Formulae and Definitions and Constants

Boyle's Law	At constant temperature, volume occupied by fixed amount of gas inversely proportional to the applied pressure	pV = pV
Charles' Law	At constant pressure, volume of a fixed amount of gas directly proportional to its absolute temperature	V/T = V/T
Avogadro's Law	At the same temperature and pressure, = volumes of any gas contains the same number of particles	V ∝ n
Dalton's Law of partial pressure	In a mixture of gases which do not interact with one another, the total pressure of the mixture is the sum of the partial pressure of the constituent gases	P = P + P + P
Pressure	Force per unit area	
R	Gas constant	

Formulae and Definitions and Constants (cont)

Partial pressure	The pressure exerted by the gas if it alone occupies the container at the same temperature	P = x · P(total)
General gas law / Ideal gas law	(pV)/T = (pV)/T	
Density, d	m/V	
Molar mass	(mRT)/pV	
	(dRT)/p	
Mole fraction (x)	nA / (nA + nB)	
Vapour pressure	Pressure exerted by a vapour in equilibrium with its liquid at a fixed temperature	
Boiling point	Temperature at which its vapour pressure equals external pressure	
Volatility	The readiness of a liquid to evaporate	
Crystal lattice	Regular arrangement of atoms, molecules or ions	
Unit cell	Small repeating unit that makes up a crystal	

Formulae and Definitions and Constants (cont)

Crystal system	Method of classifying crystalline substances based on their unit cellst
Coordination number	Number of nearest neighbouring atoms that are in direct contact with a given atom
Allotropes	Different structural forms of the same element
Allotropy	Elements that can exist in more than one crystalline structural form (under same temperature and pressure)

Solids

Fixed volume and shape

Particles closely packed, strongly held in fixed positions by strong attractive forces

Extremely difficult to compress

Definitions and formulae again

Forward	Left to right
Backward	Right to left
Chemical equilibrium	Rates of forward and backward reaction are equal (conc const)

Definitions and formulae again (cont)

Dynamic equilibrium	Both forward and reverse reactions continue indefinitely even though chemical equilibrium is attained
Law of mass action / equilibrium law	Kc = $[product]^{x / [reactant]}$ y
Equilibrium constant of concentratoin	Kc
Equilibrium partial pressure of the gases present	Kp = $(product)^{x / (reactant)}$ y
	K = 1/K^-1
	Kp - Kc(RT)^Δn
Heterogeneous equilibrium	Rreactants and products are present in more than one phase
Le Chatelier's Principle	If an external stress is applied to a system at equilibrium, the system adjusts in such a way that the stress is partially offset as the system reaches a new equilibrium position
Isolated system	No exchange of matter or energy between the system and its surroundings

Definitions and formulae again (cont)

Electrolyte	Chemical compound that will conduct electricity in molten state or aqueous solution
Strong electrolyte	Compound which is fully dissociated into ions when in molten or aqueous solution
Weak electrolyte	Partially dissociates " "
	1 - α (almost) = 1
	Ka = cα^2
	α = √(Ka / c)
	[H+] = cα / √(Ka x c)
	pKa = -log Ka
Equivalence point	The point at which there are equal amounts of H3O+ and OH- in the titration flask=
End point	The point at which the indicator changes colour
Buffer solution	Solution that keeps its pH almost the same
	pH = pKa + log [salt]/[acid]
Henderson-Hasselbalch equation	pOH = pKb + log [salt]/[base]
Buffer capacity	[acid] = [salt]

Maxwell-Boltzmann Distribution Curve

- Particles at constant temperature, constant random motion
- Speed of particles varies, wide range
- Most particles move at a speed very close to the average
- Peak of each curve = most probable speed
- Area under the curve = total number of gas particles
- Areas under both curves are equal
- Increase in temperature, increase in motion
- Curve shifts right and flattens out
- At higher temperature, less most probable speed, more high speed particles
- Average kinetic energy same
- Lighter molecules move faster than heavier molecules

Vaporisation

Open container	Water molecules at surface gain energy, change to water vapour
	Water vapour molecules escape into air
	Volume decrease
Closed container	Water vapour cannot escape
	Vapour formed, molecules collide with wall of container (vapour pressure)
	Some vapour molecules lose energy, condense
	Vaporisation and condensation occur continuously, dynamic equilibrium

Vaporisation (cont)

Rate of vaporisation = Rate of condensation (saturated vapour pressure)

Allotropes of carbon

Diamond	
Hard	Interconnected, 3D array of strong covalent bonds
	Geometrical rigidity
Insulator	Four valence electrons used in bonding
	No free mobile electrons
Insoluble	Strong covalent bond network
Very high melting point	Strong covalent bond network
	Large amount energy
Graphite (sp3 hybridisation, layered)	
Soft and slippery	Weak vdW between layers, slide over easily
Electrical conductor	Delocalised p electrons free to move
Insoluble	Strong covalent bond network
Very high melting point	Strong covalent bonds within layers
Fullerene, C60, 20 hexa, 12 penta, sp2 hybridised	
Soft and slippery	Covalent bonds in molecules
	Weak vdW between molecules
Electrical insulator	No free electrons
Insoluble in water	Bonded very tightly

