**Глоссарий терминов по темам (в алфавитном порядке):**

**Unit 1 Atom structure**

**The structure of an atom:**

**atom** - the smallest component of an element having the chemical properties of the element

**atomic number –** the number of protons found in the nucleus that can beoccupied by one or, at most, two electrons.

**atomic orbitals** - regions of space outside the nucleus that can be occupied by one or, at most, two electrons. They are named s, p, d and f. They have diﬀerent shapes.

**anion** – negative ion which is created by an electron gain.

**atomic radius** – Half the shortest internuclear distance found in the structure of an element. Other values often used to represent the atomic radius are covalent radius, van der Waals radius and metallic radius.

**Bohr’s model** – a concept or model of the atom in which the negatively charged electrons move in circular or elliptical orbits around the positively charged nucleus, energy being emitted or absorbed when electrons change from one orbit to another.

**charge density** – The charge-to-size ratio of an ion. Ions with greater charge-to-size ratio have more polarizing power.

**covalent radius** – Half the internuclear distance between two identical atoms in a single covalent bond. This is often used to represent the atomic radius of non-metallic elements.

**cation** – positive ion which is created by electron loss.

**diatomic** – An element, such as chlorine, which exists as molecules consisting of two atoms.

**effective nuclear charge** – The resultant attraction from the nucleus experienced by the outermost electrons, after taking shielding effects into account.

**electron** – particle found outside the nucleus and has negative charges.

**element** – a substance made of only one type of atom.

**isotope** – any of two or more forms of a chemical element, atoms with the same atomic number but with different mass numbers, having the same number of protons in the nucleus but having different numbers of neutrons in the nucleus.

**ion** – an electrically charged particle or group of particles formed by the loss or gain of one or more electrons.

**mass number** – the sum of the number of protons and neutrons in the nucleus of an atom.

**metallic radius** – Half the shortest internuclear distance between two adjacent atoms in a metallic bond. This is often used to represent the atomic radius of metallic elements.

**molecular** – a substance containing molecules made up of covalently-bonded atoms. The molecules are held together by intermolecular forces. Also called simple covalent.

**monatomic** – An element, such as argon, which exists as single atoms.

**neutron** – particle found in the nucleus and has no charges and has the same mass as a proton.

**nucleus** – the center part of an atom which contains protons and nucleus.

**proton** – a positively charged subatomic particle in the nucleus.

**relative atomic mass** – the ration of the average mass of one atom of that element to 1/12th of the mass of one atom of carbon-12.

**relative molecular mass** – the ratio of the average mass of that molecule to 1/12th of mass of an atom of carbon-12.

**Rutherford model** shows that an atom is mostly empty space, with electrons orbiting a fixed, positively charged nucleus in set, predictable paths.

**Thomson’s model –** in Thomson’s model,the atom is composed of electrons surrounded by a soup of positive charge to balance the electrons’ negative charges, like negatively charged “plums” surrounded by positively charged “pudding”.

**Electron shell of an atom:**

**Aufbau principle** - electrons always fill the lowest energy orbitals first.

**electron** - particle found outside the nucleus and has a negative charge.

**electronic configuration** - the arrangement of electrons in an atom.

**first ionization energy** – The amount of energy required to remove the first electron from an atom. More accurately, it is the amount of energy required to remove one mole of electrons from one mole of gaseous atoms.

**Hund's rule** - electrons never pair up in the same orbital until all orbitals of the same energy are singly occupied, and all unpaired electrons have parallel spin.

**mutual repulsion** – Repulsion between the two electrons paired within a single orbital. (Note that this is mutual repulsion within an electron pair, as in the context of explaining the low ionization energy of sulfur, not mutual repulsion between electron pairs, as in the context of working out the shape of a molecule).

**orbital** - It is the space around the nucleus in which the electron is found with a probability of 90%.

**Pauli exclusion principle** - only two electrons may occupy the same orbital, and they must do so with opposite spin.

**Quantum Numbers**- The four numbers that define each particular electron of an atom. The Principle Quantum Number (*n*) describes the electrons' energy and distance from the nucleus. The Angular Momentum Quantum Number (*l*) describes the shape of the orbital in which the electron resides. The Magnetic Quantum Number (*m* describes the orientation of the orbital in space. The Spin Quantum number describes whether the spin of the electron is positive or negative.

**shielding** - the ability of inner shells of electrons to reduce the eﬀective nuclear charge on electrons in the  
outer shell.

s**ubshells** - regions within the principal quantum shells  
where electrons have more or less energy depending on their distance from the nucleus. They are given the letters s, p, d and f.

**Mass spectrometry:**

**Acceleration -** the stage of operation of the mass spectrometer when Ions accelerated to uniform speed by electric field.

**Deflection** - the stage of operation of the mass spectrometer when Ions deflected by magnetic field; deflection depends on m/e ratio.

Detection - the stage of operation of the mass spectrometer when Electric current measured as ions land on plate.

**Mass spectrometer -** an instrument for finding the relevant  
isotopic abundance of elements and to help identify  
unknown organic compounds.

**mass spectrum –**a plot of the mass-to-charge ratio (m/z) of detected fragments against their relative abundance.

**molecular ion –**The ion formed when a molecule loses an electron during mass spectrometry but does not fragment. Represented by the symbol M+.

**molecular ion peak –**The peak on the mass spectrum of a compound at the highest mass-to-charge ratio, which corresponds to the relative atomic mass of the molecular ion.

**Unit 2 Chemical calculations**

**(пока делается – отправлю отдельно позже)**

**Unit 3 Periodicity**

**amphoteric** - able to behave as both an acid and a base.

**acid**– a substance that dissociates in water to produce hydrogen ions, or which donates protons and/or accepts electrons.

Acids produce aqueous solutions with a pH less than 7.

**alkali**– a substance that dissociates in water to produce hydroxide ions, or which accepts protons and/or donates electrons. Alkalis form aqueous solutions having a pH greater than 7.

**amphoteric** – a substance that has the characteristics of an acid and an alkali and is capable of reacting chemically either as an acid or an alkali. For example, aluminium oxide (Al2O3) is amphoteric: it reacts with acids to produce salts, and with alkalis to produce aluminates (substances containing the ion [Al(OH)4]-).

**base**– a compound that dissolves in water to produce an alkaline solution.

**electronegativity –** the ability of an atom to attract the bonding electrons in a covalent bond.

**ionization energy** – the energy needed to remove 1 mole of electrons from 1 mole of atoms of an element in the gaseous state to form 1 mole of gaseous ions.

**electron arrangement** – a shorthand way of writing the number of electrons in an atom’s electron shells.

**group** – a column in the periodic table containing elements with the same number of outer shell electrons and similar chemical properties.

**metal**– an element, such as sodium and aluminium, formed from a regular lattice consisting of positively-charged metal ions surrounded by a sea of delocalized electrons and held together by the attraction between them (metallic bonds). Metals are found on the left and middle of the periodic table.

