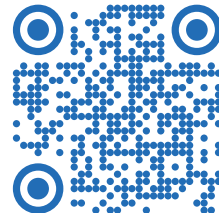


Chapter

2

Measurement and Problem Solving





Chapter 2 | Measurement and Problem Solving

2.1 - Measurement

الفكرة : الوحدة جزء أساسي من القياس، وأي خطأ فيها قد يؤدي إلى نتيجة خاطئة تمامًا

- Quantitative observation.
- Every measurement has a number and a unit.
- The unit tells you to what standard you are comparing your object.
- The number tells you:
 - 1 What multiple of the standard the object measures.
 - 2 The uncertainty in the measurement.

More digits = More precision

Scientists have measured the average global temperature rise over the past century to be 0.6°C

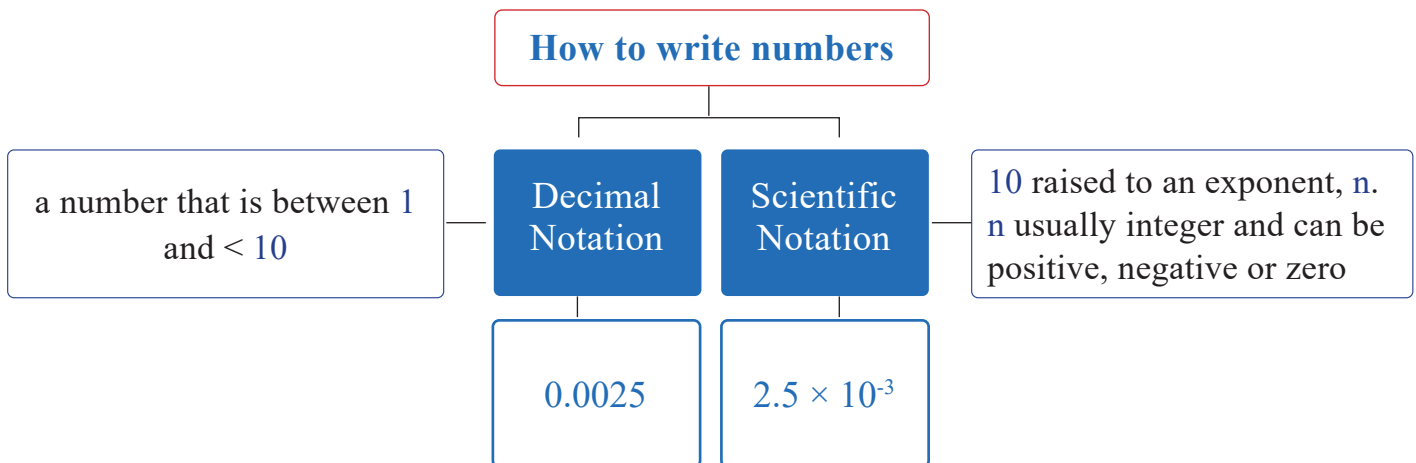
2.2 - Scientific Notation: Writing Big and Small Numbers

- Science constantly pushes the boundaries of the very large and the very small. We can, for example, now measure time periods as short as 0.0000000000000001 second and distances as great as 14,000,000,000 light-years

الفكرة : نستخدم الصيغة العلمية لكتابة الأعداد الكبيرة جدًا أو الصغيرة جدًا بطريقة مختصرة وسهلة



How to write numbers



1.2×10^{-10}

Decimal part Exponent (n) Exponential part

- إذا تم تحريك الفاصلة لليسار بالتالي يكون الأس العشري بالموجب
- إذا تم تحريك الفاصلة لليمين بالتالي يكون الأس العشري بالسالب

Decimal Notation	Scientific Notation
0.00075	
28.00	
34	
	3×10^{-5}
	4.56×10^2
	1.2×10^0



1 The correct scientific notation for the number 500.0 is:

- A) 5×10^2
- B) 5.00×10^2
- C) 5.000×10^2
- D) 5×10^{-2}
- E) none of the above

2 The distance between the two hydrogen atoms in a molecule of water is 0.000000000172 m. Express this distance in scientific notation.

