

CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the October/November 2013 series

9701 CHEMISTRY

9701/22

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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Page 2	Mark Scheme	Syllabus	Paper
	GCE AS/A LEVEL – October/November 2013	9701	22

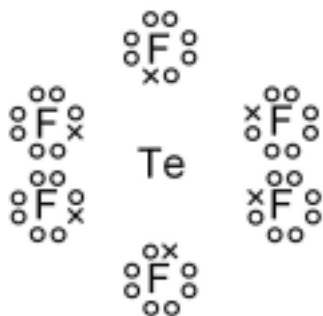
1 (a)

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

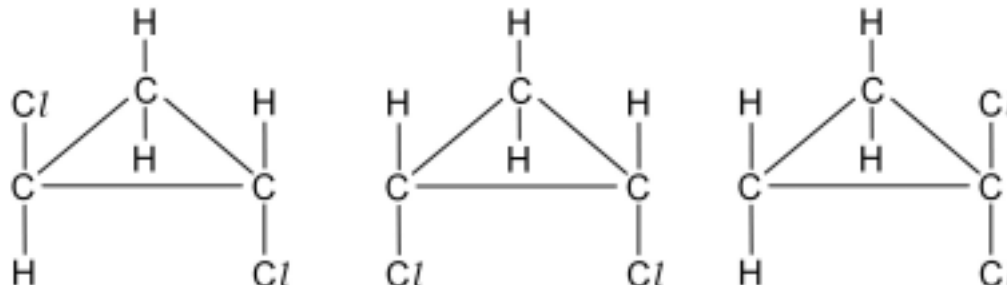
[Total: 6]

Page 3	Mark Scheme	Syllabus	Paper
	GCE AS/A LEVEL – October/November 2013	9701	22

2 (a) 117° to 120° (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 PCl_5 forms a white **or** pale yellow solid

for 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]

Page 4	Mark Scheme	Syllabus	Paper
	GCE AS/A LEVEL – October/November 2013	9701	22

(c) cold dilute aqueous NaOH

NaOCl (1)
+1 (1)

hot concentrated aqueous NaOH

NaClO₃ (1)
+5 (1) [4]

(d) MgCl₂ 6.5 to 6.9 (1)

SiCl₄ 0 to 3 (1)

MgCl₂ dissolves without reaction **or**
slight **or** partial hydrolysis occurs (1)

SiCl₄ reacts with water **or**
hydrolysis occurs (1)

SiCl₄ + 2H₂O → SiO₂ + 4HCl **or**
SiCl₄ + 4H₂O → Si(OH)₄ + 4HCl **or**
SiCl₄ + 4H₂O → SiO₂·2H₂O + 4HCl (1) [5]

[Total: 16]

4 (a) (i) H₂X + 2NaOH → Na₂X + 2H₂O (1)

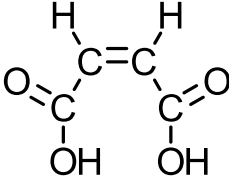
(ii) $n(\text{OH}^-) = \frac{21.6 \times 0.100}{1000} = 2.16 \times 10^{-3} \text{ mol}$ (1)

(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)

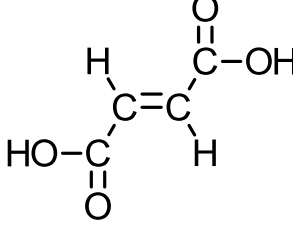
(iv) $n(\text{R}) = 1.08 \times 10^{-3} \times \frac{250}{25.0} = 0.0108 \text{ mol in } 250 \text{ cm}^3$ (1)

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

Page 5	Mark Scheme	Syllabus	Paper
	GCE AS/A LEVEL – October/November 2013	9701	22

- (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. H_2SO_4 **followed by** H_2O
or H_3PO_4 **followed by** H_2O **or**
 steam **and** H_3PO_4 catalyst (1 + 1)
- S** into **U**
 KMnO_4 (1)
 cold dilute acidified **or** cold dilute alkaline (1)
- T** into **S**
 P_4O_{10} **or** conc. H_2SO_4 **or** conc. H_3PO_4 **or** Al_2O_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 Na_2CO_3
 $\text{NaO}_2\text{CCH}(\text{OH})\text{CH}(\text{OH})\text{CO}_2\text{Na}$ (1) [2]
- (e)
- 

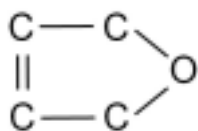
cis **or** *Z*



trans **or** *E*
- two correct structures (1)
 correct labels (1) [2]

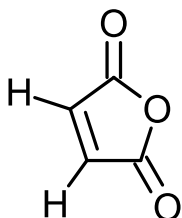
Page 6	Mark Scheme	Syllabus	Paper
	GCE AS/A LEVEL – October/November 2013	9701	22

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



(1)

correct compound, i.e.



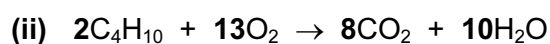
(1) [2]

(hydrogen atoms do not need to be shown)

[Total: 18]

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

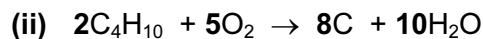
(1)



(1) [2]

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

(1)



allow balanced equations which include CO and/or 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⁻¹

(1) [5]

Page 7	Mark Scheme	Syllabus	Paper
	GCE AS/A LEVEL – October/November 2013	9701	22

- (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]