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 2017 series for most Cambridge IGCSE®️️, Cambridge International A and AS Level and Cambridge Pre-U components, and some Cambridge O Level components.
<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1(a)</td>
<td>The mass of a molecule OR the (weighted) average / (weighted) mean mass of the molecules</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Relative / compared to $\frac{1}{12}$ (the mass) of an atom of carbon–12 OR on a scale in which a carbon–12 atom / isotope has a mass of (exactly) 12 (units)</td>
<td>1</td>
</tr>
<tr>
<td>1(b)(i)</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>1(b)(ii)</td>
<td>8</td>
<td>1</td>
</tr>
<tr>
<td>1(b)(iii)</td>
<td>$\text{C}_3\text{H}_8\text{O} + 4\frac{1}{2}\text{O}_2 \rightarrow 3\text{CO}_2 + 4\text{H}_2\text{O}$</td>
<td>1</td>
</tr>
<tr>
<td>1(b)(iv)</td>
<td>HO AND propan–2–ol / 2–propanol</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>HO AND propan–1–ol / 1–propanol</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Alternative answers (any two):</td>
<td></td>
</tr>
<tr>
<td></td>
<td>HO AND butan–1–ol / 1–butanol</td>
<td></td>
</tr>
<tr>
<td></td>
<td>HO AND butan–2–ol / 2–butanol</td>
<td></td>
</tr>
<tr>
<td></td>
<td>HO AND (2–)methylpropan–1–ol / (2–)methyl–1–propanol</td>
<td></td>
</tr>
<tr>
<td></td>
<td>HO AND (2–)methylpropan–2–ol / (2–)methyl–2–propanol</td>
<td></td>
</tr>
</tbody>
</table>
### Question 1(b)(v)

**Answer**

- Correct conversions of data to SI/consistent units
  
  \[ \begin{align*}
  p &= 100000 \text{ Pa} ; \\
  V &= 20 \times 10^{-6} \text{ m}^3 ; \\
  T &= 393 \text{ K}
  \end{align*} \]

- Calculation of \( n = \frac{pV}{RT} \) from M1 values
  
  \[ n = \frac{100 \times 10^3 \times 20 \times 10^{-6}}{8.31 \times 393} \]

- Calculation of mass \( m = n \times Mr \) AND answer correct to 3sf
  
  \[ m = 6.12 \times 10^{-4} \times 60 = 0.0367 \text{ g} \]

- Alternative answer for using \( \text{C}_4\text{H}_{10}\text{O} \):
  
  \[ m = 6.12 \times 10^{-4} \times 74 = 0.0453 \text{ g} \]

**Marks**

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1(b)(v)</td>
<td>correct conversions of data to SI/consistent units</td>
<td>1</td>
</tr>
</tbody>
</table>
|          | \[ p = 100000 \text{ Pa} ; \\
|          | \[ V = 20 \times 10^{-6} \text{ m}^3 ; \\
|          | \[ T = 393 \text{ K} \] | |
|          | calculation of \( n = \frac{pV}{RT} \) from M1 values | 1 |
|          | \[ n = \frac{100 \times 10^3 \times 20 \times 10^{-6}}{8.31 \times 393} \] | |
|          | calculation of mass \( m = n \times Mr \) AND answer correct to 3sf | 1 |
|          | \[ m = 6.12 \times 10^{-4} \times 60 = 0.0367 \text{ g} \] | |
|          | Alternative answer for using \( \text{C}_4\text{H}_{10}\text{O} \): | |
|          | \[ m = 6.12 \times 10^{-4} \times 74 = 0.0453 \text{ g} \] | |
|          | **Total:** | **10** |

