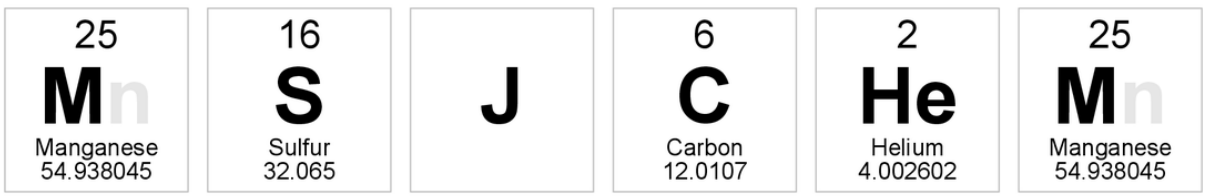
Structure 1.1

IB CHEMISTRY SL



Structure 1.1.1

Understandings:

- Elements are the primary constituents of matter, which cannot be chemically broken down into simpler substances.
- Compounds consist of atoms of different elements chemically bonded together in a fixed ratio.
- Mixtures contain more than one element or compound in no fixed ratio, which are not chemically bonded and so can be separated by physical methods.

Learning outcomes(s):

- Distinguish between the properties of elements, compounds and mixtures.

Additional notes:

- Solvation, filtration, recrystallization, evaporation, distillation and chromatography should be covered.
- The differences between homogeneous and heterogeneous mixtures should be understood.

Elements

- An element is a pure substance that cannot be broken down into a simpler substance by chemical means.
- All known elements are included on the periodic table.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	1 H 1.01						Atomic number Element Relative atomic mass											2 He 4.00
2	3 Li 6.94	4 Be 9.01											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18
3	11 Na 22.99	12 Mg 24.31											13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.07	17 Cl 35.45	18 Ar 39.95
4	19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.87	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.38	31 Ga 69.72	32 Ge 72.63	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80
5	37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.96	43 Tc (98)	44 Ru 101.07	45 Rh 102.91	46 Pd 106.42	47 Ag 107.87	48 Cd 112.41	49 In 114.82	50 Sn 118.71	51 Sb 121.76	52 Te 127.60	53 I 126.90	54 Xe 131.29
6	55 Cs 132.91	56 Ba 137.33	57 La † 138.91	72 Hf 178.49	73 Ta 180.95	74 W 183.84	75 Re 186.21	76 Os 190.23	77 Ir 192.22	78 Pt 195.08	79 Au 196.97	80 Hg 200.59	81 Tl 204.38	82 Pb 207.20	83 Bi 208.98	84 Po (209)	85 At (210)	86 Rn (222)
7	87 Fr (223)	88 Ra (226)	89 Ac ‡ (227)	104 Rf (267)	105 Db (268)	106 Sg (269)	107 Bh (270)	108 Hs (269)	109 Mt (278)	110 Ds (281)	111 Rg (281)	112 Cn (285)	113 Nh (286)	114 Fl (289)	115 Mc (288)	116 Lv (293)	117 Ts (294)	118 Og (294)

†	58 Ce 140.12	59 Pr 140.91	60 Nd 144.24	61 Pm (145)	62 Sm 150.36	63 Eu 151.96	64 Gd 157.25	65 Tb 158.93	66 Dy 162.50	67 Ho 164.93	68 Er 167.26	69 Tm 168.93	70 Yb 173.05	71 Lu 174.97
‡	90 Th 232.04	91 Pa 231.04	92 U 238.03	93 Np (237)	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (262)

Compounds

- A compound is a pure substance formed from two or more different elements chemically joined in a fixed ratio.
- Compounds have different properties from the elements that they are made from.
- For example, the properties of the compound sodium chloride (NaCl) are different from the elements that it is made from.

$$\text{sodium} + \text{chlorine} \rightarrow \text{sodium chloride}$$

$$2Na_{(s)} + Cl_{2(g)} \rightarrow 2NaCl_{(s)}$$

- Sodium is a very reactive metal and chlorine is a poisonous gas. The product formed, NaCl, is safe for human consumption.

