

Tick one box per statement: ☐ not yet ☐ nearly ☐ confident.

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1. Atomic structure and the periodic table

1.1 Atoms, elements, compounds and mixtures (4.1.1.1–4.1.1.4) , (4.1.1.1–4.1.1.4)

- ☐☐☐ Distinguish atoms, elements, compounds and mixtures, with symbols and formulae.
- ☐☐☐ Describe the five physical separation methods and choose one for a given mixture.
- ☐☐☐ Recount the development of the model of the atom from sphere to neutron.
- ☐☐☐ Use proton, neutron and electron charges and masses, atomic and mass numbers, isotopes and relative atomic mass.
- ☐☐☐ Write electronic structures for the first twenty elements.

1.2 The periodic table (4.1.2.1–4.1.2.3) (4.1.2.1–4.1.2.3)

- ☐☐☐ Relate group and period to outer-shell electrons and atomic number.
- ☐☐☐ Describe the development of the periodic table, including Mendeleev's gaps and the isotope explanation.
- ☐☐☐ Distinguish metals from non-metals by position and properties.
- ☐☐☐ State and explain the trends in Groups 0, 1 and 7, including displacement.

1.3 Transition metals – chemistry only (4.1.3) – (4.1.3)

- ☐☐☐ Compare transition elements with Group 1 in melting point, density, strength, hardness and reactivity.
- ☐☐☐ Describe ions with different charges, coloured compounds and catalysis, with named examples.

2. Bonding, structure and the properties of matter ,

2.1 Ionic, covalent and metallic bonding (4.2.1.1–4.2.1.5) , (4.2.1.1–4.2.1.5)

- ☐☐☐ Explain the three bond types in terms of electrons and electrostatic forces.
- ☐☐☐ Draw dot and cross diagrams for electron transfer and for the eight named molecules.
- ☐☐☐ Deduce ion charges and empirical formulae from group numbers and lattice models; state model limitations.

2.2 Bonding, structure and properties (4.2.2.1–4.2.2.7) , (4.2.2.1–4.2.2.7)

- ☐☐☐ Link states of matter and state symbols to particle theory, with (HT) its limitations.
- ☐☐☐ Explain the melting points and conductivity of ionic compounds, small molecules, polymers and metals.
- ☐☐☐ Explain why alloys are harder than pure metals.

2.3 Structure and bonding of carbon (4.2.3.1–4.2.3.3) (4.2.3.1–4.2.3.3)

- ☐☐☐ Explain diamond's properties from its four-bond giant structure.
- ☐☐☐ Explain graphite's properties from three bonds, layers and delocalised electrons.

☐☐☐ Describe graphene and fullerenes, including carbon nanotubes and their uses.

2.4 Bulk and surface properties incl. nanoparticles – chemistry only (4.2.4)

— (4.2.4)

☐☐☐ Compare nanoparticle, fine and coarse particle size ranges.

☐☐☐ Apply the surface-area-to-volume factor-of-10 rule to cubes.

☐☐☐ Explain why nanoparticles differ from bulk materials, their uses and the concerns.

3. Quantitative chemistry

3.1 Measurements, conservation of mass and equations (4.3.1.1–4.3.1.3)

(4.3.1.1–4.3.1.3)

☐☐☐ Balance symbol equations and use conservation of mass.

☐☐☐ Calculate relative formula masses and percentage by mass of an element.

☐☐☐ Explain apparent mass changes when a gas is involved.

☐☐☐ Estimate uncertainty as the range of repeat measurements about the mean.

3.2 Moles – amount of substance and reacting masses (4.3.2)

— (4.3.2)

☐☐☐ Use the mole, the Avogadro constant and $\text{moles} = \text{mass} / M_r$.

☐☐☐ Calculate reacting masses from balanced equations.

☐☐☐ Balance equations from reacting masses.

☐☐☐ Explain and use the limiting reactant.

☐☐☐ Calculate concentrations in g/dm^3 and, with mol/dm^3 , mass-volume relations.

3.3 Yield and atom economy – chemistry only, HT (4.3.3)

(4.3.3)

☐☐☐ Give the three reasons yield is below 100 percent.

☐☐☐ Calculate percentage yield, and (HT) the theoretical mass first.

☐☐☐ Calculate atom economy and explain its importance.

3.4 Concentrations of solutions (4.3.4)

(4.3.4)

☐☐☐ Relate moles, mass, volume and concentration in mol/dm^3 .

