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Structure 1.1

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Elements, compounds and mixtures

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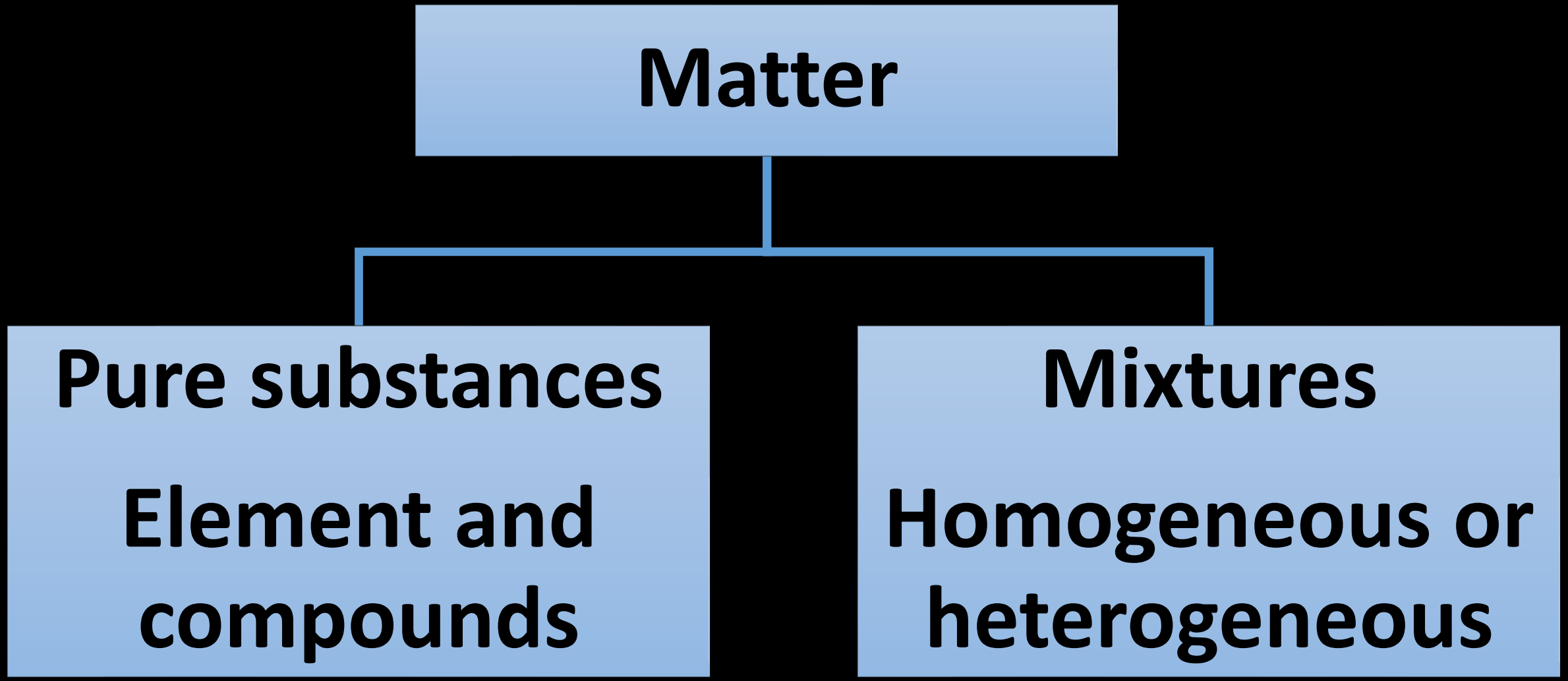
Matter



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Elements

An element is a substance that cannot be broken down into a simpler substance by chemical means.

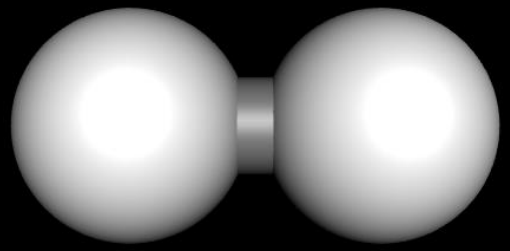
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	1 H 1.01						Atomic number / Element / Relative atomic mass											2 He 4.00
2	3 Li 6.94	4 Be 9.01											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18
3	11 Na 22.99	12 Mg 24.31											13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.07	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)

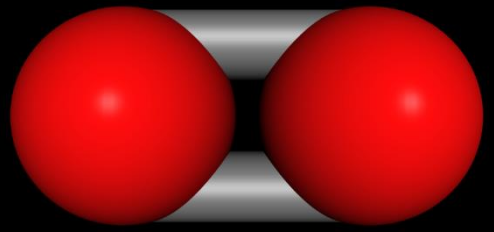
†	58 Ce 140.12	59 Pr 140.91	60 Nd 144.24	61 Pm (145)	62 Sm 150.36	63 Eu 151.96	64 Gd 157.25	65 Tb 158.93	66 Dy 162.50	67 Ho 164.93	68 Er 167.26	69 Tm 168.93	70 Yb 173.05	71 Lu 174.97
‡	90 Th 232.04	91 Pa 231.04	92 U 238.03	93 Np (237)	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es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

Elements

Some elements exist as diatomic molecules.
A molecule is an electrically neutral group of two or more atoms bonded together.