### Question 2(a)

**Answer**

- Substance | Type of bonding | Type of lattice structure |
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>copper</td>
<td>metallic</td>
<td>giant/metallic</td>
</tr>
<tr>
<td>ice</td>
<td>covalent OR hydrogen(-bonding) / H(-bonding)</td>
<td>hydrogen-bonded / simple / molecular</td>
</tr>
<tr>
<td>silicon(IV) oxide</td>
<td>covalent</td>
<td>giant (molecular) / macromolecular</td>
</tr>
<tr>
<td>iodine</td>
<td>covalent</td>
<td>simple / molecular</td>
</tr>
<tr>
<td>sodium chloride</td>
<td>ionic</td>
<td>giant / ionic</td>
</tr>
</tbody>
</table>

**Marks**

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>2(a)</td>
<td>substance</td>
<td>type of bonding</td>
</tr>
<tr>
<td></td>
<td>copper</td>
<td>metallic</td>
</tr>
<tr>
<td></td>
<td>ice</td>
<td>covalent OR hydrogen(-bonding) / H(-bonding)</td>
</tr>
<tr>
<td></td>
<td>silicon(IV) oxide</td>
<td>covalent</td>
</tr>
<tr>
<td></td>
<td>iodine</td>
<td>covalent</td>
</tr>
<tr>
<td></td>
<td>sodium chloride</td>
<td>ionic</td>
</tr>
<tr>
<td>2(b)(i)</td>
<td>hydrogen bonding</td>
<td></td>
</tr>
<tr>
<td>Question</td>
<td>Answer</td>
<td>Marks</td>
</tr>
<tr>
<td>----------</td>
<td>------------------------------------------------------------------------</td>
<td>-------</td>
</tr>
<tr>
<td>2(b)(ii)</td>
<td>H-bond between O and H of different molecules</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>minimum three partial charges (in a row) over two H₂O molecules, i.e.:</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>either $\delta^–$O–H$\delta^+$</td>
<td></td>
</tr>
<tr>
<td></td>
<td>or $H^{\delta^+}$–$\delta^–$O–H$^{\delta^+}$</td>
<td></td>
</tr>
<tr>
<td></td>
<td>lone pair of electrons on O of H-bond, in line with H-bond</td>
<td>1</td>
</tr>
<tr>
<td>2(c)(i)</td>
<td>X = liquid AND Z = solid</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Y = liquid and solid OR 'liquid / solid' OR 'liquid OR solid'</td>
<td>1</td>
</tr>
<tr>
<td>2(c)(ii)</td>
<td>(kinetic) energy reducing</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>motion slowing</td>
<td>ωwtte</td>
</tr>
<tr>
<td>2(c)(iii)</td>
<td>energy given out / released forming bonds / forming bonds exothermic</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>compensates for / counteracts heat loss / cooling</td>
<td>ωwtte</td>
</tr>
<tr>
<td></td>
<td><strong>Total:</strong> 15</td>
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</tr>
<tr>
<td>Question</td>
<td>Answer</td>
<td>Marks</td>
</tr>
<tr>
<td>----------</td>
<td>------------------------------------------------------------------------</td>
<td>-------</td>
</tr>
<tr>
<td>3(a)(i)</td>
<td>A</td>
<td>1</td>
</tr>
<tr>
<td>3(a)(ii)</td>
<td>H</td>
<td>1</td>
</tr>
<tr>
<td>3(a)(iii)</td>
<td>G</td>
<td>1</td>
</tr>
<tr>
<td>3(a)(iv)</td>
<td>B</td>
<td>1</td>
</tr>
<tr>
<td>3(a)(v)</td>
<td>F</td>
<td>1</td>
</tr>
<tr>
<td>3(b)(i)</td>
<td>(strong) heating</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>(to provide / overcome) high activation energy</td>
<td>1</td>
</tr>
<tr>
<td>3(b)(ii)</td>
<td>white flame / white light / white smoke / white solid</td>
<td>1</td>
</tr>
<tr>
<td>3(b)(iii)</td>
<td>Mg(s) + 2H₂O(l) → Mg(OH)₂(s) + H₂(g)</td>
<td>2</td>
</tr>
<tr>
<td>3(c)(i)</td>
<td>2Mg(NO₃)₂ → 2MgO + 4NO₂ + O₂</td>
<td>1</td>
</tr>
<tr>
<td>3(c)(ii)</td>
<td>CaCO₃ → CaO + CO₂</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>CaO + H₂O → Ca(OH)₂</td>
