



Coimisiún na Scrúduithe Stáit
State Examinations Commission

Leaving Certificate 2022

Marking Scheme

Chemistry

Ordinary Level

Note to teachers and students on the use of published marking schemes

Marking schemes published by the State Examinations Commission are not intended to be standalone documents. They are an essential resource for examiners who receive training in the correct interpretation and application of the scheme. This training involves, among other things, marking samples of student work and discussing the marks awarded, so as to clarify the correct application of the scheme. The work of examiners is subsequently monitored by Advising Examiners to ensure consistent and accurate application of the marking scheme. This process is overseen by the Chief Examiner, usually assisted by a Chief Advising Examiner. The Chief Examiner is the final authority regarding whether or not the marking scheme has been correctly applied to any piece of candidate work.

Marking schemes are working documents. While a draft marking scheme is prepared in advance of the examination, the scheme is not finalised until examiners have applied it to candidates' work and the feedback from all examiners has been collated and considered in light of the full range of responses of candidates, the overall level of difficulty of the examination and the need to maintain consistency in standards from year to year. This published document contains the finalised scheme, as it was applied to all candidates' work.

In the case of marking schemes that include model solutions or answers, it should be noted that these are not intended to be exhaustive. Variations and alternatives may also be acceptable. Examiners must consider all answers on their merits, and will have consulted with their Advising Examiners when in doubt.

Future Marking Schemes

Assumptions about future marking schemes on the basis of past schemes should be avoided. While the underlying assessment principles remain the same, the details of the marking of a particular type of question may change in the context of the contribution of that question to the overall examination in a given year. The Chief Examiner in any given year has the responsibility to determine how best to ensure the fair and accurate assessment of candidates' work and to ensure consistency in the standard of the assessment from year to year. Accordingly, aspects of the structure, detail and application of the marking scheme for a particular examination are subject to change from one year to the next without notice.



Coimisiún na Scrúduithe Stáit
State Examinations Commission

LEAVING CERTIFICATE EXAMINATION,

CHEMISTRY – ORDINARY LEVEL

MARKING SCHEME

Introduction

In considering the marking scheme, the following should be noted.

1. In many cases only key phrases are given which contain the information and ideas that must appear in the candidate's answer in order to merit the assigned marks.
2. The descriptions, methods and definitions in the scheme are not exhaustive and alternative valid answers are acceptable.
3. The detail required in any answer is determined by the context and the manner in which the question is asked, and by the number of marks assigned to the answer in the examination paper and, in any instance, therefore, may vary from year to year.
4. The bold text indicates the essential points required in the candidate's answer. A double solidus (//) separates points for which separate marks are allocated in a part of the question. Words, expressions or statements separated by a solidus (/) are alternatives which are equally acceptable for a particular point. A word or phrase in bold, given in brackets, is an acceptable alternative to the preceding word or phrase. Note, however, that words, expressions or phrases must be correctly used in context and not contradicted, and, where there is incorrect use of terminology or contradiction, the marks may not be awarded. Cancellation may apply when a candidate gives a list of correct and incorrect answers.
5. In general, names and formulas of elements and compounds are equally acceptable except in cases where either the name or the formula is specifically asked for in the question. However, in some cases where the name is asked for, the formula may be accepted as an alternative.
6. There is a deduction of one mark for each arithmetical slip made by a candidate in a calculation. This deduction applies to incorrect M_r values but only if a candidate shows the addition of all the correct atomic masses and the error is clearly an addition error. If the addition of atomic masses is not shown, the candidate loses the marks for an incorrect M_r .
7. Bonus marks at the rate of 10% of the marks obtained will be given to a candidate who answers entirely through Irish and who obtains less than 75% of the total marks. In calculating the bonus to be applied decimals are always rounded down, not up e.g., 4.5 becomes 4; 4.9 becomes 4, etc. The bonus table given on the next page applies to candidates who answer entirely through Irish and who obtain more than 75% of the total marks.

