
CHEMISTRY

9701/31

Paper 3 Advanced Practical Skills 1

October/November 2019

MARK SCHEME

Maximum Mark: 40

Published

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Question	Answer	Marks
1(a)	3 masses recorded with unambiguous headings in the space provided, with correct units mass used correctly calculated volume of gas collected or final volume recorded with correct units	1
	Award this mark if volume recorded by candidate lies within $\pm 10\%$ of supervisor value.	1
1(b)(i)	Correctly calculates volume of gas in $\text{cm}^3 / 24\,000$ answer to 2–4 sf	1
1(b)(ii)	Correct use of: $2 \times$ AND ans (b)(i) / 0.025 (answer to 2–4 sf)	1
1(b)(iii)	Correctly uses ans (b)(i) $\times 24.3$ and answer to 2–4 sf	1
1(c)	Student correct as reaction now slower so less gas lost (while bung is being fitted).	1
	Student incorrect as Mg is in excess. or Student incorrect as reaction is faster so more gas lost	1
1(d)	gas volume / amount / moles lower so concentration is lower	1

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Question	Answer	Marks
2(a)	I Uses a volume between 40.00 and 45.00 cm ³ and answer to at least 1 dp	1
	II The following data must be shown • burette readings and titre for rough titration • 2 × 2 'box' showing both accurate burette readings	1
	III Headings and units correct for accurate titration table and headings match readings. • Initial / start (burette) and reading / volume + unit • Final / end (burette) and reading / volume + unit • titre or volume / FA 4 and used / added (<i>not 'difference' amount or 'total'</i>) + unit	1
	IV All accurate burette readings to 0.05 cm ³	1
	V The final accurate titre recorded is within 0.10 cm ³ of any other accurate titre.	1
	Award VI if $20 < \delta \leq 30 \text{ cm}^3$	1
	Award VII if $10 < \delta \leq 20 \text{ cm}^3$	1
	Award VIII if $\delta \leq 10 \text{ cm}^3$	1
2(b)	Candidate must average two (or more) titres that are all within 0.20 cm ³ . Working must be shown or ticks must be put next to the two (or more) accurate titres selected.	1
2(c)(i)	Answers for (ii) , (iii) and (iv) given to 3–4 sf. Minimum three answers displayed.	1
2(c)(ii)	Correctly calculates 2.50×10^{-3}	1
2(c)(iii)	Correct use of ans (c)(ii) × 1000 / ans (b)	1
2(c)(iv)	Correct expression: ans (c)(iii) × 250 / vol used from (a)	1
2(d)	Correctly calculates 0.10 / vol used in (a) × 100.	1

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Question	Answer	Marks
2(e)	Question 1 - measuring cylinder greater error than burette / pipette - molar gas volume of 24 dm^3 may not be valid / temperature of the lab may not be known - too much gas for the measuring cylinder (check that vol $> 250 \text{ cm}^3$) - use gas syringe (if volume $< 100 \text{ cm}^3$)	1
	Question 2 - dilution introduces extra stage / greater cumulative error - methyl orange end-point can be difficult to see / colour change gradual / difficult to see	1

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Question	Answer	Marks
	FA 5 is $\text{Al}(\text{NH}_4)(\text{SO}_4)_2 \cdot 12\text{H}_2\text{O}$; FA 8 is KI and FeSO_4	
3(a)(i)	• melts / dissolves • condensation / moisture on the walls of the test-tube / steam produced • white smoke / fumes (NOT gas) • (gas) turns red litmus blue • gas turns blue litmus red • white residue Award 1 mark for two correct observations from the list, award 2 marks for three or more correct observations. If both gas observations are given they must be in the correct order for both to be credited.	2
3(a)(ii)	NH_3 White ppt and insoluble in excess	1
	NaOH White ppt and sol in excess Allow 1 mark for white ppt with both NH_3 and NaOH	1
	hot NaOH Gas / NH_3 (on warming) turns red litmus blue	1
	Ba^{2+} White ppt insoluble in acid / white ppt no reaction with acid Reject white ppt formed when acid added	1
3(a)(iii)	names or correct formulae	1
	NH_4^+ , Al^{3+} , SO_4^{2-} Award 1 mark for two ions, award 2 marks for three ions.	1

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Question	Answer	Marks
3(b)	Any formula (involving all three ions) in which the charges on the ions cancel (e.g. $\text{K}_3\text{Cr}(\text{SO}_4)_3$)	1
	$\text{KCr}(\text{SO}_4)_2 \cdot 12\text{H}_2\text{O}$	1
3(c)(i)	Red-brown (allow yellow / yellow-brown / orange / orange-brown / brown) (solution) or KMnO_4 / purple decolourises and turns blue-black / dark blue / black (on adding starch)	1
	Green ppt and insoluble in excess / turns brown (on standing) Reject grey-green	1
3(c)(ii)	Fe^{2+} / iron(II) and I^- / iodide This mark is free-standing	1
3(c)(iii)	Uses silver nitrate and yellow ppt	1
	ppt insoluble in HNO_3 or ppt insoluble in NH_3 (nitric acid may be added initially)	1
3(c)(iv)	$\text{Fe}^{2+}(\text{aq}) + 2\text{OH}^-(\text{aq}) \rightarrow \text{Fe}(\text{OH})_2(\text{s})$ ecf for Cr^{3+} / Cu^{2+} / Fe^{3+} or any other transition metal ion concluded in (ii).	1

