STANDARD LEVEL
HIGHER LEVEL

essentials

PEARSON BACCALAUREATE

Chemistry

CATRIN BROWN • GARTH IRWIN
SERIES EDIOR: CHRISTIAN BRYAN

Supporting every learner across the IB continuum

EXTRA

ALWAYS LEARNING

PEARSON

abundance the amount that is present

complexity level of complication

component one part of the whole

composition make-up, or ingredients

concentrated gathered together in a small region

concerted occurs in one step

consequences the negative results of an action

denominator the number or numbers below the line in a fraction

dense having a relatively large mass contained in a small volume

depleted lowered in amount or concentration

deposited placed on top of

descriptive using words to describe how something appears or how it changes

discontinuities breaks or changes that occur in a trend

dynamic proceeding in the forward and backward directions at the same time

enhanced improved

evidence information that supports a theory or conclusion

gradient the slope (or steepness) of a line

induces causes to happen

integer numbers whole numbers

interconversions changes from one to another

inverse relationship a relationship in which the value of one quantity increases as the value of another decreases

inverse the reverse or the opposite of something else

magnitude the relative size of a measurement, how large it is

maximum the largest value

measurements assigning numbers or values to physical properties

minimum the smallest value

minute extremely small

negligible so small that its contribution to the overall total is minimal

non-numerical without numbers

numerator the number or numbers above the line in a fraction

numerical including numbers

observable can be detected by sight, sound, smell etc.

observation watching an object or process and recording any changes that occur

orientation the direction that an object is moving in relative to another object

orientations directions in space that objects are facing or aligned on

point of inflection a point on a graph where the shape of the curve changes from concave to convex

powder a solid made up of very small particles

precursors simple compounds used as starting materials to make larger compounds

preferred best or most desirable

prefix a beginning added to a word

priorities order of importance

proceeds moves in a particular direction

progression a gradual change

proportion an amount expressed relative to the total

proportional related in size to

qualitatively without using numerical data

quantify make a numerical measurement of a quantity

randomly without a pattern

ranked placed in order

rate a measure of how quickly a change occurs over time

reversibly changes that happen in one direction can be reversed and the opposite changes happen in the other direction

stem the root or base from which something larger is made

substituent something that has replaced something else. In organic compounds substituents have usually replaced a hydrogen atom

successive following one after another

suffix an ending added to a word

surface area the total area of the surface of a solid

tendency observed pattern of behaviour

transformation change

variable with more than one possible value

∞ the symbol for infinity

absolute uncertainty the uncertainty that is associated with a measured or calculated value

absolute zero the temperature that represents zero on the kelvin scale (0 K). At absolute zero all movement stops and the average kinetic energy is zero

absorbance a measure of the amount of light absorbed by coloured solutions

absorption the amount of light taken in when it passes through a liquid

accurate the measured value is similar to the known exact value

acid deposition the formation of acidic solutions that happens when acidic substances dissolve in atmospheric or surface water

acid dissociation constant a measure of the strength of an acid that relates the equilibrium concentrations of the weak acid and its conjugate base in solution

acid–base titration a technique used to determine the unknown concentration of an acid (or base) solution through reaction with a base (or acid) solution of known concentration

acidic has a pH < 7 at 25°C

acidic solutions solutions that contain an excess of H+ ions. Acidic solutions have a pH < 7.

actinoids elements in the second row of the f block of the periodic table

activation energy (E_a) the minimum amount of energy needed for a reaction to occur

activity series a series that lists metals by their strength as reducing agents

addition polymers polymers that are formed by addition reactions of alkenes

addition reaction a reaction of alkenes that forms saturated products

aerosols substances used in spray cans

alcohols a family of compounds that contain the –OH functional group

aldehyde a family of compounds that contain the –CHO functional group

alkali metals the elements that are in group 1 of the periodic table

alkaline has a pH > 7 at 25 °C

alkanes hydrocarbons that only contain single bonds. They have the general formula C_nH_{2n+2}.

alkenes hydrocarbons that contain one or more double bonds

allotropes different forms of an element that can exist in the same state

alloys mixtures that are held together by metallic bonding. Usually an alloy is a mixture of two or more metals. Some alloys involve a metal mixed with a small amount of a non-metal.

amphiprotic able to act as a Brønsted–Lowry acid and a Brønsted–Lowry base

amphoteric can behave as an acid or a base

anhydrous not containing any water

anion a negatively charged ion formed when an atom (or molecule) gains an electron or electrons

anode the electrode (or half-cell) where oxidation occurs

aprotic unable to donate an H+ or form hydrogen bonds

aqueous solution a solution that is formed by dissolving a substance in water

arenes molecules that are aromatic hydrocarbons

aromatic contains delocalized pi bonds in a ring structure

aromatic hydrocarbons hydrocarbons that contain ringstructures with delocalized π bonds

Arrhenius equation an equation that shows how the rate constant of a reaction depends on the activation energy and the temperature

atom the smallest unit of an element that can exist on its own

atomic mass the mass of one mole of the atoms of an element. It has the symbol M and has the units g mol–1.

atomic number defined as the number of protons in the nucleus. It has the symbol **Z**.

atomic radius half the distance between the nuclei of two bonded atoms of an element

Aufbau principle Aufbau means “building up” in German. Electrons will occupy the lowest energy level available. Only after the lowest energy level is filled will the next highest energy level be occupied.

