Coimisiún na Scrúduithe Stáit
State Examinations Commission

Leaving Certificate 2020

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 2020

_____

CHEMISTRY – ORDINARY LEVEL

MARKING SCHEME

Candidates are required to answer eight questions in all.
These must include at least two questions from Section A.
All questions carry equal marks (50).

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.

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 ngnóthaíonn níos mó ná 75% d'iomlán na marcanna don scrúdú. Ba chóir freisin an marc bónais sin **a shlánú síos**.

Tábla 400 @ 10%

Bain úsáid as an tábla seo i gcás na n-ábhar a bhfuil 400 marc san iomlán ag gabháil leo agus inarb é 10% gnáthráta an bhónais.

Bain úsáid as an ngnáthráta i gcás 300 marc agus faoina bhun sin. Os cionn an mharc sin, féach an tábla thíos.

Bunmharc	Marc Bónais
301 - 303	29
304 - 306	28
307 - 310	27
311 - 313	26
314 - 316	25
317 - 320	24
321 - 323	23
324 - 326	22
327 - 330	21
331 - 333	20
334 - 336	19
337 - 340	18
341 - 343	17
344 - 346	16
347 - 350	15

Bunmharc	Marc Bónais
351 - 353	14
354 - 356	13
357 - 360	12
361 - 363	11
364 - 366	10
367 - 370	9
371 - 373	8
374 - 376	7
377 - 380	6
381 - 383	5
384 - 386	4
387 - 390	3
391 - 393	2
394 - 396	1
397 - 400	0

Question 1

a	b	c	d
17	**12**	**12**	**9**

(*a*) (*i*) WHAT: **brown (red, orange, yellow)** (5)

(*ii*) WHAT: **colour disappears (fades, lightens) /**
solution **decolourises / becomes colourless** (5)

(*iii*) WHAT: at least one **double (triple) bond** between pair of carbon atoms **/**
at least one **multiple** C-C **bond /**
can undergo addition reaction(s) (7)

(*b*) (*i*) DESCRIBE: test-tube clamped safely, stopper removed and
lighting taper inserted into test tube of ethyne (6)

(*ii*) DESCRIBE: **bright (yellow, luminous, sooty, smoky)** flame **/**
with **smuts (soot,** black **smoke)** (6)

(*c*) (*i*) WHICH: **Y / second** (3)

(*ii*) GIVE: **m.p.** range **higher / range narrower (range smaller)** (3)

(*iii*) NAME: **recrystallisation** (6)
[Allow (3) for 'crystallisation' or for 'filtration of hot impure solution followed by cooling of filtrate'.]

(*d*) MATCH: A: **soap**
B: **clove oil**
C: **ethanoic acid**
D: **ethanal**
(3 + 2 + 2 + 2)

[Take order of question unless clearly labelled.]

Question 2

a	b	c	d
14	**6**	**9**	**21**

(*a*) (*i*) NAME: **volumetric** flask (5)

(*ii*) HOW: **tap to dislodge all solid** into beaker **/**
nudge solid off with spatula into beaker **/**
squeeze weighing boat **and pour solid off** to beaker **/**
use a brush to transfer solid to beaker **/**
use a **wash bottle** of deionised water **to transfer solid** to beaker **/**
rinse (wash) weighing boat with deionised water into beaker **/**
add rinsings of weighing boat to the beaker **//**

pour contents of **beaker into** volumetric **flask (B) /**
using a **funnel /**
add rinsings of **beaker to** the volumetric **flask (B)** (6 + 3)

(*b*) NAME: **burette** (6)

(*c*) (*i*) NAME: **methyl orange / methyl red** (3)

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

[*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 incorrect 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 and correct colours in correct order.*]

(*d*) (*i*) WHY: titrations **2 & 3 not close enough (do not agree) /**
titrations **must agree to within 0.1** cm^3 **/**
end point passed (overshot) in third titration (6)
[Allow 3 for 'to get an accurate result']

