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 |

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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_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)
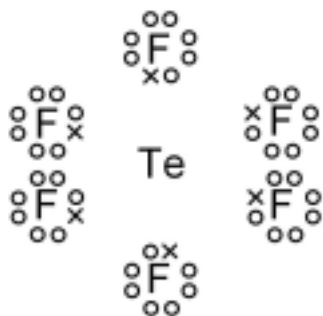
(1)

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

(iii) 90°   (1)   [3]

[Total: 6]

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2 **(a)** $117°$ to $120°$ (1)   [1]

(b) **(i)** electrophilic addition   (1)
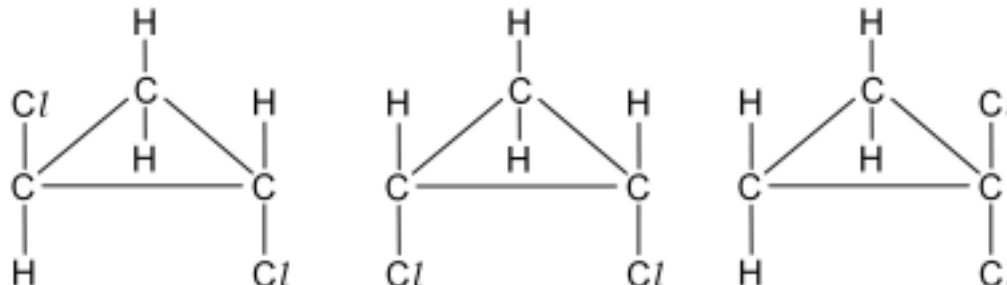
(ii)

1 mark for each correct structure
allow correctly drawn optical isomers of the first structure $(3 × 1)$ [4]

[Total: 5]

3 **(a)** **(i)** **anode** $Cl^-(aq) \rightarrow ½ Cl_2(g) + e^-$ (1)

    cathode $H^+(aq) + e^- \rightarrow ½H_2(g)$ **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)

$P + 2½Cl_2 \rightarrow PCl_5$ **or** $P_4 + 10Cl_2 \rightarrow 4PCl_5$

or

$P + 1½Cl_2 \rightarrow PCl_3$ **or** $P_4 + 6Cl_2 \rightarrow 4PCl_3$

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

(c) cold dilute aqueous NaOH

NaOCl (1)
+1   (1)

hot concentrated aqueous NaOH

NaClO$_3$ (1)
+5   (1)   [4]

(d) MgCl_2 6.5 to 6.9   (1)

SiCl_4 0 to 3   (1)

MgCl_2 dissolves without reaction **or**
        slight **or** partial hydrolysis occurs   (1)

SiCl_4 reacts with water **or**
        hydrolysis occurs   (1)

SiCl_4 + 2H$_2$O $\rightarrow$ SiO$_2$ + 4HCl **or**
SiCl_4 + 4H$_2$O $\rightarrow$ Si(OH)$_4$ + 4HCl **or**
SiCl_4 + 4H$_2$O $\rightarrow$ SiO$_2$.2H$_2$O + 4HCl (1)   [5]

[Total: 16]

4 (a) (i) H$_2$X + 2NaOH $\rightarrow$ Na$_2$X + 2H$_2$O   (1)

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

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

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

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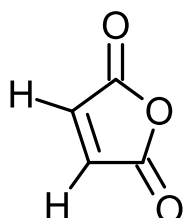   1 mol of **R** = $\dfrac{1.25 \times 1}{0.0108}$ = 115.7 = 116 g   (1)   [5]

(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.
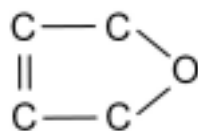
(1)

correct compound, i.e.
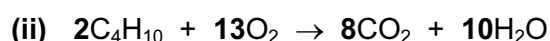

(1) [2]

(hydrogen atoms do not need to be shown)

[Total: 18]

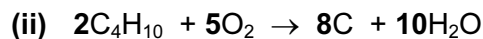**5** **(a)** **(i)** alkanes **or** paraffins **not** hydrocarbons (1)

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

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

(ii) $2C_4H_{10} + 5O_2 \rightarrow 8C + 10H_2O$
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)** $m = \dfrac{pVM_r}{RT} = \dfrac{1.01 \times 10^5 \times 125 \times 10^{-6} \times 44}{8.31 \times 293}$ g (1)

$= 0.228147345$ g
$= 0.23$ g (1)

(ii) heat released $= m\,c\,\delta T = 200 \times 4.18 \times 13.8$ J (1)
$= 11536.8$ J $= 11.5$ kJ (1)

(iii) 0.23 g of propane produce 11.5 kJ

44 g of propane produce $\dfrac{11.5 \times 44}{0.23}$ kJ

$= 2200$ kJ mol^{-1} (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]