Avogadro’s law the same volume of any gas at the same temperature and pressure will contain the same number of gas particles

Avogadro’s number the number of particles in one mole of a substance which is 6.02×10^{23}. Avogadro’s number is given the symbol N_A or L and has units of mol-1.

axial positions atoms that are bonded to the central atom and are positioned along the vertical axis of a molecule are in the axial positions

balanced equation a chemical equation in which the same number of atoms of each element are present on the reactant and product sides of the equation

base dissociation constant a measure of the strength of a weak base that relates the equilibrium concentration of the weak base and its conjugate acid in solution

basic has a pH > 7 at 25 °C

basic solutions solutions that contain an excess of OH– ions. Basic solutions have a pH > 7.

battery a device that converts stored chemical energy into electrical energy

benzene an aromatic compound with the formula C_6H_6 and in which the carbon atoms are arranged in a hexagonal ring

boiling the change of state that occurs when a liquid changes into a gas when it has been heated to the boiling point. Boiling occurs throughout the liquid.

bond (as a verb) be held together by strong attractive forces

bond enthalpy the energy required to break one mole of a particular bond in the gaseous state

bond length the distance between the centres of the two nuclei in a covalent bond

bond order the number of bonding pairs of electrons between two atoms

Born–Haber cycle an enthalpy cycle that relates the lattice enthalpy and enthalpy of formation of an ionic solid using a series of one-step processes

Brønsted–Lowry acid a substance that is a proton (H+) donor

Brønsted–Lowry base a substance that is a proton (H+) acceptor

buffer solutions solutions that resist any change in pH when small amounts of acid or base are added

calorimeter an instrument that measures the heat changes that occur during a reaction

carbocation intermediate a reaction intermediate that has a positive charge present on a carbon atom

carbon-12 the most common isotope of carbon; it has six protons and six neutrons in the nucleus

carboxylic acids a family of compounds that contain the –COOH functional group

catalyst a substance that speeds up a reaction but is unchanged at the end of the reaction

cathode the electrode (or halfcell) where reduction occurs

cation a positively charged ion formed when an atom (or molecule) loses an electron or electrons

cell diagram convention a method for representing the components of a voltaic cell

charge density a measure of the amount of charge that is contained within a volume

chemical energy energy that is stored in chemical bonds and interparticle forces

chemical environment the environment of an atom in a molecule that is described by the number and identity of the neighbouring atoms

chemical equation uses chemical formulas to show what happens in a chemical reaction

chemical formula a shorthand representation of a compound. It uses element symbols and subscripts to show how many atoms of each element are in the compound.

chemical properties a property of a substance that becomes evident when it reacts and changes into another substance. Acidity, reactivity with water, and enthalpies of reactions are examples of chemical properties.

chemical reaction a process in which one set of substances is turned into another set of substances

chemical shift a unit of measurement in NMR spectroscopy that changes according to the chemical environment of the nuclei. It has units of parts per million (ppm).

chemical symbol a one- or two-letter representation of an element's name

chiral carbon a carbon atom that has four different groups attached to it

chiral molecules a molecule that contains chiral carbons and rotates plane-polarized light

chlorofluorocarbons organic compounds (halogenoalkanes) that contain both chlorine and fluorine substituents

cis isomers isomers where the substituents are on the same side of a double bond in an alkene or on the same side in a ring compound.

closed circuit a circuit through which current can flow without being interrupted

closed system can exchange energy but not mass with the surroundings

combustion the reaction of a substance with oxygen

complementary colours colours that are opposite each other in the colour spectrum

complete combustion the combustion reaction of a substance that happens when excess oxygen is available

complex ions ions that contain a transition metal bonded to ligands

compound a pure substance that is made up of one or more elements that are present in a fixed ratio

condensation reaction a reaction that forms water as a product

condensed electron configurations electron configurations that use noble gas configurations as a core

condensed structure a drawing of a molecule that groups atoms but does not show bonds

condensing the change of state that occurs when a gas changes into a liquid

conductivity ability to conduct an electrical current

conjugate acid the acid that is formed when a compound acts as a Brønsted–Lowry base

conjugate acid–base pair two species with chemical formulas that differ by H+ conjugate base being present

conjugate base the base that is formed when a compound acts a Brønsted–Lowry acid

constructively interfere add together to give a wave with a larger amplitude

converge become closer

coordinate bond (also known as a dative bond) a covalent bond in which one atom donates both of the electrons that are shared in the bond

coordination number the number of ligands that are bonded to the central transition metal in a complex ion

corrosion a natural process in which a metal reacts with oxygen in the air to form its oxide

covalent bond a chemical bond that is formed by the electrostatic attraction between a shared pair of electrons and the nuclei of two atoms

covalent compound a compound that is formed by covalent bonding between the atoms of different elements