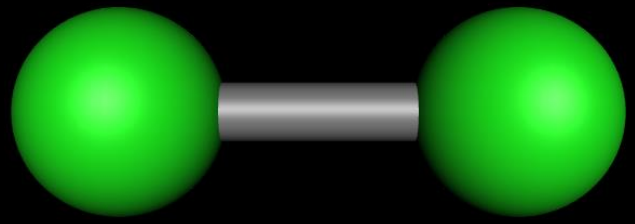
Hydrogen H_2

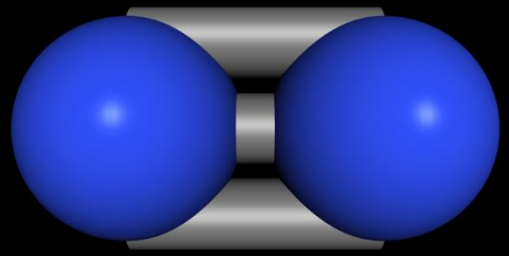




Oxygen O_2

Chlorine Cl_2





Nitrogen N_2

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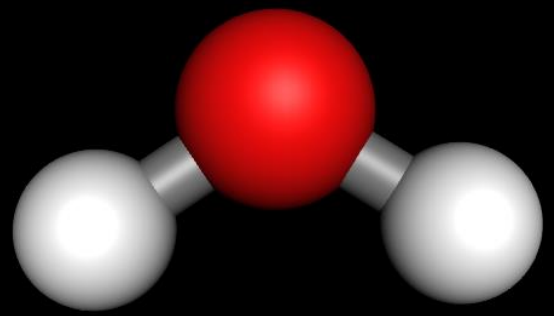
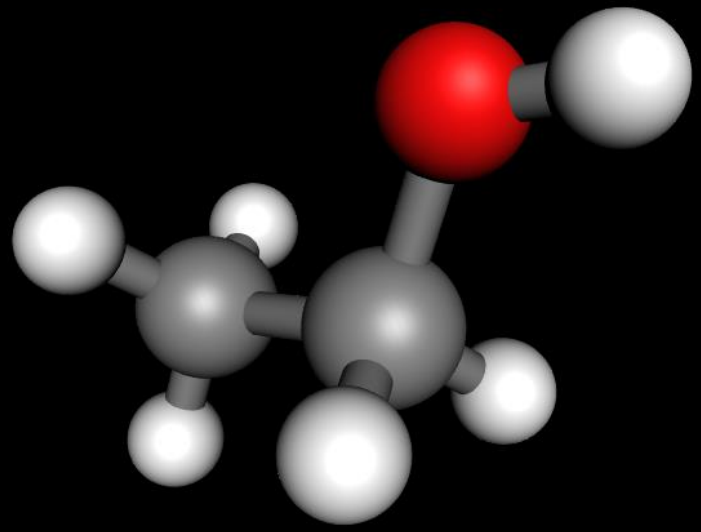
Compounds

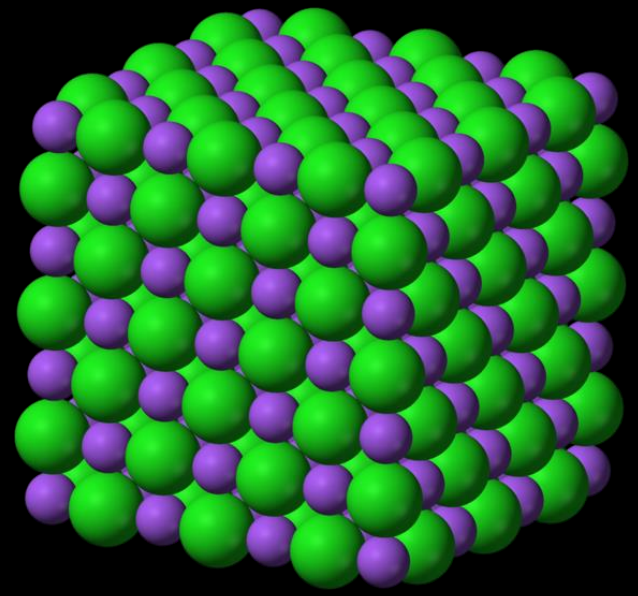
A compound is formed from two or more different elements chemically joined in a fixed ratio.



Water H_2O



Ethanol
C_2H_5OH



Sodium chloride
NaCl

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Compounds

Compounds have different properties from the elements that they are made from.

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

Mixtures

The two types of mixtures are homogeneous mixtures and heterogeneous mixtures.

Homogeneous mixtures have a constant composition throughout.

Heterogeneous mixtures have visibly different substances or phases.

Mixtures

Homogeneous mixtures:

- Have a uniform composition throughout.
- Have no visible boundaries - the components are mixed as individual atoms, ions or molecules.
- Are also called solutions or aqueous solutions (if water is part of the mixture).

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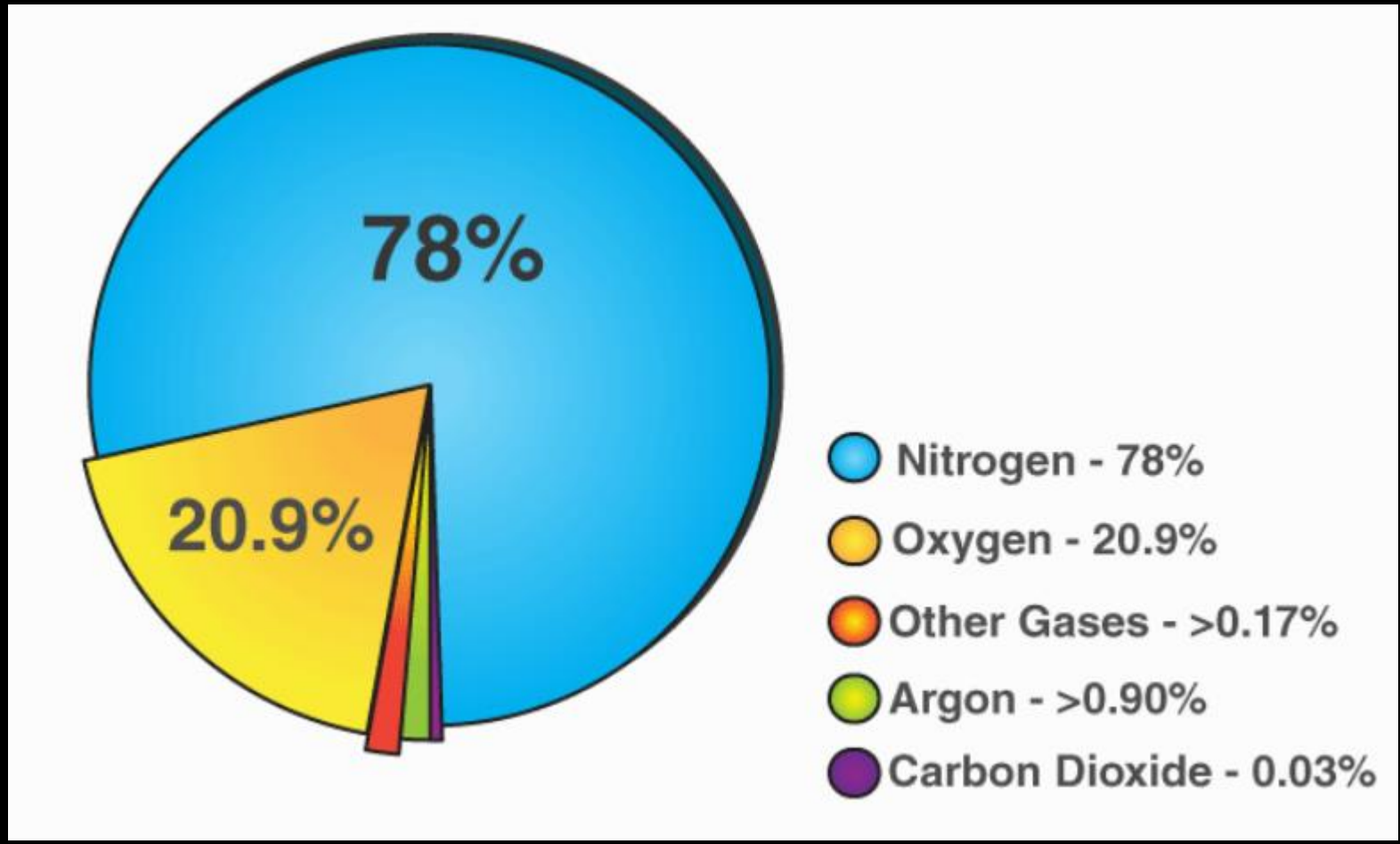
Mixtures