<td>1</td>
</tr>
<tr>
<td>3(d)(i)</td>
<td>reduce acidity in soil / increase pH of soil</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>(both) basic / base(s)</td>
<td>1</td>
</tr>
<tr>
<td>3(d)(ii)</td>
<td>CaCO₃ + 2H⁺ → Ca²⁺ + CO₂ + H₂O</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>OR</td>
<td></td>
</tr>
<tr>
<td></td>
<td>CaCO₃ + 2H⁺ → Ca²⁺ + H₂CO₃</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total:</td>
<td>16</td>
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<tr>
<td>Question</td>
<td>Answer</td>
<td>Marks</td>
</tr>
<tr>
<td>---------------</td>
<td>---------------------------------------------------------------------------------------------</td>
<td>-------</td>
</tr>
<tr>
<td>4(a)(i)</td>
<td>(molecules / isomers with) the same molecular formula / same number of atoms of each element</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>different structural / displayed formulae / arrangement of bonds</td>
<td>1</td>
</tr>
<tr>
<td>4(a)(ii)</td>
<td>$sp^2$ overlap of (2)s with two (2)p (atomic) orbitals</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>$sp^3$ overlap of (2)s with all three (2)p (atomic) orbitals</td>
<td>1</td>
</tr>
<tr>
<td>4(a)(iii)</td>
<td>$sp^2 = 116° – 124°$</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>$sp^3 = 106° – 112°$</td>
<td>1</td>
</tr>
<tr>
<td>4(b)(i)</td>
<td><img src="image1" alt="Diagram" /></td>
<td>1</td>
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<tr>
<td>4(b)(ii)</td>
<td>(electrophilic) addition</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>bromine decolourises / turns colourless / fades (from orange / brown)</td>
<td>1</td>
</tr>
<tr>
<td>4(b)(iii)</td>
<td>$HOCH_2CHBrCH_2Br$</td>
<td>1</td>
</tr>
<tr>
<td>4(b)(iv)</td>
<td>CO$_2$ / carbon dioxide</td>
<td>1</td>
</tr>
<tr>
<td>4(c)(i)</td>
<td>$P = $ propanal</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>$Q = $ propanone</td>
<td>1</td>
</tr>
<tr>
<td>Question</td>
<td>Answer</td>
<td>Marks</td>
</tr>
<tr>
<td>------------</td>
<td>------------------------------------------------------------------------</td>
<td>-------</td>
</tr>
<tr>
<td>4(c)(ii)</td>
<td><img src="image" alt="Iodomethane structure" /></td>
<td>1</td>
</tr>
<tr>
<td>4(d)(i)</td>
<td>(molecules / isomers with) the same (molecular and) structural formula</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Any two of:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>chiral centre / C attached to four different groups / atoms</td>
<td></td>
</tr>
<tr>
<td></td>
<td>non-super(im)posable mirror images</td>
<td></td>
</tr>
<tr>
<td></td>
<td>different spatial / 3D arrangement of atoms (owtte)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>different rotation of plane-polarised light</td>
<td></td>
</tr>
<tr>
<td>4(d)(ii)</td>
<td><img src="image" alt="Carbonyl reaction" /></td>
<td></td>
</tr>
<tr>
<td></td>
<td>curly arrow from lone pair on :C≡N to C((\delta^+))</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>correct dipole on carbonyl (\delta^+)C=O(\delta^-) AND curly arrow from bond to O((\delta^-))</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>correct intermediate, including C–O(^-) AND curly arrow from lone pair to H(^+)</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td><strong>Total:</strong> 19</td>
<td></td>
</tr>
</tbody>
</table>