- A) 1.72×10^{-9} m
- B) 1.72×10^{-10} m
- C) 0.172×10^{-10} m
- D) 17.2×10^9 m
- E) 1.72×10^{10} m

3 The correct decimal representation of 1.201×10^{-7} is:

- A) 12010000
- B) 0.0001201
- C) 0.0000001201
- D) 1201.000
- E) none of the above

4 The correct decimal representation of 6.453×10^3 is:

- A) 6,453
- B) 0.006453
- C) 6.5×10^3
- D) 6.453
- E) none of the above

◆ Compare the largest number of scientific notations:

$$2.5 \times 10^4 < 3.5 \times 10^4$$

$$2.5 \times 10^{-4} < 3.5 \times 10^{-4}$$

- إذا تساوت الأسس سواء بالسالب أو الموجب ننظر للرقم، الكبير هو الذي يمثل أكبر رقم

$$1.3 \times 10^5 > 1.3 \times 10^3$$

- إذا تساوت الأرقام، ننظر للأس في حالة الأس بالموجب الأس الكبير أكبر من الأس الصغير

$$1.3 \times 10^{-5} > 1.3 \times 10^{-3}$$

- إذا تساوت الأرقام، ننظر للأس في حالة الأس بالسالب الأس الصغير أكبر من الأس الكبير

2.3 & 2.4 - Significant Figures (S.F's)

الفكرة: الأرقام المعنوية توضح دقة القياس. في أي قياس تكون الأرقام المسجلة مؤكدة، ما عدا آخر رقم فهو رقم تقديري.



♦ Two different types of numbers

Exact numbers	Measured number
is the value that is known with complete certainty.	is obtained from measurements such as mass, height, volume and temperature.

Measurements are written to indicate the uncertainty in the measurement.

When writing measurements, all the digits written are known with certainty except the last one, which is an estimate.

45.872
 Estimated
 Certain

5 In the number 48.93, which digit is estimated?

- A) 4
- B) 8
- C) 9
- D) 3
- E) None of the above, all digits are certain.

6 There are exactly 2.54 centimeters in 1 inch. When using this conversion factor, how many significant figures are you limited to?

- A) 1
- B) 3
- C) ambiguous
- D) depends on if you are using it in multiplication|division or addition|subtraction
- E) infinite number of significant figures

♦ Significant figures:

1 are the digits within a number that help determine accuracy.

2 are digits in the number that determine how accurate a data value or measurement is

1 Non-zero digits

• كل الأرقام من 1 إلى 9 تعتبر (S.F)

55 → 2 S.F

986 → 3 S.F

2 Zero at left is not S.F

• الأصفار التي على اليسار لا تحتسب

0.006 → 1 S.F

00258 → 3 S.F



3 Zero between non-zero digits

- الأصفار بين الأرقام تحسب

$$2005 \rightarrow 4 \text{ S.F}$$

$$0.20007 \rightarrow 5 \text{ S.F}$$

4 Trailing zero

- الأصفار التي توجد على اليمين لها حالتين

- في حال وجود فاصلة تحسب الأصفار

- في حال عدم وجود فاصلة لا تحسب الأصفار

$$0.0200 \rightarrow 3 \text{ S.F}$$

$$7700 \rightarrow 2 \text{ S.F}$$

5 Square does not count

- الأس لا يحتسب من ضمن (S.F)

$$1.0 \times 10^2 \rightarrow 2 \text{ S.F}$$

$$0.01 \times 10^3 \rightarrow 1 \text{ S.F}$$

6 Rounding off

- التقريب :

- في حال كان العدد يساوي 5 أو أكثر يقرب

- في حال كان العدد أقل من 5 لا يقرب

Ex: round this number to 2 S.F

$$0.0024636 \rightarrow 0.0025$$

Ex: round this number to 3 S.F

$$9863200 \rightarrow 986$$

7 Addition and Subtraction

- في حال الجمع والطرح نأخذ أقل عدد بعد الفاصلة

$$15.2 + 3.326 = 18.526$$

$$1 \text{ S.F} \quad 3 \text{ S.F} = 18.5$$

$$9.15 - 3.099 = 6.055$$

$$2 \text{ S.F} \quad 3 \text{ S.F} = 6.06$$

8 Division and multiplication

- في حال الضرب والقسمة نأخذ أقل عدد S.F

$$5.35 \times 0.002 = 0.01106$$

$$3 \text{ S.F} \quad 1 \text{ S.F} = 0.01$$

$$19.8 / 10 = 1.98$$

$$3 \text{ S.F} \quad 1 \text{ S.F} = 2$$

Both Multiplication | Division and Addition | Subtraction with Significant Figures