crystal a solid in which all the individual species (ions, atoms, or molecules) are in a highly ordered arrangement

crystalline having the properties of a crystal

cycloalkanes alkanes in which the carbon atoms are linked to form a ring structure

delocalized not held in one position

dependent variable the variable (property) that is measured to see how it is affected by changes in the independent variable

destructively interfere cancel each other completely and no wave exists after they combine

diamagnetism a magnetic property of substances that generate a magnetic field that is opposed to an applied magnetic field

diastereomers isomers that contain more than one chiral carbon and are not mirror images of each other

diffraction pattern regions of high and low intensity caused by the interference of two or more electromagnetic waves

dilutes increases the volume of solution relative to the amount of solute and decreases the concentration of the solution

dipole two regions of opposite charges (or partial charges) separated by a distance

dipole–dipole forces the electrostatic attraction between permanent dipoles on two molecules

discharged changed by the electrolysis reaction (by losing its charge)

discrete energy levels energy levels that are clearly separated in energy and do not overlap are discrete

displacement reaction a reaction in which a more reactive element replaces a less reactive element in a compound

dissociate to break bonds and separate atoms in a molecule

dissociation a reaction in which a molecule is split into smaller molecules, atoms, or ions

dissolution energy cycle an enthalpy cycle that relates lattice enthalpy, enthalpy of solution, and hydration enthalpy

dissolved oxygen oxygen gas (O2) that is dissolved in water

distillation a process in which a mixture is separated into components by heating the mixture and selectively boiling off and condensing the components into a separate container

double bond a covalent bond that is formed by the sharing of two pairs of electrons

effective nuclear charge the overall attraction that the electrons have to the nucleus after the effect of the nuclear charge is reduced by the repulsions by other electrons

electrical conductivity the ability of a substance to transport charge

electrochemical cells devices that convert chemical energy to electrical energy or electrical energy to chemical energy

electrode an electrical conductor that provides a surface where current can enter or leave an electrolyte solution

electrode potential the EMF that is generated by a half-cell when it is connected to the standard hydrogen electrode

electrolysed converted into simpler compounds using electrolysis

electrolysis a process in which electrical current is used to make non-spontaneous redox reactions occur

electrolyte solution a solution that contains ions and is able to conduct charge

electrolytic cells devices that convert electrical energy to chemical energy

electromagnetic radiation a form of energy that consists of perpendicular oscillating electric and magnetic fields that travel as waves

electromagnetic spectrum the range of different frequencies or wavelengths of electromagnetic radiation

electromotive force the voltage generated by any source of electrical energy

electron a negatively charged particle that occupies the space outside the nucleus in an atom

electron affinity the energy change that occurs when one mole of electrons is added to one mole of atoms in the gaseous state

electron configuration a description of which orbitals are occupied in an atom

electron density a measure of how likely it is to find an electron at a particular location

electron density map a representation (or map) of where electrons are in a compound

electron domain a region around an atom that contains electron pairs

electron domain geometry the three-dimensional shape taken by the electron domains around a central atom

electron spin a quantum mechanical property of electrons

electron-deficient carbon a carbon that has a partial positive charge

electronegativity difference the difference in electronegativity between two atoms

electronegativity the ability of an atom to attract the shared electrons in a covalent bond

electron-sea model a model that describes metallic bonding as the attraction between a lattice of cations and a sea of delocalized valence electrons

electrophiles electron-poor species that can act as Lewis acids and accept electron pairs to form coordinate bonds

electrophilic substitution reactions substitution reactions in which an electrophile replaces a hydrogen atom

electroplating a process that uses electrolysis to deposit a layer of metal on another conducting object

electrostatic attraction the force that attracts a positively charged species to a negatively charged species

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

elementary step a single step in a reaction mechanism

emission spectra the wavelengths (or frequencies) of light emitted by atoms or compounds that contain excited electrons

emission spectrum the frequencies of electromagnetic radiation observed when a high-energy species loses energy by emitting electromagnetic radiation

empirical formula the chemical formula of a substance given as the simplest ratio

enantiomers optical isomers

endothermic reaction a reaction that takes in heat

end-point the volume of acid (or base) added when the indicator first changes colour in an acid–base titration

energy level diagram a diagram that shows the energy levels available to an electron in an atom

energy the ability to do work. Energy can be converted into different forms and transferred between objects. Energy cannot be created or destroyed.

enthalpy (H) the heat that is contained in a system

enthalpy change (**ΔH**) the change in enthalpy that occurs due to a chemical reaction or process. It is equal to the amount of heat energy released or absorbed at constant pressure.

enthalpy of atomization the enthalpy change that occurs when one mole of a gaseous atom is formed from the element in its standard state

enthalpy of formation the enthalpy change that occurs when one mole of a compound in its standard state is formed from its elements in their standards states

enthalpy of reaction ($\Delta H_{reaction}$) the enthalpy change that occurs when one mole of a substance is reacted under standard conditions

enthalpy of solution the enthalpy change that occurs when one mole of an ionic solid is dissolved in water to infinite dilution under standard conditions

entropy a measure of disorder. Entropy has the symbol S and units J K_{-1}, mol_{-1}.

