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**CHEMISTRY**

**9701/53**

Paper 5 Planning, Analysis and Evaluation

**May/June 2016**

MARK SCHEME

Maximum Mark: 30

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**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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| Question | Expected Answer   | Mark |
|----------|---|------|
| 1 (a)    | lithium and water being labelled in an arrangement that shows them coming into contact at some time   | [1]  |
|          | gas syringe OR collection over water, both using a leak-proof connection to the reaction vessel that would collect gas <b>after</b> the reagents have been mixed  | [1]  |
|          | a valid separation of the two reagents  | [1]  |
| (b) (i)  | cut (a small piece) AND remove oil  | [1]  |
| (ii)     | no change / increase in volume OR bubbles (in collector) cease (over water) OR no more gas / hydrogen collected   | [1]  |
| (iii)    | safety precautions – in a Li/LiOH/H <sub>2</sub> context<br>Any two from <ul style="list-style-type: none"> <li>• avoid skin contact / wear gloves / lab coat / use tongs in context of prevention of burns or corrosive contact only</li> <li>• keep piece of lithium / storage vessel / apparatus away from water</li> <li>• ensure unused lithium is all returned to storage vessel or stored under oil</li> <li>• keep away from naked flames / burner / sources of ignition</li> </ul> | [2]  |
| (iv)     | $(0.1/7 \times 1/2 \times 24\,000) = 171 \text{ cm}^3$<br>correct unit <b>MUST</b> be present   | [1]  |
| (v)      | use 200 cm <sup>3</sup> OR 250 cm <sup>3</sup> OR 500 cm <sup>3</sup> - the size must be reasonable and consistent with the volume in <b>b(iv)</b> .<br>correct unit <b>MUST</b> be present   | [1]  |
| (c) (i)  | use a burette twice or 50 cm <sup>3</sup> pipette twice   | [1]  |
| (ii)     | lithium / solid has all reacted / disappears / dissolves  | [1]  |

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| <b>Question</b> | <b>Expected Answer</b>   | <b>Mark</b> |
|-----------------|--|-------------|
| <b>(iii)</b>    | pipette / burette / syringe / graduated pipette  | [1]         |
| <b>(iv)</b>     | repeat the titration until results are within 0.1 cm <sup>3</sup>  | [1]         |
| <b>(d)</b>      | beaker :<br>Effect: ( $A_r$ ) (appears) more / larger<br>AND<br>Reason: (LiOH) solution more dilute (than expected)                                  | [1]         |
|                 | Flask:<br>Effect: ( $A_r$ ) None<br>AND<br>Reason: moles of (LiOH) (put in conical flask) remains the same / volume (i.e. moles) of LiOH not altered | [1]         |
|                 |  | <b>[15]</b> |