(*ii*) WHICH: **27.7** cm^3 and **27.8** cm^3 **/ second** and **fourth** (3)

(*iii*) CALCULATE: **27.75** cm^3 moles (3)

(*iv*) CALCULATE: 0**.09** moles per litre (9)

$\frac{\mathbf{25.0 \times 0.05}}{\mathbf{1}}$ **=** (3)

$\frac{\mathbf{27.75 \times M}}{\mathbf{2}}$ (3)

M = 0**.09** mol l^{-1} (3)

If first 6 not awarded,
formula may be awarded 3.

or

$\frac{25.0 \times 0.05}{1000}$ = **1.25 × 10^{-3}** moles Na_2CO_3 (3)

1.25×10^{-3} **× 2 = 2.5 × 10^{-3}** moles HCl (3)

M = $\frac{2.5 \times 10^{-3} \times 1000}{27.75}$ **=** 0**.09** mol l^{-1} (3)

Question 3

a	b	c	d	e
8	**12**	**6**	**15**	**9**

(*a*) (*i*) IDENTIFY: **manganese(IV) oxide / manganese dioxide / MnO_2 / celery / liver**, etc (4)

(*ii*) DESCRIBE: **black (brown) / powder / pellets (grains) /** small pieces of **stalks (stems) /** small **meaty (minced, red, bloody)** pieces, **etc** (4)
[IDENTIFY and DESCRIBE linked.]

(*b*) (*i*) WHAT: **oxidising** agent (reagent) **/ oxidiser / causes oxidation /**
may cause other **substances to ignite** (6)

(*ii*) GIVE: **wear PPE (gloves, eye protection) / store separately** from some other substances (6)
[Allow keep away from flame if flammable given at (i)]

(*c*) STATE: **bring flask into vertical position / bend tube /**
start timing when catalyst drops into hydrogen **peroxide (solution, liquid) /**
shake flask / mix catalyst and hydrogen **peroxide (solution, liquid) /**
add catalyst to hydrogen **peroxide (solution, liquid)** (6)

(*d*) 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)