Mixtures

- Mixtures contain more than one element and/or compound that are not chemically bonded together and so retain their individual properties.
- Mixtures can be either homogeneous or heterogeneous.
- A homogeneous mixture has the same uniform appearance and composition throughout (for example, a salt solution).
- A heterogeneous mixture consists of visibly different substances or phases (for example, sand and water).

Exercises:

1. Distinguish between an element and compound.

2. Distinguish between a homogeneous and a heterogeneous mixture.

Technique	Description
Solvation	Solvation involves the formation of ion-dipole forces between a solute and a solvent.
Filtration	Filtration is a separation technique used to separate a heterogeneous mixture such as sand in water.
Recrystallization	Recrystallization is a purification technique used to purify a solid.
Evaporation	Evaporation is a separation technique used to separate a homogeneous mixture such as a salt solution.
Distillation	Distillation is a separation technique used to separate two miscible liquids with different boiling points.
Chromatography	Chromatography is a separation technique used to separate a mixture of solutes in a solvent.

Structure 1.1.2

Understandings:

- The kinetic molecular theory is a model to explain physical properties of matter (solids, liquids and gases) and changes of state.

Learning outcomes(s):

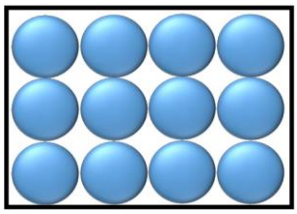
- Distinguish the different states of matter.
- Use state symbols (s, l, g and aq) in chemical equations.

Additional notes:

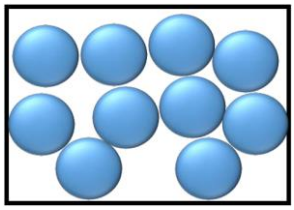
- Names of the changes of state should be covered: melting, freezing, vaporization (evaporation and boiling), condensation, sublimation and deposition.

Solids, liquids and gases

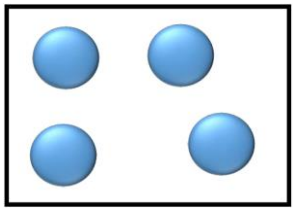
- The three states of matter are solid, liquid and gas. The particles models of each are shown below.