Candidates are required to answer any SIX questions.

All questions carry equal marks (50).



300@10%

Coimisiún na Scrúduithe Stáit

Marcanna Breise as ucht freagairt trí Ghaeilge

Léiríonn an tábla thíos an méid marcanna breise ba chóir a bhronnadh ar iarrthóirí a ghnóthaíonn níos mó ná 75% d'iomlán na marcanna.

N.B. Ba chóir marcanna de réir an ghnáthráta a bhronnadh ar iarrthóirí nach ghnóthaíonn níos mó ná 75% d'iomlán na marcanna don scrúdú. Ba chóir freisin an marc bónais sin **a shlánú síos**.

Tábla 300 @ 10%

Bain úsáid as an tábla seo i gcás na n-ábhar a bhfuil 300 marc san iomlán ag gabháil leo agus inarb é 10% gnáthráta an bhónais.

Bain úsáid as an ngnáthráta i gcás 225 marc agus faoina bhun sin. Os cionn an mharc sin, féach an tábla thíos.

Bunmharc	Marc Bónais
226	22
227 - 230	21
231 - 233	20
234 - 236	19
237 - 240	18
241 - 243	17
244 - 246	16
247 - 250	15
251 - 253	14
254 - 256	13
257 - 260	12
261 - 263	11

Bunmharc	Marc Bónais
264 - 266	10
267 - 270	9
271 - 273	8
274 - 276	7
277 - 280	6
281 - 283	5
284 - 286	4
287 - 290	3
291 - 293	2
294 - 296	1
297 - 300	0

Annotations used in marking Chemistry 2022

For a fully correct response examiners may award one total mark, e.g. six marks or a number of partial marks, e.g. 2 marks, 3 marks, 1 mark that add to the same total.

For partially correct responses examiners should place the appropriate marks near the correct part of the response and/or use 0 marks to indicate the part of the answer that is incorrect or insufficient.

Examiners should annotate fully incorrect responses or responses of no merit with a 0 mark.

Colours of annotations may vary.

Annotation	Meaning
	n marks awarded
	Mathematical slip error or other penalty as per scheme
	No marks awarded. Answer incorrect or insufficient
	Reverse order
	Surplus answer or part of answer
	Blank page or part of page
	Cancellation / contradiction
	Part of answer of significance
	Incorrect charge, subscript, etc
	Key word, phrase omitted
	Correct – e.g. used where item attempted more than once
	Incorrect

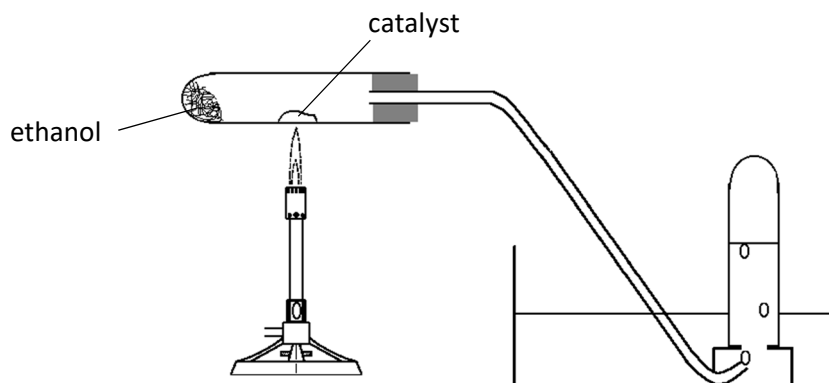
QUESTION 1

(a) (i) COPY, etc:

LABELS: **ethanol //**
catalyst (alumina, aluminium oxide, Al_2O_3)



SHOW: **collection over water / collection in gas syringe**
[Labels not required for water, trough, syringe, etc]