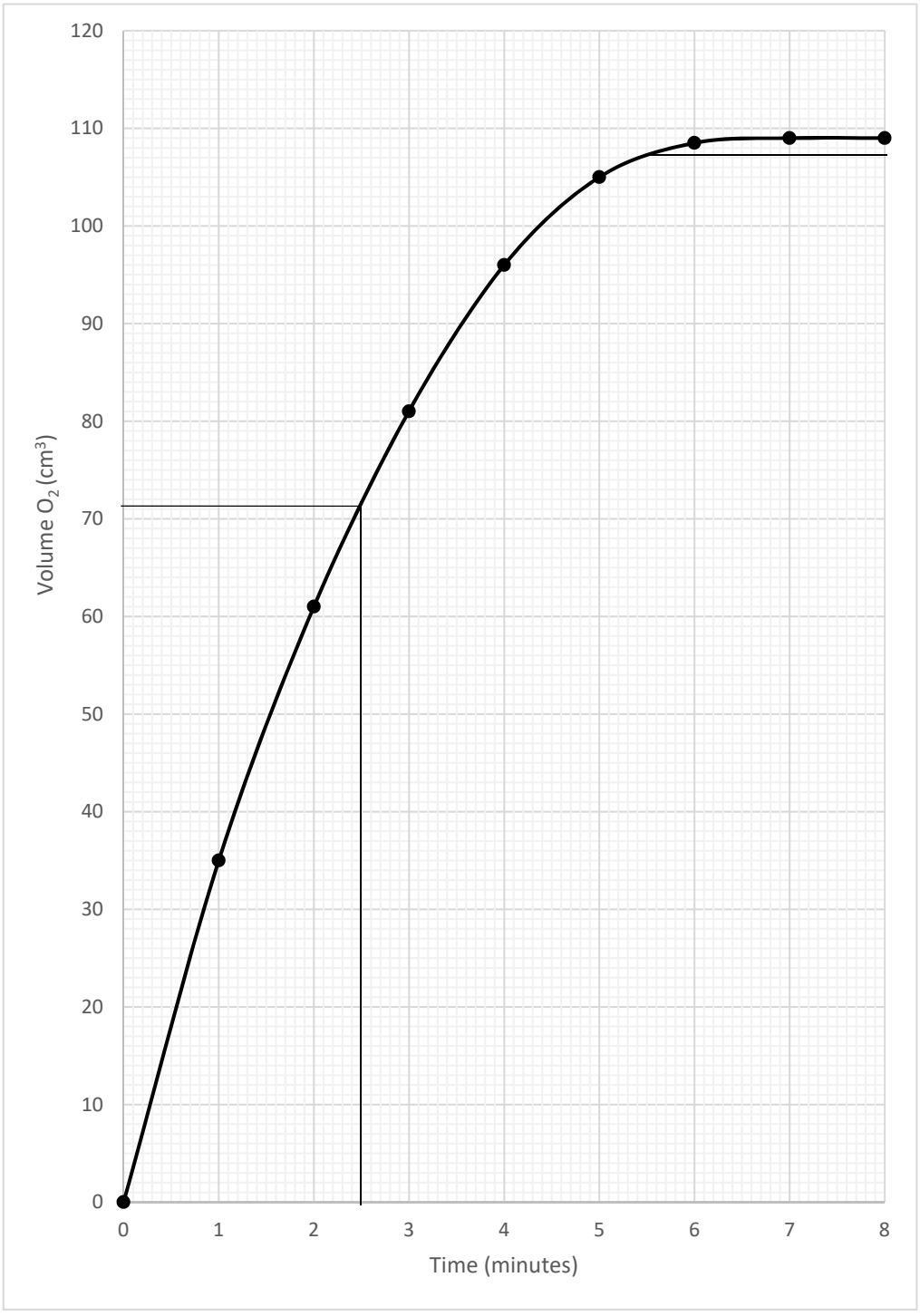
6 points correctly plotted (3)
3 further points correctly plotted (3)
[Minus 3 if graph not on graph paper.]
[Allow axes reversed]

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

(*e*) FIND: (*i*) **71** cm^3 (**70 – 74** cm^3) (3)

(*ii*) **1.5** cm^3 (**< 5** cm^3) (3)

EXPLAIN: **reaction slowing (slows) down** with time **/**
rate faster at start /
rate slower (rate zero) at end /
less reactant (H_2O_2, hydrogen **peroxide) at end /**
(H_2O_2, hydrogen **peroxide) less concentrated at end /**
more reactant (H_2O_2, hydrogen **peroxide) at start /**
(H_2O_2, hydrogen **peroxide) more concentrated at start /**
reactant (H_2O_2, hydrogen **peroxide) used up** as reaction proceeds (as time goes by) **/**
fewer collisions leading to reaction **at end /**
more collisions leading to reaction **at start** (3)
[Catalyst used up cancels correct answer.]


120
110
100
90
80
70
60
50
40
30
20
10
0
Volume O_2 (cm^3)
0
1
2
3
4
5
6
7
8
Time (minutes)

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*) STATE: *physical:* **low density / low melting point (m.p.) / silvery / soft (can be cut with a knife) / shiny / solid //**
chemical: **reactive / react with water / oxidised in air (oxygen) / form ions / form ionic compound**s **/ lose one (outer) electron** (2 × 3)

(*b*) NAME: **noble gases / inert gases / Group 18** (6)
[Allow Group 8]

(*c*) WHAT: (*i*) **yellow (amber, orange) //**
(*ii*) **blue-green / green** (2 × 3)
[allow blue for blue-green]

(*d*) IDENTIFY: **hydrogen / H_2 //**
oxygen / O_2 (2 × 3)
[H and O….(3)]

(*e*) USE: **SiH_4** (6)
[Allow (3) for valencies Si:4 (IV) and H:1(I) where formula not given or incorrect formula given]

(*f*) WHY: **to kill microorganisms (pathogens, bacteria, germs, viruses) / to disinfect / to stop spread of infection (disease)** (6)

(*g*) DEFINE: **heat evolved (produced, given out) when one mole of a substance // is burned completely / is burned in excess oxygen** (2 × 3)
[Allow involved for evolved.]

