

Grade 7 checklist

129 skills. Tick each one when you can do it. For grade 7 you need the skills for the grades below it too.

Atomic structure and the periodic table

- ☐ **Write ionic equations (Higher tier)** Show only the particles that change and leave out spectator ions, e.g. $\text{H}^+ + \text{OH}^- \rightarrow \text{H}_2\text{O}$. (Atoms, elements and compounds)
- ☐ **Plan a separation with several steps** Combine methods in a sensible order, e.g. dissolve, filter, then crystallise to get pure salt from rock salt. (Mixtures)
- ☐ **Explain what alpha scattering showed** Link each observation (most straight through, some deflected, very few bounced back) to its conclusion about the atom. (Development of the model of the atom)
- ☐ **Compare sizes using standard form** Divide one size by the other, e.g. $1 \times 10^{-10} \div 1 \times 10^{-14} = 10\,000$, and relate the scale to everyday objects. (Size and mass of atoms)
- ☐ **Calculate A_r for three isotopes** Same method with three terms; check that the abundances add up to 100%. (Relative atomic mass)
- ☐ **Predict reactions from an element's position** Use the group's typical reactions and trends, e.g. caesium reacts with water like sodium, but more vigorously. (The periodic table)
- ☐ **Explain why atomic weight order failed** Atomic weight depends on isotopes, so it does not always follow atomic number, e.g. argon and potassium. (Development of the periodic table)
- ☐ **Describe the whole development in order** Early tables, their problems, Mendeleev's changes, the discoveries that confirmed them, then isotopes and atomic number. (Development of the periodic table)
- ☐ **Explain properties using electronic structure** Metal atoms have few outer electrons, which they lose; non-metal atoms gain or share electrons. (Metals and non-metals)
- ☐ **Explain why reactivity increases down Group 1** The outer electron is further from the nucleus, so it is less strongly attracted and more easily lost. (Group 1)
- ☐ **Explain why reactivity decreases down Group 7** The outer shell is further from the nucleus, so an electron is attracted less strongly and gained less easily. (Group 7)
- ☐ **Explain a metal's use from its properties** e.g. copper is used for water pipes because it does not react with water and is strong. (Comparison with Group 1 elements)
- ☐ **Write formulae with variable-charge ions** Balance the charges, e.g. iron(III) oxide is Fe_2O_3 and copper(I) oxide is Cu_2O . (Typical properties)

Bonding, structure and the properties of matter

- ☐ **Tell chemical bonds from intermolecular forces** Chemical bonds hold atoms or ions together and are strong; intermolecular forces are weak forces between separate molecules. (Chemical bonds)
- ☐ **Describe electron transfer when the ratio is 2 : 1** For example, in lithium oxide two lithium atoms each transfer one electron to one oxygen atom. (Ionic bonding)

- ☐ **Give limitations of each type of diagram** For example, ball and stick models show gaps and sticks that are not really there; 2D diagrams do not show the 3D arrangement. (Ionic compounds)

- ☐ **Classify covalent substances as small, large or giant** Small molecules (e.g. CH₄), very large molecules (polymers) and giant covalent structures (e.g. diamond, silicon dioxide). (Covalent bonding)

- ☐ **Draw and label a diagram of metallic bonding** Regular rows of positive ions with electrons between them, labelled 'delocalised electrons'. (Metallic bonding)

- ☐ **Give limitations of the particle model (HT)** The model shows particles as solid spheres with no forces between them; real particles are not like this. (The three states of matter)

- ☐ **Use data and observations to choose state symbols** Use melting and boiling points, or words such as 'bubbles', 'precipitate' and 'solution', to decide each state. (State symbols)

- ☐ **Explain boiling point trends using molecule size** Larger molecules have stronger intermolecular forces, so they have higher melting and boiling points. (Properties of small molecules)