(ii) IDENTIFY: **Al_2O_3 / aluminium oxide / alumina**



(iii) DESCRIBE: **shake (mix, bubble into, add, use) with bromine (Br_2) solution (water) /**
shake (mix, bubble into, add, use) with acidified potassium
permanganate {manganate(VII)} solution (H^+/KMnO_4 or $\text{H}^+/\text{MnO}_4^-$)



brown (red, orange, yellow, pink, purple) colour
disappears (decolourises, fades)



SIX POINTS: [11 + 6 + 6 + 2 + 2 + 2]

(b) DESCRIBE: (i) **colourless / pale yellow / oily / liquid**



DESCRIBE: (ii) **white / crystalline / solid**



WHICH: (iii) **sodium carbonate (Na_2CO_3)**



WHICH: (iv) **sodium sulfite (Na_2SO_3)**



WHAT: (v) **colourless to purple to brown (black, muddy)**



WHAT: (vi) **brown (black, muddy, final colour in (v)) to colourless (decolourises)**



SIX POINTS: [11 + 6 + 1 + 1 + 1 + 1]

QUESTION 2

(a) WHAT: **standard** (5)

(b) DESCRIBE: use **funnel** to transfer //
add rinsings of beaker to flask //
use dropper (pipette, wash-bottle) to add last few drops //
fill to the mark //
until bottom of meniscus is on the line //
read at eye-level //
stopper //
invert to mix

ANY THREE: [6 + 4 + 2]

(c) (i) WHAT **5.3 g** (3)

$$106 \times 0.05 = 5.3 \text{ g} \quad (3)$$

(ii) CALCULATE: **1.325 g** (6)

$$m = (\text{mass in one litre } 0.05 \text{ M}) \times \frac{250}{1000} \quad (3)$$

$$m = \frac{5.3 \times 250}{1000} = 1.325 \text{ g} \quad / \quad m = \frac{5.3}{4} = 1.325 \text{ g} \quad (3)$$

(d) HOW: **rinsed with deionised (distilled, pure) water** / use **clean, dry** conical flask (6)

(e) (i) NAME: **methyl orange / methyl red** (5)

(ii) STATE: **yellow (orange) //**
to pink (red, peach) (2 × 2)

[If there is no response for (i) marks can be awarded for correct colours in (ii).]

[Marks may be given for correct colours for a named unsuitable indicator, e.g. litmus.]

[Allow (2) for correct colours reversed (and matching a named indicator where one is named.)]

[(9) marks only available for correct indicator linked to correct colours in correct order.]

(f) CALCULATE: **0.124 moles HCl per litre** (9)

$$\frac{20.1 \times M}{2} = \quad (3)$$

$$\frac{25.0 \times 0.05}{1} \quad (3)$$

3 marks may be awarded for formula if **no other marks** awarded above.

$$M = 0.124 \text{ mol l}^{-1} \text{ HCl} \quad (3)$$

or

$$\frac{25.0 \times 0.05}{1000} = 1.25 \times 10^{-3} \text{ moles Na}_2\text{CO}_3 \quad (3)$$

$$1.25 \times 10^{-3} \times 2 = 2.50 \times 10^{-3} \text{ moles HCl} \quad (3)$$

$$M = \frac{2.50 \times 10^{-3} \times 1000}{20.1} = 0.124 \text{ mol l}^{-1} \text{ HCl} \quad (3)$$

QUESTION 3

- (a) (i) IDENTIFY: **manganese(IV) oxide (manganese dioxide, MnO₂) / celery / liver, etc** ✓
[Apply (-2) for manganese oxide.]
- (ii) DESCRIBE: **black (brown) / powder / pellets (grains) / small pieces of stalks (stems) / small meaty (minced, red, bloody) pieces, etc** ✓
- (iii) EXPLAIN: **catalyst initially in neck of flask lying on its side //**
rotate flask so combine catalyst with solution
or
catalyst and peroxide initially separated using small test tube //
disturb to mix catalyst and solution
or
open (replace, insert) stopper // ✓ ✓
add catalyst quickly.