(*h*) WHY: **to get smaller (more valuable, more useful) molecules (fuel) / to convert less useful fuel (molecules) to more useful fuel (molecules) / demand for gas oil not high** compared to products of catalytic cracking **/ to get alkenes / to get raw materials for polymer industry / to increase octane number / etc** (6)

(*i*) CALCULATE: **47**% (6)

M_r = 28 + 16 **+** 16 **= 60**	(3)
% Si = $\frac{28}{60} \times 100$ = **47%**	(3)

[Slip penalty if not rounded]

(*j*) NAME: **chromatography** (6)

(*k*) **A** STATE: **transport (road, rail) //** access to **port //** skilled **workforce //** close to **raw materials // etc** ANY TWO: (2 × 3)

or

B STATE: **good conductors of heat // good conductors of electricity // ductile // malleable // shiny** when cut **// form positive ions //** usually **hard (strong) //** mostly **solid** at RTP **// etc** ANY TWO: (2 × 3)

Question 5

a	b	c	d	e
5	**21**	**12**	**6**	**6**

(*a*) DEFINE: the **number of protons** in the atoms of an element (5)

(*b*) NAME: (*i*) **nucleus**

(*ii*) **electron cloud / (shell(s) / energy levels) / outside nucleus**

(*iii*) **nucleus** (6 + 6 + 3)

(*iv*) WHY: **protons and neutrons have** much **great**er **mass** than electrons **/**
protons and neutrons each **have mass 1** amu

or

electrons much **light**er than protons or neutrons **/**
electron mass is about 1/1840 amu (3)

(*v*) WHY: **equal numbers of** positive **protons and** negative **electrons /**
6 positive **protons** and **6** negative **electrons /**
no net charge (3)

(*c*) (*i*) WHAT: **atoms of same element** / atoms with **same atomic number (number of protons) //**
but **different mass numbers /** but **different numbers of neutrons** (2 × 3)

HOW MANY: (*ii*) **7 //**
(*iii*) **8** (2 × 3)

(*d*) NAME: **alpha (α, helium nuclei)** particles **/**
beta (β, electrons) particles **/**
gamma (γ) rays **/ electromagnetic radiation** (6)

(*e*) (*i*) WHAT: **12.01** (3)

(*ii*) WHY: element composed of different **isotopes present in different abundances /**
carbon-12 most abundant isotope / average of isotope masses /
not all atoms are carbon-12 / both carbon-12 and carbon-13 present (3)
[Correct reference to masses of individual protons and neutrons acceptable.]

Question 6

a	b	c	d
5	9	24	12

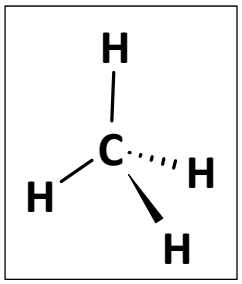
(*a*) EXPLAIN: **heat (energy) lost (produced, released, given out) / ΔH negative** (5)

(*b*) IDENTIFY: (*i*) **CH_4 / methane / LPG**

(*ii*) **H_2 / hydrogen**

(*iii*) **kerosene** (3 × 3)

(*c*) (*i*) GIVE: **methane**



(*ii*) WHAT: **tetrahedral (tetrahedron) /**

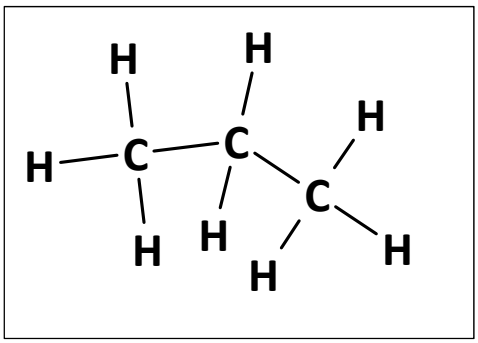
(*iii*) TO WHICH: **alkane**s

(*iv*) WHY: to give a **smell /** to **detect leaks / safety, etc** (6 + 6 + 3 + 3)