Kinetic Concept of Liquid

A liquid has fixed volume, shape follows container

Greater forces of attraction than gas, less than solid

Particles move randomly (vibrational, rotational, some translational)

Particles closely packed (not easily compressed)

Equilibrium constant and position of equilibrium

Qc < Kc	Left to right
Qc = Kc	no change
Qc > Kc	Right to left

Buffer solution

Conditions	Enough acid to react with any base added
	Enough base to react with any acid added
	Acid and base in buffer do not neutralise each other completely
Types	Acidic buffer
	Basic buffer
Assumptions to calculate pH of acidic buffers	[HA] assumbed to be the concentration of acid used (acid very slightly dissociated)
	[A-] assumed to be concentration of salt used (salt fully dissociates, concentration of A- by weak acid negligible)

Buffer solution (cont)

Explanation for titration	Initially, pH falls significantly
	pH falls slowly (buffer zone)
	mixture of unreacted weak base and salt, () formed
Preparation	Dissolving () mol of () and 1 mol of () in water and diluting to 1dm^3

Lattice structure

Metallic solid

Body centered cubic / face centered cubic / hexagonal close packed

Copper: face centered cubic, coordination number: 12

Simple molecular solid

Lattice points occupied by molecules

Attractive force: vdW, Between iodine: covalent bonds

Iodine: Face centered cubic

Ionic solid (NaCl)

Held by strong electrostatic forces

Two interpenetrating face-centered cubic arrays

6:6 coordination number

Ideal Gas Concept

Molecules occupy negligible volume compared to the volume of the container

There are no forces of attraction between the molecules

Deviation

Reasons	Gas molecules have finite volume
	Intermolecular forces of attraction
Positive deviation	
Cause	Repulsion forces
	Finite volume of particles
Explanation	Very high pressure, volume of container very small
	Particles very close together, repulsion forces
	Particles collide with walls more often
	Exerted pressure greater
Negative deviation	
Cause	Intermolecular forces of attraction
Explanation	External pressure increase, particles move closer together
	Attractive forces occur
	Particles collide less frequently with container
	Exerted pressure lower
Ideal behaviour	Low pressure (no intermolecular forces)
	High temperature (high kinetic energy)

Vapour pressure & Boiling point & Volatility

Vapour Pressure	
Causes	Collision of particles onto the wall of the container
Factors	Temperature

Vapour pressure & Boiling point & Volatility (cont)

	Temperature increase, more fraction of molecules move fast enough to escape surface of liquid
Boiling point	
Factors	External pressure
Volatile liquid	
Characteristics	Higher VP
	Lower BP
	Weak intermolecular forces (high tendency escape become vapour)
* liquid boils when vapour pressure equals external pressure	
bubbles of vapour formed in liquid, escape to atmosphere, VP high enough overcome ext P	

Kinetic Theory of Gases

- The gas consists of tiny particles of negligible volume
- Intermolecular forces of attraciton do not exist between gas particles
- The molecules of a gas are in continuous random motion
- The gaseous particles are perfectly elastic
- The average kinetic energy of the gas molecules is directly proportional to the absolute temperature

Le Chatelier's Principle

Types of solids

Crystalline	Well-defined shape
	Particles occur in orderly arrangement
	Ice, diamond, NaCl
Amorphous	Poorly defined shape
	No long range ordering
	Glass, rubber, plastic

Acids and bases

	Acid	Base
Arrhenius Theory	Substances which dissociate in water to produce H+	Substances that dissolve in water to produce OH-
Bronsted-Lowry Theory	Substances which donate a proton	Substances which accept a proton
	Conjugate base	Conjugate acid
Lewis Theory	Electron pair acceptor	Electron pair donor

Strength	Ability to form H3O+ or OH- (Arrhenius theory)
	Accept or donate protons (Bronsted-Lowry)
Strong acids	Greater tendency to donate proton
	Equilibrium more to the right

Acids and bases (cont)

	Difficult for conjugate base to accept the proton (weak conjugate base)
Weak acids	Position of equilibrium indicates the extent of dissociation of acid, acid strength
	Acid stronger, Ka bigger

Indicators

	pK(HIn)	pH range	Acid	Alkali
Methyl orange	3.7	3.2 - 4.2	Red	Yellow
Methyl red	5.1	4.2 - 6.3	Red	Yellow
Bromothymol blue	7.1	6.0 - 7.6	Yellow	Blue
Phenolpht-halein	9.3	8.2 - 10.0	Colourless	Pink

Explaination
pH changes before equivalence point
pH changes at the equivalence point
pH chages after the equivalence point
Choice of indicator