

**MARK SCHEME for the October/November 2011 question paper
for the guidance of teachers**

9701 CHEMISTRY

9701/51

Paper 5 (Planning, Analysis and Evaluation),
maximum raw mark 30

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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	GCE A LEVEL – October/November 2011	9701	51

Question	Sections	Indicative material	Mark
1 (a)	PLAN Problem	Predicts that the solubility increases (with temperature). If gave “decreasing” then ecf into sketch and do not mark explanation.	[1]
		KNO ₃ needs energy to dissolve OR supplying heat or energy or increasing temperature will promote the endothermic change/ reaction.	[1]
		Any graph showing an increasing solubility with temperature (curve or straight line) that reflects the prediction. Do not accept a concave curve that becomes vertical. Accept a convex curve (accept with a max or an end decline). There can be a plateau in solubility. Have solubility on the y axis and temperature on the x axis. Ignore units unless the unit is the label. If gave “decreasing” above then ecf into sketch. If the prediction is irrelevant e.g. rate then can mark sketch as stand alone	[1]
(b)	PLAN Problem	(i) Temperature as the independent variable.	[1]
		(ii) Solubility as the dependent variable. Has to be a double quantity, not just mass or amount of solute. Ecf “concentration” if given as y-axis in sketch.	[1]

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(c)	PLAN Methods	There are four different approaches, all of which share the first five marking points. Use 7 number labelled ticks and crosses for these points. (i) At least 5 experiments. [1] (ii) Uses a range of at least 40°C. [1] (iii) Pilot run to choose relative amounts of materials. [1] (iv) Mass by balance. Water by measuring cylinder/pipette/burette or mass of water by balance. [1] (v) stirs [1] Alternate 1 (vi) Heat mixture to dissolve all the solute. [1] (vii) Cool and measure the temperature at which first crystals appear. [1] OR Alternate 2 (vi) Heats mixture to a particular temperature. (vii) Filters the solution (not cooled or decanted) and weighs the residue. OR Alternate 3 (vi) Heats mixture to a particular temperature. (vii) filters the solution (not cooled or decanted) and evaporates the filtrate and weighs solid. OR Alternate 4 (vi) Heats mixture to dissolve the solute. (vii) Records temperature at which the solute dissolves.	
(d)	PLAN Methods	Reference to 'hot' apparatus, not Bunsen or water with Handle with tongs/heat resistant gloves/cool before handling	[1]

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(e)	PLAN Methods	1(c)(i) & (ii) could award here. Mass of solid dissolved; volume/mass of water; solubility; temperature (solution) and units. Only accept a final temperature if it relates to the temperature of solution. All five correct 2 marks; Three or four correct (one/two errors) 1 mark; Two or less correct (more than two errors) zero.	[2]
	Total		[15]

Question	Sections	Indicative material	Mark
2 (a)	ACE Data	Log ₁₀ (rate) or Log ₁₀ (1/time) or Log ₁₀ (1/t). One of these labels also serves as expression, full column no units. Accept log with no base.	[1]
		Reciprocal absolute temperature or reciprocal Kelvin temperature or 1/T (not temp etc.). One of these labels also serves as expression, full column with unit, K ⁻¹ . Don't accept 1/T × 10 ⁻³ /K ⁻¹ but /10 ⁻³ K ⁻¹ OK	[1]
		Data in both columns above to 3 sig figs and correct, allow 2 errors.	[1]
		Allow salvage mark for rate column if ALL correct. A heading of 1/time or 1/t or 1/C also serves as expression.	
(b)	ACE Data	Unambiguously labelled axes. 1/T on the x-axis and log ₁₀ (rate) on the y axis AND appropriate scaling. Ignore units unless it is the label.	[1]
		Correctly plotted points. Ecf incorrectly calculated data. All 10 points need to be plotted. Check points 3 & 7 and 1 & 10 and any others off the line.	[1]
		Line of best fit.	[1]
		Allow plot and line marks if other axes used.	

