

**CAMBRIDGE INTERNATIONAL EXAMINATIONS**  
GCE Advanced Subsidiary Level and GCE Advanced Level

## **MARK SCHEME for the October/November 2013 series**

### **9701 CHEMISTRY**

**9701/21**

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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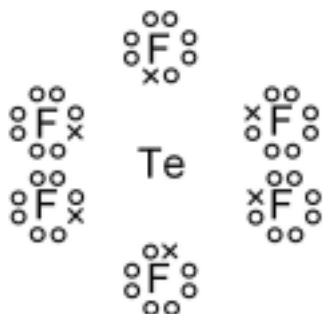
1 (a)

number of bond pairs	number of lone pairs	shape of molecule	formula of a molecule with this shape
3	0	trigonal planar	BH <sub>3</sub>
4	0	tetrahedral	CH <sub>4</sub> allow other Group IV hydrides
3	1	pyramidal <b>or</b> trigonal pyramidal	NH <sub>3</sub> allow other Group V hydrides
2	2	non-linear <b>or</b> bent <b>or</b> V-shaped	H <sub>2</sub> O allow other Group VI hydrides

1 mark for each correct row

(3 × 1) [3]

(b) (i)



(1)

(ii) octahedral **or** square-based bipyramid

(1)

(iii) 90°

(1) [3]

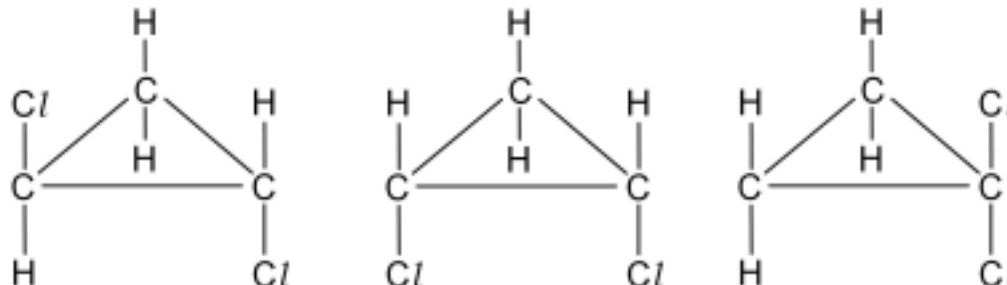
**[Total: 6]**

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2 (a)  $117^\circ$  to  $120^\circ$  (1) [1]

(b) (i) electrophilic addition (1)

(ii)



1 mark for each correct structure  
allow correctly drawn optical isomers of the first structure

(3 × 1) [4]

[Total: 5]

3 (a) (i) **anode**  $\text{Cl}^-(\text{aq}) \rightarrow \frac{1}{2} \text{Cl}_2(\text{g}) + \text{e}^-$  (1)

**cathode**  $\text{H}^+(\text{aq}) + \text{e}^- \rightarrow \frac{1}{2} \text{H}_2(\text{g})$  **or**  
 $2\text{H}_2\text{O}(\text{l}) + 2\text{e}^- \rightarrow \text{H}_2(\text{g}) + 2\text{OH}^-(\text{aq})$  (1)

(ii) because iron in steel will react with chlorine (1) [3]

(b) **sodium**

burns with a yellow **or** orange flame **or**  
forms a white solid

allow – **once only** – colour of chlorine disappears (1)

$2\text{Na} + \text{Cl}_2 \rightarrow 2\text{NaCl}$  (1)

**phosphorus**

burns with a white **or** yellow flame **or**

colour of chlorine disappears – if **not** given for Na – **or**

**for  $\text{PCl}_5$**  forms a white **or** pale yellow solid

**for  $\text{PCl}_3$**  forms a colourless liquid (1)

$\text{P} + 2\frac{1}{2}\text{Cl}_2 \rightarrow \text{PCl}_5$  **or**  $\text{P}_4 + 10\text{Cl}_2 \rightarrow 4\text{PCl}_5$

**or**

$\text{P} + 1\frac{1}{2}\text{Cl}_2 \rightarrow \text{PCl}_3$  **or**  $\text{P}_4 + 6\text{Cl}_2 \rightarrow 4\text{PCl}_3$

equation must refer to compound described (1) [4]

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**(c) cold dilute aqueous NaOH**

NaOCl (1)  
+1 (1)

**hot concentrated aqueous NaOH**

NaClO<sub>3</sub> (1)  
+5 (1) [4]

**(d) MgCl<sub>2</sub> 6.5 to 6.9** (1)

SiCl<sub>4</sub> 0 to 3 (1)

MgCl<sub>2</sub> dissolves without reaction **or**  
slight **or** partial hydrolysis occurs (1)

SiCl<sub>4</sub> reacts with water **or**  
hydrolysis occurs (1)

SiCl<sub>4</sub> + 2H<sub>2</sub>O → SiO<sub>2</sub> + 4HCl **or**  
SiCl<sub>4</sub> + 4H<sub>2</sub>O → Si(OH)<sub>4</sub> + 4HCl **or**  
SiCl<sub>4</sub> + 4H<sub>2</sub>O → SiO<sub>2</sub>·2H<sub>2</sub>O + 4HCl (1) [5]

