

Glossary

Entries that are IB command terms and entries that are IB syllabus-required definitions are coloured red and blue, respectively.

A

2-amino acids a group of soluble organic compounds that possess a carboxylic acid group ($-\text{COOH}$) and a primary amine group ($-\text{NH}_2$) bonded to a common carbon atom; 2-amino acids are the monomers of proteins

α helix *see* alpha helix

absolute configuration actual three-dimensional structure of a chiral molecule: specified verbally by the Cahn–Ingold–Prelog R, S convention and represented on paper by Fischer projections

absolute temperature a temperature based on the thermodynamic (ideal gas) scale, measured from absolute zero; absolute temperature = (temperature in $^{\circ}\text{C}$ + 273) K; temperature in $^{\circ}\text{C}$ = (absolute temperature in K – 273)

absolute zero the temperature to which substances cannot be cooled; corresponds to the complete absence of heat; the temperature at which all ionic, molecular and atomic vibrations cease and at which the pressure and volume of an ideal gas are zero

absorbance logarithm of the fractional transmission of light (often at a specified wavelength) through a sample; absorbance, $A = \log_{10}(I_0 / I)$ where, I_0 and I are the intensity of the incident and transmitted radiation, respectively (*see* Beer–Lambert law)

absorption spectroscopy production and study of the absorption spectra of a material (often gaseous atoms and molecules)

absorption spectrum consists of dark absorption lines superimposed on a bright continuous spectrum; shows the absorption of radiation by a material over a range of wavelengths

accuracy a measure of the agreement between a measurement and the true or correct value

accurate measurement a measurement obtained using accurately calibrated instruments correctly and where no systematic errors arise: it will be close to the true value of the measurement

ACE inhibitor drugs that inhibit the enzyme angiotensin-converting enzyme. They are used as hypertensive agents

acid a proton donor (Brønsted–Lowry theory) and/or electron pair acceptor (Lewis theory)

acid anhydride homologous series ($\text{RCO}(\text{O})\text{COR}$) containing a functional group characterized by two acyl groups joined by an oxygen atom

acid deposition deposition of acids from the atmosphere in solid or liquid form on the Earth's surface

acid dissociation constant, K_a the equilibrium constant for the reaction in which an acid dissociates and loses

its hydrogen in the form of a hydrogen ion (proton) or oxonium (hydronium) ion

acid rain rain water ($\text{pH} < 5.6$) polluted by the presence of a mixture of nitric and sulfuric acids; caused by sulfur dioxide from the burning of coal and oxides of nitrogen from car exhaust emissions

acid salt a salt formed from a polybasic or polyprotic acid in which some of the hydrogen has not been replaced by metal ions

acid–base indicator a weak acid whose dissociated and undissociated forms in aqueous solution are different colours – the proportion of the two coloured forms varies with pH; used to show changes in the pH of aqueous solutions

acid–base reactions the transfer of protons / hydrogen ions from an acid to a base

acidic oxide a covalent oxide, usually an oxide of a non-metal, that reacts and dissolves in water to form a solution of an acid – if insoluble in water, the oxide reacts with alkalis to give salts

acidification fall in pH of soils and water in lakes and rivers, caused by acid rain

actinoids elements 90 (thorium) to 103 (lawrencium). Electrons added during the Aufbau construction of actinide atoms go into the 5f subshell. Actinides are unstable and undergo radioactive decay

activated complex *see* transition state

activation energy the minimum amount of combined total kinetic energy a colliding pair of ions, atoms or molecules requires for a chemical reaction to occur; the energy barrier that has to be overcome to form the transition state

active site the region of an enzyme, usually a pocket or groove, that binds the substrate molecule(s) and catalyses a reaction

active site (of a catalyst) site on the surface of a solid catalyst at which catalytic activity occurs

active site (of an enzyme) the region of an enzyme, typically a pocket or groove on the surface, that binds the substrate(s) and performs catalysis

activity series an order of metal reactivity based on the relative rates of reactions of metals with oxygen, water, dilute aqueous acid and solutions of metal ions or salts (*see* electrochemical series)

acute toxicity negative effects of exposure to a chemical after a single dose in the short term

acylation introduction of an acyl group ($\text{RCO}-$) into an organic molecule

addition polymerization a type of polymerization that occurs when alkene-based monomers undergo repeated addition reactions to form a single molecule

- addition reaction** a reaction in which two (or more) molecules combine together to form a single molecule
- additives (food)** substances added to food during manufacture or preparation to improve sensory properties (taste, aroma and colour), nutrient content (vitamins and minerals), shelf-life or safety
- adduct** the chemical formed by the combination of a Lewis base with a Lewis acid
- adenosine triphosphate (ATP)** nucleotide formed in photosynthesis and respiration from ADP and phosphate, and functioning as a common intermediate between energy-requiring (endothermic) and energy-yielding (exothermic) reactions
- adsorption** accumulation, usually temporarily, of gases, liquids or solutes on the surface of a solid or liquid through the formation of weak intermolecular interactions or chemical bonds
- aerobic respiration** respiration requiring molecular oxygen, involving the oxidation of glucose to carbon dioxide and water
- aerosol** the result of breaking up a liquid sample into small droplets by a nebulization process
- affinity** the affinity of a drug is its ability to bind to its biological target
- agonist** any molecule that improves the activity of a different molecule
- AIDS** disease caused by a retrovirus, HIV (human immunodeficiency virus), and characterized by failure of the immune system to protect against infections and certain cancers
- air pollution** unwanted or toxic gases or particles that accumulate in the air as a consequence of natural processes or industrialization
- alcohols** a homologous series of organic compounds containing the functional group -OH and the general formula $\text{C}_n\text{H}_{2n+1}\text{OH}$
- aldehydes** a homologous series of compounds with the general formula RCHO , where the -CHO group (the aldehyde group) consists of a carbonyl group attached to a hydrogen atom; R is usually an alkyl or aryl group
- aldose** any monosaccharide sugar that contains an aldehyde group (-CHO) (in its acyclic (straight chain) form)
- algal bloom** rapid growth of algae on the surface of freshwaters in response to a supply of nitrogen and/or phosphorus, leading to depletion of light and oxygen below the water surface
- aliphatic** an organic compound that has carbon atoms arranged in a chain (straight or branched) or ring form but does not contain an aromatic ring with delocalized pi electrons
- alkali** a strong base which is soluble in water; alkalis are group 1 metal hydroxides and barium hydroxide
- alkali metals** the group of very reactive metals in group 1 of the periodic table; they react with water to release hydrogen gas and form strongly alkaline solutions
- alkaloids** basic nitrogen organic compounds (mostly heterocyclic) derived from plants and having a range of pharmacological properties
- alkanes** saturated hydrocarbons which have the general formula $\text{C}_n\text{H}_{2n+1}$ (if acyclic)
- alkenes** unsaturated hydrocarbons containing a carbon–carbon double bond and with the general formula C_nH_{2n} (if acyclic)
- alkyl group** a group, with the general formula $\text{C}_n\text{H}_{2n+1}$ obtained by removing a hydrogen atom from an alkane, and usually represented by R
- alkylation** introduction of an alkyl group into an organic molecule
- alkynes** unsaturated hydrocarbons with a carbon–carbon triple bond and with the general formula $\text{C}_n\text{H}_{2n-2}$ (if acyclic)
- allosteric site** this term is used in enzyme kinetics to refer to the binding site of a non-competitive inhibitor of an enzyme; the binding of the inhibitor to this site (which is not part of the active site of the enzyme) produces a conformational change in the enzyme's structure which reduces the efficiency of formation of the enzyme–substrate complex
- allosteric state** a conformational state exhibited by an allosteric enzyme
- allotrope** one of the different structural forms of an element
- allotropy** the ability of an element to exist in different structural forms or allotropes
- alloy** mixture with metallic properties made up of two or more metals, or which contains metals and carbon
- alpha helix** right-handed helical conformation of a protein chain, held together by intramolecular hydrogen bonding; a common protein secondary structure
- alpha particle** fast-moving helium nucleus emitted by radioactive nuclei, consisting of two protons and two neutrons tightly bound together; travels only a few centimetres in air and is stopped by thick paper
- amalgam** alloy that contains mercury
- amide** a homologous series of organic compounds with the general formula RCONH_2
- amide link** a chemical bond formed between two molecules when the carboxyl group of one molecule reacts with the amine group of the other molecule, thereby releasing a molecule of water
- amines** organic compounds derived by replacing one or more of the hydrogen atoms in ammonia by alkyl groups
- amino acids** a class of organic compounds that contain at least one amino group, -NH_2 , and one carboxyl group, -COOH : the 2-amino acids (or α -amino acids), $2\text{H}_2\text{N-CHR-COOH}$, are the monomers of proteins
- amino acid residue** single amino acid within a polypeptide chain
- amorphous** non-crystalline solid; lacking a definite or regular shape
- amount** a physical quantity indicating the number of moles of a substance present in a sample
- ampere** the SI unit of electrical current: a current of one ampere (amp) is a flow of one coulomb of charge per second ($1\text{ A} = 1\text{ Cs}^{-1}$)

amphiphilic a molecules that has hydrophobic (non-polar) and hydrophilic (polar) regions

amphiprotic a chemical species capable of accepting and donating protons, thus able to behave as both as an acid and a base

amphoteric a substance capable of acting as an acid or base

amylopectin water-soluble component of starch, consisting of highly branched chains of glucose molecules; the backbone of glycosidic linkages is ($1\alpha \rightarrow 4$), but the branches are ($1\alpha \rightarrow 6$)

amylose water-insoluble component of starch. It consists of between 100 and 1000 linear chains of D-glucose molecules bonded in ($1\alpha \rightarrow 4$) linkages

anabolic steroids group of synthetic hormones that promote the storage of protein and the growth of tissue, sometimes used by athletes to increase muscle size and strength

anabolism biochemical processes by which smaller molecules are joined to make larger molecules

anaerobic respiration respiration in the absence of molecular oxygen, involving the breakdown of glucose to lactic acid or ethanol

analgesic drug used to alleviate the sensation of pain

analogue a drug whose structure is related to that of another drug but whose chemical and biological properties may be quite different

analyse interpret data to reach conclusions

analyte a component of a sample upon which is carried out analytic analysis

angle strain strain due to deviation from one or more ideal bond angles

Angstrom a unit of length used for measuring atomic dimensions. One Angstrom equals 10^{-10} metres

anhydrous salt a salt that does not have its water of crystallization

anion a negatively charged ion which migrates to the anode (positive electrode) during electrolysis

anisotropic exhibiting different values of a property in different crystallographic directions

annealing process involving heating and cooling, typically used to remove internal stresses or induce softening of e.g. copper or high-carbon steel

annihilation the process of a particle and its corresponding anti-particle (a particle with the same mass but opposite electric charge) combining to produce energy in the form of photons

annotate add brief notes to a diagram or graph

anode where oxidation (the loss of electrons) occurs during an electrochemical process; in an electrolytic cell the anode is the positive electrode

anomalous data data with unexpected values that does not match the relationship predicted by the hypothesis

anomers two stereoisomers that differ only in the configuration about the carbonyl carbon atom

antacids substances, basic in nature, used to reduce the pH of the gastric juice in the stomach with the aim of relieving indigestion

antagonist molecule that blocks the ability of a given chemical to bind to its receptor, preventing a biological response

anthocyanidins common plant pigments, usually red or blue in colour: the sugar-free counterparts of anthocyanins based on the flavylum ion

anthropogenic originating from the activity of humans

antibiotic substance or a semi-synthetic substance derived from a microorganism, usually a bacterium or fungus; and able in dilute solution to inhibit or kill another microorganism, usually a bacterium

antibiotic-resistant bacteria a strain of bacteria with mutations in their plasmids that enable the bacteria to survive carbon monoxide disproportionation (HiPCO) drugs designed to kill them

antibonding orbital a molecular orbital that is higher in energy than the atomic orbitals from which it is formed

anticodon specific sequence of three nucleotides in a transfer RNA molecule, complementary to a codon for an amino acid in a messenger RNA molecule

antioxidant chemicals that prevents damage caused by oxidation that would normally occur during cell metabolism, or storage of foods, preventing the damaging effects of free radicals

antiparallel (DNA) DNA double helix consists of two linear DNA molecules that are opposite in orientation

antipyretic chemical that reduces fever

antiviral drug that acts against viruses

apply use an idea, equation, principle, theory or law in relation to a given problem or issue

aprotic solvent a solvent that is not a hydrogen bond donor

arc discharge a luminous discharge of current that is formed when a large current jumps a gap in a circuit or between two electrodes

arenes hydrocarbons based on benzene rings

aromatic an organic compound that contains a benzene ring

aromatization process by which a compound forms an aromatic ring

Arrhenius constant a constant that appears in the Arrhenius equation in front of the exponential term: a term that relates to the frequency of collisions and their orientation in space

Arrhenius equation an equation that relates the rate constants (k) for a reaction obtained at different absolute temperatures to the activation energy of the reaction; $\ln k = \ln A - \frac{E_a}{RT}$, where E_a and R refer to the activation energy and gas constant, respectively

Arrhenius plot a plot of the natural logarithm of the rate constant (k) (y-axis) against $1/(\text{absolute temperature})$ (x-axis) – a straight line will be obtained with a gradient of $-\frac{E_a}{R}$; the value of the activation energy, E_a , will be in J mol^{-1}

Arrhenius temperature dependence for many reactions (with an activation energy approximately equal to 50 kJ mol^{-1}) a rise in temperature of ten degrees Celsius leads to an approximate doubling of the initial rate

asymmetric carbon atom a carbon atom in a molecule that is attached to four different atoms and/or functional groups

asymmetric synthesis using catalysts or other means to selectively make a single diastereomer or enantiomer when more than one may potentially form

atactic polymer chain in which the stereochemical orientation of the substituents, with respect to each other along the chain, is random

atmosphere total of all the gases surrounding the Earth, extending several hundred kilometres above the surface

atom economy a ratio of the total mass of atoms in the desired product to the total mass of atoms in the reactants

atomic absorption spectroscopy instrumental technique for detecting concentrations of atoms to parts per million (or billion) by measuring the amount of light absorbed by atoms or ions vaporized in a flame or an electrical furnace

atomic force microscope (AFM) instrument able to image surfaces to molecular accuracy by mechanically probing their surface contours

atomic mass unit unit of mass, equal to $1/12$ the mass of the carbon-12 atom and used to express the mass of atoms and molecules

atomic number the number of protons in the nucleus of an atom; in atoms the atomic number is also equal to the number of extra-nuclear electrons

atomic radius one-half the distance between nuclei of atoms of the same element, when the atoms are bound by a single covalent bond or are in a metallic crystal

Aufbau principle a principle of quantum mechanics which states that the order in which the atomic orbitals of atoms are filled with electrons is the order of increasing energy

autacoid a biological substance secreted by various cells whose physiological activity is restricted to the vicinity of its release; it is often referred to as a local hormone

average bond enthalpy enthalpy change per mole when one mole of the same type of covalent bond is broken in the gas phase for many similar molecules

average rate of reaction calculated by dividing the total change in reactant or product concentration by the time for the reaction to end

Avogadro's law at a specified temperature and pressure, equal volumes of (ideal) gases contain equal numbers of moles of particles; there is a directly proportional relationship between the volume of gas, V , and the amount of particles (at constant pressure), n : $V \propto n$

Avogadro constant the number of atoms in exactly 12 grams of carbon-12; it has units of per mol (mol^{-1})

axial overlap overlap of orbitals that occurs directly between the nuclei of atoms – sigma bonds (σ) are formed

B

β -sheet or β -pleated sheet *see* beta sheet

back titration often two consecutive acid–base titrations, performed when an insoluble and slowly reacting reagent is treated with an excess of an acid or base. The excess acid or base is then titrated with base or acid solution of a primary standard (a back titration may involve redox reactions)

background radiation relatively constant low-level radiation from environmental sources such as building materials, cosmic rays, and ingested radionuclides in the body

backward reaction the conversion of products into reactants in an equilibrium

bacterium plural: **bacteria** single-celled organism lacking a nucleus

Balmer series a series of lines in the emission spectrum of visible light emitted by excited hydrogen atoms: the lines correspond to the electrons falling down into the second lowest energy level, emitting visible light

band energy gap for semiconductors and insulators, the energies that lie between the valence and conduction bands

band theory theory of the electrical properties of metals, semiconductors and insulators based on energy bands

bar unit of pressure. $1 \text{ bar} = 10^5 \text{ Pascals} = 1.01325 \text{ atmospheres}$

barbiturate group of drugs derived from barbituric acid that is used to sedate, to control convulsions, or to induce sleep

base in the Brønsted–Lowry theory a base is a proton acceptor; a Lewis base is an electron pair donor

base (DNA or RNA) one of the nitrogen-containing compounds that occurs attached to the sugar component of DNA or RNA

base dissociation constant the equilibrium constant for the reaction in which base reacts with water to produce the conjugate acid and hydroxide ions; a measure of the extent to which weak bases accept hydrogen ions in solution

base pair two nucleotides in nucleic acid chains that are paired together by intermolecular hydrogen bonding between the bases

basic oxide an ionic oxide, usually an oxide of a metal, that reacts with acids to form a salt and water; some basic oxides react with water to form alkaline or basic solutions

basic oxygen converter vessel in which scrap steel and a small amount of limestone are dissolved in molten iron and pure oxygen is then blown into the molten mixture to remove impurities

battery a group of voltaic cells connected together in series or in parallel

BCS theory theory developed to explain the properties of type 1 superconductors by John Bardeen, Leon Cooper,

and Robert Schrieffer. Key elements of the theory are Cooper pairs of electrons

Beer–Lambert law absorbance, A , of a given wavelength of light by a solution of a substance is proportional to the concentration of a substance (provided the solution is dilute): $A = \epsilon cl$, where c is the concentration of the substance, l is the path length for the radiation through the solution and ϵ is the absorption coefficient; if ϵ is in $\text{dm}^3\text{mol}^{-1}\text{cm}^{-1}$ (molar absorption coefficient) and l is in cm then c will be in mol dm^{-3}

Benedict's test test for a reducing sugar: blue copper(II) ions are converted to a red-brown precipitate of copper(I) oxide

beta particle fast-moving electron emitted by radioactive nucleus which travels a few metres in air or can pass through several millimetres of aluminium; formed when a proton inside a nucleus changes to form a neutron and a fast-moving electron

beta sheet extended, zigzag arrangement of a protein chain; a common secondary structure held together by intramolecular hydrogen bonding

bias a factor of sampling of the variables from an investigation when the conclusions obtained from the investigation do not accurately describe the characteristics of the whole population, i.e. the differences between the sample and the whole population are not just due to random chance

bimolecular involving the collision between two reactant species in an elementary step in a reaction

binding energy the binding energy is the energy released when a nucleus is formed from its constituent nucleons. The binding energy of a nucleus is the work required to completely separate the nucleons of the nucleus

binding energy per nucleon the binding energy per nucleon for an atomic nucleus equals the binding energy for the nucleus divided by the number of nucleons. It is a measure of the stability of a nucleus; the larger the binding energy per nucleon, the greater is the stability of the nucleus

bioaccumulation refers to the accumulation of substances such as chemicals or toxic substances in an organism that occurs when its absorption rate is greater than the rate at which the substance is lost

bioavailability refers to the fraction of drug that is available in the blood supply following administration

biochemical oxygen demand (BOD) amount of oxygen taken up by bacteria that decompose organic waste in water, calculated by keeping a sample of water containing a known amount of oxygen for five days at 20°C and then measuring the oxygen content; a high BOD value indicates the presence of a large number of bacteria, which suggests a high level of pollution

biodiesel diesel-equivalent fuel produced from renewable, biological sources through the combination of vegetable oils or animal fats with an alcohol and catalyst to form ethyl or methyl ester

biofuels non-petroleum based renewable fuel, such as ethanol or biodiesel, derived from biomass

bioinformatics the collection, organization and analysis of large amounts of biological data using networks of computers and databases (usually with reference to the genome project and DNA sequence information)

biological pigments a coloured substance produced in a tissue

biomagnification the progressive build-up of persistent substances by successive trophic levels

biomass a renewable energy source consisting of non-fossil biological material

biopolymer any polymeric material synthesized by a living organism

bioremediation the use of biological agents, such as bacteria or plants, to remove or neutralize contaminants, as in polluted soil or water

biuret reagent a method for detecting proteins in serum or solution. In alkaline solution, copper sulfate ions react with the peptide bonds of proteins to produce a pink to purple colour, called the biuret reaction. The amount of serum protein in a sample solution is estimated by comparing its colour with that of a standard solution whose protein concentration is known

blast furnace tall furnace allowing continuous production of iron from iron oxide using carbon monoxide as the reducing agent (similar furnaces are used for the extraction of zinc)

blood–brain barrier a network of blood vessels with closely spaced cells that makes it difficult for potentially toxic substances (such as anticancer drugs) to penetrate the blood vessel walls and enter the brain

blunt ends end of a DNA fragment produced by a restriction enzyme which cuts both strands of DNA at the same point, leaving no single-stranded sections

body-centred cubic a common crystal structure that contains atoms located at the corners of a cubic cell and one atom at the cell centre position

body mass index (bmi) a measure of body fat that is the ratio of the weight of the body in kilograms to the square of its height in metres