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Question	Answer	Marks
1(a)	I All the following data recorded • two burette readings and titre for the rough titration • initial and final burette readings for two (or more) accurate titrations	1
	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: / cm³ or (cm³) or in cm³ (for each heading) or cm³ unit given for each volume recorded	1
	III All accurate burette readings are recorded to the nearest .05 cm ³ .	1
	IV The final accurate titre recorded is within 0.10 cm ³ of any other accurate titre.	1
	Award V if $\delta \leq 0.80$ (cm ³) (Where δ is difference to the supervisor's value)	1
	Award VI if $\delta \leq 0.50$ (cm ³)	1
	Award VII if $\delta \leq 0.30$ (cm ³)	1

Question	Answer	Marks
1(b)	Correctly calculates mean titre from two (or more) accurate titres where the total spread is $\leq 0.20 \text{ cm}^3$. AND Answer is given to 2 d.p. AND Working must be shown or ticks must be put next to the two (or more) accurate titres selected.	1
1(c)(i)	Significant figures All answers in (ii)–(iv) are expressed to 3 or 4 sig. fig.	1
1(c)(ii)	Correctly calculates no of moles of NaOH used. No. of moles NaOH = $\frac{6.00}{40} \times \text{answer (b)}/1000$	1
1(c)(iii)	$\text{NaOH(aq)} + \text{HCl(aq)} \rightarrow \text{NaCl(aq)} + \text{H}_2\text{O(l)}$ or $\text{H}^+(\text{aq}) + \text{OH}^-(\text{aq}) \rightarrow \text{H}_2\text{O(l)}$ AND No. of moles of HCl = same as in moles of NaOH in (ii)	1

Question	Answer	Marks
1(c)(iv)	Correct expression shown (for the first step) (Two steps) Concentration HCl in FA 3 = ans (c)(iii) $\times 1000 / 25$ Allow ans (c)(iii) $\times 40$ (Concentration of FA 2 = Concentration of FA 3 $\times 25$) OR moles of FA 3 in 250 cm^3 = ans (c)(iii) $\times 250 / 25$ Allow ans (c)(iii) $\times 10$ (moles of FA 2) in 1 dm^3 = ans above $\times 1000 / 10$)	1
	Answer = (c)(iii) $\times 1000$	1

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Question	Answer	Marks																				
2(a)	I Suitable tables/lists with values entered in the space provided. - Three clearly labelled masses (do not allow ‘weight’) with correct units - Three unambiguous labelled temperatures, with units	1																				
	II Readings and subtraction in 2(a) and 2(d) - All four measured temperatures recorded to .0 or .5 °C - Both temperature changes correctly subtracted. - All masses in (a) and (d) recorded to one or more d.p. (balance readings must be consistent d.p. within each experiment) - Both masses correctly subtracted.	1																				
	Accuracy marks Round all thermometer readings to 0.5 °C. Check the candidate’s and supervisor’s subtractions and compare the candidate’s [corrected] temperature rise with the supervisor’s. The difference between candidate and supervisor is δ . See table below for marks available.	2																				
	<table><tr><td>Sup $\Delta T_{\max}$</td><td>> 40.0 °C</td><td>30.5–40.0 °C</td><td>20.5–30.0 °C</td><td>10.5–20.0 °C</td><td>5.5–10.0 °C</td><td>< 5.5 °C</td></tr><tr><td>1 mark</td><td>$\delta \leq 5.0$ °C</td><td>$\delta \leq 4.0$ °C</td><td>$\delta \leq 3.0$ °C</td><td>$\delta \leq 2.0$ °C</td><td>$\delta \leq 1.0$ °C</td><td>$\delta \leq 0.5$ °C</td></tr><tr><td>2 marks</td><td>$\delta \leq 2.5$ °C</td><td>$\delta \leq 2.0$ °C</td><td>$\delta \leq 1.5$ °C</td><td>$\delta \leq 1.0$ °C</td><td>$\delta \leq 0.5$ °C</td><td>not available</td></tr></table>	Sup $\Delta T_{\max}$	> 40.0 °C	30.5–40.0 °C	20.5–30.0 °C	10.5–20.0 °C	5.5–10.0 °C	< 5.5 °C	1 mark	$\delta \leq 5.0$ °C	$\delta \leq 4.0$ °C	$\delta \leq 3.0$ °C	$\delta \leq 2.0$ °C	$\delta \leq 1.0$ °C	$\delta \leq 0.5$ °C	2 marks	$\delta \leq 2.5$ °C	$\delta \leq 2.0$ °C	$\delta \leq 1.5$ °C	$\delta \leq 1.0$ °C	$\delta \leq 0.5$ °C	not available
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Question	Answer	Marks
2(b)(i)	Correctly calculates heat change Heat change = $40 \times 4.2 \times \text{temp rise}$ AND Answer is correct to 2–4 s.f.	1
2(b)(ii)	Correctly calculates number of moles of MgO No. of moles of MgO used = $\text{mass used}/40.3$ AND Answer is correct to 2–4 s.f.	1
2(b)(iii)	Correctly uses (i)/(ii) and negative sign shown Enthalpy change = $- \frac{(b)(i)}{(b)(ii)} \times 1/1000$ AND Answer is given to 2–4 s.f.	1
2(c)	Correct expression(s) shown in ‘excess’ calculation Candidate must compare the number of moles of MgO and HCl used and correctly use the mole ratio of 1:2. <u>Example of working</u> No. of moles of HCl used = $0.04 \times \text{ans 1(c)(iv)}$ (or $n = 0.04 \times 3.75 = 0.15$) Maximum no. moles MgO that can be used = $0.5 \times n$ Note – there are other valid ways of doing this calculation.	1

