



Coimisiún na Scrúduithe Stáit
State Examinations Commission

Leaving Certificate 2017

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.

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.
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 obtained more than 75% of the total marks.

Candidates are required to answer eight questions.

All questions carry equal marks (50).

Section A

At least two questions must be answered from this section.

Section B

At least five questions must be answered from this section.

Eight items to be answered in **Question 4**. Six marks 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.

Note that candidates who attempt **Question 10** are required to answer two of the parts (a), (b) and (c) and candidates who attempt **Question 11** are required to answer two of the parts (a), (b) and (c) where candidates who answer part (c) may choose **A** or **B**.



Coimisiún na Scrúduithe Stáit

400@10%

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 ghnáthrata 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 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% gnáthrata an bhónais.

Bain úsáid as an ngnáthrata 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

Section A

At least two questions must be answered from this section.

QUESTION 1

- (a) (i) WHAT: **bromine (Br₂) solution (water) / acidified potassium permanganate (H⁺/KMnO₄, H⁺/ MnO₄⁻, H⁺/Mn(VII))** (3)
[Allow H⁺/Mn⁷⁺.]
- (ii) WHAT: **red (brown, orange, yellow) /purple (pink) to colourless /decolourised (colour fades)** (2 × 3)
[Reagent and reagent colour linked.]
- (b) (i) DESCRIBE: **unstopper and quickly insert lighting taper** into test tube (6)
- (ii) DESCRIBE: **sooty, luminous (bright, yellow)** (3)
- (iii) COPY, COMPLETE, BALANCE: **C₂H₂ + 2½O₂ → 2CO₂ + H₂O** PRODUCTS: (3), BALANCING: (3)
- (iv) WHAT: **confirms (detects, shows presence of) carbon dioxide** as a product (6)
- (c) (i) LABEL: **liquid in beaker labelled mobile** (3)
white paper (thin layer) or white powder in column labelled stationary (3)
LABEL: **near end of paper (plate) in T / at top of column in C** (3)
[Below solvent level unacceptable.]
- (ii) HOW MANY: **3** (3)
[Allow 4.]
- (iii) LABEL: **uppermost component in T / lowest component in C** (3)
- (iv) EXPLAIN: **selectively adsorbed by stationary phase / different affinities for stationary phase / different affinities for (solubilities in) mobile phase (solvent)** (5)

QUESTION 2

- (a) (i) NAME: **conical flask** (5)
[Allow titration flask.]
- (ii) HOW: **deionised water / distilled water / pure water** (3)
[Mention of rinsing with second substance, e.g. solution it is to hold, cancels.]
- (b) (i) NAME: **wash bottle** (6)
[Allow squeeze (squeez, rinse) bottle; water bottle unacceptable.]
- (ii) EXPLAIN: **rinsing conical flask (pipette, burette, equipment apparatus) / washing down walls of conical flask** during titration (3)
- (c) (i) NAME: **methyl orange / methyl red / phenolphthalein, etc** (6)
- (ii) WHY: **to see end point (indicator colour change)** more easily (clearly) (3)
- (d) (i) WHAT: **helps find correct end point more accurately (easily)** thereafter (3)
- (ii) WHAT: $(19.6 + 19.5) \div 2 = \mathbf{19.55 - 19.6 \text{ cm}^3}$ (6)
[Averaging of two accurate titration values (6), averaging of three titration values (3).]
[Ignore incorrect rounding.]
- (e) CALCULATE: (i) **0.078 – 0.08 mol l⁻¹** (9)

$\frac{25 \times M}{1} =$	(3)
$\frac{19.55 \times 0.10}{1}$	(3)
$M = \mathbf{0.0782 \text{ mol l}^{-1}} \quad [\mathbf{0.078 - 0.08 \text{ mol l}^{-1}}]$	(3)

[Award (3) for $\frac{V_1 \times M_1}{n_1} = \frac{V_2 \times M_2}{n_2}$ if first (6) marks not awarded and last (3) marks can be awarded consequentially. If first (6) not awarded and formula not given, last (3) is still available consequentially.]