equatorial plane the plane that is at 90 degrees to the vertical axis of a molecule is the equatorial plane

equilibrium a state in which forward and reverse reactions are occurring at the same rate in a closed system. There is no overall change in the concentrations of reactants and products.

equilibrium position the proportion of reactants and products in a reaction mixture that is at equilibrium

equilibrium reaction a reaction in which the forward and reverse reactions are occurring at the same time

equivalence point the point in a titration at which the exact volume of the standard solution needed to completely react with the unknown solution has been added

esterification the reaction between an alcohol and a carboxylic acid to make an ester and water

esters a family of compounds that contain the –COO- functional group

evaporation the change of state that occurs when a liquid changes into a gas at a temperature below the boiling point. Evaporation occurs at the surface of the liquid.

excess reactant the reacting substance that is present in an excess and is not completely used up in the reaction

excited electrons electrons that are in high energy levels far from the nucleus

excited states energy levels of an atom or a molecule that are higher in energy than the ground state

exothermic reaction a reaction that gives off heat

expanded octets happen when the valence shells of atoms have more than eight electrons

experimental yield the mass of product that is obtained when the reaction is carried out experimentally

Faraday constant the total charge carried by one mole of electrons. It has the symbol F and has a value of 96 500 C mol_{-1}.

first electron affinity the enthalpy change that occurs when one mole of electrons is added to one mole of gaseous atoms

first ionization energy the energy required to remove one mole of electrons from one mole of gaseous atoms in their lowest energy state

forward reaction reaction that proceeds from left to right as written; reactants are converted into products

fragmentation pattern the pattern of peaks that are observed in the mass spectrum of a molecule that breaks up to form smaller ions (fragments)

free radical a chemical species that contains one or more unpaired electrons

free radicals species that contain an unpaired electron

free-radical substitution a substitution reaction in which a bonded atom is replaced by a free radical

frequency factor (also known as the pre-exponential factor) the frequency of collisions between reactant particles that occur with the correct orientation for the reaction to happen

frequency the number of wave peaks that pass through a given point in one second

full structure a drawing of a molecule that shows all atoms and bonds

functional group a group of atoms that is present in a family of compounds. The functional group gives each member of the family the characteristic chemical properties of that family of compounds.

gas a state of matter in which the substance particles are able to move independently and are spread out. A gas does not have a fixed shape or fixed volume.

gas laws equations that define how the properties of gases such as temperature, pressure, volume, and amount are related

Gibbs free energy the energy of a reaction that is available to do work

ground state the lowest energy state of an atom or molecule

groups vertical columns of elements in the periodic table

half-cell the component of a voltaic cell where either oxidation or reduction occurs

half-equation an equation that shows the changes that happen in a redox reaction due to either oxidation only or reduction only

halogenoalkanes alkanes in which a hydrogen atom has been replaced by a halogen atom

halogens the elements that are in group 17 of the periodic table

heat the transfer of energy between two objects that have different temperatures

Hess's Law enthalpy change is independent of pathway

heteroanalogues cycloalkanes in which a carbon atom is replaced by another atom such as O or N (a heteroatom)

heterogeneous mixture a mixture in which the substances are present in different states and are not spread equally through the mixture

heterolytic fission the breaking of a covalent bond to form a cation and an anion

high-resolution $_1$H NMR $_1$H NMR spectroscopy that shows the splitting of peaks that occurs due to the effect of protons on neighbouring atoms

homogeneous equilibrium an equilibrium reaction in which all the reactants and products are in the same state

homogeneous mixture a mixture in which all of the substances are present in the same state and are spread equally through the mixture

homologous series a family of organic compounds in which the chemical formula of successive members differs by CH_2.

homolytic fission the breaking of a covalent bond to form two free radicals

Hund's rule if more than one orbital in a sub-level is available, electrons occupy different orbitals with the same spins

hybridization the mixing of atomic orbitals to make hybrid orbitals

hydrated surrounded by water molecules

hydration enthalpy the enthalpy change that occurs when one mole of a gaseous ion is dissolved in water to infinite dilution under standard conditions

hydration the process by which ions become surrounded by water molecules

hydrocarbons compounds that contain only carbon and hydrogen atoms

hydrogen bonding a strong intermolecular force that occurs between molecules containing a hydrogen atom bonded to a highly electronegative atom

hydrogenation the addition reaction of alkenes with H_2

ideal gas a gas that obeys the ideal gas equation under all conditions

ideal gas equation the equation that describes the relationship between the pressure, volume, temperature, and amount of an ideal gas; PV = nRT

in phase when two waves are in phase the peaks and troughs of both waves occur at the same position.

