CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level

MARK SCHEME for the May/June 2014 series

9701 CHEMISTRY

9701/23 Paper 2 (Structured Questions AS Core), 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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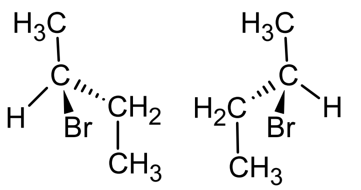
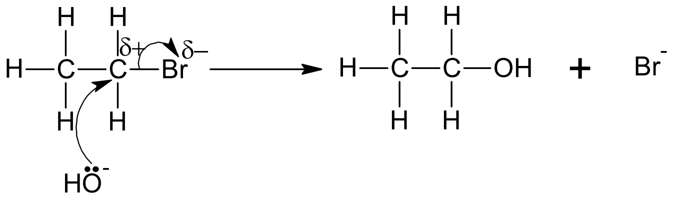
CAMBRIDGE
International Examinations

Question	Mark Scheme – 9701/23	Mark	Total mark
1 (a)	the amount of substance containing 6(.02) x 10^{23} (fundamental) particles of that substance (or; the amount of substance containing as many particles as there are atoms in 12 g of carbon-12)	(1)	[1]
(b) (i)	$2NaOH + CO_2 \rightarrow Na_2CO_3 + H_2O$	(1)	[1]
	allow ionic equations or formation of $NaHCO_3$		
(ii)	95 – 75 = 20 cm^3	(1)	[1]
(iii)	excess oxygen = 75 cm^3 so used = 25 cm^3	(1)	[1]
(iv)	$2C_xH_y + 5O_2 \rightarrow 4CO_2 + zH_2O$	(2)	[2]
(v)	$x = 2$; $y = 2$; $z = 2$ (or z = 1 if $C_xH_y + 2.5O_2 \rightarrow 2CO_2 + zH_2O$)	(1+1+1)	[3]
(c) (i)	**W** = $(CH_3)_2C{=}CH_2$ = 2–methylpropene	(1)	
	X = $(CH_3)_2CBrCH_3$ = 2–bromo–2–methylpropane	(1)	
	Y = $(CH_3)_2CHCH_2Br$ = 1–bromo–2–methylpropane	(1)	
	Z = $(CH_3)_3COH$ = 2–methylpropan–2–ol	(1)	[4]
(ii)	Markovnikov addition / H adds to C with most Hs	(1)	
	tertiary carbocation more stable than primary	(1)	
	inductive effect of three alkyl groups owtte	(1)	[Max 2]
		Total	**15**

2 (a)	$NH_4^+ + OH^- \rightarrow NH_3 + H_2O$	(1)	[1]
(b) (i)	Initial acid = $40 \times 0.4 / 1000 = 0.016$ (mol)	(1)	[1]
(ii)	$\frac{25 \times 0.12}{1000} = 3.0 \times 10^{-3}$ (mol) (of OH^- used)	(1)	[1]
(iii)	excess acid = OH^- = 0.003 acid reacted = 0.016 – 0.003 = 0.013 (mol)	(1)	[1]
(iv)	$NH_4^+:H^+$ = 1:1 so = 0.013 (mol NH_4^+)	(1)	[1]
(v)	amount of Cu = mass / M_r = 0.413 / 63.5 = 6.5×10^{-3} (mol) so Cu:NH_4 = 0.0065:0.013 = 1:2 so x = 2	(1) (1)	[2]
(vi)	M_r = 399.7	(1)	[1]
		Total	**8**

3 (a) (i)	(reaction between atmospheric N_2 and O_2) due to lightning / biological processes or bacteria <u>in soil</u> **AND** in car engines / power stations / metal refining / furnaces	(1)	[1]
(ii)	$2NO_2 + H_2O \rightarrow HNO_2 + HNO_3$ **OR** $2NO_2 + H_2O + 1/2O_2 \rightarrow 2HNO_3$ **OR** $3NO_2 + H_2O \rightarrow 2HNO_3 + NO$	(1)	[1]
(iii)	$SO_2 + NO_2 \rightarrow SO_3 + NO$	(1)	
	$NO + 1/2O_2 \rightarrow NO_2$	(1)	
	$SO_3 + H_2O \rightarrow H_2SO_4$	(1)	[3]
(b) (i)	$K_p = pN_2O_4/(pNO_2)^2$	(1)	[1]
(ii)	moles of NO_2 = 0.32	(1)	[1]
(iii)	$x(N_2O_4)$ = 1.84/2.16 = 0.85	(1)	
	$x(NO_2)$ = 0.32/2.16 = 0.15 ecf from **(b)(ii)**	(1)	[2]
(iv)	pN_2O_4 = 0.85 × 140 = 119 (kPa)	(1)	
	pNO_2 = 0.15 × 140 = 21 (kPa) ecf from **(b)(iii)**	(1)	[2]
(v)	$K_p = 119/21^2 = 0.270\ kPa^{-1}$ ecf from **(b)(i)** and **(b)(iv)**	(2)	[2]
		Total	**13**

4 (a) (i)	decreases down the group **ora**	(1)	[1]
(ii)	X–X bond strength decreases from Cl–Cl to I – I	(1)	
	But decreasing strength of H–X down group more significant	(1)	[2]
(b) (i)	$CaCl_2 + H_2SO_4 \rightarrow CaSO_4 + 2HCl$ **OR** $CaCl_2 + 2H_2SO_4 \rightarrow Ca(HSO_4)_2 + 2HCl$	(1)	[1]
(ii)	HI / I^- reduces / is oxidised by conc H_2SO_4 / because iodine is produced instead	(1)	[1]
(iii)	brown gas / fumes produced $2H_2SO_4 + 2KBr \rightarrow SO_2 + Br_2 + 2H_2O + K_2SO_4$ (or ionic)	(1) (1+1)	[3]
(c) (i)	$CH_3CH_2CH_2CH_2Br$ primary	(1)	
	$CH_3CH_2CHBrCH_3$ secondary	(1)	
	$(CH_3)_2CHCH_2Br$ primary	(1)	
	$(CH_3)_3CBr$ tertiary	(1)	[4]
(ii)	2-bromobutane	(1)	
		(1+1)	[3]
(d)	halide ions liberated (by hydrolysis of halogenoalkanes)form precipitate with Ag^+	(1)	
	OR $Ag^+ + X^- \rightarrow AgX$		
	order due to decreasing bond strength (C–I<C–Br<C–Cl)	(1)	[2]

(e) (i)	nucleophilic substitution	(2)	[2]
(ii)	 M1 = curly arrow from lone pair on OH^-; M2 for curly arrow from C-Br bond to Br **AND** dipole	(2)	[2]
(f) (i)	inert or volatile owtte	(1)	[1]
(ii)	destroy ozone	(1)	
	(in stratosphere) C–C*l* bond broken by UV / free radicals produced	(1)	[2]
		Total	**24**