CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the May/June 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.

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1 (a) (i) $NaOH + HCl \rightarrow NaCl + H_2O$ (1)

$(NH_4)_2SO_4 + 2NaOH \rightarrow 2NH_3 + Na_2SO_4 + 2H_2O$ (1)

allow ionic equations in each case

(ii) $n(NaOH) = n(HCl) = \frac{39.2 \times 2.00}{1000} = 0.0784$ (1)

(iii) $n(NaOH) = n(HCl) = \frac{29.5 \times 2.00}{1000} = 0.059$ (1)

(iv) $n(NaOH) = 0.0784 - 0.059 = 0.0194$ (1)

(v) $n[(NH_4)_2SO_4] = \frac{0.0194}{2} = 9.7 \times 10^{-3}$ (1)

(vi) mass of $(NH_4)_2SO_4 = 9.7 \times 10^{-3} \times 132.1 = 1.2814\,g$ (1)

(vii) % of $(NH_4)_2SO_4 = \frac{1.2814 \times 100}{2.96} = 43.30405405 = 43.3$

give one mark for the correct expression (1)
give one mark for answer given as 43.3 – i.e. to 3 sig. fig. (1)
allow ecf where appropriate [9]

(b) fertiliser in the river causes
excessive growth of aquatic plants/algae **or** algal bloom (1)
when plants and algae die O_2 is used up **or** fish or aquatic life die (1) [2]

(c) manufacture of HNO_3 **or** explosives **or** nylon **or**
as a cleaning agent **or** as a refrigerant
not detergent (1) [1]

[Total:12]

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2 **(a)** $K_P = \dfrac{p(NO)^4\, p(H_2O)^6}{p(NH_3)^4\, p(O_2)^5}$ (1)

atmospheres **or** Pa **or** kPa (1)
allow ecf on incorrect powers [2]

(b) **(i)** **increasing temperature**
yield of NO is decreased **or** reaction moves to LHS (1)
forward reaction is exothermic (1)

(ii) **decreasing the pressure**
yield of NO is increased **or** reaction moves to RHS (1)
more moles/molecules of gas on RHS **or**
fewer moles/molecules of gas on LHS (1) [4]

(c) let $\Delta H_f^{\ominus}$ for NO be y kJ mol^{-1}

$4NH_3(g) + 5O_2(g) \rightleftharpoons 4NO(g) + 6H_2O(g)$

$\Delta H_f^{\ominus}$ 4 × (–46.0) $4y$ 6 × (–242) (1)

$\Delta H^{\ominus}_{reaction}$ $= 4y + [6 \times (-242)] - [4 \times (-46.0)]$ (1)
$= 4y - 1452 + 184$

$\Delta H^{\ominus}_{reaction}$ is –906 kJmol^{-1} so
$4y = -906 + 1452 - 184 = 362$ (1)
whence y = $\Delta H_f^{\ominus}$ for NO = +90.5 kJ mol^{-1}
+ sign is required (1) [4]

[Total: 10]

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3 **(a)** penalise (–1) for names of elements

(i) Na **or** K **or** Li (1)

(ii) S **or** C **or** N **or** P (1)

(iii) K (1)

(iv) C (1)

(v) C*l* (1)

(vi) A*l* **or** Si (1) [6]

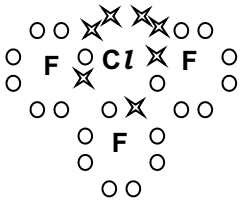
(b) **(i)** Al_2O_3 **or** SiO_2 (1)

(ii) Na_2O (1)

(iii) P_2O_3 **or** P_4O_6 **and** P_2O_5 **or** P_4O_{10} **or** SO_2 **and** SO_3 (1+1)

(iv) Al_2O_3 (1) [5]

(c) **(i)**



3 bonding pairs **and**
2 lone pairs around C*l* atom (1)
3 lone pairs on **each** of the F atoms (1)

(ii) **either**

referring to van der Waals' forces in BrF_3

van der Waals' **or**
intermolecular forces are greater/stronger (1)
because there are more electrons in BrF_3 than in ClF_3 (1)

OR referring to permanent dipoles

permanent dipole **or** intermolecular forces are stronger/greater in BrF_3 (1)
because BrF_3 has a larger permanent dipole than ClF_3

OR because difference in electronegativity is larger between Br and F than between C*l* and F (1)

part **(ii)** has a maximum of 2 marks (max 2) [4]

[Total: 15]

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4 Types of reaction used must come from the list in the question.

organic reaction	type of reaction	reagent(s)
$CH_3CH_2CH_2CH_2Br \rightarrow$ $CH_3CH_2CH_2CH_2NH_2$	nucleophilic (1) substitution (1)	NH_3 (1)
$CH_3CH_2CH_2CH_2OH \rightarrow$ $BrCH_2CH_2CH_2CH_2OH$	free radical (1) substitution (1)	Br_2 **or** Br_2 in an organic solvent (1) **not** Br_2(aq)
$CH_3COCH_3 \rightarrow$ $CH_3C(OH)(CN)CH_3$	nucleophilic (1) addition (1)	HCN **or** HCN and CN^- **or** NaCN/KCN + H^+ (1)
$CH_3CH(OH)CH_2CH_3$ $\rightarrow CH_3CH=CHCH_3$	elimination (1) **not** dehydration	conc. H_2SO_4 **or** P_4O_{10} **or** Al_2O_3 **or** H_3PO_4 (1)

[Total: 11]

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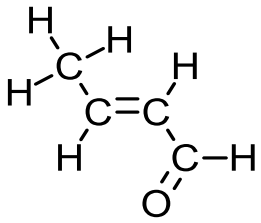
5 (a)

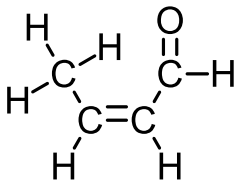
reaction	reagent	product
A	Br_2 in an inert organic solvent	$CH_3CHBrCHBrCHO$
B	PCl_3	NO REACTION
C	H_2 and Ni catalyst	$CH_3CH_2CH_2CH_2OH$
D	$NaBH_4$	$CH_3CH{=}CHCH_2OH$
E	$K_2Cr_2O_7/H^+$	$CH_3CH{=}CHCO_2H$

one mark for each correct answer [5]

(b)



trans **or** E



cis **or** Z

two correct structures (1)

both correctly labelled (1)

correctly displayed -CHO group (1) [3]

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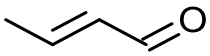
(c)



(1) [1]

(d) (i) $CH_3CH(OH)CH(OH)CO_2H$ (1)

(ii) CH_3CO_2H (1)
HO_2CCO_2H (1) [3]

allow ecf on candidate's answer to E in **(a)**

[Total: 12]

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