Chapter 1: The Study of Change

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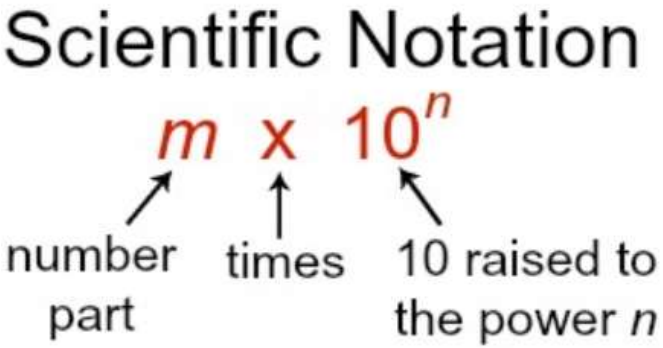
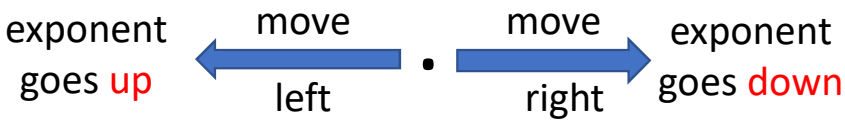
Note: Thanks for Dr. Effat & Dr.Huda. Some of the examples are used from their slides

Scientific Notation





4500000000000

4.5×10^{12}

What is the scientific notation of 602000000?

6.02×10^{8}

What is the scientific notation of 0.0000428?

4.28×10^{-5}

Write the value of the following operations •

I. $\frac{10^3 \times 10^{-2}}{10^{-6}} = 10^{(3-2+6)} = 10^7$

II. $\frac{10^8 \times 10^3}{10^{-6} \times 10^5} = 10^{(8+3+6-5)} = 10^{12}$

III. $(4 \times 10^5 \text{ cm}) \times (3 \times 10^{-7} \text{cm}) = (4 \times 3 \times 10^{(5-7)}) = 12 \times 10^{-2}$

The SI unit of electrical current is

(a) The ampere

(b) The gram

(c) The kilogram

(d) The mole

The K is the SI unit of

(a) Length

(b) Mass

(c) Temperature

(d) Current

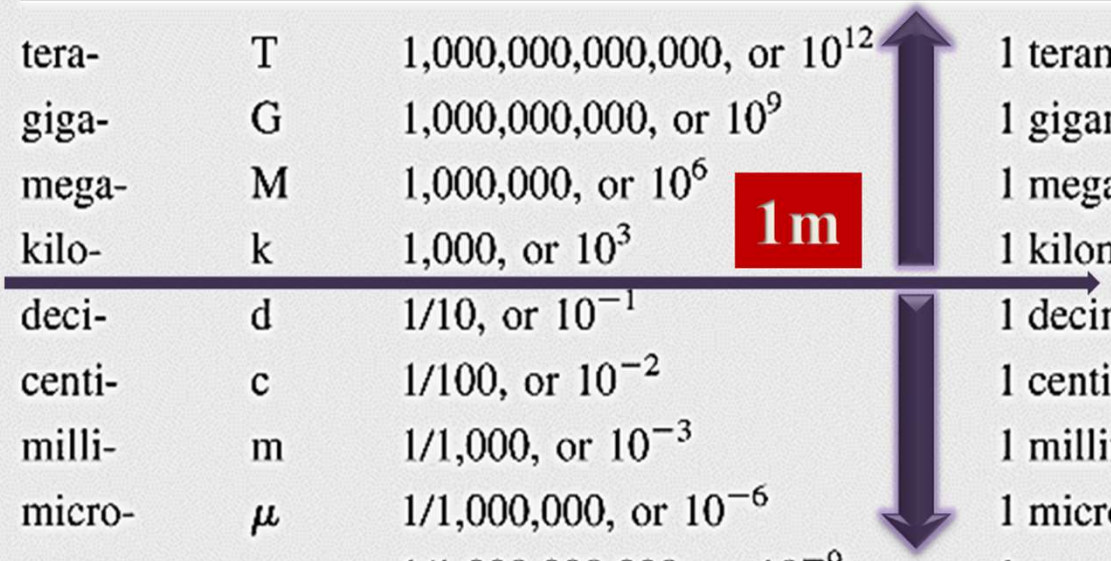
TABLE 1.2 SI Base Units

Base Quantity	Name of Unit	Symbol
Length	meter	m
Mass	kilogram	kg
Time	second	s
Electrical current	ampere	A
Temperature	kelvin	K
Amount of substance	mole	mol
Luminous intensity	candela	cd

