SimpleStudy

PRACTICE MARKING SCHEME

LEAVING CERTIFICATE · ORDINARY LEVEL · SAMPLE PAPER 2 · 2027

Chemistry

Total marks	Duration	Structure
300	2 hr 30 min	7 questions

About this document

A practice marking scheme produced by SimpleStudy to help students and teachers prepare for the Leaving Certificate examination in Chemistry. The State Examinations Commission has published this sample paper without a marking scheme; the mark allocations and answers set out here are indicative.

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Marking Scheme

This marking scheme accompanies the State Examinations Commission's Sample Paper 2 in Leaving Certificate Chemistry, Ordinary Level. It is intended to support candidates and teachers preparing for the examination. It is not an official State Examinations Commission document.

General Marking Guidelines

- Accept all reasonable responses; the lists in this scheme are indicative, not exhaustive.
- Credit content that is correct even where it is poorly expressed.
- No penalty for spelling or grammar unless the meaning is unclear.
- Where a candidate contradicts themselves, award the lower mark.
- Credit accurate labelling on diagrams, and credit a correct answer given as a labelled diagram where the question does not require prose.
- Where a candidate offers more points than the number asked for, mark the first *n* presented, unless a later point is clearly labelled as a replacement.

Seven additions for this paper:

- There are seven questions, each worth 50 marks. Candidates answer Question 1 and any five others, so six questions make up the 300 marks. Where a candidate answers all seven, mark all seven and credit the best six.
- **Formulae and Tables.** Candidates have the booklet and are directed to use its data, including atomic numbers and relative atomic masses. Where a part sends them to a particular page — 2(a)(iii) to page 81, 4(b)(v) to page 64 — the answer must rest on that data.
- **Units and significant figures.** The paper warns that marks may be lost where units are omitted. In this scheme a calculated answer carries one mark for the correct unit unless the part states otherwise. Answers given to two or more significant figures are acceptable at this level; where a part states an acceptable range, that range governs.
- **Error carried forward.** Where a candidate uses an incorrect value from an earlier part correctly in a later one, award the later marks in full. An error is penalised once only. This matters particularly in Question 6, where parts (viii) to (x) form a chain, and at 4(b)(iv) to (v).
- **Consequential answers.** Several parts ask the candidate to build on a choice they made in an earlier part — for example a colour change that must match the reagent they named. Where this applies, the part is marked against the candidate's own earlier answer, and the scheme sets out each acceptable pairing. A candidate whose later answer is internally consistent with their earlier one earns full marks even where the earlier answer was not the expected one; a candidate whose answers contradict each other earns nothing for the later part.
- **Chemical equations.** An equation earns its marks first for correct reactants and products and then for balancing; award the formulae marks where the species are right but the coefficients are wrong.
- **Units of volume and concentration.** This scheme follows the paper, which expresses concentrations in M or in moles per litre and volumes in cm^3, and writes "litres" in words. Where the scheme quotes the axis label of the graph in Question 4 it reproduces the paper's own notation. Accept any correct equivalent a candidate uses.

How the marks are set

The paper prints a total of 50 marks for each question and no sub-part marks, so every internal split is indicative. The splits reconcile upward to each question total and to the paper total of 300 marks, and follow one set of rates across all seven questions:

- **Tick, matching and completion rows inside a table** carry **2 marks per row**.
- **An answer read or selected from material printed on the page** — a letter matched to a printed structure, a choice among printed options, a bare chemical symbol — carries **2 marks**.
- **A substance, reagent, instrument or piece of apparatus the candidate must name from their own knowledge** carries **3 marks**.
- **Ticking one box from a printed list of alternatives** carries **3 marks**.
- **Developed points** are priced on the printed answer space, with the command verb as a tie-breaker.