FOUR POINTS: [9 + 5 + 2 + 2]

- (b) (i) PLOT: **axis correctly labelled cm³ (volume, V)** (3)
axis correctly labelled minute (min, time, t) (3)
axes correctly scaled (3)
7 of the points other than (0, 0) correctly plotted (3)
curve drawn through points and origin (3)
[Points joined by straight lines unacceptable.]
[Minus 3 if graph not on graph paper.]
[Axes reversed acceptable.]
- (ii) ESTIMATE: **1.3 – 1.7 minute** (6)
- (iii) FIND: **27.0 – 30.4 cm³ O₂ per minute** (3)

68 – 76 cm³ (2)

volume ÷ 2.5 = 27.0 – 30.4 cm³ O₂ per minute (1)

- (c) STATE: **partially**

EXPLAIN: **bubbles (gas, oxygen, O₂) /**
no bubbles (gas, oxygen, O₂) if fully decomposed /
don't get 250 cm³ of oxygen (O₂, gas) in test /
only 98 cm³ of oxygen (O₂, gas) in test

TWO POINTS: [6 + 2]

QUESTION 4

Eight items to be answered. Six marks to be allocated to each item and one additional mark to be added to each of the first two items for which the highest marks are awarded.

- (a) NAME: **Mendeleev** (6)
- (b) WRITE: (i) **KBr //**
(ii) **BeCl₂** (5 + 1)
- (c) WRITE: **H₂O → H₂ + ½O₂ / 2H₂O → 2H₂ + O₂** FORMULAE: (3), BALANCING: (3)
- (d) NAME: **bomb //**
calorimeter (5 + 1)
- (e) WHAT: **contains dissolved Ca²⁺ (calcium ion, Mg²⁺, magnesium ion) /**
doesn't form lather (suds) with soap //
IS: **permanent** (5 + 1)
- (f) IDENTIFY: **silver nitrate / AgNO₃** (6)
- (g) NAME: **steam //**
distillation (5 + 1)
- (h) EXPLAIN: **measure of (tendency of) a fuel to resist knocking (pinking, autoignition, pre-ignition) /**
indication of how well a fuel causes knocking (pinking, autoignition, pre-ignition) (6)
- (i) FIND: **33%** (6)
- | | |
|--|-----|
| $M_r = 59 + (2 \times 27) + (4 \times 16) = 177$ | (3) |
| $\% \text{ Co} = \frac{59}{177} \times 100 = 33\%$ | (3) |
- [Slip error if not rounded.]
- (j) DOES: **decrease** (6)
- (k) WRITE: **C₆H₆O / C₆H₅OH** (6)
[Allow (3) for incorrect formula with six carbons and one oxygen.]

(I)

A

INDICATE:

&

GIVE:

NH₃: make fertilizer (urea, ammonium nitrate, ammonium sulfate, nitric acid, nylon, plastics) //

HNO₃: fertilizer (ammonium nitrate, calcium ammonium nitrate, CAN, explosive manufacture) //

MgO: refractory (heat resistant material) / fire brick / lining chimneys (kilns) (6)

[Response to GIVE is linked to response to INDICATE.]

or

B

GIVE:

diamond, graphite, graphene, silica, quartz, boron nitride, silicon carbide, etc

(6)

QUESTION 5

(a) IDENTIFY: (i) **ionic** (4)

IDENTIFY: (ii) **covalent** (3)

STATE: (iii) **yes** (3)

EXPLAIN: (iv) **no //**
only 2 electrons in valence (outer) shell of H_2 / **each H atom has one electron**
 in valence (outer) shell / H_2 **doesn't have 8 electrons** in valence (outer) shell
 (2 × 1)

[Allow 2 marks for **yes, noble gas (He) configuration (full outer shell)** achieved.]