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Question	Answer	Marks
2(d)(i)	Readings written in space provided - Two thermometer readings are recorded both above 10 °C - Two masses are recorded giving mass of MgCO₃ between 2–5 g.	1
	Accuracy mark Check temperature subtractions of candidate and of supervisor. Compare the [corrected] candidate's temperature rise with the supervisor's. The difference is δ . If δ is less than or equal to 2.0 °C, award the mark	1
2(d)(ii)	Observations (two required) Fizzing / bubbles / effervescence AND either solid dissolves / disappears / colourless solution formed or reaction is brisk / rapid / vigorous / violent	1
2(d)(iii)	Correct expression(s) for enthalpy change, with negative sign Enthalpy change = $-40 \times 4.2 \times \text{temp rise} \times \frac{84.3}{\text{mass MgCO}_3} \times \frac{1}{1000}$	1
2(e)	Enthalpy change correctly calculated with correct sign Answer = (b)(iii) – (d)(iii) and to minimum 2 s.f. unless answer is an integer. If default values are used, the answer must be $-44.4 \text{ kJ mol}^{-1}$.	1

Question	Answer	Marks
2(f)	Plot a cooling curve (after the maximum temperature reached) OR plot a graph to get better value of ΔT OR use increased masses of FA 4 and / or FA 5 / mass of solid (added) OR heat the acid before adding solid / FA 4 and / or FA 5 Ignore answers related to the apparatus used.	1
2(g)	Correct single reading error (see below) and MgO has the greater % error (Allow MgCO₃ if this was the smaller mass.) <i>If candidate used a 1 d.p. balance for this solid, error is 0.05 or 0.1 g</i> <i>If candidate used a 2 d.p. balance for this solid, error is 0.005 or 0.01 g</i> <i>If candidate used a 3 d.p. balance for this solid, error is 0.0005 or 0.001 g</i>	1
	Correct calculation of % error for MgO % error = $2 \times \left(\frac{\text{single error}}{\text{mass of MgO used}} \right) \times 100$	1

Question	Answer	Marks
FA 6 = Zn; FA 7 = NaNO₃; FA 9 = Na₂SO₃		
3(a)	Observation Bubbling / fizzing / effervescence (<i>Ignore 'gas formed'</i>)	1
	Test for hydrogen during reaction (Gas) pops with a lighted splint / burns with a pop (allow explodes)	1
	Deduction FA 6 is a metal and gives hydrogen (with an acid)	1
3(b)(i)	Heating FA 7 – observations FA 7 melts / (partially) dissolves / becomes liquid / becomes a solution (liquid is) yellow or pale brown - Fizzing / bubbling / effervescence occurs (Gas / oxygen) re-lights a glowing splint Gas turns (blue) litmus red After standing / cooling white / off-white / cream / paler solid (formed). Award 1 mark for two correct observations from the list, award 2 marks for four or more correct observations. MAX. 2 marks	2

Question	Answer	Marks															
3(b)(ii)	Observations in the table (see below) Expected observations are in the table below. Award 1 mark for every two correct observations (*) Reject no observation the first time seen. Reject a dash every time. <table border="1"> <thead> <tr> <th>test</th><th>observation with FA 8</th><th>observation with FA 9</th></tr> </thead> <tbody> <tr> <td>To a 1 cm depth in a test-tube, add a few drops of acidified potassium manganate(VII).</td><td>No (visible) reaction / no change or solution (in test tube) becomes pink / purple / solution / KMnO_4 / MnO_4^- stays purple *</td><td>from purple to colourless or KMnO_4 / MnO_4^- decolourised</td></tr> <tr> <td>To a 1 cm depth in a test-tube, add a few drops of aqueous barium chloride or aqueous barium nitrate.</td><td>no reaction / no change / no precipitate / solution remains colourless *</td><td>white precipitate (formed) *</td></tr> <tr> <td>To a 1 cm depth in a boiling tube, add an equal volume of aqueous sodium hydroxide. Warm carefully, then</td><td>no reaction / no change / no precipitate *</td><td>no reaction / no change / no precipitate *</td></tr> <tr> <td>add aluminium foil.</td><td><u>gas / ammonia</u> turns (moist red) litmus blue *</td><td>fizzing / bubbling / effervescence or gas / H_2 pops with a lighted splint *</td></tr> </tbody> </table>	test	observation with FA 8	observation with FA 9	To a 1 cm depth in a test-tube, add a few drops of acidified potassium manganate(VII).	No (visible) reaction / no change or solution (in test tube) becomes pink / purple / solution / KMnO_4 / MnO_4^- stays purple *	from purple to colourless or KMnO_4 / MnO_4^- decolourised	To a 1 cm depth in a test-tube, add a few drops of aqueous barium chloride or aqueous barium nitrate.	no reaction / no change / no precipitate / solution remains colourless *	white precipitate (formed) *	To a 1 cm depth in a boiling tube, add an equal volume of aqueous sodium hydroxide. Warm carefully, then	no reaction / no change / no precipitate *	no reaction / no change / no precipitate *	add aluminium foil.	<u>gas / ammonia</u> turns (moist red) litmus blue *	fizzing / bubbling / effervescence or gas / H_2 pops with a lighted splint *	4
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3(b)(iii)	Both anions correct FA 8 = nitrate / NO_3^- FA 9 = sulphite / SO_3^{2-}	1															

