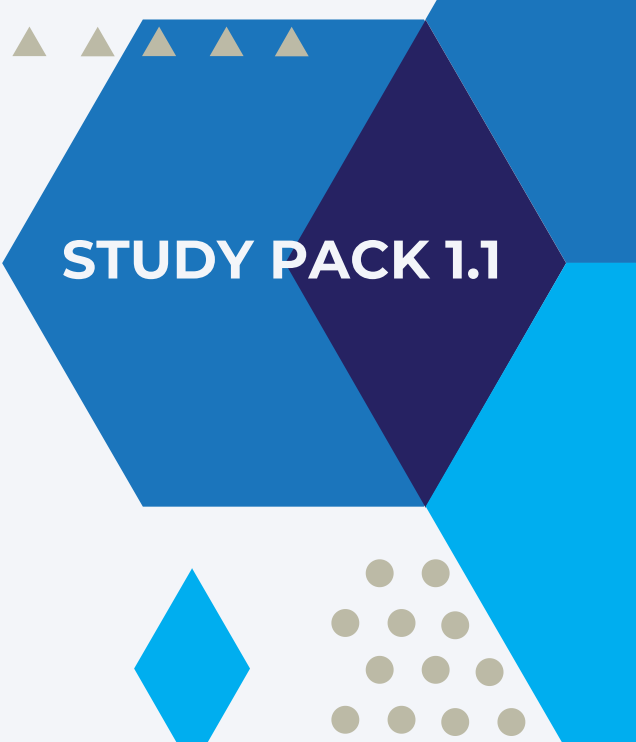
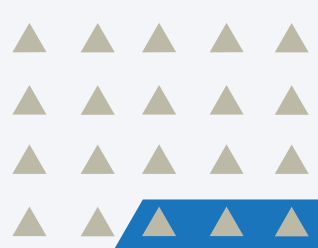


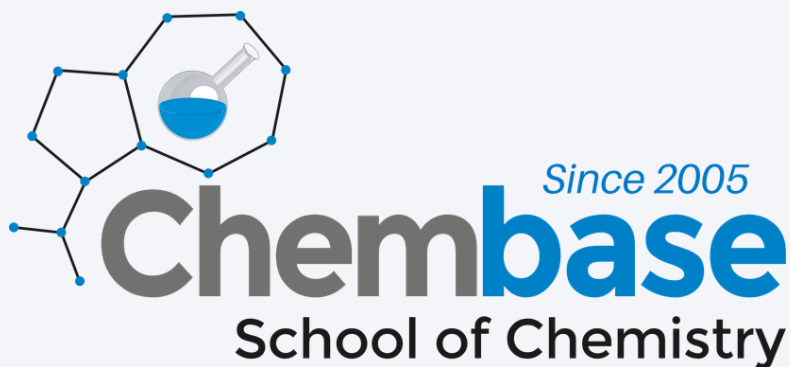


UNIVERSITY OF
CAMBRIDGE

STUDY PACK 1.1



ATOMS, MOLECULES & STOICHIOMETRY



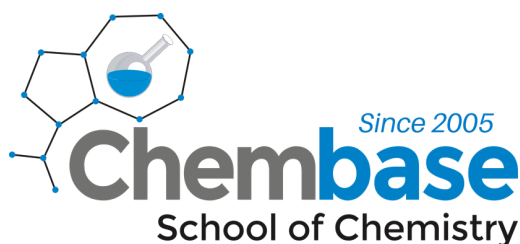
First Edition Jan 2006
Second Edition Jun 2009
Third Edition Jun 2011
Fourth Edition Jun 2021 (Revised New Syllabus)

All Rights Reserved.

Unauthorized duplication contravenes applicable laws.

No part of this publication may be reproduced or utilized in any form or by electronic, mechanical or other means, now known or hereafter invented including photocopying & recording, without the prior permission in writing from the copyright owner.