(b) DEFINE: **relative (measure of) attraction / number expressing (giving) attraction //**
for shared electrons / for shared pair / for electrons in a covalent bond (2 × 3)

(c) WRITE: (i) Na: **2, 8 / $1s^2 2s^2 2p^6$ / $1s^2 2s^2 2p_x^2 2p_y^2 2p_z^2$ //**
1 / $3s^1$ (2 × 3)

WRITE: (ii) F: **2 / $1s^2$ //**
7 / $2s^2 2p^5$ / $2s^2 2p_x^2 2p_y^2 2p_z^1$ (2 × 3)

(iii) USE: Na: **0.93 (0.9)** and F: **3.98 (4)** (5)
 [Allow difference **3.05 (3.1)**]

PREDICT: **ionic** (1)

(iv) EXPLAIN: **electron transferred from sodium atom (sodium (Na) loses an electron, Na^+)**
to a (one) fluorine (F) atom (F^-) (3)

or

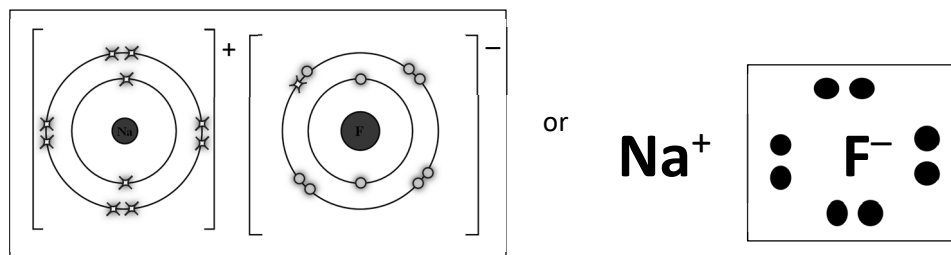


diagram showing **sodium ion** with no electrons in third shell and
fluoride ion with 8 electrons in outer shell (3)

(d) (i) HOW MANY: **three / 3**

(ii) WHAT: **trigonal pyramidal** (9 + 2)

QUESTION 6

(a) EXPLAIN: contain **hydrogen (H) and carbon (C)** only (5)

(b) GIVE: A: **ethane //**
C: **ethyne //**
E: **methylbenzene (phenylmethane)** [6 + 2 + 1]
[Allow acetylene and toluene.]
[Take order of question unless responses clearly labelled.]

(c) (i) IDENTIFY: **A (ethane) / B (ethene) / C (ethyne)** ANY TWO: (5 + 1)

(ii) IDENTIFY: **D (benzene) //**
E (methylbenzene, phenylmethane) (5 + 1)

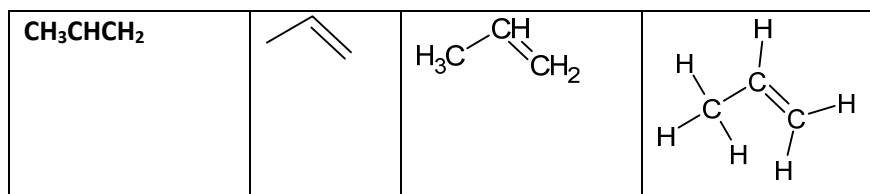
(d) WHICH: (i) **C (ethyne)**

WHICH: (ii) **B (ethene)** (5 + 1)

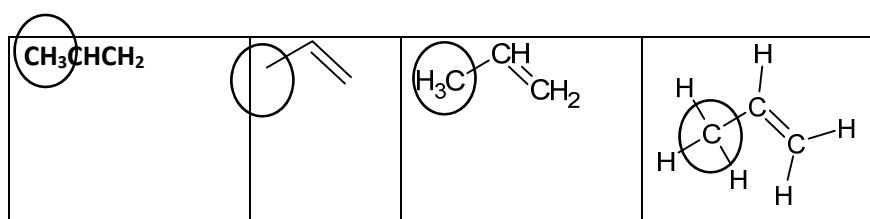
(e) COPY,
COMPLETE, **CO₂ // H₂O** PRODUCTS: (2 × 3)

BALANCE: **C₂H₂ + 2½O₂ → 2CO₂ + H₂O / 2C₂H₂ + 5O₂ → 4CO₂ + 2H₂O** BALANCING: (3)