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(c)	ACE Evaluation	Allow the candidate to select up to five anomalies which must include that furthest from the line.	[1]
		This mark is available if other axes used.	
		The data has two anomalies, Points 3 & 7.	
		Point 3, Timed to past opacity (not late stopping the clock alone), or solutions not equilibrated with water bath temperature or clock started early.	[1]
		Point 7, Timed to prior to opacity (not early stopping the clock alone), or clock started late.	[1]
		Give a rescue mark if both correct anomalies present but not linked to their points.	
		These last two marks not available if other axes used.	
(d)	ACE Evaluation	Either no repeats OR five or more points not on line hence unreliable	[1]
		OR most points on line OR points produce straight line hence reliable.	
		This mark not available if other axes used.	
(e)	ACE Data	Has construction lines on the plot.	[1]
		States intercept readings from them. (Could be to data points if the line and construction is to that point. Powers of 10 (e.g. $\times 10^{-3}$) must be included if necessary) then calculates the slope (around -1050). Slope is $(y_1 - y_2)/(x_1 - x_2)$. The sign of the gradient must be correct from the sign produced from the intercept calculations.	[1]
		Allow these marks if other axes used.	
(f)	ACE Conclusions	Correct calculation. Any calculation that has slope above multiplied by 19 i.e. $-E_A = \text{slope} \times 19$. Or slope = $-E_A/19$. Ignore units. Also accept that calculation subsequently divided by 1000 i.e. about 19950 or 19.95. T is not in this calculation.	[1]
		Allow this mark for other plots.	
(g)	ACE Conclusions	Increased K.E/energy/speed.	[1]
		More collisions/unit time or more frequent collisions or more chance of collisions or more energetic collisions or more collisions exceeding activation energy or more successful collisions or more effective collisions.	[1]
		NOT just more collisions.	
	Total		[15]

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(c)	PLAN Methods	There are four different approaches, all of which share the first five marking points. Use 7 number labelled ticks and crosses for these points. (i) At least 5 experiments. [1] (ii) Uses a range of at least 40°C. [1] (iii) Pilot run to choose relative amounts of materials. [1] (iv) Mass by balance. Water by measuring cylinder/pipette/burette or mass of water by balance. [1] (v) stirs [1] Alternate 1 (vi) Heat mixture to dissolve all the solute. [1] (vii) Cool and measure the temperature at which first crystals appear. [1] OR Alternate 2 (vi) Heats mixture to a particular temperature. (vii) Filters the solution (not cooled or decanted) and weighs the residue. OR Alternate 3 (vi) Heats mixture to a particular temperature. (vii) filters the solution (not cooled or decanted) and evaporates the filtrate and weighs solid. OR Alternate 4 (vi) Heats mixture to dissolve the solute. (vii) Records temperature at which the solute dissolves.	
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		Reciprocal absolute temperature or reciprocal Kelvin temperature or 1/T (not temp etc.). One of these labels also serves as expression, full column with unit, K ⁻¹ . Don't accept 1/T × 10 ⁻³ /K ⁻¹ but /10 ⁻³ K ⁻¹ OK	[1]
		Data in both columns above to 3 sig figs and correct, allow 2 errors.	[1]
		Allow salvage mark for rate column if ALL correct. A heading of 1/time or 1/t or 1/C also serves as expression.	
(b)	ACE Data	Unambiguously labelled axes. 1/T on the x-axis and log ₁₀ (rate) on the y axis AND appropriate scaling. Ignore units unless it is the label.	[1]
		Correctly plotted points. Ecf incorrectly calculated data. All 10 points need to be plotted. Check points 3 & 7 and 1 & 10 and any others off the line.	[1]
		Line of best fit.	[1]
		Allow plot and line marks if other axes used.	