**[Total: 16]**

**4 (a) (i) H<sub>2</sub>X + 2NaOH → Na<sub>2</sub>X + 2H<sub>2</sub>O** (1)

**(ii)  $n(\text{OH}^-) = \frac{21.6 \times 0.100}{1000} = 2.16 \times 10^{-3} \text{ mol}$**  (1)

**(iii)  $n(\text{R}) = n(\text{H}_2\text{X}) = \frac{2.16 \times 10^{-3}}{2}$   
 $= 1.08 \times 10^{-3} \text{ mol in } 25.0 \text{ cm}^3$**  (1)

**(iv)  $n(\text{R}) = 1.08 \times 10^{-3} \times \frac{250}{25.0} = 0.0108 \text{ mol in } 250 \text{ cm}^3$**  (1)

**(v) 0.0108 mol of R = 1.25 g of R**  
**1 mol of R =  $\frac{1.25 \times 1}{0.0108} = 115.7 = 116 \text{ g}$**  (1) [5]

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- (b) (i)  $M_r$  of S = 116  
 $M_r$  of T = 134  
 $M_r$  of U = 150      **all three needed**      (1)
- (ii) S      (1) [2]

- (c) S into T  
 conc.  $\text{H}_2\text{SO}_4$  **followed by**  $\text{H}_2\text{O}$   
**or**  $\text{H}_3\text{PO}_4$  **followed by**  $\text{H}_2\text{O}$  **or**  
 steam **and**  $\text{H}_3\text{PO}_4$  catalyst      (1 + 1)

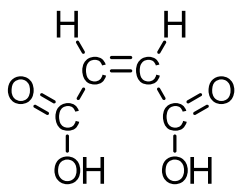
S into U  
 $\text{KMnO}_4$       (1)  
 cold dilute acidified **or** cold dilute alkaline      (1)

T into S  
 $\text{P}_4\text{O}_{10}$  **or conc.**  $\text{H}_2\text{SO}_4$  **or** conc.  $\text{H}_3\text{PO}_4$  **or**  $\text{Al}_2\text{O}_3$   
**and** heat in each case      (1) [5]

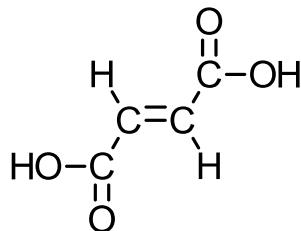
- (d) T reacting with an excess of Na  
 $\text{NaO}_2\text{CCH}(\text{ONa})\text{CH}_2\text{CO}_2\text{Na}$       (1)

U reacting with an excess of  $\text{Na}_2\text{CO}_3$   
 $\text{NaO}_2\text{CCH}(\text{OH})\text{CH}(\text{OH})\text{CO}_2\text{Na}$       (1) [2]

(e)



*cis or Z*

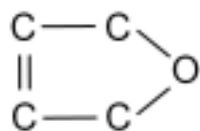


*trans or E*

two correct structures      (1)  
 correct labels      (1) [2]

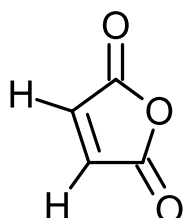
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(f) correct ring of C and O atoms, i.e.



(1)

correct compound, i.e.



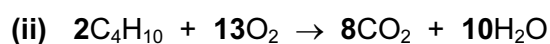
(1) [2]

(hydrogen atoms do not need to be shown)

[Total: 18]

5 (a) (i) alkanes **or** paraffins **not** hydrocarbons

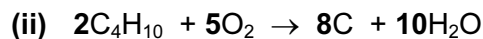
(1)



(1) [2]

(b) (i) **carbon** allow graphite

(1)



allow balanced equations which include CO and/or  $\text{CO}_2$

(1) [2]

(c) enthalpy change when 1 mol of a substance  
is burnt in an excess of oxygen/air under standard conditions  
**or** is completely combusted under standard conditions

(1)

(1) [2]

(d) (i)  $m = \frac{pVM_r}{RT} = \frac{1.01 \times 10^5 \times 125 \times 10^{-6} \times 44}{8.31 \times 293} \text{ g}$

(1)

$$= 0.228147345 \text{ g}$$

$$= 0.23 \text{ g}$$

(1)

(ii) heat released =  $m c \delta T = 200 \times 4.18 \times 13.8 \text{ J}$   
= 11536.8 J = 11.5 kJ

(1)

(1)

(iii) 0.23 g of propane produce 11.5 kJ  
44 g of propane produce  $\frac{11.5 \times 44}{0.23} \text{ kJ}$   
= 2200 kJ mol<sup>-1</sup>

(1) [5]

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- (e) (i) from methane to butane  
there are more electrons in the molecule (1)  
therefore greater/stronger van der Waals' forces (1)
- (ii) straight chain molecules can pack more closely (1)  
therefore stronger van der Waals' forces (1)  
or reverse argument [4]

**[Total: 15]**