Examples of homogeneous mixtures



Mixtures

Heterogeneous mixtures:

- Do not have a uniform composition
- Have one or more visible boundaries between the components

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Separation techniques

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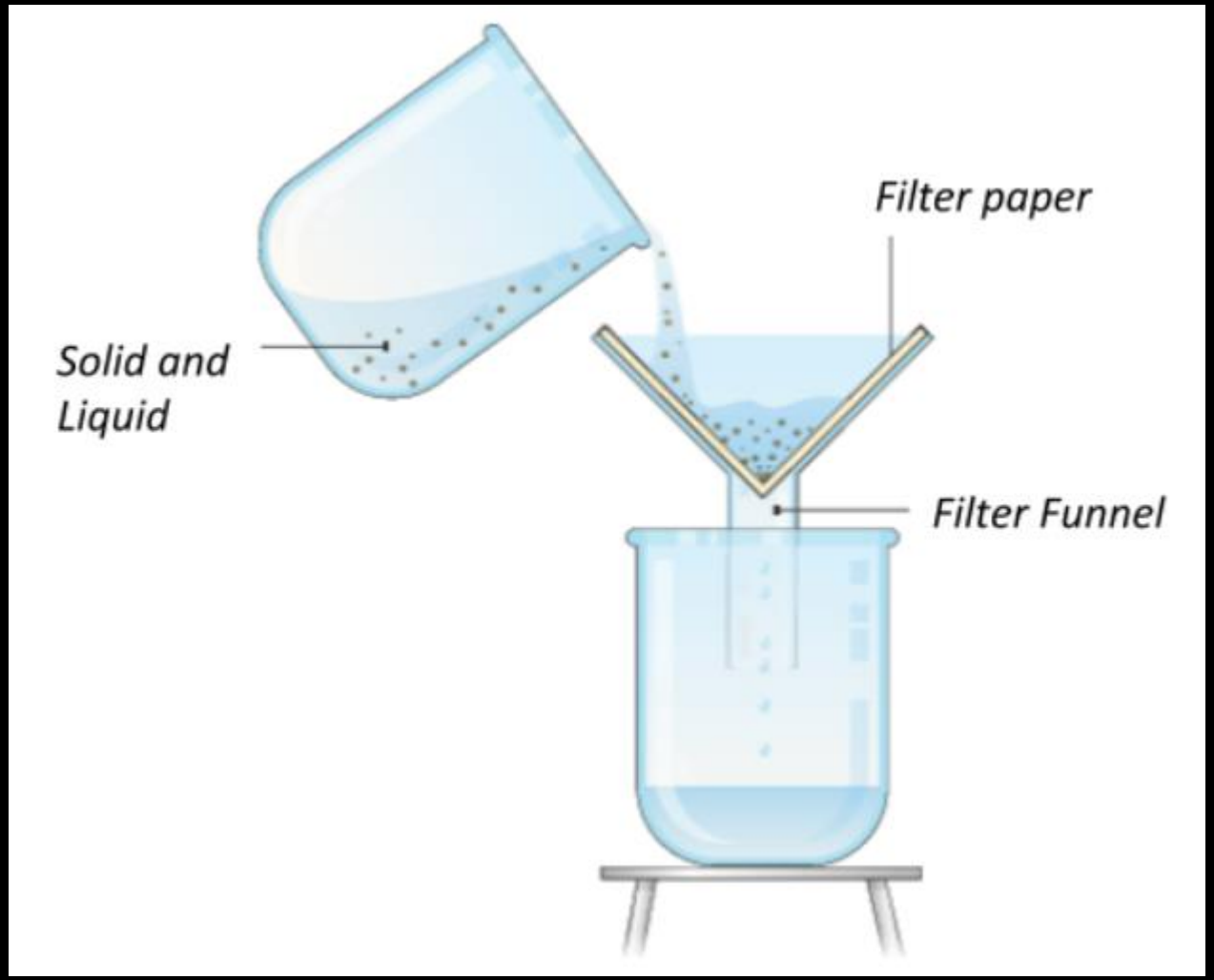
Separation techniques