Marking at Ordinary Level

This paper is assessed at Ordinary Level. The specification differentiates the two levels through the learning outcomes themselves: Ordinary level covers only the outcomes presented in normal type, while Higher level covers all of them, including those in bold type. Table 1 of the specification describes Ordinary level students as engaging with a broad range of knowledge, mainly concrete in nature but with some elements of abstraction or theory, and as demonstrating and using a moderate range of cognitive skills and tools. Examiners should therefore credit accurate, simply expressed chemistry, and should not withhold marks because an answer lacks the depth or abstraction expected at Higher Level.

Paper Structure

Question 1	**50 marks**	Compulsory. The periodic table, the synthesis and melting point of benzoic acid, iron tablets, isomers of C_6H_{14}, and the nature of scientific evidence.
Question 2	**50 marks**	Steam reforming: Lewis diagrams, bonding and boiling points, dynamic equilibrium, and the electrolysis of water.
Question 3	**50 marks**	Models in chemistry: formulae and molecular structures, the nuclear and Bohr models of the atom, and collision theory.
Question 4	**50 marks**	Greenhouse gases and the greenhouse effect, the hydrogen fuel cell, and carbon capture with a gas law calculation.
Question 5	**50 marks**	Distinguishing substances by colour: flame tests, a test for unsaturation, universal indicator and the pH scale, and a thiosulfate titration.
Question 6	**50 marks**	Standardising hydrochloric acid against sodium carbonate: making the standard solution, the indicator, and the mole calculations.
Question 7	**50 marks**	Functional groups and homologous series, the oxidation of propan-2-ol, and structural isomers of propanone.
Total	**300 marks**	Question 1 and any five of Questions 2 to 7.

Only the question numbers are printed on the paper; the descriptions above are supplied by this scheme for navigation only.

Grading Descriptors (all parts carrying a development element)

High (H) Point accurately named and developed with correct chemical reasoning, applied to the substance, data or context the part supplies. Full marks for the point.

Mid (M) Relevant point named with partial development, or chemically correct but not applied to the data or context the part supplies. Award the naming marks in full plus roughly half the development marks, rounded up to a whole mark.

Low (L) Point named or asserted only; vague, or development that does not follow from the point named. Naming marks only.

No criterion grid is used on this paper. *The longer parts — for example 5(a)(i), 6(ii) and 7(c)(iii) — are marked by required elements rather than holistically.*

Question 1 — 50 marks

Compulsory. Candidates answer all parts.

Indicative mark allocation: (a)(i) 4 · (a)(ii) 4 · (a)(iii) 4 · (b)(i) 4 · (b)(ii) 4 · (c)(i) 3 · (c)(ii) 3 · (c)(iii) 4 · (d) 10 · (e)(i) 3 · (e)(ii) 3 · (e)(iii) 2 · (e)(iv) 2 = 50 marks.

(a) The periodic table (12 marks)

Part	Acceptable Answer(s)	Marks
(i) Two differences ***2 marks each***	The modern table arranges the elements by atomic number rather than by atomic mass; it contains many more elements, including those Mendeleev left gaps for and the noble gases, which were unknown to him; it sets out the transition metals as a block and the lanthanides and actinides separately; its arrangement is explained by electron configuration, which Mendeleev did not know; it has no pairs reversed out of mass order, as Mendeleev's table did.	**4**
(ii) Why potassium is reactive	Potassium is in Group 1, so it has one electron in its outermost energy level (2). That electron is far from the nucleus and loosely held, so it is lost very easily to form a stable K^+ ion with a full outer level (2).	**4**
(iii) Why neon is unreactive	Neon is in Group 18, the noble gases, so its outermost energy level is already full with eight electrons (2). It has no tendency to lose, gain or share electrons, since it is already in a stable arrangement (2).	**4**

(b) Benzoic acid (8 marks)