incident angle that angle at which X-rays hit the surface of a crystal

incomplete combustion the combustion reaction of a substance that happens when limited amounts of oxygen is available

incomplete octet an atom that has fewer than eight electrons in its valence shell has an incomplete octet

incomplete octets happen when the valence shells of atoms have fewer than eight electrons

independent variable a variable (property) that can be changed or modified to see how it changes another variable

index of hydrogen deficiency a measure of how many H_2 molecules have to be added to a compound to make it saturated and non-cyclic

indicator a substance that has different colours at different pH values

induced dipole a dipole that forms on a molecule when its electrons are attracted or repelled by a dipole on another molecule

inductive effect stabilizing of a positive charge by the donation of electron density by neighbouring atoms

infinite dilution a solution that is so dilute that solute particles only interact with solvent and do not interact with each other

infrared spectroscopy a technique that measures the frequencies of infrared radiation absorbed by covalent bonds in a molecule

initial rate of reaction the rate of reaction that occurs at the start of the reaction (when t = 0)

initial rates method a method for determining orders of reaction. The concentrations of reactants are changed one at a time and the effect on the initial rate of reaction is observed.

initiation the first step in the free-radical mechanism, where free radicals are formed

instantaneous dipole a dipole that only exists for a brief time on a molecule

integrated area the total area that is measured under a peak

interhalogen a diatomic molecule containing two halogens, e.g. ICl, ClBr

intermolecular forces attractive forces that exist between molecules

inter-nuclear axis a line joining the centres of two nuclei

inversion having the opposite orientation

inverted of the opposite orientation

ion a charged species formed when an atom (or molecule) gains or loses an electron or electrons

ion–dipole interactions the electrostatic attraction between an ion and a dipole

ionic bond a chemical bond that is caused by the electrostatic attraction between positive and negative ions

ionic compound a compound that is formed by ionic bonding between the atoms of different elements

ionic lattice the three-dimensional structure of an ionic compound

ionic product of water a constant that relates the equilibrium concentrations of H+ ions and OH– ions in aqueous solutions at a specific temperature

ionic radius distance from the nucleus of an ion to the outer electrons

ionization energy the energy required to remove one mole of electrons from one mole of gaseous atoms in their lowest energy state

ionization the process in which an atom or molecule loses an electron and becomes a positive ion

isotopes atoms of the same element that have different numbers of neutrons and different mass numbers

isotopic composition the number and abundances of naturally occurring isotopes for an element

IUPAC International Union of Pure and Applied Chemistry

kelvin scale a scale used to measure temperature. The units are called Kelvin and have the symbol K.

ketone a family of compounds that contain the –CO– functional group

kinetic energy the energy that an object has due to its motion

lanthanoids elements in the first row of the f block of the periodic table

lattice enthalpy the enthalpy change that occurs when one mole of an ionic solid is broken into its gaseous ions

Le Châtelier's principle a system at equilibrium when subjected to a change will respond in such a way as to minimize the effect of the change

leaving group the atom or group that is substituted by a nucleophile in a nucleophilic substitution reaction

Lewis acid a substance that is an electron pair acceptor

Lewis base a substance that is an electron pair donor

Lewis structure a representation of a molecule that shows the bonds and lone pairs in the valence shell of the atoms in the molecule. It uses lines or pairs of crosses (or dots) to represent electron pairs.

ligands species that donate a lone pair of electrons to a transition metal ion and form a coordinate bond

limit a final value

limit of convergence the final value that the emission frequencies converge to

limiting reactant the reacting substance that is completely used up in a chemical reaction and determines the amount of products formed

liquid a state of matter in which the substance particles are able to move. A liquid does not have a fixed shape but it does have a fixed volume.

litmus an indicator that is blue in basic solutions (pH > 7) and red in acidic solutions (pH < 7)

London (dispersion) forces the electrostatic attraction between instantaneous dipoles on one molecule and induced dipoles on another molecule

lone pairs non-bonding pairs of electrons that belong to one atom

malleability the ability to be shaped under pressure

Markovnikov's rule a rule for predicting the products formed in the addition reactions of unsymmetrical alkenes

mass number defined as the number of protons and neutrons in the nucleus. It has the symbol **A**.

mass spectrometer an instrument that determines the masses and abundances of different chemical species present in a sample

mass spectrometry a technique that determines the masses and abundances of different chemical species present in a sample

mass spectrum a graphical representation of the results obtained by a mass spectrometer. Vertical lines occur at the mass of each ion present and the height of the line represents the abundance of that ion.

Maxwell–Boltzmann distribution the range of kinetic energies that a sample of particles has at a given temperature

metalloids elements that have the properties of metals and non-metals

metals elements that tend to lose electrons and form positive ions

mixture a combination of two or more substances that are not chemically bonded to each other

molar concentration the number of moles of solute in a solution relative to the volume of solution measured in dm3. It has the symbol C and units mol dm_{-3}.

molar mass the mass of one mole of a substance. It has the symbol M and has the units g mol-1.

molar volume the volume occupied by one mole of a gas. It has the symbol V_m.

mole a unit of amount equal to the number of atoms in exactly 12 g of carbon-12. It has the symbol mol.

molecular formula the chemical formula of a molecule

molecular geometry the three dimensional shape of a molecule

molecular ion also known as a parent ion. The ion that is formed when a molecule loses a single electron.

