8 The Periodic Table

8.1 Arrangement of elements

1 Describe the Periodic Table as an arrangement of elements in periods and groups and in order of increasing proton number/atomic number

The Periodic Table of Elements

Group																	
I	II											III	IV	V	VI	VII	VIII
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –	113 Nh nihonium –	114 Fl flerovium –	115 Mc moscovium –	116 Lv livermorium –	117 Ts tennessine –	118 Og oganesson –

Key

atomic number
atomic symbol
name
relative atomic mass

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

The Periodic Table of Elements

2 Describe the change from metallic to non-metallic character across a period

- Metallic metals are on the left and non-metals are on the right. In between there are metalloid which are Boron, Silicon, Germanium, Arsenic, Antimony, Tellurium.

3 Describe the relationship between group number and the charge of the ions formed from elements in that group

Group Number	Group Name	Example Elements	Common Ion Charge
1	Alkali metals	Li, Na, K	+1
2	Alkaline earth metals	Mg, Ca, Ba	+2
3	Boron group	B, Al	+3
4	Carbon group	C, Si, Sn	±4 (can be +4 or −4 depending on compound)
5	Nitrogen group	N, P	−3 (non-metals), sometimes +3 or +5 in covalent compounds
6	Oxygen group (Chalcogens)	O, S	−2 (non-metals), sometimes +4 or +6 in covalent compounds
7	Halogens	F, Cl, Br, I	−1
8	Noble gases	He, Ne, Ar	0 (generally do not form ions)

4 Explain similarities in the chemical properties of elements in the same group of the Periodic Table in terms of their electronic configuration AND 5 Explain how the position of an element in the Periodic Table can be used to predict its properties

- Elements in the same group have the same electronic configuration, so they have the same chemical properties.
- The position of the element can be used to tell the electronic configuration

6 Identify trends in groups, given information about the elements

- Trends in groups include: electron arrangement, type of oxide, reaction of acid, bonding, and physical features.
- Group of 1-4: (↑ means increases and ↓ means decreases)

Group	Example Elements	Density Trend	Melting/Boiling Point Trend	Reactivity Trend	Physical Properties	Type of Oxide	Bonding
1 (Alkali metals)	Li, Na, K	↑ down group	↓ down group	↑ down group	Soft, low density, shiny, malleable	Basic oxides (Na_2O)	Metallic
2 (Alkaline earth metals)	Mg, Ca, Ba	↑ down group	↓ down group	↑ down group	Harder than Group 1, higher density	Basic oxides (CaO)	Metallic
3 (Boron group)	B, Al	↑ down group	↓ down group	Reactivity ↑ down group	B: brittle non-metal; Al: strong, malleable metal	Amphoteric (Al_2O_3), basic (Ga_2O_3)	Covalent (B), Metallic (Al)
4 (Carbon group)	C, Si, Sn	↑ down group	↓ down group	Non-metallic → metallic reactivity	C: non-metal (diamond hard, graphite soft); Si: brittle; Sn/Pb: malleable metals	Non-metal oxides acidic (CO_2), metallic oxides basic (SnO)	Covalent (C, Si), Metallic (Sn, Pb)

- Trends for groups 5-8 and transition metals:

5 (Nitrogen group)	N, P, Bi	↑ down group	↑ down group	Non-metal reactivity ↓ down group	N: gas; P: brittle solid; Bi: heavy metal	Non-metal oxides acidic (N_2O_5), metallic oxides basic	Covalent (N, P), Metallic (Bi)
6 (Oxygen group / Chalcogens)	O, S, Se	↑ down group	↑ down group	Reactivity ↓ down group	O: gas; S: brittle solid; Se: brittle solid	Non-metal oxides acidic (SO_2), metallic oxides basic	Covalent (O, S), Metallic (Po)
7 (Halogens)	F, Cl, Br, I	↑ down group	↑ down group	Reactivity ↓ down group	F/Cl: gases; Br: liquid; I: solid	Acidic oxides (Cl_2O_7)	Covalent
8 (Noble gases)	He, Ne, Ar	↑ down group	↑ down group	Very low reactivity	Colorless gases, monatomic, low density	No stable oxides (XeO_4 rare)	Atomic (monatomic gases)
Transition metals	Fe, Cu, Cr	High densities	High melting/boiling points	Variable reactivity	Hard, strong, malleable, good conductors	Mostly basic oxides (FeO), some amphoteric (ZnO, Cr_2O_3)	Metallic bonding, variable oxidation states

