

## **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.

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1 (a) (i)



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 (1)

is burnt in an excess of oxygen/air

**or** is completely combusted

under standard conditions (1) [3]

(c)

$$\begin{array}{rclcl}
 \text{CS}_2 & + & 3\text{O}_2 & \rightarrow & \text{CO}_2 & + & 2\text{SO}_2 & & \\
 \Delta H_f^\ominus / \text{kJ mol}^{-1} & & & & x & & -395 & & 2(-298) \\
 \Delta H_{\text{reaction}} = -395 + 2(-298) - x = -1110 \text{ kJ mol}^{-1} & & & & & & & & (1) \\
 \text{gives } x = -395 + (-596) + 1110 = +119 \text{ kJ mol}^{-1} & & & & & & & & (1) \quad [3]
 \end{array}$$

(d) (i)  $\text{CS}_2 + 2\text{NO} \rightarrow \text{CO}_2 + 2\text{S} + \text{N}_2$   
**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]**

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- 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)                                                              | CO <sub>2</sub>      | + | H <sub>2</sub>       | ⇌ | CO                   | + | H <sub>2</sub> O     |         |
| initial moles                                                    | 0.70                 |   | 0.70                 |   | 0.30                 |   | 0.30                 |         |
| equil. moles                                                     | (0.70-x)             |   | (0.70-x)             |   | (0.30+x)             |   | (0.30+x)             | (1)     |
| equil. concn.                                                    | $\frac{(0.70-x)}{1}$ |   | $\frac{(0.70-x)}{1}$ |   | $\frac{(0.30+x)}{1}$ |   | $\frac{(0.30+x)}{1}$ |         |
| $K_c = \frac{(0.30+x)^2}{(0.70-x)^2} = 1.44$                     |                      |   |                      |   |                      |   |                      | (1)     |
| gives x = 0.25                                                   |                      |   |                      |   |                      |   |                      | (1)     |
| at equilibrium,                                                  |                      |   |                      |   |                      |   |                      |         |
| $n(\text{CO}_2) = n(\text{H}_2) = 0.70 - 0.25 = 0.45$ moles      |                      |   |                      |   |                      |   |                      |         |
| <b>and</b>                                                       |                      |   |                      |   |                      |   |                      |         |
| $n(\text{CO}) = n(\text{H}_2\text{O}) = 0.3 + 0.25 = 0.55$ moles |                      |   |                      |   |                      |   |                      | (1) [4] |

[Total: 10]

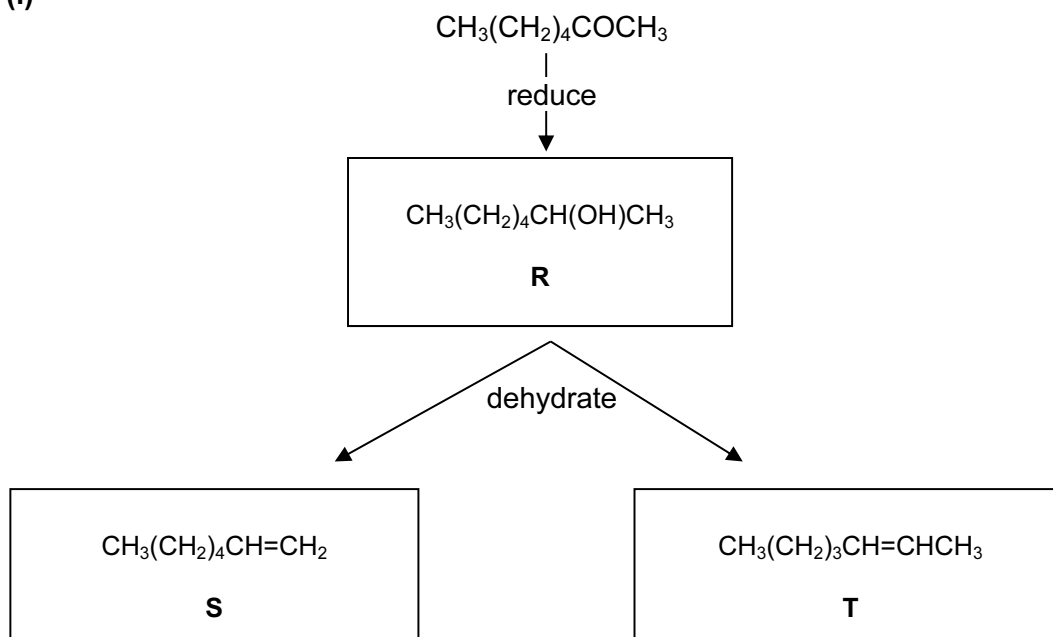
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- 3 (a) (i) He or Ne or Ar or Kr (1)
- (ii) P or As (1)
- (iii) Br (1)
- (iv) Na allow Ar (1)
- (v) Si (1)
- (vi) P allow Si (1)
- (vii) Cl or F or Br (1) [7]
- (b) (i) any **two** from  $P_4O_6$ ,  $SO_2$  and  $Cl_2O_7$  (1+1)
- (ii)  $Al_2O_3$  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]**

|        |                                |          |       |
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4 (a) (i)



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

$\text{NaBH}_4$  **or**  $\text{LiAlH}_4$  **or**  $\text{H}_2/\text{Ni}$  **or**  $\text{Na}/\text{C}_2\text{H}_5\text{OH}$  (1)

dehydration

$\text{P}_4\text{O}_{10}/\text{P}_2\text{O}_5$  **or**  $\text{H}_3\text{PO}_4$  **or** conc.  $\text{H}_2\text{SO}_4$  **or**  $\text{Al}_2\text{O}_3$  (1) [5]

(b)

|                                              |                                                                                                           |
|----------------------------------------------|-----------------------------------------------------------------------------------------------------------|
| Tollens' reagent                             | NO REACTION                                                                                               |
| HCN                                          | $\begin{array}{c} \text{CH}_3(\text{CH}_2)_4\text{C}(\text{OH})\text{CH}_3 \\   \\ \text{CN} \end{array}$ |
| $\text{K}_2\text{Cr}_2\text{O}_7/\text{H}^+$ | NO REACTION                                                                                               |

one mark for each correct answer (3 × 1) [3]

|               |                                       |                 |              |
|---------------|---------------------------------------|-----------------|--------------|
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(c)  $\text{Na}_2\text{CO}_3$  or  $\text{NaHCO}_3$  effervescence/colourless gas

or

Na colourless gas

or

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

or

$\text{C}_2\text{H}_5\text{OH}/\text{conc. H}_2\text{SO}_4$  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]**

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- 5 (a) (i)  $\text{CH}_2=\text{CHCO}_2\text{H}$  (1)
- (ii)  $\text{BrCH}_2\text{CHBrCH}_2\text{OH}$  (1)
- (iii) product is  $\text{HOCH}_2\text{CH}(\text{OH})\text{CH}_2\text{OH}$
- correct addition across  $>\text{C}=\text{C}<$  (1)
- original  $-\text{CH}_2\text{OH}$  remains (1)
- (iv)  $\text{HO}_2\text{CCO}_2\text{H}$  (1) [5]
- (b) (i) nucleophilic substitution (1)
- (ii) oxidation (1) [2]
- (c) (i) **step I**
- $\text{H}_2$  (1)
- heat with Ni catalyst (1)
- step II**
- acidified  $\text{K}_2\text{Cr}_2\text{O}_7$  (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]**