

CHEMISTRY**9701/22**

Paper 2 AS Level Structured Questions

May/June 2016

MARK SCHEME

Maximum Mark: 60

Published

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Page 2	Mark Scheme	Syllabus	Paper
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Question	Answer							Mark	Total
1 (a)	name of element	nucleon number	atomic number	number of protons	number of neutrons	number of electrons	overall charge		
	boron	10	5	5	5	5	0	[1]	
	nitrogen	15	7	7	8	10	-3	[1]	
	lead	208	82	82	126	80	+2	[1]	
	lithium	6	3	3	3	2	+1	[1]	[4]
(b) (i)	Group 17/VII/7 AND big (owtte) increase/big difference/big gap/big jump/jump in increase/jump in difference after 7th IE							[1]	[1]
(ii)	increases across period due to increasing attraction (of nucleus for electrons) due to increasing nuclear charge/atomic/proton number AND constant/similar shielding/ same (outer) shell/energy level							[1]	
(iii)	$1s^2 2s^2 2p^6 3s^2 3p^4$							[1]	[1]
(c) (i)	$(100 - 99.76 - 0.04) = 0.2$							[1]	[1]
(ii)	$\frac{0.2x + (99.76 \times 16) + (0.04 \times 17)}{100} = 16.0044$ $x = 18$							[1]	
								[1]	[2]
								[Total 11]	

Page 3	Mark Scheme	Syllabus	Paper
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Question	Answer	Mark	Total
2 (a) (i)	enthalpy/energy/heat change when one mole of <u>gaseous atoms</u> is produced	[1]	[3]
	from the element in its standard state	[1]	
	under standard conditions	[1]	
(ii)	fluorine and chlorine are gases/bromine liquid and iodine solid OR as ΔH_{at} for bromine/iodine also includes changes of state	[1]	[1]
(iii)	$(\frac{1}{2}Cl_2 + \frac{1}{2}I_2 \rightarrow ICl)$ $\Delta H_f = (\frac{1}{2}E(Cl_2) + \frac{1}{2}E(I_2)) - E(ICl)$ OR $E(ICl) = (151/2) + (242/2) + 24$	[1]	[2]
	$E(ICl) = (+) 220.5/221$	[1]	
(b) (i)	stronger/more/greater id-id/London/dispersion forces	[1]	[2]
	due to increasing numbers of electrons	[1]	
(ii)	(intermolecular forces in HF are) hydrogen bonds (which are) stronger (than vdW)/more energy needed to separate molecules	[1] [1]	[2]
	OR		
	HF much more polar / F much more electronegative	[1]	
	Intermolecular forces in HF stronger (than in HCl, HBr, HI)	[1]	
(c) (i)	P = iodine / I_2 / I ; Q = chlorine / Cl_2 / Cl	[1]	[1]
(ii)	weaker H– P than H– Q bond ORA/easier/less energy to break H– P than H– Q ORA	[1]	[2]
	due to greater distance/shielding of nucleus from bond pair ORA	[1]	