- ☐ **Compare intermolecular forces with covalent bonds** Covalent bonds are strong and intermolecular forces are weak, which explains the bulk properties of molecular substances. (Properties of small molecules)

- ☐ **Tell polymers from giant covalent structures** Polymers are separate chain molecules with forces between them; a giant covalent structure is one continuous network of covalent bonds. (Polymers)

- ☐ **Contrast giant covalent and small molecular substances** Melting a giant structure breaks covalent bonds; melting small molecules only overcomes intermolecular forces. (Giant covalent structures)

- ☐ **Interpret diagrams of pure metals and alloys** Regular layers of identical atoms compared with layers disrupted by atoms of a different size. (Properties of metals and alloys)

- ☐ **Compare conduction in metals and ionic compounds** Metals conduct when solid because electrons move; ionic compounds conduct only when molten or dissolved, because ions move. (Metals as conductors)

- ☐ **Link diamond's properties to its uses** Its hardness and very high melting point make it useful for cutting tools and drill tips. (Diamond)

- ☐ **Describe carbon nanotubes and their properties** Cylindrical fullerenes with a very high length to diameter ratio; very strong and conduct electricity. (Graphene and fullerenes)

- ☐ **Explain how the ratio changes with size** If the side of a cube is 10 times smaller, its surface area to volume ratio is 10 times bigger. (Sizes of particles and their properties)

- ☐ **Use data to compare nanoparticles with normal particles** For example, compare the protection, the coverage or the amount of material needed. (Uses of nanoparticles)

Quantitative chemistry

- ☐ **Balance equations with brackets in formulae** Count atoms inside brackets carefully, e.g. Ca(OH)₂ + 2HNO₃ → Ca(NO₃)₂ + 2H₂O. (Conservation of mass and balanced equations)

- ☐ **Show that M_r values balance in equations** The total M_r of the reactants (using balancing numbers) equals the total M_r of the products. (Relative formula mass)

- ☐ **Explain mass changes using the particle model** Gas particles move quickly and randomly and spread out, so they leave an open container or reach the reactants from the air. (Mass changes when a reactant or product is a gas)

- ☐ **Write a mean with its uncertainty** Give the mean $\pm$ uncertainty with a unit, e.g. $24.3 \pm 0.2 \text{ cm}^3$. (Chemical measurements and uncertainty)

- ☐ **Calculate mass from moles** $\text{mass (g)} = \text{moles} \times M_r$. (Moles)

- ☐ **Calculate product mass from reactant mass** Moles of known substance $\rightarrow$ mole ratio $\rightarrow$ moles of wanted substance $\rightarrow$ mass. (Amounts of substances in equations)

- ☐ **Find the simplest whole-number mole ratio** Divide every number of moles by the smallest one. (Using moles to balance equations)

- ☐ **Write the balanced equation from the ratio** The whole numbers are the balancing numbers in front of each formula. (Using moles to balance equations)

- ☐ **Identify the limiting reactant using moles** Divide the moles of each reactant by its balancing number; the smallest value is limiting. (Limiting reactants)

- ☐ **Explain how mass and volume affect concentration (HT)** More solute in the same volume, or the same solute in less volume, gives a higher concentration. (Concentration of solutions)

- ☐ **Calculate theoretical mass from an equation (HT)** Use reacting masses: moles of reactant $\rightarrow$ mole ratio $\rightarrow$ moles of product $\rightarrow$ mass. (Percentage yield)

- ☐ **Recognise reactions with 100% atom economy** A reaction with only one product has an atom economy of 100%. (Atom economy)

- ☐ **Convert between mol/dm^3 and g/dm^3** Multiply mol/dm^3 by M_r to get g/dm^3 ; divide by M_r to go back. (Concentrations in mol/dm^3)

- ☐ **Explain how amount and volume affect concentration** More solute in the same volume gives a higher concentration; the same solute in more volume gives a lower one. (Concentrations in mol/dm^3)

