

## CHAPTER 1: The Study of Change

### 1.4: Measurement

Different instruments enable us to measure a substance's properties:

**Macroscopic properties** (determine directly): objects which is measurable and observable by naked eye.

**Microscopic properties** (determine indirectly): describe objects which is commonly too small to be seen by naked eye and require a lens or microscopic to see them.

Any measured quantity is written as a number with an appropriate unit

Table 1: The seven fundamental unit of measurement

Physical proprieties	Name of unit	Symbols
Length	Meter	m
Mass	Kilogram	Kg
Time	Second	S
Electric current	Ampere	A
Temperature	Kelvin	K
Amount of substance	Mole	M
Luminous intensity	Candela	cd

Ex: which one of the following is not an SI unit?

A. Minute

B. Kilogram

C. kelvin

D. meter

**Table 2: common prefix used in the SI and metric system**

Prefix	Abbreviation	Meaning
Tera	T	$10^{12}$
Giga	G	$10^9$
Mega	M	$10^6$
Kilo	K	$10^3$
Deci	D	$10^{-1}$
Centi	Cm	$10^{-2}$
Milli	m	$10^{-3}$
Micro	$\mu$	$10^{-6}$
Nano	n	$10^{-9}$
Pico	p	$10^{-12}$

## Measurements

### 1) Mass and weight

**Mass:** amount of matter in an object (SI unit of mass is Kg)

**Weight:** force that gravity exerts on an object

The process of measuring mass is called weighting

For simplicity when convert unit from one to another

Small  $\xrightarrow{10^-}$  large

Large  $\xrightarrow{10^+}$  small



Ex:

A) 15 kg to mg

15 kg (large) → mg (small)

15 kg  $\xrightarrow{10^{+3}}$  gram  $\xrightarrow{10^{+3}}$  mg

B) 20 ng to Gg

20 ng (small) → Gg (large)

20 ng  $\xrightarrow{10^{-9}}$  gram  $\xrightarrow{10^{-9}}$  Gg

Questions

Q1. Which of the following is the same as 0.001 cm?

- A. 0.01mm
- B. 0.01 dm
- C. 0.01 m
- D. 0.1 mm

Q2. Which of these quantities represent the largest distance?

- A.  $2 \times 10^2$  cm
- B. 0.0010 Km
- C.  $1 \times 10^5 \mu\text{m}$
- D.  $2 \times 10^2$  mm

Q3. There are ..... ng in a pg

- A. 0.001
- B. 1000
- C. 0.01
- D. 100

$10^{-12} \text{ p} \rightarrow 1 \text{ ng}$

~~$0.001 \times 0.001$~~

~~$x = 0.001 \times 10^{-12}$~~

$x \times 10^{-12} = 0.001$

$x = \frac{0.001}{10^{-12}}$

## Volume SI-Unit is ( $m^3$ )

$$\begin{aligned} \text{Area of square} &= \text{length} \times \text{width} \\ &= m \times m = m^2 \end{aligned}$$

$$\begin{aligned} \text{Volume of cube} &= \text{length} \times \text{width} \times \text{height} \\ &= m \times m \times m = m^3 \end{aligned}$$

$$1 \text{ cm}^3 = (1 \times 10^{-2} \text{ m})^3 = 1 \times 10^{-6} \text{ m}^3$$

$$1 \text{ dm}^3 = (1 \times 10^{-1} \text{ m})^3 = 1 \times 10^{-3} \text{ m}^3$$

- Another unit used to measure volume is the liter (L)

$$\begin{aligned} 1 \text{ L} &= 1000 \text{ mL} = 1 \times 10^3 \text{ mL} \\ &= 1000 \text{ cm}^3 = 1 \times 10^3 \text{ cm}^3 \\ &= 1 \text{ dm}^3 = 1 \text{ dm}^3 \end{aligned}$$

$$1 \text{ mL} = 1 \text{ cm}^3$$

Ex.2: Convert 45 L to  $\text{cm}^3$  ?

large  $\longrightarrow$  small

$$\text{L} \xrightarrow{10^3} \text{mL} = \text{cm}^3$$

$$\Rightarrow 45 \times 10^3 \text{ cm}^3$$

## Density

SI-Unit is (  $\text{Kg/m}^3$  )

$$\text{density} = \frac{\text{mass}}{\text{volume}}$$

$$d = \frac{m}{v} = \frac{g}{\text{ml}} \text{ (or any units)}$$

$$1 \text{ g/cm}^3 = 1 \text{ g/ml} = 1 \times 10^3 \text{ kg/m}^3$$



## Questions

Q1. The mass of 5 ml of unknown liquid was found to be 5.34 gram. The density (mg/ml) for this liquid is?

