UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the May/June 2012 question paper

for the guidance of teachers

9701 CHEMISTRY

9701/23 Paper 2 (AS Structured Questions), maximum raw mark 60

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1 (a) (i) from Na to C*l*

nuclear charge increases (1)
electrons are in the same shell/have the same shielding (1)
nuclear attraction increases (1)

(ii) argon does not form any bonds/compounds **or**
argon exists as single atoms/is monatomic (1) [4]

(b) (i)

radius of cation/nm			radius of anion/nm		
Na^+	Mg^{2+}	Al^{3+}	P^{3-}	S^{2-}	Cl^-
0.095	0.065	0.050	0.212	0.184	0.181

(1)

(ii) cations contain fewer electrons than the corresponding atoms **or**
cations contain fewer electrons than they do protons (1)
nucleus has a greater attraction (1)

(iii) anions contain more electrons than the corresponding atoms **or**
anions contain more electrons than they do protons (1)
nucleus has a smaller attraction (1) [5]

(c) (i) $Na_2O + H_2O \rightarrow 2NaOH$ (1)
$SO_2 + H_2O \rightarrow H_2SO_3$ (1)

(ii) for Na_2O 10 to 14 (1)
for SO_2 1 to 4 (1)

(iii) $NaOH + H_2SO_3 \rightarrow NaHSO_3 + H_2O$ **or**
$2NaOH + H_2SO_3 \rightarrow Na_2SO_3 + 2H_2O$ (1) [5]

[Total: 14]

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2 (a) (i) $Na_2CO_3 + 2HCl \rightarrow 2NaCl + H_2O + CO_2$ (1)

(ii) $n(HCl) = \frac{35.8}{1000} \times 0.100 = 3.58 \times 10^{-3}$ (1)

(iii) $n(Na_2CO_3) = \frac{35.8}{2} \times 10^{-3} = 1.79 \times 10^{-3}$ mol in 25.0 cm^3 (1)

(iv) $n(Na_2CO_3) = 1.79 \times 10^{-3} \times 10 = 1.79 \times 10^{-2}$ mol in 250 cm^3 (1)

(v) mass of $Na_2CO_3 = 1.79 \times 10^{-2} \times 106 = 1.90$g
M_r of $Na_2CO_3 = 106$ (1)
mass of $Na_2CO_3 = 1.90$ g (1) [6]

(b) $n(H_2O)$ in 5.13 g of washing soda $= \frac{5.13 - 1.90}{18} = 1.79 \times 10^{-1}$ mol (1)

$n(Na_2CO_3)$ in 5.13 g of washing soda $= 1.79 \times 10^{-2}$ mol
$n(H_2O) : n(Na_2CO_3) = 10 : 1$ (1)

or
1.90 g Na_2CO_3 are combined with 3.23.g H_2O
106 g Na_2CO_3 are combined with $\frac{3.23 \times 106}{1.90} = 180.2$ g H_2 (1)
this is 10 mol of H_2O (1)

or
1.79×10^{-2} mol $Na_2CO_3.xH_2O \equiv 5.13$ g of washing soda
1 mol $Na_2CO_3.xH_2O \equiv \frac{5.13}{1.79 \times 10^{-2}} = 286.6$ g (1)
$Na_2CO_3 = 106$ and $H_2O = 18$ hence $x = 10$ (1) [2]

[Total: 8]

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3 **(a)** $CH_3OCH_3(l) + 3O_2(g) \rightarrow 2CO_2(g) + 3H_2O(l)$ (1)

the enthalpy change/heat change/heat evolved when

one mole of CH_3OCH_3/a compound (1)

is completely burned **or**

burned in an excess of air/oxygen (1) [3]

(b)

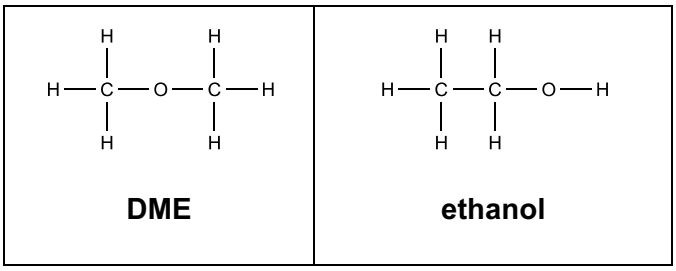
	$2CH_3OH(l)$	$\rightarrow$	$CH_3OCH_3(g)$	+	$H_2O(l)$
$\Delta H^{\ominus}_f$/kJ mol^{-1}	2(–239)		–184		–286

$\Delta H^{\ominus}_{reaction}$ = –184 + (–286) – 2(–239) (1)

= +8 kJ mol^{-1} (1)

correct sign (1) [3]

(c) **(i)**



both correct (1)

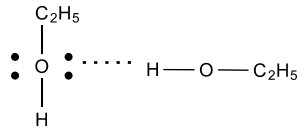
(ii) structural isomerism **or** functional group isomerism (1) [2]

(d) **(i)** hydrogen bonds (1)

(ii) lone pair on O atom of C_2H_5OH (1)

correct dipole $O^{\delta-}$—$H^{\delta+}$ on bond in one molecule of ethanol (1)

hydrogen bond shown between lone pair of an O atom and a hydrogen atom, i.e.