- (ii) **3.12 – 3.2 g l⁻¹** (6)

$M_r = \mathbf{40^*}$	(3)
$0.0782 \times 40 = \mathbf{3.128 \text{ g l}^{-1}} \quad [\mathbf{3.12 - 3.2 \text{ g l}^{-1}}]$	(3)

** Addition must be shown for error to be treated as a slip.*

QUESTION 3

- (a) WAS: **released** (5)
- JUSTIFY: **temperature goes up / container gets hot / ΔH negative / exothermic** (6)
- (b) WHAT: **insulation by plastic (polystyrene)** (3)
cardboard (lid) (3)
- WHY: **to get accurate temperature rise / to distribute heat evenly / to avoid hot spots (cold spots) / to ensure complete reaction / to ensure an accurate result** (6)
- (c) NAME: **graduated cylinder / volumetric flask / burette / pipette** (6)
- (d) (i) WHAT: **corrosive** (6)
- (ii) DESCRIBE: **wear gloves / wear eye protection / have spill absorbent to hand / do not carry bottles by the neck, etc** (6)
- (e) (i) WHAT: **3.4 °C** (3)
- (ii) JUSTIFY: **only half acid is neutralised / molarity (concentration) of NaOH is 0.5 M (halved)** (6)
[Allow (6) for WHAT and JUSTIFY for lower temperature rise because lower concentration of base used.]

Section B

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: Marie Curie (6)

(b) NAME: nucleus / proton / neutron // electron cloud (2 × 3)

(c) DEFINE: loss (donation) of electrons (6)

(d) WHY: increasing nuclear charge (number of protons, atomic number) / increasing attraction between nucleus and electrons (6)

(e) WHAT: proportional ($\propto$) / vary directly / graph is a straight line through the origin / $T = kV$ / $V = kT$ / directly proportional relationship (6)

[Allow (6) for linear relationship or 'temperature increases as volume increases'.]
['Inversely proportional' unacceptable.]

(f) WRITE: $2\text{Mg} + \text{O}_2 \rightarrow 2\text{MgO}$ / $\text{Mg} + \frac{1}{2}\text{O}_2 \rightarrow \text{MgO}$ REACTANTS & PRODUCT: (3), BALANCING: (3)

(g) CLASSIFY: substitution (6)

(h) WHAT: diffusion (6)

(i) EXPRESS: 160 ppm (mg l^{-1}) (6)

$0.016 \times 10 = 0.16$ g per litre (3)
$0.16 \times 1000 = 160$ ppm (mg l^{-1}) (3)

$0.016 \times 1000 = 16$ mg per 100 cm^3 (3)
$16 \times 10 = 160$ ppm (mg l^{-1}) (3)

(j) NAME: hydrogen / oxygen //
USE: hydrogen produced used as a fuel / oxygen produced used for breathing (2 × 3)
[NAME and USE must match.]

(k) A
STATE: lightning / bacteria (6)
[Allow (3) for clover, legumes, etc.]

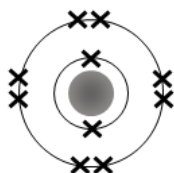
or

B
NAME: carbon (6)

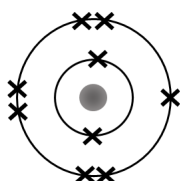
QUESTION 5

- (a) (i) WHAT: **substance that cannot be made simpler by chemical means** (5)
- (ii) NAME: **Mendeleev** (6)
- (b) DEFINE: **number of protons** in the nucleus of an atom (6)
[Allow 'number of electrons'.]
- (c) (i) HOW: different **number of neutrons** / **one has 6 neutrons, one has 8 neutrons** (6)
[Allow (3) for 'different mass numbers'.]
- (ii) WHAT: **isotopes** (3)
- (iii) HOW MANY: **6** (6)
- (iv) IDENTIFY: **carbon / C** (3)

- (d) DRAW: (i)



- (ii)



[Apply penalty of (–1) if electrons in first shell not shown but once only.]

(6 + 3)

- EXPLAIN: **fluorine** more reactive (3)

fluorine has seven (not got eight) electrons in outer shell / fluorine does not have a full outer shell / fluorine does not have a stable electron arrangement (configuration) / fluorine is not a noble (inert) gas / fluorine atoms tend to react to get (want) another (eight) electrons in outer shell / neon has eight electrons in outer shell / neon has a full outer shell / neon has a stable electron arrangement (configuration) / neon is a noble (inert) gas (3)

[Where neon given as the more reactive element, second (3) may be awarded for a chemically correct statement.]