| <b>Question</b>       | <b>Expected Answer</b>  | <b>Mark</b>      |                  |                       |       |                       |       |                       |       |                       |       |                       |                |                       |       |                       |       |                       |       |                       |       |                       |       |  |
|-----------------------|---|------------------|------------------|-----------------------|-------|-----------------------|-------|-----------------------|-------|-----------------------|-------|-----------------------|----------------|-----------------------|-------|-----------------------|-------|-----------------------|-------|-----------------------|-------|-----------------------|-------|--|
| <b>2 (a)</b>          | <table border="1"> <tr> <td><math>1/T/K^{-1}</math></td> <td><math>\log_{10}(1/t)</math></td> </tr> <tr> <td><math>3.47 \times 10^{-3}</math></td> <td>-1.92</td> </tr> <tr> <td><math>3.41 \times 10^{-3}</math></td> <td>-1.76</td> </tr> <tr> <td><math>3.33 \times 10^{-3}</math></td> <td>-1.56</td> </tr> <tr> <td><math>3.30 \times 10^{-3}</math></td> <td>-1.45</td> </tr> <tr> <td><math>3.26 \times 10^{-3}</math></td> <td>-1.25 or -1.26</td> </tr> <tr> <td><math>3.22 \times 10^{-3}</math></td> <td>-1.28</td> </tr> <tr> <td><math>3.19 \times 10^{-3}</math></td> <td>-1.18</td> </tr> <tr> <td><math>3.16 \times 10^{-3}</math></td> <td>-1.08</td> </tr> <tr> <td><math>3.12 \times 10^{-3}</math></td> <td>-0.95</td> </tr> <tr> <td><math>3.05 \times 10^{-3}</math></td> <td>-0.90</td> </tr> </table> | $1/T/K^{-1}$     | $\log_{10}(1/t)$ | $3.47 \times 10^{-3}$ | -1.92 | $3.41 \times 10^{-3}$ | -1.76 | $3.33 \times 10^{-3}$ | -1.56 | $3.30 \times 10^{-3}$ | -1.45 | $3.26 \times 10^{-3}$ | -1.25 or -1.26 | $3.22 \times 10^{-3}$ | -1.28 | $3.19 \times 10^{-3}$ | -1.18 | $3.16 \times 10^{-3}$ | -1.08 | $3.12 \times 10^{-3}$ | -0.95 | $3.05 \times 10^{-3}$ | -0.90 |  |
|                       | $1/T/K^{-1}$  | $\log_{10}(1/t)$ |                  |                       |       |                       |       |                       |       |                       |       |                       |                |                       |       |                       |       |                       |       |                       |       |                       |       |  |
|                       | $3.47 \times 10^{-3}$   | -1.92            |                  |                       |       |                       |       |                       |       |                       |       |                       |                |                       |       |                       |       |                       |       |                       |       |                       |       |  |
|                       | $3.41 \times 10^{-3}$   | -1.76            |                  |                       |       |                       |       |                       |       |                       |       |                       |                |                       |       |                       |       |                       |       |                       |       |                       |       |  |
|                       | $3.33 \times 10^{-3}$   | -1.56            |                  |                       |       |                       |       |                       |       |                       |       |                       |                |                       |       |                       |       |                       |       |                       |       |                       |       |  |
|                       | $3.30 \times 10^{-3}$   | -1.45            |                  |                       |       |                       |       |                       |       |                       |       |                       |                |                       |       |                       |       |                       |       |                       |       |                       |       |  |
|                       | $3.26 \times 10^{-3}$   | -1.25 or -1.26   |                  |                       |       |                       |       |                       |       |                       |       |                       |                |                       |       |                       |       |                       |       |                       |       |                       |       |  |
|                       | $3.22 \times 10^{-3}$   | -1.28            |                  |                       |       |                       |       |                       |       |                       |       |                       |                |                       |       |                       |       |                       |       |                       |       |                       |       |  |
|                       | $3.19 \times 10^{-3}$   | -1.18            |                  |                       |       |                       |       |                       |       |                       |       |                       |                |                       |       |                       |       |                       |       |                       |       |                       |       |  |
|                       | $3.16 \times 10^{-3}$   | -1.08            |                  |                       |       |                       |       |                       |       |                       |       |                       |                |                       |       |                       |       |                       |       |                       |       |                       |       |  |
|                       | $3.12 \times 10^{-3}$   | -0.95            |                  |                       |       |                       |       |                       |       |                       |       |                       |                |                       |       |                       |       |                       |       |                       |       |                       |       |  |
| $3.05 \times 10^{-3}$ | -0.90   |                  |                  |                       |       |                       |       |                       |       |                       |       |                       |                |                       |       |                       |       |                       |       |                       |       |                       |       |  |
|                       | Column values for $1/T$ correctly calculated  | [1]              |                  |                       |       |                       |       |                       |       |                       |       |                       |                |                       |       |                       |       |                       |       |                       |       |                       |       |  |
|                       | Column values for $\log_{10}(1/t)$ correctly calculated   | [1]              |                  |                       |       |                       |       |                       |       |                       |       |                       |                |                       |       |                       |       |                       |       |                       |       |                       |       |  |
|                       | 3sf in $1/T$ AND 2 dp in $\log_{10}(1/t)$   | [1]              |                  |                       |       |                       |       |                       |       |                       |       |                       |                |                       |       |                       |       |                       |       |                       |       |                       |       |  |
| <b>(b)</b>            | candidate's points plotted correctly from table in 2(a)   | [1]              |                  |                       |       |                       |       |                       |       |                       |       |                       |                |                       |       |                       |       |                       |       |                       |       |                       |       |  |
|                       | line of best fit drawn  | [1]              |                  |                       |       |                       |       |                       |       |                       |       |                       |                |                       |       |                       |       |                       |       |                       |       |                       |       |  |

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| Question | Expected Answer  | Mark |
|----------|--|------|
| (c)      | <p>Two anomalies identified</p> <p>Reasons:</p> <p>Points to the left of the line:<br/> the time of disappearance was thought to be later<br/> OR the time was stopped too late (after reaction ended)<br/> OR the (hydrochloric acid) solution had not reached the temperature of the water bath<br/> OR the timer was started early<br/> OR magnesium folded up (reduced surface area)</p> <p>Points to the right of the line:<br/> the Mg may have been thought to have disappeared earlier than it did<br/> OR the timer was started late<br/> OR the timer was stopped too early (reaction still going)</p> | [1]  |
| (d) (i)  | <p>two co-ordinates in correct x, y format</p> <p>gradient calculated correctly from candidate's stated co-ordinates</p> <p>(the value <b>MUST</b> be negative unless the graph is mis-plotted)</p> <p>value <b>MUST</b> be to 3 significant figures</p> <p>Expected range –2500 to –3500</p>  | [1]  |
| (ii)     | <p><math>-E_A = \text{gradient} \times 0.0191</math><br/> OR <math>-E_A = \text{gradient} \times 0.0191</math> then divide by 1000<br/> OR correct transformations</p> <p>correct calculation and sign from candidate's gradient, gradient may be in calculation form, minimum 2 significant figures</p>   | [1]  |

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| <b>Question</b> | <b>Expected Answer</b>   | <b>Mark</b> |
|-----------------|--|-------------|
| <b>(e)</b>      | valid answer dependent on candidate's graph, e.g.<br>reliable because most of the points on/close to the line<br>OR<br>unreliable as most points not on the line                                   | [1]         |
| <b>(f)</b>      | Student X is correct; reaction time less OR reaction is faster<br>AND<br>percentage error/uncertainty will be greater OR<br>greater error/uncertainty in time/data/recordings                      | [1]         |
| <b>(g)</b>      | reaction time is longer/rate slower<br>AND<br>some of the magnesium is not in contact (with the acid) OR less surface area for reaction (with HCl) OR only the bottom of the magnesium is reacting | [1]         |
| <b>(h)</b>      | initial rate lower/slower.<br>AND<br>the concentration of H <sup>+</sup> ions is lower/pH higher<br>OR ethanoic acid less dissociated/weaker acid  | [1]         |
|                 |  | <b>[15]</b> |