$$d = \frac{m}{V} = \frac{5.34 \times 10^3 \text{ mg}}{5 \text{ ml}} = 1068 \text{ mg/ml}$$

Q2. If a piece of metal has a density of  $3.5 \times 10^3 \text{ kg / m}^3$  and mass of 23.6 g then the volume ( $\text{cm}^3$ ) of this metal is?

$$3.5 \times 10^3 \text{ kg / m}^3 = \frac{23.6 \times 10^3}{V}$$

$$V = 6.7 \times 10^{-6} \text{ m}^3 \xrightarrow{\times 10^{+6}} 6.7 \text{ cm}^3$$

Q3. The diameter of an atom is approximately  $1 \times 10^{-8} \text{ cm}$ . What is this diameter when expressed in nanometers?

- A.  $1 \times 10^{-19} \text{ nm}$     B.  $1 \times 10^{-1} \text{ nm}$     C.  $1 \times 10^1 \text{ nm}$     D.  $1 \times 10^{-10} \text{ nm}$



## 3) Temperature

It's a physical property of matter that quantitatively expresses the common notion of hot and cold .Temperature is measured with thermometer, which may be calibrated to a variety of temperature scales.

### Temperature SI-Unit is Kelvin (K)

Scales of temperature are:  
1- degrees Celsius ( $^{\circ}\text{C}$ )

2- Kelvin (K)

3- degrees Fahrenheit ( $^{\circ}\text{F}$ )

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

$$\text{K} = (^{\circ}\text{C} + 273.15)$$

$$^{\circ}\text{F} = \frac{9}{5} \times ^{\circ}\text{C} + 32$$

#### Note:

- $^{\circ}\text{F}$  - most commonly scale used in the USA
- smallest scale size
- $\text{K}$  - is the absolute temperature scale (0 K zero kelvin = - 273.15)
- 0 K is the lowest temperature that can be attained theoretically.
- its never be in negative (-ve) value.

Ex.3 Convert  $75^{\circ}\text{C}$  to  $^{\circ}\text{F}$  & K ?

$$^{\circ}\text{F} = \frac{9}{5} \times 75 + 32 = 167^{\circ}\text{F}$$

$$\text{K} = 75 + 273.15 = 348.15 \text{ K}$$

## Questions

Q1. Which of the following is the lowest temperature?

A. The freezing point of water

B.  $5^{\circ}\text{C}$

C.  $25^{\circ}\text{F}$

D. 280 k



## Q2. Convert

- A. 75 C to F and K
- B. 115 K to F and C
- C. 70 F to C and K

## Q3. The temperature on warm summer day is 87 F. what is in C?

- A. 15
- B. 31
- C. 26
- D. 11

## Numbers

In scientific work we recognized two types of numbers

### 1. Exact numbers : value which known exactly

Exact number is an integer number (infinite significant figure) Such as:

No of student in the class (you know the exact number of student and u can't make error in the number of them)

Dozen = 12

couple = 2

### 2. Inexact numbers: Values whose have some uncertainties

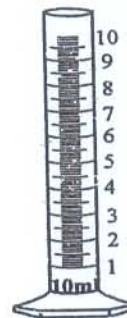
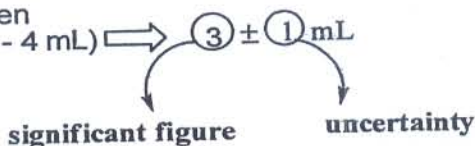
## Handling number

- ⇒ Significant Figures : The meaningful digits in a measured or calculated quantity
- ⇒ Scientific Notation : A system used when working with very large or very small numbers

### Significant Figures

If we measure a volume in the graduated cylinder with a scale that gives an uncertainty of 1ml in the measurement.

If the volume is found to be 3 mL then the actual volume is in the range (2 - 4 mL)



graduated cylinder

### Guidelines for Using Significant Figures

How to determine significant figures

#### 1. Non-Zero digits are significant

356 ml is 3 significant figures(S.F)

#### 2. Zeros between non-Zero digits are significant

4063 g is 4 S.F

#### 3. Zeros at the Left of the number are not significant

0.097 g = 2 S.F

#### 4. Zeros at Right of the number are :

##### A. With decimal points:

≥1 : all zeros are S.F

700.0 ml = 4 S.F

<1: Start with the first non-zero & count all digits (even zero) after it

0.0025 ml = 2 S.F

0.3006 ml = 4 S.F

##### B. Without decimal points:

50000 ml = 1 S.F

= 2 S.F

= 3 S.F

= 4 S.F

$5 \times 10^4$

$50 \times 10^3$

$500 \times 10^2$

$5000 \times 10$  (Note: don't write  $5000 \times 10^1$ )