Solid



Liquid



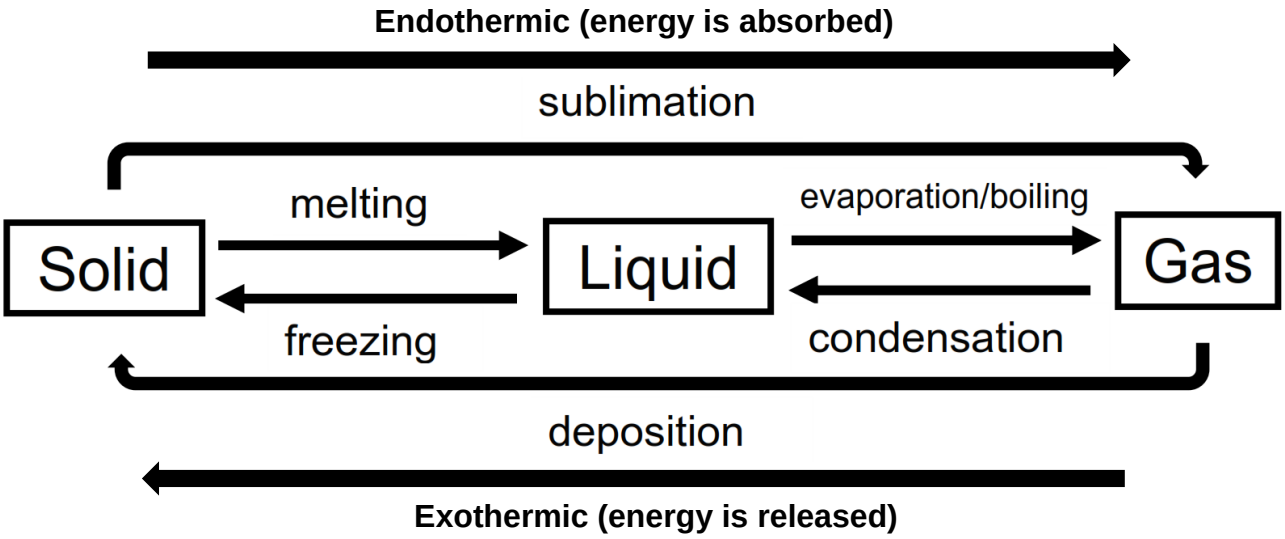
Gas

Exercise: Complete the table about the properties of solids, liquids and gases.

Property	Solid	Liquid	Gas
shape			
volume			
compressibility			
fluidity			

Changes of state (phase changes)

- Changes of state are physical changes.
- In some changes of state, energy is released; they are exothermic.
- In some changes of state, energy is absorbed; they are endothermic.



Exercise: Complete the table below about the changes of state.

Change of state	Description	Exothermic or endothermic?
Melting		
Evaporation/boiling/ vaporisation		
Sublimation		
Condensation		
Freezing		
Deposition		

State symbols

- State symbols show the physical state (solid, liquid, gas or aqueous) of the reactants and products in a chemical equation.

  (s) solid

  (l) liquid

  (g) gas

  (aq) aqueous (in solution)

- The reaction below shows solid sodium reacting with liquid water to produce a solution of sodium hydroxide and hydrogen gas.

$$2Na_{(s)} + 2H_2O_{(l)} \rightarrow 2NaOH_{(aq)} + H_{2(g)}$$

Structure 1.1.3

Understandings:

- The temperature, T, in Kelvin (K) is a measure of average kinetic energy E_k of particles.

Learning outcome(s):

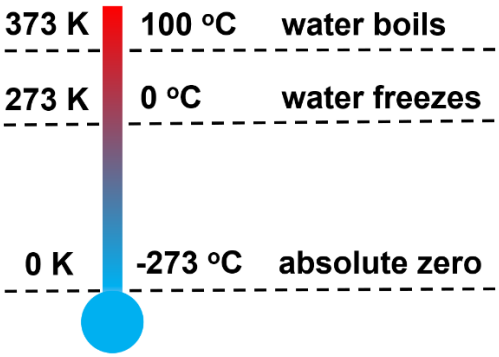
- Interpret observable changes in physical properties and temperature during changes of state.
- Convert between values in the Celsius and Kelvin scales.

Additional notes:

- The kelvin (K) is the SI unit of temperature and has the same incremental value as the Celsius degree (°C).

Temperature scales

- The Celsius temperature scale is the scale based on 0 °C for the freezing point of water and 100 °C for the boiling point of water.
- The temperature in kelvin (K) is directly proportional to the average kinetic energy of the particles in a substance.
- It is an absolute temperature scale where the lowest possible value is zero (absolute zero, 0 K).
- One degree on the kelvin scale is equal to one degree on the Celsius scale.



Converting between ºC and K

- To convert between ºC and K, add or subtract 273.
- For example, 25 ºC is 298 K.

Exercises:

Convert these temperatures to K.

1) 35.0 ºC
2) 0 ºC
3) 51.0 ºC
4) -18.0 ºC
5) -273 ºC
6) 125 ºC

Convert these temperatures to ºC.

1) 25.0 K
2) 273 K
3) 3800 K
4) 0 K
5) 373 K
6) 646 K

Heating and cooling curves

- The heating curve for water is shown.
- As heat is added the temperature increases unless there is a phase change when the temperature remains constant.
- At these points the energy added is being used to overcome the intermolecular forces between the water molecules.