

Grade 3 skills checklist

111 skills: the first skills to learn. Tick each one when you can do it.

Atomic structure and the periodic table

- ☐ **Tell elements from compounds using formulae** An element's formula has one symbol (Fe, O₂); a compound's formula has two or more different symbols (CO₂, NaCl). (Atoms, elements and compounds)
- ☐ **Recall symbols of the first 20 elements** Also the Group 1 and Group 7 elements and others in the course, with the correct capital and lower-case letters. (Atoms, elements and compounds)
- ☐ **Define a mixture** Two or more elements or compounds that are not chemically combined together. (Mixtures)
- ☐ **State that models change with new evidence** A scientific model may be changed or replaced when new experimental evidence doesn't fit it. (Development of the model of the atom)
- ☐ **Recall the charges of subatomic particles** Proton +1, neutron 0, electron -1. (Relative charges of subatomic particles)
- ☐ **State where each particle is found** Protons and neutrons are in the nucleus; electrons are in shells around it. (Relative charges of subatomic particles)
- ☐ **Recall relative masses of subatomic particles** Proton 1, neutron 1, electron very small. (Size and mass of atoms)
- ☐ **Recall how many electrons each shell holds** For the first 20 elements: 2 in the first shell, then up to 8 in the second and 8 in the third. (Electronic structure)
- ☐ **Identify groups and periods** Groups are the vertical columns; periods are the horizontal rows. (The periodic table)
- ☐ **State how early tables were ordered** By atomic weight, because protons, neutrons and electrons had not been discovered. (Development of the periodic table)
- ☐ **Locate metals and non-metals in the table** Metals are on the left and towards the bottom; non-metals are on the right and towards the top. (Metals and non-metals)
- ☐ **Name Group 0 and some of its elements** The noble gases: helium, neon, argon, krypton, xenon and radon. (Group 0)
- ☐ **Explain the name 'alkali metals'** They react with water to form hydroxides that dissolve to give alkaline solutions. (Group 1)
- ☐ **Recall the halogens and their states** At room temperature chlorine is a green gas, bromine a red-brown liquid and iodine a grey-black solid. (Group 7)
- ☐ **Locate the transition metals in the table** They are the central block, between Group 2 and Group 3. (Comparison with Group 1 elements)

Bonding, structure and the properties of matter

- ☐ **Name the three types of strong bond** Ionic, covalent and metallic. (Chemical bonds)

- ☐ **State that metals lose and non-metals gain electrons** Metal atoms lose outer electrons to form positive ions; non-metal atoms gain electrons to form negative ions. (Ionic bonding)

- ☐ **Describe an ionic compound as a giant structure** It is a giant structure (lattice) of ions arranged in a regular pattern. (Ionic compounds)

- ☐ **Describe a covalent bond as a shared pair** A covalent bond is a pair of electrons shared between two atoms. Covalent bonds are strong. (Covalent bonding)

- ☐ **State that metals have giant structures** The atoms in a metal are arranged in a regular pattern in a giant structure. (Metallic bonding)

- ☐ **Name the changes of state** Melting and freezing happen at the melting point; boiling and condensing happen at the boiling point. (The three states of matter)

- ☐ **Recall the four state symbols** (s) solid, (l) liquid, (g) gas, (aq) aqueous: dissolved in water. (State symbols)

- ☐ **State that ionic compounds have high melting points** Ionic compounds such as sodium chloride are solids at room temperature with high melting and boiling points. (Properties of ionic compounds)

- ☐ **State that small molecules have low boiling points** Substances made of small molecules are usually gases or liquids at room temperature. (Properties of small molecules)

- ☐ **State that polymers have very large molecules** Polymer molecules are long chains made of many repeating units. (Polymers)

- ☐ **Name examples of giant covalent structures** Diamond and graphite (both forms of carbon) and silicon dioxide (silica). (Giant covalent structures)

- ☐ **State that pure metals can be bent and shaped** The atoms in a pure metal are arranged in layers. (Properties of metals and alloys)

- ☐ **State that metals conduct electricity and heat** Metals are good conductors of electricity and of thermal energy. (Metals as conductors)