Part	Acceptable Answer(s)	Marks
(i) The two compounds ***2 marks each***	**Phenylmethanol (benzyl alcohol)** and **potassium permanganate ($KMnO_4$)**. Deduct 2 marks for each incorrect box ticked, to a minimum of zero.	**4**
(ii) Measuring a melting point	*1 mark per element, to a maximum of 4.* Pack a little of the dry sample into a capillary tube sealed at one end; attach the tube to a thermometer with the sample level with the bulb; place both in a heated oil bath, or use a melting point apparatus; heat slowly and stir the bath; record the temperature at which the sample begins to melt and the temperature at which it has melted completely; compare with the literature value of 122 °C. A labelled diagram showing the thermometer, capillary tube, sample and heated bath earns the marks equally.	**4**

(c) Iron tablets (10 marks)

Part	Acceptable Answer(s)	Marks
(i) Apparatus for grinding	A **mortar and pestle**	**3**

Part	Acceptable Answer(s)	Marks
(ii) Reading the top of the meniscus	Potassium permanganate solution is deeply coloured and almost opaque, so the bottom of the meniscus cannot be seen through it; the top of the meniscus is the only part that can be read reliably.	**3**
(iii) Percentage of iron	Total mass of the five tablets = 5 × 0.3 = 1.5 g (2) Percentage = 0.18 ÷ 1.5 × 100 = **12%** (2)	**4**

(d) Matching the isomers of C_6H_{14} (10 marks)

2 marks per row × 5 = 10 marks.

Name	Letter	Marks
2-methylpentane	**W**	**2**
2,2-dimethylbutane	**Z**	**2**
hexane	**V**	**2**
3-methylpentane	**X**	**2**
2,3-dimethylbutane	**Y**	**2**

(e) The work of scientists (10 marks)

Part	Acceptable Answer(s)	Marks
(i) Peer review	Before work is published it is examined by other scientists working in the same field, who check the methods, the data and the conclusions; the work is published only if they are satisfied that it is sound.	**3**
(ii) Primary and secondary data	Primary data is gathered first-hand by the investigator from their own experiment or observations; secondary data is obtained from someone else's work, such as a textbook, a database, a published paper or the Formulae and Tables booklet.	**3**
(iii) Quantitative data	Any numerical measurement recorded in a school experiment, named: a titre read from a burette in cm^3; the mass of a sample on a balance in grams; a temperature in °C; a volume of gas collected; a pH reading from a meter.	**2**
(iv) Qualitative data	Any observation recorded without a number: the colour change at the end point of a titration; the flame colour in a flame test; effervescence on adding acid; a precipitate forming; a smell.	**2**

Question 2 — 50 marks

Candidates answer any five of Questions 2 to 7. Each carries 50 marks.

Indicative mark allocation: (a)(i) 3 · (a)(ii) 4 · (a)(iii) 4 · (a)(iv) 4 · (a)(v) 4 · (b)(i) 4 · (b)(ii) 4 · (b)(iii) 5 · (b)(iv) 5 · (c)(i) 4 · (c)(ii) 3 · (c)(iii) 3 · (c)(iv) 3 = 50 marks.

(a) Bonding and boiling points (19 marks)

Part	Acceptable Answer(s)	Marks
(i) Lewis diagram of H_2	Two hydrogen atoms sharing a single pair of electrons, with no lone pairs.	**3**
(ii) Lewis diagram of H_2O	An oxygen atom sharing one pair of electrons with each of two hydrogen atoms, with **two lone pairs** shown on the oxygen. *2 marks for the two bonding pairs, 2 for both lone pairs.*	**4**
(iii) Classifying the bonding *2 marks each*	**H_2 is pure covalent** — both atoms are the same element, so the electronegativity difference is zero and the electrons are shared equally. **H_2O is polar covalent** — oxygen is 3.44 and hydrogen 2.20, a difference of 1.24, which lies between 0.4 and 1.7.	**4**
(iv) Methane against water	Water molecules are polar and form **hydrogen bonds** with one another, because hydrogen is bonded directly to the highly electronegative oxygen, which also carries lone pairs (2). Methane is a non-polar molecule with only weak van der Waals forces between its molecules, so far less energy is needed to separate them and it boils at a much lower temperature (2).	**4**
(v) Methane against hydrogen	Both have only van der Waals forces between their molecules (1), but a methane molecule is considerably larger and contains ten electrons against hydrogen's two (2). Larger molecules with more electrons have stronger van der Waals attractions, so methane needs more energy to boil (1).	**4**