8.2 Group I properties

1 Describe the Group I alkali metals, lithium, sodium and potassium, as relatively soft metals with general trends down the group, limited to:

(a) decreasing melting point

(b) increasing density [exception is sodium and potassium]

(c) increasing reactivity

2 Predict the properties of other elements in Group I, given information about the elements

Element	Density (g/cm^3)	Melting Point (°C)	Reactivity Trend
Lithium (Li)	0.53	181	Reacts slowly with water, produces hydrogen gas and lithium hydroxide.
Sodium (Na)	0.97	98	Reacts vigorously with water, melts into a

			ball, produces hydrogen gas and sodium hydroxide.
Potassium (K)	0.86	63	Reacts very vigorously, ignites hydrogen gas, produces potassium hydroxide.
Rubidium (Rb)	1.53	39	Reacts explosively with water, produces rubidium hydroxide.
Cesium (Cs)	1.88–1.90	28	Extremely reactive, explodes violently in water, produces cesium hydroxide.
Francium (Fr)	~2.48 (estimated)	~27 (estimated)	Highly radioactive, extremely reactive, but too unstable for lab experiments.

8.3 Group VII properties

1 Describe the Group VII halogens, chlorine, bromine and iodine, as diatomic non-metals with general trends down the group, limited to:

(a) increasing density

(b) decreasing reactivity

2 State the appearance of the halogens at r.t.p. as:

(a) chlorine, a pale yellow-green gas

(b) bromine, a red-brown liquid

(c) iodine, a grey-black solid

3 Describe and explain the displacement reactions of halogens with other halide ions

- A more reactive halogen displaces a less reactive halogen from a solution.
- EXAMPLE: Cl_2 (aq) + 2KBr (aq) → 2KCl (aq) + Br_2 (aq)
- The ionic equation, $Cl_2 + 2Br^- \rightarrow 2Cl^- + Br$, shows that chlorine displaced bromide ions. The more reactive halogen becomes ions and the less reactive halogen gets displaced.

4 Predict the properties of other elements in Group VII, given information about the elements

Element	Symbol	Appearance	Density (g/cm^3)	Melting Point (°C)	Reactivity Trend
Fluorine	F	Pale yellow gas	~0.0017	-220	Most reactive halogen, reacts explosively with many substances
Chlorine	Cl	Greenish-yellow gas	~0.0032	-101	Very reactive, displaces bromine and iodine from salts

Bromine	Br	Red-brown liquid	~3.12	-7	Reactive, but less than chlorine; displaces iodine
Iodine	I	Dark grey solid (sublimes to purple vapor)	~4.93	114	Less reactive, reacts slowly with water
Astatine	At	Black solid (rare, radioactive)	~7 (estimated)	~302 (estimated)	Least reactive halogen, unstable and radioactive

8.4 Transition elements

1 Describe the transition elements as metals that:

(a) have high densities

(c) have high melting points

(d) form coloured compounds

(e) often act as catalysts as elements and in compounds

2 Describe transition elements as having ions with variable oxidation numbers, including iron(II) and iron(III)

Transition Metal	Symbol	Common Oxidation Numbers
Scandium	Sc	+3
Titanium	Ti	+2, +3, +4
Vanadium	V	+2, +3, +4, +5

Chromium	Cr	+2, +3, +6
Manganese	Mn	+2, +3, +4, +6, +7
Iron	Fe	+2, +3
Cobalt	Co	+2, +3
Nickel	Ni	+2, +3
Copper	Cu	+1, +2
Zinc	Zn	+2
Silver	Ag	+1
Gold	Au	+1, +3
Mercury(liquid at room temperature)	Hg	+1, +2

8.5 Noble gases

1 Describe the Group VIII noble gases as unreactive, monatomic gases and explain this in terms of electronic configuration

- Elements react to obtain a full outer shell of electrons and become stable. Since noble gases have outer electron shells, they do not need to be reactive.

END OF CHAPTER