Bohr's theory a model of the atom that explains emission and absorption of radiation as transitions between states in which the electron orbits the nucleus at a definite distance

boiling the change of a liquid into a gas at constant temperature; occurs when the vapour pressure of the liquid is equal to the external pressure exerted on the liquid – it is characterized by the appearance of bubbles of vapour throughout the liquid which break through the surface of the liquid

boiling point the temperature at which a liquid is converted to a gas at the same temperature; a liquid boils when the vapour pressure of the liquid equals the surrounding pressure

boiling point composition diagram diagram showing the relationship between vapour pressure and composition

bomb calorimeter device used to measure energy changes (at constant volume) that occur when substances, for example, alcohols or hydrocarbons, are burnt in excess oxygen in a sealed container

bond angle an angle formed by the location of three atoms or two covalent bonds in space, used to describe the shapes of molecules; the angle ABC where atoms A and C are bonded to atom B

bond enthalpy the amount of energy (in kilojoules) required to break one mole of a particular covalent bond in the gaseous state into gaseous atoms (under standard thermodynamic conditions): a measure of the strength of the bond

bond order in a Lewis structure, the number of pairs of electrons in a bond; in molecular orbital theory, one-half the difference between the number of bonding electrons and the number of antibonding electrons.

bonding orbital a molecular orbital that is lower in energy than the atomic orbitals from which it is formed

Born–Haber cycle an enthalpy cycle based upon experimental data commonly used to calculate the lattice enthalpies of ionic solids; it is a series of reactions (and the accompanying enthalpy changes) which, when summed, represents the hypothetical one-step reaction in which elements in their standard states are converted into crystals of an ionic compound (and the accompanying enthalpy change) under standard thermodynamic conditions

boron neutron capture therapy a treatment for cancers, especially virulent ones of the brain, in which a person who has been injected with a boron compound that concentrates in cancerous cells is exposed to neutron irradiation causing the boron compound to emit alpha particles that destroy the cancer cells

bottom-up approach building larger nano-based objects from atoms or molecules

Boyle's law the product of pressure and volume (for a fixed mass of ideal gas at constant temperature) is a constant

brachytherapy a type of radiation treatment in which the radioactive substance is placed inside the patient as close as possible to the area being treated

Bragg's law a relationship that stipulates the condition for diffraction by a set of crystallographic planes

Bragg peak the point at which protons (and other heavily charged particles) deposit most of their energy. This point occurs at the ends of the protons' paths

branched-chain hydrocarbon a hydrocarbon which has alkyl groups bonded to its longest unbranched chain

breathalyser a breath analysis device, which shows the estimate blood alcohol content in the body based on the chemical analysis of a breath sample

broad-spectrum antibiotic antibiotic that is effective against a wide range of strains of bacteria

Brønsted–Lowry theory a theory of acidity that describes an acid as a proton or hydrogen ion donor, and a base as a proton or hydrogen ion acceptor

buffer solution an aqueous solution consisting of a weak base and its conjugate acid, which resists a change in pH when small amounts of either hydroxide ions (from a base) or hydrogen ions (from an acid) are added; buffers typically consist of a weak acid and its corresponding salt (an acidic buffer) or a weak base and its corresponding salt (a basic buffer)

buffering capacity the ability of a buffer to absorb hydrogen ions or hydroxide ions without a significant change in pH

burner reactors a new type of nuclear reactor that accepts recycled nuclear fuel and consumes more transuranic elements (chemical elements with atomic numbers greater than 92, the atomic number of uranium) than it creates, while generating electricity

C

C terminus amino acid residue at one end of a polypeptide chain that contains a free carboxyl group

calculate find a numerical answer showing the relevant stages in the working (unless instructed not to do so)

calibration curve a general method for determining the concentration of a compound in an unknown sample by comparing the unknown to a series of standard samples of known concentrations.

calorie notionally the energy required to raise the temperature of 1 g of water by 1 °C; a calorie is approximately equivalent to 4.2 joules

calorific value amount of heat released by a unit mass of a substance, for example a food, (or a unit volume of a gas) being burnt

calorimeter a piece of apparatus (insulated) for measuring the energy released or absorbed during a chemical reaction; in an open vessel at constant pressure, the heat change equates to the enthalpy change (ΔH)

cap-and-trade a regulation mechanism that sets an overall limit on the emission of a certain pollutant, but allows companies that can easily reduce emissions to sell credits to other companies for which such reduction would be difficult. The cap ensures that emissions will not exceed a specific level

capsid a protein coat that surrounds and encloses the nucleic acid (DNA or RNA) of a virus

capsomere protein-based subunit of a viral capsid

caramelization type of non-enzymatic browning which involves the high-temperature decomposition of sugars, forming brown pigment and releasing volatile products

carbocation an organic ion with a positive charge on an electron-deficient carbon atom

carbon cycle the combined processes, including photosynthesis, decomposition, and respiration, by which carbon as a component of various compounds cycles between its major reservoirs the atmosphere, oceans, and living organisms

carbon footprint the total emissions resulting from a particular person, group, activity or event, expressed as equivalent tonnes of carbon dioxide

carbon monoxide disproportionation (HiPCO) is the disproportionation of carbon monoxide into carbon dioxide and graphite. It is a process used in the production of carbon nanotubes

carbon sink the removal and storage of carbon from the atmosphere in carbon sinks (such as oceans, forests or soils) through physical or biological processes, such as photosynthesis

carbon taxation a charge on fossil fuels (coal, oil, natural gas) based on their carbon content

carboxoamide amides of carboxylic acids, having the structure $RC(=O)NR_2$

carboxylic acids a homologous series of organic compounds with the general formula $RCOOH$

carotenoid pigments found in plants, including algae and bacteria; composed of conjugated molecules containing carbon and hydrogen and sometimes oxygen

carrier gas inert gas used to carry the sample in gas chromatography

catabolism generally, process of breakdown of complex molecules into simpler ones, often providing biologically available energy

catalysis a reaction process accelerated by the presence of a substance (a catalyst) which is neither consumed nor produced during the overall reaction

catalyst a substance which, when present in relatively small amounts, increases the rate of a chemical reaction but which is not consumed during the overall process – the function of a catalyst is to provide a new reaction pathway with a lower activation energy

catalyst poison a substance that prevents the activity of a catalyst

catalyst selectivity relative activity of a catalyst in reference to a particular compound in a mixture; the relative rate of a single reactant in competing reactions

catalytic converter part of the exhaust system of a modern car running on unleaded petrol, consisting of a platinum/rhodium catalyst in a honeycomb structure which converts carbon monoxide, nitrogen monoxide and unburnt hydrocarbons into carbon dioxide, nitrogen and dinitrogen oxide

catalytic cracking cracking carried out in the presence of a heated catalyst, for example, aluminium oxide (alumina) or silicon dioxide (silica)

catenation the spontaneous linking of atoms of certain chemical elements, such as carbon atoms, to make stable rings or long chains

cathode where reduction (the gain of electrons) occurs during an electrochemical process; in an electrolytic cell the cathode is the negative electrode

cation a positively charged ion attracted to the cathode during electrolysis; metals form cations via loss of one or more electrons

cation-exchange capacity the capacity of a soil to exchange cations with the soil solution, often used as a measure of potential soil fertility; generally expressed in milliequivalents per 100g of soil

cell the smallest unit of life consisting of a cell surface membrane enclosing the cytoplasm and DNA

cell diagram a shorthand form of summarizing the electrodes and electrolytes present in a voltaic cell, which traces the path of the electrons; the reduced form of the metal to be oxidized at the anode is written first, followed by its oxidized form, then the oxidized form of the metal to be reduced at the cathode, and finally the reduced form of the metal at the cathode; the salt bridge is indicated by || and the phase boundaries between the electrodes and their ions by |

cell potential the potential difference between the two half-cells (in their standard states) of an electrochemical cell

cellular respiration cellular process by which glucose (and other substances) are broken down, in the presence of enzymes, to release useful energy for other cellular processes

cellulose an indigestible polysaccharide for humans; an unbranched polymer of glucose residues joined by beta-1,4 linkages. The β -configuration allows cellulose to form very long straight chains

cement Portland cement is a mixture of calcium silicates and aluminates made by heating limestone ($CaCO_3$) with clay (containing aluminosilicates) in a kiln. The product is ground to a fine powder. When mixed with water it settles in a few hours and then hardens over a longer period of time due to the formation of hydrated aluminates and silicates

central dogma genetic information flows from DNA to RNA to protein

centrifuge centrifugation is sedimentation of particles under the influence of the centrifugal force and it is used for separation of superfine suspensions

ceramic materials made of non-metallic minerals that have permanently hardened by heating to a high temperature

chain (addition) polymerization chain reaction in which the growth of a polymer chain proceeds exclusively by reaction(s) between monomer(s) and reactive site(s) on the polymer chain, with regeneration of the reactive site(s) at each growth step

chain reaction a reaction intermediate generated in one step reacts in such a way that this intermediate is regenerated

change of state the inter-conversion of a substance between the solid, liquid and gaseous states

charge carrier a free and mobile conduction electron or hole in a semiconductor

charging (battery) process of supplying electrical energy for conversion to stored chemical energy

Charles' law the volume of a fixed mass (at constant pressure) of an ideal gas is directly proportional to absolute temperature

chelating agent a ligand that forms chelates

chelation the formation or presence of bonds (or other attractive interactions) between two or more separate binding sites within the same ligand and a single central atom

chelation therapy a medical procedure that involves the administration of chelating agents to remove heavy metals from the body

chemical environment number and types of atoms a particular atom within a molecule is bonded to

chemical equilibrium when the rate of the forward reaction is equal to the rate of the backward reaction and consequently there are no changes in the concentrations of reactants and products

chemical feedstock raw materials required for an industrial process

chemical kinetics the branch of physical chemistry concerned with the mechanisms and rates of chemical reactions

chemical library large collection of stored chemicals usually used in screening for drug leads

chemical property a property of a substance that is observed during a reaction in which the chemical composition of the substance is changed, for example, reactivity with oxygen

chemical shift position (in ppm) of a resonance in the NMR spectrum relative to a standard such as TMS (tetramethylsilane); an atomic property that varies depending on the chemical and magnetic properties of an atom and its arrangement within a molecule

chemical vapour deposition (CVD) this high temperature coating process involves the deposition of a solid material onto a heated substrate via a chemical reaction from a gas phase. This process can be done in atmosphere or vacuum

chemical weathering breakdown of rock material brought about by the action of chemicals, usually in aqueous solution

chemisorption binding of a liquid or gas on the surface or in the interior of a solid by chemical bonds or forces

chemotherapy use of chemical agents in the treatment or control of disease, particularly cancer, or mental illness

chiral a molecule that has a non-superimposable mirror image

chiral auxiliary a chiral compound that is covalently attached to the substrate as a controlling element in a diastereoselective reaction and is subsequently cleaved from the product

chlor-alkali industry the industrial electrolysis of brine which results in the production of sodium hydroxide and chlorine

chlorofluorocarbons (CFCs) group of compounds in which some or all of the hydrogen atoms of an alkane have been replaced (substituted) by chlorine and fluorine atoms

chlorophyll green pigment found in plants involved in absorbing light for photosynthesis; a magnesium-based porphyrin

chromatogram record obtained from chromatography

chromatography technique for analysing or separating mixtures of gases, liquids or dissolved substances based upon differential solubility in two phases

chromophore a group of atoms responsible for absorbing electromagnetic radiation; they usually have delocalized pi electrons

cis a term used to describe isomers of 1,2-disubstituted alkenes with functional groups or atoms which are on the same side of the molecule as each other

cis-trans isomerism a form of stereoisomerism that describes the orientation of functional groups at the ends of a bond around which no rotation is possible

cis-trans isomers if alkenes have two different substituents at each end of the C=C then they can exist as stereoisomers (as *cis-trans* isomers). This is because there is restricted rotation of the double bond due to the pi bond which means they don't readily interconvert. *Cis-trans* isomerism can also occur in aliphatic ring compounds

classify to arrange or order by class or category

clock reaction when a mixture of reacting chemical compounds involved in a redox reaction shows a sudden colour change

closed system a system where the amount of matter is fixed but heat can flow in or out, or the volume can be altered; a prerequisite for the establishment of an equilibrium

coal a solid fuel consisting mostly of carbon which originated in prehistoric forests which have decomposed forming solid carbon mixed with various hydrocarbons and other substances

coal gas a fuel consisting of a mixture of carbon monoxide and hydrogen gas, produced by the reaction of coal with steam

coal gasification a process in which the gaseous fuels, carbon monoxide and hydrogen, can be produced by the reaction of coal with steam

coal liquefaction a process in which liquid fuels can be produced from solid coal. There are two main approaches: (i) reducing the coal with hydrogen, converting the carbon to hydrocarbons; (ii) distilling the coal to extract existing liquid hydrocarbons trapped within the solid coal

co-enzyme organic co-factor required for the action of certain enzymes; often contains a vitamin as a component

codon sequence of three adjacent nucleotides in a nucleic acid that codes for a specific amino acid

coefficients the numbers that appear to the left of chemical formulas in a balanced equation

co-factor a substance other than a protein that is required for a protein's biological activity

coke solid material left behind when volatile components in coal have been removed by heating; it contains a high percentage of carbon and is used as a reducing agent and fuel

colligative property a physical property that depends on the number of solute species present, but not on their chemical identity

collision theory a simple model to account for the variation in the rate of reaction with temperature, surface area and concentration; it considers particles to be hard spheres that react with each other when they collide with sufficient kinetic energy

colloid system in which there are two or more phases, with one (the dispersed phase) distributed in the other (the continuous phase)

colorimeter an instrument used to measure the intensity of colour in a solution

column chromatography form of chromatography that uses a column or tube to hold the stationary phase

combinatorial chemistry automated, parallel synthesis of a library of chemical structures, usually drug leads

combined gas law the gas law that combines absolute temperature, pressure and volume, but not the amount of gas

$$\frac{PV}{T} = \text{constant}; \quad \frac{P_1 \times V_1}{T_1} = \frac{P_2 \times V_2}{T_2},$$

where P represents the pressure of the gas, V represents the volume and T represents the absolute temperature

combustion a highly exothermic and rapid chemical reaction in which a substance reacts with oxygen during burning

comment give a judgment based on a given statement or result of a calculation

common ion effect suppression of the solubility of a weak electrolyte by the presence, in the same solution, of a strong electrolyte containing an ion in common with the weak electrolyte

compare give an account of similarities and differences between two (or more) items, referring to both (all) of them throughout

compare and contrast give an account of similarities and differences between two (or more) items or situations, referring to both (all) of them throughout

competitive inhibitor generally competes with the substrate for the enzyme's active site: the percentage of competitive inhibition at fixed inhibitor concentration can be decreased by increasing the substrate concentration; at high concentrations of the substrate it is possible to reach V_{max} even in the presence of the inhibitor; however, the value of K_m is decreased

complementary base pairing length of single-stranded DNA whose sequence base pairs with another length of single-stranded DNA

complementary colour one of two coloured lights so related to each other that when blended together they produce white light; so-called because each colour makes up in the other what it lacks to make it white

complex ion a transition metal ion, surrounded by a fixed number of ligands which form dative (or coordinate) covalent bonds with vacant orbitals in the metal ion

composite a material formed by combining materials differing in composition or form obtaining specific characteristics and properties. The constituents keep their identity such that they can be physically identified and they exhibit an interface between one another

compound a substance formed by the chemical combination of two or more chemical elements in fixed proportions

computed tomography scan (CAT) a diagnostic imaging procedure that uses a combination of X-rays and computer technology to produce horizontal, or axial, images (often called slices) of the body

concentrated a solution with a relatively high concentration of solute

concentration the ratio of the amount (in moles) of a substance dissolved in a given volume of solution; expressed in mol dm^{-3}

condensation the change of a gas to a liquid at constant temperature

condensation polymer a type of polymer made by a process that involves the elimination of small molecules, usually water

condensation reaction an addition reaction immediately followed by an elimination reaction

condensed to form a solid or liquid from a gas at constant temperature

condensed structural formula a formula in which the single bonds between the atoms are not shown with lines

conducting polymer polymer having high conductivity, approaching that of metals

conductimetric (or conductometric) titration titration in which the end point is determined by measuring the resistance of the solution to an electric current

conduction band energy band in a solid in which electrons are freely mobile and can produce a net electric current

configurational isomer stereoisomers that can be interconverted only by the breaking and reforming of a covalent bond

conformational isomers the spatial arrangement of atoms in a molecule that can be adjusted or changed by rotations about sigma bonds

conformational selection is a process involved in protein folding in which one protein (a chaperone, for example) binds to a protein chain and shifts the conformation towards a stable, functional state

conformations a conformation is one of the very large numbers of possible spatial arrangements of atoms that can be interconverted by rotation about a single bond in a molecule

conjugate acid the chemical species formed when a proton or hydrogen ion is accepted by a base

conjugate base the chemical species formed when an acid loses a proton or hydrogen ion

conjugate pair two chemical species related to each other by the loss or gain of a single proton or hydrogen ion

conjugated molecules with double or triple bonds that are separated by one single bond: there is delocalization of electrons in the pi (π) orbitals between the carbon atoms linked by the single bond

construct represent or develop in graphical form

Contact process sulfur dioxide and air are passed over a heated vanadium(v) oxide catalyst to produce sulfur trioxide which is then dissolved in sulfuric acid to form disulfuric acid (oleum) which is diluted to produce concentrated sulfuric acid

continuous spectrum an emission spectrum that exhibits all the wavelengths or frequencies of visible light

control group a group of patients in a clinical trial who are given another drug, a placebo or no treatment at all, to compare with the group receiving the drug under trial

control rod long steel or aluminium rods filled with a substance which has a high absorptive power for neutrons, for example, boron. They can be raised or lowered into holes drilled into the moderator of a nuclear power plant to control the rate of the nuclear reaction

convergence the lines in an emission spectrum become progressively closer to each other (at higher frequency or smaller wavelength) and finally merge

cooling curve a plot of temperature against time for a substance where heat energy is being lost to the surroundings. It can be used to identify changes of state, for example, melting and boiling

