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 May/June 2012 question papers for most IGCSE, GCE Advanced Level and Advanced Subsidiary Level syllabuses and some Ordinary Level syllabuses.
1 (a)

<table>
<thead>
<tr>
<th></th>
<th>Na₂O</th>
<th>MgO</th>
<th>Al₂O₃</th>
<th>SiO₂</th>
<th>P₄O₁₀</th>
<th>SO₂</th>
<th>Cl₂O₇</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>alkaline</td>
<td>basic</td>
<td>amphoteric</td>
<td>acidic</td>
<td>acidic</td>
<td>acidic</td>
<td>acidic</td>
</tr>
</tbody>
</table>

Na₂O is alkaline – allow basic

MgO is basic – allow alkaline

Al₂O₃ is amphoteric

SiO₂, P₄O₁₀, and SO₂ are all acidic

(b) any two from: sodium, phosphorus, sulfur and chlorine

two names required

(c) (i) any three from:

- floats
- vigorous/violent reaction occurs
- melts/forms a sphere
- moves
- disappears – allow dissolves
- effervescence/gas produced

(ii) Na + H₂O → NaOH + ½H₂

or

2Na + 2H₂O → 2NaOH + H₂

(d) (i) combustion of fossil fuels – e.g. from car engines from car exhausts or during the extraction of metals from sulfide ores or volcanic eruptions/burning sulfur from volcanoes or burning biomass

(ii) H₂SO₄

or

SO₃ allow H₂SO₃ formula required

(iii) acid rain

or

its consequences e.g. damage to buildings, damage to crops, plants, marine life deforestation

or

SO₃ is toxic

(e) it is a reducing agent/antioxidant

or

it kills bacteria
### Q2

<table>
<thead>
<tr>
<th>(a)</th>
<th>((\text{NH}_4)_2\text{SO}_4 + 2\text{NaOH} \rightarrow 2\text{NH}_3 + \text{Na}_2\text{SO}_4 + 2\text{H}_2\text{O})</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>correct products</td>
</tr>
<tr>
<td></td>
<td>correctly balanced equation</td>
</tr>
<tr>
<td>(b)</td>
<td>(\text{NaOH} + \text{HCl} \rightarrow \text{NaCl} + \text{H}_2\text{O})</td>
</tr>
<tr>
<td>(i)</td>
<td>[n(\text{HCl}) = \frac{31.2}{1000} \times 1.00 = 0.0312 = 0.03]</td>
</tr>
<tr>
<td>(ii)</td>
<td>[n(\text{NaOH}) = \frac{50.0}{1000} \times 2.00 = 0.10]</td>
</tr>
<tr>
<td>(iii)</td>
<td>[n(\text{NaOH}) \text{ used up} = 0.10 - 0.0312 = 0.0688 = 0.07]</td>
</tr>
<tr>
<td>(iv)</td>
<td>[n[(\text{NH}_4)_2\text{SO}_4] = \frac{0.0688}{2} = 0.0344 = 0.03]</td>
</tr>
<tr>
<td>(v)</td>
<td>mass of ((\text{NH}_4)_2\text{SO}_4) = 0.0344 \times 132 = 4.5408 = 4.54)</td>
</tr>
<tr>
<td>(vi)</td>
<td>percentage purity [= \frac{4.5408 \times 100}{5.00} = 90.816] = 90.8]</td>
</tr>
</tbody>
</table>

[Total: 9]
3  (a) \( \text{C(s)} + \text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g}) \)  
the enthalpy change/energy change/heat change when  
one mole of a compound/\text{CO}_2  
is formed from its elements in their standard states  


(b) (i) \[
\begin{align*}
\Delta H^\circ/\text{kJ mol}^{-1} & \quad \text{CO}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightleftharpoons \text{CH}_3\text{OH}(\text{g}) + \text{H}_2\text{O}(\text{g}) \\
-394 & \qquad 0 \quad -201 \quad -242 \\
\Delta H^\circ_{\text{reaction}} & = -201 + (-242) - (-394) \\
& = -49 \text{ kJ mol}^{-1} \\
& \text{correct sign}
\end{align*}
\]

(ii) removal of \text{CO}_2 from the atmosphere  
\text{CO}_2 is a greenhouse gas/causes global warming  

(c) In this part, in each case, the ‘effect’ must be correctly stated  
in order to gain the explanation mark.