PUBLISHED BY :



PRODUCER OF
**WORLD PRIZE
& ISLAND TOP**
AWARD WINNERS SINCE 2005

 **Pearson
Edexcel**
UNIVERSITY OF
CAMBRIDGE

COPYRIGHT OWNER :

Prof. IMRAN RAZEEK I.Chem.C(P1), M.Ed, Ph.D (Reading)

**Honorary Professor | Founder, Chairman & Head of Department of
Chembase School of Chemistry | Chief Chemistry Educator**

CHEMBASE SCHOOL OF CHEMISTRY

 34, 1/2, Galle Road, Dehiwela. SRI LANKA.

 **+94 754 456 456 | +94 776 534 233**

 **info@chembase.lk**



**JOIN LIVE CLASSES @
WWW.CHEMBASE.LK**



**ONLINE COURSES @
WWW.CHEMBASEACADEMY.COM**



CHEMBASE.LK



CHEMBASE.LK



CHEMBASE SCHOOL OF CHEMISTRY



CHEMBASE SCHOOL OF CHEMISTRY

ACCREDITED & APPROVED BY :

 **UK International
Qualifications**



R.S.D.C.A
Regional Skill
Development &
Certification Authority

AN ACCREDITED TEACHING INSTITUTE OF UK INTERNATIONAL QUALIFICATIONS.

Chemical Formulae

1. What is meant by the term Valency?

Valency of an element is equal to the number of positive or negative charge acquired by the atom by losing or gaining electrons

2. Write down the Rules of writing a Chemical formula?

- a) Write down the symbols of the elements/ radicals given in the chemical name of the compound.
- b) Write down the valencies of each element or radical under the corresponding symbol.
- c) Cross them over as shown below
- d) The valencies show the simplest combining ratio & may be cancelled down in order to simplify
- e) If an element has more than one valency, the name of the compound will indicate the valency in capital roman numerals.
Eg: Copper (I) Oxide
 Lead (IV) chloride

5. Explain why the valency of noble gases is zero hence forming no compounds

Noble gases possess a completely filled outermost shell of electrons. Therefore, it will not lose or gain electrons, hence the valency is zero forming no bonds.

6. Assign the valency for the following Elements & Radicals:

ELEMENTS			RADICALS		
	Symbol	Valency		Symbol	Valency
Hydrogen	H		Hydroxide	OH	
Carbon	C		Nitrite	NO ₂	
Nitrogen	N		Nitrate	NO ₃	
Oxygen	O		Sulfite	SO ₃	
Sodium	Na		Sulfate	SO ₄	
Magnesium	Mg		Ammonium	NH ₄	
Aluminium	Al		Carbonate	CO ₃	
Silicon	Si		Hydrogen-carbonate (bicarbonate)	HCO ₃	
Phosphorus	P		Hydrogen- Sulfite (bisulfite)	HSO ₃	
Sulfur	S		Hydrogen- Sulfate (bisulfate)	HSO ₄	
Chlorine	Cl		Phosphate	PO ₄	
Potassium	K		Manganate (VII)	MnO ₄	
Manganese	Mn		Chlorate (I)	ClO	
Iron	Fe		Chlorate (V)	ClO ₃	
Cobalt	Co		Vanadate (V)	VO ₃	
Copper	Cu		Chromate (VI)	CrO ₄	
Zinc	Zn		Dichromate (VI)	Cr ₂ O ₇	
Bromine	Br		Oxalate	C ₂ O ₄	
Barium	Ba		Thiosulfate	S ₂ O ₃	
Iodine	I		Tetrathionate	S ₄ O ₆	
Lead	Pb		Peroxi di sulfate (per sulfate)	S ₂ O ₈	
Mercury	Hg				
Silver	Ag				

7. Write the formulae of the following, by showing the valencies of each element & Crossing them over:

Aluminium Oxide

Iron (II) Sulfate

Copper (I) Oxide

Lead (II) Nitrate

Ammonium Carbonate

Calcium Hydrogen Carbonate

Lead (IV) Oxide

Tin (II) Chloride

Iron (III) hydroxide

Ammonium Phosphate

Magnesium Chromate (VI)

Potassium Chlorate (V)

Aluminium Vanadate (V)

Sodium dichromate (VI)

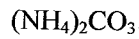
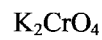
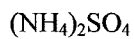
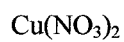
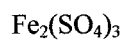
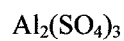
Calcium Oxalate

Zinc nitrate

Sodium thiosulfate

Sodium Chlorate (I)

Naming of Compounds



Atoms, Molecules & Stoichiometry

1. Explain why the mass of an atom is measured in relative masses?

The mass of an individual atom is very small therefore it is only possible to measure the atomic masses in relative masses. Since SI units cannot be used, we use an atom itself to measure the mass of another atom.