(1) [4]

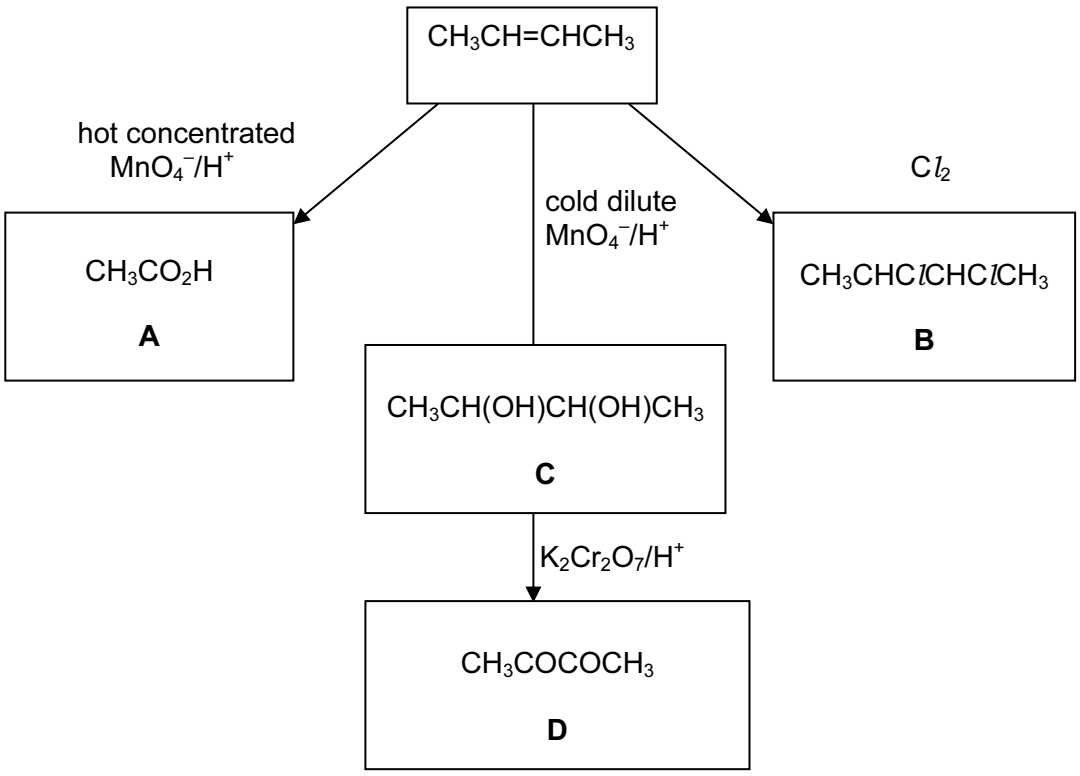
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4 **(a)** high temperature and high pressure (1)
high temperature and catalyst (1) [2]

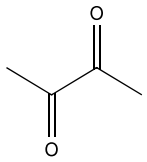
(b) $C_{12}H_{26} \rightarrow C_4H_8 + C_8H_{18}$ **or**
$C_{12}H_{26} \rightarrow 2C_4H_8 + C_4H_{10}$ (1) [1]

(c)



(4 × 1) [4]

(d) **(i)**

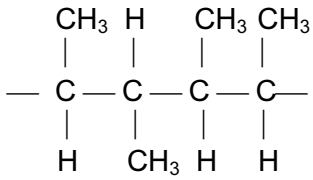


(1)

(ii) compound **B** (1)
compound **C** (1) [3]

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(e)



allow any orientation of CH_3– groups (1) [1]

(f) **(i)** $CH_2=CH—CH=CH_2$
allow $CH_3CHOHCH=CH_2$ and $CH_3C\equiv CCH_3$ (1)

(ii) $CH_2BrCHBrCHBrCH_2Br$
allow $CH_3CBr_2CBr_2CH_3$ from $CH_3CHOHCH=CH_2$
allow $CH_3CHOHCHBrCH_2Br$ from $CH_3C\equiv CCH_3$ (1)

(iii) electrophilic addition
both words required (1) [3]

[Total: 14]

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5 (a) (i) CO_2/carbon dioxide (1)

(ii) carboxylic acid **or** $–CO_2H$ **or** –COOH (1) [2]

(b) (i) dehydration **or** elimination (1)

(ii) **H** contains >C=C< bond (1)
H contains $–CO_2H$ group (1)
H is $CH_2=CHCO_2H$ (1) [4]

(c) $n(\mathbf{F}) = \frac{0.600}{90} = 6.67 \times 10^{-3}$ mol (1)

F contains one –OH group and one $–CO_2H$ group
hence one mole of **F** produces one mole of H_2 with Na (1)
$n(H_2) = 6.67 \times 10^{-3}$ mol (1)
vol. of $H_2 = 6.67 \times 10^{-3} \times 24000$ cm^3
= 160 cm^3 at room temperature and pressure (1)
[4]

(d) (i)

$HOCH_2CH_2CO_2H$	$CH_3CH(OH)CO_2H$
J	**K**

one isomer correct (1)

(ii)

$HO_2CCH_2CO_2H$	CH_3COCO_2H
product from J	**product from K**

one oxidation product correct (1) [2]

[Total: 12]

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