- ☐ **Calculate gas volume from mass** Find moles = $\text{mass} \div M_r$, then multiply by 24. (Volumes of gases)

- ☐ **Calculate moles or mass from gas volume** Moles = $\text{volume (dm}^3) \div 24$; mass = moles $\times M_r$. (Volumes of gases)

Chemical changes

- ☐ **Explain why a reaction is a redox reaction** Show that one substance gains oxygen while another loses oxygen in the same reaction. (Metal oxides)

- ☐ **Link reactivity to forming positive ions** The more easily a metal's atoms lose electrons to form positive ions, the more reactive the metal is. (The reactivity series)

- ☐ **Evaluate an unfamiliar extraction method** Use the information given and the reactivity series to judge a method on energy, cost, raw materials and waste. (Extraction of metals and reduction)

- ☐ **Write half equations for displacement reactions** For example, $\text{Mg} \rightarrow \text{Mg}^{2+} + 2\text{e}^-$ and $\text{Cu}^{2+} + 2\text{e}^- \rightarrow \text{Cu}$. (Oxidation and reduction in terms of electrons)

- ☐ **Explain these reactions as redox reactions** The metal atoms lose electrons (oxidised) and the hydrogen ions gain electrons (reduced). (Reactions of acids with metals)

- ☐ **Write balanced equations for neutralisation reactions** For example, $\text{CaCO}_3 + 2\text{HCl} \rightarrow \text{CaCl}_2 + \text{H}_2\text{O} + \text{CO}_2$. (Neutralisation and salt production)

- ☐ **Choose suitable reactants for a named salt** Pick the acid with the right negative ion and an insoluble compound of the metal (or a metal that is safe to use). (Soluble salts)

- ☐ **Calculate a concentration in mol/dm³** moles = concentration $\times$ volume in dm³, use the mole ratio, then concentration = moles $\div$ volume. (Titrations)

- ☐ **Convert between mol/dm³ and g/dm³** Concentration in g/dm³ = concentration in mol/dm³ $\times$ M_r. (Titrations)

- ☐ **Explain why a stronger acid has lower pH** At the same concentration, a strong acid releases more H⁺ ions, so its pH is lower. (Strong and weak acids)

- ☐ **Explain what happens when ions are discharged** At the electrodes, ions gain or lose electrons and become atoms or molecules of elements. (The process of electrolysis)

- ☐ **Write half equations for molten electrolysis** For example, $\text{Pb}^{2+} + 2\text{e}^- \rightarrow \text{Pb}$ and $2\text{Br}^- \rightarrow \text{Br}_2 + 2\text{e}^-$. (Electrolysis of molten ionic compounds)

- ☐ **Explain why the anodes must be replaced** Oxygen formed at the carbon anodes reacts with them to form carbon dioxide, so they wear away. (Using electrolysis to extract metals)

- ☐ **Plan the required practical investigation** Use inert electrodes and a d.c. supply, identify each product, and compare solutions to test a hypothesis. (Electrolysis of aqueous solutions)

- ☐ **Write the half equation for hydrogen** $2\text{H}^+ + 2\text{e}^- \rightarrow \text{H}_2$. (Half equations at electrodes)

Energy changes

- ☐ **Suggest and explain improvements to the practical** For example, a lid and extra insulation reduce energy transfer to the surroundings, and repeats let you calculate a mean. (Energy transfer in exothermic and endothermic reactions)

- ☐ **Explain why some reactions need heating to start** Particles must collide with at least the activation energy, so energy (e.g. a spark or flame) must be supplied at first. (Reaction profiles)

- ☐ **Calculate the energy change for a simple reaction** Overall energy change = energy to break bonds – energy released making bonds, e.g. for $\text{H}_2 + \text{Cl}_2 \rightarrow 2\text{HCl}$. (Energy change of reactions (bond energies))