2. Define “**Relative atomic mass**”? Write its units.

Average mass of an atom of an element compared to $1/12^{\text{th}}$ the mass of an atom of $^{12}_6\text{C}$ isotope. No units.

$$\text{R.A.M} = \frac{\text{The average mass of an atom of an element}}{1/12^{\text{th}} \text{ the mass of an atom of } ^{12}_6\text{C} \text{ isotope}}$$

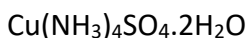
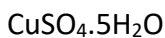
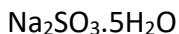
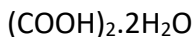
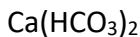
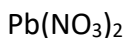
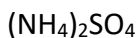
3. Define “**Relative molecular / formula mass**”? Write its units.

Average mass of all atoms / ions in a molecule / formula compared to $1/12^{\text{th}}$ the mass of an atom of $^{12}_6\text{C}$ isotope. No units.

4. Define “**molar mass**”? Write its units.

Molar mass is the mass of one mole of the of a substance. (Molecule / compound) Unit : g mol^{-1}

5. Calculate the Relative molecular mass & molar mass of these molecules



6. Define “Relative isotopic mass”?

The mass of an atom of an isotope compared to 1/12th the mass of an atom of $^{12}_6\text{C}$ isotope. No units.

$$\text{R.I.M} = \frac{\text{The mass of an atom of an isotope}}{1/12^{\text{th}} \text{ the mass of an atom of } ^{12}_6\text{C} \text{ isotope}}$$

7. i) The relative abundance of “Cl” isotopes are ^{35}Cl - 75% & ^{37}Cl - 25%. Calculate the relative atomic mass (RAM) of “Cl”?

ii) Two isotopes of “X” exist in nature as ^{16}X & ^{18}X , the relative abundance of ^{16}X is 70%, find the relative atomic mass of “X”?

Mass Spectrometer

1. What is mass spectrometer?

The mass spectrometer is an instrument used for accurately measuring atomic masses & for finding the number of isotopes of an element by separating the positively charged gaseous particles as to their mass/charge ratio.

2. Name the main five sections of a mass spectrometer

1. Vaporizer - The sample is vaporized
2. Ionizer - Positive ions are obtained
3. Accelerator - Positive ions are accelerated by an electric field.
4. Deflector - Positive ions are deflected by a magnetic field.
5. Detector - Ions are detected & a record is made.

3. Describe briefly how a mass spectrometer works stating the principle of each stage

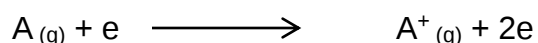
The mass spectrometer separates positively charged gaseous particles according to their mass/charge ratio thus detect their presence by an ion detector.

i. Vaporization:-

The sample is introduced into the vaporizing chamber; before it passes onto the ionizing chamber the sample is completely vaporized. The particles present in gaseous state can be gaseous atoms, compounds or molecules.

ii. Ionization:-

After vaporization, the molecule passes in to the ionization chamber, where atoms of the element are bombarded by a stream of high energy electrons. This causes ionization resulting positively charged ions. One or two electrons are knocked out of the atoms leaving cations. Mostly uni positive cations are produced.



iii. Acceleration:-

These cations pass through the electric field. Thus ions are accelerated by the electric field.