(b) The equilibrium (18 marks)

Part	Acceptable Answer(s)	Marks
(i) Dynamic equilibrium	The state reached in a reversible reaction when the rate of the forward reaction equals the rate of the reverse reaction, so the concentrations stay constant (2), while both reactions continue to take place — the system is not static (2).	**4**
(ii) K_c expression	**$K_c = [H_2]^3[CO] \div [CH_4][H_2O]$** *2 marks for the correct fraction, 2 for the cube on the hydrogen term.*	**4**
(iii) Increasing the pressure	The concentration of methane **increases** (2). There are 2 molecules of gas on the left of the equation and 4 on the right; increasing the pressure shifts the equilibrium towards the side with fewer gas molecules, which is the left, so methane is re-formed (3).	**5**

Part	Acceptable Answer(s)	Marks
(iv) Increasing the temperature	The concentration of methane **decreases** (2). ΔH is positive, so the forward reaction is endothermic; raising the temperature shifts the equilibrium in the endothermic direction, to the right, using up methane (3).	**5**

(c) Electrolysis of water (13 marks)

Part	Acceptable Answer(s)	Marks
(i) Electrolysis	The use of electrical energy to bring about a chemical reaction: a direct current is passed through a liquid or solution containing ions, and the compound is broken down, the ions moving to the electrodes and being discharged there.	**4**
(ii) Gas A	**Oxygen**	**3**
(iii) Gas B	**Hydrogen**	**3**
(iv) Parts C	The **electrodes** — the anode on the left and the cathode on the right. Accept carbon or graphite electrodes.	**3**

Examiner note on the printed diagram. *The identification rests on the polarity shown. Tube A stands over the electrode wired to the positive terminal, the anode, where oxygen is produced; tube B stands over the electrode wired to the negative terminal, the cathode, where hydrogen is produced. The drawn gas columns support this, the column in B being the taller of the two, although the drawing is not to the expected 2 : 1 ratio and the front of the paper states that diagrams are generally not drawn to scale. Candidates may therefore reason from the polarity, from the relative gas volumes, or from both; credit either. Do not expect a candidate to quantify the ratio from the diagram.*

Question 3 — 50 marks

Candidates answer any five of Questions 2 to 7. Each carries 50 marks.

Indicative mark allocation: (a)(i) 3 · (a)(ii) 4 · (a)(iii) 4 · (a)(iv) 3 · (a)(v) 6 · (b)(i) 5 · (b)(ii) 5 · (b)(iii) 3 · (c)(i) 4 · (c)(ii) 7 · (c)(iii) 6 = 50 marks.

(a) Modelling ethane (20 marks)

Part	Acceptable Answer(s)	Marks
(i) Empirical formula	The formula showing the simplest whole-number ratio of the atoms of each element present in a compound.	**3**
(ii) Condensed against molecular	The molecular formula C_2H_6 gives only how many atoms of each element are present (2); the condensed structural formula CH_3CH_3 also shows how they are grouped and joined, that the molecule is two CH_3 groups bonded to one another (2).	**4**
(iii) 3D against 2D	The 2D structure shows which atoms are bonded to which, but draws the molecule flat (2); the 3D model shows the actual arrangement in space, that the four bonds around each carbon point towards the corners of a tetrahedron rather than lying at right angles in a plane (2).	**4**
(iv) Information not given	Any one of: the bond lengths; the size of the bond angles as numbers; the strength of the bonds; that the bonds are formed by shared pairs of electrons; the relative molecular mass; the state of ethane at room temperature; that the C–C bond can rotate.	**3**
(v) Butane *2 marks each*	Empirical formula $\mathbf{C_2H_5}$; molecular formula $\mathbf{C_4H_{10}}$; 2D structure drawn as four carbons in a chain carrying ten hydrogens, with all bonds shown.	**6**