Question	Answer	Marks
3(b)(iv)	One relevant ionic equation with state symbols • $\text{Ba}^{2+}(\text{aq}) + \text{SO}_3^{2-}(\text{aq}) \rightarrow \text{BaSO}_3(\text{s})$ • $\text{Ba}^{2+}(\text{aq}) + \text{SO}_4^{2-}(\text{aq}) \rightarrow \text{BaSO}_4(\text{s})$ • $2\text{MnO}_4^{-}(\text{aq}) + 6\text{H}^{+}(\text{aq}) + 5\text{SO}_3^{2-}(\text{aq}) \rightarrow 5\text{SO}_4^{2-}(\text{aq}) + 2\text{Mn}^{2+}(\text{aq}) + 3\text{H}_2\text{O}(\text{l})$ • $3\text{NO}_3^{-}(\text{aq}) + 27\text{H}^{+}(\text{aq}) + 3\text{Al}(\text{s}) \rightarrow 3\text{NH}_3(\text{g}) + 9\text{H}_2\text{O}(\text{l}) + 3\text{Al}^{3+}(\text{aq})$	1

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1(a)	I Clear presentation of unambiguous readings of time and volume with correct units.	1
	II Award if volume after 4 minutes is within 0.75–1.25 range.	1
	III Award if volume after 4 minutes is within 0.9–1.1 range.	1
1(b)(i)	Correct expression Moles oxygen = $\frac{\text{correct volume after 4 mins}}{24\,000}$	1
1(b)(ii)	Correct use of moles of oxygen: Moles H ₂ O ₂ = moles oxygen × 2 Working and answer may be credited from answer in (i).	1
	Correctly uses: Conc H ₂ O ₂ = $\frac{\text{Moles H}_2\text{O}_2}{0.03}$ and both final answers (if given) in (b) to 2–4 sf	1
1(c)	(Not correct) reaction (starts fast and then) slows OR volume of gas collected in 2nd minute is less than in the 1st minute Allow sketch of suitable volume of gas against time with 1 and / or 2 minutes marked on time axis and tangent to curve drawn. Reject answer based on consumption of FB 2 .	1
	Greater concentration so greater rate / frequency of collision at start	1
1(d)	Rate: Greater volume at specified time as greater surface area OR reaction complete sooner as greater surface area OR Final volume: No effect as manganese(IV) oxide is the catalyst Reject MnO ₂ is in excess Reject has no effect on reaction	1

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Question	Answer	Mark
2(a)	I All the following data recorded - two burette readings and titre for the rough titration - initial and final burette readings for two (or more) accurate titrations	1
	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	1
	III All accurate burette readings are recorded to the nearest 0.05 cm ³ .	1
	IV The final accurate titre recorded is within 0.10 cm ³ of any other accurate titre.	1
	Award V if $\delta \leq 0.50 \text{ cm}^3$ (Where δ is difference to the supervisor's value)	1
	Award VI if $\delta \leq 0.30 \text{ cm}^3$	1
	Award VII if $\delta \leq 0.20 \text{ cm}^3$	1
2(b)	Correctly calculates mean titre from two (or more) accurate titres where the total spread is $\leq 0.20 \text{ cm}^3$. AND Answer is given to 2 dp AND Working must be shown or ticks must be put next to the two (or more) accurate titres selected.	1
2(c)(i)	Correctly calculates $\frac{0.02 \times (\mathbf{b})}{1000}$ and answer to 3 or 4 sf	1
2(c)(ii)	Correct use of $\frac{(\mathbf{c})(\mathbf{i}) \times 5}{2}$ and answer to 3 or 4 sf	1

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Question	Answer	Mark
2(c)(iii)	Correct use of (ii) $\times 40$ and answer to 3 or 4 sf	1
2(d)	Two from Vol gas not measured at R.T.P. (as given) / molar volume of gas not 24 dm³ under conditions used and need to measure temperature (and calculate actual molar volume) Reaction not gone to completion (after 4 mins) / reaction still fizzing after 4 minutes / assumption about completion (made in 1(b)(ii)) is not valid and leave until no increase in volume / no fizzing Gas / oxygen escapes (before bung replaced) and practical method e.g. small tube with catalyst / float catalyst in a boat / use a divided flask Error in volume of H₂O₂ / water or 50 cm³ measuring cylinder used and use a burette or graduated pipette Air gap in measuring cylinder does not reach scale and use gas syringe / allow more air to enter measuring cylinder to reach scale Allow: If candidate's gas volume is < 100 cm³ or < 50 cm³ then allow Error in volume measured and use a gas syringe or use a burette (respectively) as finer calibration.	2
2(e)	(Statement is not correct as) acid is in excess	1
2(f)(i)	Correctly calculates % = 0.037/0.833 or $[1 - 0.796/0.833] \times 100 = 4.442\%$ and answer given to 2 or more sf	1
2(f)(ii)	Hydrogen peroxide decomposes (slowly) when left	1

