MARK SCHEME for the May/June 2013 series

9701 CHEMISTRY

9701/23  Paper 2 (AS Structured Questions), maximum raw mark 60

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 2013 series for most IGCSE, GCE Advanced Level and Advanced Subsidiary Level components and some Ordinary Level components.
1 (a) (i)

\[
\begin{array}{c}
\text{S} \quad \begin{array}{c}
\text{O}
\end{array}
\end{array}
\begin{array}{c}
\text{C}
\end{array}
\begin{array}{c}
\text{O}
\end{array}
\begin{array}{c}
\text{S}
\end{array}
\begin{array}{c}
\text{O}
\end{array}
\end{array}
\]

S atom has 6 and C atom has 4 electrons (1)
S=C double bonds (4 electrons) clearly shown (1)

(ii) linear and 180° (1) [3]

(b) (i) \( \text{CS}_2 + 3\text{O}_2 \rightarrow \text{CO}_2 + 2\text{SO}_2 \) (1)

(ii) enthalpy change when 1 mol of a substance
is burnt in an excess of oxygen/air
\text{or} is completely combusted
under standard conditions (1) [3]

(c)

\[
\begin{align*}
\text{CS}_2 + 3\text{O}_2 & \rightarrow \text{CO}_2 + 2\text{SO}_2 \\
\Delta H^\circ/\text{kJ mol}^{-1} & = -395 + 2(-298) - x = -1110 \text{ kJ mol}^{-1}
\end{align*}
\]
gives \( x = -395 + (-596) + 1110 = +119 \text{ kJ mol}^{-1} \) (1) [3]

(d) (i) \( \text{CS}_2 + 2\text{NO} \rightarrow \text{CO}_2 + 2\text{S} + \text{N}_2 \)
\text{or}
\( \text{CS}_2 + 2\text{NO} \rightarrow \text{CO} + 2\text{S} + \text{N}_2\text{O} \)
correct products (1)
correct equation (1)

(ii) from −2 to 0 both required (1) [3]

[Total: 12]
2 (a) (i) if the conditions of a system in equilibrium are changed (1)
the position of equilibrium moves so as to reduce that change (1) [2]

(ii) lower temperature (1)
because the forward reaction is exothermic (1)
higher pressure (1)
because the forward reaction shows a reduction in volume
or
there are fewer molecules/moles on RHS of equilibrium (1) [4]

(b) \[ \begin{array}{ccc}
\text{CO}_2 & + & \text{H}_2 & \rightleftharpoons & \text{CO} & + & \text{H}_2\text{O} \\
\text{initial moles} & 0.70 & 0.70 & 0.30 & 0.30 \\
\text{equil. moles} & (0.70-x) & (0.70-x) & (0.30+x) & (0.30+x) & (1) \\
\text{equil. concn.} & (0.70-x) & (0.70-x) & (0.30+x) & (0.30+x) & (1)
\end{array} \]

\[ K_c = \frac{(0.30+x)^2}{(0.70-x)^2} = 1.44 \]
gives \( x = 0.25 \) (1)
at equilibrium,
\( n(\text{CO}_2) = n(\text{H}_2) = 0.70 - 0.25 = 0.45 \text{ moles} \)
and
\( n(\text{CO}) = n(\text{H}_2\text{O}) = 0.3 + 0.25 = 0.55 \text{ moles} \) (1) [4]

[Total: 10]
3 (a) (i) He or Ne or Ar or Kr (1)
   (ii) P or As (1)
   (iii) Br (1)
   (iv) Na allow Ar (1)
   (v) Si (1)
   (vi) P allow Si (1)
   (vii) Cl or F or Br (1) [7]
(b) (i) any two from P_4O_6, SO_2 and Cl_2O_7 (1+1)
   (ii) Al_2O_3 or SiO_2 (1)
   (iii) MgSO_3 (1) [4]
(c) (i) Si is giant molecular/giant covalent or
   P, S, and Cl are simple molecular (1)
   (ii) the molecules are S_8, P_4, Cl_2 (1)
   larger molecules have more electrons (1)
   and hence greater van der Waals' forces (1) [4]

[Total: 15]
4 (a) (i) 

\[
\begin{align*}
\text{reduce} & \\
\text{dehydrate} & \\
\end{align*}
\]

one mark for each correct compound, R, S and T  
allow correct cis and trans versions of compound T for 2 marks (3 × 1) 

(ii) reduction 

NaBH₄ or LiAlH₄ or H₂/Ni or Na/C₂H₅OH 

dehydration 

P₄O₁₀/P₂O₅ or H₃PO₄ or conc. H₂SO₄ or Al₂O₃ 

(b) 

<table>
<thead>
<tr>
<th>Tollens’ reagent</th>
<th>NO REACTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>HCN</td>
<td>CH₃(CH₂)₄C(OH)CH₃</td>
</tr>
<tr>
<td>K₂Cr₂O₇/H⁺</td>
<td>NO REACTION</td>
</tr>
</tbody>
</table>

one mark for each correct answer (3 × 1) [3]
(c) \( \text{Na}_2\text{CO}_3 \text{ or NaHCO}_3 \) effervescence/colourless gas

or

Na colourless gas

or

\( \text{PCl}_3/\text{PCl}_5 \) etc. steamy fumes

or

C\(_2\)H\(_5\)OH/conc. H\(_2\)SO\(_4\) sweet smell of ester

or

\( \text{K}_2\text{Cr}_2\text{O}_7/\text{H}^+ \) orange solution becomes green

correct reagent

(1)

correct observation

(1) [2]

[Total: 10]
5  (a) (i)  \( CH_2=CHCO_2H \)  (1)

   (ii)  \( BrCH_2CHBrCH_2OH \)  (1)

   (iii) product is \( HOCH_2CH(OH)CH_2OH \)  
       correct addition across \( \text{>C=C<} \)  (1)
       original \( -CH_2OH \) remains  (1)

   (iv)  \( HO_2CCO_2H \)  (1) [5]

(b) (i) nucleophilic substitution  (1)

   (ii) oxidation  (1) [2]

(c) (i) step I

   \( H_2 \)  (1)
   heat with Ni catalyst  (1)

   step II

   acidified \( K_2Cr_2O_7 \)  (1)
   heat or distil off product  (1)

(ii) structural isomerism  
or
functional group isomerism  (1) [5]

(d) both oxidation and reduction have occurred or

disproportionation has taken place  (1) [1]

[Total: 13]