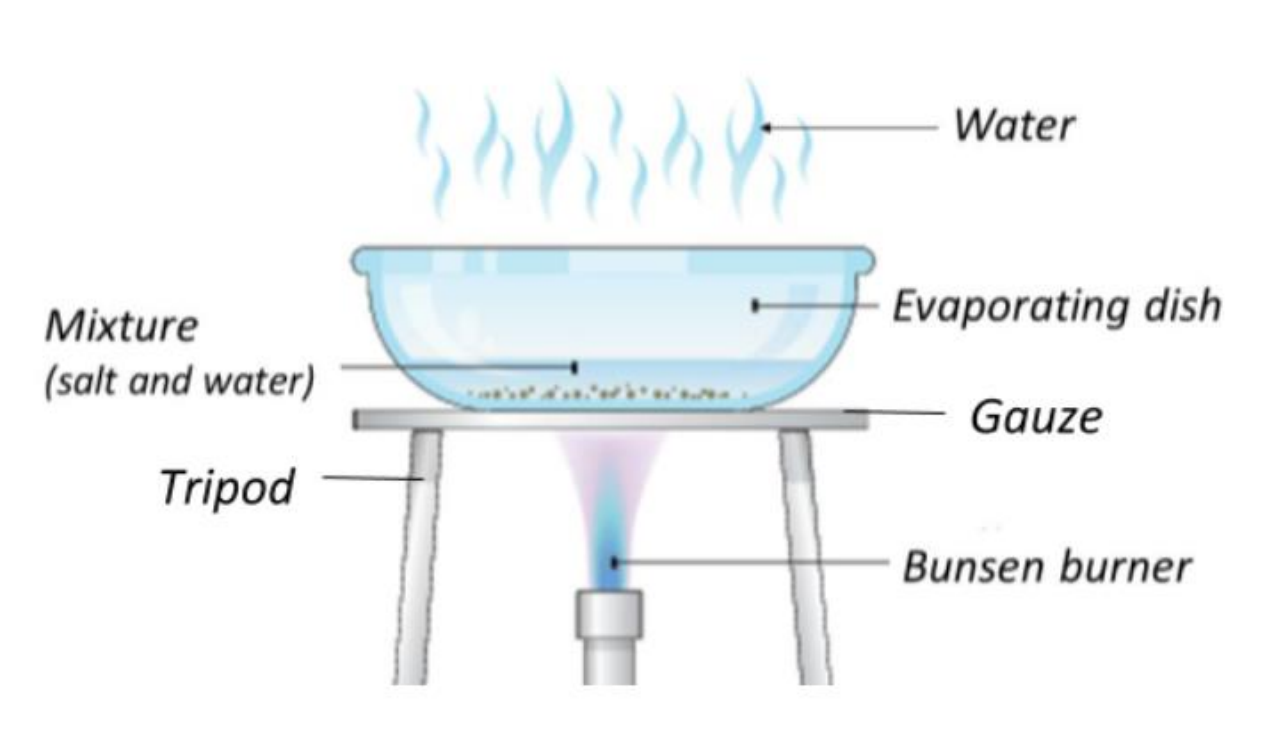
Filtration



Can be used to separate a mixture that has a solid that is not dissolved in the solvent.

Separation techniques

Evaporation



Can be used to separate a mixture that has a solute that is dissolved in the solvent (an aqueous solution).

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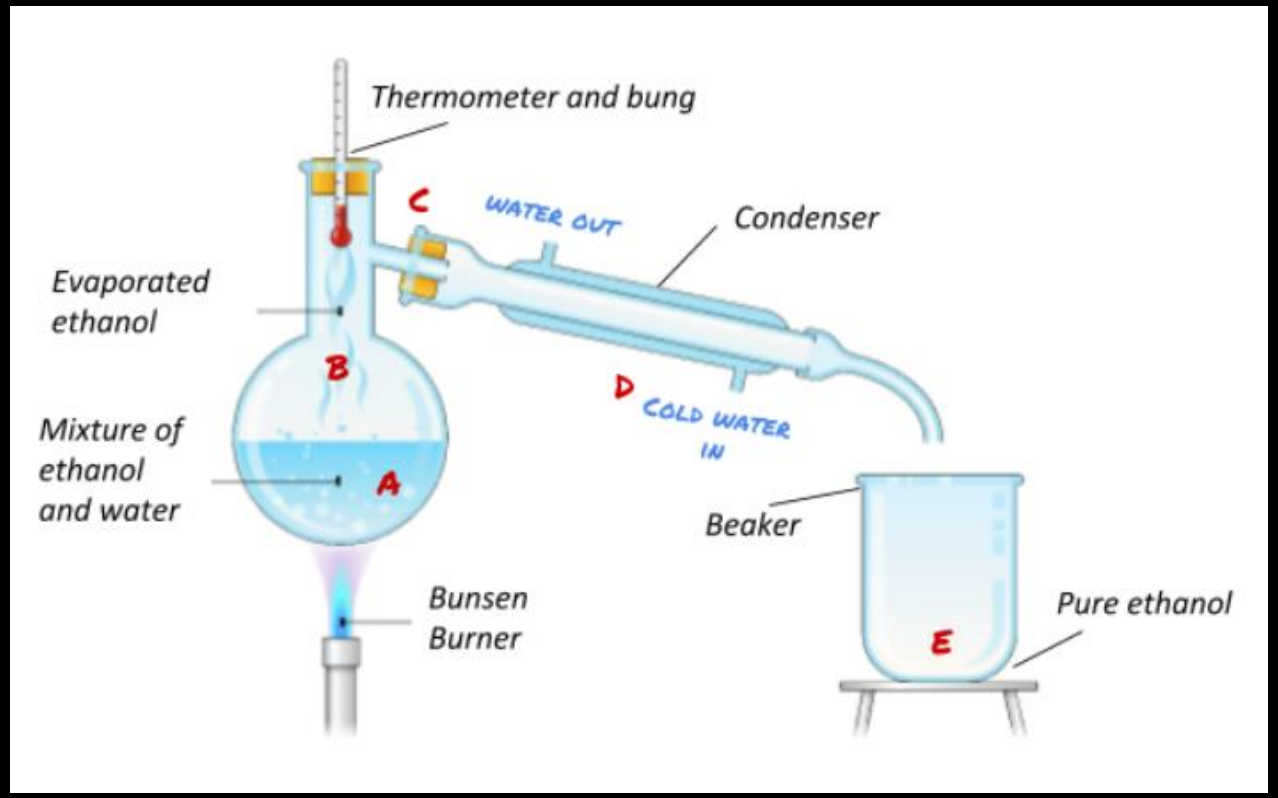
Separation techniques

Distillation



Can be used to separate a mixture of liquids that have different boiling points.

