Cambridge Assessment International Education

Cambridge International AS & A Level

CHEMISTRY **9701/36**

Paper 3 Advanced Practical Skills 2 **October/November 2022**

MARK SCHEME

Maximum Mark: 40

Published

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge International will not enter into discussions about these mark schemes.

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Generic Marking Principles

These general marking principles must be applied by all examiners when marking candidate answers. They should be applied alongside the specific content of the mark scheme or generic level descriptors for a question. Each question paper and mark scheme will also comply with these marking principles.

GENERIC MARKING PRINCIPLE 1:

Marks must be awarded in line with:

- the specific content of the mark scheme or the generic level descriptors for the question
- the specific skills defined in the mark scheme or in the generic level descriptors for the question
- the standard of response required by a candidate as exemplified by the standardisation scripts.

GENERIC MARKING PRINCIPLE 2:

Marks awarded are always **whole marks** (not half marks, or other fractions).

GENERIC MARKING PRINCIPLE 3:

Marks must be awarded **positively**:

- marks are awarded for correct/valid answers, as defined in the mark scheme. However, credit is given for valid answers which go beyond the scope of the syllabus and mark scheme, referring to your Team Leader as appropriate
- marks are awarded when candidates clearly demonstrate what they know and can do
- marks are not deducted for errors
- marks are not deducted for omissions
- answers should only be judged on the quality of spelling, punctuation and grammar when these features are specifically assessed by the question as indicated by the mark scheme. The meaning, however, should be unambiguous.

GENERIC MARKING PRINCIPLE 4:

Rules must be applied consistently, e.g. in situations where candidates have not followed instructions or in the application of generic level descriptors.

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GENERIC MARKING PRINCIPLE 5: Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen).
GENERIC MARKING PRINCIPLE 6: Marks awarded are based solely on the requirements as defined in the mark scheme. Marks should not be awarded with grade thresholds or grade descriptors in mind.

Science-Specific Marking Principles

1	Examiners should consider the context and scientific use of any keywords when awarding marks. Although keywords may be present, marks should not be awarded if the keywords are used incorrectly.
2	The examiner should not choose between contradictory statements given in the same question part, and credit should not be awarded for any correct statement that is contradicted within the same question part. Wrong science that is irrelevant to the question should be ignored.
3	Although spellings do not have to be correct, spellings of syllabus terms must allow for clear and unambiguous separation from other syllabus terms with which they may be confused (e.g. ethane / ethene, glucagon / glycogen, refraction / reflection).
4	The error carried forward (ecf) principle should be applied, where appropriate. If an incorrect answer is subsequently used in a scientifically correct way, the candidate should be awarded these subsequent marking points. Further guidance will be included in the mark scheme where necessary and any exceptions to this general principle will be noted.
5	‘List rule’ guidance For questions that require ***n*** responses (e.g. State **two** reasons …): • The response should be read as continuous prose, even when numbered answer spaces are provided. • Any response marked *ignore* in the mark scheme should not count towards ***n***. • Incorrect responses should not be awarded credit but will still count towards ***n***. • Read the entire response to check for any responses that contradict those that would otherwise be credited. Credit should **not** be awarded for any responses that are contradicted within the rest of the response. Where two responses contradict one another, this should be treated as a single incorrect response. • Non-contradictory responses after the first ***n*** responses may be ignored even if they include incorrect science.

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6 Calculation specific guidance

Correct answers to calculations should be given full credit even if there is no working or incorrect working, **unless** the question states 'show your working'.

For questions in which the number of significant figures required is not stated, credit should be awarded for correct answers when rounded by the examiner to the number of significant figures given in the mark scheme. This may not apply to measured values.

For answers given in standard form (e.g. $a \times 10^n$) in which the convention of restricting the value of the coefficient (a) to a value between 1 and 10 is not followed, credit may still be awarded if the answer can be converted to the answer given in the mark scheme.

Unless a separate mark is given for a unit, a missing or incorrect unit will normally mean that the final calculation mark is not awarded. Exceptions to this general principle will be noted in the mark scheme.

7 Guidance for chemical equations

Multiples / fractions of coefficients used in chemical equations are acceptable unless stated otherwise in the mark scheme.

State symbols given in an equation should be ignored unless asked for in the question or stated otherwise in the mark scheme.

