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 must be read in conjunction with the question papers and the report on the examination.

- Cambridge will not enter into discussions or correspondence in connection with these mark schemes.

Cambridge is publishing the mark schemes for the October/November 2011 question papers for most IGCSE, GCE Advanced Level and Advanced Subsidiary Level syllabuses and some Ordinary Level syllabuses.
1 (a) (i) either burn or shine light/uv on mixture of $\text{H}_2 + \text{Cl}_2$ but NOT heat [1]

(ii) red/orange/brown colour of bromine decolourises/disappears
steamy/misty/white fumes produced
container gets warm/hot [2]

(iii) $\text{H-H} = 436$  $\text{Cl-Cl} = 244$  $\text{H-Cl} = 431$

$\Delta H = 436 + 244 - 2(431) = -182 \text{ kJ mol}^{-1}$ [2]

$\text{H-H} = 436$  $\text{Br-Br} = 193$  $\text{H-Br} = 366$

$\Delta H = 436 + 193 - 2(366) = -103 \text{ kJ mol}^{-1}$ [2]

(iv) H-Br bond is weaker than the H-CI bond – allow converse. [1] [8]

(b) (i) light [1]

(ii) bonds broken = C-H & I-I = 410 + 151 = 561
bonds made = C-I & H-I = 240 + 299 = 539

$\Delta H = 551 - 539 = +22 \text{ kJ mol}^{-1}$ [2]

(iii) The overall reaction is endothermic or no strong bonds/only weak bonds are formed or high $E_{\text{act}}$ [1] [4]

(c) (i) homolytic fission is the breaking of a bond to form (two) radicals-neutral species/odd-electron species [1]

(ii) $\text{CH}_2\text{Cl}$
the C-Br bond is the weakest or needs least energy to break/breaks most easily [1] [3]

(d)

Correct chiral atom identified [1] [3]

[Total: 18]
2 (a) (i) Order w.r.t. [CH₃CHO] = 1 [1]
    Order w.r.t. [CH₃OH] = 1 [1]
    Order w.r.t. [H⁺] = 1 [1]

(ii) \( \text{rate} = k[\text{CH₃CHO}][\text{CH₃OH}][\text{H}^+] \) [1]

(iii) units = mol⁻² dm⁶ s⁻¹ [1]

(iv) rate will be 2 × 4 = 8 times as fast as reaction 1 (relative rate = 8) [1] [6]

(b) | [CH₃CHO] /mol dm⁻³ | [CH₃OH] /mol dm⁻³ | [H⁺] /mol dm⁻³ | [acetal A] /mol dm⁻³ | [H₂O] /mol dm⁻³ |
---|------------------|------------------|----------------|-------------------|----------------|
at start | 0.20            | 0.10             | 0.05           | 0.00              | 0.00           |
at equilibrium | (0.20 – x)       | (0.10 – 2x)      | 0.05            | x                 | x              |
at equilibrium | 0.175            | 0.05             | 0.05            | 0.025            | 0.025          |

(i) 3 values in second row 3 x [1]

(ii) 4 values in third row 4 x [1]

(iii) \( K_c = \frac{[\text{acetal A}][\text{H}_2\text{O}]}{[\text{CH}_3\text{CHO}][\text{CH}_3\text{OH}]^2} \) [1]
    units = mol⁻¹ dm³ [1]

(iv) \( K_c = \frac{0.025^3}{(0.175 × 0.05^2)} = 1.4(3) \) (mol⁻¹ dm³) [1] [max 9]
    [Total: 15]
3 (a) for example.... also allow \( d_{xz} \)

\[ \text{shape (4 lobes)} \quad \text{[1]} \]
\[ \text{correct label e.g. } d_{xy} \quad \text{[1]} \]
\[ \text{[2]} \]

(b) (i)

\[ E = hf \text{ or photon's energy } = E \text{ in above diagram} \quad \text{[1]} \]
\[ \text{electron promoted from lower to higher orbital} \quad \text{[1]} \]
\[ \text{size of } \Delta E \text{ depends on the ligand} \quad \text{[1]} \]
\[ \text{as } \Delta E \text{ changes, so does } f \text{ in } E = hf \quad \text{[1]} \]
\[ \text{[7]} \]