**metalloid** – an element, such as silicon, that has properties (such as electrical conductivity) intermediate between metals and non-metals.

**non-metal** – an element, such as sulfur and chlorine, that typically has physical properties that are opposite to that of metals. For example, they typically have low melting and boiling points, solid non-metals are usually brittle, dull and act as electrical insulators. Chemically, non-metal oxides tend to be acidic. Non-metals are found on the right of the periodic table.

**oxidation state** – the charge a particular atom in a compound would have if the compound consisted entirely of separate ions. Also called the oxidation number. In ions, the oxidation state is the ionic charge. Elements are assumed to exist in the zero-oxidation state.

**Periodic Table** – the repeating patterns in the physical and chemical properties of the elements across the periods of the Periodic Table.

**period** – a row in the periodic table containing elements with the same number of full electron shells.

**property** – Any characteristic of an element.

**Trends down a group:**

the number of outer shell electrons is the same;

the number of complete electron shells increases by one.

**Trends across a period:**

the number of outer shell electrons increases by one;

the number of complete electron shells stays the same.

**Unit 4 Bonding**

**bond energy** - the energy needed to break one  
mole of a given bond in a gaseous molecule.

**co-ordinate bond (or dative covalent bond)** - a covalent bond in which both electrons in the bond come from the same atom.

**covalent bond** - a bond formed by the sharing of pairs of  
electrons between two atoms.

**delocalised electrons** - electrons that are not associated with any one particular atom or bond.

**dipole–dipole forces** - the forces between two molecules having permanent dipoles.

**dot-and-cross diagram** - a diagram showing the arrangement of the outer-shell electrons in an ionic or covalent element or compound.

**hybridization** - the process of mixing atomic orbitals so that each has some character of each of the orbitals mixed.

**Hydrogen bonding** - the strongest type of intermolecular force. It is formed between molecules having a hydrogen atom bonded to one of the most electronegative elements (F, O or N).

intermolecular forces - the weak forces between molecules.

**ionic bond** - the electrostatic attraction between oppositely charged ions.

**lone pairs (of electrons)** - pairs of electrons in the outer shell of an atom that are not bonded.

**Metallic bonding** - the strong attractive forces (bond) between the positively charged ions and the delocalized electrons.

**pi (π) bonds** - multiple covalent bonds involving the  
sideways overlap of p atomic orbitals.

**sigma (σ) bonds** - single covalent bonds, formed by the  
‘end-on’ overlap of atomic orbitals.

**spin-pair repulsion** - electrons repel each other as they have the same charge. Electrons arrange themselves so that they first singly occupy different orbitals in the same sublevel.

**van der Waals’ forces** - very weak forces of attraction between all atoms or molecules.

**Unit 5 Energetics**

**bond enthalpy** - the average bond dissociation enthalpy for a particular bond in a range of different compounds. Precisely, it is the average enthalpy change for breaking one mole of a particular bond in a range of different compounds in the gas phase.

**calorimetry** - a technique used for measuring the amount of heat energy absorbed or given out by a reaction.

**‘Delta H’** - ΔH –the symbol used to represent enthalpy change.

**endothermic reaction** - a chemical reaction during which heat energy is taken in from the surroundings. ΔH for the reaction is positive.

**enthalpy** - a measure of the energy stored in (or heat content of) a system. Given the symbol H.

**enthalpy change (for a reaction)** - the heat energy exchange between the reacting system and its surroundings at constant pressure.

**enthalpy level diagram** - a diagram showing the amount of energy contained in both the reactants and the products for a reaction, and therefore the difference between them. Also called an enthalpy profile diagram.

**exothermic reaction** - a chemical reaction during which heat energy is given out to the surroundings. ΔH for the reaction is negative.

**Hess cycle** - a diagram showing a reaction taking place by two or more alternative routes, all of which involve the same enthalpy change, according to Hess's law. Also called an enthalpy cycle.

**Hess’s Law** - a rule stating that the overall enthalpy change for a reaction is independent of the route the reaction takes.

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

**standard enthalpy of combustion** - the enthalpy change when 1 mole of a substance undergoes complete combustion under standard conditions (298 K and 100 kPa), with all substances being in their standard states.

**standard enthalpy of formation** - the enthalpy change when 1 mole of a substance is formed from its elements under standard conditions (298 K and 100 kPa), with all substances being in their standard states.

**standard enthalpy of neutralization** - the enthalpy change when 1 mole of water is produced by the reaction of an acid and a base under standard conditions (298 K and 100 kPa), with all substances being in their standard states.

**standard enthalpy of reaction** - the enthalpy change for a reaction under standard conditions (298 K and 100 kPa), with all substances being in their standard states.

**standard state** - the state a substance is in under standard conditions (298 K and 100 kPa).

**Unit 6 Kinetics**

activation energy - the minimum amount of energy particles needs to have if a collision between them is to result in a reaction.

catalyst - a substance that increases the rate of a reaction but remains chemically unchanged itself at the end of the reaction.

**collision theory** - a theory stating that for a reaction to occur the particles must collide, have sufficient energy (at least the activation energy) and collide with the correct orientation.

**energy distribution curve** - a graph of energy against the number of particles in a sample with those energies. Also called a Maxwell–Boltzmann curve, the energy distribution curve is a representation of the Maxwell–Boltzmann distribution.

**enthalpy level diagram** - a diagram showing the amount of energy contained in the reaction mixture over time, beginning with the enthalpy of the reactants and ending with the enthalpy of the products. Also called an enthalpy profile diagram.

**heterogeneous catalyst** - a catalyst in a different phase to the reactants.

**homogeneous catalyst** - a catalyst in the same phase as the reactants.

kinetic theory - the theory that particles in gases and liquids are in constant movement. The kinetic theory can be used to explain the effect of temperature and pressure on the volume of a gas as well as rates of chemical reactions.

**Maxwell–Boltzmann distribution** - the characteristic distribution of the energies of particles. Often plotted as a graph, called an energy distribution curve or Maxwell–Boltzmann curve, of energy against the number of particles in a sample with those energies.

order of reaction - the power to which the concentration  
of a reactant is raised in the rate equation. If the concentration does not affect the rate, the reaction is zero order. If the rate is directly proportional to the reactant concentration, the reaction is first order. If the rate is directly proportional to the square of the reactant concentration.

**phase** - a region of a physical system with uniform chemical composition or physical properties. For example, 'the gas phase' indicates a region composed only of gas.

**rate constant** is the constant of proportionality in the rate equation.

**rate of a reaction** is the decrease in concentration of reactants per unit time, or the increase in concentration of products per unit time.

**transition state** - a state through which a reaction passes between the reactants and the products. It is the state that has the highest energy, represented by the highest point on an enthalpy profile diagram or enthalpy level diagram.

**Unit 7 Equilibrium**

**catalyst –** a substance that speeds up a chemical reaction without itself being consumed by the reaction. It works by providing an alternative route with a lower activation energy, by which the reaction can take place.