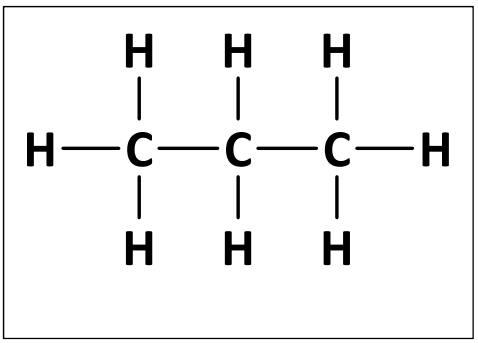
(*v*) COPY COMPLETE & BALANCE **$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$**

PRODUCT FORMULAE: (3) BALANCING: (3)

(*d*) (*i*) DRAW: (6)



or



[H's need not be shown explicitly]

(*ii*) IDENTIFY: **butane / C_4H_{10} / $CH_3CH_2CH_2CH_3$** (6)

Question 7

a	b	c	d
6	**12**	**6**	**26**

(*a*) WHAT: **gives hydroxyl (hydroxide) ions (OH^-) //**
in aqueous solution (water) (2 × 3)
or
proton (hydrogen ion, H^+) acceptor (6)
[Allow 3 for either 'reacts with acid to form salt and water' or for 'substance with pH above 7']

(*b*) DEFINE: pH = **–log //**
$[H^+]$ / $[H_3O^+]$ (2 × 3)

CALCULATE: **12.7** (6)

pOH = –log 0.05 = **1.3**	(3)
pH = 14 – pOH = 14 – 1.3 = **12.7**	(3)

[No rounding or incorrect rounding = slip error]
[Allow (3) for pH = –log 0.05 = **1.3**]

(*c*) WHAT: **lathers poorly / forms scum //**
with soap
or
contains **dissolved //**
calcium (Ca, magnesium, Mg) ions / Ca^{2+} (Mg^{2+}) (2 × 3)

(*d*) (*i*) IS: **basic** (6)

(*ii*) HOW: reference to **calcium (Ca, magnesium, Mg)** ions (6)

(*iii*) HOW: reference to **hydrogencarbonate** (6)

(*iv*) WHAT: **white (cloudy) / solid (precipitate)** (3)

(*v*) GIVE: **taste**s nicer (better) **/ calcium** content **/ good for bones (teeth)** (5)

Question 8

a	b	c
27	**12**	**11**

(*a*) (*i*) GIVE: A: **ethanol //**
B: **ethanal //**
C: **ethanoic acid**
(3 × 3)
[Take order of question unless clearly labelled.]

(*ii*) WHICH: **A / ethanol / first //**
E / benzyl alcohol / phenyl methanol / fifth (2 × 3)

(*iii*) IS: **no / insoluble** (3)

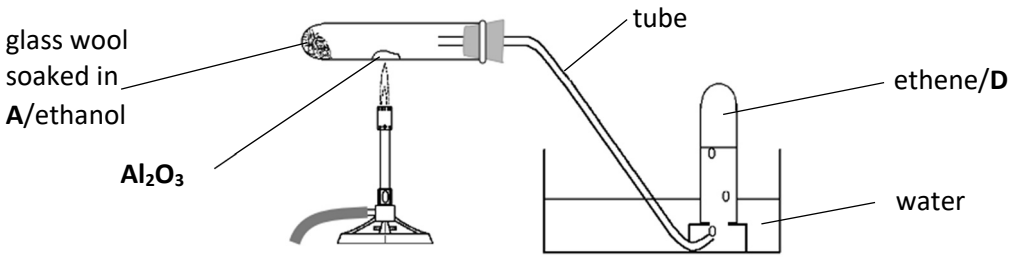
(*iv*) WHICH: **D / ethene / fourth** (6)