(b) (ii)

\[ \text{colour due to the absorption of light NOT emitted light} \quad \text{[1]} \]
\[ E = hf \text{ or photon's energy } = E \text{ in above diagram} \quad \text{[1]} \]
\[ \text{electron promoted from lower to higher orbital} \quad \text{[1]} \]

(c) (i) \( \text{O.N.(carbon)} = +3 \quad (4 \times (-2) + 2x = -2, \text{ thus } 2x = +6) \quad \text{[1]} \)

(c) (ii) \( \text{O.N.} = +3 \quad \text{[1]} \)

(c) (iii)

\[ 2 \text{K}_3\text{Fe(C}_2\text{O}_4)_3 \rightarrow 3 \text{K}_2\text{C}_2\text{O}_4 + 2 \text{FeC}_2\text{O}_4 + 2 \text{CO}_2 \quad \text{[2]} \]
\[ \text{Or } K_3\text{Fe(C}_2\text{O}_4)_3 \rightarrow 3/2 \text{K}_2\text{C}_2\text{O}_4 + \text{FeC}_2\text{O}_4 + \text{CO}_2 \quad \text{[2]} \]

\[ \text{[max 5]} \]

\[ \text{[Total: 14]} \]

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4 (a) (i) \( \text{C}_2\text{H}_5\text{NH}_2 + \text{HA} \rightarrow \text{C}_2\text{H}_5\text{NH}_3^+ + \text{A}^- \) (HA can be \( \text{H}_2\text{O}, \text{HCl} \) etc.) [1]
Allow ⇌ instead of arrow

(ii)

<table>
<thead>
<tr>
<th>most basic</th>
<th>least basic</th>
</tr>
</thead>
<tbody>
<tr>
<td>ethylamine</td>
<td>ammonia</td>
</tr>
<tr>
<td>phenylamine</td>
<td></td>
</tr>
</tbody>
</table>

(iii) ethylamine > \( \text{NH}_3 \) due to electron-donating ethyl/alkyl group
phenylamine < \( \text{NH}_3 \) due to delocalisation of lone pair over ring [4]

(b) (i) \( \text{C}_6\text{H}_5\text{OH} + \text{OH}^- \rightarrow \text{C}_6\text{H}_5\text{O}^- + \text{H}_2\text{O} \) (or with \( \text{Na}^+ / \text{H}_2\text{O} / \text{A}^- \)) [1]

(ii) pKa of nitrophenol is smaller/\( K_a \) is larger because it’s a stronger acid/dissociates more than phenol
stronger because the anionic charge is spread out moreover the \( \text{NO}_2 \) group or \( \text{NO}_2 \)
is electron-withdrawing [1]

(iii) pKa = 1.0 [1]

(iv) Nitro group increases acidity / electron-withdrawing groups increase acidity [5]

(c) (i) \( \text{B} \) is phenyldiazonium cation, \( \text{C}_6\text{H}_5^-\text{N}=\equiv\text{N} \) [1]

(ii)

<table>
<thead>
<tr>
<th>reaction</th>
<th>reagent(s)</th>
<th>conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1</td>
<td>( \text{NaNO}_2 + \text{HCl} ) or ( \text{HNO}_2 ) [1]</td>
<td>( T &lt; 10^\circ\text{C} ) [1]</td>
</tr>
<tr>
<td>Step 2</td>
<td>( \text{H}_2\text{O} / \text{aq} )</td>
<td>heat/boil/( T &gt; 10^\circ ) (both) [1]</td>
</tr>
<tr>
<td>Step 3</td>
<td>( \text{HNO}_3 ) NB ( \text{HNO}_3) (aq) OK for both</td>
<td>dilute (both) [1]</td>
</tr>
</tbody>
</table>

[Total: 14]
5 (a) (i) C=C double bonds / alkenes
   (ii) –OH groups / accept alcohols or acids
   (iii) CH₃CO– or CH₃CH(OH)– groups
   (iv) carbonyl, >C=O, groups / accept aldehydes and ketones 4 × [1] [4]

(b) D  
    E  
    2 × [1] [2]