$$(\quad) \rightarrow \times \div \rightarrow + -$$



7 Which of the following statements is NOT part of the rules for determining significant figures?

- A) Non-zero digits at the end of a number are not significant.
- B) Zeroes between two numbers are significant.
- C) Zeroes to the left of the first non-zero number are not significant.
- D) Trailing zeroes at the end of a number, but before an implied decimal point are ambiguous.
- E) All of the above statements are part of the rules.

8 The correct number of significant figures in the number 1.250100 is:

- A) 5
- B) 7
- C) 4
- D) ambiguous
- E) none of the above

9 The correct number of significant figures in the number 0.027090 is:

- A) 7
- B) 6
- C) 5
- D) ambiguous
- E) none of the above

10 The correct number of significant figures in the number “ 9.080×10^4 ” is:

- A) 3
- B) 4
- C) 5
- D) ambiguous
- E) none of the above

11 When the value 4.449 is rounded to two significant figures, the number should be reported as:

- A) 4.4
- B) 4.5
- C) 4.44
- D) 4.45
- E) none of the above

12 Determine the answer to the following equation with correct number of significant figures:

$$2.02 + 8.102 - 0.0297 =$$

- A) 10.0923
- B) 10.09
- C) 10.1
- D) 10.092
- E) none of the above

13 Determine the answer for the equation below with correct number of significant figures: $3.215 \times 13.2 \div 0.218 =$

- A) 194.669
- B) 195
- C) 194.7
- D) 194.67
- E) none of the above

14 How many significant digits should be reported in the answer to the following calculation? $(4.3 - 3.7) \times 12.3 =$

