



Coimisiún na Scrúduithe Stáit
State Examinations Commission

Leaving Certificate 2021

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, 2021

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 bónaís 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 2021

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) IDENTIFY:
- (i) A = **water / H₂O**
- (ii) B = **ethyne** (6 + 5)
- (b) DESCRIBE: **effervescence / fizzing / bubbling (bubbles) / flask gets hot / steam / white smoke (vapour) / solid disappearing / dirty brown liquid produced / carbide reacts / gas formed (evolved) / gas flows along delivery tube** (6)
- (c) (i) WHAT: **insoluble** in water
- (ii) WHY: **impure / contain air (oxygen, nitrogen)** (6 + 3)
- (d) (i) EXPLAIN: **contains multiple (triple or double) carbon-carbon bond / can add hydrogen** (6)
- (ii) DESCRIBE: **shake (mix, bubble into, add, use) with bromine (Br₂) solution (water) / shake (mix, bubble into, add, use) with acidified potassium permanganate solution (H⁺/KMnO₄ or H⁺/MnO₄⁻)** (3)
- brown (red, orange, yellow, pink, purple) colour //**
disappears (decolourises, fades) (2 × 3)
- (e) GIVE: **very hot / very high temperature //**
cleaner / clear / no (less) soot //
blue / non-luminous
- ANY TWO: (6 + 3)

Question 2

(a) (i) IDENTIFY: A: **pipette** (3)
C: **evaporating basin** (3)

(ii) WOULD: **pipette / A** (3)
EXPLAIN: **pipette has narrower neck / pipette designed to deliver fixed volume** (3)
[Accept opposites in terms of B.]

(iii) HOW: **deionised (distilled, pure) water //**
NaOH (sodium hydroxide) solution / solution it will contain (2 × 3)

(b) (i) NAME: **methyl orange / methyl red / phenolphthalein** (3)

(ii) STATE: **yellow (orange) / pink //**
to pink (red, peach) / to colourless (2 × 3)

[Colours must be linked to indicator.][Clear unacceptable for colourless.]

[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 (3) 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.]

(iii) WHAT: **water (H₂O) //**
sodium chloride (NaCl, salt) //
indicator (methyl orange) ANY TWO: (2 × 3)

(c) CALCULATE: **0.276 moles per litre NaOH** (9)

$$\frac{23.0 \times 0.3}{1} = \quad (3)$$

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

$$M = 0.276 \text{ mol l}^{-1} \quad (3)$$

If first 6 not awarded formula may be awarded 3.

or

$$\frac{23.0 \times 0.3}{1000} = 6.9 \times 10^{-3} \text{ moles HCl} \quad (3)$$

$$6.9 \times 10^{-3} \times 1 = 6.9 \times 10^{-3} \text{ moles NaOH} \quad (3)$$

$$M = \frac{6.9 \times 10^{-3} \times 1000}{25.0} = 0.276 \text{ mol l}^{-1} \quad (3)$$

(d) (i) HOW: **evaporate all water (solvent) / evaporate to dryness /**
boil away (off) all water (solvent) (4)