Cooper pairs two electrons in a material that couple together as a result of interacting with the lattice. Main cause of superconductivity in BCS theory

cooperative binding a situation in which the binding of one ligand to a macromolecule favours the binding of another

coordinate bond a covalent bond in which one of the atoms supplies both of the electrons of the shared pair

coordination number the number of ligands surrounding a central metal ion

coordination polymerization a form of addition polymerization in which a monomer adds to a growing polymer chain through an organometallic active centre

copolymer a material created by polymerizing a mixture of two (or more) starting compounds

corrosion the process by which a metal undergoes oxidation by air and water

coulomb the SI unit of electrical charge: one coulomb of charge is passed around a circuit when a current of one ampere is allowed to flow for one second

Coulomb's law the force between two charged particles is directly proportional to the product of their charges and inversely proportional to the square of the distance between them

covalent bond the sharing of one or more pairs of electrons between two atoms

cracking process of breaking down long-chain alkanes into smaller alkanes and alkenes using heat, usually in the presence of a catalyst

critical current maximum current through a material that allows it to remain in the superconducting state

critical mass the smallest mass of a fissionable material that will sustain a nuclear chain reaction at a constant level

critical temperature (T_c) maximum temperature at which a material is superconducting

critical temperature (gases) the temperature of the liquid-vapour critical point, that is, the temperature above which a gas cannot be liquefied by an increase of pressure

cross links covalent bonds between adjacent chains in a polymer

cross-tolerance tolerance to a drug that generalizes to drugs that are chemically related or that produce similar effects

crude oil mixture of hydrocarbons formed originally from marine animals, found beneath the ground trapped between layers of sedimentary rock; it is obtained by drilling

crystal field theory theory of bonding in transition metal complexes in which ligands and metal ions are treated as point charges; a purely ionic mode

crystalline polymer polymer in which sections of adjacent chains are packed in a regular array

crystallinity for polymers, the state where a periodic and repeating atomic arrangement is achieved by molecular chain alignment

curly arrow used to show the notional movement of a pair of electrons in a reaction mechanism; the tail of the arrow shows where the electrons come from and the head where they go to

current the rate of flow of electric charge or electrons through a conductor, measured in coulombs per second or amperes

cyclic molecules having atoms arranged in a ring or closed-chain structure

cyclization formation of a cyclic compound from an open-chain compound

cytochrome class of iron-containing proteins important in cell respiration as catalysts of oxidation–reduction reactions

D

d-block metal metals located between groups 2 and 3 of the periodic table where the d-shell is being filled across the period

d–d splitting a splitting of the d orbitals of the transition metal ion in a complex ion, caused by the ligands

d–d transition an electronic transition between two levels of d orbitals; the energy separation usually corresponds to that of visible light and for this reason, such transitions are responsible for the colours of many transition metal ions

Dalton's law of partial pressures the total pressure of a mixture of ideal gases exerts is the sum of the partial pressures of all the component gases

Daniell cell a voltaic cell consisting of a copper cathode immersed in 1 mol dm⁻³ copper(II) sulfate solution and a zinc anode immersed in 1 mol dm⁻³ zinc sulfate solution; it has a standard cell potential of 1.10 V

dative covalent bond see coordinate bond

daughter nucleus the daughter nucleus refers to the nucleus that was formed during a radioactive decay process

de Broglie's relationship de Broglie's equation is used to describe the wave properties of matter, specifically, the wave nature of the electron: $\lambda = \frac{h}{p}$, where λ represents the wavelength, h represents Planck's constant, m represents the mass of a particle, moving at a velocity v and p represents the momentum of the particle

decay constant the constant ratio for the number of atoms of a radionuclide that decay in a given period of time compared with the total number of atoms of the same kind present at the beginning of that period

decomposition the formation of new substances from a single substance upon heating

deduce reach a conclusion from the information given

define give the precise meaning of a word, phrase or physical quantity

degeneracy (atomic energy levels) when two or more orbitals have the same potential energy

degeneracy (in DNA) ability of codons to code for more than one amino acid; this property of the genetic code makes it more fault-tolerant for mutations

degenerate a group of orbitals with the same energy

delocalized molecules or ions that have p orbitals extending over three or more atoms have delocalized π electrons; metallic bonding involves the delocalization of valence electrons between all the ions within a crystal

demonstrate make clear by reasoning or evidence, illustrating with examples or practical application

denaturation (protein) partial or complete unfolding of a protein chain (or nucleic acid); the process is usually reversible and is brought about by heat and a variety of chemicals, for example, urea and organic solvents

dependence a compulsive urge to take a drug for physical or psychological reasons

dependent variable the variable that is measured during an investigation

deposition the formation of a solid from a gas at constant temperature

depressant drug used medicinally to relieve anxiety, irritability and tension

derive manipulate a mathematical relationship(s) to give a new equation or relationship

desalination removal of dissolved salts from an aqueous solution

describe give a detailed account

design produce a plan, simulation or model

designer drug drug with properties and effects similar to a known hallucinogen or narcotic but having a slightly altered chemical structure, created in order to evade restrictions against illegal substances

desolvation the removal of surrounding water from molecules before they can interact with another; for example a drug with its binding site. Energy is required to break the intermolecular forces involved

desorption the opposite of adsorption, i.e. a decrease in the amount of adsorbed substance

determine find the only possible answer

dextrorotatory rotates the plane of plane-polarized light clockwise, in the (+) direction

diamagnetic a diamagnetic compound has all of its electron spins paired giving a net spin of zero. Diamagnetic compounds are weakly repelled by a magnet. Diamagnetism is a form of magnetism which is exhibited by a substance in the presence of an externally applied magnetic field

diamagnetic effect weak repulsion by a strong magnetic field

diaphragm cell industrial electrolytic cell in which a porous diaphragm is used to separate the electrodes thereby allowing electrolysis of sodium chloride solution, without allowing the products to react

diastereomers one of a set of stereoisomers that are not enantiomers

diatomic a molecule containing two atoms of the same element covalently bonded together

dietary fibre the indigestible carbohydrates (mainly cellulose) found in fruit, vegetables, grain and nuts

dilute a solution containing a relatively low concentration of solute

dimer a molecule formed by the bonding of two identical monomers: the bonds will be relatively strong hydrogen bonds or covalent bonds

diode electronic device that allows current to flow in one direction only; often used to rectify current (convert ac to dc)

dioxin a general term that describes a group of hundreds of chemicals that are highly persistent in the environment. The most toxic compound is 2,3,7,8-tetrachlorodibenzo-*p*-dioxin or TCDD

dipeptide a peptide that is composed of two amino acid molecules linked by a peptide bond

dipole a pair of separated opposite electrical charges located on a pair of atoms within a molecule

dipole moment product of the charge at one end of a dipole and the distance between the charges: the larger the dipole moment of a molecule, the greater the polarity of the bond; dipole moments are measured in units called debyes (D)

dipole-dipole forces weak intermolecular forces caused by electrostatic interactions between permanent dipole moments that exist in polar molecules

diprotic an acid which contains two replaceable hydrogen atoms per molecule (also known as dibasic)

directing effect the ability of substituent functional groups to direct further substitution to certain positions on the benzene ring during the electrophilic substitution of benzene derivatives

disaccharide carbohydrate consisting of two covalently joined monosaccharide units

discharge the conversion of ions to atoms or molecules during electrolysis

discharge tube a device in which a gas or metal vapour inside sealed glass is used to conduct current when voltage is applied

disconnection a mental process in which a target molecule is dissected into two fragments (synthons) that can generate the molecule by known reactions

discuss offer a considered and balanced review that includes a range of arguments, factors or hypotheses. Opinions or conclusions should be presented clearly and supported by appropriate evidence

disproportionation the simultaneous oxidation and reduction of atoms of a single chemical element to produce two products: the element undergoing disproportionation must have a minimum of three stable oxidation states and be in an intermediate oxidation state

distinguish give the differences between two or more different items

disulfide bridge (or linkage) covalent bond ($-S-S-$) formed (in the presence of an enzyme) between two adjacent polypeptide chains by the reaction between sulfhydryl groups ($-SH$) of two cysteine residues

diuretic substance that leads to an increase in the discharge of urine

DNA profiling distinctive pattern of fragments of DNA obtained by restriction enzyme digestion and electrophoretic separation of repeated DNA segments from individual people

dopant element introduced into a semiconductor to establish either p-type (acceptors) or n-type (donors) conductivity

doping incorporation of impurities within the crystal lattice of silicon so as to increase its conductivity

double helix coiled structure of double-stranded DNA in which strands linked by hydrogen bonds form a spiral or helical configuration, with the two strands oriented in opposite directions

double-blind study study of the effects of a drug where both the researcher and the participants are not aware of which treatment each participant is receiving

downfield low-field or higher frequency or higher delta ppm value area of the NMR spectrum

draw represent by means of a labelled, accurate diagram or graph, using a pencil. A ruler (straight edge) should be used for straight lines. Diagrams should be drawn to scale. Graphs should have points correctly plotted (if appropriate) and joined in a straight line or smooth curve

drug chemical intended to affect the structure or any function of the body of humans or other animals

drug candidate chemical compound that has potential to be developed into a therapeutic drug; not all drug candidates become products

drug metabolism the reactions undergone by a drug when it is in the body. Most metabolic reactions are catalysed by enzymes, especially in the liver

drug target gene or protein that plays a role in a disease process and is the intended site of drug activity

ductile the ability of metals to be drawn out under tension and stretched into wires

dynamic equilibrium an equilibrium is described as dynamic because although there is no change in macroscopic properties the forward and backward reactions are occurring (at equal rates)

dyspepsia (indigestion) a condition characterized by upper abdominal symptoms that may include pain or discomfort, bloating, feeling of fullness with very little intake of food, feeling of unusual fullness following meals, nausea, loss of appetite, heartburn, regurgitation of food or acid, and belching

E

effective nuclear charge the nuclear charge exerted on a particular electron, equal to the actual nuclear charge minus the effect of nuclear shielding

effusion a method by which gaseous substances can be separated according to their molecular masses. A mixture of gases is placed in a vessel. Molecules pass through a small hole in this vessel; the rate at which they pass through the hole is related to their mass. Heavier molecules pass through the hole at a lower rate, so the gas mixture is separated

elastomer a polymeric material that may experience large and reversible elastic deformations

electrochemical series an arrangement of elements and ions (which can undergo redox reactions) arranged in order of their standard reduction potentials, with the most negative (that is, most reducing) at the top of the series

electrode a conductor which dips into the electrolyte of an electrolytic or voltaic cell and allows the current (electrons) to flow to and from the electrodes; electrodes may be inert, functioning only to transfer electrons, or may be active and be involved in the cell reactions

electrode potential the potential formed between a metal and an aqueous solution of its ions or between ions of the same element in different oxidation states

electrolysis a process in which chemical decomposition of an ionic substance, known as the electrolyte, is caused by the passage of an electric current; the conduction in the electrolyte occurs via migration of ions: no free electrons are transferred between the electrodes through the electrolyte

electrolyte the solution or molten liquid in an electrolytic cell or voltaic cell: an ionic compound (a salt, alkali or acid) that will conduct electricity during electrolysis when it is melted or, if soluble, dissolved in water

electromagnetic spectrum entire range of electromagnetic radiation or waves including, in order of decreasing frequency, cosmic-ray photons, gamma rays, X-rays, ultraviolet radiation, visible light, infrared radiation, microwaves and radio waves

electromagnetic wave a wave of oscillating electric and magnetic fields that can move through space; they are transverse in nature and all travel through a vacuum at a speed of $3 \times 10^8 \text{ ms}^{-1}$

electromotive force (of a cell) the energy per unit charge that is converted reversibly from chemical energy into electrical energy; the SI unit of electromotive force (EMF) is the volt

electron negatively charged sub-atomic particle present in all atoms and located in shells, or energy levels, outside the nucleus

electron affinity the energy released by the addition of one mole of electrons to one mole of gaseous atoms (under standard thermodynamic conditions) to form one mole of gaseous uninegative ions

electron arrangement the distribution of electrons among the available shells

electron density the probability of finding an electron or pair of electrons in a particular region or volume of an atom or molecule

electron domain refers to the number of lone pair or bond locations around a particular atom in a molecule

electron in the box model the particle in a box is an elementary problem in quantum mechanics which displays how boundary conditions that a wave function must satisfy lead to the quantization of energy. The system consists of a particle mass m in a one-dimensional region of space of length L : the potential is zero for $0 \leq x \leq L$ and infinite elsewhere

electron shells the main energy levels of an atom where the electrons are located

electron transport chain a series of electron carriers that transfer high-energy electrons along a redox chain, driving ATP synthesis in the process

electron volt the amount of kinetic energy gained by an electron when accelerated through an electric potential difference of 1 Volt; equivalent to 1.603×10^{-19} J; a unit of energy or work

electronegativity a measure of the tendency of an atom in a molecule to attract a pair of shared electrons towards itself; electronegativity values increase from left to right across the periodic table and decrease down a group

electrophile a molecule or cation that can act as an electron pair acceptor (lone pair or π pair) or Lewis acid in a reaction with an organic molecule

electrophilic addition addition reaction initiated by the rate-determining attack of an electrophile on the π electrons of the carbon-carbon double bond

electrophilic substitution reaction involving the substitution of an atom or group of atoms in benzene (or derivative) with an electrophile as the attacking species

electrophoresis movement of charged ions in response to an electrical field, often used to separate mixtures of ions, proteins, or nucleic acids

electroplating the coating of a metal with a thin layer of another metal by electrolysis

electrorefining an electrochemical process that produces a purified metal from a less pure metal. The metal to be purified is made into the anode in an electrolytic cell

and it is dissolved by the application of a current into a usually acidic aqueous electrolyte or a molten salt. At the same time, the pure metal is deposited on the cathode

electrostatic precipitation removal of very fine particles suspended in a gas by electrostatic charging and subsequent precipitation onto a collector in a strong electric field

element a pure substance that cannot be decomposed or broken down into simpler substances by chemical methods

elementary steps many reactions occur in a series of steps each of which involves one or two reacting particles (atoms, ions or molecules)

elimination a reaction in which atoms or small molecules are removed from a single molecule, usually to give a double bond, or between two molecules

Ellingham diagrams diagrams that explain how standard free energies of formation of metal oxides vary with temperature; they allow prediction of the conditions required for metal extraction from oxide ores

elution process of removing an adsorbed material (the adsorbate) from an adsorbent by washing it with a liquid (the eluent): the solution consisting of the adsorbate dissolved in the eluent is the eluate

embodied energy the energy used during the entire life cycle of a product, including its manufacture, transportation, and disposal, as well as the inherent energy captured within the product itself

emission spectroscopy study of emission spectra produced by excited substances (often gaseous atoms or molecules)

empirical formula a formula for a compound which shows the simplest whole number ratio of atoms present

emulsifier substance that enables the mixing of two insoluble liquids

emulsion system consisting of two immiscible liquids, one of which is dispersed in the other in the form of small droplets

enantiomer a chiral compound whose molecular structure is not superimposable on its mirror image

enantiomerically pure opposite of racemic, the compound contains only a single enantiomer

end-point where the indicator changes colour suddenly during a titration: at this stage the acidic and basic forms of the indicator are present in equal concentrations (see equivalence point)

endocrine gland gland producing a hormone that passes directly into the bloodstream

endothermic reaction a reaction in which heat energy is absorbed from the surroundings; there is a fall in temperature when the reaction occurs or heat energy has to be continually supplied to make the reaction occur

energy density the amount of energy stored in a given system or region of space per unit volume

energy efficiency the amount of energy extracted from a system divided by the amount of energy put into the system in order to recover the energy

enrichment the physical process of increasing the proportion of isotope uranium-235 to uranium-238 to make the mixture more usable as nuclear fuel

enthalpy the difference in the enthalpy between the reactants and products can be measured as heat (at constant pressure); it has no absolute values – only enthalpy changes can be measured

enthalpy change of atomization the enthalpy change when one mole of gaseous atoms is formed under standard thermodynamic conditions (with no change in pressure)

enthalpy change of fusion the enthalpy change when one mole of a solid melts to a liquid at its melting point

enthalpy change of hydration the enthalpy change when one mole of aqueous ions is formed from separate ions in the gas phase under standard thermodynamic conditions

enthalpy change of neutralization the enthalpy change when one mole of acid undergoes complete neutralization with a base to form one mole of water under standard thermodynamic conditions:

$$\text{H}^+(\text{aq}) + \text{OH}^-(\text{aq}) \rightarrow \text{H}_2\text{O}(\text{l})$$

enthalpy change of solution the enthalpy change when one mole of a substance is dissolved in a solvent to infinite dilution (in practice, to form a dilute solution) under standard thermodynamic conditions

enthalpy change of sublimation the sum of the enthalpies of fusion and vaporization at the same temperature

enthalpy change of vaporization the enthalpy change when one mole of a pure liquid is vaporized at its boiling point

enthalpy level diagram a diagram that traces the changes in the enthalpy or potential energy of a chemical system during the course of a reaction

entropy a thermodynamic function that measures how energy is distributed or dispersed among particles (sometimes crudely called disorder or randomness)

entropy change the change in entropy that accompanies a physical or chemical change is given by the sum of the entropies of the products minus the sum of the entropies of the reactants

enzyme a globular protein that acts on a specific substrate molecule and catalyses a specific biochemical reaction

epimers are diastereoisomers that have the opposite configuration at only one of two or more chiral centres present in the respective molecular entities

equation of state see combined gas law

equilibrium see chemical equilibrium

equilibrium constant the value obtained when equilibrium concentrations of the chemical species are substituted in the equilibrium expression – the value indicates the equilibrium position

equilibrium expression the expression obtained by multiplying the product concentrations and dividing by the multiplied reactant concentrations, with each concentration raised to the power of the coefficient in the balanced equation (pure solids and pure liquids

are not included in equilibrium expressions involving aqueous solutions)

equilibrium law in any reversible reaction at a state of equilibrium, the rate of the forward reaction equals the rate of the reverse reaction

equilibrium position a particular set of equilibrium concentrations of reactants and products

equivalence point the point in an acid–base titration where the acid and base have been added in stoichiometric amounts, so that neither is present in excess; if a suitable indicator is chosen it will correspond to the end-point

essential amino acids amino acids that are required by animals but that they cannot synthesize and which must be obtained from the diet

essential fatty acids fatty acids that cannot be synthesized by humans and must be obtained from the diet

esterification the reaction between a carboxylic acid and alcohol to form an ester and water, catalysed by concentrated sulfuric acid

esters organic compounds formed by the condensation reaction between alcohols and acids; esters formed from carboxylic acids have the general formula RCOOR'

estimate find an approximate value for an unknown quantity

eutrophication the process by which lake or pond water becomes rich in mineral and organic nutrients that promote a proliferation of plant life, especially algae, which reduces the dissolved oxygen content and often causes the extinction of other organisms

evaluate make an appraisal by weighing up the strengths and limitations

evaporation occurs at the surface of a liquid and involves the liquid changing into a gas at a temperature below the boiling point of the liquid

examine consider an argument or concept in a way that uncovers the assumptions and interrelationships of the issue

excess a reactant is in excess when, after the reaction is complete, some of it remains unreacted, i.e. it is present in a molar ratio that exceeds the value implied by the stoichiometric equation

excitation energy minimum energy required to change a system from its ground state to a particular excited state

exothermic reaction a reaction in which heat energy is released to the surroundings from the reactants: the bonds of the products contain less enthalpy than the bonds of the reactants

experimental yield the quantity of a product that is obtained from a chemical reaction (see theoretical yield)

explain give a detailed account of causes, reasons or mechanisms

explore undertake a systematic process of discovery

exponential factor the expression in the Arrhenius equation

external beam therapy a type of therapeutic radiation treatment that is delivered externally from a machine directed to the cancer inside the patient

extrapolation to estimate (a value of a variable outside a known range) from values within a known range by assuming that the estimated value follows logically from the known values