Units Conversion

TABLE 1.3 Prefixes Used with SI Units

Prefix	Symbol	Meaning	Example
tera-	T	1,000,000,000,000, or 10^{12}	1 terameter (Tm) = 1×10^{12} m
giga-	G	1,000,000,000, or 10^{9}	1 gigameter (Gm) = 1×10^{9} m
mega-	M	1,000,000, or 10^{6}	1 megameter (Mm) = 1×10^{6} m
kilo-	k	1,000, or 10^{3}	1 kilometer (km) = 1×10^{3} m
deci-	d	1/10, or 10^{-1}	1 decimeter (dm) = 0.1 m
centi-	c	1/100, or 10^{-2}	1 centimeter (cm) = 0.01 m
milli-	m	1/1,000, or 10^{-3}	1 millimeter (mm) = 0.001 m
micro-	μ	1/1,000,000, or 10^{-6}	1 micrometer (μm) = 1×10^{-6} m
nano-	n	1/1,000,000,000, or 10^{-9}	1 nanometer (nm) = 1×10^{-9} m
pico-	p	1/1,000,000,000,000, or 10^{-12}	1 picometer (pm) = 1×10^{-12} m



Units Conversion

1. Prefix → Base Unit

e.g. 6km → ? m

6×10^3 m

(km is 10^3 m from the table of prefixes)

2. Base Unit → Prefix

e.g. 6m → ? km

6×10^{-3} m (m is 10^{-3} km

(reverse the power sign from the table of prefixes)

3. Prefix → Prefix

e.g. 6 km →? nm

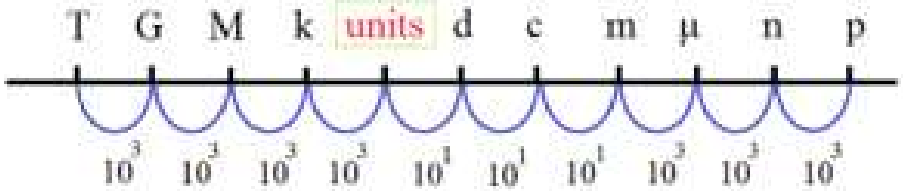
$6 \times 10^3 \times 10^9$

$= 6 \times 10^{12}$ nm

(Keep the power of the first one (km) and reverse the power sign of the second (nm))

Units Conversion (second method)

1- رسم المسطرة



2- نحدد العامل

3- من كبير إلى صغير نضرب ومن صغير إلى كبير نقسم

PREFIX	tera	giga	mega	kilo	m (meter)	deci	centi	milli	micro	nano	pico
SYMBOL	T	G	M	k		d	c	m	μ	n	p
NUMBER	10^{12}	10^{9}	10^{6}	10^{3}	10^{0}	10^{-1}	10^{-2}	10^{-3}	10^{-6}	10^{-9}	10^{-12}

How many nanogram in a gram?

1 g $\rightarrow$ ng (Base Unit $\rightarrow$ Prefix)

reverse the power sign $10^{-9} \rightarrow 10^{9}$

Answer: 1×10^{9} ng

How many Ts in a second?

1 s $\rightarrow$ Ts (Base Unit $\rightarrow$ Prefix)

reverse the power sign $10^{12} \rightarrow 10^{-12}$

Answer: 1×10^{-12} Ts

- Mount Everest is 8.847×10^5 cm high. How many meters high is the mountain?