(c) isomers of C
    cis  
    trans  
    correct structure (excl. stereochemistry) [1]
    cis and trans drawn correctly [1]
    type of isomerism is **cis-trans or geometrical isomerism** [3]

[Total: 9]
6 (a) (i) \(2H_2NCH_2CO_2H \rightarrow H_2NCH_2CONHCH_2CO_2H + H_2O\) \[[1]\]

(ii) Skeletal formula required \[[1],[2]\]

(b) (i) \(\alpha\) helix \[[1]\]

\(\beta\) pleated sheet \[[1]\]

(ii) **Students should choose one of the structures below**

For \(\alpha\) helix:
- Need to show a helix with C=O - - - H-N between turns

For \(\beta\) pleated sheet:
- Need to show two parallel ‘zig-zag’ strands with C=O - - - H-N between them

Whichever is chosen, overall structure \[[1]\] position of H bonds \[[1]\] \[[4]\]

(c)

<table>
<thead>
<tr>
<th>amino acid residue 1</th>
<th>amino acid residue 2</th>
<th>type of bonding</th>
</tr>
</thead>
<tbody>
<tr>
<td>–HNCH(CH_2CH_2CH_2CH_2NH_2)CO–</td>
<td>HNCH(CH_2CH_2CO_2H)CO–</td>
<td>Ionic bonds or hydrogen bonds</td>
</tr>
<tr>
<td>–HNCH(CH_3)CO–</td>
<td>–HNCH(CH_3)CO–</td>
<td>van der Waals’</td>
</tr>
<tr>
<td>–HNCH(CH_2SH)CO–</td>
<td>–HNCH(CH_2SH)CO–</td>
<td>Disulfide bonds</td>
</tr>
<tr>
<td>–HNCH(CH_2OH)CO–</td>
<td>–HNCH(CH_2CO_2H)CO–</td>
<td>Hydrogen bonds</td>
</tr>
</tbody>
</table>

\[[4]\]  

[Total: 10]
7 (a) Sketch and label the apparatus used to carry out electrophoresis e.g.

![Electrophoresis Apparatus Diagram]

Marks: power supply / electrolyte + filter paper / buffer / acid mixture central 4 × [1]

(b) (i) pH of the buffer [1]
Charge on the amino acid species [1]

(ii) Size of the amino acid species / $M_r$ [1]
Voltage applied [1]
Magnitude of the charge (on the amino acid species) [1]
Temperature [1]

(max 3) [max 3]

(c) (i) They have insufficient electron density / only one electron [1]

(ii) Sulfur [1]
because it has the greatest atomic number / number of electrons [3]

[Total: 10]
8 (a)  

<table>
<thead>
<tr>
<th>traditional material</th>
<th>modern polymer used</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paper/cardboard/wood/leaves</td>
<td>PVC in packaging</td>
</tr>
<tr>
<td>hessian/hemp/jute</td>
<td></td>
</tr>
<tr>
<td>steel/aluminium</td>
<td></td>
</tr>
<tr>
<td>Cotton/wool/linen</td>
<td>Terylene in fabrics</td>
</tr>
<tr>
<td>Glass/china/porcelain/earthenware</td>
<td>Polycarbonate bottle</td>
</tr>
<tr>
<td>metal/leather</td>
<td></td>
</tr>
</tbody>
</table>

3 → 2 marks, 2 → 1 mark [2]  

(b) Reasons: Plastics/polymers pollute the environment for a long time do not decompose/biodegrade quickly [1]  
They are mainly produced from oil [1]  
Produce toxic gases on burning [1]  

Strategy 1: Recycle polymer waste / use renewable resources [1]  
Strategy 2: Develop biodegradable polymers [1]  

[max 3]  

(c) PVC [1]  
Combustion would produce HCl / dioxins as a pollutant [1]  

or [1]  
nylon/acrylic [1]  
Combustion would produce HCN [1]  

[2]  

(d) (i) Polythene (or other addition polymer) [1]  

(ii) Addition polymerisation [1]  
The polymer chains don’t have strong bonds between them – easy to melt [1]  
Could be answered with a suitable diagram [3]  

[Total: 10]