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Examples of how to apply the list rule
State **three** reasons … [3]

A

1	Correct	✓	**2**
2	Correct	✓	
3	Wrong	×	

B
(4 responses)

1	Correct, Correct	✓, ✓	**3**
2	Correct	✓	
3	Wrong	ignore	

C
(4 responses)

1	Correct	✓	**2**
2	Correct, Wrong	✓, ×	
3	Correct	ignore	

D
(4 responses)

1	Correct	✓	**2**
2	Correct, CON (of 2.)	×, (discount 2)	
3	Correct	✓	

E
(4 responses)

1	Correct	✓	**3**
2	Correct	✓	
3	Correct, Wrong	✓	

F
(4 responses)

1	Correct	✓	**2**
2	Correct	✓	
3	Correct CON (of 3.)	× (discount 3)	

G
(5 responses)

1	Correct	✓	**3**
2	Correct	✓	
3	Correct Correct CON (of 4.)	✓ ignore ignore	

H
(4 responses)

1	Correct	✓	**2**
2	Correct	×	
3	CON (of 2.) Correct	(discount 2) ✓	

I
(4 responses)

1	Correct	✓	**2**
2	Correct	×	
3	Correct CON (of 2.)	✓ (discount 2)	

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Question	Answer	Marks
1(a)	**I** the following data must be shown • two burette readings and titre for the rough titration • initial and final burette readings for **two** (or more) accurate titrations	**7**
	II titre values shown for **accurate** titrations **and** appropriate headings and units in the accurate titration table • initial / start **and** (burette) reading / volume • final / end **and** (burette) reading / volume • titre **or** volume / **FB 4 and** used / added unit: / cm^3 **or** (cm^3) **or** in cm^3 (for each heading) **or** cm^3 unit given for each volume recorded	
	III all accurate burette readings are to the nearest 0.05 cm^3.	
	IV the final accurate titre recorded is within 0.10 cm^3 of any other accurate titre.	
	V, **VI**, **VII** award **V** if **d** $\leqslant$ 0.60 (cm^3) award **VI** if **d** $\leqslant$ 0.40 (cm^3) award **VII** if **d** $\leqslant$ 0.20 (cm^3) where **d** is the difference between the supervisor's and candidate's mean titres	
1(b)	candidate calculates mean correctly to 2 decimal places (dp) • candidate must take the average of two (or more) titres that are within a total spread of not more than 0.20 cm^3. • working / explanation must be shown or ticks must be put next to the two (or more) accurate readings selected. • the mean should be quoted to **2 dp** and be rounded to the nearest 0.01 cm^3.	**1**
1(c)(i)	all answers to **(c)(ii)**, **(c)(iv)** and **(c)(v)** expressed to 3 or 4 significant figures (sf)	**1**
1(c)(ii)	**correctly calculates** amount of K_2CO_3 in 25 cm^3 amount = $\frac{8.46}{40} \times \frac{1}{138.2} = 1.53(0) \times 10^{-3}$ (mol)	**1**
1(c)(iii)	$CO_3^{2-}(aq) + 2H^+(aq) \rightarrow CO_2(g) + H_2O(l)$	**1**

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Question	Answer	Marks
1(c)(iv)	**correct use** of **(c)(ii)** to calculate HCl concentration in **FB 4** concentration of HCl in **FB 4** = $0.00153(0) \times 2 \times \frac{1000}{\text{titre}}$ (mol dm^{-3})	**1**
1(c)(v)	**correct use** of **(c)(iv)** to calculate HCl concentration in **FB 1** concentration of HCl in **FB 1** = **(c)(iv)** $\times \frac{250}{10}$ (mol dm^{-3})	**1**
1(d)	titre will be smaller / reduced because **amount** / **concentration** of K_2CO_3 (in hydrated salt) is smaller	**1**
1(e)	one of: • use 62.5 cm^3 / 2.5 × the volume of **FB 2** • change the concentration of **FB 2** to 21.15 g dm^{-3} • make a subsequent dilution of **FB 4** of 100 cm^3 to 250 cm^3	**1**