QUESTION 6

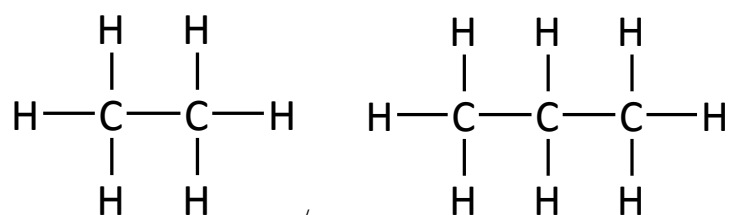
- (a) WHY: compounds of **carbon and hydrogen** only (5)
- (b) GIVE: **paddy fields / bog (marsh) / decomposition of organic waste (slurry) / decomposition of vegetation / animal digestive systems, etc** (6)
[Allow (3) for cow, ruminant or other named mammal; allow (3) for 'animal waste'.]

WHY: **to give it an odour (smell) / detection by odour (smell) / for safety / in case of a leak** to enable detection (6)

- (c) TO WHICH: **alkanes** (6)

NAME: any other alkane, e.g. **ethane / propane, etc**

DRAW: **CH₃CH₃ / CH₃CH₂CH₃ / etc**



(6 + 3)

[Hs need not be explicitly shown.][Alkane name must match structure for (9).]

- (d) NAME: **fractional distillation** (6)

- (e) WHAT: measure of **tendency of fuel to resist pre-ignition (auto-ignition, pinking, knocking) /**
measure of **tendency of fuel to pre-ignite (auto-ignite, pink, knock)** (6)

NAME: **isomerisation (making branched compounds) / catalytic cracking (making shorter compounds) / dehydrocyclisation (cyclisation, making rings) / addition of lead / addition of oxygenates / addition of methyl *tert*-butyl ether (MTBE) / addition of ethanol (methanol)**

ANY ONE: (6)

QUESTION 7

- (a) WRITE:
- 1 **electrons //**
 - 2 **positively-charged //**
 - 3 **negatively-charged //**
 - 4 **ionic //**
 - 5 **molecules //**
 - 6 **crystal lattice**

FIRST FIVE: (6 + 4 × 5)

- (b) (i) DESCRIBE: (3 × 4)

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

*[Allow 'inoculating loop', or 'spatula' for 'platinum wire'.]

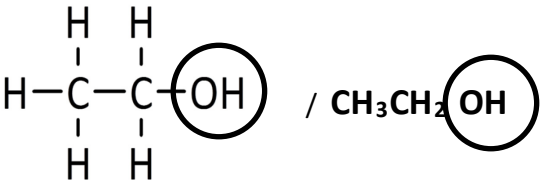
[Allow 'record result' for 'observe colour of flame' where clear reference to what kind of observation is made is in response.]

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

- (ii) WHAT COLOUR: **yellow (amber)** (6)

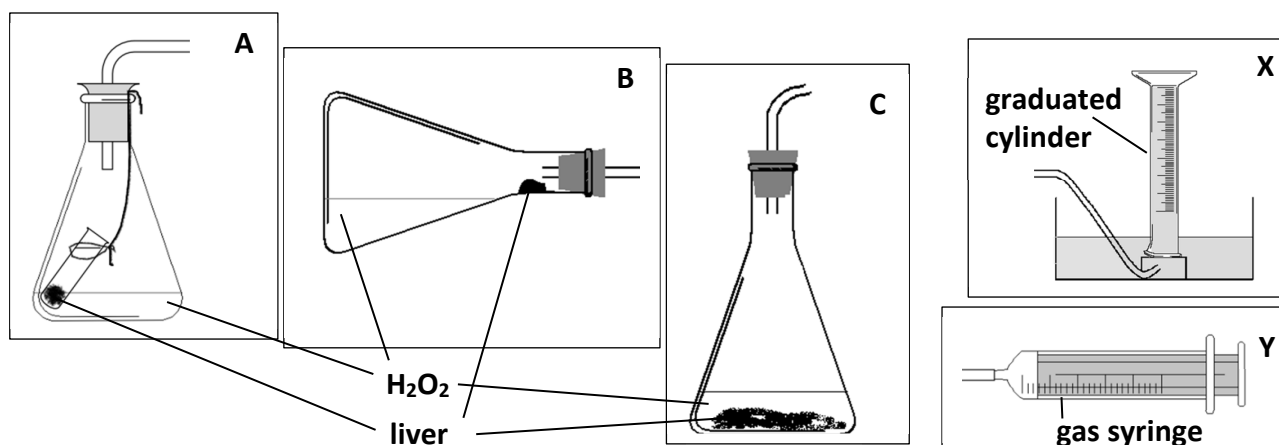
- (c) NAME: **sodium chloride / NaCl / Na⁺Cl⁻** (6)