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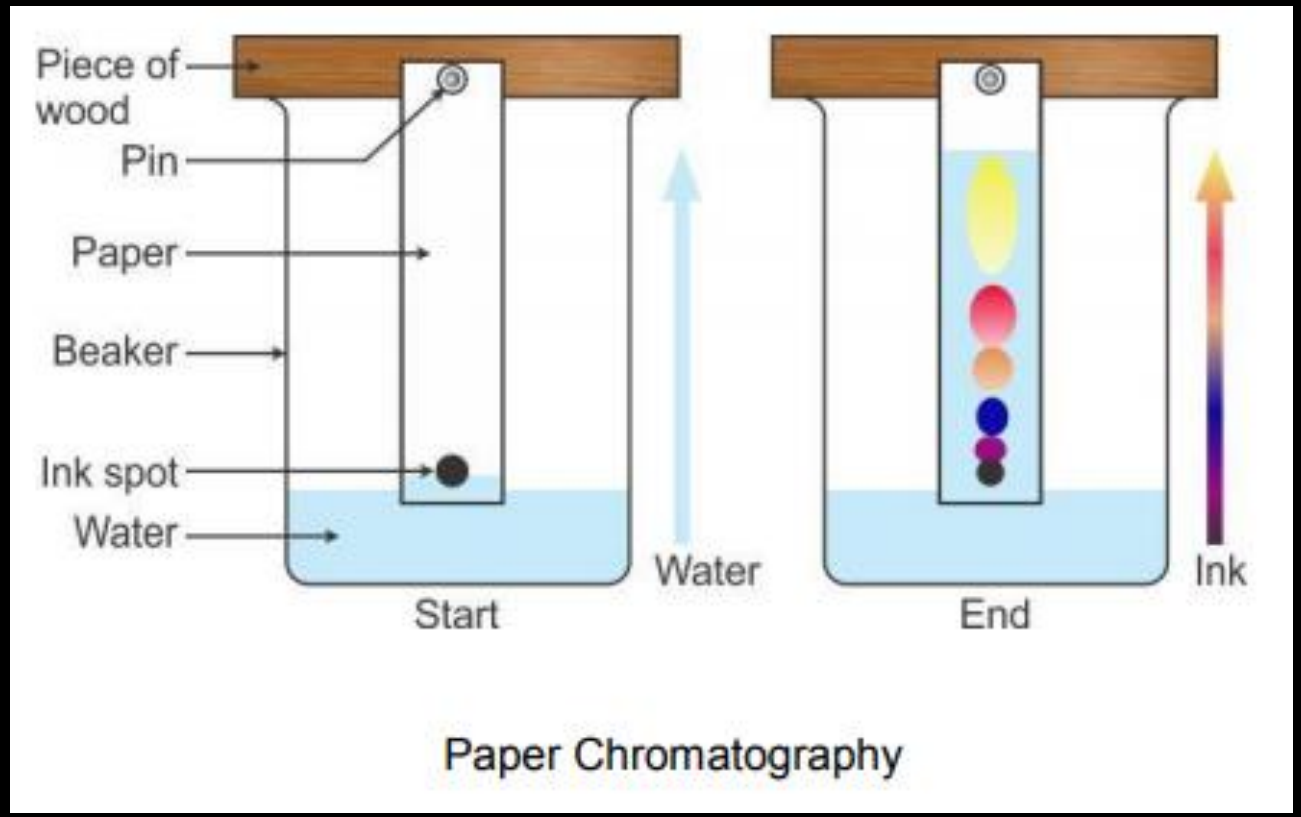
Separation techniques

Chromatography



Paper Chromatography

Can be used to separate a mixture of substances that have different solubilities in the mixture.

Separation techniques

Technique	Description
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.

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Solvation

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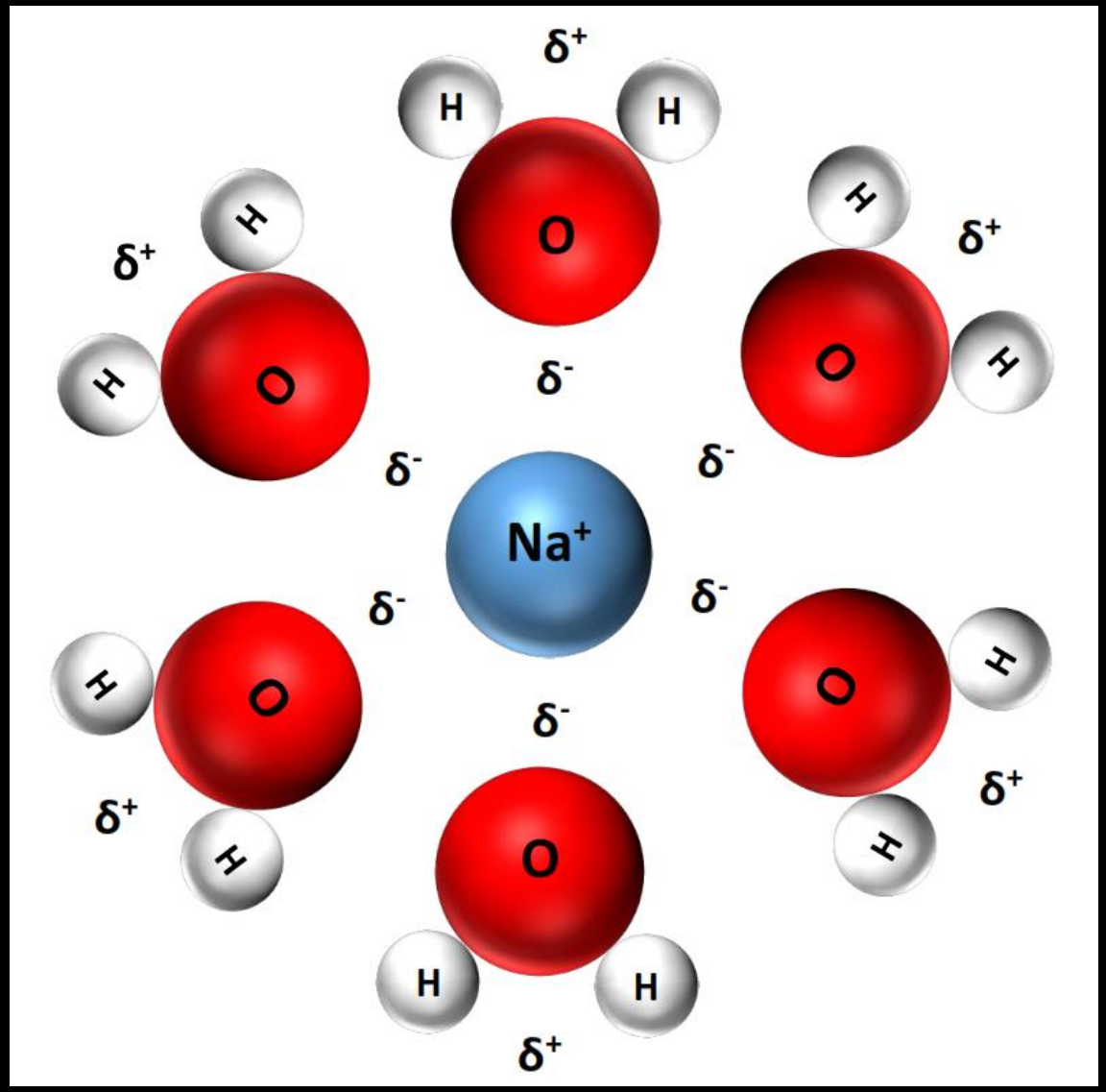
Solvation



