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.

Cambridge will not enter into discussions about these mark schemes.

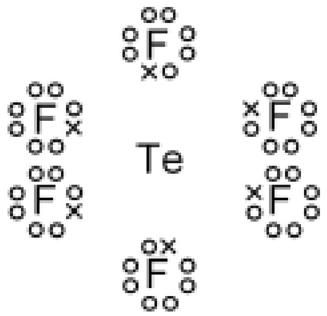
Cambridge is publishing the mark schemes for the October/November 2013 series for most IGCSE, GCE Advanced Level and Advanced Subsidiary Level components and some Ordinary Level components.

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_2O allow other Group VI hydrides

1 mark for each correct row (3 × 1) [3]

(b) (i)



(1)

(ii) octahedral **or** square-based bipyramid (1)

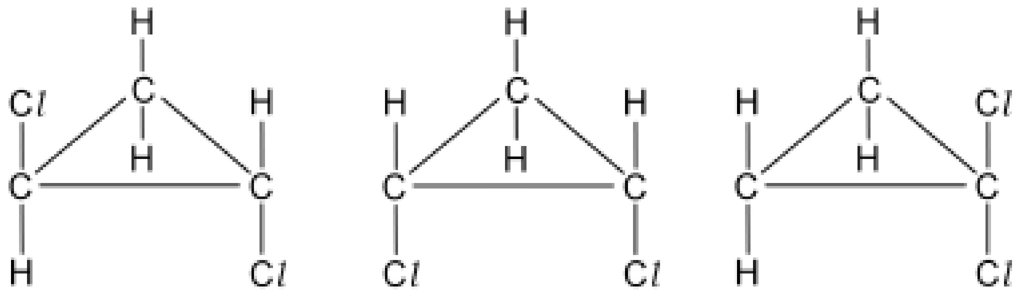
(iii) 90° (1) [3]

[Total: 6]

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** $Cl^-(aq) \rightarrow \frac{1}{2} Cl_2(g) + e^-$ (1)

cathode $H^+(aq) + e^- \rightarrow \frac{1}{2}H_2(g)$ **or**
$2H_2O(l) + 2e^- \rightarrow H_2(g) + 2OH^-(aq)$ (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)
$2Na + Cl_2 \rightarrow 2NaCl$ (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)

$P + 2\frac{1}{2}Cl_2 \rightarrow PCl_5$ **or** $P_4 + 10Cl_2 \rightarrow 4PCl_5$

or

$P + 1\frac{1}{2}Cl_2 \rightarrow PCl_3$ **or** $P_4 + 6Cl_2 \rightarrow 4PCl_3$

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

(c) **cold dilute aqueous NaOH**

NaOC*l* (1)
+1 (1)

hot concentrated aqueous NaOH

NaC*l*O$_3$ (1)
+5 (1) [4]

(d) MgC*l*$_2$ 6.5 to 6.9 (1)

SiC*l*$_4$ 0 to 3 (1)

MgC*l*$_2$ dissolves without reaction **or** slight **or** partial hydrolysis occurs (1)

SiC*l*$_4$ reacts with water **or** hydrolysis occurs (1)

$SiCl_4 + 2H_2O \rightarrow SiO_2 + 4HCl$ **or**
$SiCl_4 + 4H_2O \rightarrow Si(OH)_4 + 4HCl$ **or**
$SiCl_4 + 4H_2O \rightarrow SiO_2.2H_2O + 4HCl$ (1) [5]

[Total: 16]

4 **(a)** **(i)** $H_2X + 2NaOH \rightarrow Na_2X + 2H_2O$ (1)

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

(iii) $n(\mathbf{R}) = n(H_2X) = \frac{2.16 \times 10^{-3}}{2}$
$= 1.08 \times 10^{-3}$ mol in 25.0 cm^3 (1)

(iv) $n(\mathbf{R}) = 1.08 \times 10^{-3} \times \frac{250}{25.0} = 0.0108$ mol in 250 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 g (1) [5]

(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]

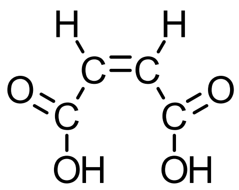
(d) **T** reacting with an excess of Na

$NaO_2CCH(ONa)CH_2CO_2Na$ (1)

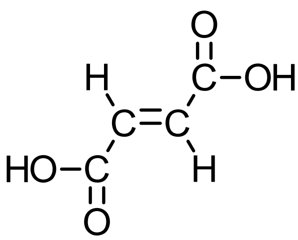
U reacting with an excess of Na_2CO_3

$NaO_2CCH(OH)CH(OH)CO_2Na$ (1) [2]

(e)



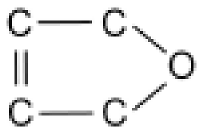
cis **or** Z



trans **or** E

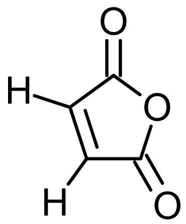
two correct structures (1)
correct labels (1) [2]

(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)

(ii) **2**C_4H_{10} + **13**O_2 $\rightarrow$ **8**CO_2 + **10**H_2O (1) [2]

(b) **(i)** **carbon** allow graphite (1)

(ii) **2**C_4H_{10} + **5**O_2 $\rightarrow$ **8**C + **10**H_2O
allow balanced equations which include CO and/or CO_2 (1) [2]

(c) enthalpy change when 1 mol of a substance (1)
is burnt in an excess of oxygen/air under standard conditions
or is completely combusted under standard conditions (1) [2]

(d) **(i)** $m = \frac{pVM_r}{RT} = \frac{1.01\times10^5 \times 125\times10^{-6} \times 44}{8.31\times293}$ g (1)

= 0.228147345 g
= 0.23 g (1)

(ii) heat released = m c δ T = 200 × 4.18 × 13.8 J (1)
= 11536.8 J = 11.5 kJ (1)

(iii) 0.23 g of propane produce 11.5 kJ
44 g of propane produce $\frac{11.5\times44}{0.23}$ kJ
= 2200 kJ mol^{-1} (1) [5]

(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]