Cambridge International AS & A Level

Cambridge Assessment International Education
Cambridge International Advanced Subsidiary and Advanced Level

CHEMISTRY **9701/33**

Paper 3 Advanced Practical Skills **March 2018**

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.

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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.

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Question	Answer	Marks
1(a)	**I** Single table to show temperature of **FA 2**/reactant(s), time and rate for **5** experiments. (*not all experiments need have been done – minimum 2*)	**1**
	II Headings unambiguous and units correct – displays: (°C), / s, in s^{-1} (*ignore factor of 1000 in rate unit*)	**1**
	III All temperatures recorded to .0 or .5, all times as integers. (*minimum 4 experiments carried out*)	**1**
	IV Selects temperatures in experiments 4 and 5 that are ⩾ 4 °C apart from all others and none above 60 °C. (*Paper states 55 °C but T for Expt 2 may be slightly higher.*)	**1**
	V Rates correctly calculated to 2–4 sf (*minimum 3 results*)	**1**
	Award **VI** if candidate for expt 1 is within 10% of supervisor (*If expts have been renumbered by candidate then compare time for the expt carried out at the lowest temperature.*)	**1**
	Award **VII** if **all** times decrease with increasing temperature.	**1**
	Award **VIII** if all results give an increasing gradient graph (*Allow if 4 out of the 5 points show an increasing gradient line.*) (*Do not award if no graph drawn or fewer than 5 points plotted.*)	**1**
1(b)	**I** Axes labelled (*name or unit*) **and** linear scales chosen so graph occupies more than half the available length for both axes including 15 °C on *x*-axis and 0 on *y*-axis.	**1**
	II All points recorded (*minimum 4 recorded*) accurately plotted *Any point which should be on a line must be on that line.* *Any point not on a line must be in the correct part of the small square.* *If blobs shown then they must be correctly centred and be less than ½ a small square across.*	**1**
	III Line of best fit drawn (*smooth curve expected but allow suitable straight line*) *Ignore any obviously anomalous points.*	**1**
	IV Anomalous points indicated **and** line extrapolated to 15 °C If no points anomalous then smooth line very close to all points	**1**

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Question	Answer	Marks
1(c)	Both construction lines at 17.5 °C shown *Allow other clear indication linking 17.5 °C with rate*	**1**
	Correctly calculates time from rate reading (*ignore sf*) Rate must be correctly read from the graph (to within 0.5 s^{-1} of examiner value) If no construction lines are drawn examiner infers rate and checks rate and time given by candidate. *If construction lines / 'point' drawn in wrong place then allow as ecf* (*i.e. wrong temp selected*)	**1**
1(d)	Rate of reaction increases with / is proportional to increase in temperature because it / **graph line** curves upwards / has a positive gradient **or figures** from table. Directly proportional is CON	**1**
	Rate of rate of reaction increases because gradient increases with temperature / rate of reaction increases more / at a greater rate than increase in temperature as gradient increases (**or** from relevant figures from graph or results table)	**1**
1(e)(i)	Correctly calculates initial concentration of thio to 2–4 sf. (*Penalise incorrect sf only once in this section.*) $^{18.1}/_{248.2}$ = 0.073 / 0.0729 / 0.07293 mol dm^{-3}	**1**
1(e)(ii)	Correctly calculates concentration of acid in the mixture to 2–4 sf 0.05 × $^{2}/_{3}$ = 0.033(3) mol dm^{-3}	**1**

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Question	Answer	Marks
1(e)(iii)	Shows working to compare concentration of thio in mixture with **(ii)** **or** moles of thio and of acid in mixture [conc of thio in mixture = $0.073 \times {}^{1}/_{3} = 0.024(31)$ mol dm^{-3}] **or** [moles of thio (in 10 cm^3) = $(7.3 / 7.29 / 7.293) \times 10^{-4}$ mol **and** moles of acid (in 20 cm^3) = $1(.000) \times 10^{-3}$ mol]	**1**
	Comparison using equation moles thio : acid = 1 : 2 ($^{thio}/_{acid} = 0.5$) **and** thio / **FA 1** in excess [concentration of $^{thio}/_{acid}$ in mixture = $^{0.024}/_{0.033} > 0.5$ This may be shown as thio : acid = 0.0243 > 0.0167 or 0.0486 > 0.033] **or** [moles of $^{thio}/_{acid}$ in mixture = $^{0.00073}/_{0.001} > 0.5$ This may be shown as thio : acid = 0.00146 > 0.001] *Allow ecf from **(ii)*** ($7.29 \times 10^{-2} \times {}^{2}/_{3} > 3.33 \times 10^{-2}$ **and FA 1** / thio in excess gains both marks)	**1**
1(f)(i)	Correct working shown **or** correct answer to minimum 2 sf ($^{0.5}/_{\text{time for expt 2}}$) × 100 *If* ' × 100' *not in working allow if answer shows its use.* (t_2 *must match the time recorded for the expt labelled 2 in the results table*)	**1**
1(f)(ii)	It is more difficult to distinguish exactly when the printing disappears at the lower temperature (in expt 1) *ora*	**1**