☐☐☐ Calculate an unknown concentration from titration volumes and the equation ratio.

3.5 Volumes of gases – chemistry only, HT (4.3.5)

— (4.3.5)

☐☐☐ State that equal gas volumes contain equal moles at the same temperature and pressure.

☐☐☐ Use the equation ratio to relate gas volumes in reactions.

4. Chemical changes

4.1 Reactivity of metals and displacement (4.4.1.1–4.4.1.3)

(4.4.1.1–4.4.1.3)

☐☐☐ Recall the reactivity series order including carbon and hydrogen, with water and acid reactions.

☐☐☐ Explain reactivity as the tendency to form positive ions and deduce order from results.

☐☐☐ Relate extraction method to reactivity: carbon reduction vs electrolysis.

☐☐☐ (HT) Use OIL RIG to write ionic equations for displacement and redox.

4.2 Reactions of acids and making salts (4.4.2.1–4.4.2.6) (4.4.2.1–4.4.2.6)

- ☐☐☐ Predict acid-metal and acid-base products, naming salts from acid and base.
- ☐☐☐ Describe RP1 salt preparation from an insoluble oxide or carbonate.
- ☐☐☐ Use the pH scale, universal indicator and pH probe; write the neutralisation ionic equation.
- ☐☐☐ (Chem) Describe titration method (RP2) and (HT) strong vs weak acids with the factor-of-10 pH rule.

4.3 Electrolysis (4.4.3.1–4.4.3.3) (4.4.3.1–4.4.3.3)

- ☐☐☐ Describe electrolytes, electrode attraction and discharge.
- ☐☐☐ Predict products for molten binary compounds and aqueous solutions.
- ☐☐☐ Explain aluminium extraction: cryolite mixture and anode replacement.
- ☐☐☐ (HT) Write balanced half-equations at both electrodes.

5. Energy changes

5.1 Exothermic and endothermic reactions (4.5.1.1–4.5.1.3) (4.5.1.1–4.5.1.3)

- ☐☐☐ Define exothermic and endothermic from temperature change, with examples and uses.
- ☐☐☐ Draw and interpret reaction profiles with activation energy and overall energy change.
- ☐☐☐ (HT) Calculate overall energy change from bond energies and explain the difference between the two reaction types.

5.2 Chemical cells and fuel cells – chemistry only (4.5.2) — (4.5.2)

- ☐☐☐ Explain how cells produce electricity and what the voltage depends on.
- ☐☐☐ Compare non-rechargeable and rechargeable cells.
- ☐☐☐ Describe hydrogen fuel cells and (HT) their electrode half-equations, evaluating them against rechargeable cells.

6. The rate and extent of chemical change

6.1 Rate of reaction (4.6.1.1–4.6.1.5) (4.6.1.1–4.6.1.5)

- ☐☐☐ Calculate mean rates in g/s, cm³/s and (HT) mol/s, and read product-time graphs with tangents.
- ☐☐☐ Recall the five factors affecting rate and investigate concentration (RP5).
- ☐☐☐ Explain each factor with collision theory and activation energy.
- ☐☐☐ Describe catalysts and their effect on the reaction profile, including enzymes.

6.2 Reversible reactions and dynamic equilibrium (4.6.2.1–4.6.2.3) (4.6.2.1–4.6.2.3)

- ☐☐☐ Represent reversible reactions and their opposite energy changes.
- ☐☐☐ Define dynamic equilibrium in a closed system.
- ☐☐☐ (HT) Predict the effect of concentration, pressure and temperature changes with Le Chatelier's principle, and the catalyst's null effect.

7. Organic chemistry

7.1 Crude oil, fuels and feedstock (4.7.1.1–4.7.1.3) , (4.7.1.1–4.7.1.3)

- ☐☐☐ Describe crude oil's origin and composition; name and formulate the first four alkanes.
- ☐☐☐ Explain fractional distillation and match fraction properties to uses.
- ☐☐☐ Relate molecule size to boiling point, viscosity and flammability.
- ☐☐☐ Describe cracking conditions and products, balance cracking equations and use the bromine-water test.

7.2 Reactions of alkenes and alcohols – chemistry only (4.7.2.1–4.7.2.3) — (4.7.2.1–4.7.2.3)

- ☐☐☐ Recognise alkenes C_nH_{2n} as unsaturated and describe their addition reactions.
- ☐☐☐ Describe the four reactions and uses of the first four alcohols, with fermentation conditions.
- ☐☐☐ Describe the reactions of the first four carboxylic acids, including ester formation, and (HT) weak-acid ionisation.

