UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the October/November 2011 question paper for the guidance of teachers

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 must be read in conjunction with the question papers and the report on the examination.

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International Examinations

1 **(a)** same proton number/atomic number (1)
different mass number/nucleon number (1) [2]

(b) $A_r = \frac{(32 \times 95.00) + (33 \times 0.77) + (34 \times 4.23)}{100}$ (1)

$= \frac{3040 + 25.41 + 143.82}{100} = \frac{3209.23}{100}$

which gives $A_r = 32.09$ (1) [2]

(c)

	number of		
isotopes	protons	neutrons	electrons
^{213}Po	84	129	84
^{232}Th	90	142	90

allow **one mark** for each correct column
if there are no 'column' marks,
allow **maximum one mark** for a correct row (3 × 1) [3]

(d) **(i)** nucleon no. is 228 (1)
proton no. is 88 (1)

(ii) Ra **not** radium (1) [3]

[Total: 10]

2 **(a)** **(i)** mass of C = $\frac{12 \times 1.32}{44}$ = 0.36g (1)

n(C) = $\frac{0.36}{12}$ = 0.03 (1)

(ii) mass of H = $\frac{2 \times 0.54}{18}$ = 0.06 g (1)

n(H) = $\frac{0.06}{1}$ = 0.06 (1)

(iii) yes **because** 0.03 mol of C are combined with 0.06 mol of H **or**
C : H ratio is 1 : 2 **or**
empirical formula is CH_2 (1) [5]

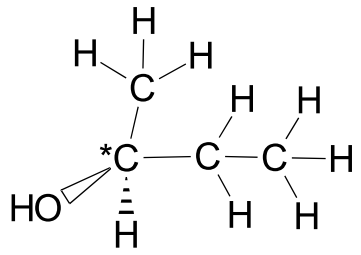
(b) (i) C : H : O = $\frac{64.86}{12}$: $\frac{13.50}{1}$: $\frac{21.64}{16}$ (1)

= 5.41: 13.50 : 1.35

= 4 : 10 : 1

gives $C_4H_{10}O$ (1)

(ii)



correct compound **and** correct chiral C* (1)
correct mirror object/ mirror
image relationship in 3D (1)

(iii)

$CH_3CH_2CH_2CH_2OH$	$CH_3C(H)(CH_3)CH_2OH$	$CH_3C(OH)(CH_3)CH_3$
(1)	(1)	(1)

[7]

[Total: 12]

3 (a) $C(g) \rightarrow C^+(g) + e^-$
correct equation (1)
correct state symbols (1) [2]

(b) (i) Na and Mg
Mg has greater nuclear charge/more protons than Na (1)

in both atoms, the 3s electrons are in the same orbital/
same energy level/same shell (1)

(ii) Mg and A*l*
in A*l* outermost electron is in 3p rather than 3s (1)

3p electron is at higher energy **or**
is further away/is more shielded from nucleus (1)

(iii) **He and Ne**
both He and Ne have the highest nuclear charges in their Period (1)

(iv) **He, Ne, and Ar**
going down the group,

valence/outer shell electrons are farther from the nucleus (1)

there is greater shielding (1)

attraction between valence electrons and nucleus is less **or**
effective nuclear charge is less (1) [8]

(c) **(i)** **from Na to C*l***
increased nuclear charge/nuclear attraction (1)

(ii) cation has fewer electrons than atom **or**
cation has lost outer electrons **or**
cation has fewer shells (1)

but cation has same nuclear charge as atom **or**
proton number is the same (1) [3]

3 **(d)** ignore any state symbols

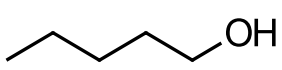
$MgO(s)$	+	$NaOH(aq)$			$\rightarrow$	NO REACTION	(1)
$MgO(s)$	+	**2**$HCl(aq)$			$\rightarrow$	$MgCl_2 + H_2O$	(1)
$Al_2O_3(s)$	+	**2**$NaOH(aq)$	+	**3**$H_2O(l)$	$\rightarrow$	**2**$NaAl(OH)_4$ **or**	(1)
$Al_2O_3(s)$	+	**2**$NaOH(aq)$	+	$H_2O(l)$	$\rightarrow$	**2**$NaAlO_2 + 2H_2O$ **or**	
$Al_2O_3(s)$	+	**6**$NaOH(aq)$	+	**3**$H_2O(l)$	$\rightarrow$	**2**$Na_3Al(OH)_6$	
$Al_2O_3(s)$	+	**6**$HCl(aq)$			$\rightarrow$	**2**$AlCl_3$ + **3**H_2O **or**	(1)
$Al_2O_3(s)$	+	**6**$HCl(aq)$			$\rightarrow$	Al_2Cl_6 + **3**H_2O	
$SO_2(g)$	+	$NaOH(aq)$			$\rightarrow$	$NaHSO_3$ **or**	(1)
$SO_2(g)$	+	**2**$NaOH(aq)$			$\rightarrow$	$Na_2SO_3 + H_2O$	
$SO_2(g)$	+	$HCl(aq)$			$\rightarrow$	NO REACTION	(1)

[6]

[Total: 19]

4 **(a)** **(i)** C_2H_5O (1)

(ii)



(1) [2]

(b) (i) functional group isomerism
or structural isomerism (1)

do **not** allow 'functional isomerism' or positional isomerism

(ii)

compound	type of isomerism
P	*cis-trans* **or** geometrical
T	optical

(1 + 1) [3]

(c) (i) dehydration/elimination (1)

(ii) conc. H_2SO_4 / P_4O_{10} / Al_2O_3 / H_3PO_4 / pumice (1)

(iii) $CH_2=CHCH=CH_2$

allow $CH_2=C=CHCH_3$ (1) [3]

(d) (i) $CH_3CH_2CH(OH)CH_2CH_3$ (1)

(ii) steam with H_3PO_4 catalyst **or**
conc. H_2SO_4 then water (1 + 1)

only allow condition mark if reagent mark has been given

(iii) $Cr_2O_7^{2-}/H^+$ **or**
MnO_4^-/H^+ (1) [4]

[Total: 12]

5 (a) **V** is HCHO (1) [1]

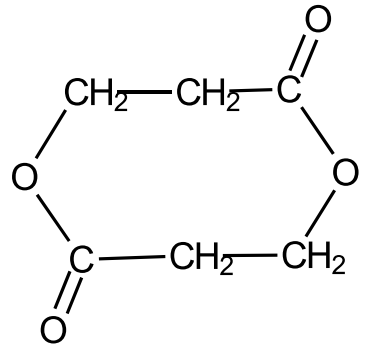
(b) (i) ester (1)

(ii) **W** is HCO_2CH_3 (1) [2]

(c) (i) **X** is $HOCH_2CH_2CO_2H$ (1)

(ii) **Y** is $HO_2CCH_2CO_2H$ (1) [2]

(d) (i) **Z** is



(1)

(ii) esterification **or**
dehydration **or**
elimination **or**
condensation (1) [2]

[Total: 7]