QUESTION 8

- (a) DRAW:  (5)
- [Hs of ethyl group need not be explicitly shown.]
- CIRCLE: **circle around OH** (6)
[Allow OH in incorrect **alcohol**.]
- EXPLAIN: ethanol is **polar covalent / hydrogen bonds (dipole-dipole attractions) can form between ethanol and water** (6)
[‘Like dissolves like’ allow (3).][‘OH makes it soluble in water’ allow (3).]
- (b) TO WHICH: **aldehyde** (6)
- (c) WHICH: (i) **ethanoic acid //**
(ii) **ethanal //**
(iii) **ethanoic acid** [Accept ethanol.] (6 + 6 + 3)
- (d) NAME OR GIVE: **potassium permanganate {manganate(VII)} / KMnO_4 / MnO_4^- / sodium (potassium) dichromate / $\text{Na}_2\text{Cr}_2\text{O}_7$ / $\text{Cr}_2\text{O}_7^{2-}$, etc** (6)
- (e) SELECT: **gas chromatography (GC) / mass spectrometry** (6)

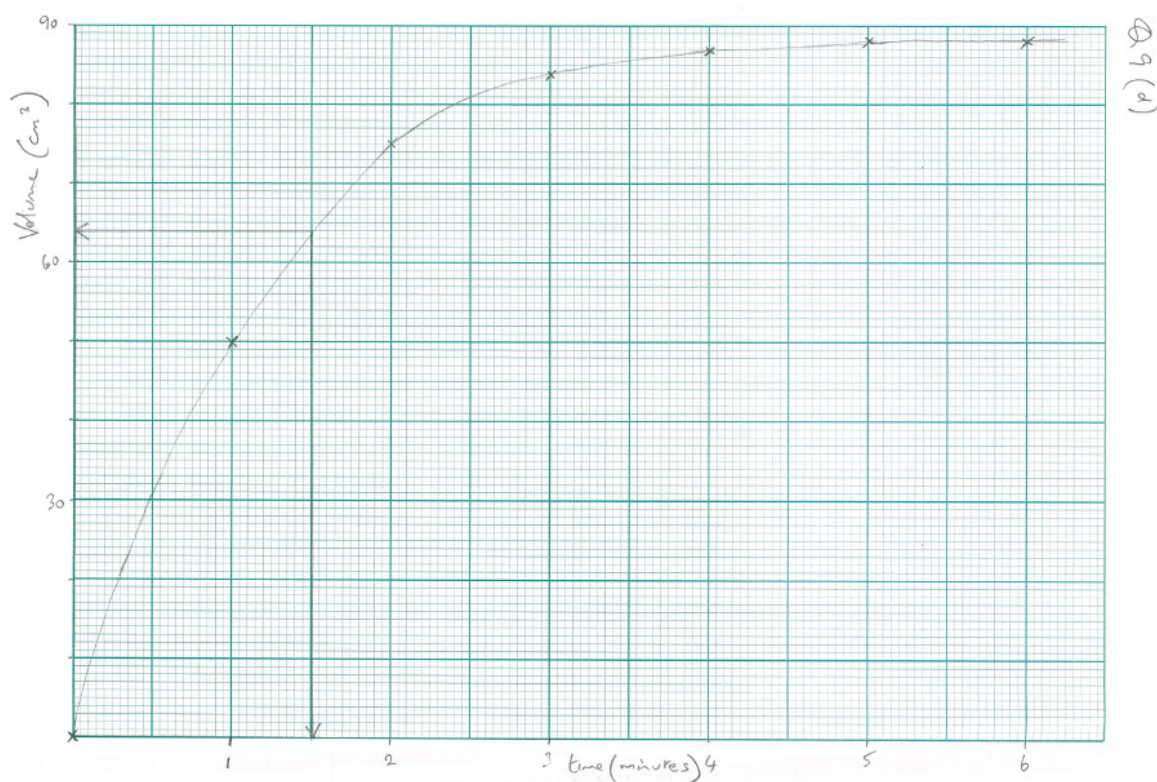
QUESTION 9

- (a) COPY & COMPLETE: **shorter / less //**
amount (quantity) / mass / volume / (3 + 2)
- (b) (i) WHAT: substance that **alters (increases, decreases) rate (speed, activation energy) of a reaction //**
without being consumed (2 × 3)
- (ii) WHAT: **catalyst //**
produced by living cells / biological (2 × 3)
- (iii) IDENTIFY: **manganese dioxide / manganese(IV) oxide / MnO_2 / copper(II) oxide / CuO , etc** (3)
- (c) DRAW: (i) **A / B**
[Allow C]
- (ii) **X / Y** (6 + 3)



[Allow collection of oxygen gas as a foam when delivery tube is inserted into a small amount of soapy solution in graduated cylinder.]

(d) PLOT:



axes correctly labelled with unit or quantity

(3)

axes correctly scaled

(3)

six points correctly plotted

(6)

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