(f) (i) DRAW: (6)



(ii) INDICATE: (3)



QUESTION 7

(a) DEFINE: (i) gives hydrogen (hydronium) ions (H^+ , H_3O^+) in aqueous solution (water) / proton (hydrogen ion, H^+) donor

DEFINE: (ii) gives hydroxide (hydroxyl) ions (OH^-) in aqueous solution (water) / proton (hydrogen ion, H^+) acceptor

(5 + 3)

(iii) DEFINE: $\text{pH} = -\log \frac{[\text{H}^+]}{[\text{H}_3\text{O}^+]}$

[Accept non-square brackets]

(2 × 3)

(iv) CALCULATE: 2.5

(6)

$\log 0.003 / -\log 0.003$	(3)
$\text{pH} = -\log 0.003 = 2.5$	(3)

[No rounding or incorrect rounding = slip error.]

[Negative final answer is not a slip error.]

(b) WRITE: A 0 //

B OH^- //

C H^+ //

D 1 //

E 10 //

F increases //

G decreases

(4 × 6) + (3 × 2)

QUESTION 8

- (a) (i) EXPLAIN: **biological / protein / produced in living cells // catalyst** ✓✓
- (ii) GIVE: **solvent / fuel / fuel additive / disinfectant / hand sanitiser / preservative / to make essences (flavourings, drugs, lacquers, polishes, polymers) / chemical industry, etc** ✓

(iii) HOW MANY: **2** ✓

FOUR POINTS: [9 + 4 + 2 + 2]

(b) (i) HOW MANY: **2** ✓

WHICH: **hydrogen (H)** ✓

(ii) CLASSIFY: **oxidation** ✓

(iii) HOW: **tetrahedral to planar** ✓

FOUR POINTS: [6 + 6 + 2 + 1]

(c) (i) HOW MANY: **1** ✓

WHICH: **oxygen (O)** ✓

(ii) CLASSIFY: **oxidation** ✓

(iii) WHAT: **purple / pink // to colourless** ✓✓

FIVE POINTS: [6 + 6 + 3 + 2 + 1]

QUESTION 9

(a) DESCRIBE:

ANY THREE POINTS FROM TABLE: [6 + 4 + 2]

Method 1	Method 2	Method 3	Point
clean a platinum (nichrome) wire* (rod, probe) in HCl (concentrated hydrochloric acid)	soak wood (splint, stick) overnight in water / use damp (wet) wood (splint, stick)	prepare a solution of the given salt	1
dip wet rod in salt (sample)	dip** splint (stick) in salt (sample)	in water and ethanol (propanol)	2
hold salt in or over hot (blue) part of Bunsen flame	hold salt in or over hot (blue) part of Bunsen flame	spray salt solution onto (into) hot (blue) part of Bunsen flame	3
yellow (amber, orange) colour confirms sodium salt	yellow (amber, orange) colour confirms sodium salt	yellow (amber, orange) colour confirms sodium salt	4

[*Allow 'metal inoculating loop', or 'metal spatula' for 'platinum (nichrome) wire'.]

[**Method 2: 'Soak splint (stick) in salt solution' merits marks for two points.]

[Clear labelled diagram for some or all points acceptable.]

ANY THREE: [6 + 4 + 2]

- (b) DEFINE: (i) **loss** of electrons
(ii) **gain** of electrons

[Take order of question unless clearly labelled.]