**dynamic equilibrium** – the stage in a reversible reaction when the rates of the forward and backward reactions are the same and the concentrations of the components of the mixture remain constant.

**equilibrium constant** – a value for the ratio of concentration of products to reactants at equilibrium. It is constant at a specific temperature.

***K*c** – the equilibrium constant given in units of concentration. For the general reaction: aA + bB <-> cC + dD. *K*c is given, in terms of the equilibrium concentrations, by: *K*c = [C]c[D]d /[A]a[B]b

**Le Chatelier’s principle** – a principle stating that if a factor affecting the position of an equilibrium is altered, the position of the equilibrium changes to oppose the effect of the change.

**mole fraction** – the mole fraction of a component is equal to the number of moles of the component in a mixture divided by the total number of moles.

mole fraction of A = no. moles of A / total no. moles of all components.

**partial pressure** – the pressure that a gas would exert if it were the only gas present. The partial pressure of a particular gas is equal to the mole fraction multiplied by the total pressure:

Partial pressure = mole fraction × total pressure

The sum of all partial pressures in a mixture is equal to the total pressure.

**reversible reaction** – a reaction that does not go to completion. Instead, a state of dynamic equilibrium is set up, with products reforming reactants at the same rate that reactants form products.

**yield** – the amount of a substance produced.

**Unit 8 Alkanes**

**addition reaction** - an organic reaction in which two reactant molecules combine to give a single product molecule.

**Bitumen** – a fraction of crude oil consisting of hydrocarbon chains with 40+ carbon atoms. Also known as tar and used in road surfacing and in roofing.

***cis*–*trans* isomerism** – a category of stereoisomerism in alkenes in which groups are attached to the carbon atoms involved in the double bond in a different way. In *cis* isomers, the groups are on the same side of the double bond, whereas in *trans* isomers, the groups are on opposite sides. Also known as geometric isomerism.

**catalytic cracking** - the bonds are broken using a high temperature (450 o C, which is generally lower than in thermal cracking), a slight pressure (slightly greater than 1 atmosphere), and a zeolite catalyst.

**chain isomers** – a category of structural isomerism in which molecules have the same molecular formula but have a different arrangement of the carbon chain. Chain isomers belong to the same homologous series. For example, 3-methylpentane and 2,3-dimethylbutane are both chain isomers of hexane.

**complete combustion** – the combustion of hydrocarbons to produce carbon dioxide and water

**diesel or gas oil** - used for truck, central heating fuel.

**displayed formula** – a chemical formula showing the arrangement of atoms and bonds in a molecule.

**elimination reactions** - small removal molecules from the larger.

**E–Z isomerism** – a system of notation used for complex stereoisomers that cannot be identified as either *cis* or *trans* isomers.

**empirical formula** – a chemical formula showing the simplest ratio of atoms present in a molecule. For example, the empirical formula of hexane is C3H7

**free radicals** – the species produced when a bond breaks homolytically functional group. An atom or group of atoms present in a molecule that is responsible for its characteristic chemical properties.

**gasoline** – a fraction of crude oil consisting of hydrocarbon chains with 5–10 carbon atoms. Also known as petrol and mainly used as a fuel for internal combustion engines.

**general formula** – a chemical formula used to calculate the molecular formula of any member of a homologous series. For example, the general formula for alkanes is C*n*H2*n*+2. The general formula of a specific alkane can be calculated by substituting n with the number of carbon atoms it contains.

**hydrocarbon** – a compound made up of carbon and hydrogen only.

**homologous series** – a group of compounds that all have the same functional group but a different number of carbon atoms. Examples include alkanes, alkenes, alcohols, amines and halogenoalkanes.

**incomplete combustion** – if oxygen is not present in sufficiently large quantities, carbon monoxide or carbon is produced instead of carbon dioxide:

C4H10 + 2½O2 🡪 **4C** + 5H2O or

C4H10 + 4½O2 🡪 **4CO** + 5H2O

**initiation step** – the first step in the mechanism of free radical substitution of alkanes by halogens. It involves the breaking of the halogen–halogen bond by UV light from the Sun

**isomerism** – the existence of molecules that have the same molecular formula but a different arrangement of atoms. Two broad categories are structural isomerism and stereoisomerism.

**isomerism** – a category of structural isomerism in which molecules have the same molecular formula but contain different functional groups and so belong to different homologous series. For example, both propanol (an alcohol) and methoxyethane (an ether) have the molecular formula C3H8O but contain different functional groups.

**kerosene** – a fraction of crude oil consisting of hydrocarbon chains with 11–16 carbon atoms. Used as a fuel for jet aircraft and as a feedstock for the chemical industry.

**liquefied petroleum gas** – gas for camping/ cooking with number of hydrocarbons 1-4

**molecular formula** – a chemical formula showing the actual number of each type of atom in a molecule. For example, the molecular formula of hexane is C6H14

**nucleophile** – species that can act as a donor of a pair of electrons.

**optical isomerism** – a category of stereoisomerism, in which two molecules are non-superimposable, mirror images of each other, a feature known as chirality. Optical isomers are also known as enantiomers.

**organic** – compounds that contain carbon atoms, which are usually bonded together to form chains or rings.

**petrol or gasoline** - fuel for cars

**positional isomerism** – a category of structural isomerism in which molecules have the same molecular formula but in which the functional group is attached to a different carbon atom. Positional isomers belong to the same homologous series.

**propagation step** – a step in a free-radical mechanism in which the radicals formed can then attack reactant molecules generating more free-radicals, and so on.

**saturated hydrocarbons** – compounds of hydrogen and carbon only in which the carbon–carbon bonds are all single covalent bonds, resulting in the maximum number of hydrogen atoms in their molecules.

**substitution reaction** – a reaction that involves the replacement of one atom, or group of atoms, by another.

**skeletal formula** – a chemical formula showing the bonds between carbon atoms but, unlike in a displayed formula, the carbon and hydrogen atoms are not shown.

**stereoisomerism** – a category of isomerism in which molecules have the same molecular formula but a different 3D arrangement of atoms. Two types are cis-trans isomerism and optical isomerism.

**structural isomerism** – a category of isomerism in which molecules have the same molecular formula but a different structural formula. Three types are chain isomerism, positional isomerism and functional group isomerism.

**structural formula** – a chemical formula showing how the atoms are arranged in a molecule and, in particular, showing what functional groups are present. Unlike in a displayed formula, single bonds are not shown, but multiple bonds may be shown. For example, the structural formula of propane is CH3CH2CH3, and propene is CH3CH2=CH2

**termination step** – two free radicals reacting together will form a molecule, with no free radicals generated.

**thermal cracking** – the bonds are broken using a high temperature (400 – 900oC) and a high pressure (70 atmospheres).

**Unit 9 Alkenes**

**addition reaction –** a type of reaction in which two molecules combine to form a large molecule. At least one of the molecules must be unsaturated.