Solvation involves the formation of ion-dipole forces between a solute and a solvent.

When a salt is dissolved the ions are pulled apart from the lattice structure and surrounded by water molecules.

The forces of attraction between the solute particles and the water molecules are ion-diploe forces.

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States of matter and changes of state

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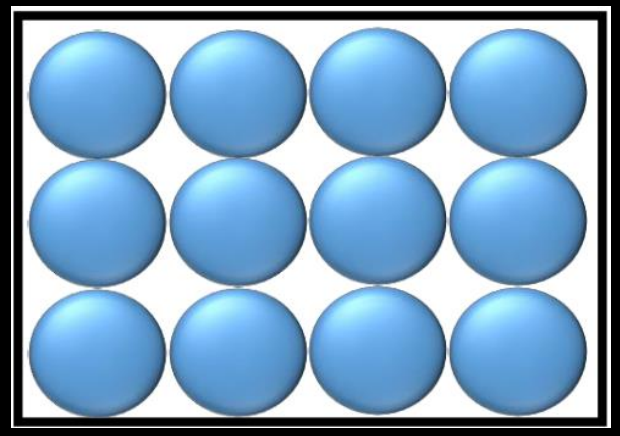
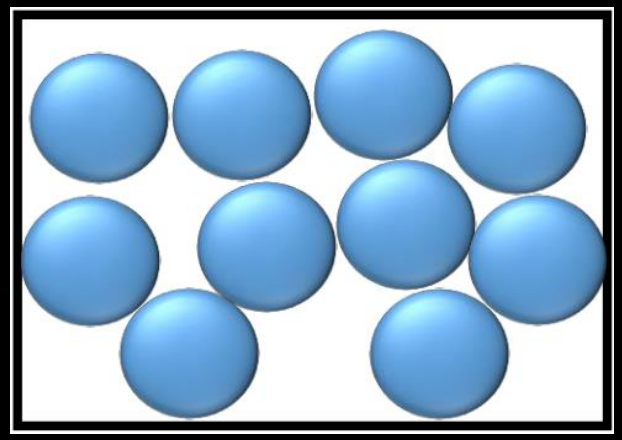
States of matter

Solid



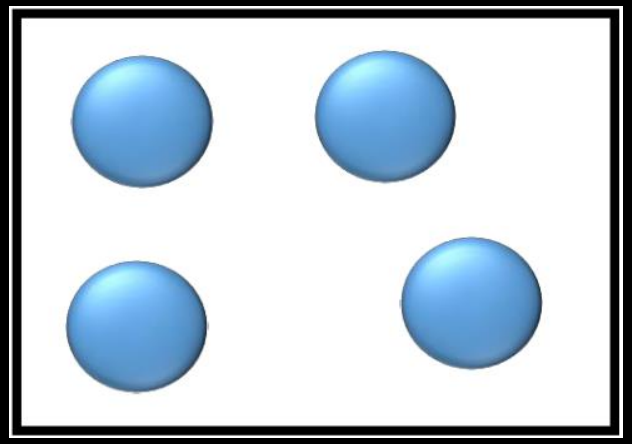
Solids have a fixed shape and volume

Liquid



Liquids have a fixed volume but no fixed shape

Gas



Gases have neither a fixed volume nor a fixed shape

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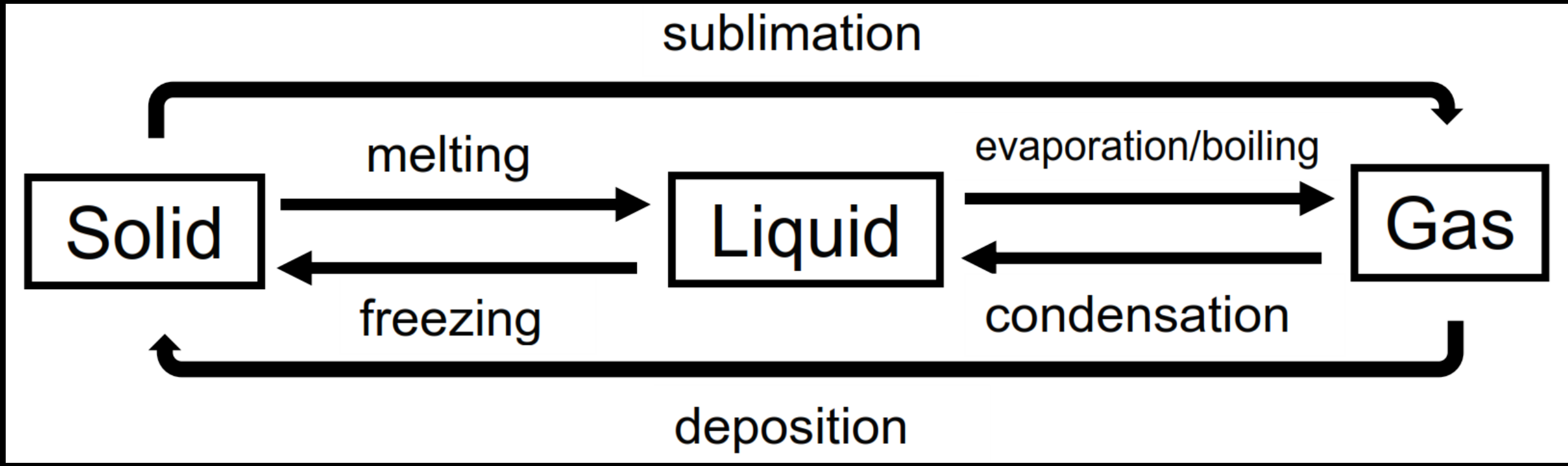
Changes of state

Heat is absorbed (endothermic)



Heat is released (exothermic)

State symbols

State symbols show the physical state of a substance.