F

face-centred cubic an arrangement of atoms in crystals in which the atomic centres are disposed in space in such a way that one atom is located at each of the corners of the cube and one at the centre of each face

Faraday constant the quantity of electric charge (in coulombs) transferred by one mole of electrons; it has the (approximate) value of $96\,500\text{ C mol}^{-1}$

Faraday's first law of electrolysis the amount of a chemical product formed during electrolysis is directly proportional to the quantity of electricity passed

Faraday's second law of electrolysis the amount of chemical product formed (for a constant quantity of electricity) is proportional to the relative atomic mass of the ion and its charge

Fahrenheit scale the temperature scale in which 212°F is the boiling point of water and 32°F is the freezing point of water

fast tracking a method of pushing a drug through clinical trials and the regulatory process as quickly as possible

fatty acid a group of long monobasic acids, found in animal and vegetable fats and oils, having the general formula $\text{C}_n\text{H}_{2n+1}\text{COOH}$ and containing an even number of carbon atoms

Fenton reaction the iron-salt-dependent decomposition of hydrogen peroxide, generating the highly reactive hydroxyl radical (possibly via an oxoiron(IV) intermediate)

ferromagnetism permanent and large magnetizations found in iron, nickel and cobalt, which result from the parallel alignments of neighbouring magnetic moments

fibrous protein insoluble protein that serves in a protective or structural role

fingerprint region region of the infrared spectrum of a substance between 910 and 1430 cm^{-1} where the pattern of peaks is characteristic of that compound, even though all the peaks might not all have been assigned to specific vibrations of the molecule

first ionization energy the energy required to remove one mole of electrons from one mole of isolated gaseous atoms to form one mole of gaseous unipositive ions under standard thermodynamic conditions

first-order reaction a reaction in which the initial rate of reaction is directly proportional to the concentration of only one reactant

Fischer projection means of depicting the absolute configuration of chiral molecules on a flat page which employs a cross to represent the chiral centre: the horizontal arms of the cross represents bonds coming out of the plane of the page, and the vertical arms of the cross represent bonds going back into the plane of the page

fissile (material) a substance whose nuclides are capable of sustaining a fission chain reaction (because sufficient neutrons with low enough energy to be captured by, and fission other nuclei, are produced upon fission). Fissile materials are a subset of fissionable materials

fission product the atoms (fission fragments) formed by the fission of heavy elements such as uranium

fissionable (material) a substance containing nuclei that are capable of undergoing nuclear fission

five prime end (5') the end of a DNA or RNA strand with a free $5'$ -phosphate group

fluid mosaic model a model of a membrane in which a variety of proteins interact with a tightly packed bilayer of phospholipid molecules

fluidized bed combustion crushed coal and limestone are suspended in the bottom of a boiler by an upward stream of hot air; as the coal burns, sulfur dioxide gas from the coal combines with limestone to form solid calcium sulfate that is recovered with the ash

fly ash finely divided particles of ash present in flue gases resulting from the combustion of a fossil fuel

foam dispersion of a gas in a liquid or solid

focussed electron beam induced processing (FEBIP) a process of decomposing gaseous molecules by electron beam leading to deposition of non-volatile fragments onto a nearby substrate

Foods and Drug Administration (FDA) the drugs regulatory authority for the USA

formal charge the charge an atom in a Lewis structure would have if the bonding electrons were shared equally

formula units the symbols used in equations to represent elements and compounds with giant structures

formulate express precisely and systematically the relevant concept(s) or argument(s). It can also refer to the construction of a chemical equation or equilibrium expression

forward reaction the conversion of the reactant into products in an equilibrium reaction

fossil fuel formed from the remains of living organisms and all have a high carbon or hydrogen content

fraction mixture of liquids with similar boiling points collected by fractional distillation

fractional distillation a mixture of liquids is separated into its components by successive vaporizations and condensations in a vertical fractionating column

fractionating column a column packed with inert beads in which many separate distillations can occur so that a liquid mixture can be separated into its components

free radical a species with one or more unpaired electrons, often produced by photolysis

freeze drying the process of drying a material by first freezing it and then encouraging the ice within it to sublime

freezing the change of a liquid into a solid at constant temperature

freezing point the temperature at which a liquid turns to a solid at the same temperature

frequency the number of waves produced every second by the source, measured in units of hertz (Hz) or s^{-1} (per second) and given the symbol F or ν (nu)

Friedel–Crafts reaction method for substituting an alkyl or acyl group into a benzene ring and forming a C–C bond, involving the reaction between benzene (or other aromatic compound) with a halogenoalkane or acyl chloride in the presence of a so-called halogen carrier (for example, anhydrous aluminium chloride); it proceeds via electrophilic substitution

fuel cell device which converts chemical energy directly into electrical energy: a gaseous fuel, usually hydrogen or a hydrocarbon, and oxygen are passed over porous electrodes where combustion occurs; this is accompanied by the production of an electric current

fuel rod nuclear fuel rods are the source of nuclear energy in a nuclear reactor. Pellets of nuclear fuel (fissile materials) are placed inside protective metal tubes. They are loaded individually into the core of the reactor

full structural formula a formula showing the relative positioning of all the atoms in a molecule and the bonds between them

fullerenes cage-like molecules composed of fused rings of carbon atoms arranged into pentagons and hexagons

functional group an atom or group of atoms (other than hydrogen) that imparts specific physical and chemical properties to a homologous series of organic compounds

functional group interconversion the chemical conversion of a functional group into another functional group

fusion a nuclear reaction in which light nuclei combine to form more massive nuclei with the simultaneous release of energy. To overcome the electrostatic forces of repulsion between two nuclei that fuse together, very high temperatures and pressures are required to produce energy by fusion

G

galvanization the coating of another metal with zinc

gamma camera a device used in nuclear medicine to scan patients who have been injected with small amounts of radioactive materials

gamma decay a radioactive process in which an excited atomic nucleus loses energy by emitting a gamma ray without a change in its atomic or mass numbers

gamma knife a type of radiosurgery that uses gamma rays to treat brain cancer

gamma rays electromagnetic radiation of very short wavelength which can penetrate several metres of concrete; released as a result of energy changes within the nuclei of atoms

gas a state of matter in which there are small attractive forces operating between the particles; the individual particles move at high velocity in straight lines (until they collide with each other or the walls of the container)

gas constant the constant that appears in the ideal gas equation, defined as $R = \frac{PV}{T}$ for one mole of ideal gas; it has the value of $8.314 \text{ J mol}^{-1} \text{ K}^{-1}$

gas–liquid chromatography (GLC) form of partition or adsorption chromatography in which the mobile phase is a gas and the stationary phase a liquid; solid and liquid samples are vaporized before being introduced to the column

gateway drug habit-forming substance whose use may lead to the abuse of drugs that are more addictive or more dangerous

gel electrophoresis a technique for separating protein molecules of varying sizes in a mixture by moving them through a block of gel (of agarose or polyacrylamide) by means of an electric field, with smaller molecules moving faster, and therefore further, than larger ones. The technique can also be applied to the separation of DNA fragments

gene segment of a DNA molecule that contains the genetic code for a single protein molecule

genetically modified (GM) food foods derived from genetically modified organisms which have had specific changes introduced into their DNA by genetic engineering

genetically modified organism an organism whose genetic characteristics have been altered by the insertion of a modified gene or a gene from another organism using the techniques of genetic engineering

genetic code the set of sixty-four codons corresponding to each of the 20 amino acids

genome all the genetic material present in a virus, bacterium or nucleus of a cell

giant covalent lattice a regular arrangement, usually three-dimensional, of covalently bonded atoms that extends throughout the substance

giant structure a lattice, usually three-dimensional, of ions or atoms in which the bonding (ionic, covalent or metallic) extends throughout the substance

Gibbs equation $\Delta G = \Delta H - T\Delta S$ where ΔH equals the change in enthalpy, T equals the absolute temperature, and ΔS equals the change in entropy

Gibbs free energy change of formation, ΔG_f the Gibbs free energy of formation of the species from its elements (in their standard states under standard thermodynamic conditions) expressed as Gibbs free energy per mole of the species

Gibbs free energy change, ΔG a thermodynamic function equal to the enthalpy change minus the product of the entropy change and the absolute temperature: a negative sign indicates that the reaction is spontaneous under standard thermodynamic conditions; the energy available to do work (at constant pressure)

glass a hard, transparent material composed of metal silicates that does not have a crystalline structure and is regarded as supercooled liquid

global warming increase in the average temperature of the Earth's atmosphere since the Industrial Revolution, believed to be a consequence of rising levels of greenhouse gases, especially carbon dioxide

global warming potential (GWP) the total contribution to global warming resulting from the emission of one unit of a gas relative to one unit of the reference gas, carbon dioxide, which is assigned a value of 1

globular protein soluble protein with a globular or rounded shape

glycogen a very large, branched polymer of glucose residues, where the main chain is joined together by alpha-1,4-glycosidic bonds, whereas the side chains are joined together by alpha-1,6-glycosidic bonds

glycolysis an ATP-generating metabolic process that occurs in nearly all living cells, in which glucose is converted in a series of enzyme-controlled steps to pyruvic acid, without the presence of oxygen; it occurs in the cytoplasm of cells

glycosidic bond (linkage) covalent bond, C–O–C, formed between two reacting sugar molecules; or the bond between the sugar and base in a nucleotide, in the presence of enzymes

Graham's law a law describing the relationship of the mass of gas molecules and their effusion rate

$$\frac{\text{rate}_1}{\text{rate}_2} = \sqrt{\frac{\text{mass}_2}{\text{mass}_1}}, \text{ where rate}_1 \text{ and rate}_2 \text{ refer to the rates}$$

of effusion of two gases (measured in moles per unit time) and mass_1 and mass_2 are their formula masses. The equation can also be expressed in terms of the densities of the gases, density_1 and density_2

grain orderly arrangement of metal atoms in a crystal structure

graphene a single atom thick planar sheet of graphite (in isolation)

gravimetric analysis a method of quantitative analysis for finding the composition and formulas of compounds based on accurate weighing of reactants and products

green chemistry the design of chemical products and processes that reduce or eliminate the use and generation of hazardous substances

greenhouse effect heating effect occurring in the atmosphere because of the presence of greenhouse gases that absorb infrared radiation

greenhouse gases gases that contribute to the greenhouse effect and global warming by absorbing infrared energy emitted or reflected from the surface of the Earth

Grignard reagent alkyl- or aryl- magnesium halide; important in the synthesis of carbon–carbon bonds

ground state the lowest possible energy state of an atom or molecule

group a column of the periodic table which contains elements with similar chemical properties: atoms of elements in the same group have the same number of electrons in their outer or valence shell

H

Haber process the industrial manufacture of ammonia from nitrogen and hydrogen, carried out at high pressure (~350 atm) and moderate temperature (~350 °C) in the presence of an iron catalyst

Haber-Weiss reaction the reaction of superoxide ($\text{O}_2^{\bullet-}$) with hydrogen peroxide to produce molecular oxygen (O_2), hydroxide radical (OH), and OH^- ; often, iron-catalyzed; a source of oxidative stress in blood cells and various tissues

half-cell an electrode in contact with an aqueous solution of ions: two half-cells can be connected to make a voltaic cell

half-equation the two parts of a redox reaction, one describing the oxidation and the other reduction

half-life (drug) the time taken for the plasma concentration of a drug to fall by half

half-life (in a chemical reaction) the time taken for the concentration of a reactant to reach a value which is the mean or average of its initial and final values

half-life (of a radionuclide) The time for half the atoms in a radioactive substance to undergo radioactive decay.

The longer the half-life, the more slowly it decays

halide a compound of one of the halogens, group 7

halide ions the halide ions are fluoride (F^-), chloride (Cl^-), bromide (Br^-) and iodide (I^-); the halides are salts that contain a metal ion combined with the halide ions

hallucinogens drugs that induce alterations in perception, thinking and feeling

halogen carrier electron-deficient metal halide (in its anhydrous form) that acts as a Lewis acid during electrophilic substitution

halogenation any reaction in which a halogen atom (and no other elements) is introduced into a molecule

halogenoalkanes a homologous series of organic compounds in which one (or more) of the hydrogen atoms of an alkane have been substituted or replaced by halogen atoms

halogens a group of reactive non-metals in group 7 of the periodic table, composed of diatomic molecules

hardening (of oils) process of converting unsaturated oils into more solid saturated fats by hydrogenation using a nickel catalyst

Haworth projection a structural representation of a cyclic carbohydrate. The ring is drawn as if planar, and the substituents point straight up or down

heat the form of energy transferred between two objects due to a temperature difference between them; the origin of heat energy is the movement of atoms, ions and molecules, that is, their kinetic energy

heat capacity the amount of heat energy required to raise the temperature of a substance by one Kelvin (or one degree Celsius)

heat engine a device that converts heat energy into work

heavy metal toxic metals, such as cadmium, mercury and lead, which have relatively high relative atomic masses; they often function as enzyme inhibitors

heavy water water in which the hydrogen isotope deuterium $^2\text{H}_2\text{O}$ is present, rather than the more common hydrogen-1 isotope that makes up most of the hydrogen in normal water

heavy-water reactor a nuclear reactor in which heavy water serves as a moderator and sometimes also as a coolant

Heisenberg's uncertainty principle a principle of quantum mechanics which states that it is not possible to determine the position and momentum of a particle at the same instant: the act of observing the particle will in some way affect its behaviour

Helicobacter pylori a bacterium that can survive in the stomach and cause damage to the stomach lining, leading to ulcers

heme an iron atom complexed in the centre of an organic ring called a porphyrin

Henderson–Hasselbach equation the equation derived from the expression for K_a , that enables the calculation of the pH of a buffer:

$$\text{pH} = \text{p}K_a + \log_{10} \frac{[\text{A}^-(\text{aq})]}{[\text{HA}(\text{aq})]}$$

(it is assumed in a calculation that all of the anion, $\text{A}^-(\text{aq})$, is derived from the salt and none from the acid)

Henry's law the amount of a gas that dissolves in a liquid is proportional to the partial pressure of the gas over the liquid, provided no chemical reaction takes place between the liquid and the gas

hertz (Hz) a unit of frequency equal to one cycle per second or s^{-1}

Hess's law the total enthalpy change for a reaction is independent of the route taken – it depends only on the initial and final states

heterogeneous a combination of substances that does not have a uniform composition and properties; a mixture of physically distinct substances with different properties

heterogeneous catalysis when the catalyst and the reactants are in different phases (or states)

heterogeneous equilibrium where the reactants and products are in more than one phase

heterolytic fission the cleavage of a covalent bond so that one of the atoms or groups separates with both bonding electrons and becomes negatively charged, leaving the other atom or group positively charged

hexose a monosaccharide with six carbon atoms

high-density lipoprotein (HDL) smallest and densest lipoproteins, which contain a high proportion of protein; because HDL can remove cholesterol from the arteries, and transport it back to the liver for excretion, it is seen as 'good cholesterol'

high-level nuclear waste high-level radioactive wastes are the highly radioactive materials produced as a by-product of the reactions that occur inside nuclear reactors, for example, spent nuclear fuel rods

high-performance liquid chromatography (HPLC) technique in which the sample is forced through the

chromatography column under pressure; the mobile phase is a liquid and the stationary phase is a solid

high-resolution NMR NMR performed in the presence of a strong and stable magnetic field so that spin–spin coupling can be observed

high spin complex a metal–ligand complex with the same number of unpaired electrons as the uncomplexed metal ion. When a weak ligand complexes the metal ion, the crystal field splitting is small and the electrons can still occupy all of the d orbitals without pairing

high temperature superconductors ceramic materials that superconduct with a T_c of 30 K or greater

histones a type of basic protein that forms the unit around which DNA is coiled in the nucleosomes of eukaryotic chromosomes

hole (electron) for semiconductors and insulators, an empty electron state in the valence band that behaves as a positive charge carrier in an electric field

homogenous having uniform properties or composition

homogeneous catalysis when the catalyst and the reactants are in the same phase (or physical state)

homogeneous equilibrium where the reactants and products are in the same phase

homologous series a group of organic compounds that follow a regular structural pattern and have the same general molecular formula, differing only by the addition of methylene, $-\text{CH}_2-$, groups; the members will have almost identical chemical and physical properties, for example, boiling point and viscosity, that increase gradually

homolytic fission the breaking of a covalent bond so that one electron from the bond is left on each fragment, resulting in the formation of two free radicals

homopolymer polymer that is constructed from only one monomer

hormone a molecule that is secreted directly into the bloodstream of an organism through a ductless gland and acts as a chemical messenger, carrying information from one cell or group of cells to another area

host–guest chemistry a branch of chemistry in which a larger and structurally concave organic molecule (the host) selectively binds to a smaller molecule or ion (the guest). This may mimic a biological effect, or prevent a biological interaction

humus part of the soil which consists of complex organic matter and is derived from the decayed remains of plants and animals

Hund's rule the electronic configuration in orbitals of the same energy will have the maximum number of unpaired electrons; electrons with parallel spins are lower in energy than a corresponding pair with opposed spins

hybridization the mixing of two or more atomic orbitals to form the equivalent number of hybrid molecular orbitals (all of identical shape and energy) which overlap and form covalent bonds

hydrated ion ions dissolve in water and attract the polar molecules of water, becoming associated with a variable

or definite number of water molecules via electrostatic attraction or coordinate bonding

hydrated salt a salt associated with a definite number of molecules of water

hydration a reaction where an unsaturated molecule adds a molecule of water, or where water molecules interact with ions in aqueous solution

hydrocarbon an organic compound containing only hydrogen and carbon atoms

hydrochlorofluorocarbons (HCFCs) compounds containing carbon, hydrogen, chlorine and fluorine; they have a lower ozone-depleting potential than CFCs because the hydrogen makes them less stable and therefore less damaging to the ozone layer

hydrocracking process by which the hydrocarbon molecules of crude oil or petroleum are broken into simpler molecules, by the addition of hydrogen under high pressure and in the presence of a catalyst

hydrofluorocarbons (HFCs) compounds containing carbon, hydrogen and fluorine which, because they contain no chlorine atoms, do not directly affect stratospheric ozone; however, they are efficient absorbers of infrared radiation

hydrogen bond an unusually strong intermolecular interaction that occurs among molecules possessing permanent dipole moments, for example, O–H, N–H and H–F

hydrogenation the addition of hydrogen across a multiple bond, often performed in the presence of a heated transition metal catalyst

hydrolysis a chemical reaction involving water as a reactant

hydrolytic rancidity hydrolytic cleavage of triglycerides in fats and oils to yield free fatty acids – associated with off flavours in dairy products

hydrophilic used to describe molecules or functional groups that are soluble in water

hydrophobic used to describe molecules or functional groups that are poorly soluble or insoluble in water

hypervalent the ability of an atom in a molecule or ion to expand its valence shell beyond the limits of the octet rule