- ☐ **State that diamond is a form of carbon** Diamond is made only of carbon atoms, in a giant covalent structure. (Diamond)

- ☐ **Describe graphite as layers of carbon atoms** Graphite is made of layers of carbon atoms arranged in hexagonal rings. (Graphite)

- ☐ **Describe graphene as one layer of graphite** Graphene is a single layer of carbon atoms in hexagonal rings, one atom thick. (Graphene and fullerenes)

Quantitative chemistry

- ☐ **State the law of conservation of mass** No atoms are lost or made in a reaction, so the mass of the products equals the mass of the reactants. (Conservation of mass and balanced equations)

- ☐ **Count the atoms in a formula** Multiply the small numbers by the big number in front, e.g. $2\text{H}_2\text{O}$ contains 4 hydrogen atoms and 2 oxygen atoms. (Conservation of mass and balanced equations)

- ☐ **Read relative atomic masses from the periodic table** A_r is the larger of the two numbers in each box, e.g. O = 16, Na = 23. (Relative formula mass)

- ☐ **State that gases can enter or leave** In an open container, gases can escape into the air or react from the air. (Mass changes when a reactant or product is a gas)
- ☐ **Calculate a mean from repeat readings** Add up the results, leaving out any anomalous ones, and divide by how many you added. (Chemical measurements and uncertainty)
- ☐ **Recall the unit of concentration** Mass of solute per volume of solution, usually grams per dm^3 (g/dm^3). (Concentration of solutions)

Chemical changes

- ☐ **Name the oxide formed by a metal** A metal reacting with oxygen forms the metal oxide, e.g. magnesium + oxygen $\rightarrow$ magnesium oxide. (Metal oxides)
- ☐ **Recall the order of the reactivity series** Potassium, sodium, lithium, calcium, magnesium, (carbon), zinc, iron, (hydrogen), copper, from most to least reactive. (The reactivity series)
- ☐ **Explain why gold is found as the metal** Gold is so unreactive that it is found in the Earth as the metal itself, not as a compound. (Extraction of metals and reduction)
- ☐ **Name the products of metal + acid** A salt and hydrogen, e.g. magnesium + hydrochloric acid $\rightarrow$ magnesium chloride + hydrogen. (Reactions of acids with metals)
- ☐ **Name the salt type from each acid** Hydrochloric acid gives chlorides, nitric acid gives nitrates and sulfuric acid gives sulfates. (Neutralisation and salt production)
- ☐ **Name reactants needed to make a salt** For example, copper(II) oxide and sulfuric acid make copper(II) sulfate. (Soluble salts)
- ☐ **Use pH to classify solutions** Below 7 is acidic, 7 is neutral and above 7 is alkaline. (The pH scale and neutralisation)
- ☐ **Name the electrodes and their charges** The cathode is the negative electrode and the anode is the positive electrode. (The process of electrolysis)
- ☐ **State the products from molten lead bromide** Lead is produced at the cathode and bromine at the anode. (Electrolysis of molten ionic compounds)

Energy changes

- ☐ **Define exothermic and endothermic reactions** Exothermic reactions transfer energy to the surroundings so their temperature rises; endothermic reactions take in energy so their temperature falls. (Energy transfer in exothermic and endothermic reactions)
- ☐ **Give examples of exothermic reactions** Combustion, many oxidation reactions and neutralisation are all exothermic. (Energy transfer in exothermic and endothermic reactions)
- ☐ **State what activation energy is** The minimum amount of energy that particles must have to react when they collide. (Reaction profiles)
- ☐ **State what a cell does** A cell contains chemicals that react to produce electricity. (Cells and batteries)
- ☐ **Name what a hydrogen fuel cell uses** Hydrogen (the fuel) and oxygen or air are supplied to the cell from outside. (Fuel cells)