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(c)	ACE Evaluation	Allow the candidate to select up to five anomalies which must include that furthest from the line.	[1]
		This mark is available if other axes used.	
		The data has two anomalies, Points 3 & 7.	
		Point 3, Timed to past opacity (not late stopping the clock alone), or solutions not equilibrated with water bath temperature or clock started early.	[1]
		Point 7, Timed to prior to opacity (not early stopping the clock alone), or clock started late.	[1]
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(e)	ACE Data	Has construction lines on the plot.	[1]
		States intercept readings from them. (Could be to data points if the line and construction is to that point. Powers of 10 (e.g. $\times 10^{-3}$) must be included if necessary) then calculates the slope (around -1050). Slope is $(y_1 - y_2)/(x_1 - x_2)$. The sign of the gradient must be correct from the sign produced from the intercept calculations.	[1]
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(g)	ACE Conclusions	Increased K.E/energy/speed.	[1]
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Question	Sections	Indicative material	Mark
1 (a)	PLAN Problem	Predicts that the rate of effusion decreases as the M_r increases. If candidates gave 'increasing' then ecf into sketch.	[1]
		(i) Correctly labelled axes with rate of effusion on the y-axis and M_r on the x-axis.	[1]
		(ii) Any graph showing a decreasing rate of effusion with increasing M_r (curve or straight line). This curve should not start vertical or show a positive gradient at any stage. It should not touch either axis.	[1]
(b)	PLAN Problem	(i) M_r as the independent variable.	[1]
		(ii) Rate of effusion/time as the dependent variable.	[1]
(c)	PLAN Methods	(i) Flush out the syringe with the gas under test at least once before filling. Accept gas removal by vacuum pump.	[1]
		(ii) Starts the descent of the piston above the start volume to ensure constant speed. (Free movement, not pushed to start mark.)	[1]
		(iii) Uses the same volume for all the gasses or measures the time between the same two volume marks. Alternatively, candidates may record volume effused over a fixed time for all gases. Table in 1(e) will change slightly in this case.	[1]
		(iv) Constant/same temperature for all experiments.	[1]
		(v) Ensures that the syringe is vertical or at the same angle throughout.	[1]
		(vi) Repeats the procedure (to obtain means). These may be referred to in the table in 1(e) .	[1]
(d)	PLAN Methods	Reference to flammability of hydrogen/butane or the poisonous nature of chlorine. Accept explosive nature of hydrogen or butane. Must name the gas.	[1]
		Keep away from flames/use a fume cupboard or gas mask (not just mask). This mark is conditional on naming a gas correctly above. If a candidate only suggests that <u>some</u> gases are poisonous and then suggests a fume cupboard is necessary do not give any marks.	[1]
		If, for example, a candidate suggests that hydrogen, oxygen and butane are flammable, do not award the first mark but reference to no naked flames etc would be worth the second mark. Mark similarly if candidate suggests chlorine and carbon dioxide or butane are poisonous.	

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(e)	PLAN Methods	Name /formulae of all the gases; correct M_r s; effusion time (or effusion volume for alternative method); rate of effusion; with relevant units. If an incorrect formula is given, ecf for M_r . All five correct 2 marks; One/two errors, three or four correct 1 mark; More than two errors zero mark.	[2]
	Total		[15]

Question	Sections	Indicative material	Mark
2 (a)	ACE Data	Moles of oxygen; e.g. D/16 ; no units.	[1]
		Moles of lead; e.g. E/207; no units.	[1]
		There must be full columns of data with these two headings. Do not accept any incorrect units in these headings. Can accept A_r oxygen etc., not M_r , instead of numerical values.	
		Correct data for moles of lead and oxygen (allow 2 errors). Ecf if 32 used for M_r oxygen. A salvage mark can be awarded for one completely correct mass column, i.e. heading, expression, units and data.	[1]
(b)	ACE Data	Unambiguously labelled axes/Appropriate scaling. Moles of lead or moles of oxygen can be on either axis.	[1]
		Correctly plotted points. All 10 points need to be plotted.	[1]
		Line of best fit which should be drawn to the origin. Lines should be straight with no kinks.	
		If 'non-plots' are given, e.g. moles lead oxide vs moles lead, plotting marks are still available. Candidates cannot access marks in 2(c) or 2(d) but can access marks in 2(e) .	[1]
(c)	ACE Evaluation	Anomalies identified. Allow candidates to select up to 5 anomalous points which must include that furthest from the line.	[1]
		Correct explanation for the first anomaly.	[1]
		Correct explanation for the second anomaly.	[1]
		Point 4, incomplete reduction (to lead side of line).	
		Point 8, material carried away by stream of hydrogen (to oxygen side of line).	
		If two correct explanations are given but not allocated to specific points, give 1 mark.	

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(d)	ACE Evaluation	Either no repeats/most points not on the line hence unreliable. Most points on or close to the line hence reliable, not just a straight line is produced.	[1]
(e)	ACE Data	Construction lines present. Takes intercept readings from the graph. Calculates the slope correctly using intercept readings. Gradient can be either $(y_1 - y_2)/(x_1 - x_2)$ or $(y_2 - y_1)/(x_2 - x_1)$.	[1] [1]
(f)	ACE Conclusions	Line is the ratio of oxygen to lead or vice versa. Calculation to determine the formula, i.e. gives the ratio of atoms commensurate with the answer in 2(e). States formula. Pb_3O_4 would usually mean that the last 2 marks are awarded automatically. Ecf an over-approximation of the ratio.	[1] [1] [1]
	Total		[15]