- ☐ **Evaluate rechargeable and non-rechargeable cells** Compare cost, lifetime, voltage, waste and convenience using given data, and reach a justified conclusion. (Cells and batteries)

- ☐ **Evaluate fuel cells against rechargeable batteries** Compare range, refuelling or recharging time, storage, safety, disposal and how the hydrogen or electricity is produced. (Fuel cells)

The rate and extent of chemical change

- ☐ **Calculate the gradient of a tangent (HT)** Rate at that time = change in y $\div$ change in x, using two points far apart on the tangent. (Calculating rates of reactions)

- ☐ **Calculate a mean rate in mol/s (HT)** Convert a mass to moles with $\text{moles} = \frac{\text{mass}}{M_r}$ (or A_r), then divide by the time in seconds. (Calculating rates of reactions)

- ☐ **Calculate surface area to volume ratio** For a cube, surface area = $6 \times \text{side}^2$ and volume = side^3 ; smaller pieces have a larger ratio. (Collision theory and activation energy)

- ☐ **Link catalysis to successful collisions** With a lower activation energy, more collisions have enough energy to react, so successful collisions are more frequent. (Catalysts)

- ☐ **Explain how the rates change before equilibrium** The forward rate falls as reactants are used up and the reverse rate rises as products build up, until they are equal. (Equilibrium)

- ☐ **Predict the effect of a change in conditions** Use the information given (equation, energy change, numbers of molecules) to say which way the position shifts. (Changing conditions and equilibrium)

- ☐ **Explain shifts using Le Chatelier's principle** The system counteracts the change by using up an added substance or replacing a removed one. (Effect of changing concentration)

- ☐ **Explain temperature effects using Le Chatelier** Increasing the temperature favours the endothermic direction, which takes in energy. (Effect of temperature changes)

- ☐ **Deduce the energy change from yield data** If the yield falls as the temperature rises, the forward reaction is exothermic. (Effect of temperature changes)

- ☐ **Recognise when pressure has no effect** If both sides have the same number of gas molecules, changing the pressure does not move the position. (Effect of pressure changes)

- ☐ **Explain pressure effects using Le Chatelier** Fewer molecules exert a lower pressure, so shifting to that side counteracts a pressure increase. (Effect of pressure changes)

Organic chemistry

- ☐ **Work out an alkane's formula from its Mr** $M_r = 14n + 2$, so solve for n: an M_r of 72 gives $n = 5$, which is C_5H_{12} . (Crude oil, hydrocarbons and alkanes)

- ☐ **Explain why there are so many carbon compounds** Carbon atoms can bond to each other to form chains of different lengths, making families of similar compounds. (Fractional distillation and petrochemicals)

- ☐ **Explain the boiling point trend using intermolecular forces** Larger molecules have stronger forces between the molecules, so more energy is needed to overcome them. (Properties of hydrocarbons)

- ☐ **Work out an alkene's formula from its Mr** $M_r = 14n$, so an M_r of 56 gives $n = 4$: C_4H_8 , butene. (Structure and formulae of alkenes)

- ☐ **Draw displayed formulae of addition products** Keep the carbon chain, make the $C=C$ single, and put one new atom or group on each carbon of the old double bond. (Reactions of alkenes)

- ☐ **Explain the bromine water test** Bromine adds across the $C=C$ to form a colourless product; alkanes have no $C=C$, so the bromine water stays orange. (Reactions of alkenes)

- ☐ **Explain the conditions used for fermentation** Too hot denatures the enzymes in yeast; oxygen would oxidise the ethanol to ethanoic acid. (Alcohols)

- ☐ **Explain why carboxylic acids are weak acids** They only partially ionise in water, so the H^+ concentration is lower and the pH higher than a strong acid of the same concentration. (Carboxylic acids)

- ☐ **Draw the monomer from a repeating unit** Put a C=C between the two chain carbons and remove the brackets, n and the extending bonds. (Addition polymerisation)