The rate and extent of chemical change

- ☐ **Say what the rate of reaction measures** Rate is how quickly a reactant is used up or a product is formed.
(Calculating rates of reactions)
- ☐ **Name the five factors that affect rate** Concentration of solutions, pressure of gases, surface area of solids, temperature and the presence of a catalyst. (Factors which affect the rate of reaction)
- ☐ **State that particles must collide to react** A reaction can only happen when reactant particles collide with each other. (Collision theory and activation energy)
- ☐ **State what a catalyst does** It increases the rate of a reaction but is not used up. (Catalysts)
- ☐ **Recognise the reversible reaction symbol** $\rightleftharpoons$ The $\rightleftharpoons$ symbol shows that a reaction can go in both directions. (Reversible reactions)
- ☐ **Recall what exothermic and endothermic mean** Exothermic reactions transfer energy to the surroundings; endothermic reactions take in energy from the surroundings. (Energy changes and reversible reactions)

Organic chemistry

- ☐ **State what crude oil is** A finite resource found in rocks: the remains of an ancient biomass, mainly plankton, that was buried in mud. (Crude oil, hydrocarbons and alkanes)
- ☐ **Define a hydrocarbon** A compound whose molecules are made of hydrogen and carbon atoms only.
(Crude oil, hydrocarbons and alkanes)
- ☐ **Name fuels produced from crude oil** Petrol, diesel oil, kerosene, heavy fuel oil and liquefied petroleum gases (LPG). (Fractional distillation and petrochemicals)
- ☐ **Name materials made by the petrochemical industry** Solvents, lubricants, polymers and detergents.
(Fractional distillation and petrochemicals)
- ☐ **Name the products of complete combustion** A hydrocarbon burns completely in oxygen to form carbon dioxide and water. (Properties of hydrocarbons)
- ☐ **Define cracking** Breaking down large hydrocarbon molecules into smaller, more useful molecules.
(Cracking and alkenes)
- ☐ **State what an alkene is** A hydrocarbon with a carbon–carbon double bond, $C=C$. (Structure and formulae of alkenes)
- ☐ **Name the functional group of the alkenes** $C=C$, the carbon–carbon double bond. (Reactions of alkenes)
- ☐ **Name the functional group of the alcohols** The $-OH$ group. (Alcohols)
- ☐ **Give the main uses of alcohols** As fuels and solvents; ethanol is the main alcohol in alcoholic drinks.
(Alcohols)
- ☐ **Name the functional group of carboxylic acids** The $-COOH$ group. (Carboxylic acids)
- ☐ **Define monomer and polymer** Monomers are small molecules that join together in large numbers to make a very large molecule, a polymer. (Addition polymerisation)
- ☐ **Name natural polymers that are important for life** DNA, proteins, starch and cellulose. (DNA and other naturally occurring polymers)

Chemical analysis

- ☐ **Define a pure substance in chemistry** A single element or a single compound, not mixed with any other substance. (Pure substances)
- ☐ **Define a formulation** A mixture that has been designed as a useful product. (Formulations)
- ☐ **Give examples of formulations** Fuels, cleaning agents, paints, medicines, alloys, fertilisers and foods. (Formulations)
- ☐ **Tell mixtures from pure substances on chromatograms** A mixture gives two or more spots; a pure substance gives a single spot. (Chromatography)
- ☐ **Describe the test for hydrogen** Hold a burning splint at the open end of a test tube of the gas. (Test for hydrogen)
- ☐ **State the positive result for hydrogen** Hydrogen burns rapidly with a pop sound (a 'squeaky pop'). (Test for hydrogen)
- ☐ **Describe the test for oxygen** Put a glowing splint into a test tube of the gas. (Test for oxygen)
- ☐ **State the positive result for oxygen** The glowing splint relights (bursts back into flame). (Test for oxygen)
- ☐ **Describe the test for carbon dioxide** Bubble the gas through limewater, or shake the gas with limewater. (Test for carbon dioxide)
- ☐ **State the positive result for carbon dioxide** The limewater turns milky (cloudy). (Test for carbon dioxide)
- ☐ **Describe the test for chlorine** Put damp litmus paper into the gas. (Test for chlorine)
- ☐ **State the positive result for chlorine** The litmus paper is bleached and turns white. (Test for chlorine)
- ☐ **Recall the five flame test colours** Lithium crimson, sodium yellow, potassium lilac, calcium orange-red, copper green. (Flame tests)
- ☐ **Recall the coloured hydroxide precipitates** Copper(II) blue, iron(II) green, iron(III) brown. (Metal hydroxides)
- ☐ **Describe the test for carbonate ions** Add dilute acid and bubble any gas given off through limewater. (Carbonates)
- ☐ **State the positive result for carbonates** Fizzing, and the gas turns limewater milky (cloudy). (Carbonates)
- ☐ **Recall the silver halide precipitate colours** Chloride white, bromide cream, iodide yellow. (Halides)
- ☐ **Describe the test for sulfate ions** Add dilute hydrochloric acid, then barium chloride solution, to a solution of the sample. (Sulfates)
- ☐ **State the positive result for sulfates** A white precipitate of barium sulfate forms. (Sulfates)
- ☐ **State what instrumental methods are** Methods that use instruments (machines) to detect and identify elements and compounds. (Instrumental methods)