This called Scientific Notation





### Scientific Notation:

Deal only with no. before ( $\times 10^n$ ) and use the rules of S.F that learned before

There are 3 S.F  $2.34 \times 10^3$  (We can't say 2340 & the answer is 4 S.F----- wrong)

**Q1. The numbers of significant figures in the following two quantities 0.2300 and 0.0023?**

- A. 5,4                      B. 4,4                      C. 4,2                      D. 2,2

**Q2. In which of the following number all zero are significant?**

- A. 100.090090              B. 143,29              C. 0.05843              D. 0.1000

**Q3. Indicate the number of significant figures in each of the following quantities?**

- A. 122 gram  
B.  $5.0 \times 10^{-5}$  meter  
C. 0.0002796 second  
D. 8.007 mm  
E. 237 K

**Q4. The number 0.00430 has ..... significant figures**

- A. 2              B. 3              C. 5              D. 6              E. 4



### Division and multiplication

In division and multiplication the result must be reported with the least significant figures

Ex.

$$\frac{56.2}{3 \text{ S.F.}} \times \frac{0.25}{2 \text{ S.F.}} = \frac{14.05}{4 \text{ S.F.}} \xrightarrow{\text{Rounding}} = 14 \text{ (2 S.F.)}$$

Rounding (See Rounding in the next pages)

↓  
least S.F in Equation  
So, the answer must be 2 S.F

### Addition and subtraction

The result should be reported to the same number of decimal places as that of the term with the least number of decimal place.

Ex.

$$\frac{12.01}{2 \text{ decimal places}} + \frac{1.008}{3 \text{ decimal places}} = \frac{13.018}{3 \text{ decimal places}} \xrightarrow{\text{Rounding}} = 13.02 \text{ (2 decimal places)}$$

↓  
least decimal places in Equation  
So, the answer must be 2 S.F after decimal



When more than one operation is involved in a calculation, note the number of S.F in each operation, but round only the final answer

Q1. Express the result of the following calculation to the proper number of significant figures?

- A.  $43.92 + 147.6 + 1.387 + 561 \dots\dots\dots 754$   
B.  $0.335 + 1.774 + 10.82 \dots\dots\dots 12.93$   
C.  $2.4 + 3.69 \times 4.2 \dots\dots\dots 18$   
D.  $27.43 + 3.32 \times 25.61 \dots\dots\dots 112$   
E.  $6.022 \times 10^{23} / 12.0 \dots\dots\dots 5.02 \times 10^{22}$   
F.  $2.13 + 3.3 / 2.2 \dots\dots\dots 7.0$   
G.  $32.0 \times 5.000 / 3 \dots\dots\dots 53.3$   
H.  $333 \times 10^2 + 2.26 \times 10^3 \dots\dots\dots 35.5 \times 10^3$   
I.  $10.07 + 7.393 / 2.5 \dots\dots\dots 6.9$   
J.  $0.002843 \times 12.80184 / 0.00032 \dots\dots\dots 113.7$

Q2. How many significant figures should there in the answer of following operations?

1.  $(29.2 - 20.0) (1.79 \times 10^2) / 1.39$

- A.1                      B.2                      C.3                      D.4

2.  $(13.7 + 0.027) / 8.221$

- A. 1                      B.2                      C.3                      D.4

3.  $10.07 + 7.395 / 2.5$

- A.1                      B.2                      C.3                      D.4



## Rounding off:

- a)  $>5$  : add 1 to the last digit
- b)  $<5$  : remove the number
- c)  $= 5$  : - odd number before 5: add 1 to the no.  
- even number before 5: - if numbers after 5: add 1  
- if no numbers after 5: remove 5

## Q1. Round

- a) Round 4.69 to 2 S.F ?
- b) Round 4.63 to 2 S.F ?
- c) Round 4335 to 3 S.F ?
- d) Round 4325 to 3 S.F ?
- e) Round 432500 to 3 S.F ?