Question	Answer	Mark
FB 6 is FeSO_4 ; FB 7 is Na_2SO_3 ; FB 8 is NaNO_3		
3(a)(i)	Expected observations are in the table below. Award 1 mark for every two correct observations (*)	8

<i>test</i>	<i>observations</i>		
	FB 6	FB 7	FB 8
+ H^+ MnO_4^-	(from) purple to colourless / yellow or KMnO_4 / MnO_4^- decolourised *	Purple to colourless or KMnO_4 / MnO_4^- decolourised *	No effect / no (colour) change / no reaction or solution (in test tube) becomes pink/purple or solution/ KMnO_4 / MnO_4^- stays purple*
+ NaOH	Green ppt and insoluble in excess / turns brown *	No effect / no (visible) reaction/ (solution) stays colourless / no ppt *	No effect / no (visible) reaction/ (solution) stays colourless / no ppt *
+ warm	Ignore	no effect/ no gas (formed on heating) *	
+ H_2O_2 & OH^-	(Yellow solution and) Brown / red-brown / orange-brown / rust ppt and insoluble in excess/ bubbling *	No effect / no (visible) reaction / (solution) stays colourless *	No effect/no (visible) reaction/ (solution) stays colourless and
+ Ba^{2+}	White ppt *	White ppt *	No effect / no (visible) reaction/ no ppt *
+ Al & NaOH		Fizzing / bubbling / effervescence *	Fizzing / bubbling effervescence *
		Gas / H_2 pops with a lighted splint * litmus turns blue is CON	Gas / NH_3 turns litmus blue. *

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Question	Answer	Mark
Reagent(s) must be stipulated in parts (ii), (iii), (iv) & (v) The reasons in (ii), (iii) & (v) must refer to observations in (i) The formula or name of the ion must be correct but allow bod for an error in the reagent formula.		
3(a)(ii)	Fe^{2+} / iron(II) because green ppt formed with NaOH / OH^- Allow from grey-green ppt turning brown / black	1
3(a)(iii)	Two of SO_3^{2-} , SO_4^{2-} , CO_3^{2-} because white ppt with Ba^{2+}	1
3(a)(iv)	Any cation from QA notes with suitable reason <i>For NH_4^+ the reason must include no ammonia / litmus turning blue with warm / hot with NaOH</i>	1
3(a)(v)	NO_3^- or NO_2^- because forms NH_3 / red litmus turned blue with NaOH(aq) and Al (foil)	1

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Question	Answer	Mark
3(b)	Table (rows or columns) to show test, space for expected results for both liquids with at least one entry attempted.	1
	Test and positive result for each organic chemical Ethanoic acid Add named carbonate / named reactive metal and fizzing / positive gas test or Add ethanol / other named alcohol + conc H ₂ SO ₄ / warm and sweet / fruity smell / ester formed or Use named pH indicator and appropriate final colour given	1
	Propan-1-ol (Acidified) potassium / sodium manganate(VII) / KMnO ₄ / NaMnO ₄ and decolourised/ purple to colourless Allow (acidified) potassium/sodium dichromate / K ₂ Cr ₂ O ₇ / Na ₂ Cr ₂ O ₇ and orange to green or ethanoic acid / other named carboxylic acid + conc H ₂ SO ₄ / warm and sweet / fruity smell / ester formed	1

CHEMISTRY

9701/35

Paper 3 Advanced Practical Skills 1

October/November 2019

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.

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This document consists of **8** printed pages.

PUBLISHED**Generic Marking Principles**

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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**:

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- 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.

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:

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Question	Answer	Marks
1(a)	3 masses recorded with unambiguous headings in the space provided, with correct units mass used correctly calculated volume of gas collected or final volume recorded with correct units	1
	Award this mark if volume recorded by candidate lies within $\pm 10\%$ of supervisor value.	1
1(b)(i)	Correctly calculates volume of gas in $\text{cm}^3 / 24\,000$ answer to 2–4 sf	1
1(b)(ii)	Correct use of: $2 \times$ AND ans (b)(i) / 0.025 (answer to 2–4 sf)	1
1(b)(iii)	Correctly uses ans (b)(i) $\times 24.3$ and answer to 2–4 sf	1
1(c)	Student correct as reaction now slower so less gas lost (while bung is being fitted).	1
	Student incorrect as Mg is in excess. or Student incorrect as reaction is faster so more gas lost	1
1(d)	gas volume / amount / moles lower so concentration is lower	1