(*v*) IDENTIFY: **E / benzyl alcohol / phenyl methanol / fifth / F / benzoic acid / sixth** (3)

(*b*) (*i*) WHAT: **catalyst //**
in a **biological** system **/** for a reaction **in living organism** (2 × 3)

(*ii*) SUPPLY: **oxidation** (6)

(*c*) (*i*) DRAW:



horizontal (slightly slanting upwards) test tube with delivery tube //
collection over water //
ethanol, Al_2O_3 and Bunsen (heat source) shown correctly

(*ii*) CLASSIFY: **elimination / dehydration** (3 + 3 + 3 + 2)

Question 9

a	b	c	d
12	**12**	**21**	**5**

(*a*) WHAT: (*i*) **2, 6**

[Allow (3) for 2 electrons in first shell]
[Allow (3) for 6 electrons in outer (valence) shell]

(*ii*) **2, 8, 2** (2 × 6)

[Allow (3) for 2 electrons in first shell]
[Allow (3) for 2 electrons in outer (valence) shell]

[Take order of question unless clearly labelled.][Accept Bohr diagram.]

(*b*) DEFINE: (*i*) **loss** of electrons
(*ii*) **gain** of electrons (2 × 6)

[Take order of question unless clearly labelled.]

(*c*) (*i*) WHICH: **oxygen / O / O_2** (6)

(*ii*) WHICH: **Mg / magnesium** (6)

(*iii*) GIVE: **solid / hard / brittle / crystalline /**
high melting point (high m.p.) / high boiling point (high b.p) /
water soluble / conduct electricity when molten (dissolved in water**)**
(6 + 3)

(*d*) WHAT: magnesium **more easily oxidised / copper less easily oxidised** (5)

Question 10

a	b	c
25	**25**	**25**

(*a*) WRITE:

1 **physical //**

2 **biological //**

3 **aerobically //**

4 **microorganisms //**

5 **chemical //**

6 **nutrients //**

7 **eutrophication //**

8 **sludge** 4 + (7 × 3)

(*b*) IN WHICH: (*i*) **gas**
(*ii*) **gas** (4 + 3)

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

(*iv*) CALCULATE: **80**.0 cm^3 (6)

$\frac{p_1V_1}{T_1} = \frac{p_2V_2}{T_2} \Rightarrow$

$\frac{\mathbf{2 \times 10^5 \times 120}}{\mathbf{819}} = \frac{\mathbf{1 \times 10^5 \times V_2}}{\mathbf{273}}$ (3)

V_2 = **80**.0 cm^3 (3)

(*v*) NAME: **Boyle / Charles / Gay-Lussac** of pressure **/**
Ideal Gas Law (Equation of State of an Ideal Gas)

STATE: Boyle:
pressure and volume inversely proportional at constant temperature **/** $\boldsymbol{pV = k}$ **/** $\boldsymbol{V \propto {}^1/_p}$ **/** $\boldsymbol{p_1V_1 = p_2V_2}$

or
Charles:
temperature and volume directly **proportional** at constant pressure **/** $\boldsymbol{\frac{V}{T} = k}$ **/** $\boldsymbol{V \propto T}$ **/** $\boldsymbol{\frac{V_1}{T_1} = \frac{V_2}{T_2}}$

or
Gay-Lussac:
temperature and pressure directly **proportional** at constant volume
/ $\boldsymbol{\frac{p}{T} = k}$ **/** $\boldsymbol{p \propto T}$ **/** $\boldsymbol{\frac{p_1}{T_1} = \frac{p_2}{T_2}}$

or
Ideal Gas Law (Equation of State of an Ideal Gas)
$\boldsymbol{pV = nRT}$ (6 + 3)
[NAME and STATE linked, i.e. STATE must match NAME if given.]