8.847×10^5 cm $\rightarrow$ m (Prefix $\rightarrow$ Base Unit)

Use the prefix directly $\rightarrow 10^{-2}$

Answer: 8.847×10^3 m

- How many m^3 in 3.5L?

3.5 L $\rightarrow$ m^3 (1L=1dm^3)
3.5 dm^3 $\rightarrow$ m^3 (Prefix $\rightarrow$ Base Unit) use the prefix directly
Note: don't forget the power of unit
3.5 x$(10^{-1})^3$ m^3 = 3.5x10^{-3} m^3
Answer: 3.5x10^{-3} m^3

- Convert 25.5 m^3 to Mm^3?

25.5 m^3 $\rightarrow$? Mm^3 (Base Unit $\rightarrow$ Prefix)
reverse the power sign 10^6 $\rightarrow$$10^{-6}$
Note: don't forget the power of unit
25.5 x$(10^{-6})^3$ m^3 = 25.5x$10^{(-6x3)}$ Mm^3 =25.5x10^{-18} Mm^3
Answer: 25.5x10^{-18} Mm^3

What is the largest mass? •

- 4.5×10^{2} kg
- 45×10^{-4} pg
- 4.5×10^{-9} Tg
- 45×10^{9} ng

Put all of them in the same unit, (Prefix → Base Unit) use the prefix directly

A. 4.5×10^{2} kg → 4.5×10^{5} g
B. 45×10^{-4} pg → 45×10^{-16} g
C. 4.5×10^{-9} Tg → 4.5×10^{3} g
D. 45×10^{9} ng → 45 g = 4.5×10^{1} g

- Convert 6 Mm to cm?

  6 Mm (10^6)→ ?cm (10^{-2})

  Keep the power of the first one (Mm) and reverse the power sign of the second (cm)

  ∴ $6x10^6x10^2=6x10^{6+2}=6x10^8$ cm

- Convert $1.8x10^9$ ns to μs ?

  $1.8x10^9$ ns (10^{-9})→ ?μs (10^{-6})

  Keep the power of the first one (ns) and reverse the power sign of the second (μs)

  ∴ $1.8x10^9x10^{-9}x10^6= 1.8x10^6$ μs

- How many kg in $3.3x10^{-4}$ Tg ?

  $3.3x10^{-4}$ Tg (10^{12})→? kg (10^3)

  Keep the power of the first one (Tg) and reverse the power sign of the second (kg)

  ∴$3.3x10^{-4}$ $x10^{12}x10^{-3} = 3.3x10^5$ kg

- Which of the following is the largest volume?
- A) 7 m^3
- B) 3X10^7 cm^3
- C) 1.2X 10^3 dm^3
- D) 2.1 X10^4 L

عند مقارنة القيم بوحدات مختلفة لابد من توحيد الوحدات أولا.

Best way to figure this is to change all the units to m^3

فالأن سوف نحول جميع الوحدات إلى m^3

القيمة قبل التحويل(Before conversion)	القيمة بعد التحويل (After conversion)
7 m^3	7 m^3
3×10^7 cm^3	30 m^3
1.2×10^3 dm^3	1.2 m^3
2.1×10^4 L	21 m^3

Ans: B

Questions in Density

- Bromine is a red liquid at 25°C. Its density is 3.12 g/cm^3. What is the volume of 28.1 g of liquid bromine?

$$d = \frac{m}{V}$$

$$3.12\ g/cm^3 = \frac{28.1\ g}{V}$$

$$V = \frac{28.1\ g}{3.12\ g/cm^3}$$

$$V = 9.01\ cm^3$$

- The density of silver is 2.70 g/cm^3. What is the density in kg/m^3 of silver?

$$1\ \text{g/cm}^3 \rightarrow 1000\ \text{kg/m}^3$$
$$2.70\ \text{g/cm}^3 \rightarrow \text{x}\ \text{kg/m}^3$$

$$x = 2.70 \times 1000$$
$$x = 2.7 \times 10^3\ kg/m^3$$

- Which is greater? 450 g/L or 63 g/ml?