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Question	Answer	Marks
2(a)	I Uses a volume between 40.00 and 45.00 cm ³ and answer to at least 1 dp	1
	II The following data must be shown • burette readings and titre for rough titration • 2 × 2 ‘box’ showing both accurate burette readings	1
	III Headings and units correct for accurate titration table and headings match readings. • Initial / start (burette) and reading / volume + unit • Final / end (burette) and reading / volume + unit • titre or volume / FA 4 and used / added (<i>not ‘difference’ amount or ‘total’</i>) + unit	1
	IV All accurate burette readings to 0.05 cm ³	1
	V The final accurate titre recorded is within 0.10 cm ³ of any other accurate titre.	1
	Award VI if $20 < \delta \leq 30 \text{ cm}^3$	1
	Award VII if $10 < \delta \leq 20 \text{ cm}^3$	1
	Award VIII if $\delta \leq 10 \text{ cm}^3$	1
2(b)	Candidate must average two (or more) titres that are all within 0.20 cm ³ . Working must be shown or ticks must be put next to the two (or more) accurate titres selected.	1
2(c)(i)	Answers for (ii) , (iii) and (iv) given to 3–4 sf. Minimum three answers displayed.	1
2(c)(ii)	Correctly calculates 2.50×10^{-3}	1
2(c)(iii)	Correct use of ans (c)(ii) × 1000 / ans (b)	1
2(c)(iv)	Correct expression: ans (c)(iii) × 250 / vol used from (a)	1
2(d)	Correctly calculates 0.10 / vol used in (a) × 100.	1

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Question	Answer	Marks
2(e)	Question 1 - measuring cylinder greater error than burette / pipette - molar gas volume of 24 dm³ may not be valid / temperature of the lab may not be known - too much gas for the measuring cylinder (check that vol > 250 cm³) - use gas syringe (if volume < 100 cm³)	1
	Question 2 - dilution introduces extra stage / greater cumulative error - methyl orange end-point can be difficult to see / colour change gradual / difficult to see	1

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Question	Answer	Marks
	FA 5 is $\text{Al}(\text{NH}_4)(\text{SO}_4)_2 \cdot 12\text{H}_2\text{O}$; FA 8 is KI and FeSO_4	
3(a)(i)	• melts / dissolves • condensation / moisture on the walls of the test-tube / steam produced • white smoke / fumes (NOT gas) • (gas) turns red litmus blue • gas turns blue litmus red • white residue Award 1 mark for two correct observations from the list, award 2 marks for three or more correct observations. If both gas observations are given they must be in the correct order for both to be credited.	2
3(a)(ii)	NH_3 White ppt and insoluble in excess	1
	NaOH White ppt and sol in excess Allow 1 mark for white ppt with both NH_3 and NaOH	1
	hot NaOH Gas / NH_3 (on warming) turns red litmus blue	1
	Ba^{2+} White ppt insoluble in acid / white ppt no reaction with acid Reject white ppt formed when acid added	1
3(a)(iii)	names or correct formulae	1
	NH_4^+ , Al^{3+} , SO_4^{2-} Award 1 mark for two ions, award 2 marks for three ions.	1

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Question	Answer	Marks
3(b)	Any formula (involving all three ions) in which the charges on the ions cancel (e.g. $\text{K}_3\text{Cr}(\text{SO}_4)_3$)	1
	$\text{KCr}(\text{SO}_4)_2 \cdot 12\text{H}_2\text{O}$	1
3(c)(i)	Red-brown (allow yellow / yellow-brown / orange / orange-brown / brown) (solution) or KMnO_4 / purple decolourises and turns blue-black / dark blue / black (on adding starch)	1
	Green ppt and insoluble in excess / turns brown (on standing) Reject grey-green	1
3(c)(ii)	Fe^{2+} / iron(II) and I^- / iodide This mark is free-standing	1
3(c)(iii)	Uses silver nitrate and yellow ppt	1
	ppt insoluble in HNO_3 or ppt insoluble in NH_3 (nitric acid may be added initially)	1
3(c)(iv)	$\text{Fe}^{2+}(\text{aq}) + 2\text{OH}^-(\text{aq}) \rightarrow \text{Fe}(\text{OH})_2(\text{s})$ ecf for Cr^{3+} / Cu^{2+} / Fe^{3+} or any other transition metal ion concluded in (ii).	1

CHEMISTRY

9701/36

Paper 3 Advanced Practical Skills 2

October/November 2019

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.

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- marks are not deducted for omissions
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GENERIC MARKING PRINCIPLE 4:

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GENERIC MARKING PRINCIPLE 6:

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Rounding errors (RE) and transcription errors (TE) are penalised only once in the paper.