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Question	Answer	Marks
1(g)	**One** of Take the temperature on initial mixing and the temperature as soon as the printed sheet is obscured (and calculate a mean T). Take the temperature of **FA 1** / both solutions (and calculate (weighted) mean) Use a thermostatically controlled water bath (to prevent temperature fluctuations)	**1**
	One of Use (graduated) pipette / burette / measuring cylinders calibrated to greater precision / smaller percentage error to measure volumes. Use (graduated) pipette / burette to measure **FA 1** / thio and **FA 2** / acid / (volumes of) solutions / reactants (instead of the measuring cylinders) Use light sensor/colorimeter (to avoid subjective judgement of turbidity) (*Do not allow use a more accurate thermometer*)	**1**

Question	Answer	Marks
	FA 3 = HNO_3(aq); **FA 4** = $BaCO_3$(s); **FA 5** = $MgSO_4$(aq)	
2(a)	Test: selects $AgNO_3$ and NH_3 **and** test-tube or boiling tube used	**1**
	Observation: no reaction / no change / no ppt / (solution) remains colourless *This mark may be awarded without NH_3 being specified in test.*	**1**
	Test: selects NaOH + A*l* (and warm) **and** boiling tube used *Penalise lack of test-tube/boiling tube only once*	**1**
	Observation: effervescence / gas / NH_3 turns (damp) red litmus blue	**1**
	If the Devarda's test has been carried out first then allow Test: selects (aqueous acidified) $KMnO_4$ **and** test-tube or boiling tube used (1) Observation: stays purple / does not decolourise (1) *Allow the observation*: no reaction / no ppt / no change *if* $BaCl_2$ *or* $Ba(NO_3)_2$ *selected as a test.*	
2(b)	NO_3^- / nitrate (ion) from evidence of ammonia (*Allow* NO_2^- / *nitrite*)	**1**

Question	Answer	Marks
2(c)	**Gas** / **CO_2** / **effervescence** turns limewater milky / cloudy white / (forms) white ppt	**1**
	2* = 1 mark Do not penalise 'no observation', 'transparent', 'clear', '–' for 'no visible reaction' more than once.	
	FA 4 + **FA 3** effervescence / fizzing / bubbling * colourless solution formed *	
	FA 5 + Na_2CO_3 white ppt * (soluble in excess is CON)	
	FA 5 + NaOH white ppt * insoluble in excess *	
	FA 5 + NH_3 white ppt * insoluble in excess *	
	FA 5 + Ag^+ no reaction / no ppt / no change *	
	FA 5 + Ba^{2+} white ppt * insoluble in acid * (*addition of* H_2SO_4 *shown in observation table negates second point*)	
	FA 6 + NaOH no change / no visible reaction / no ppt / faint / slight white ppt *	
	FA 6 + NH_3 no change / no visible reaction / no ppt / faint / slight white ppt *	
	FA 6 + H_2SO_4 white ppt * (soluble in excess is CON)	
	FA 6 + **FA 5** white ppt * (soluble in excess is CON)	**7**

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Question	Answer	Marks
2(d)	Selects either HC*l* or HNO_3	**1**
2(e)	**FA 4**: Ba^{2+} / barium **and** CO_3^{2-} / carbonate (*allow* Ca^{2+} *if* white ppt insoluble in excess *formed with* NaOH – *see 8th observation box*)	**1**
	FA 5: Mg^{2+} / magnesium **and** SO_4^{2-} / sulfate (*allow* Ca^{2+} *if* no ppt *with* NH_3 – *see 4th observation box*) (*Do not allow* Ca^{2+} *for both. Anions are stand alone marks*.) 4 ions = 2 marks; 2 or 3 ions = 1 mark	**1**

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