I

ideal gas a hypothetical state that consists of molecules or atoms that occupy negligible space and have no attractive or repulsive forces operating between them, or between themselves and the walls of the container; all collisions between the molecules or atoms are perfectly elastic; the behaviour of an ideal gas is exactly described by the ideal gas equation

ideal gas equation an equation relating the absolute temperature (T), pressure (P), volume (V) and amount (n) of an ideal gas; $PV = nRT$

ideal solution all molecules in an ideal solution interact in exactly the same way; the solvent-solvent, solvent-solute,

and solute-solute intermolecular forces are all equivalent. Ideal solutions obey Raoult's law exactly. Real solutions behave ideally only when they are very dilute

identify find an answer from a given number of possibilities

incineration the process of burning solid waste under controlled conditions to reduce its weight and volume, and often to produce energy

independent variable the variable that is manipulated or changed during an investigation

index of hydrogen deficiency a basis for the comparison of the molecular formula of a given compound to that of an acyclic alkane which has the same number of carbon atoms (since the latter has the maximum number of hydrogens per carbon possible C_nH_{2n+2}); can be used to determine possible structural formulas from a molecular formula

individual order of reaction the power to which the concentration of a particular species is raised in the rate expression: if $\text{rate} = k[A]^a[B]^b$, then a and b are the individual orders with respect to the reactants; the individual orders indicate how the rate will change when the concentration of that species is changed

induced fit model model of an enzyme–substrate reaction that causes a conformational change in the active site of the enzyme which allows the substrate to fit perfectly

inductive effect effect of a functional group or atom in an organic molecule which attracts sigma electrons towards itself, or repels them, resulting in the formation of a dipole in the molecule

inductively coupled plasma (ICP) the high temperature source used to generate ions in ICP-MS

inductively coupled plasma optical emission spectroscopy (ICP-OES) the technique is based upon the spontaneous emission of photons from atoms and ions that have been excited in an radio frequency discharge

inert electrode an electrode that serves only as a source or sink for electrons without playing a chemical role in the electrode reaction (though it may act as a catalyst)

infrared spectroscopy absorption spectroscopy carried out in the infrared region of the electromagnetic spectrum, generally detecting bond stretching and bending

inhibitor a substance that decreases the rate of a chemical reaction

inhibition decreasing the rate of a chemical reaction

initial rate the rate of a chemical reaction extrapolated back to the instant the reactants were mixed

initial rates method method of finding the rate-law expression by carrying out a reaction with different initial concentrations and analysing the resultant changes in initial rates

initiation the first elementary step in a free radical reaction; it involves the homolytic cleavage of a bond, typically by ultraviolet radiation or high temperature, to generate free radicals

- instantaneous rate of reaction** the rate of a reaction at a particular point in time; evaluated from the slope of a plot of concentration versus time
- integration trace** area under an NMR resonance peak, which is proportional to the number of hydrogens which that resonance peak represents; experimentally, the integrals will appear as a line over the NMR spectrum
- inter-nuclear axis** the imaginary axis that passes through the two nuclei in a bond
- intercalated** the term intercalation denotes a process in which a molecule or an ion (guest) is placed into a host lattice. The structure of the host remains unchanged or is only slightly altered in the guest–host complex that is in the intercalation compound (intercalate)
- intercalation** incorporation of a foreign atom in a crystal lattice (usually in the spaces between atoms)
- intermediate** a chemical species that is neither an initial reactant nor a final product but is formed and consumed during the overall chemical reaction; intermediates never appear in a rate expression
- internal resistance** resistance offered by the chemical constituents of a cell or a battery
- internal salts** the formation of an internal salt (or zwitterion) occurs when a proton is transferred from the acidic carboxylic acid functional group to the basic amine group
- interpolation** estimating a value between two known values, frequently on a graph
- interpret** use knowledge and understanding to recognize trends and draw conclusions from given information
- intoximeter** a device that uses a fuel cell or infrared spectroscopy to determine blood alcohol content
- intravenously** administering a drug directly into a vein by injection
- iodine number** mass of iodine in grams which 100 grams of a fat or oil can absorb; it is directly related to the amount of unsaturated fatty acids present in the fat or oil
- ion** a charged particle formed by the loss or gain of electrons from a single atom (simple or monatomic ion), or a group of atoms (polyatomic ion) (see cation and anion)
- ion exchange** exchange of ions of the same charge between an aqueous solution and a solid in contact with it
- ion-exchange chromatography** form of chromatography in which ions are retained by oppositely charged groups covalently bonded to a solid support; the analyte ions are retained by displacing ions associated with the bonded functional group
- ionic bonding** a strong electrostatic force of attraction between all the oppositely charged ions arranged into a lattice
- ionic liquid** any salt that has a relatively low melting point; they are used as solvents where water or traditional organic solvents cannot be used
- ionic product constant, K_w (of water)** the product of the concentrations of hydrogen and hydroxide ions in water under standard thermodynamic conditions
- ionic radius** the radius of an ion in the crystalline form of a compound, which varies periodically: the ionic radius increases down a group and generally decreases from left to right across a period
- ionization energy** the enthalpy change when an electron is removed from an atom or ion in the gaseous state, under standard conditions
- isoelectric focusing** electrophoresis in which the protein mixture is subjected to an electric field in a gel medium in which a pH gradient has been established; each protein then migrates until it reaches the site at which the pH is equal to its isoelectric point
- isoelectric point (of an amino acid) (pI)** pH at which an amino acid in solution has no overall electrical charge; at this pH the amino acid does not move when placed in an electric field
- isoelectronic species** two chemical species which have the same number of total electrons or the same number of electrons in the valence shell
- isomerization** chemical process carried out in a refinery that involves a rearrangement of atoms and bonds within a molecule, without changing the molecular formula
- isotactic** polymer chain in which the substituents are all stereochemically oriented on the same side of the chain
- isotopes** two or more atoms of the same element with different numbers of neutrons (and therefore different mass numbers)
- ## J
- justify** give valid reasons or evidence to support an answer or conclusion
- ## K
- Kekulé structure** a localized description of the structure of benzene in which there is a six-membered ring with alternate double and single bonds
- Kelvin scale** a thermodynamic or an absolute temperature scale starting from absolute zero (-273°C), the lowest temperature possible, using units of kelvin (K) with the same magnitude as degrees Celsius
- ketones** a homologous series of compounds with the general formula RCOR' , having two alkyl or aryl groups bonded to a carbonyl group
- ketose** simple sugar that has a ketone as its carbonyl group (in its acyclic (straight chain) form)
- Kevlar** an amide polymer synthesized by the copolymerization of benzene-1,4-diamine and terephthaloyl dichloride
- kinetic theory** explains the physical properties of solids, liquids and gases in terms of the movement of particles (atoms, ions or molecules): the theory also accounts for the changes that occur during a change in state
- knocking** the pre-ignition of the fuel–air mixture before the spark in an internal combustion engine leads to a characteristic knocking sound. This is more common when the fuel–air mixture is ‘lean’ i.e. having a greater proportion of air
- kwashiorkor** form of malnutrition involving an inadequate intake of protein

L

label add labels to a diagram

lactose intolerant unable to digest lactose (milk sugar) due to a deficiency of lactase, an enzyme for the metabolism of lactose

lanthanoids a series of fourteen elements in the periodic table, generally considered to range in proton number from cerium to lutetium inclusive

Larmor frequency resonance frequency of a spin in a magnetic field; the frequency which will cause a transition between the two spin energy levels of a nucleus

lattice a regular, repeating three-dimensional arrangement of atoms, molecules or ions within a crystal

lattice enthalpy the energy released when one mole of a solid ionic compound is decomposed to form gaseous ions (infinitely far apart) under standard thermodynamic conditions

law of conservation of mass mass is not lost or gained during a chemical reaction – the total mass of the reactants equals the total mass of the products

laxative a medication used to produce bowel movements

Le Châtelier's principle if a constraint is imposed on a system at equilibrium, the system will shift in the direction which tends to partially counteract the change; used to predict which way a reaction will shift if the conditions are changed

lead discovery the process of identifying active new chemical entities, which by subsequent modification may be transformed into a clinically useful drug

lead-acid cell a series of secondary (rechargeable) cells in which the anode is lead, the cathode is lead coated with lead(IV) oxide and the electrolyte is moderately concentrated sulfuric acid

least count the smallest division that is marked on an instrument

leaving group an atom or group of atoms which breaks away from a molecule during a substitution or an elimination reaction

lethal dose (50%) dose of a toxicant that will kill 50% of the test organisms within a designated period: the lower the LD₅₀, the more toxic the compound

levorotatory rotates the plane of plane-polarized light anticlockwise, in the (–) direction

Lewis (electron dot diagram) structure a diagram of a molecule showing how the valence electrons are arranged among the atoms in the molecule

Lewis acid a chemical species that can accept an electron pair to form a dative or coordinate covalent bond

Lewis base a chemical species that can donate an electron pair to form a dative or coordinate covalent bond

ligand a molecule or negative ion that donates a pair (or pairs) of electrons to a central metal ion to form a dative or coordinate covalent bond

ligand field splitting removal of a degeneracy of atomic levels in an ion, induced by the bonding or removal of ligands

ligand replacement one or more ligands in a complex ion are replaced, often reversibly, by another

ligand (field) splitting energy ligands complexed to a metal ion will raise the energy of some of its d orbitals and lower the energy of others; the difference in energy is called the ligand field splitting energy

lignite sometimes called 'brown coal'. A fuel consisting of about 24–35% carbon, in which the biological molecules have been to polymerize forming a substance called lignin

limit of convergence the short wavelength limit of a set of spectral lines that obey a Rydberg series formula; equivalently, to the e long-wavelength limit of the continuous spectrum corresponding to ionization

limiting reactant the reactant that is completely consumed, or used up, when a reaction goes to completion; the limiting reagent determines the yield of the reaction

line of best fit the straight or curved line which gives the best approximation to a given set of data

line spectrum an emission spectrum that has only certain wavelengths or frequencies of visible light (it takes the form of a series of bright lines on a black background)

linear combination of atomic orbitals an approximation which sums atomic orbitals (with certain coefficients) to produce molecular bonding and anti-bonding orbitals

lipase an enzyme that catalyzes the reaction of triacylglycerol and water to yield diacylglycerol and a fatty acid

lipids group of organic compounds that contain carbon, hydrogen and oxygen; includes fats, oils, waxes, sterols, and triglycerides, which are insoluble in water but soluble in non-polar organic solvents, for example, ethanol (alcohol)

lipophilic compounds that are fatty and non-polar in character

lipophilicity represents the affinity of a molecule or a moiety for a lipophilic environment. It is commonly measured by its distribution behaviour, e.g. partition coefficient in octan-1-ol/water

lipoproteins group of proteins in which at least one of the components is a lipid; lipoproteins, classified according to their densities and chemical qualities, are the means by which lipids are transported in the blood

liquid a state of matter in which particles are loosely attracted by intermolecular forces; a liquid always takes up the shape of the walls of its container and its particles are not arranged into a lattice

liquid crystal substance that flows like a liquid but has some order in its arrangement of molecules

list give a sequence of names or other brief answers with no explanation

literature value a value from the chemical literature of a physical constant or experimental measurement

lithium-ion cell a secondary (rechargeable) cell in which lithium ions are intercalated in a graphite lattice. The cell reaction involves the migration of lithium ions out

of the graphite electrode while their electrons enter the external circuit

lobe a rounded region of electron density projecting away from the nucleus

lock and key hypothesis or model a model for the mechanism of enzyme activity postulating that the three-dimensional shapes of the substrate and the enzyme are such that they fit together as a key fits into a specific lock

London dispersion forces are the underlying interactions between all atoms and molecules; they are the sole interactions between noble gas atoms and between non-polar molecules – believed to occur when the electrons within a molecule induce a temporary dipole in an adjacent atom or molecule

lone pair a lone or non-bonding pair of electrons is a pair of outer or valence shell electrons (that have opposing spins) which are not used to form covalent bonds within the molecule

loss of biodiversity a term describing the variety of life present in a particular ecosystem. ‘Loss of biodiversity’ usually describes the way in which human impact on the ecosystem affects the natural interdependence of species, leading to many organisms being displaced or dying out

low-density lipoprotein (LDL) a lipoprotein that carries cholesterol around the body, for use by cells; transports cholesterol to the arteries and increased levels are associated with atherosclerosis, and thus heart attacks and strokes, hence cholesterol inside LDL is called ‘bad cholesterol’

low-level nuclear waste a general term for a wide range of items that have become contaminated with radioactive material or have become radioactive through exposure to neutron radiation, for example, hospital waste and clothing of nuclear power plant workers

low-resolution NMR NMR performed in an inhomogeneous magnetic field, where spin–spin coupling cannot be observed

low spin complex a metal–ligand complex with fewer unpaired electrons than the uncomplexed metal ion. When a strong ligand complexes the metal ion, the crystal field splitting is large and some electrons pair rather than occupying the higher energy d orbitals

Lyman series emission spectral lines that are caused by the transition of electrons to the ground state of hydrogen; these spectral lines appear at ultraviolet wavelengths

lyotropic liquid crystal liquid crystal prepared by mixing two or more components, one of which is polar in character

lysis the process where a cell loses its contents due to the weakening of a cell wall or cell membrane

lysozyme an enzyme capable of destroying the cell walls of bacteria and thereby acting as a mild antiseptic

M

macrocyclic a cyclic macromolecule

macronutrients nutrients that the body uses in relatively large amounts – proteins, carbohydrates and fats

macroscopic properties properties of substances in bulk that can be observed or easily measured

magnetic confinement a method of controlling plasmas and fusion reactions using magnetic fields

magnetic resonance imaging use of a nuclear magnetic resonance spectrometer to produce electronic images of specific atoms and molecular structures in solids, especially human cells, tissues, and organs

Maillard reaction a form of non-enzymatic browning between an amino acid and a reducing sugar, usually requiring the addition of heat – the reactive carbonyl group of the sugar interacts with the nucleophilic amino group of the amino acid

malleable the ability of metals to be bent and beaten into thin sheets without breaking

marasmus form of malnutrition that involves an insufficient intake of energy (calories)

Markovnikov’s rule rule that predicts the major and minor products when a hydrogen halide adds across the double bond in an unsymmetrical alkene: it states that the major product will be the one in which the hydrogen atom attaches itself to the carbon atom with the larger number of hydrogen atoms

mass defect the difference in mass between a nucleus and the combined masses of its neutrons and protons

mass–energy equivalence the physical principle that a measured quantity of energy is equivalent to a measured quantity of mass. The equivalence is expressed by Einstein’s equation, $E = mc^2$, where E represents energy, m represents the equivalent mass, and c represents the speed of light

mass number the sum of the number of protons and neutrons in the nucleus of the atom or ion

mass spectrometer an instrument (maintained under a hard vacuum) in which gaseous atoms or molecules are fragmented and ionized and then accelerated into a magnetic field where the ions are separated according to their mass-to-charge ratio

matter any substance that has mass

Maxwell–Boltzmann distribution curve describes the distribution of velocities or kinetic energies among the atoms or molecules of an ideal gas

measure find a value for a quantity

mechanism a description in terms of bond breaking, bond making and intermediate formation that occurs during the series of elementary steps by which an overall chemical reaction occurs; also describes the movement of electrons

medicine substance intended for use in the diagnosis, cure, mitigation, treatment or prevention of disease

Meissner effect the effect by which a weak magnetic field decays rapidly to zero in the interior of a superconductor

melanin pigment responsible for the brown hue of eyes, skin and hair

melting the change of a solid into liquid at constant temperature

melting point the temperature at which a solid is converted to a liquid at the same temperature

- meniscus** the curved upper surface of a liquid in a container that is concave if the liquid wets the container walls and convex if it does not
- mercury cell** electrolytic cell with a flowing mercury cathode used in the industrial production of chlorine from concentrated sodium chloride solution
- messenger RNA** class of RNA molecules, each of which is complementary (in base pairs) to one strand of DNA; carries the genetic message from the nuclear DNA to the ribosomes
- metabolic pathway** a sequence of enzyme-controlled biochemical reactions in which the products of one reaction are the reactants for the next
- metabolism** the chemical reactions that take place in the cells of living organisms
- metabolites** chemical substances involved in cell metabolism
- metallic bonding** the electrostatic attraction between positively charged nuclei and the sea of delocalized electrons
- metalloid** a class of chemical elements intermediate in properties between metals and non-metals. They are electrical semiconductors and their oxides are amphoteric
- metals** chemical elements which are shiny solids under standard conditions (except mercury) and are good conductors of heat and electricity when solid; they form positive ions (cations)
- micelle** a globular or roughly spherical structure composed of organic molecules so their nonpolar ends are oriented toward the interior of the aggregate and the polar ends are oriented away from the interior
- Michaelis constant** the substrate concentration at which an enzyme-catalysed reaction occurs at one half of its maximum rate, V_{\max} : it is an approximate measure of the substrate affinity for the enzyme; in general, a lower value of the Michaelis constant K_m means tighter substrate binding
- microbial rancidity** rancidity caused by microorganisms
- microbial fuel cell** devices that use bacteria as the catalysts to oxidize organic and inorganic matter and generate current
- micronutrients** nutrients that the body uses in relatively small amounts – vitamins and minerals
- microstate** in statistical mechanics, the specific distribution and thermodynamic properties of particles within a given system
- mineral ore** impure mineral from which a metal can be profitably mined or extracted
- mixture** a mixture has the properties of the substances in it, and can be separated by simple physical processes, and no chemical reaction occurs when mixtures are made
- mobile phase** liquid or gas which percolates through or along the stationary phase during chromatography
- moderator** a substance, such as heavy water or graphite, which is used in a nuclear reactor to decrease the velocity of fast neutrons thereby increasing the probability of fission
- moiety** part of a molecule
- molar absorption coefficient** absorbance of light per unit path length (usually centimetre) and per unit concentration (moles per cubic decimetre): the proportionality coefficient in the Beer–Lambert law
- molar gas volume** one mole of an ideal gas occupies 22.7 cubic decimetres (dm^3) at 0°C (273K) and one atmosphere pressure (stp)
- molar mass** the mass in grams of one mole of molecules or the formula units of an ionic compound; numerically equal to the relative molecular or atomic mass of a substance, but has units of grams per mole (g mol^{-1})
- molar solution** a solution that contains one mole of solute per cubic decimetre of solution
- mole** the measure of the amount of a substance; one mole of a substance contains 6.02×10^{23} (Avogadro's constant) of atoms, ions or molecules
- mole fraction** number of moles of a substance divided by the total number of moles of all the components present in the mixture. Mole fractions are used to calculate the partial pressures of gases
- molecular formula** a chemical formula which shows the actual number of atoms of each element present in a molecule of a covalent compound
- molecular ion** unipositive ion formed by an unfragmented molecule losing one electron following electron bombardment
- molecular orbital** a wave function that describes the behaviour of an electron in a molecule. Molecular orbitals are usually spread across many atoms in the molecule, and they are often described as a combination of atomic orbitals on those atoms
- molecular orbital theory** a theory of chemical bonding based upon the postulated existence of molecular orbitals
- molecular orbitals** formed in molecules when atomic orbitals combine and merge as atoms bond together – σ and π bonds are molecular orbitals
- molecularity** the number of chemical species or particles participating in an elementary step of the mechanism: each step has its own molecularity but the overall reaction has no molecularity (unless it is an elementary process)
- molecule** a group of atoms held together by covalent bonds; a molecule is the smallest unit of a compound that can exist by itself and retain all of its chemical properties
- monochromatic light** light composed of one wavelength. It may be obtained by the use of a laser or by gaseous discharge tubes in combination with proper filters
- monodentate** a ligand that forms a single dative covalent bond to a central metal ion
- monomer** a small molecule, a large number of which can be polymerized via the formation of covalent bonds to form a polymer

monoprotic an acid which contains one replaceable hydrogen atom per molecule, sometimes also known as monobasic

monosaccharide sugar that cannot be hydrolysed to simpler sugars

mono-unsaturated fats a class of fats having long carbon chains with one carbon–carbon double bond with hydrogen atoms

multi-drug resistance the resistance of bacteria against more than two of the antibiotics that were once effective

multi-stage flash distillation form of distillation in which water is heated then discharged into a chamber maintained slightly below the saturation vapour pressure of the incoming water, so that a fraction of the water content flashes into steam; the steam condenses and the unflashed brine enters another chamber at a lower pressure, where a portion flashes to steam; each evaporation and condensation chamber is called a stage

multiplet pattern of multiple resonances (NMR peaks) observed when the initially single frequency of a given nucleus is split by interactions with neighbouring spins through spin–spin coupling

mutagen an agent, such as a chemical, ultraviolet radiation, or a radioactive element, that can induce or increase the frequency of mutation in an organism