**addition polymerization –** a type of polymerization in which unsaturated monomers (e.g. alkenes) undergo addition reactions with themselves to form polymers.

**alkenes –** a homologous series of unsaturated hydrocarbons with the general formula C*n*H2*n*

**alkyl group –** ahomologous series of hydrocarbon molecules, with the general formula C*n*H2*n*+1

**bromine water –** an aqueous solution of bromine that can be used to test for the presence of unsaturation.

**carbocation -** an ion containing a positively charged carbon atom. Carbocations are intermediates in electrophilic addition reactions of alkenes.

**degree of polymerization –** the number of monomers in a polymer, represented by the letter n. (Note that this 'n' is distinct from the 'n' used in a general formula).

**electrophile –** a species that takes part in a reaction by accepting a lone pair of electrons from a nucleophile.

**electrophilic addition –** an addition reaction in which an electrophile attacks a double bond and becomes bonded to one of the atoms that formed the double bond by a single covalent bond. One example is the formation of halogenoalkanes from alkenes, in which a halogen (X2) or hydrogen halide (HX) attacks a carbon–carbon double bond.

**electrophilic addition reactions of alkenes -** making halogenoalkanes, dihalogenoalkanes and alcohols.

**homologous series –** agroup of compounds that all have the same functional group but a different number of carbon atoms. Examples include alkanes, alkenes, alcohols, amines and halogenoalkanes.

**hydration –** the addition of water across a carbon–carbon double bond.

**hydrogenation –** the addition of hydrogen across a carbon–carbon double bond.

**monomer –** the repeating unit from which a polymer is made. For example, the monomer of polypropene is propene.

**Markownikoff's rule –** the more electronegative part of the electrophile will usually attach itself to the more highly substituted carbon atom.

**pi bond –** a covalent bond formed by the sideways overlap of atomic orbitals. It is involved in double bonds and prevents rotation about the bond. Represented by the symbol π.

**polymerization –** the formation of a long chain molecule (polymer) consisting of many monomer molecules joined together.

**positional isomerism –** acategory of structural isomerism in which molecules have the same molecular formula but in which the functional group is attached to a different carbon atom. Alkenes with more than three carbon atoms can form positional isomers.

**sigma bond –** the strongest type of covalent bond, formed by the end-to-end overlap of atomic orbitals. Represented by the symbol σ.

**unsaturated –** ahydrocarbon, such as an alkene, that contains one or more carbon–carbon multiple bonds.

**unsymmetrical –** an alkene (such as propene) in which the atoms or groups of atoms attached to opposite ends of the carbon–carbon double bond is not the same. This means that when they undergo addition reactions, unsymmetrical alkenes create a mix of different products.

**Unit 10 Alcohols**

**alcohol –** a family of compounds which contains the –OH group.

**aldehyde –** primary alcohol oxidation product.

**anaerobic –** reaction which takes place without oxygen.

**biofuel –** a fuel derived or produced from renewable biological sources.

**carbon-neutral –** biofuel does not have net carbon dioxide emissions during the process from growing to combustion.

**chain reaction –** a series of reactions where the products of one reaction are the reactants for the next.

**chlorofluorocarbon –** a compound made of chlorine, fluorine and carbon only.

**dehydration –** the name of the reaction when alcohols undergo elimination to give alkenes, a molecule of water is removed.

**ethanol –** the alcohol which contains two carbon atoms. Formula: CH3CH2OH

**ester –** a family of compound which contain the group –COO–

**fermentation –** reaction in which yeast is used to convert glucose into ethanol.

**free radical –** ahighly reactive substance which contains a single unpaired electron.

**hydrofluorocarbon –** acompound made of hydrogen, fluorine and carbon only.

**inert –** very unreactive.

**intermolecular forces –** the forces which hold molecules together.

**ketone –** secondary alcohol oxidation product.

**methanol –** the simplest alcohol, containing only one carbon. Formula: CH3OH.

**ozone –** aform of oxygen with the formula O3

**ozone layer –** a layer of the stratosphere, which contains high levels of ozone.

**primary alcohol –** propan-1-ol

**secondary alcohol –** propan-2-ol

**stratosphere –** layer of the Earth’s atmosphere, 15-30 km above the Earth’s surface.

**ultraviolet –** a type of electromagnetic radiation.

**Unit 11 Halogenoalkanes**

**bromo –** the prefix used in the name of a halogenoalkane to indicate it contains at least one bromine atom.

**chloro –** the prefix used in the name of a halogenoalkane to indicate it contains at least one chlorine atom.

**chlorofluorocarbon –** a type of halogenoalkane containing chlorine and fluorine atoms.

**chlorofluoroalkanes** have been responsible for damaging the Earth’s ozone layer, but alternative inert compounds, such as fluoroalkanes, are now replacing the use of CFCs.

**electrophile –** a species that takes part in a reaction by accepting a lone pair of electrons from a nucleophile.

**electrophilic addition –** areaction in which an electrophile attacks a double bond and becomes bonded to one of the atoms that formed the double bond by a single covalent bond. One example is the formation of halogenoalkanes from alkenes, in which a halide ion attacks a carbon–carbon double bond.

**elimination –** a reaction in which atoms are lost from a molecule but not replaced by others. One example is the reaction between a halogenoalkane and a base, forming an alkene, a halide ion and water.

**fluoro –** the prefix used in the name of a halogenoalkane to indicate it contains at least one fluorine atom.

**free radical –** ahighly-reactive atom or group of atoms containing one or more unpaired electrons. One example is a chloride ion.

**free radical substitution –** a reaction in which a free radical attack an atom or group of atoms with a partial positive charge (an electrophile), substituting an existing atom or group of atoms called the leaving group. One example is the formation of halogenoalkanes from alkanes, in which a halogen atom substitutes a hydrogen atom bonded to a carbon atom.

**halogenoalkanes –** a group of organic molecules that are similar to alkanes but in which one or more hydrogen atoms are replaced by one or more halogen atoms. Also known as haloalkanes.

**homolytic fission –** the process in which a covalent bond is broken and one electron from the bond goes to each atom that formed the bond.

**hydrolysis –** the nucleophilic substitution of a halogenoalkane with a hydroxide ion.

**initiation –** the first step of a free radical substitution reaction, in which a free radical is formed by homolytic fission.

**iodo –** the prefix used in the name of a halogenoalkane to indicate it contains at least one iodine atom.

**nucleophilic substitution –** a reaction in which a nucleophile attacks an atom or group of atoms with a partial positive charge (an electrophile), substituting an existing atom or group of atoms called the leaving group. One example is the reaction of a halogenoalkane and ammonia, resulting in an amine and ammonium halide.

**nucleophilic substitution –** R-X + 2NH3 🡪 R-NH2 + NH4X

**nucleophilic substitution –** R-X + OH- 🡪 R-OH + X-

**nucleophile –** an ion or molecule that donates a lone pair of electrons to form a covalent bond. Nucleophiles are attracted to atoms with a slight positive charge, such as those involved in a polar bonds.

primary halogenoalkane – containing one halogen atom, the halogen atom is bonded to a carbon atom, which is itself bonded to one other carbon atom and two hydrogen atoms.