1st density	2nd density
450 g/L 1g/ml → 1000 g/L x g/ml → 450 g/L $x = \frac{450}{1000} = 0.45\ g/ml$	63 g/ml

Ans: 63 g/ml

- How many g/L are in 1.23 g/ml?

$$1 \text{ g/ml} \rightarrow 1000 \text{ g/L}$$
$$1.23 \text{ g/ml} \rightarrow x \text{ g/L}$$

$$x = 1.23 \times 1000$$
$$x = 1.23 \times 10^3 \text{ g/L}$$

Ans: 1.23×10^3 g/L

A sample of iron has the same dimensions of 2 cm x 3 cm x 2 cm. If the mass of this rectangular-shaped object is 94 g, what is the density of iron?

$$d = \frac{m}{V}$$

$$V = 2\ cm \times 3\ cm \times 2\ cm = 12\ cm^3$$

$$d = \frac{94\ g}{12\ cm^3}$$

$$d = 7.833\ g/cm^3$$

If you have equal masses of the following metals, which will occupy the largest volume?

a) Au, density=19.3 g/cm^3

b) Pb, density=11.3 g/cm^3

c) Ag, density=10.5 g/cm^3

d) Al, density=2.70 g/cm^3

$$d=m/V$$

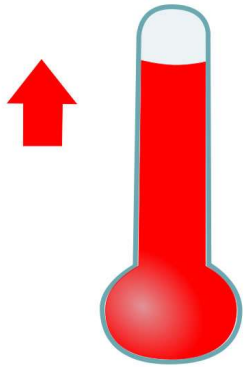
Density is inversely proportional to volume

الكثافة تتناسب عكسيا مع الحجم. فأصغر العناصر كثافة لها أكبر حجم

Answer: d

Temperature Units Conversion

- Which temperature is hotter: 17°C or 58°F?



عند مقارنة قيمتين بوحدات مختلفة لابد من توحيد الوحدات. فإما توحدي القيميتين إلى °C أو إلى °F

Best way to figure this is to change all the units to °C or °F

1st temperature	2nd temperature
58°F $°C = \frac{5}{9} \times (°F - 32)$ $°C = \frac{5}{9} \times (58 - 32)$ $°C = \frac{5}{9} \times 26$ $°C = 14$	17 °C

➢ K → °C or °C → K

K = °C + 273.15

°C = K - 273.15

➢ Fahrenheit °F → °C or °C → °F

°F = [(9/5) × °C] + 32

°C = (5/9) (°F - 32)

- Liquid nitrogen boils at –195.8°C. Express the boiling point of liquid nitrogen in K.

$$K = °C + 273.15$$

$$K = -195.8 + 273.15$$

$$K = 77.35$$

➢ K → °C or °C → K

K = °C + 273.15

°C = K - 273.15

➢ Fahrenheit °F → °C or °C → °F

°F = [(9/5) × °C] + 32

°C = (5/9) (°F - 32)

- Gallium is a metal that can melt in your hand at 302.93 K. What is the temperature in °F?

يتم حل هذا التمرين في خطوتين

1- تحويل K إلى °C (convert K to °C)

$$K = {}^{\circ}C + 273.15$$
$$302.93 = {}^{\circ}C + 273.15$$
$$^{\circ}C = 302.93 - 273.15$$
$$^{\circ}C = 29.78$$

2- تحويل الناتج إلى °F (convert °C to °F)

$$^{\circ}F = \frac{9}{5} \times {}^{\circ}C + 32$$
$$^{\circ}F = (\frac{9}{5} \times 29.78) + 32$$
$$^{\circ}F = 53.604 + 32$$
$$^{\circ}F = 85.604$$

➢ K → °C or °C → K

$K = {}^{\circ}C + 273.15$

$^{\circ}C = K - 273.15$

➢ Fahrenheit °F → °C or °C → °F

$^{\circ}F = [(9/5) \times {}^{\circ}C] + 32$

$^{\circ}C = (5/9)(^{\circ}F - 32)$