molecularity the number of particles in an elementary step

molecule the smallest unit of a covalent compound

molten melted (of a liquid that is formed only at high temperatures)

molten liquids liquids made by heating substances above their melting point

monochromatic (light) with one specific wavelength

monomers individual molecules that can combine to form polymers

network covalent structures covalent compounds in which all of the atoms are linked by covalent bonds

neutral has a pH = 7 at 25 °C

neutralization reaction a reaction between an acid and a base

neutron a neutral particle found in the nucleus of an atom

nitration an electrophilic substitution reaction in which an NO_2 group replaces an H atom

noble gases the elements that are in group 18 of the periodic table

non-metals elements that tend to gain electrons and form negative ions

non-polar covalent bond a covalent bond in which the electron pair is equally shared between the two nuclei

non-polar molecules molecules that do not contain a net dipole

non-spontaneous not happening by itself

non-superimposable cannot be placed on top of each other to give the same arrangement

nuclear charge the total charge exerted by the nucleus of an atom. It depends on the number of protons in the nucleus.

nuclear spin a quantum mechanical property of a nucleus that can be modified by a magnetic field

nucleons particles found in the nucleus of an atom. Protons and neutrons are both nucleons.

nucleophile an electron-rich species that can act as a Lewis base and donate an electron pair to form a coordinate bond

nucleophiles electron-rich species that can act as Lewis bases and donate electron pairs to form coordinate bonds

nucleophilic substitution reactions substitution reactions in which a nucleophile replaces a leaving group

nucleus the dense positively charged core of an atom. Almost all of the mass of an atom is contained in the nucleus.

octet rule atoms in covalent compounds will have eight electrons in their valence shell

open system can exchange mass and energy with the surroundings

optical isomers isomers that rotate plane-polarized light in opposite directions

optically active rotating plane-polarized light

optically inactive not rotating plane-polarized light

orbital a region of space where there is a high probability of finding an electron

order of reaction the number of particles of a particular reactant that are involved in the ratedetermining step

organic synthesis the process of making an organic compound from readily available starting materials using a series of reactions

out of phase when two waves are out of phase the peaks of one wave occur at the same position as the troughs of the other wave

overall dipole the dipole on a molecule that is made by the summing of individual dipoles from any polar bonds in the molecule

overall order of reaction the total number of reactant particles that are involved in the ratedetermining step

oxidation half-equation a half-equation that shows only the chemical changes that happen in a redox reaction due to oxidation

oxidation state a measure of how many electrons an atom has gained or lost in forming a compound or ion

oxidation the loss of electrons by a chemical species

oxides compounds that contain only oxygen and one other element

oxidizing agent a substance that oxidizes another substance and is reduced itself

paramagnetism a magnetic property of substances that generate a magnetic field that is aligned with an applied magnetic field

parent ion (also known as a molecular ion) the ion that is formed when a molecule loses a single electron

Pauli exclusion principle two electrons occupying the same orbital must have different spins

percentage composition the mass of each element in a compound given as a percentage of the total mass

percentage uncertainty the absolute uncertainty expressed as a percentage of the measured or calculated value

percentage yield the experimental yield expressed as a percentage of the theoretical yield

periods horizontal rows of elements in the periodic table

period number the number of the outermost energy level occupied by electrons, equivalent to the row in the periodic table where the element appears

periodic table a table that organizes the elements by increasing atomic number and the number of valence electrons

periodicity patterns in physical and chemical properties observed in the periodic table

permanent dipole a dipole that is always present on a polar molecule

pH curves graphs of pH against volume of acid or base added in an acid–base titration

pH meter an instrument that measures pH

pH range (for indicators) the pH range at which an intermediate colour is observed because both the indicator and its conjugate base are present

phase boundary a boundary that exists between components of a cell that are in different phases, e.g. a metal electrode and a salt solution in a voltaic half-cell.

photochemical chemical changes that happen after light energy is absorbed by compounds

photons particles of light (electromagnetic radiation)

physical properties a property of a substance that can be measured without it changing into another substance. Melting points, boiling points, appearance, and density are examples of physical properties.

pi (π) bonds covalent bonds formed by side‑on overlap of atomic orbitals

plane-polarized light light that only oscillates in one plane

polar containing partial charges separated by a distance

polar covalent bond a covalent bond in which the electron pair is not equally shared between the two nuclei

polar molecules molecules that contain an overall dipole

polarimeter an instrument that measures the rotation of planepolarized light

polyatomic ions ions that contain more than one atom

polymers very large molecules made up of repeating units

post-combustion occurring after the combustion reaction of a substance

potential difference the difference in voltage between the anode and cathode in a cell

power source an electronic device that is a source of electrical energy

precise repeated measurements give similar results

pre-combustion occurring before the combustion reaction of a substance

primary carbon a carbon atom that is bonded to one alkyl chain

primary nitrogen a nitrogen atom that is bonded to one alkyl chain

principal energy level the highest energy level occupied by electrons in an atom

products the substances that are made from other substances in a chemical reaction. Products appear on the right of the arrow in a chemical equation.