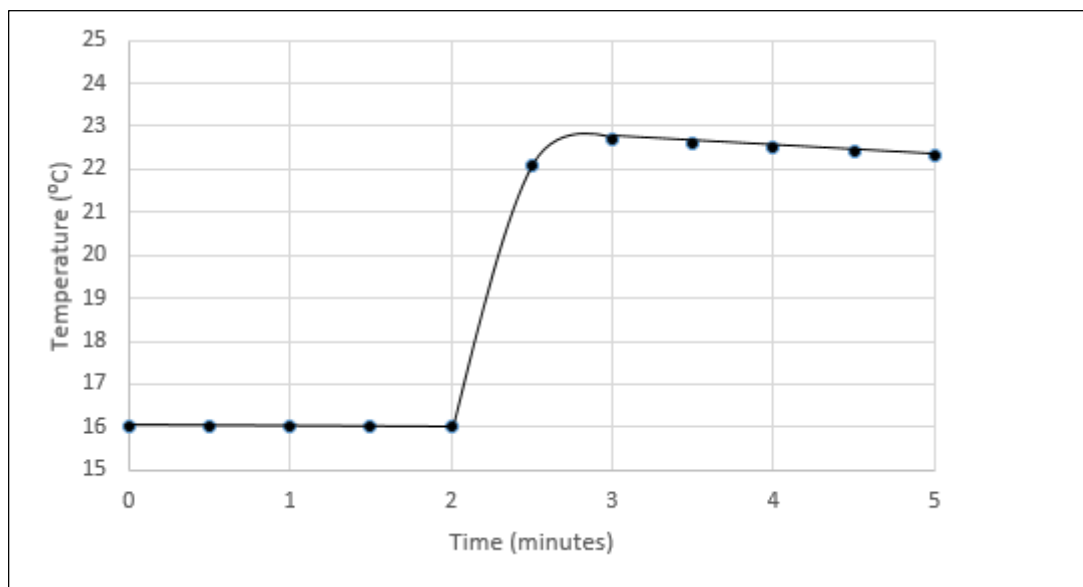
(ii) CALCULATE: **0.40365 g NaCl** (4)

$$M_r \text{ NaCl} = 58.5 \quad (2)$$

$$58.5 \times 0.0069 = 0.40365 \text{ g} \quad (2)$$

Question 3

- (a) PLOT: axes correctly labelled with unit ($^{\circ}\text{C}$ and minute or min) (3)
 or quantity (temperature and time or t) (3)
 axes correctly scaled (3)
 8 points correctly plotted (3)
 3 further points correctly plotted (3)
 [Minus 3 if graph not on graph paper.]
 [Axes reversed acceptable.]
 curve correctly drawn through points (3)
 [Points joined by straight lines acceptable here.]



- (b) (i) ESTIMATE: **6.7 – 7.0 $^{\circ}\text{C}$** (6)
- (ii) IS: **exothermic** (3)
 JUSTIFY: **temperature goes up / heat given out in reaction** (3)
- (c) WHY: **reduce (stop) heat loss to surroundings / doesn't absorb heat / low heat capacity / ensure accurate temperature change (result) obtained** (6)
- (d) (i) WHAT: **corrosive** (6)
 [Allow harmful, burning, irritating.]
- (ii) DESCRIBE: **wear gloves (PPE) / wear eye protection / mop up spillages, etc** (6)
- (e) FIND: **$-57.0 \text{ kJ mol}^{-1}$** (5)

$\frac{5.7}{0.1} =$	(2)
57 kJ mol^{-1}	(2)
exothermic $\Rightarrow$ $-57.0 \text{ kJ mol}^{-1}$	(1)

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) EXPLAIN: **isotopes / different numbers of neutrons** (6)
- (b) EXPLAIN: **spontaneous decay of unstable nucleus / spontaneous decay of unstable atom // releasing radiation (or named radiation)** (2 × 3)
- (c) NAME: **strontium (Sr) / lithium (Li)** (6)
- (d) EXPLAIN: **fluorine has more protons (greater atomic number, greater effective nuclear charge) /
lithium has fewer protons (smaller atomic number, smaller effective nuclear charge) /
lithium has 3 protons but fluorine has 9** (6)
- (e) WHAT: **directly proportional** (6)
[inversely proportional unacceptable]
[Allow 3 for 'direct' relationship]
- (f) WHICH: (i) **gas** (3)
(ii) **solid** (3)
- (g) IS: **true** (3)
- EXPLAIN: **all have empirical formula CH₂O /
same ratio of number of atoms of elements C, H and O** (3)
[EXPLAIN marks available only when IS marks awarded.]
- (h) WHY: **to give it an odour (smell) / detection by odour (smell) / for safety /
in case of a leak to enable detection** (6)
- (i) FIND: **1.36 mg per 1 cm³ / 0.00136 g per 1 cm³** (2 × 3)
- | | |
|---|-----|
| 1360 ÷ 1000 | (3) |
| ⇒ 1.360 mg per 1 cm³ / 0.00136 g per 1 cm³ | (3) |
- (j) WHY: **causes algal bloom (eutrophication, oxygen depletion, fish-kill, increase BOD) /
causes bad smell (unpleasant taste, unsightly appearance) /
microorganisms in waste could cause illness /
toxins in waste / contaminates (pollutes) drinking water / etc** (6)
[causes pollution, contamination or damages environment ...3]
- (k) SUPPLY: **broken //**
formed (created, made) (2 × 3)