**propagation –** one or more steps in a free radical substitution reaction that follow initiation, in which new free radicals are created to continue the reaction.

**R group –** a symbol (R) used to represent an unspecified side chain or carbon chain in an organic molecule.

**SN2 mechanism of reaction** is characteristic of primary haloalkanes.

SN1 mechanism and the SN2 mechanism are both likely to play a part in the nucleophilic substitution of secondary.

**substitution –** a reaction in which an atom in a molecule is replaced by another atom or group of atoms.

**TSN1 mechanism of reaction** is characteristic of tertiaryhaloalkanes.

**termination –** one or more steps in a free radical substitution reaction that follow propagation, in which one free radical combine with another, leading to the end of the reaction.

tertiary halogenoalkane – the carbon atom bonded to the halogen atom is also bonded to three other carbon atoms (alkyl groups).

tertiary carbocations are more stable than primary carbocations due to the inductive effect of the alkyl groups attached to the carbon atom bonded to the halogen.

**Unit 12 Analytical Techniques**

**adsorption –** the adhesion of molecules to a surface. The molecules that attach are called adsorbate and the surface is the adsorbent. Adsorption is vital to chromatography.

**chemical shift –** a measure of the chemical environment of a particular nucleus within a molecule. Chemical shift values are quoted relative to a standard compound tetramethylsilane (TMS) and are measured in parts per million (ppm) of the strength of the magnetic field strength required for resonance in TMS.

**chromatogram** – the visible record of the separation of substances in mixtures by chromatography.

**chromatography –** alaboratory technique used to separate substances in a mixture. The mixture is dissolved in a mobile phase, which is then passed through a stationary phase. Substances are separated on the basis of their affinity with the stationary phase.

**column chromatography –** aform of chromatography in which the mixture to be separated is dissolved in a solvent. This is the eluent and is passed through a column containing a stationary phase (often aluminium oxide). The components of the mixture move at different rates through the column and can be collected as they run out of the bottom.

**eluent –** the mobile phase in column chromatography. Consists of the mixture to be separated dissolved in a solvent.

**fingerprint region – t**he region below 1500 cm-1 in an infrared spectrum, where there are many peaks which are difficult to assign. An exact match of the fingerprint region with a reference spectrum gives the identity of a compound.

**fragmentation –** a phenomenon whereby some ions disintegrate into smaller fragments during mass spectrometry, leading to multiple peaks in the resulting spectrum.

**gas–liquid chromatography –** a form of chromatography in which a mixture is injected into a coiled capillary tube inside an oven, where it vaporizes. An unreactive carrier gas (the mobile phase) transports the mixture through the coil, where the components interact with a powder lining the coil, which acts as the stationary phase. The components exit the coil at different times after injection and may pass straight into a mass spectrometer.

**high performance liquid chromatography –** a form of column chromatography in which the eluent moves through the column under high pressure. This results in a faster and more effective separation.

**infrared spectroscopy –** atechnique that measures the absorption of different frequencies of infrared energy by a sample of a substance. This gives information about the types of functional group present in a compound.

**infrared spectrum –** a plot of transmission of infrared radiation against wavenumber (1 / wavelength).

**integration –** amathematical technique for working out the area under the peak on a line graph. This is useful in proton NMR as the area under a peak in a 1H NMR spectrum is proportional to the number of hydrogen atoms in that chemical environment. The integration trace is sometimes shown as a line of the spectrum whose height is proportional to the number of hydrogen atoms of that type.

**mass spectrometry –** an accurate instrumental technique that can be used to determine the relative isotopic mass and the relative abundance for each isotope of an element in a sample. This can be used to identify the sample.

**mass spectrum –** a plot of the mass-to-charge ratio (m/z) of detected fragments against their relative abundance.

**mass-to-charge ratio –** the mass divided by the charge of an ion. Often called the m/z value.

**mobile phase –** the part of chromatography consisting of the mixture to be separated dissolved in a solvent and passed over/through the stationary phase. The mobile phase can be a liquid or gas.

**molecular ion – t**he ion formed when a molecule loses an electron during mass spectrometry but does not fragment. Represented by the symbol M+

**molecular ion peak –** the peak on the mass spectrum of a compound at the highest mass-to-charge ratio, which corresponds to the relative atomic mass of the molecular ion.

**NMR spectroscopy –** atechnique used to investigate the chemical environment of isotopes in a molecule which have an odd mass number (and so exhibit spin). NMR spectroscopy gives us information about the local environment of specific atoms in a molecule, and so can be used to deduce information about the molecular structure of a sample.

**NMR spectrum –** aplot of the different chemical shift values (in parts per million, or ppm) of peaks found in NMR analysis of a compound. NMR spectra usually give information about the local chemical environments of 13C or 1H atoms in a molecule. Integration of the area under the peaks in a 1H NMR spectrum gives the relative number of protons in each type of chemical environment. Splitting of peaks in a 1H NMR spectrum gives information about the number of protons attached to adjacent carbon atoms.

**retention time –** the time it takes for a component of a mixture to pass through the coil during gas–liquid chromatography.

**spin coupling –** a phenomenon that occurs as the spins on atoms which are close together interact with each other.

**splitting** is the name given to the observation that peaks in 1H NMR spectra often appear as a number of clustered peaks rather than one single peak. This is due to spin coupling interactions between adjacent atoms, and therefore gives information about the number of nearby hydrogen atoms.

**stationary phase –** the part of chromatography that remains stationary and separates the components of a mixture by interacting with them to different degrees. The stationary phase is usually a solid, often in powder form.

**thin layer chromatography (TLC) –** a form of chromatography in which the stationary phase is a thin layer of adsorbent material attached to a plate of glass or plastic (TLC plate). A small drop of mixture is placed on the plate, which is placed vertically inside a jar containing solvent. This is the mobile phase and separates the components of the mixture as it rises up the TLC plate.

**TMS –** Tetramethylsilane. A substance used as a reference compound for NMR as its methyl groups are particularly well shielded and so it produces a strong, single peak at the far right of an NMR spectrum.

**Wavenumber –** the number of cycles of waves in a unit length; the reciprocal of wavelength (1 / wavelength). Usually measured in m-1 or cm-1

**Unit 13 The Redox reactions**

**anode –** the positive electrode.

**electrochemical cell –** two half cells connected by a salt bridge, creating a potential difference that can be used to produce a current in a complete circuit.

**electrochemical series –** a list of standard electrode potentials ordered with the more negative electrode potentials at the top and the more positive potentials at the bottom.

**electrode – t**he part of a half cell at which either oxidation or reduction occurs.

**electrode potential –** a measure of how likely a half cell is to gain electrons. Represented by *E* (or *E*θ under standard conditions) and sometimes called reduction potentials. The electrode potential of a half cell cannot be measured directly but must be calculated by connecting the half-cell to a standard hydrogen electrode. Half cells with negative values of *E*θ are less likely to gain electrons (i.e. worse reducing agents) than hydrogen.