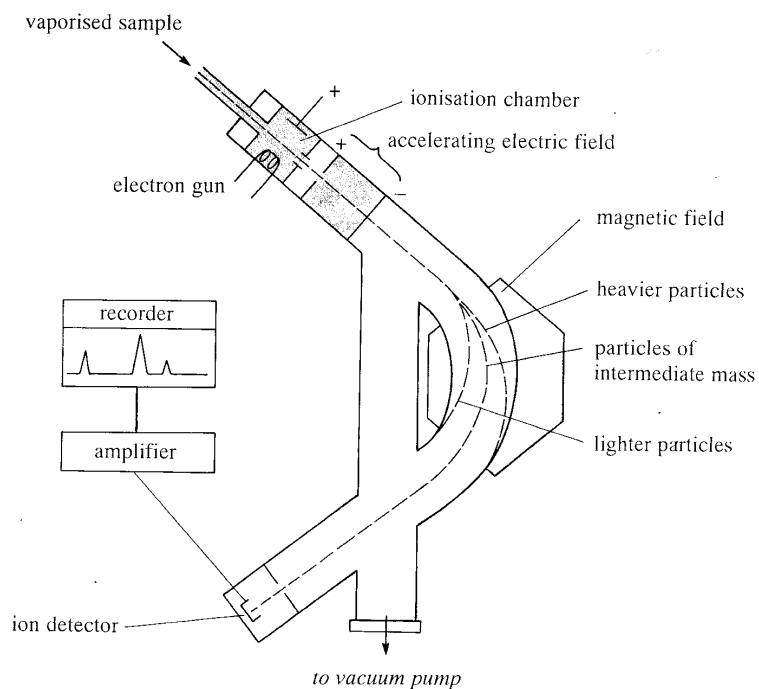
iv. Deflection:-

The magnetic field deflects the particles according to their mass/charge ratio. The particle with the highest mass / charge ratio will deflect less due to its greater kinetic energy & the particle with the least mass/charge ratio will deflect more.

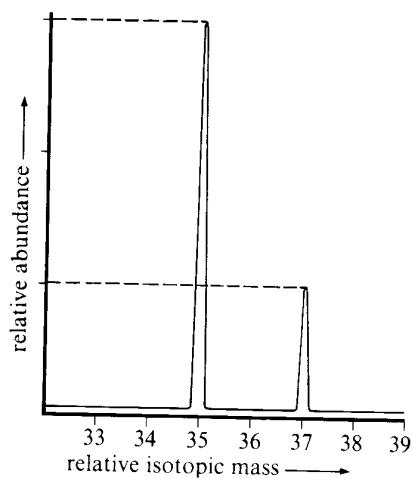
v. Detection:-

When a positively charged particle reaches the ion detector, it will produce a signal thus will be amplified to a computer and a record will be made.

4. Detailed labeled diagram of a mass spectrometer



5. The Mass Spectrum trace for Chlorine is shown below

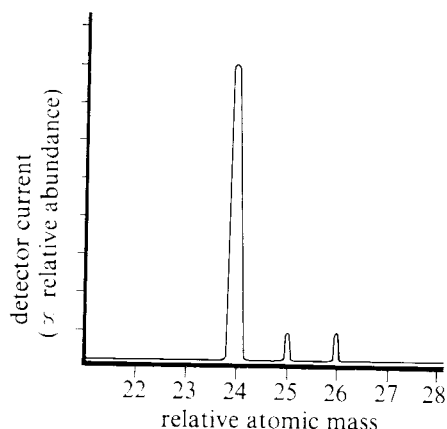


Calculate the;

- I. Relative abundance of each isotope ^{37}Cl & ^{35}Cl
- II. Relative atomic mass of chlorine

5. The Mass Spectrum trace for Magnesium is shown below

Calculate the;



I. Relative abundance of each isotope of 'Mg'

II. Relative atomic mass of Magnesium

7. If a mono atomic element is introduced into the mass spectrometer
- How many different particles will you expect in the ionizing chamber?
 - What are the factors, which is responsible for the number of particles to differ from one mono atomic element to another?
 - Rubidium has two isotopes ^{85}Rb & ^{87}Rb and if the ionizing chamber forms both +1 & +2 ions, write the formulae & the m/e values of all the species you would expect to find in the ionizing chamber
 - Relative abundances of the isotopes of Rubidium are ^{85}Rb 72.12% & ^{87}Rb 27.88%, Sketch a mass spectrum you would expect from a sample of 'Rb' & calculate the Relative Atomic Mass.