(6 + 3)

- (iii) IDENTIFY: **sodium (Na)**

(3)

- (c) (i) WHAT: **blue colour of solution (copper ions, Cu^{2+} , copper(II) sulfate, CuSO_4) disappears (fades) /**
magnesium (Mg) dissolves (appears to disappear) /
brown (red, black) flecks of metal (copper, solid) appear ✓

- (ii) WHICH: **magnesium (Mg)** ✓

- (iii) WOULD: **no** ✓

EXPLAIN: **sodium is above (higher up than) copper on electrochemical series /**
sodium more easily oxidised (more reactive) than copper /
copper not easily oxidised compared to sodium / ✓
sodium metal cannot exist in solution

FOUR POINTS: (9 + 9 + 4 + 4)

QUESTION 10

- (a) WHAT: (i) **number of protons** ✓
[Allow number of electrons in a neutral atom]
- WHAT: (ii) **number protons and neutrons (nucleons) in nucleus** ✓
- (iii) WHAT: **atoms of same element / atoms with same atomic number //**
different numbers of neutrons (nucleons) / different mass numbers ✓ ✓
FOUR POINTS: (6 + 3 + 2 + 1)
- (iv) HOW: **no neutron (one nucleon) in ${}^1_1\text{H}$, one neutron (two nucleons) in ${}^2_1\text{H}$ /**
differ by one neutron / one proton in ${}^1_1\text{H}$, one proton and one neutron
in ${}^2_1\text{H}$ ✓
- (v) DEFINE: **spontaneous decay of unstable nucleus / unstable nucleus //**
releasing (releases) radiation (or named radiation) ✓ ✓
[Allow decay of unstable atom but apply (–1)]
- (vi) WHAT: **electron / negative particle with very small mass** ✓
FOUR POINTS: (6 + 3 + 3 + 1)

- (b) (i) EXPLAIN: **state where forward and reverse reactions //**
have equal rates
or
state where concentrations of reactants and products //
are constant (2 × 3)
- (ii) WHY: **both of the reactions continue /**
reaction(s) does (do) not stop /
reactants continue changing into products and vice versa (2)
- (iii) WRITE: $K_c = \frac{[\text{NO}_2]^2}{[\text{N}_2\text{O}_4]}$ (8)
[numerator correct (4) and denominator correct (4); inverted (4)]
[Accept round brackets.]
- (iv) STATE: **stress (change of conditions) applied to a system in equilibrium //**
results in reaction to relieve (reduce, absorb, counteract) the stress ✓ ✓
- (v) USE: **RHS side favoured / forward reaction favoured / side with more moles**
(more molecules) is favoured
[More NO_2 in question.] ✓

THREE POINTS: (6 + 2 + 1)

(c) (i) HOW MANY: **0.16875 – 0.17** moles oxygen gas (6)

$$n = \frac{m}{M_r} \Rightarrow \frac{5.4}{32} \quad (3)$$

$$= \mathbf{0.16875} \text{ moles O}_2 \quad (3)$$

(ii) WHAT VOLUME: **3.78 – 3.81** litres O₂ (6)

$$0.16875 \times \mathbf{22.4} \quad (3)$$

$$= \mathbf{3.78} \text{ litres O}_2 \quad (3)$$

(iii) HOW MANY: **1.0×10^{23} – 1.02×10^{23}** molecules O₂ (6)

$$0.16875 \times \mathbf{6 \times 10^{23}} \quad (3)$$

$$= \mathbf{1.0125 \times 10^{23}} \text{ molecules O}_2 \quad (3)$$

(iv) HOW MANY: **0.3375 – 0.34** moles CO₂ (3)

$$0.16875 \times \mathbf{2} = \mathbf{0.3375} \text{ moles CO}_2 \quad (3)$$

(v) WHAT MASS: **9.45 – 9.52** g CO (4)

$$M_r \text{ CO} = \mathbf{28} / n = \frac{m}{M_r} \quad (2)$$

$$0.3375 \times 28 = \mathbf{9.45 – 9.52} \text{ g CO} \quad (2)$$

QUESTION 11

(a) (i) DESCRIBE: **grit channels (meshes, screens, settlement tanks) / remove large solid (insoluble) matter / physically / remove sludge** (4)

(ii) WHAT: **organic matter oxidised (removed, reduced, broken down) // biologically (by micro-organisms)** (5 + 1)

(iii) IDENTIFY: **phosphorus (P) / nitrogen (N)**
[Allow nitrates or phosphates] ✓