Question	Answer	Marks
1(a)	I All the following data recorded - two burette readings and titre for the rough titration - initial and final burette readings for two (or more) accurate titrations	1
	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 / FB3 and used / added (<i>not</i> 'difference', 'amount', 'total') unit: / cm ³ or (cm ³) or in cm ³ (for each heading) or cm ³ unit given for each volume recorded	1
	III All accurate burette readings are to the nearest 0.05 cm ³ .	1
	IV The final accurate titre recorded is within 0.10 cm ³ of any other accurate titre.	1
	Award V if $\delta \leq 0.80$ (cm ³) (Where δ is difference to the supervisor's value)	1
	Award VI if $\delta \leq 0.50$ (cm ³)	1
	Award VII if $\delta \leq 0.30$ (cm ³)	1
1(b)	Candidate calculates the mean correctly. - Candidate must take the average of two (or more) titres that are within a total spread of not more than 0.20 cm³. - 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 nearest 0.01 cm³.	1
1(c)(i)	All quoted answers in (ii)–(v) are expressed to 3 or 4 sig fig. Minimum of 3 answers displayed to qualify for this mark.	1
1(c)(ii)	Correctly calculates no of moles of HCl used. No of moles HCl = $0.5 \times \frac{25}{250} \times \text{answer (b)} / 1000$	1
1(c)(iii)	$\text{Ca(OH)}_2 + 2 \text{HCl} \rightarrow \text{CaCl}_2 + 2\text{H}_2\text{O}$ and Correctly calculates number of moles of $\text{Ca(OH)}_2 = 0.5 \times \text{answer in (ii)}$	1

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Question	Answer	Marks
1(c)(iv)	Correct use of (iii) to calculate concentration of Ca(OH)_2 in FB 1 Concentration Ca(OH)_2 in FB 1 = ans (iii) $\times$ 40	1
1(c)(v)	Correct use to obtain mass of Ca(OH)_2 Mass of Ca(OH)_2 = answer (iv) $\times$ 74.1	1

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Question	Answer	Marks
2(a)(i)	Six pieces of data shown, with unambiguous headings and correct units. • (mass of) container and FB 4 • (mass of) container (plus residue) • (mass of) FB 4 used • first / start / initial (temperature) / T of FB 6 • final / highest (temperature) • (temperature) rise / change	1
	Precision of readings shown in 2(a) and 2(b) • all four thermometer readings are shown to 0.0 or 0.5 °C • both balance readings for each experiment are shown to <u>same</u> number of d.p. • masses and temperatures subtracted correctly	1
	Accuracy (Q) mark If δ is less than or equal to 2.0 °C, award this mark	1
2(a)(ii)	Correctly calculated answer Energy change = $40 \times 4.2 \times \text{temp rise}$	1
2(a)(iii)	Correctly calculated moles of Ca(OH)₂ Moles of FB 4 = $\frac{\text{mass used}}{74.1}$	1
2(a)(iv)	Correct use • $\Delta H = (\text{ii}) / (\text{iii}) \times 1000$ • Negative sign must be shown on answer line. • Answer should be expressed to 2, 3 or 4 sig fig	1

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Question	Answer	Marks																		
2(b)(i)	Readings written in space provided - Two thermometer readings are recorded both above 10 °C - Two masses are recorded giving mass of CaO between 0.5–2.0 g.	1																		
	Two accuracy marks Calculate the difference between corrected candidate’s and supervisor’s temp rise (δ) See table for accuracy marks.	2																		
	<table><tr><td>Sup $\Delta T_{\max}$</td><td>$\geq 25.5\text{ }^{\circ}\text{C}$</td><td>25.0–15.5 °C</td><td>15.0–10.5 °C</td><td>10.0–5.5 °C</td><td>$< 5.5\text{ }^{\circ}\text{C}$</td></tr><tr><td>1 mark</td><td>$\delta \leq 3.0\text{ }^{\circ}\text{C}$</td><td>$\delta \leq 2.5\text{ }^{\circ}\text{C}$</td><td>$\delta \leq 2.0\text{ }^{\circ}\text{C}$</td><td>$\delta \leq 1.5\text{ }^{\circ}\text{C}$</td><td>$\delta \leq 0.5\text{ }^{\circ}\text{C}$</td></tr><tr><td>2 marks</td><td>$\delta \leq 2.0\text{ }^{\circ}\text{C}$</td><td>$\delta \leq 1.5\text{ }^{\circ}\text{C}$</td><td>$\delta \leq 1.0\text{ }^{\circ}\text{C}$</td><td>$\delta \leq 0.5\text{ }^{\circ}\text{C}$</td><td>not available</td></tr></table>	Sup $\Delta T_{\max}$	$\geq 25.5\text{ }^{\circ}\text{C}$	25.0–15.5 °C	15.0–10.5 °C	10.0–5.5 °C	$< 5.5\text{ }^{\circ}\text{C}$	1 mark	$\delta \leq 3.0\text{ }^{\circ}\text{C}$	$\delta \leq 2.5\text{ }^{\circ}\text{C}$	$\delta \leq 2.0\text{ }^{\circ}\text{C}$	$\delta \leq 1.5\text{ }^{\circ}\text{C}$	$\delta \leq 0.5\text{ }^{\circ}\text{C}$	2 marks	$\delta \leq 2.0\text{ }^{\circ}\text{C}$	$\delta \leq 1.5\text{ }^{\circ}\text{C}$	$\delta \leq 1.0\text{ }^{\circ}\text{C}$	$\delta \leq 0.5\text{ }^{\circ}\text{C}$	not available	
	Sup $\Delta T_{\max}$	$\geq 25.5\text{ }^{\circ}\text{C}$	25.0–15.5 °C	15.0–10.5 °C	10.0–5.5 °C	$< 5.5\text{ }^{\circ}\text{C}$														
1 mark	$\delta \leq 3.0\text{ }^{\circ}\text{C}$	$\delta \leq 2.5\text{ }^{\circ}\text{C}$	$\delta \leq 2.0\text{ }^{\circ}\text{C}$	$\delta \leq 1.5\text{ }^{\circ}\text{C}$	$\delta \leq 0.5\text{ }^{\circ}\text{C}$															
2 marks	$\delta \leq 2.0\text{ }^{\circ}\text{C}$	$\delta \leq 1.5\text{ }^{\circ}\text{C}$	$\delta \leq 1.0\text{ }^{\circ}\text{C}$	$\delta \leq 0.5\text{ }^{\circ}\text{C}$	not available															
2(b)(ii)	Correct expressions shown for enthalpy change - Energy released ($40 \times 4.2 \times \text{temp rise}$) - No of moles used = $\frac{\text{mass of FB 4 used}}{56.1}$ $\Delta H = \frac{\text{energy}}{\text{no of moles}} \times 1000$ - An attempted answer, quoted to 2 or more sig fig Negative sign in answer	1																		