N

N terminus amino acid residue at one end of a polypeptide chain that contains a free amino group

n-type semiconductor formed when the impurities added to silicon donate electrons which enter the unoccupied energy level

nanocatalyst a catalyst consisting of catalytic nanoparticles

nanoparticle particles between 1 and 100 nanometres in size

nanotechnology engineering of functional systems at the 1–100 nm scale

nanotube a one-dimensional fullerene (a convex cage of atoms with only hexagonal and/or pentagonal faces) with a cylindrical shape

naphtha general term used to describe a light hydrocarbon fraction from crude oil distillation with a boiling point between 40 °C and 150 °C; an important feedstock used to manufacture other substances

narcotic addictive drug that reduces pain, alters mood and behaviour, and usually induces sleep

narrow-spectrum antibiotic antibiotic that is effective against only a small number of bacterial strains

native state occurrence of an element in an uncombined or free state in nature

natural product a chemical compound produced by a living organism – usually one that has a pharmacological or biological activity

nematic phase phase composed of rod-shaped molecular aggregates that are arranged with parallel but not lateral order

net ionic equation the simplified equation for a reaction involving ionic substances – only those ions that actually participate in the reaction are included in the ionic equation; spectator ions are not included

neuraminidase an enzyme present in the flu virus which is crucial to the infection process

neurotransmitter a chemical substance that transmits nerve impulses across a synapse. A neurotransmitter can excite or inhibit another neuron

neutralization a chemical reaction between an acid and a base to produce a salt and water only

neutron neutral sub-atomic particle found in the nucleus of all atoms (except that of the most abundant isotope of hydrogen) – it has approximately the same mass as the proton

Newman projection a representation of the conformation of a molecule in which the viewer's eye is considered to be sighting down a carbon–carbon bond; the front carbon is represented by a point and the back carbon by a circle

nickel–cadmium cell a secondary (rechargeable) cell consisting of a cadmium anode and a nickel(III) hydroxide cathode, combined with a potassium hydroxide electrolyte. The cell reaction involves the oxidation of cadmium to cadmium(II) and the reduction of nickel(III) to nickel(II)

nitrating mixture 1 : 2 molar mixture of concentrated nitric and sulfuric acids used to nitrate some aromatic organic compounds; produces the electrophilic nitronium cation, NO_2^+

nitration type of reaction in which a nitro group ($-\text{NO}_2$) is introduced into an aromatic compound, usually via the use of a nitrating mixture

nitrification process in which ammonia in plant and animal wastes and dead remains is oxidized, first to nitrites and then to nitrates; the reactions are catalysed by the bacteria *Nitrosomonas* and *Nitrobacter*

nitrile a compound of the form RCN , where R is an alkyl group or aryl group

noble gases a group of very unreactive gases found in group 0 of the periodic table; they exist as single atoms and all have filled outer or valence shells

node the point on a stationary wave where the amplitude of oscillation is zero. It is a point where the two component waves arrive out of phase at all times

non-competitive inhibitor a substance that will bind to a site on the enzyme, other than the active site, which reduces the ability of the enzyme to form the enzyme–substrate complex; V_{max} is decreased by the inhibitor and cannot be restored by increasing the substrate concentration; non-competitive inhibition is thus dependent on the concentration of the inhibitor and the affinity of the enzyme for the inhibitor

non-essential fatty acids these fatty acids (such as oleic acid, $\text{CH}_3(\text{CH}_2)_7\text{CH}=\text{CH}(\text{CH}_2)_7\text{COOH}$, do not have to

be taken in by humans in their diet, as unlike essential fatty acids, they can be synthesized in normal human metabolism

non-invasive without making a surgical cut or inserting a medical instrument into the body

non-metals chemical elements that are typically poor conductors of heat and electricity; they form covalent bonds and/or form negative ions (anions)

non-renewable an energy source that is finite, so once it has been used it will no longer be available to us

normal boiling point the temperature at which the vapour pressure of a liquid is exactly one atmosphere

normal phase form of chromatography whereby retention on a sorbent bed increases with the polarity of the sorbent

normal salt formed when all of the replaceable hydrogens of an acid have been replaced by metal ions

nuclear charge the total charge of all the protons in the nucleus

nuclear fission splitting of relatively large atoms or nuclei to release two or more smaller atoms or nuclei, accompanied by production of large amounts of heat and ionizing radiation

nuclear fuel a fissionable isotope with a relatively long half-life, used a source of energy in a nuclear reactor

nuclear magnetic resonance (NMR) absorption of radio waves at a precise frequency by nuclei with an odd nucleon number when in an external magnetic field

nuclear medicine a branch of medicine dealing with the use of radioactive materials in the diagnosis and treatment of disease

nuclear power power whose source is nuclear fission or nuclear fusion

nuclear reactor a device containing fissionable material so it is capable of maintaining a controlled, self-sustaining nuclear fission chain reaction. The energy released in the fission process appears as heat. This heat is used to boil water and produce steam to drive turbines connected to electric generators

nuclear spin a property of certain nuclei (those with odd numbers of protons and/or neutrons in their nucleus) which gives them a magnetic moment; nuclei that do not exhibit this characteristic will not produce an NMR signal

nucleocapsid a viral capsid and its nucleic acid contents. Viral enzymes may be present

nucleon a particle in a nucleus, either a neutron or proton

nucleophile a species (molecule or anion) which contains a lone pair of electrons that can be donated to an electron-deficient centre in an organic molecule to form a coordinate (dative) bond

nucleophilic addition type of reaction in which the rate-determining step is the attachment of a nucleophile to a positive (electron-deficient) part of the molecule (often a carbon-oxygen bond in a carbonyl compound)

nucleophilic substitution the substitution of an atom or group of atoms with a nucleophile as the attacking species; can occur via an S_N1 or S_N2 mechanism

nucleosynthesis the production of new elements via nuclear reactions

nucleotide monomer of the nucleic acids (DNA and RNA) composed of a five-carbon sugar (a pentose), a nitrogen-containing base, and phosphoric(v) acid

nucleus the central part of an atom containing protons and frequently neutrons. A nucleus is described by its atomic number and nucleon number

nuclide the general term for a unique nucleus

nutrient a substance needed by living organisms for metabolism

nutrient depletion where the nutrients in the soil are being consumed faster than they are being produced or added, so that the amount of nutrients is decreasing

nylon a hard synthetic polymer with a long chain of carbon atoms in which amide groups ($-\text{NH}-\text{CO}-$) are combined at regular intervals; there is extensive hydrogen bonding between the chains

O

octane number a value used to indicate the resistance of a motor fuel to knock, based on a scale on which isooctane is 100 (minimal knock) and heptane is 0 (bad knock)

octet a set of eight electrons in the valence shell of an atom or ion

octet rule atoms (with an atomic number greater than five) fill their valence or electron shell with eight electrons (an octet) when they form compounds

opiate a medication (or illegal drug) derived from the opium poppy

opium dried latex containing morphine, obtained from the unripe seed pods of the opium poppy (*Papaver somniferum*)

opsin a protein found in the retina, which combines with retinal to form rhodopsin

optical activity a substance that rotates plane polarized light

optical emission spectroscopy (OES) uses quantitative measurement of the optical emission from excited atoms to determine analyte concentration

optical isomerism occurs when a molecule has no plane of symmetry and can exist in left- and right-handed forms that are non-superimposable mirror images of each other: the molecule must possess a chiral centre; optical isomers rotate plane-polarized light

orbital a region in space in which an electron may be found in an atom or molecule; each atomic orbital can hold up to a maximum of two electrons with opposite spins

orbits the path of an electron as it travels round the nucleus of an atom (see Bohr's theory)

order of reaction see overall order or individual order

organic chemistry the study of carbon-containing compounds with the exception of the allotropes of the element itself, metal carbonates and its oxides and halides

organometallic compound organic compounds that contain a metal, particularly compounds in which the metal atom has a direct bond with a carbon atom

orphan drug an orphan drug is a drug for the treatment of a rare disease for which reasonable recovery of the sponsoring firm's research and development expenditure is not expected within a reasonable time

osmosis a process where solvent molecules move through a semi-permeable membrane from a dilute solution into a more concentrated solution (which becomes more dilute)

outline give a brief account or summary

overall order of reaction the sum of the individual orders with respect to each of the reactants in the rate expression

oxidation an increase in oxidation number or the loss of electrons

oxidation number a number (usually an integer), positive or negative, given to indicate whether an element in a compound has been reduced or oxidized during a redox reaction

oxidative rancidity reaction of unsaturated fat with excited molecular oxygen to produce undesirable flavours

oxidizing agent a substance that brings about oxidation; it accepts electrons from the reactant or one of the reactants, being itself reduced

oxoanion an anion containing oxygen

ozone depletion the production of a 'hole' in the ozone layer by the action of chlorine atoms released from chlorofluorocarbons (CFCs), which destroy ozone by reactions on the surface of ice crystals

ozone layer layer of ozone in the stratosphere (between 15 and 30 km altitude) which prevents harmful ultraviolet radiation from reaching the Earth's surface

P

p-type semiconductor formed when the impurities added to silicon withdraw electrons from the occupied energy level leaving positive 'holes' which allow conduction to occur

PANs peroxyacetyl nitrates – compounds formed in photochemical smog by the addition of nitrogen dioxide to the peroxyacyl radical

paper chromatography chromatography carried out using a special grade of filter paper as the stationary phase

parallax error an error in reading an instrument when the eye of the observer and the pointer are not in a line perpendicular to the plane of the scale

parallel synthesis single-batch method that uses a mixture of reagents at each step of a synthesis to generate a large number of different products

paramagnetic a paramagnetic compound has one or more unpaired electrons. Paramagnetic compounds are weakly attracted by a magnet

parent nucleus the nucleus that undergoes radioactive decay

parenteral drug (or nutrients) taken into the body or administered in a manner other than through the digestive tract, as by intravenous or intramuscular injection

partial pressure the pressure a gas in a mixture of (ideal) gases would exert on the container if it were the only gas in the container; equal to the mole fraction of that gas multiplied by the total pressure

particulates any type of solid particle or droplet in the air in the form of haze, smoke or dust, which can remain suspended in the air or atmosphere for extended periods

partition distribution of a solute between two immiscible solvents

partition coefficient P_c the ratio of solubility of a substance in two immiscible solvents, e.g. in octan-1-ol and water

parts per million (ppm) concentration expressed as parts of solute per million parts of solution. Usually refers to parts per million by mass. In very dilute aqueous solutions, ppm is approximately equal to mg solute per litre of solution

pascal the SI unit of pressure, defined as one newton per square metre

Pauli exclusion principle no two electrons in an atom can have the same set of four quantum numbers: the Pauli principle states that a maximum of two electrons can occupy an atomic orbital – and these electrons must have opposite spins

Pauling scale a common comparative measure of electronegativity which runs from 0 (least electronegative or most electropositive) to 4 (most electronegative or least electropositive)

peer-reviewed journal a publication in which new scientific research is published. The editorial process involves each article being checked and reviewed by other experts in the specific fields involved

penicillinase enzyme produced by some bacterial species that inactivates the antimicrobial activity of certain penicillins

penicillins a group of antibiotics, originally derived from the mould *Penicillium notatum*, which work by disrupting synthesis of the bacterial cell wall

peptic ulcer a hole in the lining of the stomach, duodenum or oesophagus

peptide bond an amide bond resulting from the condensation reaction between the amine group of one amino acid and the carboxylic acid group of another

peptidoglycan carbohydrate polymer cross-linked by proteins, found in the cell walls of bacteria

percentage error an error expressed as a percentage of the value measured or the true value

percentage uncertainty $\frac{\text{random uncertainty}}{\text{actual measurement}} \times 100$

percentage yield the actual or experimental yield as a percentage of the theoretical or calculated yield

$$\text{percentage yield} = \frac{\text{actual yield}}{\text{theoretical yield}} \times 100$$

period a horizontal row in the periodic table which contains elements with same number of shells, and with an increasing number of electrons in the outer or valence shell

periodic table a table of the chemical elements arranged in order of increasing proton (atomic) number to show the similar chemical properties of groups of elements

periodicity the regular repetition of chemical and physical properties as you move across (from left to right) and down the periodic table

pH the negative logarithm (to the base ten) of the hydrogen ion concentration (in mol dm^{-3})

pH probe an electrode that can be used to accurately measure (via voltage) the pH of an aqueous solution

pH scale typically ranges from 0 to 14 and is used to describe the acidity or alkalinity of an aqueous solution

pharmacology science of studying both the mechanisms and the actions of drugs, usually in animal models of disease, to evaluate their potential therapeutic value

pharmacophore molecular framework that carries the essential features responsible for a drug's activity

phase a physically or chemically distinct part of a chemical equilibrium; a phase is homogenous throughout and is separated from other phases by a phase boundary

phase change a change in the nature of a phase or in the number of phases as a result of some variation in externally imposed conditions, such as temperature or pressure

phase diagram a graph of pressure versus temperature showing the regions where each phase of a system is thermodynamically the most stable

phase equilibrium an equilibrium in which the identities of the phases are fixed, with transfer from one phase to another feasible

phenol group of organic compounds in which at least one hydroxyl group is bonded to directly to one of the carbon atoms of a benzene ring

phonon a single quantum of vibrational or elastic energy

phosphodiester linkage the covalent bond that holds together the polynucleotide chains of RNA and DNA by joining a carbon atom in the pentose sugar of one nucleotide to a carbon atom in the pentose sugar of the adjacent nucleotide

phospholipids lipids consisting of glycerol to which two fatty acids and one ionized phosphate group are chemically bonded

photochemical reaction a reaction initiated by light

photochemical smog form of local atmospheric pollution found in large cities in which oxides of nitrogen and unburnt hydrocarbons react in the presence of light to produce a range of harmful products including ozone and PANs

photoconduction change in the electrical conductivity of a substance as a result of absorbing electromagnetic radiation

photoelectric emission ejection of electrons from the surface of a conductor by incident electromagnetic radiation, especially by visible light

photon a 'packet' or quantum of light, or other electromagnetic radiation

photosynthesis a process occurring in green plants where light energy is absorbed by chlorophyll contained in

chloroplasts. This energy is used to synthesise glucose from carbon dioxide and water in the presence of various enzymes. Oxygen is released as a by-product

photovoltaic cell capable of producing a voltage when exposed to radiant energy, especially light

photovoltaic device system that converts solar radiation directly into electric energy

physical change a change that does not involve changing any substances into new chemical substances

physical property a property that can be measured without changing the chemical composition of a substance, for example, density and melting point

physical weathering breakdown of rock and minerals into small sized particles through mechanical stress

physisorption a physical adsorption process in which there are van der Waals forces of interaction between gas or liquid molecules and a solid surface

pi bond a bond formed by the sideways overlap of two p-orbitals; in a π bond the electron density lies to either side of a plane through the nuclei of the two atoms

pi delocalization a situation in a molecule where the π electrons in a molecule are not localized between a pair of atoms but can move over several adjacent atoms

piezoelectric effect crystals which acquire a charge when compressed or distorted are said to be piezoelectric. Thus this provides a very convenient transducer effect between electrical and mechanical oscillations

pig iron impure, high-carbon iron produced by reduction of iron ore in a blast furnace

pigment substance that has a colour resulting from selective colour absorption

placebo an inactive substance or treatment that looks the same as, and is given the same way as, an active drug or treatment being tested; the effects of the active drug or treatment are compared to the effects of the placebo

placebo effect improvement in the condition of a sick person that occurs in response to treatment but that cannot be considered due to the specific treatment used

Planck's constant the constant of proportionality relating the energy of a photon to the frequency of that photon; approximately 6.63×10^{-34} Joule-seconds (Js)

plane-polarized light light which vibrates in one plane, formed by passing unpolarized light through a polarizer; plane-polarized light is used for the detection of optical activity

plasma a hot ionized gas consisting of approximately equal numbers of positively charged ions and negatively charged electrons

plasmids small circular DNA molecules occurring in bacteria, which can be exchanged between different cells under natural conditions

plasticizer substance added to a plastic to make it flexible

plum pudding model an early model of the atom as evenly distributed positively charged protons with negative electrons oscillating around them

pOH the negative logarithm (to the base ten) of the hydroxide ion concentration (in mol dm^{-3})

- polar covalent bond** formed when electrons are shared unequally between two atoms due to a difference in electronegativity: one atom has a partial positive charge, and the other atom has an equal but opposite partial negative charge; the larger the difference in electronegativities the greater the polarity and the larger the partial or fractional charges
- polar molecule** an unsymmetrical molecule whose individual dipoles do not sum to zero or cancel
- polar stratospheric clouds** clouds in the stratosphere that form under extremely cold conditions, when nitric acid, water vapour and other trace chemicals freeze to form ice crystals; they provide a solid surface on which chlorine-containing reservoir compounds can gather, and on this surface the chemical reactions involved in the depletion of ozone are greatly increased
- polar vortex** a phenomenon that occurs during the polar winter in which stratospheric air moves in a circular motion, with a volume of relatively still air at its centre; the temperature in the vortex is approximately -80°C , which assists in the formation of polar stratospheric clouds
- polarimeter** a device used to study optically active substances
- polarization** the separation of charge in a polar bond
- pollutant** a waste material that pollutes air, water or soil
- pollution** modification of the environment caused by human activities
- polyamide** a polymer in which the monomer molecules are linked by amide bonds
- polycrystalline** a structure that consists of many crystals joining one another on their boundaries is described as polycrystalline. The crystals are ordered in planes, called lattices
- polydentate** a ligand that forms multiple dative covalent bonds to a central metal ion
- polyester** a synthetic polymer formed by reacting alcohols with acids, so that the monomers are linked by the group $-\text{O}-\text{CO}-$
- polymer** a compound containing very large molecules composed of repeating units called monomers
- polymerase chain reaction (PCR)** repetitive enzyme-based procedure, using a thermostable DNA polymerase, which results in the production of many copies of a DNA sequence
- polymorphic** natural variations in a gene, DNA sequence or chromosome that have no adverse effects on the individual and occur with fairly high frequency in the general population
- polynucleotide** a chain made up of many nucleotides which forms nucleic acids: DNA strands are long polynucleotide chains
- polypeptide** long linear chain of between 10 and 100 amino acids linked via peptide bonds
- polyprotic acid** an acid with more than one acidic proton or replaceable hydrogen. The molecule will dissociate in a stepwise manner, one proton or hydrogen ion at a time
- polysaccharide** carbohydrate whose molecules contain chains of monosaccharide molecules
- polysome** a group of several ribosomes simultaneously translating the same messenger RNA: shortened form of the term polyribosome
- poly-unsaturated fats** a class of fats having long carbon chains with many double bonds unsaturated with hydrogen atoms
- porphyrins** molecules featuring four pyrrole groups joined together by alternating carbon-carbon single and double bonds. Chlorophylls are examples of porphyrins
- positron** a particle with the same mass as an electron but the opposite charge
- positron emission tomography (PET)** tomography in which a computer-generated image of local metabolic and physiological functions in tissues is produced through the detection of gamma rays that are emitted when introduced radionuclides decay and release positrons
- potency** refers to the amount of drug required to achieve a specific biological effect
- potential barrier** the potential in a region in a field where the force exerted on a particle is such as to oppose the passage of the particle through the regions
- potential difference** the work done per coulomb in moving charge from one point to another; if the potential difference between two points is 1 volt, then the passage of 1 coulomb of charge between these points involves 1 joule of energy ($1\text{ V} = 1\text{ J C}^{-1}$)
- precipitate** an insoluble substance formed by a chemical reaction in solution
- precipitation** a reaction in which an insoluble substance is prepared from two solutions of two soluble substances
- precision** total amount of random error present in a measurement: indicates how close together a series of measurements are
- predict** give an expected result
- pre-existing equilibrium model** is a model of substrate-protein interaction in which the substrate selects and binds to a conformation of a protein already present in an equilibrium mixture of structures, preferentially selecting that structure. This model is an alternative to the induced fit model of protein-substrate interaction and is an important consideration in drug design
- pressure law** the gas law stating that the pressure of a fixed mass (at constant volume) of an ideal gas is directly proportional to absolute temperature
- primary alcohol** an alcohol in which the hydroxyl group is bonded to a primary carbon
- primary amine** an amine in which the amino group is directly bonded to one carbon of any hybridization which cannot be a carbonyl group carbon
- primary battery** group of voltaic cells in which the chemical reaction producing the voltage is not reversible; cannot be recharged