- (I) **A**
GIVE: **SO₂ / burning sulfur (sulfur compounds) etc** (6)
[Award 3 for volcanoes, fossil fuels, etc]
- or*
- B**
WHY: **to prevent corrosion (rust) / to improve appearance** (6)

Question 5

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

(2 × 3)

(ii) WRITE: H: **2.20 //**

Be: **1.57 / 1.6 //**

O: **3.44**

(3 × 1)

[Take order of question unless answers clearly labelled.]

USE: BeO: **ionic**

(3)

H₂O: **polar** covalent

(3)

(b) WOULD: **yes**

(3)

EXPLAIN: **ionic bonding (ionic compound) / ions free to move**

(3)

[EXPLAIN marks available only when WOULD marks awarded.]

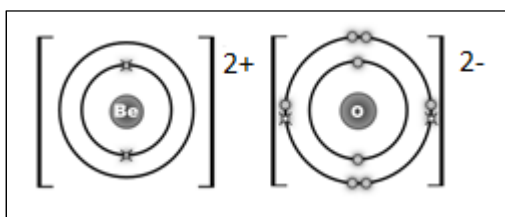
(c) WRITE: (i) **2, 2 / 1s² 2s²**

(3)

WRITE: (ii) **2, 6 / 1s² 2s² 2p⁴ / 1s² 2s² 2p_x² 2p_y¹ 2p_z¹**

(3)

(iii) USE:



or

Be²⁺

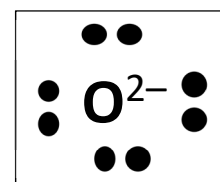


diagram showing **beryllium ion with no electrons in outer shell //**

and showing **oxygen ion with 8 electrons in outer shell**

(2 × 3)

or

outer **two electrons** transferred **from beryllium** atom / **Be²⁺//**

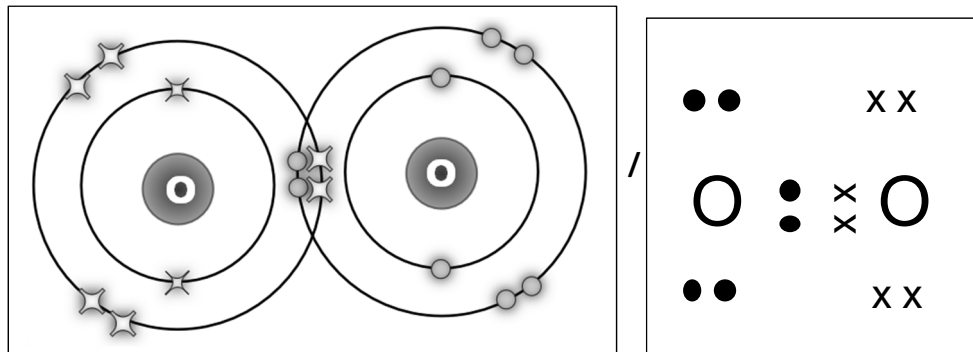
to an (one) oxygen atom / **O²⁻**

(2 × 3)

[Diagram not essential.]

- (d) (i) EXPLAIN: **two shared electrons / one shared pair of electrons / an atom shares one electron with another atom / covalent bond between 2 atoms with each atom contributing one electron** (6)

(ii) USE:



two bond pairs shown //

two lone pairs in valence shell of each oxygen shown

(2 × 3)

[Electrons in inner shell of oxygen need not be shown.]

[Any electron can be represented by a dot or a cross.]