- ☐ **Explain why the repeating unit matches the monomer** No other product forms in addition polymerisation, so the repeating unit has the same atoms as the monomer. (Addition polymerisation)

- ☐ **Explain what condensation polymerisation is** Monomers with two functional groups join together, and a small molecule is lost at each link. (Condensation polymerisation)

- ☐ **Complete a polyester equation using block diagrams** Remove H from each –OH and OH from each –COOH, join the blocks with ester links, and add $2n \text{ H}_2\text{O}$. (Condensation polymerisation)

- ☐ **Explain how amino acids join together** The –NH_2 of one reacts with the –COOH of another, and a water molecule is lost (condensation). (Amino acids)

- ☐ **Draw the repeating unit of a polypeptide** For glycine it is $\text{–NH–CH}_2\text{–CO–}$ (with the C=O shown), in brackets with n. (Amino acids)

- ☐ **Link natural polymers to condensation polymerisation** Proteins, starch and cellulose form by condensation: water is released each time two monomers join. (DNA and other naturally occurring polymers)

Chemical analysis

- ☐ **Compare data to rank samples by purity** The purer sample melts closer to the pure value and over a narrower range of temperatures. (Pure substances)

- ☐ **Predict effects of changing a formulation** Changing the amount of one component changes the properties of the product, so it may no longer do its job. (Formulations)

- ☐ **Explain how chromatography separates substances** Each substance is distributed differently between the mobile and stationary phases, so each moves a different distance. (Chromatography)

- ☐ **Use different solvents to test purity** A pure compound gives a single spot in every solvent; a mixture may only separate in some solvents. (Chromatography)

- ☐ **Explain why limewater turns milky** Carbon dioxide reacts with calcium hydroxide to form insoluble calcium carbonate, a white precipitate. (Test for carbon dioxide)

- ☐ **Evaluate flame tests as a method** Quick and cheap, but they work for only some ions, rely on judging colours and fail with mixtures. (Flame tests)

- ☐ **Write ionic equations with state symbols** e.g. $\text{Fe}^{3+}(\text{aq}) + 3\text{OH}^{-}(\text{aq}) \rightarrow \text{Fe}(\text{OH})_3(\text{s})$. (Metal hydroxides)

- ☐ **Write the ionic equation for carbonate and acid** $\text{CO}_3^{2-} + 2\text{H}^{+} \rightarrow \text{H}_2\text{O} + \text{CO}_2$. (Carbonates)

- ☐ **Explain why acid is added in other tests** In the halide and sulfate tests, the acid removes carbonate ions, which would also form a precipitate. (Carbonates)

- ☐ **Write ionic equations for silver halide precipitates** e.g. $\text{Ag}^{+}(\text{aq}) + \text{Cl}^{-}(\text{aq}) \rightarrow \text{AgCl}(\text{s})$. (Halides)

- ☐ **Plan tests to identify several unknown compounds** Choose a test for each positive ion and each negative ion, and give the result for each compound. (Sulfates)

- ☐ **Write the ionic equation for barium sulfate** $\text{Ba}^{2+}(\text{aq}) + \text{SO}_4^{2-}(\text{aq}) \rightarrow \text{BaSO}_4(\text{s})$. (Sulfates)

- ☐ **Evaluate methods for a given situation** Weigh up cost, speed, sample size, number of samples, mixtures and whether amounts are needed, then reach a judgement. (Instrumental methods)
- ☐ **Relate line intensity to concentration** The more concentrated the metal ion, the more intense (brighter) its lines. (Flame emission spectroscopy)
- ☐ **Use calibration data to find concentration** Use intensities for solutions of known concentration to read off the concentration of the unknown. (Flame emission spectroscopy)