primary carbon atom a carbon atom that is singly bonded to only one other carbon atom

primary pollutant a pollutant that enters the atmosphere directly from various sources

primary smog a smog containing soot particles and aqueous sulfur dioxide from the combustion of coal in power stations

primary standard a reagent that is extremely pure, stable, has no water of crystallization, and has a high molar mass; can be used to prepare a solution of accurately known concentration (see standard solution)

primary structure order or sequence of the amino acids in a polypeptide chain

principal quantum number (n) a quantum number that can be regarded as a 'label' for the shells of an atom

probe radio-labelled fragment of nucleic acid containing a nucleotide sequence complementary to a section of a gene

prodrug inactive form of a drug; the drug is converted to its active form by processes in the body of the person who has taken it

product inhibition a form of metabolic control in which the end product of a pathway inhibits the enzyme, usually an allosteric enzyme, that catalyses the earliest irreversible reaction that is unique to the pathway

promoter a substance added to a solid catalyst to improve its performance

propagation an elementary reaction involving one radical causing the formation of another radical

propagation of errors calculating the overall error from a series of mathematical operations

prostaglandins group of organic compounds derived from essential fatty acids and causing a range of actions, including inflammation

protein a long sequence of amino acid residues combined together via peptide bonds, which takes up a particular shape or conformation when folded

protein engineering the design of proteins with desired function by the substitution, addition and/or deletion of amino acids

proteinogenic amino acids the 20 amino acids coded for by DNA

proteomics the study of the full set of proteins encoded by a genome

protic solvent a solvent that is a hydrogen bond donor

proticity the number of replaceable hydrogen atoms a molecule of acid contains

proton positively charged sub-atomic particle found in the nuclei of all atoms – it has approximately the same mass as the neutron

proton pump inhibitors a series of drugs which inhibit the proton pump responsible for releasing hydrochloric acid into the stomach

pseudo first-order rate constant if the rate expression is $\text{rate} = k[A][B]$, then the function $k[A]$ is the pseudo first-order rate constant with respect to B; similarly, $k[B]$ is

the pseudo first-order rate constant with respect to A: the term is used when the concentration of one reactant greatly exceeds that of another

purine nitrogen-containing base found in nucleotides and nucleic acids; contains one six-membered ring fused with a five-membered ring

pyrimidine nitrogen-containing base found in nucleotides and nucleic acids; contains one six-membered ring

pyrolysis chemical decomposition occurring as a result of high temperature in inert (non-oxidizing) conditions

pyrrole a five-membered ring containing four carbon atoms and one nitrogen atom. Pyrrole itself (C_4H_4NH) is a colourless, volatile liquid. Many naturally occurring larger molecules contain pyrrole rings

Q

qualitative analysis analysis used to determine the nature but not the concentration of the constituents of a material or substance

quantitative analysis analysis used to determine the amount of each component in a material or substance

quantum number a label for a state of a quantized system, such as a sub-atomic particle, atom, ion or molecule

quantum mechanics a branch of physics that describes the behaviour of objects of atomic and subatomic size

quantum tunnelling a process by which a quantum system can suddenly and discontinuously make a transition from an initial configuration to a final one, even if the system does not have enough energy to classically attain the configurations between the two

quaternary structure overall three-dimensional structure of a protein composed of two or more polypeptide chains

quenching process of rapidly cooling steel from a temperature above the critical temperature

R

racemic mixture an equimolar mixture of two enantiomers of the same compound; as their rotation of plane-polarized light is equal but opposite, the mixture is not optically active

radical a species with one or more unpaired electrons, often produced by photolysis

radical cation radical with a positive charge

radioactive a substance that contains unstable radioactive atoms that release ionizing radiation as they decay

radioactive decay spontaneous disintegration of a radionuclide accompanied by the emission of ionising or nuclear radiation in the form of alpha particles, gamma rays or beta particles

radioactive tracer an element or compound containing atoms that can be distinguished from their normal counterparts by physical means (e.g., radioactivity assay or mass spectrography) and can thus be used to follow (trace) the metabolism of the normal substances

radioactivity spontaneous disintegration of the nuclei of certain elements or atoms with the emission of alpha or beta particles, sometimes accompanied by gamma radiation

- radioactivity level** the number of disintegrations per second that occur in a radioactive source; it is a measure of the strength of the source. The S.I. unit of activity is the Becquerel (Bq)
- radiocarbon dating** the determination of the approximate age of an object by measuring the amount of carbon-14 it contains
- radioisotope** a naturally or artificially produced radioactive isotope of an element
- radionuclides** an unstable isotope of an element that decays or disintegrates spontaneously, thereby emitting radiation
- radiopharmaceutical** a radioactive chemical or pharmaceutical preparation, labelled with a radionuclide in tracer or therapeutic concentration, used as a diagnostic or therapeutic agent
- radiotherapy** treatment of disease with radiation, especially by selective irradiation with X-rays or other ionizing radiation and by ingestion of radioisotopes
- radio waves** a form of electromagnetic radiation with wavelengths greater than a few metres. They are generated by the oscillating motion of the electrons in a conductor
- random uncertainty** an error which is present every time a measurement is recorded – the effects can be reduced by repeating the measurement and averaging
- Raoult's law** the vapour pressure of an ideal solution is equal to the vapour pressure of the pure solvent multiplied by the mole fraction of the solvent in the solution
- rare earth elements** are the lanthanoids, scandium, and yttrium
- rate constant, k** the constant of proportionality in a rate expression; the rate constant is unaffected by changes in the concentrations of the reactants, and is affected only by changes in temperature
- rate expression** the experimentally determined relationship between the rate of a reaction and the concentrations of the chemical species that occur in the reaction
- rate of reaction** how fast reactants are being converted to products during a chemical reaction – either the rate of formation of a product or the rate of consumption of a reactant may be used: they are related to each other by dividing the corresponding coefficient in the stoichiometric equation; the rate of a reaction has units of $\text{mol dm}^{-3} \text{s}^{-1}$
- rate-determining step** the slowest elementary step in a reaction mechanism that controls the rate of the overall reaction
- reaction kinetics** see chemical kinetics
- reaction mechanism** a list of all elementary reactions that occur in the course of an overall chemical reaction
- reaction pathway** a sequence of reactions involving the conversion of organic compounds
- reaction quotient** a value obtained by applying the equilibrium law to any concentrations other than to equilibrium concentrations
- reactor vessel** the protective containment vessel surrounding the nuclear fission core in a nuclear reactor
- real gas** a real gas does not obey the gas laws and exhibits non-ideal behaviour; its molecules have a finite size and there are intermolecular or interatomic forces of attraction operating between the molecules or atoms
- receptor** specific proteins found on the cell surface to which hormones or other molecules bind, triggering a specific reaction within the cell. Receptor proteins are responsible for initiating reactions as diverse as nerve impulses, changes in cell metabolism, and hormone release
- recrystallization** a technique for the purification of solid crystalline substances (often organic). The procedure is applied when a solute is much more soluble in a hot solvent and much less soluble when the solvent is cold
- redox equation** an equation constructed by combining two half-equations so the numbers of electrons on both sides of the equation cancel
- redox equilibrium** an equilibrium involving a redox (electron transfer) reaction
- redox reaction** a reaction involving reduction and oxidation and which results in one or more electrons being transferred and is accompanied by changes in oxidation numbers
- redox titration** a titration used to determine the concentration of a solution of an oxidizing agent or of a reducing agent
- reducing agent** a chemical that brings about reduction; it donates electrons to a reactant, being itself oxidized
- reducing sugar** a type of sugar with an aldehyde or ketone group, which allows the sugar to act as a reducing agent, for example in the Maillard reaction and Benedict's reaction
- reduction** a decrease in oxidation number or gain of electrons
- reflux** process of boiling a liquid in a flask connected to a condenser so that the condensed liquid runs back into the flask
- reforming** cyclization of straight-chain hydrocarbons from crude oil by heating under pressure with a catalyst
- relative atomic mass** the weighted average mass (according to relative abundances) of all the naturally occurring isotopes of an element compared with an atom of the ^{12}C carbon isotope, which has a mass of exactly 12
- relative formula mass** the sum of the relative atomic masses of the atomic species as given in the formula of an ionic compound; it is a pure number without units
- relative isotopic mass** the mass of a particular isotope of an element compared to the mass of one twelfth of a carbon-12 atom; measured using a mass spectrometer
- relative molecular mass** the relative molecular mass of a compound is the sum of the relative atomic masses of the atomic species in one molecule; it is a pure number without units

renewable an energy source that is naturally replenished on a timescale useful to humans

repeatability the closeness of agreement between independent results obtained with the same method, under the same conditions (same operator, same apparatus, same laboratory and after short intervals of time) (see precision)

replacement reaction a redox reaction in which a more reactive element displaces a less reactive element from a solution of its ions or salt, often in aqueous solution

replication (DNA) synthesis of double-stranded DNA (daughter DNA) identical in sequence to the original (parent) DNA

reproducibility the ability to duplicate measurements over long periods of time by different laboratories

residence time the amount of time a substance can remain in a reservoir: the reservoir can be aquatic, atmospheric or terrestrial

resin identification codes an international system of symbols used to identify the type of plastic used for manufacturing. The symbols used consist of an identifying number within a series of arrows. The resin identification code is primarily used for recycling purposes

resolution the chemical or physical process of separating enantiomers

resolution the size of the smallest increment which can be shown on the measurement display. On a digital display, it is the value of the least significant digit

resonance occurs when more than one valid Lewis structure can be written for a particular molecule or ion: the actual electronic structure is not represented by any one of the Lewis structures but by a weighted average of them

resonance energy the difference in energy between the resonance hybrid and the individual resonance structures

resonance hybrid a molecule or ion described by a single localized structure, often using dotted lines to indicate partial bonds

resonance structure the Lewis structures that can be drawn for a resonance-stabilized molecule: their sum (according to their weightings) or blend describes the resonance hybrid

respiration the enzyme-controlled transfer of chemical energy by the oxidation of glucose, to other energy-requiring processes within living cells

restricted rotation the phenomenon where bonded atoms cannot rotate relative to one another because either the bond between them prevents it or the two atoms are part of a ring that restricts rotation; restricted rotation gives rise to geometrical isomerism in organic compounds

restriction enzyme enzyme that causes cleavage of both strands of double-stranded DNA at or near specific base sequences

retention factor, R_f distance travelled by a compound on a chromatography column or chromatography paper divided by the distance travelled by the solvent or eluent

retention time time between injection of a substance onto a chromatography column and the appearance of the peak

retro-synthesis the process of working backwards from the target molecule to devise a synthetic pathway (route)

retrovirus RNA virus containing reverse transcriptase

reverse osmosis method for removing dissolved salts from water, for example, in the desalination of sea water, by the use of a semipermeable membrane and high pressure

reverse phase form of chromatography in which non-polar to moderately polar analytes are extracted from a polar solution using a nonpolar sorbent

reverse reaction see backward reaction

reverse transcriptase enzyme found in retroviruses capable of synthesizing DNA complementary to RNA

reversible reaction a physical or chemical reaction that can go either backwards or forwards depending on the conditions; when a reversible reaction has equal forward and reverse rates the reaction is at equilibrium

Reye's syndrome potentially fatal condition that causes damage to the brain and liver – associated with aspirin consumption by children during a viral illness

rhodopsin molecule formed from the covalent cross-linking of retinal with the protein opsin, responsible for the absorption of light in the visual cycle of mammals

ribosome complex of proteins and RNA, the site of protein synthesis in cells; receives messenger RNA from the nucleus

ring-opening polymerization polymerization in which a cyclic monomer is converted into a polymer which does not contain rings

RNA polymerase an enzyme that links the growing chain of ribonucleotides during transcription

Rydberg equation a mathematical formula used to predict the wavelength of light resulting from an electron moving between energy levels of an atom

S

salinization the increase in salt concentration in soil

salt an ionic compound formed by the reaction of an acid with a base, in which the hydrogen of the acid has been replaced by a metal ion

salt bridge an electrical connection made between two half-cells that contains an electrolyte with ions that do not cause precipitation of the ions in the two half-cells; it allows ions to flow to maintain electroneutrality while preventing the two solutions from mixing, and thus prevents a build-up of charge which would stop the flow of current

salt hydrolysis occurs when one or both ions derived from a soluble salt undergo a chemical reaction with water molecules, leading to production of an acidic or an alkaline solution

Sankey diagram illustrates an energy input/energy output situation. It is drawn to scale. Sankey diagrams allow the visualisation of flow through a process or system more easily than numerical data can. They show not

only the order of changes but also the quantitative distribution of values in the transfers

saturated used to describe an organic molecule, for example an alkane, that contains no carbon–carbon multiple bonds and contains only carbon–carbon single bonds

saturated vapour pressure the pressure exerted by a pure substance (at a given temperature) in a system containing only the vapour and liquid of the substance

scanning tunnelling microscope (STM) an instrument able to image conducting surfaces to atomic accuracy

Schrödinger wave equation a mathematical equation explaining the movement of an electron around an atom in the form of a standing wave

scintillator a substance that emits visible light when hit by a subatomic particle, X-ray or gamma ray

scintillation counter an instrument used for the detection of radioactivity; the radiation is absorbed by a scintillator which results in minute flashes of light that are detected by a photocathode. The resultant electron emission is amplified by a photomultiplier and an amplifier

scission breaking of a molecular bond causing the loss of a side-group or shortening of the overall chain

screening a procedure by which compounds are tested for biological activity

second electron affinity the addition of one mole of electrons to one mole of gaseous singly negative ions (under standard thermodynamic conditions)

Second Law of Thermodynamics spontaneous processes are accompanied by an increase in the total entropy of the universe

second messenger a method of cellular signalling when a signalling molecule is rapidly produced/secreted, which can then go on to activate proteins within the cell to produce a cellular response

second-order reaction a reaction in which the rate of reaction is proportional to the product of the concentrations of two of the reactants or to the square of the concentration of one of the reactants

secondary alcohol an alcohol in which hydroxyl group is bonded to a secondary carbon atom

secondary amine an amine in which the amino group is directly bonded to two carbons of any hybridization; these carbons cannot be carbonyl group carbons

secondary battery group of voltaic cells in which the chemical reaction producing the voltage is reversible; it can be recharged

secondary carbon atom a carbon atom that is singly bonded to two other carbon atoms

secondary pollutant formed when primary pollutants react with each other or with other compounds present in the atmosphere

secondary smog *see* photochemical smog

secondary structure (of a protein) the three-dimensional conformation of sections of polypeptide chains resulting from hydrogen-bonding between the peptide

link regions of the chain; common protein secondary structures include the α -helix, the β -sheet and the random coil

sedative drug that depresses the central nervous system, producing a calming effect

semiconductor crystalline material with a conductivity intermediate between that of a conductor and an insulator

semi-conservative replication the normal process of DNA synthesis, in which the two original strands of the molecule separate, and each acts as a template on which a new complementary strand is laid down

semi-crystalline a solid with some degree of crystallinity

semi-crystalline polymer thermoplastic with both amorphous and crystalline regions

semi-synthetic synthesized using natural chemicals as starting materials

separation funnel a funnel with a tap at the lower end and a stopper in the top used to separate immiscible liquids by running off the lower layer through the tap

shelf-life the period of time which a product can be stored, under specified conditions, and remain in optimum condition and suitable for consumption

shielding screening of an applied magnetic field experienced by a nucleus due to the electron cloud around an atom or molecule

shielding effect shielding electrons are the electrons in the energy levels between the nucleus and the outer or valence electrons, described as ‘shielding’ electrons because they ‘shield’ the valence electrons from the nuclear charge and reduce the attractive force on them by the protons in the nucleus

show give the steps in a calculation or derivation

side effect secondary and usually adverse effect of a drug

sigma bond formed by the head-on overlap between atomic orbitals along an imaginary line joining the two nuclei (the inter-nuclear axis); the electron density is concentrated around the two nuclei

signal transduction the process by which chemical, electrical, or biological signals are transmitted into and within a cell

significant figures the figures in a number that are meaningful

simple cubic lattice a unit cell with one atom at each of the four corners. Each atom is in contact with six identical neighbouring atoms. Unit cell, atoms are located at all corner and face-centred positions

sink a natural removal process for pollutants in the troposphere such as dissolution and removal via rain

skeletal formula a formula representing organic molecules where the carbon and hydrogen atoms are omitted and only the bonds between them are shown

sketch represent by means of a diagram or graph (labelled as appropriate). The sketch should give a general idea of the required shape or relationship, and should include relevant features (for example, intercept) clearly

indicated. When you see the command term sketch it is not necessary to use graph paper. However, make sure that the axes of your graph are labelled and that you include appropriate units, if this is applicable

slag mixture of molten non-metallic oxides produced during the extraction of iron in the blast furnace

smelting melting or fusing an ore, often with a reducing agent, in order to extract a metal

smart material polymer material which reacts in a desired manner to external influences

smog form of air pollution consisting of a combination of smoke and fog

S_N1 (halogenoalkanes) a nucleophilic substitution in which a carbocation intermediate is formed in the rate-determining step which then reacts with the nucleophile