- A) 1
- B) 2
- C) 3
- D) 4
- E) none of the above



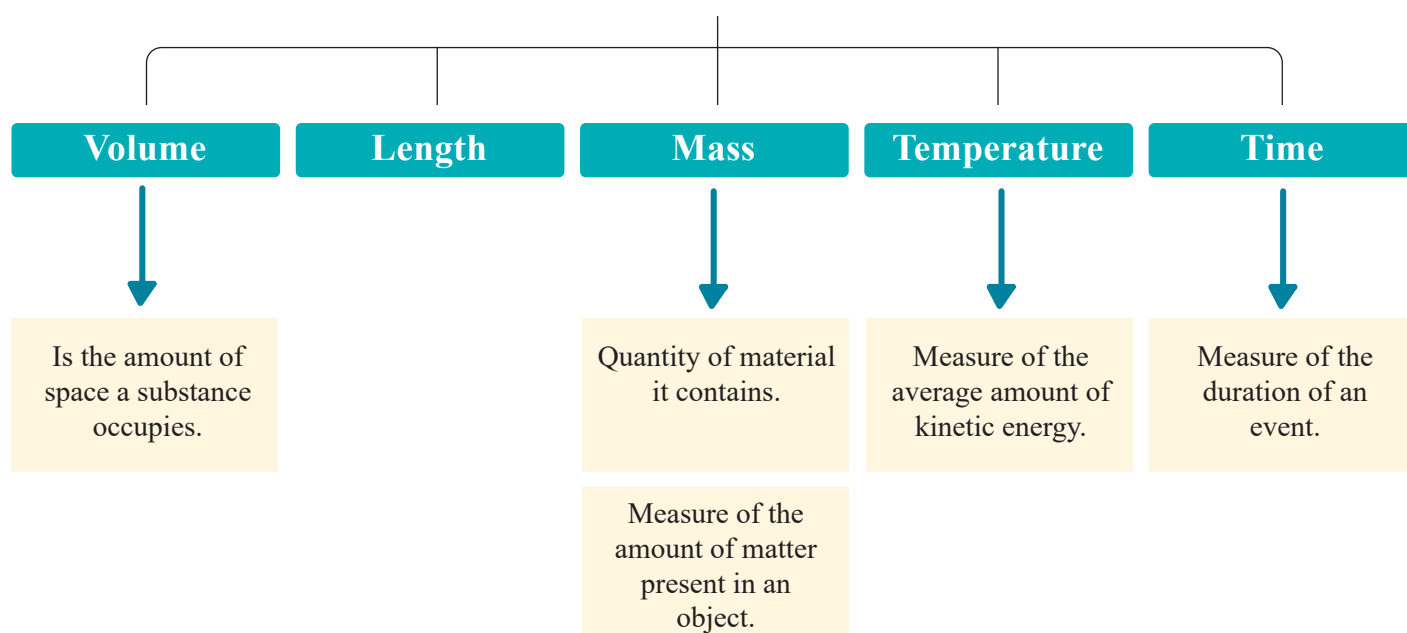
2.5 - The Basic Units of Measurement

◆ Part 1

- Units tell the standard quantity to which we are comparing the measured property. *Without an associated unit, a measurement is without meaning.*
- Scientists use a set of standard units for comparing all our measurements. So, we can easily compare our results.
- Each of the units is defined as precisely as possible.

Quantity	SI System		Metric System	
	Unit	Symbol	Name of Unit	Abbreviation
Length				
Mass				
Time				
Temperature				
Volume				

Units of Measurement and Their Abbreviations





15 What is the base SI unit for length?

- A) mile
- B) centimeter
- C) foot
- D) meter
- E) none of the above

17 The amount of space occupied by a substance is:

- A) Mass
- B) Density
- C) Weight
- D) Length
- E) Volume

16 The common English unit in which the speed of an automobile is expressed is miles/hr. What is the set of base SI units for speed?

- A) mile/s
- B) km/hr
- C) km/s
- D) m/s
- E) none of the above

International System of Units (SI)

◆ Part 2

TABLE 2.2 SI Prefix Multipliers

Prefix	Symbol	Meaning	Multiplier
tera-	T	trillion	1,000,000,000,000 (10^{12})
giga-	G	billion	1,000,000,000 (10^9)
mega-	M	million	1,000,000 (10^6)
kilo-	k	thousand	1,000 (10^3)
hecto-	h	hundred	100 (10^2)
deca-	da	ten	10 (10^1)
deci-	d	tenth	0.1 (10^{-1})
centi-	c	hundredth	0.01 (10^{-2})
milli-	m	thousandth	0.001 (10^{-3})
micro-	μ	millionth	0.000001 (10^{-6})
nano-	n	billionth	0.000000001 (10^{-9})
pico-	p	trillionth	0.000000000001 (10^{-12})
femto-	f	quadrillionth	0.000000000000001 (10^{-15})



18 The correct prefix for the multiplier 1,000 is:

- A) mega.
- B) milli.
- C) micro.
- D) nano.
- E) none of the above

19 The correct prefix for the multiplier 0.000001 is:

- A) mega.
- B) milli.
- C) micro.
- D) nano.
- E) none of the above

20 Which measurement below represents the heaviest mass?

- A) 1 mg
- B) 1 kg
- C) 1 pg
- D) 1 Mg
- E) 1 dg

21 Which of the following sets of units is NOT in the order of increasing size?

- A) $\mu\text{g} < \text{g} < \text{kg}$
- B) $\text{mL} < \text{dL} < \text{L}$
- C) $\text{ns} < \text{ms} < \text{s}$
- D) $\text{cm} < \mu\text{m} < \text{km}$
- E) $\mu\text{mol} < \text{mmol} < \text{mol}$

International System of Units (SI); Conversation Factor

◆ Part 3

Units of Measurement and Their Abbreviations

Volume	Length	Mass	Temperature	Time
$1 \text{ L} = 1000 \text{ cm}^3$ $1 \text{ L} = 1.057 \text{ qt}$ $946 \text{ mL} = 1 \text{ qt}$ $1 \text{ gal} = 3.785 \text{ L}$	$1 \text{ m} = 39.37 \text{ in}$ $1 \text{ m} = 1.094 \text{ yd}$ $1 \text{ in} = 2.54 \text{ cm}$ $1 \text{ km} = 0.6214 \text{ mi}$ $1 \text{ ft} = 30.48 \text{ cm}$	$1 \text{ kg} = 2.205 \text{ lb}$ $1 \text{ lb} = 453.59 \text{ g}$ $1 \text{ oz} = 28.35 \text{ g}$		$1 \text{ day} = 24 \text{ h}$ $1 \text{ h} = 60 \text{ min}$ $1 \text{ min} = 60 \text{ s}$



$$\frac{\cancel{\text{given unit}}}{\cancel{\text{given unit}}} \times \frac{\text{desired unit}}{\cancel{\text{given unit}}} = \text{desired unit}$$

22 Write the equality and two conversion factors of:

A) There are 40. mg of propranolol in 1 tablet.