**electrolysis –** the process of passing an electric current through a molten or aqueous compound to split it into elements.

**electromotive force (e.m.f) –** the maximum voltage an electrochemical cell can produce. This can only be observed when negligible current flows.

**cathode –** the negative electrode.

**cryolite –** the substance Na3AlF6 (sodium hexafluoroaluminate) used to dissolve aluminium oxide to make the electrolyte for the extraction of aluminium by electrolysis.

**displacement reaction –** areaction in which an element is displaced out of a compound by a more reactive element; for example, bromine displaces iodine in: Br2 + 2KI → 2KBr + I2

**disproportionation –** a reaction in which the same element is both oxidized and reduced; for example, chlorine in: Cl2 + H2O → HCl + HOCl.

**half-cell –** half of an electrochemical cell, where either oxidation or reduction occurs. It consists of an electrode in contact with a solution of ions. The simplest half cells are a metal electrode immersed in a solution of metal ions.

**half equation –** an equation describing either the oxidation or reduction in a redox reaction; for example, Cl2 + 2e- → 2Cl- shows the reduction of chlorine to chloride ions.

**hydrogen electrode –** the half cell against which all other electrode potentials are measured. Also known as the standard hydrogen electrode. It consists of a 1moldm-3 solution of H+ ions, in which is immersed a platinum-covered electrode, and over which is passed hydrogen gas at standard temperature and pressure. The half equation is 2H+(aq) + 2e- → H2(g), and the standard electrode potential is 0.

**oxidation –** a reaction in which a substance loses electrons or increases its oxidation state.

**oxidation half equation –** a half equation where the reactant loses at least one electron. It is written with the electrons on the right of the arrow, i.e. as an oxidation.

**oxidation number –** a simple way of keeping track of redox reactions, so that it is easy to see which species has been oxidized and which reduced. Also known as an oxidation state.

**oxidation state –** the charge a particular atom in a compound would have if the compound consisted entirely of separate ions. Also called the oxidation number.

**oxidizing agent –** the species that accepts electrons, thus oxidizing another species while it is itself reduced.

**redox –** achemical reaction that involves an oxidation and a reduction.

**reduction –** areaction in which a substance gains at least one electron or decreases its oxidation state.

**reducing agent –** aspecies that donates electrons, thus reducing another species while it is itself oxidized.

**reduction half equation –** a half equation where the reactant gains at least one electron. It is written with the electrons on the left of the arrow, i.e. as a reduction (sometimes known as a reduction potential). Electrodes with negative values of Eθ are better at releasing electrons (better reducing agents) than hydrogen.

**salt bridge –** provides electrical contact between solutions without allowing them to mix. The simplest salt bridge is a piece of paper soaked in saturated salt solution, such as KCl(aq), KNO3(aq) or NH4NO3(aq). A better version is a glass tube filled with the salt in jelly form.

**spectator ion –** an ion that does not take part in a reaction but remains unchanged. Spectator ions may still appear in the overall redox equation for the reaction.

**standard electrode potential –** the potential difference between a particular electrode and a standard hydrogen electrode when both half cells are under standard conditions.

**standard hydrogen electrode –** the half-cell against which all other electrode potentials are measured. Also known as the standard hydrogen electrode. It consists of a 1moldm-3 solution of H+ ions, in which is immersed a platinum-covered electrode, and over which is passed hydrogen gas at standard temperature and pressure. The half equation is 2H+(aq) + 2e- → H2(g), and the standard electrode potential is 0.

**Unit 14 Halogens**

**bleach –** NaClO

**chlorate ion –** ClO-

**chloric (I) acid –** HClO

**diatomic –** molecules that exist as two atoms covalently bonded together.

**displacement –** the reaction when a more reactive halogen reacts with a compound containing a less reactive halogen.

**halide –** the name of a halogen when it has reacted with another substance and gained a full outer electron shell.

**halogen –** an element that belongs to group 7 of the periodic table.

**hydrogen halide –** acompound formed from the reaction between hydrogen and a halogen.

**metal halide –** a compound formed from the reaction between a metal and a halogen.

**sublime –** to change from a solid to a gas without first becoming a liquid.

**volatile –** a substance that evaporates or produces vapour at relatively low temperatures.

**Unit 14 The Alkaline Earth elements**

**alkaline earth metals –** any of the chemical elements, beryllium, magnesium, calcium, strontium, barium and radium. They react easily with other substances.

**alabaster –** CaSO4·2H2O an [almost](https://dictionary.cambridge.org/ru/%D1%81%D0%BB%D0%BE%D0%B2%D0%B0%D1%80%D1%8C/%D0%B0%D0%BD%D0%B3%D0%BB%D0%B8%D0%B9%D1%81%D0%BA%D0%B8%D0%B9/almost) [transparent](https://dictionary.cambridge.org/ru/%D1%81%D0%BB%D0%BE%D0%B2%D0%B0%D1%80%D1%8C/%D0%B0%D0%BD%D0%B3%D0%BB%D0%B8%D0%B9%D1%81%D0%BA%D0%B8%D0%B9/transparent), [white](https://dictionary.cambridge.org/ru/%D1%81%D0%BB%D0%BE%D0%B2%D0%B0%D1%80%D1%8C/%D0%B0%D0%BD%D0%B3%D0%BB%D0%B8%D0%B9%D1%81%D0%BA%D0%B8%D0%B9/white) [stone](https://dictionary.cambridge.org/ru/%D1%81%D0%BB%D0%BE%D0%B2%D0%B0%D1%80%D1%8C/%D0%B0%D0%BD%D0%B3%D0%BB%D0%B8%D0%B9%D1%81%D0%BA%D0%B8%D0%B9/stone), often used for making [decorative](https://dictionary.cambridge.org/ru/%D1%81%D0%BB%D0%BE%D0%B2%D0%B0%D1%80%D1%8C/%D0%B0%D0%BD%D0%B3%D0%BB%D0%B8%D0%B9%D1%81%D0%BA%D0%B8%D0%B9/decorative) [objects](https://dictionary.cambridge.org/ru/%D1%81%D0%BB%D0%BE%D0%B2%D0%B0%D1%80%D1%8C/%D0%B0%D0%BD%D0%B3%D0%BB%D0%B8%D0%B9%D1%81%D0%BA%D0%B8%D0%B9/object).

**barium meal –** barium sulphate, that is swallowed by a person just before an X-ray is taken of their stomach and bowels, so that these organs can be seen clearly.