S_N2 (halogenoalkanes) a nucleophilic substitution where a concerted reaction occurs in which the nucleophile begins to bond with the carbon bearing the halogen as the halogen begins to leave the molecule

soil degradation decline in soil quality caused by its improper use

soil organic matter (SOM) carbon-containing material in the soil that is derived from living organisms

soil solution aqueous liquid found within a soil; normally contains ions released from mineral particles, organic matter or plant roots and leaves

solar cell solar cells convert light into electricity. Solar cells rely on the photovoltaic effect to absorb the energy of the sun and cause current to flow between two oppositely charged layers

solar energy energy transmitted from the Sun in the form of electromagnetic radiation

solid a state of matter whose particles are in fixed positions and are not able to move from one location to another; the particles are held in a lattice by chemical bonds or intermolecular forces

solid phase chemistry carrying out a synthesis with one of the reactant molecules attached to an insoluble material known as a solid support

solubility product for a sparingly soluble salt, MX [M⁺X⁻] in water, the solubility product constant, K_{sp} , is defined as $[M^+(aq)] \times [X^-(aq)]$. The solubility product is the equilibrium constant for the dissolution process: $MX(s) \rightleftharpoons M^+(aq) + X^-(aq)$. In general for a salt M_aX_b , $K_{sp} = [M^{b+}]^a [X^{a-}]^b$ with units of $(mol\ dm^{-3})^{a+b}$

solute the solid, liquid or gas that has been dissolved to form a solution

solution formed when a solid, liquid or gas is dissolved into a solvent

solvation the process by which solvent molecules surround and interact with solute ions or molecules

solve obtain an answer using algebraic and/or numerical methods

solvent a liquid that dissolves solids, liquids or gases to form a solution

solvent extraction the extraction of solute from aqueous solution using an organic solvent in which the solute of interest is more soluble

source areas or sites where a pollutant is released into the atmosphere

Southern blotting DNA that has been separated by electrophoresis, transferred from the gel to nitrocellulose in single-strand form for hybridization

specific energy the energy released from a fuel, per unit of mass of fuel consumed. Usually expressed in megajoules (MJ) per kilogram (kg), $MJ\ kg^{-1}$

specific heat capacity the amount of heat energy required to raise the temperature of a given mass of substance (which can be 1 g or 1 kg), by one kelvin (or degree Celsius), equivalent to the heat capacity divided by mass

specific rotation the measure of a substance's optical activity, normalized for concentration of the sample

spectator ions ions present in solution that do not participate directly in a reaction

spectral line a particular wavelength of light emitted (or absorbed) by an atom, ion (or molecule)

spectral series a group of related lines in the emission (or absorption) spectrum of a substance. The lines in a spectral series occur when all the transitions all occur between one particular energy level and a set of different energy levels

spectrochemical series arrangement of ligands in order of increasing ability to produce d-orbital splitting

spectroscope optical instrument that produces a spectrum for observation by the eye

spin pair two electrons with opposite spins, usually occupying the same orbital

spin resonance exchange of energy between two systems at a specific frequency

spin-spin splitting/coupling interaction between the spin magnetic moments of different nuclei: in high-resolution NMR spectroscopy it gives rise to multiplet patterns

spontaneous reaction a reaction which will occur when the reactants are mixed together under standard conditions, accompanied by a decrease in free energy: the Gibbs free energy change, ΔG^\ominus , is negative; spontaneous reactions can do work (note that a spontaneous reaction may be fast or slow)

standard a measurement, specification or object against which other measurements are compared

standard electrode potential the potential difference generated by a half-cell under standard conditions when an electrode is connected by a salt bridge and an external circuit to a standard hydrogen electrode

standard enthalpy change of combustion the enthalpy change when one mole of a compound is completely combusted (burned) in excess oxygen under standard thermodynamic conditions (with no change in pressure)

standard enthalpy change of formation the enthalpy change when one mole of a compound is formed under

standard thermodynamic conditions (with no change in pressure) from its elements in their standard states

standard enthalpy change of reaction the enthalpy change for the amounts of reactants in a specified stoichiometric equation under standard thermodynamic conditions (pressure 101.3 kPa and 298 K)

standard hydrogen electrode (SHE) a reference half-cell used to measure standard electrode potentials; it consists of hydrogen gas (at a pressure of one atmosphere) bubbled over a platinum electrode in a one molar aqueous solution of hydrochloric acid at 298 K and is assigned a voltage of zero

standard reference electrode an electrode measuring system which provides a constant stable voltage regardless of the composition of the external solution: this voltage is used as the base from which standard electrode potentials are measured

standard solution a solution whose concentration is accurately known and does not change with time

standard state a reference state for a specific element according to standard thermodynamic conditions

starch consists of amylose and amylopectin

state give a specific name, value or other brief answer without explanation or calculation

state function a property that is determined by the state of the system. The change in the state function is path independent and defined by the properties in the initial and the final state only

state symbol indicates whether a substance shown in an equation is a solid (s), liquid (l), gas (g) or in aqueous solution (dissolved in water) (aq)

states of matter solid, liquid and gas are the three states of matter in which all substances can exist, depending on the conditions of temperature and pressure

static equilibrium a system in which the total amounts do not change, and the starting materials are no longer turning into products, and the products do not turn back into starting materials

stationary phase one of the two phases forming a chromatographic system, which may be a solid, a gel or a liquid; if a liquid, it may be distributed on a solid – the liquid may also be chemically bonded to the solid (bonded phase) or immobilized on it (immobilized phase)

statistical mechanics equations describing how particles distribute themselves in predictable ways, despite each particle moving around randomly

steady state term used in reaction kinetics to describe the near constant (steady) concentration of a reactive intermediate species in a reacting system when it is formed at a rate which is approximately equal to its rate of removal

steam cracking cracking in the presence of steam at very high temperatures

steam distillation a technique used to purify organic substances that are immiscible with water and which would decompose if distilled. The impure substance is

added to water and steam is blown through the mixture. The distillate is a two-phase mixture of water and the purified organic material

step polymer a type of polymer formed when all molecules in the system can react with each other, and the growth of polymer chains takes place by condensation reactions between molecules of all degrees of polymerization

stereoisomerism isomerism arising from differences in the shapes of molecules; includes geometrical and optical isomerism

stereoregular polymer regular polymer, the molecules of which can be described in terms of only one species of stereo-repeating unit in a single sequential arrangement

steric factor an attempt to account for deviations of reaction rates from collision theory which incorporates the idea that molecules colliding will react only in certain orientations

steric hindrance the prevention or slowing down of a reaction by atoms or functional groups blocking the access of an attacking molecule or ion

steroid group of lipids with a characteristic fused carbon-ring structure, which includes cholesterol and the sex hormones

sticky ends two DNA molecules with short overhanging single-stranded sequences that are complementary to one another, facilitating the sealing of the ends

stimulant drug that temporarily arouses or accelerates physiological activity and prevents sleep

Stock notation a naming system for inorganic compounds based on the indication of the oxidation number (as a Roman numeral, in brackets) of each of the major elements in the compound

stoichiometric quantities refers to a reaction where amounts of reactants are reacted together so that all are consumed at exactly the same time

straight-chain hydrocarbon a hydrocarbon with an open chain of atoms with no side-chains

strain the change in dimensions per unit dimensions produced by an applied stress on a body

stratosphere layer of the atmosphere between 20 and 50 kilometres above the surface of the Earth, above the troposphere

stress forces applied to deform the body or as the equal and opposite forces with which the body resists

$$\text{stress} = \frac{\text{deforming force}}{\text{original cross-sectional area}}$$

strong acid an acid completely dissociated or ionized when dissolved in water

strong base a base completely dissociated or ionized when dissolved in water

strong nuclear force the strong nuclear force holds protons and neutrons together. It is a short range attractive force (the range is about 10^{-15} m). For longer distances, the force becomes too small or negligible, but for very small distances it is repulsive, and hence it prevents the nucleus from collapsing

structural isomerism a type of isomerism in which the connectivity of atoms in the isomeric compounds differs

sub-atomic particles the particles – electrons, protons and neutrons – from which all atoms are made

sublimation the direct change of state from solid to gas without melting or freezing occurring

sub-shell a sub-division of a shell; atoms can contain up to four different types of sub-shell: s, p, d and f

substitution reaction a reaction in which one atom or group of atoms is replaced by another atom or functional group

substrate compound acted upon by an enzyme

successive ionization energies the energies involved for the successive removal of electrons from an atom

suction filtration the mixture of solid and liquid is poured through a filter paper in a Buchner funnel. The solid is trapped by the filter and the liquid is drawn through the funnel into the flask below, by a vacuum

suggest propose a hypothesis or other possible answer

superconductivity a state where a material exhibits no electrical resistance and excludes the inner magnetic field

superconductor an element, inter-metallic alloy, or compound that will conduct electricity without resistance below a certain temperature. Once set in motion, current will flow forever in a closed loop of superconducting material

supercritical fluid a substance at a temperature above its critical point, having properties intermediate between those of a liquid and those of a gas

suppository a small plug of medication designed for insertion into the rectum or vagina, where it melts

supramolecular chemistry a field of chemistry related to species of greater complexity than molecules, that are held together and organized by means of intermolecular interactions

supramolecule any organized system of two or more molecules held together by intermolecular forces

suspension mixture in which small solid or liquid particles are suspended in gas or liquid

sympathomimetic drugs drugs that mimic the effects of the sympathetic nervous system

syndiotactic polymer chain in which the stereochemical orientation of the substituents, with respect to each other along the chain, alternates

synergistic effect condition in which the result of the combined action of two or more drugs is greater than the sum of their separate, individual effects

synthesis (direct) a reaction in which a compound is formed from its elements

synthetic equivalents the actual compounds used to function as synthons in the synthesis of a target molecule

synthetic route a synthetic route is a path from reactants to products. Often, the route will involve numerous reactions and purifications

synthons a fragment, usually a cation or anion, resulting from the disconnection of the target molecule in the retrosynthesis of organic compounds

system the mixture of chemicals being studied – everything outside the system is the 'surroundings'; the system and the surroundings (the rest of the universe) are separated by a boundary or interface

systematic error an error which biases your measurements in some predictable way – the effects cannot be reduced by repeating the measurement and averaging

T

tacticity any type of regular or symmetrical molecular arrangement in a polymer structure

target molecule the organic molecule that is to be synthesized

temperature a measurement of the average kinetic energy of the molecules in an object or system and can be measured with a thermometer

temperature inversion occurs when cold dense air is near the ground, with a layer of warmer and therefore lighter air above it; often occurs in valleys, trapping pollutants formed during the day in towns and cities located there

tempering process of reheating quench-hardened steel which relieves internal stresses and imparts toughness and ductility (*see annealing*)

tensile strength the resistance of a material to a force tending to tear it apart, measured as the maximum tension the material can withstand without tearing

tensile force forces being applied onto a material (usually a wire) on two opposite sides in order to stretch it. Both forces' values are the same as the tensile force value

tensile stress tensile force per unit cross-sectional area

tension a force on a body directed to produce strain (extension)

teratogenic able to disturb the growth and development of an embryo or fetus

termination an elementary step in a chain reaction involving the combination of two radicals to form a molecule

tertiary alcohol an alcohol in which a hydroxyl group is bonded to a tertiary carbon

tertiary amine an amine in which the nitrogen atom is directly bonded to three carbons of any hybridization which cannot be carbonyl group carbons

tertiary carbon atom a carbon atom that is directly attached to three other carbon atoms

tertiary structure overall three-dimensional folded shape of a protein composed of a single polypeptide chain

tetramethylsilane (TMS) reference standard for proton (and carbon) nuclear magnetic resonance

tetrapyrroles natural pigments containing four pyrrole rings joined by one-carbon units linking position 2 of one pyrrole ring to position 5 of the next

theoretical yield the maximum amount or mass of a particular product that can be formed when the limiting reactant is completely consumed and there are no losses or side reactions

- therapeutic index** the ratio of a drug's undesirable effects with respect to its desirable effect and is therefore a measure of how safe that drug is and the larger the therapeutic index, the safer the drug is
- therapeutic window** range of a drug's concentration in the blood between its therapeutic level and its toxic level
- thermal cracking** cracking carried out at a high temperature in the absence of a catalyst
- thermal decomposition** the chemical decomposition of a substance into simpler substances at high temperatures
- thermal pollution** industrial discharge of heated water into a river, lake or other body of water, causing a rise in temperature that endangers aquatic life by decreasing the solubility of dissolved oxygen
- thermochemical equation** a balanced stoichiometric chemical equation that includes the enthalpy change
- thermodynamics** the laws that govern energy transfers and the direction of chemical and physical changes. It also deals with the conditions under which heat can be transformed into work
- thermometric titration** titration in which the end point is determined by measuring the temperature of a solution
- thermonuclear fusion** a nuclear fusion reaction taking place at very high temperatures
- thermoplastics** plastics that soften when heated and can then be re-moulded
- thermosetting plastics** plastics that do not soften on heating but only char and decompose – they cannot be re-moulded
- thermotropic liquid crystal** liquid crystal prepared by heating the substance
- thin-layer chromatography** form of chromatography in which compounds are separated by a suitable solvent or solvent mixture on a thin layer of adsorbent material coated onto a flat support
- three prime end (3')** the end of a nucleic acid that lacks a nucleotide bound at the 3' position of the terminal residue
- threshold frequency** minimum frequency of electromagnetic radiation, typically ultraviolet radiation, capable of generating photoelectric emission in a metal
- titration** a chemical technique in which one solution is used to analyse another solution and find its concentration or amount
- titration curve** a plot showing the pH of a solution being analysed as a function of the amount of acid or base added
- tolerance** capacity of the body to endure or become less responsive to a drug with repeated use or exposure
- top-down approach** making nano-scale structures by machining and etching techniques
- trans** a prefix typically used to describe the isomer of a 1,2-disubstituted alkene or cyclic structure with atoms or functional groups on opposite sides of a double bond or ring
- trans fat** common name for unsaturated fat with *trans*-isomer fatty acid(s). *Trans* fats may be mono-unsaturated or poly-unsaturated but never saturated
- transcription** enzyme-controlled process where the sequence of bases in one strand of the DNA of a gene is used to specify a complementary sequence of bases in a messenger RNA chain
- transesterification** animal and plant fats and oils (made of triglycerides which are esters of free fatty acids with glycerol) and an alcohol (methanol or ethanol) are converted into ethyl esters and glycerol with the help of a base catalyst, usually sodium hydroxide
- transfer RNA** small RNA molecules that find specific amino acids and attach them to a growing polypeptide chain in the sequence specified by the codons in the messenger RNA
- transition element** a metal in the d-block of the periodic table which has at least one of its ions with a partly filled d-sub shell
- transition metal** *see* transition element
- transition state** the partially bonded chemical species located at the top of the activation energy barrier as a reaction proceeds from reactants to products
- transition-state theory** explains the reaction rates of elementary steps: the theory assumes an equilibrium between the reactants and the transition state
- translation** the process by which messenger RNA directs the amino acid sequence of a growing polypeptide during protein synthesis
- transuranium elements** all elements beyond uranium on the periodic table. The transuranic elements are all radioactive and are produced by nuclear reactions. They do not occur naturally
- triglyceride** a molecule of triglyceride is composed of a molecule of glycerol in which each of the three carbons is linked through an ester bond to a fatty acid
- triose** monosaccharide with three carbon atoms
- triple point** the unique temperature and pressure at which all three phases of a substance (solid, liquid and gas) are in equilibrium
- troposphere** layer of the atmosphere closest to the ground and extending upwards (15–30 kilometres) to the stratosphere
- twisted nematic** type of liquid-crystal display where the liquid-crystal fluid rotates the plane of polarization 90°
- type 1 superconductor** the type 1 category of superconductors is mainly comprised of metals and metalloids that show some conductivity at room temperature. They require low temperature to slow down molecular vibrations sufficiently to facilitate unimpeded electron flow in accordance with what is known as BCS theory
- type 2 superconductor** they have higher thermal conductivity than type 1 and their transition from a normal to a superconducting state is gradual across a region of 'mixed state' behaviour. This allows some penetration of external magnetic fields

U

ultraviolet/visible spectroscopy the absorption of ultraviolet/visible light by a molecule causing the promotion of an electron from a ground electronic state to an excited electronic state

uncertainty principle it is impossible to specify simultaneously both the momentum and the position of a particle

unimolecular involving one particle dissociating into two or more particles in an elementary step in a reaction mechanism

unit cell the smallest fragment of the structure of a solid that by repetition can generate the entire structure

universal indicator a mixture of several acid–base indicators which change colour as the pH increases

unsaturated used to describe a molecule, such as an alkene, containing one or more carbon–carbon double bonds

V

valence band band of allowed energy states that exists in solids and is completely filled with electrons at zero degrees kelvin; the valence band is separated from the conduction band by an energy gap in insulators and semiconductors and overlaps the conduction band in metals

valence bond in the valence bonding theory, a valence bond is a chemical bond formed by overlap of half-filled atomic orbitals on two different atoms

valence bond theory a theory that explains the shapes of molecules in terms of overlaps between half-filled atomic orbitals, or half-filled hybridized orbitals

valence shell electron pair repulsion (VSEPR) a model which states that the shape of bonds around the central atom of a molecule is determined by minimizing the repulsion between the centres of negative charge (lone pairs and bonding pairs)

van Arkel–Ketelaar triangle of bonding triangles used to show different compounds in varying degrees of ionic, metallic and covalent bonding

van der Waals' forces includes several different types of interaction between atoms and molecules; namely London dispersion forces, dipole–induced dipole interactions and dipole–dipole interactions

vapour a vapour may be described as a gas in contact with its liquid at a temperature below its boiling point; it may be formed by the sublimation of a solid or the evaporation of a liquid

vapour pressure the pressure of the vapour over a liquid where the liquid and vapour are in equilibrium

vibrational energy the energy possessed by a substance due to the vibration of chemical bonds

vinca alkaloids naturally occurring compounds that are used as anticancer agents

virus simple organism that consists essentially of a core of RNA or DNA surrounded by a protein coat; only able to replicate inside a host cell

visual cycle the visual cycle is the enzyme-controlled biological conversion of a photon (light wave) into an electrical signal in the retina

vitamin various unrelated fat-soluble or water-soluble organic substances essential in minute amounts for normal growth and activity of the body and obtained naturally from plant and animal foods

vitrification a process of treating radioactive waste that stabilises the waste by mixing it with molten glass. Vitrification is a process of converting a material into a glass-like amorphous solid which is free from crystalline structure, either by the rapid addition or removal of heat. This is one of the processes used in the disposal and storage of nuclear waste materials

volatile organic compounds (VOCs) organic chemicals that have a very high vapour pressure and low solubility in water under normal atmospheric conditions

volatility a qualitative measure of the how readily a liquid or solid is vaporized upon heating or evaporation

volt the unit of potential difference defined as one joule of work per coulomb of charge transferred (1 volt = 1 joule per coulomb)

voltaic cell a voltaic cell contains two half-cells, each of which is composed of an electrode in contact with an electrolyte

vulcanization non-reversible chemical reaction involving sulfur where cross-links are formed between molecular chains in rubber materials

W

water of crystallization water molecules that are chemically incorporated into the crystal lattice of many inorganic salts when they crystallize from aqueous solution

wave equation the velocity (v) of a wave is given by the product of the wavelength (λ) and the frequency (f), that is, $v = f \times \lambda$

wave function (wave equation) a mathematical function that gives the amplitude of a wave as a function of position. Wave functions (wave equations) are used in chemistry to represent the behaviour of electrons in atoms or molecules

wave–particle duality light sometimes acts like a wave, and sometimes acts like a particle, depending on the experiment you are performing

wavelength the distance between corresponding points, for example, between two peaks or two troughs, on a wave; denoted by the Greek letter lambda (λ)

wavenumber reciprocal of the wavelength of radiation (in cm), and thus the number of complete waves within 1 cm: commonly used in infrared spectroscopy

weak acid an acid that is only partially dissociated or ionized when dissolved in water

weak base a base that is only partially dissociated or ionized when dissolved in water

weathering chemical and physical breakdown of rock into small fragments

work the force multiplied by the distance through which the force is applied

Winkler method a redox titration used to determine the amount of dissolved oxygen in a water sample

wrought iron formed when carbon is removed from pig iron; it is relatively pure iron and is easily shaped

X

xenobiotic metabolism xenobiotic metabolism in living organisms consists of the entire set of physical and chemical changes that occur in foreign substances from uptake to excretion

xenobiotics chemical substances that are foreign to the biological system. They include naturally occurring compounds, drugs, environmental agents, carcinogens, insecticides, etc.

X-ray crystallography a technique used to determine the detailed, three-dimensional structure of molecules. It is based on the scattering of X-rays through a crystal of the molecule under study

Z

zeolite natural or synthetic hydrated aluminosilicate with an open three-dimensional structure, in which water molecules are held in cavities in the lattice

zero error when the scale on the measuring instrument does not start from exactly zero

zero-order reaction a chemical reaction in which the rate of reaction is independent of the concentration of a reactant

Ziegler–Natta process method for the manufacture of high-density polyethylene and isotactic polypropene using a catalyst of titanium(IV) chloride and an alkyl aluminium compound

zwitterions ions whose positive and negative charges are separated from each other within the chemical species; zwitterions are responsible for the relatively high melting points of amino acids and their solubility in water

zymase a mixture of enzymes found in yeast involved in fermentation (a form of anaerobic respiration)