B) A metric ton is 1000 kg.

23 An American nickel five cent coin has a mass of approximately 5 grams. Five grams is equivalent to which term?

- A) 5000 kilograms
- B) 5000 milligrams
- C) 50 centigrams
- D) 5000 micrograms
- E) none of the above

24 Which of the following would NOT be considered a correct conversion factor?

- A) 1 dozen eggs = 12 eggs
- B) 12 eggs = 1 dozen eggs
- C) 1 pair of shoes = 1 shoe
- D) 100 pennies = 1 dollar
- E) 5 cents = 1 nickel

25 How many milliliters are in 17.5 L?

- A) 175
- B) 1.75×10^{-2}
- C) 1.75×10^3
- D) 1.75×10^4
- E) none of the above

26 How many microliters are in 41.0 mL?

- A) 4.1×10^3
- B) 4.1×10^{10}
- C) 0.041
- D) 4.10×10^4
- E) none of the above

27 How many low dose 81 mg aspirin tablets can be made from 1.21 kg of aspirin?

- A) 1.5×10^3 tablets
- B) 1.5×10^4 tablets
- C) 1.5×10^5 tablets
- D) 1.21×10^3 tablets
- E) 1.21×10^4 tablets

28 How many cm^3 are there in 2.5 m^3 ?

- A) 2.5×10^6
- B) 2.5×10^{-2}
- C) 2.5×10^2
- D) 2.5×10^{-6}
- E) none of the above



2.10 -Density (الكثافة)

Density is : Ratio of mass to volume.

- Its value depends on the kind of material, not the amount.
- SI unit kg/m^3

The Density : solids > liquids > gases (Except ice is less dense than liquid water!)

- Solid: g/cm^3
- Liquid: g/mL
- Gas: g/L

The water displacement method is a system of measurements used to determine the volume of an object that does not have a regular shape.

$$\text{density (d)} = \frac{\text{mass}}{\text{volume}} = \frac{m}{v}$$

- $d = \text{density (g/cm}^3\text{)}$
- $m = \text{mass (g)}$
- $V = \text{volume (cm}^3 \text{ or ml)} \rightarrow V = \text{Length} \times \text{width} \times \text{height} \rightarrow V = V_2 - V_1$

29 A lead ball has a mass of 55.0 grams and a density of 11.4 g/cm^3 . What is the volume of the ball?

- A) 0.207 mL
- B) 0.207 L
- C) 4.82 mL
- D) 4.82 L
- E) none of the above

30 Given the density of Au is 19.3 g/cm^3 , determine the mass of gold (in grams) in an ingot with the dimensions of 10.0 in $\times$ 4.00 in $\times$ 3.00 in.

- A) 3.80×10^4
- B) 102
- C) 2.32×10^3
- D) 0.161
- E) none of the above



31 What is the density (g/mL) of an object that has a mass of 14.01 grams and, when placed into a graduated cylinder, causes the water level to rise from 25.2 mL to 33.6 mL?

- A) 0.60
- B) 1.7
- C) 1.8
- D) 2.4
- E) none of the above

32 An object weighing 1.840 kg has a volume of 0.0015 m³. What is the density of the object in g/cm³?

- A) 1.2
- B) 0.0012
- C) 0.82
- D) 0.0028
- E) none of the above

33 Given the following list of densities, which materials would float in a molten vat of lead provided that they do not themselves melt? Densities (g/mL): lead = 11.4, glass = 2.6, gold = 19.3, charcoal = 0.57, platinum = 21.4.

- A) gold and platinum
- B) glass and charcoal
- C) gold, platinum, glass and coal
- D) gold and charcoal
- E) none of the above