**calcium hydroxide –** Ca(OH)2 a [white](https://dictionary.cambridge.org/ru/%D1%81%D0%BB%D0%BE%D0%B2%D0%B0%D1%80%D1%8C/%D0%B0%D0%BD%D0%B3%D0%BB%D0%B8%D0%B9%D1%81%D0%BA%D0%B8%D0%B9/white) [alkaline](https://dictionary.cambridge.org/ru/%D1%81%D0%BB%D0%BE%D0%B2%D0%B0%D1%80%D1%8C/%D0%B0%D0%BD%D0%B3%D0%BB%D0%B8%D0%B9%D1%81%D0%BA%D0%B8%D0%B9/alkali) [chemical](https://dictionary.cambridge.org/ru/%D1%81%D0%BB%D0%BE%D0%B2%D0%B0%D1%80%D1%8C/%D0%B0%D0%BD%D0%B3%D0%BB%D0%B8%D0%B9%D1%81%D0%BA%D0%B8%D0%B9/chemical) [compound](https://dictionary.cambridge.org/ru/%D1%81%D0%BB%D0%BE%D0%B2%D0%B0%D1%80%D1%8C/%D0%B0%D0%BD%D0%B3%D0%BB%D0%B8%D0%B9%D1%81%D0%BA%D0%B8%D0%B9/compound) used to make [cement](https://dictionary.cambridge.org/ru/%D1%81%D0%BB%D0%BE%D0%B2%D0%B0%D1%80%D1%8C/%D0%B0%D0%BD%D0%B3%D0%BB%D0%B8%D0%B9%D1%81%D0%BA%D0%B8%D0%B9/cement) and [plaster](https://dictionary.cambridge.org/ru/%D1%81%D0%BB%D0%BE%D0%B2%D0%B0%D1%80%D1%8C/%D0%B0%D0%BD%D0%B3%D0%BB%D0%B8%D0%B9%D1%81%D0%BA%D0%B8%D0%B9/plaster) and to [reduce](https://dictionary.cambridge.org/ru/%D1%81%D0%BB%D0%BE%D0%B2%D0%B0%D1%80%D1%8C/%D0%B0%D0%BD%D0%B3%D0%BB%D0%B8%D0%B9%D1%81%D0%BA%D0%B8%D0%B9/reduce) [acidity](https://dictionary.cambridge.org/ru/%D1%81%D0%BB%D0%BE%D0%B2%D0%B0%D1%80%D1%8C/%D0%B0%D0%BD%D0%B3%D0%BB%D0%B8%D0%B9%D1%81%D0%BA%D0%B8%D0%B9/acidity) in [soil](https://dictionary.cambridge.org/ru/%D1%81%D0%BB%D0%BE%D0%B2%D0%B0%D1%80%D1%8C/%D0%B0%D0%BD%D0%B3%D0%BB%D0%B8%D0%B9%D1%81%D0%BA%D0%B8%D0%B9/soil).

**calcium carbonate –** CaCO3, a common, white chemical compound found naturally as chalk, marble, and limestone, and in bones and shells, etc.

**flame test – a** test for the presence of particular metal ions, involving holding the substance in a flame. Different ions produce different coloured flames due to a different pattern of electron transitions and corresponding energy emissions on heating.

**limestone –** a [white](https://dictionary.cambridge.org/ru/%D1%81%D0%BB%D0%BE%D0%B2%D0%B0%D1%80%D1%8C/%D0%B0%D0%BD%D0%B3%D0%BB%D0%B8%D0%B9%D1%81%D0%BA%D0%B8%D0%B9/white) or [light](https://dictionary.cambridge.org/ru/%D1%81%D0%BB%D0%BE%D0%B2%D0%B0%D1%80%D1%8C/%D0%B0%D0%BD%D0%B3%D0%BB%D0%B8%D0%B9%D1%81%D0%BA%D0%B8%D0%B9/light) [grey](https://dictionary.cambridge.org/ru/%D1%81%D0%BB%D0%BE%D0%B2%D0%B0%D1%80%D1%8C/%D0%B0%D0%BD%D0%B3%D0%BB%D0%B8%D0%B9%D1%81%D0%BA%D0%B8%D0%B9/grey) [rock](https://dictionary.cambridge.org/ru/%D1%81%D0%BB%D0%BE%D0%B2%D0%B0%D1%80%D1%8C/%D0%B0%D0%BD%D0%B3%D0%BB%D0%B8%D0%B9%D1%81%D0%BA%D0%B8%D0%B9/rock) that is used as a [building](https://dictionary.cambridge.org/ru/%D1%81%D0%BB%D0%BE%D0%B2%D0%B0%D1%80%D1%8C/%D0%B0%D0%BD%D0%B3%D0%BB%D0%B8%D0%B9%D1%81%D0%BA%D0%B8%D0%B9/building) [material](https://dictionary.cambridge.org/ru/%D1%81%D0%BB%D0%BE%D0%B2%D0%B0%D1%80%D1%8C/%D0%B0%D0%BD%D0%B3%D0%BB%D0%B8%D0%B9%D1%81%D0%BA%D0%B8%D0%B9/material) and in the making of [cement](https://dictionary.cambridge.org/ru/%D1%81%D0%BB%D0%BE%D0%B2%D0%B0%D1%80%D1%8C/%D0%B0%D0%BD%D0%B3%D0%BB%D0%B8%D0%B9%D1%81%D0%BA%D0%B8%D0%B9/cement).

**marble –** CaCO3 a [type](https://dictionary.cambridge.org/ru/%D1%81%D0%BB%D0%BE%D0%B2%D0%B0%D1%80%D1%8C/%D0%B0%D0%BD%D0%B3%D0%BB%D0%B8%D0%B9%D1%81%D0%BA%D0%B8%D0%B9/type) of very hard [rock](https://dictionary.cambridge.org/ru/%D1%81%D0%BB%D0%BE%D0%B2%D0%B0%D1%80%D1%8C/%D0%B0%D0%BD%D0%B3%D0%BB%D0%B8%D0%B9%D1%81%D0%BA%D0%B8%D0%B9/rock) that has a [pattern](https://dictionary.cambridge.org/ru/%D1%81%D0%BB%D0%BE%D0%B2%D0%B0%D1%80%D1%8C/%D0%B0%D0%BD%D0%B3%D0%BB%D0%B8%D0%B9%D1%81%D0%BA%D0%B8%D0%B9/pattern) of [lines](https://dictionary.cambridge.org/ru/%D1%81%D0%BB%D0%BE%D0%B2%D0%B0%D1%80%D1%8C/%D0%B0%D0%BD%D0%B3%D0%BB%D0%B8%D0%B9%D1%81%D0%BA%D0%B8%D0%B9/line) going through it, [feels](https://dictionary.cambridge.org/ru/%D1%81%D0%BB%D0%BE%D0%B2%D0%B0%D1%80%D1%8C/%D0%B0%D0%BD%D0%B3%D0%BB%D0%B8%D0%B9%D1%81%D0%BA%D0%B8%D0%B9/feel) [cold](https://dictionary.cambridge.org/ru/%D1%81%D0%BB%D0%BE%D0%B2%D0%B0%D1%80%D1%8C/%D0%B0%D0%BD%D0%B3%D0%BB%D0%B8%D0%B9%D1%81%D0%BA%D0%B8%D0%B9/cold), and can be [polished](https://dictionary.cambridge.org/ru/%D1%81%D0%BB%D0%BE%D0%B2%D0%B0%D1%80%D1%8C/%D0%B0%D0%BD%D0%B3%D0%BB%D0%B8%D0%B9%D1%81%D0%BA%D0%B8%D0%B9/polished) to [become](https://dictionary.cambridge.org/ru/%D1%81%D0%BB%D0%BE%D0%B2%D0%B0%D1%80%D1%8C/%D0%B0%D0%BD%D0%B3%D0%BB%D0%B8%D0%B9%D1%81%D0%BA%D0%B8%D0%B9/become) [smooth](https://dictionary.cambridge.org/ru/%D1%81%D0%BB%D0%BE%D0%B2%D0%B0%D1%80%D1%8C/%D0%B0%D0%BD%D0%B3%D0%BB%D0%B8%D0%B9%D1%81%D0%BA%D0%B8%D0%B9/smooth) and [shiny](https://dictionary.cambridge.org/ru/%D1%81%D0%BB%D0%BE%D0%B2%D0%B0%D1%80%D1%8C/%D0%B0%D0%BD%D0%B3%D0%BB%D0%B8%D0%B9%D1%81%D0%BA%D0%B8%D0%B9/shiny).