propagation of uncertainties a mathematical process for determining the uncertainty in a calculated value from the uncertainties in all the measurements used in the calculation

propagation the steps in the free-radical mechanism where free radicals react to form new free radicals

protic able to donate an H+ or form hydrogen bonds

proton a positively charged particle found in the nucleus of an atom

proton acceptor a substance that acts as a Brønsted–Lowry base and accepts H+ from an acid

proton donor a substance that acts as a Brønsted–Lowry acid and donates H+ to a base

proton nuclear magnetic resonance spectroscopy a technique that measures the frequency of radio waves absorbed by hydrogen atoms in a molecule

qualitative data data that are obtained by making observations

quantitative data data that are obtained by making measurements

quantized occurring with discrete or specific values; not continuous

racemic mixture a mixture that contains equal amounts of two optical isomers

random errors errors that are associated with measurements and are a result of natural variability due to the procedure or instrument used to make the measurement

rate constant a constant that relates the rate of a reaction to the concentrations of the reactants

rate expression a mathematical equation that shows how the rate depends on the concentrations of the reactants

rate of reaction how fast a reaction happens, or how quickly reactants are changed into products

rate-determining step the slowest elementary step in a reaction mechanism

reactants the substances that are turned into other substances in a chemical reaction. Reactants appear on the left of the arrow in a chemical equation.

reaction intermediate a species made in one elementary step and used in another step. It does not appear in the overall equation for the reaction.

reaction mechanism a description of a reaction as a series of elementary steps

reactive can easily undergo chemical reactions

reactive site the part of a molecule where the reaction happens

real gas a gas that does not obey the ideal gas equation under all conditions

redox titration a technique used to determine the unknown concentration of a solution through a redox reaction with another solution of known concentration

reducing agent a substance that reduces another substance and is oxidized itself

reduction half-equation a half-equation that shows only the chemical changes that happen in a redox reaction due to reduction

reduction the gain of electrons by a chemical species

reference standard a substance that gives a reliable measured value that other substances can be compared to

reflux a process in which a reaction mixture is kept at the boiling point of the solvent by condensing the solvent that boils off and returning it to the reaction mixture

refrigerants substances used in refrigerators

relative abundance the number of atoms of one isotope of an element expressed as a ratio or percentage of the total number of atoms of all isotopes of that element

relative atomic mass the mass of an atom of an element relative to the mass of an atom of carbon-12. The relative atomic mass has the symbol $\mathbf{A}_r$ and it has no units.

relative formula mass the mass of one unit of an ionic compound expressed relative to the mass of an atom of carbon-12. It has the symbol M r and it has no units.

relative mass the mass of an object or particle expressed as a ratio of the mass of another object or particle. Relative masses have no units.

relative molecular mass the mass of one unit of a covalent compound expressed relative to the mass of an atom of carbon-12. It has the symbol $\mathbf{M}_r$ and it has no units.

relative uncertainty the absolute uncertainty expressed as a ratio of the measured or calculated value

repeating units a group of atoms that come from a monomer and link repeatedly to form the polymer chain

resonance hybrid the true structure that results from resonance and the delocalization of pi electrons

resonance structures the possible Lewis structures that can be drawn for some compounds containing a double bond

resonance when a molecule has more than one Lewis structure

retention keeping the same orientation

retro-synthesis working backwards from a target molecule to determine the stepwise conversions and starting materials needed for its synthesis

reverse reaction reaction that proceeds from right to left as written. Products are converted into reactants

salt bridge a device that connects the anode and cathode in a voltaic cell. It contains a concentrated solution of an unreactive salt and allows ions to flow into the two half-cells.

saturate create a non-cyclic compound that has only single bonds

saturated only single bonds are present in the molecule (the molecule only contains sigma bonds)

scattered deflected from the original direction

Schrödinger wave equation an equation that describes the behaviour of electrons as three dimensional waves moving around the nucleus of an atom

second electron affinity the enthalpy change that occurs when one mole of electrons is added to one mole of gaseous 1– ions

second ionization energy the enthalpy change that occurs when one mole of electrons is removed from one mole of gaseous 1+ ions

secondary carbon a carbon atom that is bonded to two alkyl chains

secondary nitrogen a nitrogen atom that is bonded to two alkyl chains

shielding the blocking effect that electrons in inner energy levels have on valence electrons. Shielding prevents the valence electrons from experiencing the full nuclear charge.

sigma (σ) bonds covalent bonds formed by head-on overlap of atomic orbitals

single-crystal X-ray crystallography a technique that records the diffraction pattern generated by X-rays scattered by a crystal and uses this to determine the structure of the compound

S_N1 first-order nucleophilic substitution reaction

S_N2 second-order nucleophilic substitution reaction

solid a state of matter in which the substance particles are held in fixed positions. A solid has a fixed shape and fixed volume.

solubility a measure of how easily a substance can be dissolved into a solvent (usually water)

solute the substance that is dissolved into a solvent to form a solution. The solute is present in a smaller amount than the solvent.

solution a homogeneous mixture formed by dissolving a solute (or solutes) into a solvent

solvent the substance that a solute dissolves in to form a solution. The solvent is present in a larger amount than the solute.