Chemistry of the atmosphere

- ☐ **Calculate percentage oxygen from experimental results** Divide the decrease in gas volume, when oxygen is removed by a reaction, by the starting volume and multiply by 100. (Proportions of gases in the atmosphere)
- ☐ **Use given evidence to evaluate a theory** Say which evidence supports the theory, which does not, and why the evidence is uncertain, then give a conclusion. (The Earth's early atmosphere)
- ☐ **Balance the symbol equation for photosynthesis** The balanced equation is $6\text{CO}_2 + 6\text{H}_2\text{O} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2$. (How oxygen increased)
- ☐ **Explain how these deposits removed carbon dioxide** The carbon in the organisms came from carbon dioxide, and burying them locked it away for millions of years. (How carbon dioxide decreased)
- ☐ **Explain why more greenhouse gases cause warming** More long wavelength radiation is absorbed and re-emitted towards the Earth, so less escapes to space and the average temperature rises. (Greenhouse gases)
- ☐ **Describe uncertainties in climate evidence** The climate is complex, so models are simplified, data about the past are incomplete and future emissions are unknown. (Human activities that increase greenhouse gases)
- ☐ **Explain effects on food production and wildlife** Changes in temperature and rainfall change where crops grow well and where species can survive. (Global climate change)
- ☐ **Calculate and compare emissions from data** Use given data, e.g. grams of carbon dioxide per km $\times$ distance, and convert units correctly. (The carbon footprint and its reduction)
- ☐ **Write balanced equations for combustion** For example, $2\text{CH}_4 + 3\text{O}_2 \rightarrow 2\text{CO} + 4\text{H}_2\text{O}$ for incomplete combustion of methane. (Atmospheric pollutants from fuels)
- ☐ **Explain why carbon monoxide is toxic** It combines with haemoglobin in red blood cells, so the blood carries less oxygen. (Properties and effects of atmospheric pollutants)

Using resources

- ☐ **Interpret resource data from charts and tables** Read values, describe trends and calculate, for example how many years a reserve will last. (Using resources and sustainable development)
- ☐ **Compare treating ground water and salty water** Ground water only needs filtering and sterilising; salty water must be desalinated, which needs large amounts of energy. (Potable water)
- ☐ **Calculate dissolved solids from practical results** Mass of dried residue $\div$ volume of the sample, e.g. in g/dm^3 after converting cm^3 to dm^3 . (Potable water)

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- ☐ **Compare treating waste, ground and salt water** Ground water needs the least treatment; waste water needs many stages; salt water needs desalination, which uses large amounts of energy. (Waste water treatment)
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- ☐ **Explain displacement and electrolysis of copper compounds** Iron is more reactive than copper; at the negative electrode $\text{Cu}^{2+} + 2\text{e}^- \rightarrow \text{Cu}$. (Alternative methods of extracting metals)
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- ☐ **Explain why LCAs are not fully objective** Giving numerical values to the effects of pollutants needs value judgements. (Life cycle assessment)
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- ☐ **Evaluate a recycling scheme from given data** Balance the resources and energy saved against the energy and cost of collecting, transporting and sorting. (Ways of reducing the use of resources)
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- ☐ **Explain sacrificial protection using relative reactivity** A more reactive metal loses electrons (is oxidised) in preference to iron, so the iron does not rust. (Corrosion and its prevention)
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- ☐ **Choose an alloy using data on properties** Match properties such as density, strength and resistance to corrosion to the use, quoting the data. (Alloys as useful materials)
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- ☐ **Explain thermosoftening vs thermosetting using structure** Thermosetting polymers have cross-links between chains so do not melt; thermosoftening polymers have only weak intermolecular forces between chains. (Ceramics, polymers and composites)
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- ☐ **Explain the choice of pressure** Higher pressure favours the side with fewer gas molecules and increases the rate, but costs more and is more dangerous. (The Haber process)
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- ☐ **Calculate percentage of nitrogen in a fertiliser** Mass of nitrogen atoms in the formula $\div M_r \times 100$, e.g. 35% in ammonium nitrate. (Production and uses of NPK fertilisers)
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