(b) Models of the atom (13 marks)

Part	Acceptable Answer(s)	Marks
(i) The nuclear model	Nearly all the mass of the atom, and all of its positive charge, is concentrated in a very small central nucleus (3); the rest of the atom is mostly empty space, with the electrons moving around the nucleus (2).	**5**
(ii) Bohr's modification	Bohr proposed that the electrons move around the nucleus in fixed orbits or energy levels at set distances (3), that an electron in a given level has a fixed amount of energy, and that electrons move between levels only by absorbing or emitting a definite amount of energy, which explained the line spectra of the elements (2).	**5**
(iii) Sodium on Bohr's model	**2, 8, 1**	**3**

(c) Collision theory (17 marks)

Part	Acceptable Answer(s)	Marks
(i) The factor changed	The **concentration** of the reactants — the number of particles present in the same volume.	**4**
(ii) Greatest rate	**C** (3). It contains the most particles in the same volume — eight of each reactant, against six in B and four in A — so the particles are closer together, collide more frequently, and there are more effective collisions each second (4).	**7**
(iii) Effect of temperature	The rate **increases** (2). At a higher temperature the particles have more kinetic energy and move faster, so they collide more often (2), and a greater proportion of the collisions have energy equal to or greater than the activation energy, so more of them are effective (2).	**6**

Question 4 — 50 marks

Candidates answer any five of Questions 2 to 7. Each carries 50 marks.

Indicative mark allocation: (a)(i) 4 · (a)(ii) 4 · (a)(iii) 5 · (a)(iv) 7 · (a)(v) 5 · (a)(vi) 4 · (b)(i) 4 · (b)(ii) 4 · (b)(iii) 5 · (b)(iv) 3 · (b)(v) 5 = 50 marks.

(a) Greenhouse gases and fuel cells (29 marks)

Part	Acceptable Answer(s)	Marks
(i) Greenhouse gas	A gas present in the atmosphere that absorbs infrared radiation given off by the Earth's surface and re-emits it in all directions, so that heat is trapped rather than escaping to space and the atmosphere is warmed.	**4**
(ii) Two without carbon ***2 marks each***	**Water vapour (H_2O)**, **nitrous oxide (N_2O)**, **ozone (O_3)** or **sulfur hexafluoride (SF_6)**. Do not accept carbon dioxide, methane or CFCs, all of which contain carbon.	**4**
(iii) Natural against enhanced	The natural greenhouse effect is caused by gases that have always been present, chiefly water vapour and carbon dioxide; it keeps the Earth roughly 33 °C warmer than it would otherwise be and makes life possible (3). The enhanced greenhouse effect is the additional warming caused by the extra greenhouse gases released by human activity, chiefly from burning fossil fuels, which traps more heat and raises global temperatures further (2).	**5**
(iv) The hydrogen fuel cell	Hydrogen is fed continuously to one electrode, where it is oxidised, losing electrons to form H^+ ions (2). The electrons cannot pass through the electrolyte and travel instead through the external circuit, and this flow of electrons is the electric current (2). The H^+ ions pass through the electrolyte to the other electrode (1), where oxygen from the air gains those electrons and combines with the H^+ ions to form water, the only product (2).	**7**
(v) Chemical cell against fuel cell	A chemical cell contains a fixed quantity of reactants sealed inside it, so it goes flat once they are used up and must be replaced or recharged (3). A fuel cell is supplied continuously with fuel and oxygen from outside, so it goes on producing electricity for as long as that supply is maintained (2).	**5**
(vi) Two other sources ***2 marks each***	Agriculture, including methane from livestock and nitrous oxide from fertilisers; electricity generation; heating of homes and buildings; industry, including cement manufacture; waste and landfill.	**4**

(b) Carbon capture (21 marks)