specific heat capacity the amount of heat needed to raise the temperature of 1 g of a substance by 1K. Units are $J\ g^{-1}, K^{-1}$.

spectator ions ions that are present in solution but do not participate in any reactions

spectrochemical series a list of ligands that orders them according to the size of the splitting energy they produce when bonding to transition elements

spectrophotometer an instrument that measures the absorbance of light

splitting energy the energy gap between the two sets of d orbitals in a transition element complex

splitting pattern the pattern of peaks that are observed for signals in a $_1H$ NMR spectrum

spontaneous happening by itself

standard conditions a set of consistent reaction conditions that is used when measuring cell potentials

standard electrode potential the EMF that is generated by a half-cell when it is connected to the standard hydrogen electrode under standard conditions

standard enthalpy changes the heat that is given off or taken in by reactions that occur under standard conditions

standard enthalpy of formation (ΔHf) the enthalpy change that occurs when one mole of a substance is formed from its elements in their standard states and under standard conditions

standard Gibbs free energy of formation the change in Gibbs free energy that occurs when one mole of a compound is formed from its elements in their standard states

standard hydrogen electrode a reference half-cell that is used to measure the electrode potentials of other half-cells

standard solution a solution that has a known concentration

standard states the state in which an element or compound exists under standard conditions

standardize to determine the concentration of a solution

states of matter the different ways that substances can exist. Solids, liquids, and gases are the three states of matter that are most common.

stereospecific produces a particular stereoisomer

steric hindrance the blocking of a reaction site on a molecule by other parts of the molecule such as alkyl side chains

stoichiometric coefficients the numbers that are written in front of the chemical formulas in a balanced equation

stoichiometric equivalent reactants are present in the exact amounts required to react completely based on the stoichiometric coefficients in the chemical equation

strong acids acids that fully dissociate in aqueous solution

strong bases bases that fully dissociate in aqueous solution

structural formula a representation of a molecule that shows how the atoms are arranged

structural isomers compounds that have the same molecular formula but a different arrangement of atoms

sub-atomic particles particles that are smaller than an atom and combine to make up an atom

sub-levels different energy levels that exist within a main energy level

sublimation the change of state that occurs when a solid changes directly into a gas

sublime convert directly from solid to gas

surroundings everything that is outside of the system

symmetrical alkene an alkene that has the same groups on the two carbons that make the double bond

system the part of the universe being studied

systematic errors errors that result from inaccuracy or bias in the procedure or instrument used to make the measurement

temperature a measure of the average kinetic energy of particles

termination the last step in the free-radical mechanism, where two radicals combine and end the reaction

tertiary carbon a carbon atom that is bonded to three alkyl chains

tertiary nitrogen a nitrogen atom that is bonded to three alkyl chains

theoretical yield the mass of product that would be formed if all of the limiting reactant is changed into products

titration a technique used to determine the concentration of a solution by reacting it with another solution of known concentration

trans isomers isomers where the substituents are on the opposite sides of a double bond in an alkene or on the opposite sides in a ring compound.

transition elements elements that have a partially filled sub‑level or can form ions with a partially filled d sub-level

transition state a high energy state that must be reached before a reaction can happen

transitions movement of an electron from one energy level to another

triple bond a covalent bond that is formed by the sharing of three pairs of electrons

unhybridized atomic orbitals that do not mix to form hybrid orbitals are unhybridized

universal gas constant a physical constant used in many chemical and physical equations. It has the symbol R and has a value of 8.31 J K_{-1}, mol_{-1}.

universal indicator an indicator that is a series of different colours at different pH values

unreactive does not easily undergo chemical reaction

unsaturated the molecule contains double or triple bonds (the molecule contains pi bonds)

unsaturation multiple bonds or rings

unsymmetrical alkene an alkene that has different substituents on the two carbons making the double bond

valence electrons the electrons that are in the outermost level of an atom

vaporization the change of state that occurs when a liquid changes into a gas. There are two types of vaporization: boiling and evaporation.

vibrational energy the kinetic energy associated with the vibrations (stretches and bends) in molecules

volatility a measure of how easily a substance can be converted to a gas

voltaic cells devices that convert chemical energy to electrical energy

VSEPR theory Valence Shell Electron Pair Repulsion theory

wavelength the distance between two successive peaks in a wave

wavenumbers a unit of frequency. wavenumber = 1/cm = cm–1

weak acids acids that partially dissociate in aqueous solution

weak bases bases that partially dissociate in aqueous solution

Winkler Method a method that uses redox reactions to determine the concentration of dissolved oxygen in aqueous solutions

work the ability to move an object against an opposing force

yield amount of product obtained

absorption taking in

accepts takes

aligned lined up

components parts

conducted undertook

conserved saved/retained, left unchanged

deform distort

dense solid

derived calculated

disorder randomness

dispersed spread out

donates gives or provides

emit give out

in-depth covered in more detail or involving a higher level of understanding

initiate start

key strands important features

mean average

propagate continue

rate speed

regions particular parts

retain keep

significant large, meaningful

specific clearly defined

terminate end

transport movement

trend pattern