**higher temperature**  
yield is reduced/equilibrium goes to LHS  
because forward reaction is exothermic/reverse reaction is endothermic

**higher pressure**  
yield is increased or equilibrium goes to RHS 
fewer moles/molecules on RHS or more moles/molecules on LHS

**use of catalyst**  
yield does not change  
forward and backward rates speeded up by same amount

[Total: 14]
4 (a) (i) \( C_2H_5OH \rightarrow C_2H_4 + H_2O \) (1)

(ii) elimination or dehydration (1)

(iii) phosphoric acid or concentrated sulfuric acid
sulfuric acid must be ‘concentrated’
allow aluminium oxide (1) [3]

(b)

<table>
<thead>
<tr>
<th></th>
<th>with HBr</th>
<th>with MnO(_4^-)</th>
</tr>
</thead>
<tbody>
<tr>
<td>colour at start</td>
<td>colourless</td>
<td>purple or pink</td>
</tr>
<tr>
<td>colour after reaction</td>
<td>colourless</td>
<td>colourless or decolourised</td>
</tr>
<tr>
<td>structural formula of product</td>
<td>CH(_3)CH(_2)Br</td>
<td>HOCH(_2)CH(_2)OH</td>
</tr>
</tbody>
</table>

with hydrogen bromide
from colourless to colourless both colours required

do not allow ‘clear’ instead of colourless (1)

CH\(_3\)CH\(_2\)Br (1)

with potassium manganate(VII)
from purple/pink to colourless/decolourised both colours required (1)

HOCH\(_2\)CH\(_2\)OH (1) [4]

(c) (i) \( C_6H_{10} \) (1)

(ii) accept answers which have –CH\(_2\)– in the ring (1)

(iii) electrophilic addition (1)

(iv) accept answers which have –CH\(_2\)– in the ring

HO\(_2\)C(CH\(_2\))\(_4\)CO\(_2\)H or HO\(_2\)CCH\(_2\)CH\(_2\)CH\(_2\)CH\(_2\)CO\(_2\)H (1) [5]

[Total: 12]
5  (a) carboxylic acid or $-\text{CO}_2\text{H}$ or $-\text{COOH}$  

(b) (i) alcohol  

(ii) $n(\text{H}_2) = \frac{160}{24000} = 6.67 \times 10^{-3}$ mol  
$n(\text{H atoms}) = 2 \times 6.67 \times 10^{-3} \text{ mol} = 1.33 \times 10^{-2} \text{ mol}$  

(iii) $n(\text{X}) = \frac{0.600}{90} = 6.67 \times 10^{-3}$ mol  
$n(\text{X}) : n(\text{H atoms}) = 6.67 \times 10^{-3} : 1.33 \times 10^{-2}$  
$= 1 : 2$  
since each $-\text{OH}$ group produces one H atom  
there are two $-\text{OH}$ groups  

(c) (i) 

(ii) $\text{HOCH}_2\text{CH(OH)CHO}$ as the minimum  
allow the gem diols $(\text{HO})_2\text{CHCH}_2\text{CHO}$ or $\text{CH}_3\text{C(OH)}_2\text{CHO}$  

(iii) $\text{HOCH}_2\text{CH(OH)CO}_2\text{H}$ or $\text{HOCH}_2\text{CH(OH)CO}_2^-$  

(d) (i) $\text{HOCH}_2\text{CH(OH)CH}_2\text{OH}$  

(ii) $\text{HO}_2\text{CCOCO}_2\text{H}$  

[Total: 10]