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 will not enter into discussions about these mark schemes.

Cambridge is publishing the mark schemes for the May/June 2015 series for most Cambridge IGCSE®, Cambridge International A and AS Level components and some Cambridge O Level components.
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| 1 (a)    | I The following data must be shown  
• burette readings **and** titre for rough titration  
• 2 × 2 “box” showing both accurate burette readings | 1 |
|          | II Headings and units correct for accurate titration table and headings match readings.  
• initial/start (burette) reading/volume + unit  
• final/end (burette) reading/volume + unit  
• titre or volume/FA 3 used/added (*not* “difference” or “total”) + unit  
*Units: (cm$^3$) or/cm$^3$ or in cm$^3$ or cm$^3$ by every entry* | 1 |
|          | III All accurate burette readings recorded to 0.05 cm$^3$  
*Do not award this mark if:*  
50.00 is used as an initial burette reading  
or more than one final burette reading is 50.00  
or any burette reading is greater than 50.00. | 1 |
|          | IV Two accurate titres are within 0.10 cm$^3$.  
*Do not award if 3rd titre > 0.10 cm$^3$ away from either previous titre unless a further titration is also carried out which is within 0.1 cm$^3$ of any other.*  
*Do not award the mark if any ‘accurate’ burette reading (apart from an initial 0) are given to zero dp.* | 1 |

**Examiner checks and corrects titre subtractions where necessary. Examiner selects the best mean titre using a hierarchy:**  
*two identical titres within 0.05 cm$^3$, two or more titres within 0.10 cm$^3$ etc.*  
*Examiner subtracts (corrected) candidate’s titre from Supervisor’s titre.*

| Award V, VI and VII if $\delta < 0.20$ cm$^3$ | 1 |
| Award V and VI if 0.20 < $\delta$ < 0.40 cm$^3$ | 1 |
| Award V if 0.40 < $\delta$ < 0.60 cm$^3$ | 1 |
| Spread penalty: if the two ‘best’ titres are $\geq 0.50$ cm$^3$ apart, cancel one of the Q marks | [7] |

| (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 readings selected.  
The mean should normally be quoted to 2 dp rounded to the nearest 0.01. Example: 26.667 must be rounded to 26.67.  
Two special cases where the mean may not be to 2 dp:  
allow mean to 3 dp only for 0.025 or 0.075 eg 26.325;  
allow mean to 1 dp if all accurate burette readings were given to 1 dp and the mean is exactly correct. eg 26.0 and 26.2 = 26.1 is correct but 26.0 and 26.1 = 26.1 is incorrect.  
Note: The candidate’s mean will sometimes be marked as correct even if it is different from the mean calculated by the Examiner for the purpose of assessing accuracy. | 1 | [1] |
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<tr>
<td>(c)(i)(ii)</td>
<td>Correctly calculates&lt;br&gt;Concentration = 0.1 × 0.900 = 0.09(00) and&lt;br&gt;No. of moles = (i) × (b)_{1000}</td>
<td>1</td>
</tr>
<tr>
<td>(iii)(iv)</td>
<td>Correctly calculates&lt;br&gt;No. of moles of I$_2$ = 0.5 × (ii) and&lt;br&gt;Concentration of I$<em>2$ = (iii) × $^{1000}</em>{25}$</td>
<td>1</td>
</tr>
<tr>
<td>(v)</td>
<td>Equation correctly balanced&lt;br&gt;2Fe$^{3+}$ + 2I$^-$ → 2Fe$^{2+}$ + I$_2$ and use of 2:1 mole ratio: answer to (v) = 2 × (iv)</td>
<td>1</td>
</tr>
<tr>
<td>(vi)</td>
<td>Two steps are required:&lt;br&gt;• $M_r = \frac{38.56}{(v)}$&lt;br&gt;• Mass of water = $M_r - (55.8 + 18 + [2 × 96.1])$ or $M_r - 266$&lt;br&gt;Correctly calculates $x$ from mass of water&lt;br&gt;moles of water = mass / 18 and answer expressed to nearest integer&lt;br&gt;Final answers to (i) – (v) shown to 2 – 4 sf (minimum 4 steps attempted)</td>
<td>1 [6]</td>
</tr>
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</table>

**Total: 14**

2 (a) Initial and highest thermometer readings shown and temperature rise correctly calculated with unambiguous headings and correctly displayed units. 1

Examiner to calculate Supervisor’s and candidate’s $\Delta T$.
Calculate the difference between the two values.