(s) – solid

(l) – liquid

(g) – gas

(aq) – aqueous

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

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Temperature and changes of state

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.

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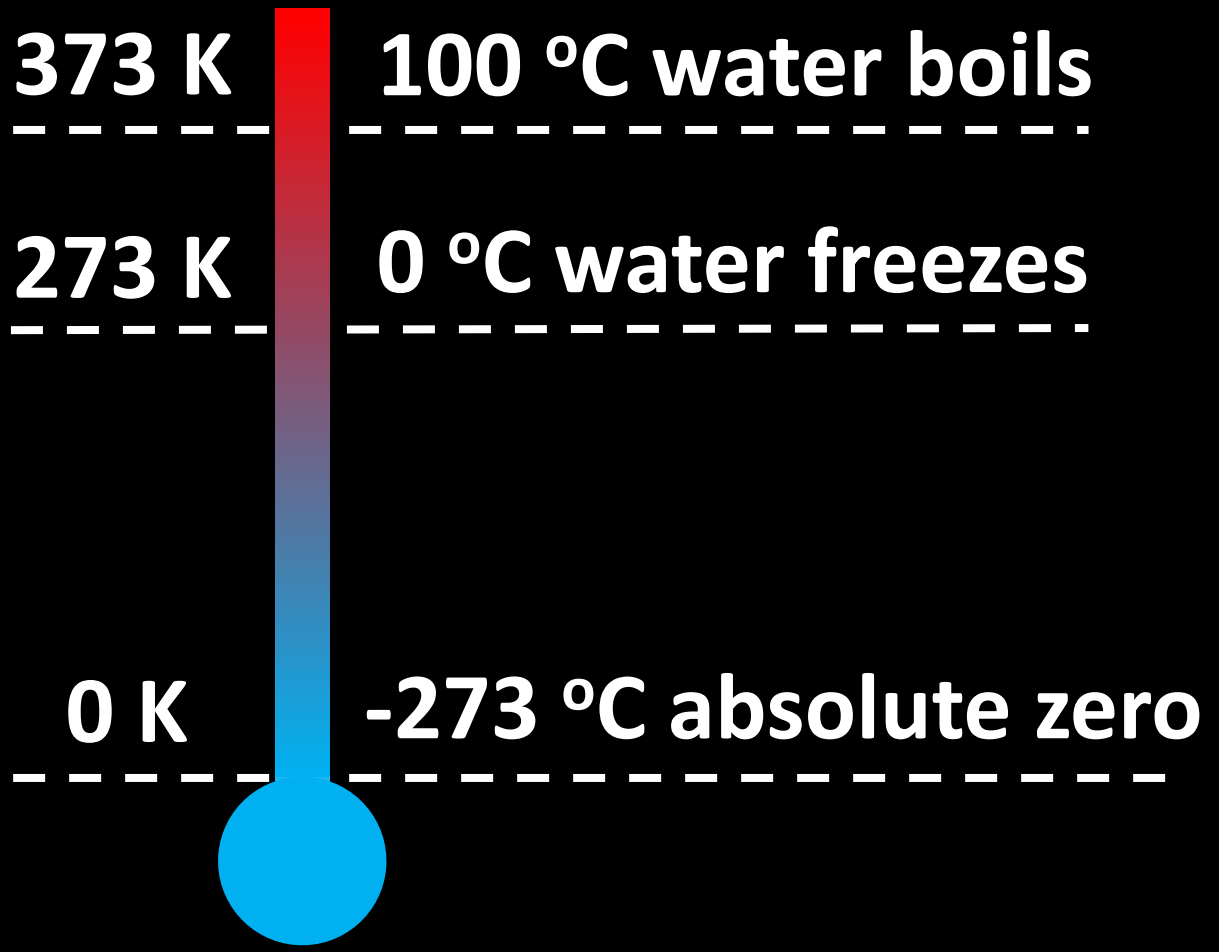
Temperature scales

The Kelvin scale is an absolute temperature scale.