Part	Acceptable Answer(s)	Marks
(i) Carbon capture	Removing carbon dioxide from the atmosphere, or from the emissions of a power station or industrial plant, and holding it somewhere it cannot contribute to the greenhouse effect — dissolved in the oceans, stored in rock formations underground, or taken up by vegetation.	**4**
(ii) The relationship	As the temperature of the water rises, the solubility of carbon dioxide falls: the two are inversely related (2). The fall is steepest at the lower temperatures, from about 0.055 mol L^{-1} at 5 °C to about 0.039 at 15 °C, and becomes more gradual at higher temperatures, reaching about 0.026 at 30 °C (2).	**4**
(iii) Effect of warming seas	Warmer seawater dissolves less carbon dioxide, so the oceans absorb less of it from the atmosphere and may release some of what they already hold (3). More carbon dioxide therefore remains in the atmosphere, strengthening the greenhouse effect and raising temperatures further, which in turn warms the oceans — a feedback that makes the problem worse (2).	**5**
(iv) Moles at 15 °C	Approximately **0.039 mol**. Accept 0.038 to 0.040.	**3**
(v) Volume	$V = nRT \div P = (0.039 \times 8.314 \times 298) \div 101325 = 9.5 \times 10^{-4}$ m^3 = **0.95 litres** (950 cm^3). *3 marks for substituting into the rearranged equation, 1 for the answer, 1 for the unit.* Accept 0.93 to 0.98 litres, and accept the answer left in m^3. Error carried forward from part (iv) applies in full.	**5**

Question 5 — 50 marks

Candidates answer any five of Questions 2 to 7. Each carries 50 marks.

Indicative mark allocation: (a)(i) 9 · (a)(ii) 6 · (b)(i) 5 · (b)(ii) 3 · (b)(iii) 3 · (c)(i) 6 · (c)(ii) 3 · (c)(iii) 3 · (c)(iv) 3 · (c)(v) 3 · (d)(i) 3 · (d)(ii) 3 = 50 marks.

(a) Flame tests (15 marks)

Part	Acceptable Answer(s)	Marks
(i) Carrying out a flame test	*1 mark per element, to a maximum of 9.* Three marks are available for naming the apparatus — a clean nichrome or platinum wire in a handle, a Bunsen burner, and a watch glass — and the remainder for the procedure: dip the wire in concentrated hydrochloric acid on the watch glass; hold it in the blue flame until it imparts no colour, to show that it is clean; dip it in the acid again and then into the solid sample, so that some adheres; hold the wire in the edge of the hot blue flame with the air hole open; observe and record the colour; clean the wire again before testing the next sample.	**9**
(ii) Identifying the salts ***2 marks each***	Blue-green: **copper chloride ($CuCl_2$)** Yellow-orange: **sodium chloride (NaCl)** Lilac: **potassium chloride (KCl)**	**6**

(b) Testing for unsaturation (11 marks)

Part	Acceptable Answer(s)	Marks
(i) Unsaturated	A compound containing at least one double or triple bond between carbon atoms (3), so it does not contain the maximum possible number of hydrogen atoms and can undergo addition reactions (2).	**5**
(ii) A suitable solution	**Bromine water.** Accept acidified potassium permanganate.	**3**
(iii) The expected result	Marked against the candidate's own answer to part (ii): • named **bromine water** → circle **yellow to colourless** • named **acidified potassium permanganate** → circle **pink to colourless** Either is fully correct when consistent with (ii). A candidate who names a solution in (ii) and circles the option inconsistent with it earns nothing here. The two options in which a colourless solution gains a colour are incorrect in every case.	**3**

(c) Strong and weak acids (18 marks)