(3)

[Allow (3) for 5 points correctly plotted.]

(e) ESTIMATE: **64 cm³ [60 – 70 cm³]**

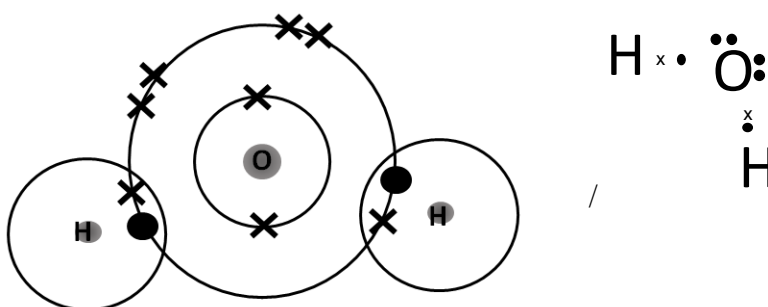
(6)

[Allow (3) for extrapolation involving 1.5 minutes done on graph where corresponding volume not written.]

QUESTION 10: Answer any **two** of the parts (a), (b) and (c).

- (a) (i) HOW: **primary treatment / settling / mechanically / screening / grit channels** (6)
- (ii) DESCRIBE: **microbes (bacteria, fungi, decomposers) break down // organic matter in sewage / aerobically / by oxidation / aeration / agitation** (2 × 3)
- (iii) AT WHAT: **tertiary treatment / third stage** (6)
- (iv) WHAT: **eutrophication / algal bloom** (7)
 [Allow 'fish kill', 'smelly water', 'green water', 'pollution', etc.]
 ['Dirty water' insufficient on its own.]

- (b) (i) EXPLAIN: attraction for a **shared pair of electrons** (4)
 [Allow (2) for 'attraction for *shared electrons*'.]
- (ii) DRAW:



6 valence oxygen electrons //
2 hydrogen electrons //
two lone pairs in molecule //
two bond pairs in molecule

ANY THREE: (3 × 3)

- (iii) WHAT: **v-shaped /angular** (3)
- (iv) DEFINE: **relative (measure of) attraction / number expressing (giving) attraction //**
for shared electrons (pair) / for electrons in a covalent bond (2 × 3)
- (v) USE: **electronegativity difference is non-zero /**
1.24 (electronegativity difference) < 1.7 ⇒ polar /
electronegativity of oxygen (O) greater than that of hydrogen (H) /
electrons more attracted to oxygen (O) than to hydrogen (H) (3)
 [H = 2.20, O = 3.44 / electronegativity difference 1.24 with no conclusion or incorrect conclusion (1).]