Chemistry of the atmosphere

- ☐ **Name the two main gases in air** Nitrogen makes up about four-fifths of the air and oxygen about one-fifth. (Proportions of gases in the atmosphere)

- ☐ **Give the percentages of nitrogen and oxygen** Air is about 80% nitrogen and about 20% oxygen.
(Proportions of gases in the atmosphere)
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- ☐ **Say where the early atmosphere came from** Intense volcanic activity during the Earth's first billion years released the gases that formed it. (The Earth's early atmosphere)
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- ☐ **Name the process that produced the oxygen** Photosynthesis by algae and plants produced the oxygen that is now in the atmosphere. (How oxygen increased)
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- ☐ **Name a process that removed carbon dioxide** Photosynthesis by algae and plants took carbon dioxide out of the atmosphere. (How carbon dioxide decreased)
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- ☐ **Name three greenhouse gases** Water vapour, carbon dioxide and methane are greenhouse gases.
(Greenhouse gases)
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- ☐ **Give two activities that release carbon dioxide** Burning fossil fuels and deforestation both increase the carbon dioxide in the atmosphere. (Human activities that increase greenhouse gases)
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- ☐ **State a major cause of climate change** An increase in the average global temperature is a major cause of climate change. (Global climate change)
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- ☐ **Give one way to reduce carbon dioxide emissions** For example, generate electricity from renewable resources instead of burning fossil fuels. (The carbon footprint and its reduction)
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- ☐ **Name the products of complete combustion** A fuel containing carbon and hydrogen forms carbon dioxide and water when it burns in plenty of oxygen. (Atmospheric pollutants from fuels)
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- ☐ **State that carbon monoxide is toxic** Carbon monoxide is a toxic (poisonous) gas. (Properties and effects of atmospheric pollutants)
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Using resources

- ☐ **State what humans use Earth's resources for** To provide warmth, shelter, food and transport. (Using resources and sustainable development)
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- ☐ **State what potable water means** Potable water is water that is safe to drink. (Potable water)
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- ☐ **Say why waste water must be treated** Towns and industry produce large amounts of waste water that must be treated before it is released into the environment. (Waste water treatment)
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- ☐ **Name the four stages of an LCA** Extracting and processing raw materials, manufacturing and packaging, use and operation, and disposal. (Life cycle assessment)
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- ☐ **State the three ways to reduce resource use** Reduce use, reuse and recycle. (Ways of reducing the use of resources)
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- ☐ **Define corrosion and give an example** Corrosion is the destruction of materials by chemical reactions with substances in the environment; rusting is an example. (Corrosion and its prevention)
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- ☐ **State what an alloy is** A mixture of a metal with at least one other element, usually another metal (or carbon, in steel). (Alloys as useful materials)
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- ☐ **Name the raw materials for soda-lime glass** Sand, sodium carbonate and limestone, heated together.
(Ceramics, polymers and composites)
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- ☐ **State what the Haber process makes** Ammonia, which is used to make nitrogen-based fertilisers. (The Haber process)
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☐ **State why farmers use fertilisers** Compounds of nitrogen, phosphorus and potassium improve agricultural productivity (bigger crop yields). (Production and uses of NPK fertilisers)

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