Part	Acceptable Answer(s)	Marks
(i) Strong against weak acid	A strong acid dissociates completely, or almost completely, into ions in water, so almost every molecule releases its hydrogen ion (3). A weak acid dissociates only partially, forming an equilibrium in which most of the acid remains as undissociated molecules, so the same concentration gives far fewer hydrogen ions (3).	**6**
(ii) Indicator in HCl	Circle the swatch at **0**. A 1.0 M solution of a fully dissociated strong acid has a pH of 0. Accept the swatch at 1.	**3**
(iii) Indicator in ethanoic acid	Circle the swatch at **2**. A 1.0 M solution of this weak acid is only partially dissociated and has a pH of about 2.4. Accept the swatch at 3. Do not accept 0 or 1, which are the strong-acid colours and would not distinguish the two acids.	**3**
(iv) The pH scale	A scale running from 0 to 14 that measures how acidic or basic a solution is, based on the concentration of hydrogen ions present: below 7 is acidic, 7 is neutral and above 7 is basic.	**3**
(v) Another way	A **pH meter**. Accept a pH probe used with a datalogger.	**3**

Parts (ii) and (iii) are answered by circling a colour on the printed scale, and this scheme identifies the swatches by their pH number rather than by a colour name, since the printed swatches do not correspond to the colour names used on a standard indicator chart. The distinction the question tests is that the two acids, at the same concentration, give different pH values because one is fully and the other only partially dissociated.

(d) The thiosulfate titration (6 marks)

Part	Acceptable Answer(s)	Marks
(i) After the starch is added	**Blue-black**	**3**
(ii) At the end point	**Colourless**	**3**

Question 6 — 50 marks

Candidates answer any five of Questions 2 to 7. Each carries 50 marks.

Indicative mark allocation: (i) 6 · (ii) 9 · (iii) 4 · (iv) 3 · (v) 3 · (vi) 3 · (vii) 6 · (viii) 6 · (ix) 5 · (x) 5 = 50 marks. Parts (viii) to (x) form a chain; error carried forward applies through it.

Part	Acceptable Answer(s)	Marks
(i) Naming the equipment *2 marks each*	**Volumetric flask** (accept graduated flask); **electronic balance** (accept digital balance); **wash bottle**.	**6**
(ii) Making the standard solution	*1 mark per element, to a maximum of 9.* Place a clean, dry beaker on the balance and zero it; add sodium carbonate with a spatula until the balance reads 10.6 g; dissolve the solid in a small volume of deionised water, stirring with a glass rod; transfer the solution through a funnel into a 250 cm^3 volumetric flask; rinse the beaker, rod and funnel into the flask with deionised water several times, so that none of the solid is lost; add deionised water until the level is just below the calibration mark; add the last of the water dropwise from the wash bottle until the bottom of the meniscus sits on the mark at eye level; stopper the flask; invert it repeatedly to mix the solution thoroughly.	**9**
(iii) Why sodium carbonate suits	Any one, developed: it can be obtained in a very high state of purity; it is stable in air and does not absorb water vapour or carbon dioxide, so its mass does not change as it is weighed; it does not decompose on storage; its relatively high molar mass means weighing errors have a proportionately small effect; it dissolves readily in water.	**4**
(iv) A suitable indicator	**Methyl orange**	**3**
(v) Colour in hydrochloric acid	**Red** (accept pink)	**3**
(vi) Colour in sodium carbonate	**Yellow**	**3**
(vii) Two precautions *3 marks each*	Add the acid dropwise as the end point approaches; swirl the conical flask continuously throughout; stand the flask on a white tile or sheet of paper so that the colour change is easy to see; wash down the inside walls of the flask with deionised water near the end point; read the burette with the eye level with the meniscus; repeat the titration until two titres agree to within 0.1 cm^3; use only a few drops of indicator.	**6**
(viii) Moles in 10.6 g	$M(Na_2CO_3) = 2(23.0) + 12.0 + 3(16.0) =$ **106.0** (3) $n = 10.6 \div 106.0 =$ **0.1 mol** (3)	**6**
(ix) Moles in the 25.0 cm^3 portion	25.0 cm^3 is one tenth of 250 cm^3, so $n = 0.1 \div 10 =$ **0.01 mol**. *3 marks for the dilution factor, 2 for the answer.*	**5**

Part	Acceptable Answer(s)	Marks
(x) Moles of HCl needed	The equation shows 2 mol of HCl for every 1 mol of Na_2CO_3, so n = 2 × 0.01 = **0.02 mol**. *3 marks for the ratio, 2 for the answer.*	**5**

Question 7 — 50 marks

Candidates answer any five of Questions 2 to 7. Each carries 50 marks.