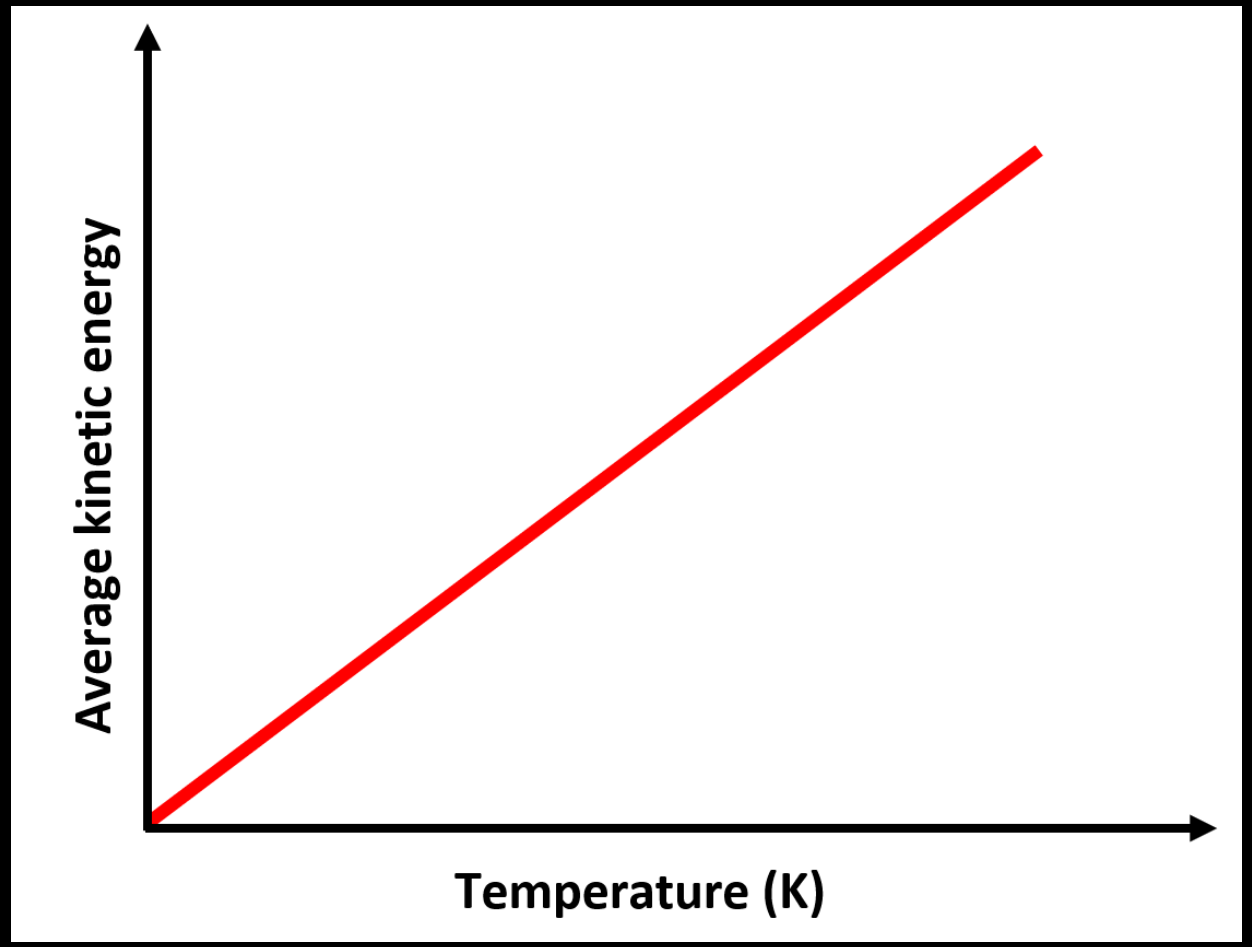
One degree on the kelvin scale is equal to one degree on the Celsius scale.

To convert from °C to K, add or subtract 273

25 °C = 298 K

Temperature and kinetic energy

Absolute temperature in kelvin (K) is directly proportional to the average kinetic energy of the particles in a substance.



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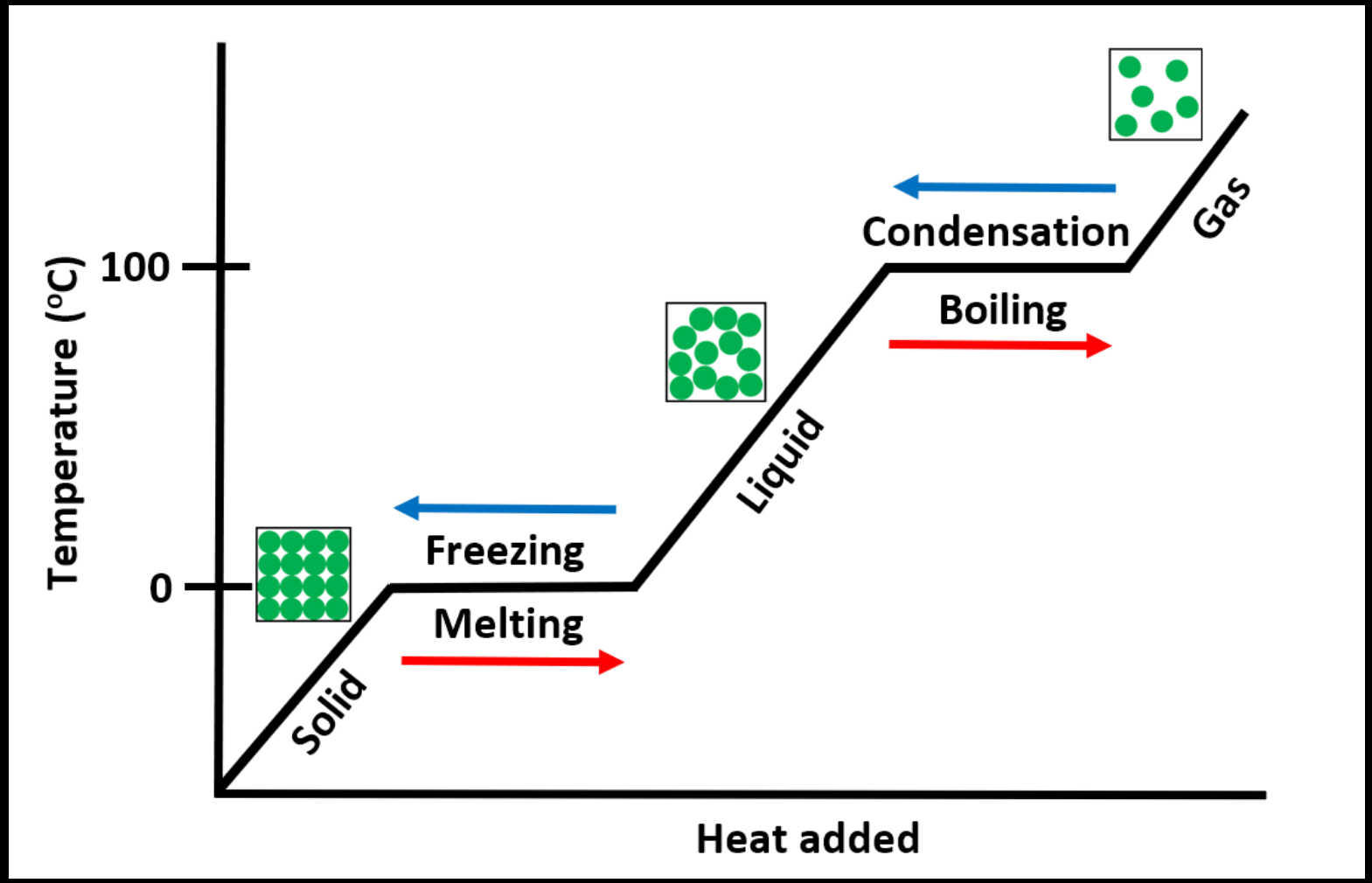
Heating and cooling curves



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.