ATOMIC STRUCTURE

A guide for A level students

KNOCKHARDY PUBLISHING

2015
SPECIFICATIONS

ATOMIC STRUCTURE

INTRODUCTION

This *Powerpoint* show is one of several produced to help students understand selected topics at AS and A2 level Chemistry. It is based on the requirements of the AQA and OCR specifications but is suitable for other examination boards.

Individual students may use the material at home for revision purposes or it may be used for classroom teaching if an interactive white board is available.

Accompanying notes on this, and the full range of AS and A2 topics, are available from the KNOCKHARDY SCIENCE WEBSITE at...

www.knockhardy.org.uk/sci.htm

Navigation is achieved by...

either clicking on the grey arrows at the foot of each page

or using the left and right arrow keys on the keyboard

THE STRUCTURE OF ATOMS

Atoms consist of a number of fundamental particles, the most important are ...

	Mass / kg	Charge / C	Relative mass	Relative charge
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NEUTRON				
ELECTRON				

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NEUTRON	1.675×10^{-27}	0	1	0
ELECTRON	9.109×10^{-31}	1.602×10^{-19}	$\frac{1}{1836}$	-1

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$$6 \times 1.672 \times 10^{-27} + 6 \times 1.675 \times 10^{-27} + 6 \times 9.109 \times 10^{-31} = 2.0089 \times 10^{-26}\ \text{kg}$$

MASS NUMBER AND ATOMIC NUMBER

Atomic Number (Z)	**Number of protons in the nucleus of an atom**
Mass Number (A)	**Sum of the protons and neutrons in the nucleus**

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THESE ALWAYS GO TOGETHER – ANYTHING WITH 11 PROTONS MUST BE SODIUM

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$$11$$

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THERE WILL BE 12 NEUTRONS IN THE NUCLEUS

23 – 11 = 12

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MASS NUMBER AND ATOMIC NUMBER

	Protons	Neutrons	Electrons	Charge	Atomic Number	Mass Number	Symbol
A	19	21	19				
B	20			0		40	
C				+	11	23	
D	6	6		0			
E	92			0		235	
F	6					13	
G		16		2-	16		
H							$^{27}Al^{3+}$

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	Protons	Neutrons	Electrons	Charge	Atomic Number	Mass Number	Symbol
A	19	21	19	0	19	40	^{40}K
B	20	20	20	0	20	40	^{40}Ca
C	11	12	10	+	11	23	$^{23}Na^{+}$
D	6	6	6	0	6	12	^{12}C
E	92	143	92	0	92	235	^{235}U
F	6	7	6	0	6	13	^{13}C
G	16	16	18	2-	16	32	$^{32}S^{2-}$
H	13	14	10	3+	13	27	$^{27}Al^{3+}$

RELATIVE MASSES

Relative Atomic Mass (A_r)

The mass of an atom relative to the ^{12}C isotope having a value of 12.000

$$A_r = \frac{\text{average mass per atom of an element}}{\text{mass of one atom of carbon-12}} \times 12$$

Relative Isotopic Mass

Similar, but uses the mass of an isotope ^{238}U

Relative Molecular Mass (M_r)

Similar, but uses the mass of a molecule CO_2, N_2

Relative Formula Mass

Used for any formula of a species or ion $NaCl$, OH^-

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Definition **Atoms with…**

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Physical properties (such as density) can differ

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Theory Relative atomic masses measured by chemical methods rarely produce whole numbers but they should do (allowing for the low relative mass of the electron). This was explained when the mass spectrograph revealed that atoms of the same element could have different masses due to the variation in the number of neutrons in the nucleus. The observed mass was a consequence of the abundance of each type of isotope.

ISOTOPES OF HYDROGEN

	Protons	Neutrons
${}^{1}_{1}H$	1	0
${}^{2}_{1}H$	1	1
${}^{3}_{1}H$	1	2

ISOTOPES - CALCULATIONS

There are two common isotopes of chlorine. Calculate the average relative atomic mass of chlorine atoms

	Protons	Neutrons	%
$^{35}_{17}Cl$	17	18	75
$^{37}_{17}Cl$	17	20	25

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Method 1 Three out of every four atoms will be chlorine-35

$$\text{Average} = \frac{35 + 35 + 35 + 37}{4} = 35.5$$

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Method 1 Three out of every four atoms will be chlorine-35

Average = $\frac{35 + 35 + 35 + 37}{4}$ = 35.5

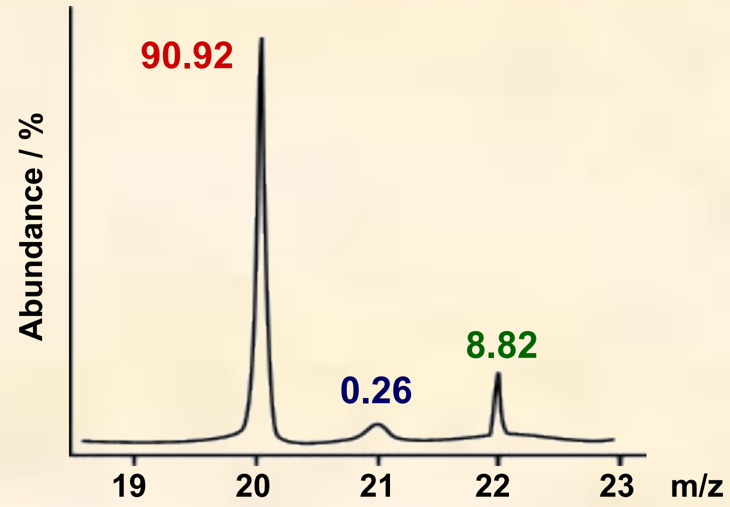
Method 2 Out of every 100 atoms 75 are ^{35}Cl and 25 are ^{37}Cl

Average = $\frac{(75 \times 35) + (25 \times 37)}{100}$ = 35.5

MASS SPECTRA

An early application was the demonstration by Aston, (Nobel Prize, 1922), that naturally occurring neon consisted of 3 isotopes... ^{20}Ne ^{21}Ne ^{22}Ne.

- **positions of peaks gives atomic mass**
- **peak intensity gives relative abundance**
- **highest abundance is scaled up to 100%**
  - other values are adjusted accordingly.



Calculate the average relative atomic mass of neon using the above information.

Out of every 100 atoms 90.92 are ^{20}Ne , 0.26 are ^{21}Ne and 8.82 are ^{22}Ne

$$\text{Average} = \frac{(90.92 \times 20) + (0.26 \times 21) + (8.82 \times 22)}{100} = 20.179$$

Relative atomic mass = **20.18**

MASS SPECTRA

Naturally occurring potassium consists of potassium-39 and potassium-41. Calculate the percentage of each isotope present if the average is 39.1.

Assume there are x nuclei of ^{39}K in every 100; so there will be (100-x) of ^{41}K

so $$\frac{39x + 41(100-x)}{100} = 39.1$$

therefore $$39x + 4100 - 41x = 3910$$

thus $$-2x = -190$$

and $$x = 95$$

ANSWER There will be **95%** ^{39}K and **5%** ^{41}K

ATOMIC STRUCTURE

THE END