Indicative mark allocation: (a)(i) 9 · (a)(ii) 6 · (b)(i) 5 · (b)(ii) 4 · (b)(iii) 4 · (b)(iv) 3 · (c)(i) 5 · (c)(ii) 5 · (c)(iii) 9 = 50 marks.

(a) Functional groups (15 marks)

Part	Acceptable Answer(s)	Marks
(i) Completing the structures ***3 marks each***	The alkane completed as $CH_3–CH_2–CH_3$, with all eight hydrogens shown. Propan-1-ol completed as $CH_3–CH_2–CH_2–OH$, with the OH group on an end carbon. The carboxylic acid completed as $CH_3–CH_2–COOH$, the end carbon carrying both a double-bonded oxygen and an OH group. Every atom and bond must be shown.	**9**
(ii) Completing the table ***2 marks each***	The alkane is **propane**. Propan-1-ol belongs to the **alcohol** series. The carboxylic acid is **propanoic acid**.	**6**

(b) Oxidation of propan-2-ol (16 marks)

Part	Acceptable Answer(s)	Marks
(i) Bonds broken	On the propan-2-ol molecule, circle the **O–H bond** and the **C–H bond on the middle carbon**, the carbon that carries the OH group. *3 marks for the O–H, 2 for the correct C–H.* Circling any other C–H bond earns nothing.	**5**
(ii) Bonds formed	On the propanone molecule, circle the **C=O double bond** on the middle carbon — specifically the second bond between that carbon and the oxygen.	**4**
(iii) Planar carbon atom	**Propanone** — the carbon of the C=O group has three groups around it arranged in a plane, whereas every carbon in propan-2-ol is tetrahedral.	**4**
(iv) Type of reaction	**Elimination reaction** — two hydrogen atoms are removed from the molecule and nothing is added in their place.	**3**

(c) Propanal and propanone (19 marks)

Part	Acceptable Answer(s)	Marks
(i) Structure of propanal	$CH_3–CH_2–CHO$ drawn out in full, with the C=O double bond on an end carbon and that carbon also carrying one hydrogen, and every other atom and bond shown. *3 marks for the carbonyl group in the terminal position with its hydrogen, 2 for the remaining atoms and bonds.*	**5**

Part	Acceptable Answer(s)	Marks
(ii) Structural isomers	Compounds with the same molecular formula (3) but a different arrangement of the atoms within the molecule, and therefore different structural formulae and different properties (2).	**5**
(iii) Test to distinguish them	*4 marks for the reagent and conditions, 5 for both observations.* Add **Fehling's solution** to each and warm in a water bath. Propanal, the aldehyde, gives a **brick-red precipitate** of copper(I) oxide; propanone, the ketone, leaves the solution **blue** with no precipitate. **Also accept:** Tollens' reagent warmed, giving a silver mirror with propanal and no change with propanone; acidified potassium dichromate, turning from orange to green with propanal and unchanged with propanone; or acidified potassium permanganate, decolourised by propanal and unchanged by propanone. Both observations are required: a named reagent with only one observation earns a maximum of 6.	**9**

This marking scheme is indicative. The paper prints a total of 50 marks for each question and no sub-part marks, so all internal splits are those of this scheme; they reconcile to 50 marks for each question and to 300 marks for the six questions a candidate answers. Examiners should use professional judgement when awarding marks and should credit all reasonable responses not listed here. Prepared by SimpleStudy for study purposes; not an official State Examinations Commission document.