(*c*) (*i*) WHAT: [(6 × 12) + (12 × 1) + (6 × 16)] = **180** g (3)

HOW MANY: 0.**1** moles glucose (6)

$n = \frac{m}{A_r} = \frac{18.0}{180}$ = 0.**1** moles glucose (6)

(*ii*) WHAT: **1:6** / **1 to 6** / **one** glucose **for six** O_2 / **six O_2 for (to) one glucose** (3)

HOW MANY: 0.**6** moles O_2 (3)

0.1 moles glucose $\Rightarrow$ 0.**6** moles O_2 (3)

WHAT VOLUME: **13.4**4 litres O_2 (3)

0.6 × 22.4 = **13.4**4 litres O_2 (3)

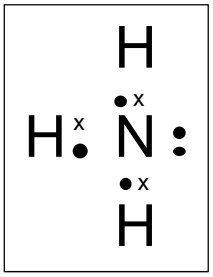
(*iii*) WHAT MASS: **26.4** g carbon dioxide (7)

M_r = 12 + (2 × 16) = **44** (3)
0**.6** moles carbon dioxide (2)
0.6 × 44 = **26.4** g carbon dioxide (2)

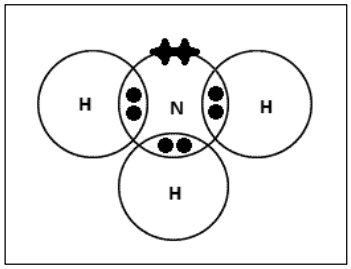
Question 11

a		b		cA	cB
i	ii, iii, iv	i , ii	iii, iv	25	25
9	16	13	12		

(*a*) (*i*) DRAW:



or



three bond pairs in nitrogen valence shell (6)

one lone pair (two separate non-bonding electrons) in nitrogen valence shell (3)

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

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

(*iii*) WRITE: **3.**04 and **2.2**0 (3)

PREDICT: **polar** (3)

(*iv*) WOULD: **yes / soluble** (2)

EXPLAIN: **water polar / hydrogen bonds (dipole-dipole attractions) can form between** ammonia **and water** (2)

[Do not accept 'like dissolves like'.]

[If 'no' or 'insoluble' is given for WOULD, EXPLAIN marks not available.]

(*b*) (*i*) EXPLAIN: state where **forward and reverse** reactions **// have equal rates**

or

state where **concentrations of reactants and products // is constant** (4 + 3)

(*ii*) WRITE: $K_c = \frac{[\mathbf{H_2}]^3[\mathbf{CO}]}{[\mathbf{CH_4}][\mathbf{H_2O}]}$ (6)

[numerator correct (3); denominator correct (3); correct expression inverted (3)][plus signs in expression unacceptable]

(*iii*) SUPPLY: **time / activation energy** (3)

(*iv*) TO WHAT: **temperature // pressure // concentration** of any reactant or product ANY TWO: (6 + 3)

(*c*)

A

(*i*) EXPLAIN: **reactants continuously (always) being added / products continuously (always) being removed / non-stop / not a batch process / reaction vessel only emptied (cleaned)** very **occasionally / reactants flow into reactor as products flow out / etc** (4)

WHAT NAME:

(*ii*) **feedstock** (6)
[Allow raw materials (3)]

(*iii*) **co-product**s (6)
[Allow by-product (6)]

(*iv*) **quality control (assurance) / QC / QA** (6)

(*v*) **effluent (emission, pollution, environmental) control / waste disposal / environmental management (control)** (3)

or

B

(*i*) WHAT: **ions / Na^+** and **Cl^- /**
[Allow '**Na** and **Cl ions'** for 'Na^+ and Cl^-']

(*ii*) WHAT: **atoms**

(*iii*) WHAT: **molecules** (6 + 6 + 3)

(*iv*) WHY: **electrons free to move / delocalised electrons / electrons shared by all atoms (positive ions)**

(*v*) WHAT: **x-rays**

(6 + 4)