- (iii) WHY: **no attraction between polar water and non-polar oxygen molecules / water polar and oxygen non-polar / molecules (substances) with similar bonding dissolve one another / molecules (substances) with dissimilar bonding do not dissolve one another** (5)

[Allow (3) for 'like dissolves like'.]

Question 6

- (a) EXPLAIN: **compounds of hydrogen (H) and carbon (C) / contain hydrogen (H) and carbon (C) only** (5)
- (b) LIST: **light gasoline, kerosene, gas oil (diesel oil)** (6)
[reversed (3)]
- (c) WHERE: (i) **high** (6)
WHERE: (ii) **low** (6)
- (d) WHICH: (i) **kerosene /**
WHICH: (ii) **gas oil (diesel oil) / kerosene** (6 + 3)
- (e) (i) WHAT: **octane number (octane rating)** (6)
(ii) WHY: **to improve (increase) octane number (rating) /
to reduce knocking (pinking, pinging, tapping, engine noise) /
to stop petrol autoigniting (pre-igniting, igniting too early,
igniting before spark) /** (6)
(iii) WHY: **toxic / poisonous / harmful / may cause cancer (brain damage) /
damages health / poisons catalytic converter** (6)
[causes pollution (damages environment) ...3]

Question 7

(a) (i) WHAT: **gives hydrogen (hydronium) ions (H^+ , H_3O^+) in aqueous solution (water) / proton (hydrogen ion, H^+) donor** (6)

(ii) DEFINE: **$\text{pH} = -\log //$
 $[\text{H}^+] / [\text{H}_3\text{O}^+]$ (2 × 3)
[Accept non-square brackets]**

(iii) CALCULATE: **1.7** (6)

$\log 0.02$ (3) $\text{pH} = -\log 0.02 = 1.7$ (3)

[No rounding or incorrect rounding = slip error.]

[Negative answer is not a slip error.]

(iv) WHY: **dissolves (corrodes) pipes / dissolves toxic (harmful, heavy) metals / causes tooth decay / stains sinks and baths** (3)
[damages health or unsafe to drink are unacceptable answers]

(v) DOES: **increase** (3)

(b) (i) HOW: **mix (shake) soap flakes with hard water //**
scum formed / no lather (2 × 3)

(ii) NAME: **calcium hydrogencarbonate (calcium bicarbonate, $\text{Ca}(\text{HCO}_3)_2$, magnesium hydrogencarbonate, magnesium bicarbonate, $\text{Mg}(\text{HCO}_3)_2$)** (6)

(iii) GIVE: **boil / add Na_2CO_3 (sodium carbonate, washing soda) / use ion exchange** (6)

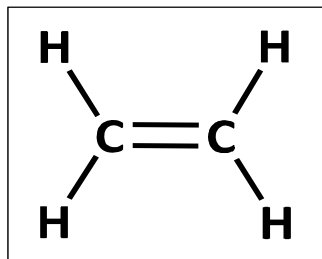
(iv) GIVE: ***advantage:* tastes nicer / contains calcium / good for teeth and bones** (4)

***disadvantage:* wastes soap / wastes heat / forms fur (scale) on kettles (pipes, boiler)** (4)

Question 8

(a) (i) NAME: **alkenes** (3)

(ii) DRAW:



(6)

(iii) IS: **planar**

(6)

(b) (i) NAME: **ethane** (6)

(ii) IDENTIFY: **A: bromine (Br₂)** (3)

B: hydrogen chloride (HCl) (3)

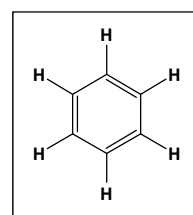
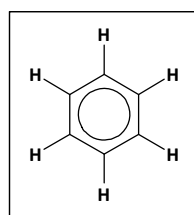
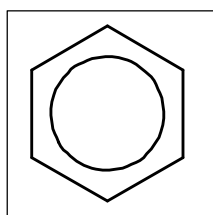
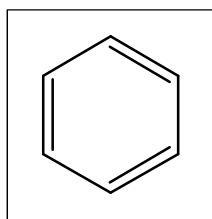
[Allow hydrochloric acid for hydrogen chloride.]

