m}{s}$

$1mi = 1.6km = 1600m$

$1h = 3600s$

Dimension of Physical Quantities

- Length – L
- Mass – M
- Time – T
- Area → L^2
- Volume → L^3
- Force $\frac{ML}{T^2}$

⇒ Scientific Notations

- $300000000 \sim 3 \times 10^8$

- $0.00004 \rightarrow 4 \times 10^{-5}$

- $0.0000000000000003 = 3 \times 10^{-13}$

Rules with S.N.

1. $5 \cdot 10^{2} + 7 \cdot 10^{-1} = 5 \times 10^{2} + 0.007 \times 10^{2} = 5.007 \times 10^{2}$

$7 \cdot 10^{-1} = 0.7 = 0.007 \times 10^{2}$

$= 0.007 \times 100 = 0.7$

2. Multiplication and division

$5 \times 10^{3} \times 2 \times 10^{2} = 10 \times 10^{5} = 10^{6}$

$A \cdot 10^{a} \cdot B \cdot 10^{b} = (AB) 10^{a+b}$

$\frac{A \cdot 10^{a}}{B 10^{b}} = \left(\frac{A}{B}\right) \cdot 10^{a-b}$

$\frac{5 \times 10^{3}}{2 \times 10^{2}} = 2.5 \times 10^{1}$

⇒ Significant Figures:

Measurement

1. $5\,m$ — $5\,m$

5. $5.0005\,m \rightarrow$

$2.50 \rightarrow 3$

$2.5 \rightarrow 2$

$2.503 \rightarrow 4$

$0.0103 \rightarrow 3 = 103 \times 10^{-2}$

Rules:

Rule 1) S.F in the result of multiplication or division is no greater than least number of S.Fs in any of the factors

$A = \pi \cdot r^2 \qquad r = 8m$

$A = 3.14153\ldots \cdot 8^2 = 201.061928 m^2 \equiv 2 \times 10^2 m^2$

Rule 2 The result of addition or subtraction

Result has no S.Fs beyond the last decimal place where both of the original numbers have SFs

$1.040 + 0.21392 + 1.253 = 42$

(4, 5, 3 → 3)

⇒ Example

$X^2 = \underbrace{C_1^2 t + C_2 t^2}_{RHS}$ (LHS)

X - length
t - time

$[C_1] = ?$ $\qquad [C_2] = ?$

$[LHS] = [RHS]$

$[X^2] = [C_1^2 t + C_2 t^2]$

$m^2 = [C_1^2 t + C_2 t^2] = [C_1^2 t] + [C_2 t^2]$ R2

$m^2 = [C_1^2 t] = [C_1^2][t] = [C_1]s$ | $[C_1] = \frac{m^2}{s}$ $[C_1] = \frac{m}{\sqrt{s}}$ $\frac{m}{\sqrt{s}}$

$m^2 = [C_2 t^2] = [C_2][t^2] = [C_2]s^2$ $\boxed{[C_2] = \frac{m^2}{s^2}}$

$\boxed{V \cdot x = \frac{1}{2} C_1^2 t^2 + 2 C_2 x^2}$ V – velocity

$[C_1]$ $[C_2]$

$m \cdot t = 3F \cdot s \cdot C_1 + C_2 \frac{m}{s}$

$[C_1]$ $[C_2]$

Rule 1) $[LHS] = [RHS]$ Rule 2

$[V \cdot x] = \left[\frac{1}{2} C_1^2 t^2 + 2 C_2 x^2\right]$

Rule 3

$[V][x] = \left[\frac{1}{2} C_1^2 t^2\right] + [2 C_2 x^2]$

$\frac{m}{s} : m = \left[\frac{1}{2}\right][C_1^2][t^2] + [2][C_2][x^2]$

$\frac{m^2}{s} = [C_1^2] s^2 + [C_2] m^2$ Rule 2

$\frac{m^2}{s} = [C_1^2] s^2$; $\frac{m^2}{s} = [C_2] m^2$

$[C_1] = \frac{m}{\sqrt{s}}$; $[C_2] = \frac{1}{s}$

$\frac{m^2}{s} = [C_1]^2 s^2$

$[C_1]^2 = \frac{m^2}{s^3}$

$[C_1] = \sqrt{\frac{m^2}{s^3}} = \frac{m}{s^{3/2}}$

$[C_2] = \frac{1}{s}$

$\Rightarrow \quad \sin(C \cdot x)$

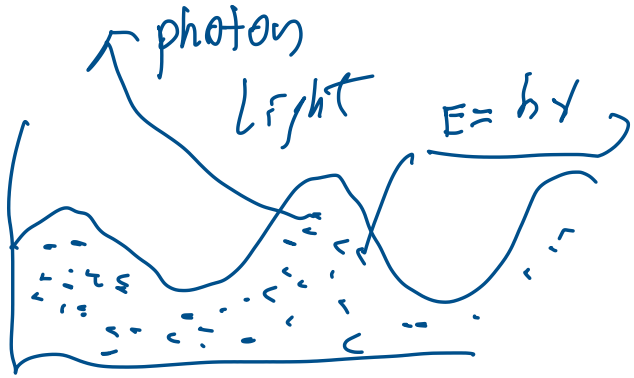
$[C] = ?$

$[Cx] = 1$

$[C][x] = 1$

$[C]\,m = 1$

$[C] = \frac{1}{m}$



Natural Units

$1 = c = 2.997924 \times 10^8 \frac{m}{s}$ — speed of light

$G = 6.67 \times 10^{-11} \frac{N}{kg^2} \cdot m^2$ — gravitational const

$e = 1.602 \times 10^{-19}$ Coulomb

$1 = h = 6.626 \times 10^{-34}$ Joules s $\quad \hbar = \frac{h}{2\pi}$ → Planck const

$1s = 2.997924 \ldots \times 10^8 m$

$m = \frac{1s}{2.997924 \times 10^8}$

$s = \frac{1}{6.62 \times 10^{-34}} J^{-1}$

$[m] = \frac{1}{2.9979 \times 6.62 \times 10^{-35}} J^{-1}$

$\frac{10\,J}{2} \rightarrow 5J$

$\frac{5}{2} J = \frac{2.5\,J}{2} = 1.25\,J$

$E = mc^2 \Rightarrow [E] = [m]$