## Q2. Round the numbers 0.007225 to three significant figures?

- A. 0.007      B. 0.00722      C. 0.0072      D. 0.00723

## Q3. In which of the following number correctly rounded to 3 significant figures?

- A. 3.2550 ..... 3.25
- B. 0.01832 ..... 0.018
- C. 100 ..... 100
- D. 10.25001 ..... 10.3
- E. 1.325 ..... 1.33

## Uncertainty and Error in measurements:

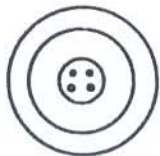
Precision and Accuracy:

### Precision:

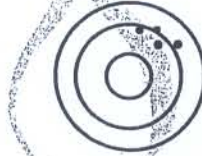
How much measurements are close each to other

### Accuracy:

How much measurements are close to the true value



Accurate & precise



inaccurate & precise



inaccurate & imprecise

**Q1. The agreement between the measured and the true value of an object is called?**

- A. Uncertainty      B. accuracy      C. Precision      D. Error

**Q2. Four students determine the mass of copper in a sample as a laboratory exercise. The true mass is 3.79 grams. The student results for three trials are as follows. Which set is the most accurate and the most precise?**

Student	First trial	Second trial	Third trial	Average
A	4.00	4.01	3.99	4.00
<u>B</u>	3.78	3.80	3.79	3.79
C	3.90	3.79	3.68	3.79
D	3.70	3.50	3.90	3.70



## 1.9: Dimensional Analysis

Dimensional analysis is the method to convert a number from one unit to another using a conversion factor.

Conversion factors establish a relationship of equivalence in measurements between two different units.

We know that

1 week = 7 days we can write it as

$$\left( \frac{7 \text{ days}}{1 \text{ week}} \right) \text{ or } \left( \frac{1 \text{ week}}{7 \text{ days}} \right)$$

1 mile = 1.61 km , we can write conversion factor as:

$$\left( \frac{1.61 \text{ km}}{1 \text{ mile}} \right) \text{ or } \left( \frac{1 \text{ mile}}{1.61 \text{ km}} \right)$$

So, we can use this equation to solve problems:

$$\text{Given Unit} \times \left( \frac{\text{Desired Unit}}{\text{Given Unit}} \right) = \text{Desired Unit}$$

Conversion factor

Ex. How many days are in 16 weeks? (7 = 1 week)

$$16 \cancel{\text{ weeks}} \times \left( \frac{7 \text{ days}}{1 \cancel{\text{ week}}} \right) = 112 \text{ days}$$

(desired)                      (given)



**Q1. The Mercedes that just went by at 190 km/h is using gasoline at a rate of 16 L per 100 km. What does this correspond to in miles per gallon? (Hint: 1 gallon = 3.78L, 1 mile = 1.61 km)**

Answer: 14.68

**Q2. Convert 4.0 feet to cm? (Hint: 1 feet = 12 inch, 1 inch = 2.54 cm)?**

Answer: 121.92

**Q3. Convert 235 ml to qt.? (Hint: 1L= 1.06 qt)?**

Answer: 0.249

ALQUSOUR  
ACADEMY

أكاديمية القصور

نستقبلكم و نستقبل إتصالاتكم

يوماً من الساعة 12:30 ظهراً و لغاية الساعة 12:30 ليلاً  
عدا يوم الجمعة من الساعة 2:00 ظهراً و لغاية الساعة 11:00 ليلاً

\* للتسجيل بالدورات والاستفسار عن التلاخيص  
إربد 0785706008  
عمان 0785706006

[www.facebook.com/alqusouracademy.page](http://www.facebook.com/alqusouracademy.page)



## Questions

1-Lead melts at 601.0°C. What temperature is this in °F?

- A. 302°F      B.365°F      C.1,050°F      D.1,114°F

2- The number  $1.050 \times 10^9$  has how many significant figures?

- A. 2    B.3      C.4      D.9

3-How many significant figures are there in  $1.3070 \times 10^2$  g?

- A. 6      B.5      C.4      D.3

4-Do the indicated arithmetic and give the answer to the correct number of significant figures.

$$(1.500 + 61.326) \div 2.01 =$$

- A. 32.0      B. 31.2      C. 31.25      D. 31.3

5-When 7.02°C is converted to the Fahrenheit scale, how many significant figures are there in the °F result?

- A. 1      B.2      C.3      D.4

6- The density of mercury is  $13.6 \text{ g/cm}^3$ . How many liters does 251 g of Hg occupy?

- A. 18.5 L      B.54.9 L      C. $1.85 \times 10^{-2}$  L      D. $5.42 \times 10^{-2}$  L





**Answer sheet**

Question No.	Answer
1	
2	
3	
4	
5	
6	

ALQUSOUR  
ACADEMY



## Answers

Question No.	Answer
1	D 1,114°F
2	C 4
3	B 5
4	D 31.3
5	C 3
6	C $1.85 \times 10^{-2}$ L

ALQUSOUR  
ACADEMY

مقرنا في عمان