**sparingly soluble – a** substance of which only a very small amount will dissolve.

**slaked lime – c**alcium hydroxide in solid form and is used to neutralize acidic soil.

**thermal decomposition – t**he process of splitting compounds using heat.

**thermal stability – t**he degree of resistance to thermal decomposition a compound has.

**Unit 16 Thermodynamics**

**anion –** a negatively-charged ion.

**bond dissociation enthalpy –** the energy required to break a particular bond. A cycle used to calculate the enthalpy of formation of an ionic compound. The formation is considered to be broken down into 5 steps: atomization of the metal, atomization of the non-metal, ionization of the metal, electron affinity of the non-metal, and lattice formation.

**cation –** apositively-charged ion.

**covalent character –** covalent character occurs in ionic compounds where some of the electron density is shared between the two ions.

**Δ*G –*** Delta G’, the symbol used to represent Gibbs free energy change.

**Δ*H –*** ‘Delta H’, the symbol used to represent enthalpy change.

**Δ*S –*** ‘Delta S’, the symbol used to represent entropy change.

**Δ*G*sol** – the Gibbs free energy change for dissolving.

**endothermic reaction –** a chemical reaction during which heat energy is taken in from the surroundings. Δ*H* for the reaction is positive.

**enthalpy –** ameasure of the energy stored in (or heat content of) a system. Given the symbol *H.*

**enthalpy change (for a reaction)** – the heat energy exchange between the reacting system and its surroundings at constant pressure. Given the symbol Δ*H.*

**entropy –** a measure of disorder, given the symbol *S*. The units of *S* are: J K–1 mol–1

**entropy change (for a reaction)** – the total entropy of the products of a reaction minus the total entropy of the reactants.

**exothermic reaction –** a chemical reaction during which heat energy is given out to the surroundings. Δ*H* for the reaction is negative.

**Gibbs free energy change –** a quantity taking into account the thermodynamic factors affecting whether or not a reaction takes place spontaneously. Δ*G* = Δ*H* – *T*Δ*S* and a reaction is spontaneous if Δ*G* < 0.

**Hess cycle –** adiagram showing a reaction taking place by two or more alternative routes, all of which involve the same enthalpy change, according to Hess's law. Also called an enthalpy cycle.

**Hess's Law –** a rule stating that the overall enthalpy change for a reaction is independent of the route the reaction takes.

**lattice dissociation enthalpy –** the enthalpy changes to break apart one mole of solid ionic compound into its constituent gaseous ions. This quantity has the same magnitude but opposite sign to the lattice formation enthalpy.

**lattice formation enthalpy –** the enthalpy changes for the formation of one mole of solid ionic compound from its constituent gaseous ions. This quantity has the same magnitude but opposite sign to the lattice dissociation enthalpy.

**mean bond enthalpy –** the average (mean) bond dissociation enthalpy for a particular bond in a range of different compounds. Precisely, it is the average enthalpy change for breaking one mole of a particular bond in a range of different compounds in the gas phase.

**polarizable –** the more easily polarizable an anion is, the more easily its electron density can be distorted by positive charge. Large ions are more polarizable than smaller ions.

**polarizing –** a cation is polarizing if it is able to draw electron density away from an anion, distorting the anion's electron density. Small and highly charged cations are the most polarizing.

**spontaneous reaction –** a reaction that tends to occur of its own accord.

**standard conditions –** the conditions under which standard enthalpy changes are measured. These are 298 K and 100 kPa.

**standard enthalpy of atomization –** the enthalpy changes when 1 mole of gaseous atoms of a substance are formed from the substance in its standard state under standard conditions.

**standard enthalpy of combustion –** the enthalpy changes when 1 mole of a substance undergoes complete combustion under standard conditions, with all substances being in their standard states.

**standard enthalpy of electron affinity –** the standard enthalpy of first electron affinity is the enthalpy change for the conversion of one mole of gaseous atoms into one mole of gaseous anions, each atom gaining one electron, under standard conditions, with all substances being in their standard states. Subsequent electron affinities represent the addition of further electrons to the gaseous anions.

**standard enthalpy of formation –** the enthalpy changes when 1 mole of a substance is formed from its elements under standard conditions, with all substances being in their standard states.

**standard enthalpy of hydration –** the enthalpy changes when one mole of gaseous ions is converted to one mole of aqueous ions under standard conditions, with all substances being in their standard states.

**standard enthalpy of solution –** the enthalpy changes when one mole of an ionic compound is dissolved in water to produce aqueous ions under standard conditions, with all substances being in their standard states.

**standard ionization enthalpy –** the first standard ionization enthalpy is the enthalpy change for the conversion of 1 mole of gaseous atoms to 1 mole of gaseous cations, each atom losing an electron, under standard conditions with all substances in their standard states. Subsequent ionization enthalpies represent removing further electrons from the gaseous cations.

**standard enthalpy of electron affinity –** the standard enthalpy of first electron affinity is the enthalpy change for the conversion of one mole of gaseous atoms into one mole of gaseous anions, each atom gaining one electron, under standard conditions, with all substances being in their standard states. Subsequent electron affinities represent the addition of further electrons to the gaseous anions.

**standard enthalpy of combustion –** the enthalpy changes when 1 mole of a substance undergoes complete combustion under standard conditions, with all substances being in their standard states.

**standard enthalpy of atomization –** the enthalpy changes when 1 mole of gaseous atoms of a substance are formed from the substance in its standard state under standard conditions.

**thermodynamics –** abranch of study concerned with the transfer of heat and work and the conversion between heat and other forms of energy. In its modern form it is based on four laws, the zeroth, first, second and third laws of thermodynamics.