(c) NAME: **elimination / dehydration** (6)

(d) NAME: **poly(ethene) / polythene / polyethylene** (6)

(e) (i) EXPLAIN: **contains a benzene ring**

(ii) DRAW:



(6 + 5)

Question 9

- (a) WHAT: **change in concentration per unit time (rate of change of concentration) of one reactant or product**

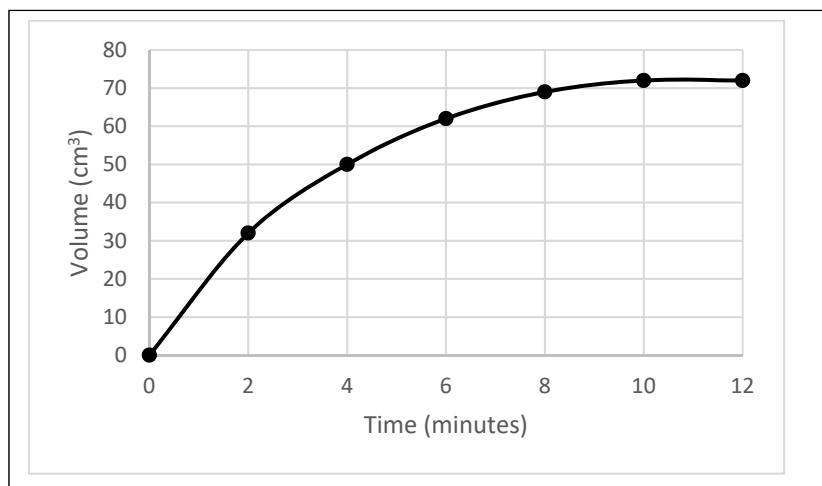
or

$$\frac{\text{change in concentration}}{\text{time}} \quad (6)$$

- (b) (i) PLOT: **axes correctly labelled with unit (cm^3 and minute or min) or quantity (volume or vol or V and time or t)** (3)
axes correctly scaled (3)

4 points correctly plotted (3)
3 further points correctly plotted (3)
 [Minus 3 if graph not on graph paper.]
 [Axes reversed acceptable.]

smooth curve correctly drawn through points and (0, 0) (3)



- (ii) DOES: **decreases** (3)

GIVE: **Zn (zinc, HCl, hydrochloric acid, reactants) used up (concentration decreases) / graph becomes less steep / graph levels off** (3)

- (c) FIND: (i) **72 cm^3** (3)

FIND: (ii) **2.2 – 2.6 minutes** (6)
 [First 3 marks can be awarded for extrapolating from 36 cm^3 .]

FIND: (iii) **$11.0 - 11.4 \text{ cm}^3 \text{ H}_2$ per minute** (6)

$$55 - 57 \text{ cm}^3 \quad (3)$$

$$\text{volume} \div 5 = 11.0 - 11.4 \text{ cm}^3 \text{ H}_2 \text{ per minute} \quad (3)$$

(d) HOW: (i) **increased / greater / speeded up**

HOW: (ii) **increased / greater / speeded up**

(4 + 4)

Question 10

- (a) WRITE: 1 **atomic //**
 2 **mass //**
 3 **neutral //**
 4 **Rutherford //**
 5 **positive //**
 6 **Bohr //**
 7 **negative** (2 × 6 + 4 × 3 + 1)

- (b) DEFINE: (i) **loss of electrons**
 (ii) **gain of electrons** (4 + 3)

- (iii) WHAT: **2:1** (6)
 [Reverse unacceptable unless clearly labelled oxygen:hydrogen]

- (iv) IDENTIFY: **platinum (Pt) / carbon (graphite, C)** (6)

- (v) AT: **X / anode** (6)

- (c) (i) WHAT: **speeds up (alters) the rate of a chemical reaction //**
without being used up (but is chemically unchanged) in the reaction (2 × 3)

- (ii) WHAT: [14 + (2 × 1) + 12 + 16 + 14 + (2 × 1)] = **60 g** (6)