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Question	Answer	Marks
2(c)	Possible working: Attempt at Hess Cycle diagram or clear working shown - Downward arrow from Ca(OH)_2 - Downward arrow from CaO OR Use of equations $\text{Ca(OH)}_2(\text{s}) + 2\text{HCl}(\text{aq}) \rightarrow \text{CaCl}_2(\text{aq}) + 2\text{H}_2\text{O}(\text{l})$ $\text{CaO}(\text{s}) + 2\text{HCl}(\text{aq}) \rightarrow \text{CaCl}_2(\text{aq}) + \text{H}_2\text{O}(\text{l})$	1
	Correctly uses values for ΔH, with sign correct $\Delta H = (\text{a})(\text{iv}) - (\text{b})(\text{ii})$ <i>Correct answer with some working gains both marks.</i> <i>Correct answer with no working gains one mark.</i> <i>Wrong answer – look at working and award one mark if appropriate.</i> <i>If default values are used, $\Delta H = +27 \text{ kJ mol}^{-1}$</i>	1
2(d)(i)	Temperature rise / change would be the same and because acid is used in excess / CaO is the limiting factor	1
2(d)(ii)	No, because there is no ‘frothing up’ / spitting out of reagents / no acid spray or No, because a taller cup would not (significantly) reduce heat loss	1

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Question	Answer	Marks
	FB 7 is ZnCO_3 ; FB 8 is KI; FB 9 is KNO_2	
3(a)	Observations when FB 7 is heated • Condensation / water droplets / steam produced • solid becomes fluidised / powder jumps around • solid turns yellow / yellow-green (when hot) • solid goes white or paler <u>when cooled</u> Award 1 mark for two correct points from the list, award 2 marks for three or more correct points from the list.	2
	(Gas) turns limewater milky / chalky / white precipitate / cloudy white	1
3(b)(i)	Observations (see also the table shown on the next page) Award 1 mark for two correct points (*) in the table	5

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Question	Answer			Marks
3(b)(i)	Table of Observations for 3(b)(i)			
	<i>test</i>	<i>observations with FB 8</i>	<i>observations with FB 9</i>	
	To a 1 cm depth in a test-tube, add a few drops of acidified potassium manganate(VII)	yellow / yellow-brown / brown / orange / orange-brown / red-brown coloration (formed) *	KMnO ₄ decolorised / purple to colourless *	
	To a 1 cm depth in a test-tube, add an equal volume of dilute nitric acid, then add a few drops of aqueous barium nitrate, then	no (visible) reaction / no change / no precipitate / solution remains colourless / goes (pale) yellow *	no (visible) reaction / no change / no precipitate / solution remains colourless and	
	add a few drops of aqueous silver nitrate.	(pale) yellow precipitate (formed) *	no (visible) reaction / no change / no precipitate / solution remains colourless *	
	To a 1 cm depth in a boiling tube, add an equal volume of aqueous sodium hydroxide and warm carefully, then	no (visible) reaction / no change / no precipitate / solution remains colourless / no gas *	no (visible) reaction / no change / no precipitate / solution remains colourless / no gas *	
	add a strip of aluminium foil.	fizzing / bubbling / effervescence or gas / H ₂ pops with lighted splint * litmus turns blue is CON any other 'positive' gas test is CON	Fizzing / bubbling / effervescence * <u>gas / NH₃</u> turns litmus blue *	

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Question	Answer	Marks
3(b)(ii)	$\text{Ag}^+(\text{aq}) + \text{I}^-(\text{aq}) \rightarrow \text{AgI}(\text{s})$	1
3(b)(iii)	Al/ aluminium is oxidised (not 'aluminium ions') and Nitrite/nitrate ion is reduced / N^{5+} / N^{3+} (not ' FB 9 reduced')	1
3(c)(i)	At first: no change / stays colourless / goes yellow / light brown and With acid: goes brown / orange-brown / red-brown / yellow-brown / yellow	1
3(c)(ii)	I_2 (<i>formula required</i>)	1
3(c)(iii)	Add starch and mixture goes dark blue / blue-black (ignore state) OR Add sodium thiosulfate and brown colour disappears / brown decolourised / iodine colour fades / solution goes colourless	1