7.3 Synthetic and naturally occurring polymers (4.7.3.1–4.7.3.2) (4.7.3.1–4.7.3.2)

- ☐☐☐ Draw addition polymers from alkene monomers and relate repeating units back to monomers.
- ☐☐☐ (HT) Explain condensation polymerisation with functional groups, polyester and polypeptide examples.
- ☐☐☐ Name DNA's structure and the monomers of proteins, starch and cellulose.

8. Chemical analysis

8.1 Purity, formulations and chromatography (4.8.1.1–4.8.1.3) , (4.8.1.1–4.8.1.3)

- ☐☐☐ Distinguish pure substances from mixtures using melting and boiling point data.
- ☐☐☐ Identify formulations and explain their purpose.
- ☐☐☐ Explain paper chromatography, calculate R_f values and interpret chromatograms.

8.2 Identification of common gases (4.8.2) (4.8.2)

- ☐☐☐ Describe the tests and positive results for hydrogen, oxygen, carbon dioxide and chlorine.

8.3 Identification of ions – chemistry only (4.8.3.1–4.8.3.2) — (4.8.3.1–4.8.3.2)

- ☐☐☐ Give flame-test colours for Li, Na, K, Ca and Cu, noting masking in mixtures.
- ☐☐☐ Identify metal ions with sodium hydroxide solution, including the aluminium excess test.
- ☐☐☐ Test for carbonates, halides and sulfates with reagents and precipitate colours.
- ☐☐☐ (HT) Describe flame emission spectroscopy and its advantages.

9. Chemistry of the atmosphere

9.1 Evolution of the Earth's atmosphere (4.9.1.1–4.9.1.2) (4.9.1.1–4.9.1.2)

- ☐☐☐ Describe the evidence for and composition of the early atmosphere.
- ☐☐☐ Explain how oceans, carbonates and photosynthesis changed the atmosphere to today's proportions.

9.2 Greenhouse gases and global climate change (4.9.2.1–4.9.2.3)

(4.9.2.1–4.9.2.3)

- ☐☐☐ Name the greenhouse gases and explain the mechanism in terms of wavelength.
- ☐☐☐ Relate human activities to rising gas levels and interpret given climate data.
- ☐☐☐ Describe consequences of global climate change and the basis of scientific consensus.

9.3 Atmospheric pollutants and their sources (4.9.3.1–4.9.3.2)

(4.9.3.1–4.9.3.2)

- ☐☐☐ Link complete and incomplete combustion to the products CO₂, water, CO and particulates, with effects.
- ☐☐☐ Explain the formation and effects of sulfur dioxide and oxides of nitrogen, including acid rain and its reduction.

10. Using resources

10.1 Resources and potable water (4.10.1.1–4.10.1.3)

(4.10.1.1–4.10.1.3)

- ☐☐☐ Distinguish finite from renewable resources and define sustainable development.
- ☐☐☐ Distinguish potable from pure water and describe UK treatment; compare with desalination.
- ☐☐☐ Describe sewage treatment in order, and compare ease of obtaining potable water from waste, ground and salt water.
- ☐☐☐ (HT) Describe phytomining and bioleaching for low-grade copper ores.

10.2 Life cycle assessment and recycling (4.10.2.1–4.10.2.2)

(4.10.2.1–4.10.2.2)

- ☐☐☐ List the four LCA stages and explain why LCAs are not purely objective.
- ☐☐☐ Evaluate reduce, reuse and recycling for given materials, with reasons.

10.3 Using materials – corrosion and alloys, chemistry only (4.10.3.1–4.10.3.2)

, (4.10.3.1–4.10.3.2)

- ☐☐☐ Describe corrosion and its prevention, including sacrificial zinc.
- ☐☐☐ Recall named alloys with compositions and uses, and interpret alloy data.
- ☐☐☐ Compare glasses, clay ceramics, polymers and composites, including thermosoftening vs thermosetting.

10.4 The Haber process and NPK fertilisers – chemistry only (4.10.4.1–4.10.4.2)

— (4.10.4.1–4.10.4.2)

- ☐☐☐ State the raw material sources and conditions of the Haber process.
- ☐☐☐ Describe the separation and recycling of ammonia and unreacted gases.
- ☐☐☐ (HT) Apply equilibrium principles to explain the compromise conditions.
- ☐☐☐ Name the NPK compounds and how they are produced, evaluating fertiliser manufacture.