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Question	Answer	Marks
2(a)	**I six pieces of data recorded** two balance readings, two thermometer readings, mass used, temperature rise **and** all shown in the **Results** space provided	**4**
	II correct subtractions in (a) to calculate the mass of **FB 5** **and** the temperature change	
	III, **IV** award **III** for **d** ⩽ 0.60 (°C g^{-1}) award **IV** for **d** ⩽ 0.30 (°C g^{-1}) where **d** is the difference between the supervisor's and candidate's ratio of $\frac{\text{rise in temperature}}{\text{mass of FB 5}}$ calculated correctly to 2 dp	
2(b)(i)	**correct calculation** of energy change energy change = 30 × 4.18 × temperature rise (J) **and** answer given to 2 – 4 sf	**1**
2(b)(ii)	**correctly calculates** amount of Na_2CO_3 amount $= \frac{\text{mass used}}{106}$ (mol) **and** answer given to 2 – 4 sf	**1**
2(b)(iii)	**correct use** of **(c)(i)** and **(c)(ii)** enthalpy change $= \frac{(b)(i)}{(b)(ii)} \times \frac{1}{1000}$ (kJ mol^{-1}) **and** answer with negative sign **and** given to 2 – 4 sf	**1**

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Question	Answer	Marks
2(c)	student is **not** correct because temperature rise will be halved / lower so greater percentage error in measurement **OR** student **is** correct because there will be less spray / frothing out of the cup	**1**
2(d)	**I six unambiguous headings with correct units** given for all readings (/ °C and / g, etc.) • initial thermometer reading / temperature • minimum / final thermometer reading / temperature • (mass of) container and **FB 6** / solid • (mass of) container (empty or with residual **FB 6**) • (mass of) **FB 6** / solid used • temperature change / decrease	**3**
	II four readings recorded • two thermometer readings and two balance readings recorded in the space for **Results** • mass used is between 7.00 – 11.00 g • thermometer readings show a decrease in temperature of at least half of the supervisor's value	
	III precision of all readings in (a) and (d) • four balance readings recorded to same dp (two or more) • four thermometer readings recorded to .0 or .5°C	
2(e)(i)	**worrect working shown** • energy change = 30 × 4.18 × temperature decrease (J) • amount of carbonate $= \frac{\text{mass used}}{286}$ (mol) • enthalpy change $= \frac{\text{energy change}}{\text{no. of moles}} \times \frac{1}{1000}$ (kJ mol^{-1}) • answer shown with positive sign and to 2 or more sf	**2**
2(e)(ii)	**correct calculation**: enthalpy of dehydration = **2(e)(i)** – **2(b)(iii)** (kJ mol^{-1})	**1**

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Question	Answer	Marks
	FB 7 is NaBr(aq) + Na_2SO_4(aq); **FB 8** is $ZnCO_3$(s)	
3(a)(i)	potassium manganate(VII) / $KMnO_4$ is decolorised **or** (purple solution) turns yellow / yellow-brown / orange-brown / amber / brown	**1**
3(a)(ii)	**reagents selected:** • (aqueous) silver nitrate / $AgNO_3$ • (aqueous) barium nitrate / $Ba(NO_3)_2$ **or** (aqueous) barium chloride / $BaCl_2$ **observations:** • (adding) $AgNO_3$ gives a cream / off-white precipitate • precipitate is insoluble / partially soluble in (excess) ammonia • (adding) $Ba(NO_3)_2$ / $BaCl_2$ gives a while precipitate • precipitate insoluble / not soluble in HCl / HNO_3 **conclusions: the anions in FB 7 are** • Br^- / bromide • SO_4^{2-} / sulfate	**4**
3(b)(i)	**heating FB 8** • condensation (of liquid) • (solid) turns yellow / yellow-green **or** yellow(-green) solid formed • on cooling, (residue) becomes paler / turns white • attempts to test with limewater • gas / CO_2 gives a **white precipitate** (with limewater) (There are 5 marking points. The last 2 may be awarded if the gas test and result is given in **(b)(ii)**.)	**2**
3(b)(ii)	fizzing / bubbling / effervescence **and** **either** (reaction is) rapid / vigorous **or** solid dissolves / colourless solution formed	**1**

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Question	Answer	Marks
3(b)(iii)	**observations**: **M1**: **a**dd (aqueous) ammonia / NH_3 giving white precipitate **M2**: ppt soluble / dissolves in excess (NH_3)	**2**
3(b)(iv)	**FB 8** is **$ZnCO_3$**	**1**

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