(c) (i) STATE: **reactants and products** in a chemical reaction //
have constant mass

or

matter cannot be created or destroyed //
in a chemical reaction / but can be changed from one (form) substance into
another (2 × 3)

(ii) WHAT: $23 + (3 \times 14) = \mathbf{65}$ (3)

(iii) HOW MANY: **2** (6)

$$n = \frac{m}{A_r} = \frac{130}{65} = \mathbf{2} \text{ moles} \quad (6)$$

(iv) WHAT: **84 g nitrogen gas** (3)

$$130 - 46 = \mathbf{84} \text{ g nitrogen gas} \quad (3)$$

2 moles NaN_3 produces 3 moles nitrogen
gas
 $3 \times 28 = \mathbf{84} \text{ g nitrogen gas}$ (3)

(v) HOW MANY: **3 moles nitrogen** (7)

$$\begin{aligned} 1 \text{ mole} &= 22.4 \text{ litres} & (3) \\ 67.2 \div 22.4 &= \mathbf{3} \text{ moles } \text{N}_2 & (4) \end{aligned}$$

QUESTION 11: Answer any **two** of the parts (a), (b) and (c).

(a) (i) DOES: **no //**

EXPLAIN: **forward and reverse reactions continue (have equal rates) / both reactions continue / chemical equilibrium is dynamic**
[EXPLAIN marks may be awarded (7) marks unless response to DOES is incorrect.]

(4 + 3)

(ii) WRITE: $K_c = \frac{[\text{SO}_3]^2}{[\text{SO}_2]^2[\text{O}_2]}$ (6)

[Allow (3) for numerator only correct; allow (3) for denominator only correct;
allow (3) for correct numerator and denominator inverted.]

(iii) PREDICT: **increase / more (sulfur trioxide) SO₃ / equilibrium moves to the right / equilibrium moves to side with fewer moles (molecules)**

(iv) GIVE: **change temperature / add or remove heat / change concentration of reactant or product**

(9 + 3)

(b) DEFINE: (i) **gives hydrogen (hydronium) ions (H⁺, H₃O⁺) in aqueous solution / proton (hydrogen ion, H⁺) donor / a substance that brings about a lower pH when dissolved in water** (4)

(ii) **pH = -log₁₀ // [H⁺] / [H₃O⁺]** (2 × 3)

WHAT: **pH + pOH = 14 / pH = 14 - pOH / they add to 14** (3)

CALCULATE: **0.5 (0.5 - 0.523)** (6)

$\text{pH} = -\log 0.3$	(3)
$= 0.523 (0.5 - 0.523)$	(3)

LIST: **mouthwash, tapwater, coffee, beer** (6)
[Allow (3) for reverse order.]

(c) Answer part A or part B.

A

- HOW: (i) helps to **trap heat (infrared, ir)** from the sun / **keeps heat (infrared, ir)** in atmosphere / **stops heat (infrared, ir)** escaping from atmosphere into outer space / **keeps Earth warm** / to **prevent Earth being too cold** for life (6)
- (ii) **blocks uv** / **protects from uv** / **protects from harmful rays from sun** / **prevents skin cancer(s)** (6)
[Allow (3) marks for 'protects from eye (tissue) damage' / 'prevents damage to plants or plankton'.]
- GIVE: **deforestation** / increased **burning fossil fuels** / increased **use of transport** relying on fossil fuels, / **industrialization** / **using CFCs**, etc
- WHAT: **global warming** / **melting polar ice-caps** / **rise in sea levels** / **flooding** / **climate change** / **loss of habitat** / **extinction of species** / **changes to crop yields**, etc (6 + 3)
- HOW: **reduced use of CFCs** / **Montreal protocol** / **use HCFCs in aerosols (fire extinguishers, air conditioning, refrigerants, etc)** (4)

B

- (i) SUGGEST: **gold corrodes least easily** / **gold least reactive** / **gold least easily oxidised** / **gold doesn't tarnish** / **gold keeps its shine** / **gold most malleable** (7)
['Gold pretty', 'gold bright', etc, not acceptable.]
- (ii) WHICH: **sodium //**
- HOW: **in oil (paraffin)** (2 × 3)
- (iii) WHAT: **rusting //**
- WHICH: **zinc** (2 × 3)
- (iv) WHY: **very costly** to produce from its ores / **uses a lot of electricity** to produce from its ore / **environmentally friendly** to recycle / to **preserve** a valuable **resource** / **finite metal** (6)

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