- HOW MANY: **27 moles urea** (6)

$n = \frac{m}{A_r} = \frac{1620}{60} \quad (3)$
$= \mathbf{27 \text{ moles urea}} \quad (3)$

- (iii) HOW MANY: **1.5 or 6/4 or 3/2 moles NO₂** (3)

4 moles urea ⇒ 6 moles NO ₂ 1 mole urea ⇒ 1.5 or 6/4 or 3/2 moles NO₂ (3)

- WHAT VOLUME: **33.6 litres NO₂** (4)
 [Allow 907.2 litres NO₂ from 27 moles urea]

$1.5 \times \mathbf{22.4} \quad (2)$
$= \mathbf{33.6 \text{ litres NO}_2} \quad (2)$

Question 11

- (a) WHAT: (i) **group**
- WHAT: (ii) **period** (4 + 3)
- (iii) IDENTIFY: **lithium (Li) / beryllium (Be)** (6)
- (iv) HOW: **atomic number / number of protons** (6)
- (v) HOW: **from properties of elements in same group (column) /
elements in same group (column) have similar properties /
from properties of carbon (C) and silicon (Si)** (6)
- (b) (i) WHAT: **state where forward and reverse reactions //**
have equal rates
or
state where concentrations of reactants and products //
are constant (4 + 3)
- (ii) WRITE: $K_c = \frac{[\text{HCO}_3^-]^2}{[\text{H}_2\text{CO}_3][\text{CO}_3^{2-}]}$ (6)
[numerator correct (3) and denominator correct (3); inverted (3)]
[Accept round brackets.]
- (iii) SUPPLY: **Le Châtelier's //**
increase (2 × 3)
- (iv) USE: **negative effect / cannot make shell / shell thinner /
shell has poor quality / harder to make shell / takes longer to make shell** (3)
- EXPLAIN: **carbonate ion (CO_3^{2-}) used up /
equilibrium moves to right /
carbonate ion (CO_3^{2-}) converted to hydrogencarbonate /
carbonic acid reacts with (uses up) carbonate ion (CO_3^{2-}) /
less carbonate ion available** (3)

(c) (i) SUGGEST: **so there is sufficient oxygen (air)** (4)

(ii) USE: **MgO** (9)

or

Mg: 2 or II //

O: 2 or II (2 × 3)

(iii) REPLACE & BALANCE: **Mg + ½ O₂ → MgO // 2Mg + O₂ → 2MgO** FORMULAE: (3); BALANCING: (3)

(iv) WOULD: **increase** (3)

EXPLAIN: **oxygen (air) absorbed or reacted / MgO heavier than Mg, etc** (3)

(d)

A

(i) WHICH **nitrogen (N₂, N)** (4)

(ii) GIVE: **nitrogen: packaging food to prevent oxidation / packaging to prevent crushing of food (crisps, etc, delicate items) / flushing (purging) tanks of flammable liquids (gases, vapours) / freezing (preserving) food (biological specimens, sperm, semen) / remove unwanted skin cells / remove skin cancer (warts, verrucae) / feedstock for ammonia industry, etc //**

oxygen: breathing (respiration) gas for patients (divers, firefighters, pilots, etc) / steelmaking / to support combustion of ethyne, in rockets etc / skin (muscle) therapy / welding / reduce river pollution / etc (2 × 3)

(iii) EXPLAIN: **triple bond / strong bond / non-polar** (6)

(iv) WHAT: **nitrogen fixation** (6)

(v) GIVE: **absorb (protect from) uv (ultraviolet) radiation** (3)

or

B

- (i) GIVE: **metals (metallic) / often good catalysts / variable valency / form coloured compounds, etc** (4)
- (ii) IDENTIFY: **coke (carbon, C)** (6)
- (iii) WHAT: **slag / calcium silicate (CaSiO_4)**
- GIVE: **roadmaking (hardcore) / lightweight building blocks / cement making** (6 + 3)
- (iv) IDENTIFY: **carbon (C)** (6)
[allow sand or silicon or silica]