III and IV awarded dependant on comparability between Supervisor’s and candidate’s $\Delta T$ values. 1 1 [3]

(b)(i)(ii) Correctly calculates<br>energy produced = 25 × 4.2 × $\Delta T$(a) and<br>moles of FA 6 = 0.5 × $^{25}_{1000}$ (= 0.0125) and both answers to a minimum of 2 sf 1

(iii) Correct expression $\Delta H = (i)_{1000} \times (ii)$ 1 [2]

(c) Precision of readings shown in (a) and (c): all four thermometer readings shown to 0.0 or 0.5°C 1

Examiner to calculate Supervisor’s and candidate’s $\Delta T$.
Calculate the difference between the two values.
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Marks awarded dependant on comparability between Supervisor’s and candidate’s $\Delta T$ values. 1 [2]

(d)(i)(ii) Correct expressions
- energy produced = $25 \times 4.2 \times \Delta T(c)$
- $\Delta H = \frac{(d)(i)}{1000} \times (b)(ii)$ 1

Correct (negative) sign shown in answers to (b)(iii) and (d)(ii) and both answers shown to 2 – 4 sf 1 [2]

(e) Hess’ Law cycle drawn to show
- displacement equation across top
- left hand downward arrow, labelled (b)(iii) or calculated value
- right hand downward arrow, labelled (d)(ii) or calculated value
- allow from clear use of equations: Fe equation reversed and added to Zn equation or arrows showing correct directions 1

Correctly calculates (b)(iii) – (d)(ii), with correct sign. 1 [2]

(f)(i) Correctly calculates: max % error = $\left(\frac{2 \times 0.5}{\Delta T(e)}\right) \times 100$ 1

(ii) One of the following:
- use a more concentrated solution of copper(II) sulfate (and larger quantities of metals)
- use a lid with hole for thermometer or another specific suggestion to improve insulation
- plot a cooling curve
- use a larger volume / use a burette / pipette to reduce percentage error in volume
- use a pipette / burette instead of a measuring cylinder 1 [2]

[Total: 13]
FA 7 = Na$_2$S$_2$O$_3$(s); FA 8 = Zn(NO$_3$)$_2$(aq); FA 9 = BaCl$_2$(aq)

3 (a)(i) Any two observations from the following:
- solid melts/dissolves or changes to liquid/solution
- condensation (inside tube) or steam/water
- vapour/water/steamy fumes (not white fumes)
- effervescence
- (blue) litmus turns red
- (dark) brown residue obtained or yellow solid
- bad egg smell

(ii) White/off-white/cream/yellow ppt/solid obtained (in either part of (ii))

Gas turns potassium manganate(VII) to colourless

(iii) Any two observations from the following:
- brown/yellow-brown/green-brown (mixture/precipitate) obtained (at first)
- changes to white/off-white (ppt) (when FA 1 added)
- (colourless) solution formed/ppt/solid soluble (with excess FA 1)

(iv) Equation concludes with: ....... + S + SO$_2$

(b) test observations

<table>
<thead>
<tr>
<th></th>
<th>FA 8</th>
<th>FA 9</th>
</tr>
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<tbody>
<tr>
<td>(i) + NaOH</td>
<td>white ppt soluble in excess</td>
<td>[1]</td>
</tr>
<tr>
<td>(ii) + AgNO$_3$ then NH$_3$</td>
<td>white ppt soluble</td>
<td>[1]</td>
</tr>
<tr>
<td>(iii) + NH$_3$</td>
<td>white ppt soluble in excess</td>
<td>[1]</td>
</tr>
<tr>
<td>(iv) + H$_2$SO$_4$</td>
<td>no change/no reaction/no ppt (not clear solution)</td>
<td>white ppt</td>
</tr>
<tr>
<td>(v) + FA 9</td>
<td>no change/no reaction/no ppt (not clear solution)</td>
<td>[1]</td>
</tr>
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</tbody>
</table>
| 3 | (b)(vi) | 3 identifications correct = two marks  
Any 2 identifications correct = one mark  
**FA 8**: cation is Zn$^{2+}$/zinc; anion is unknown  
**FA 9**: cation is Ba$^{2+}$/barium; anion is Cl$^{-}$/chloride | 1 | 1 |   |   |   |
| (vii) | unknown ion = NO$_3^-$  
reagent(s) = NaOH and Al/Zn (and warm)  
observeration(s) = (gas) turns red litmus blue or ammonia produced | 1 |   | [8] |   |   |   |

**Total: 13**