The content on this sheet is common to Paper 1 & Paper 2

Atomic Structure, Bonding and Types of Substance

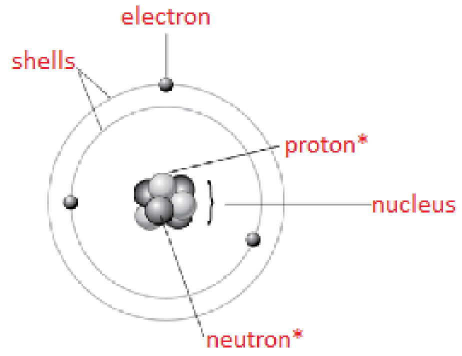
* Indicates that these are some examples only: you could be asked about any substance / reaction.
‡ There are many acceptable answers, such as *almost* zero, 0.0005, 1 / 2000 etc.

1.1 — How has Dalton's model of the atom changed

Dalton said: 1) atoms cannot be broken down into something simpler; 2) atoms of a given element are identical; 3) atoms of different elements are different from one another; 4) atoms of elements can combine to form compounds.

The discovery of the electron by JJ Thomson in 1897 disproved point 1. The discovery of the central nucleus in the atom by Rutherford around 1911 also disproved point 1. The proton was discovered in 1918, and confirms point 3 is correct. The discovery of the neutron by Chadwick in 1932 disproved point 2.

1.2 — Describe the structure of the atom



1.3 — Charge & mass of sub-atomic particles

Particle	Relative mass	Relative charge
Proton	1	+1
Electron	1 / 1835‡	-1
Neutron	1	0

1.4 — Numbers of protons and electrons

Explain why the overall charge of an **atom** is always zero.

- Atoms have equal numbers of protons and electrons. Their equal and opposite charges cancel each other out.

1.5 — Size of the nucleus

Compared to the size of the atom overall, the nucleus is very small.

1.6 — Mass of the atom

Most of the mass of the atom is in the nucleus. This is because the protons and neutrons are the particles with most mass, and they are in the nucleus.

1.7 — Mass number

An atom's mass number tells us the total number of protons and neutrons.

1.8 — Atomic number

Atoms of an element always contain the same number of protons. The number of protons in any element is unique to that element.

1.9 — Isotopes

Isotopes of an element always contain the same number of protons, but a different number of neutrons in their nuclei This means that the atomic number is always the same, but different isotopes have different mass numbers.

1.10 — Calculate the PEN numbers in atoms*

Atom	Protons	Electrons	Neutrons
${}^{1}_{1}H$	1	1	0
${}^{2}_{1}H$	1	1	1
${}^{9}_{4}Be$	4	4	5
${}^{28}_{14}Si$	14	14	14
${}^{35}_{17}Cl$	17	17	18
${}^{37}_{17}Cl$	17	17	20
${}^{79}_{35}Br$	35	35	44
${}^{81}_{35}Br$	35	35	46
${}^{192}_{77}Ir$	77	77	115
${}^{226}_{88}Ra$	88	88	138

1.11 — Elements with relative atomic masses (A_r) that aren't whole numbers

Explain why chlorine and copper have A_r values that are not whole numbers.

They have isotopes with different mass numbers. (The weighted mean of these isotopes is not a whole number.)

1.12 — Calculate relative atomic mass values* (HT only)

$$\frac{(\%\ \text{isotope 1} \times \text{mass isotope 1})+(\%\ \text{isotope 2} \times \text{mass isotope 2})+[...]}{100}$$

● Calculate the relative atomic mass of oxygen. Give your answer to 5 significant figures. Isotopic data: ${}^{16}O$ = 99.55%, ${}^{17}O$ = 0.03%, ${}^{18}O$ = 0.42%.

$$\frac{(99.55 \times 16)+(0.03 \times 17)+(0.42 \times 18)}{100}$$

16.009 %

● Calculate the relative atomic mass of silicon. Give your answer to 4 significant figures. Isotopic data: ${}^{28}Si$ = 92.23%, ${}^{29}Si$ = 4.68%, ${}^{30}Si$ = 3.09%.

$$\frac{(92.23 \times 28)+(4.68 \times 29)+(3.09 \times 30)}{100}$$

28.11 %

1.13 — Mendeleev & the organisation of elements

Mendeleev organised the elements into groups by using their: a) chemical properties, b) physical properties and c) atomic weight (or mass).

1.14 — Mendeleev & his table

Mendeleev was unique amongst scientists of his time as he predicted the existence of undiscovered elements. He also accurately predicted some of their properties.

1.15 — Mendeleev & the organisation of the elements

Although he ordered most elements by atomic weight, the (unknown at the time) existence of isotopes meant that some elements switched positions, for example iodine and tellurium were not listed in order of atomic weight.

1.16 — Atomic number

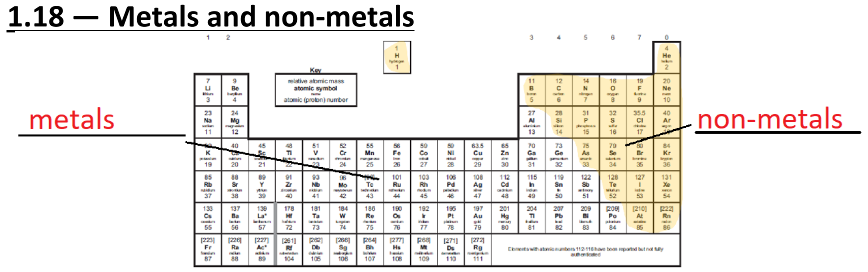
The elements are ordered in the modern periodic table by increasing atomic number. This atomic number is unique to that particular element.

1.17 — Arrangement of the elements

The elements are arranged in rows called periods.

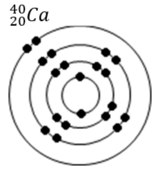
The elements are arranged in columns called groups, with elements which have similar chemical properties.

1.18 — Metals and non-metals



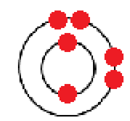
1.19 — Electronic configuration*

Can be shown in diagram form, for example: ${}^{40}_{20}Ca$



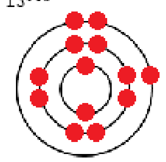
Or electron notation, for example: 2.8.8.2

${}^{12}_{6}C$



2.4

${}^{27}_{13}Al$



2.8.3

1.20 — Electron configuration & periodic table position

Elements in the same row have the same number of electron shells. Elements in the same column have the same number of electrons in their outer shell.