(iv) WHAT: **eutrophication / excessive plant growth / algal bloom (growth) / oxygen depletion (hypoxia) / fish kill / shellfish poisoning / water colour (taste, smell, aesthetic value, usefulness as source of drinking water, value for leisure) impaired, / water unsafe to drink, etc** ✓

(v) WHY: **too expensive (high cost) / nitrate (phosphate, nutrient) concentration low / treated water released to sea** ✓

THREE POINTS: (9 + 3 + 3)

(b) (i) WHAT: **solid //**
liquid //
gas // (3 × 3)
[Allow plasma, Bose-Einstein condensate, etc]

(ii) COMPARE: **particles freer to move (can slide around one another, less rigidly packed) in liquid (lava, molten rock) / particles unable to move in solid (rock) / particles less free (unable) to move in solid (rock)** (3)

(iii) WHAT: **diffusion / dissipation** (3)

(iv) CALCULATE: **5.2 litres** (9)

$$\frac{p_1 V_1}{T_1} = \frac{p_2 V_2}{T_2} / \frac{V_1}{T_1} = \frac{V_2}{T_2} / \quad (3)$$

$$\frac{1.5}{293} = \frac{V_2}{1023} \quad (3) \text{ Kelvin essential}$$

$$\Rightarrow V_2 = \mathbf{5.2 \text{ litres}} \quad (3)$$

[Allow 56.3 litres ...6]

NAME: **combined (general) gas law / Charles' law** (1)

- (c) (i) WHY: **ensure sample (mixture) moves up** paper or plate /
ensure sample (mixture) not washed into (dissolved in) solvent (7)
or
- (ii) WHAT: **ensure stationary phase (solid) stays in (not washed out of) column** (7)
- (iii) STATE: **P: paper** and water / paper and **water**
T: silica (SiO₂) / alumina (aluminium oxide, Al₂O₃) /
C: silica (SiO₂) / alumina (aluminium oxide, Al₂O₃) (6)
[Diagram and stationary phase must agree.]
- (iv) DOES: **P: up /**
T: up /
C: down (3)
[Diagram and direction must agree.]
- (v) LABEL X: **P: lowest (can include S) /**
T: lowest (can include S) /
C: highest (can include top of column) (3)
[Diagram and position must agree.]
- (vi) LABEL Y: **P: highest /**
T: highest /
C: lowest (3)
[Diagram and position must agree.]
- (vii) DESCRIBE: **no separation / no bands / no spots /**
all mixture remains at bottom (doesn't move up) in P and T /
all mixture remains at the top (doesn't move down) in C (3)

(d)

A

- (i) IS: **batch**
- (ii) WHY: **unreactive (inert) / resistant to corrosion / can withstand heating (pressure) / easily cleaned** (6 + 3)
- (iii) SUGGEST: **add catalyst / heat (increase temperature) / increase reactant (X, Y) in batch / increase factory output** ANY TWO: (3 + 1)
- (iv) WHAT: **sold / disposed of / used / stored** (6)
- (v) SUGGEST: **recycle / re-use / recover** (6)

or

B

- (i) EXPLAIN: *malleability: can be hammered into sheets (formed into different shapes, easily bent)*
lustre: shine (sheen, polish, ability to reflect light) (6 + 3)

- (ii) SELECT: **malleability //**
chemical inertness //
melting point high //
lustre

ANY TWO: (2 × 3)

- (iii) DRAW:

	Carbons need not be shown explicitly	Carbons need not be shown explicitly	Carbons need not be shown explicitly Allow Hs need not be shown explicitly where CH bond is shown	Allow Hs not shown explicitly where CH bond is shown

(6)

- (iv) DRAW:

		Carbons need not be shown explicitly Hs need not be shown explicitly where CH bond is shown	

[Correct carbon skeleton (4 carbons) with chlorine atoms on alternate carbons.]
 [n acceptable for 2][Allow end bonds shown or not shown.]

(4)