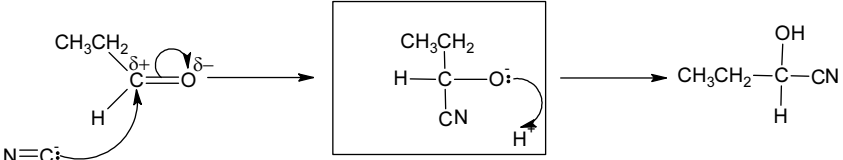
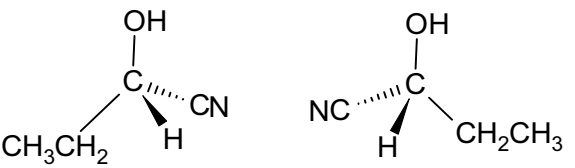
Page 4	Mark Scheme	Syllabus	Paper
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Question	Answer	Mark	Total
(iii)	2HP (or 2HI) \rightarrow (or \rightleftharpoons) $\text{H}_2 + \text{P}_2$ (or I_2)	[1]	[1]
(iv)	$\text{Ag}^+(\text{aq}) + \text{Q}^-(\text{aq})$ (or Cl^-) $\rightarrow \text{AgQ}(\text{s})$ (or $\text{AgCl}(\text{s})$) $\text{AgQ}(\text{s})/\text{AgCl}(\text{s}) + 2\text{NH}_3(\text{aq}) \rightarrow \text{Ag}(\text{NH}_3)_2^+(\text{aq}) + \text{Q}^-(\text{aq})/\text{Cl}^-(\text{aq})$	[1] [1]	[2]
(d) (i)	no of Cl increases <u>by one</u> each time/matches group number due to increasing number of valence/outer(most/shell) electrons/oxidation number/valency (of Mg , Al , Si)	[1] [1]	[2]
(ii)	$\text{MgCl}_2 + \text{aq} \rightarrow \text{Mg}^{2+} + 2\text{Cl}^-$ $\text{AlCl}_3 + 6\text{H}_2\text{O} \rightarrow \text{Al}(\text{H}_2\text{O})_6^{3+} + 3\text{Cl}^- / \text{Al}(\text{H}_2\text{O})_5(\text{OH})^{2+} + \text{H}^+ + 3\text{Cl}^-$ $\text{SiCl}_4 + 2\text{H}_2\text{O} \rightarrow \text{SiO}_2 + 4\text{H}^+ + 4\text{Cl}^-$	[1] [1] [1]	[3]
		[Total 21]	
3 (a)	$\text{Cr}_2\text{O}_7^{2-} + 8\text{H}^+ + 3\text{H}_2\text{C}_2\text{O}_4 \rightarrow 2\text{Cr}^{3+} + 6\text{CO}_2 + 7\text{H}_2\text{O}$ M1 = species M2 = balancing	[1] [1]	[2]
(b) (i)	$(0.02 \times 32.0/1000 =) 6.40 \times 10^{-4}$	[1]	[1]
(ii)	$(6.4 \times 10^{-4} \times 3 =) 1.92 \times 10^{-3}$	[1]	[1]
(iii)	$(0.242 / 1.92 \times 10^{-3} =) 126(.0)$	[1]	[1]
(iv)	$(126 - 90 = 36; 36 / 18 = 2 \text{ hence}) x = 2$	[1]	[1]
		[Total 6]	

Page 5	Mark Scheme	Syllabus	Paper
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Question	Answer	Mark	Total
4 (a)	CH ₃ CH ₂ CH ₂ COOH	[1]	
	(CH ₃) ₂ CHCOOH / CH ₃ CH(CH ₃)COOH	[1]	[2]
(b) (i)	Two from 1. CH ₃ CH ₂ COOCH ₃ 2. CH ₃ COOCH ₂ CH ₃ 3. HCOOCH ₂ CH ₂ CH ₃	[1] [1]	[2]
	(ii) correct acid + alcohol for either ester 1. methanol + propanoic acid 2. ethanol + ethanoic acid 3. propan-1-ol + methanoic acid (conc)H ₂ SO ₄ / (conc)H ₃ PO ₄ AND heat / warm / reflux	[1] [1]	[2]
(c)	Peak at 1710–1750 (for ester) due to C(=)O Peak at 1500–1680 (for X) due to C(=)C / alkene Peak at 3200–3650 (for X) due to (alcohol) O(–)H	[1] [1] [1]	[3]
		[Total 9]	
5 (a) (i)	acidified / H ⁺ AND potassium / sodium dichromate	[1]	[1]
	(ii) distillation (rather than reflux) (ensures aldehyde escapes) to avoid further oxidation / to avoid forming acid / as reflux causes further oxidation	[1] [1]	[2]

Page 6	Mark Scheme	Syllabus	Paper
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Question	Answer	Mark	Total
(b)	<p>reaction 3 – (conc) H_2SO_4 / (conc) H_3PO_4 or Al_2O_3 / pumice / porcelain / porous pot / ceramic</p> <p>AND heat</p> <p>reaction 4 – KBr / NaBr with (conc) H_2SO_4 or (red)P and Br_2 / PBr_3</p> <p>AND heat</p>	[1] [1]	[2]
(c) (i)	 <p>M1 = lone pair on C of CN^- AND curly arrow from lone pair to carbonyl carbon</p> <p>M2 = dipole on $\text{C}=\text{O}$ AND curly arrow to O from =</p> <p>M3 = intermediate with negative charge</p> <p>M4 = lone pair and curly arrow to H^+</p>	[1] [1] [1] [1]	[4]
(ii)		[1+1]	[2]

Page 7	Mark Scheme	Syllabus	Paper
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Question	Answer	Mark	Total
(iii)	<p>attack / attach from either side / above or below / from two directions because the carbonyl / molecule is planar / trigonal / flat / because of the shape of the molecule</p> <p>OR</p> <p>product is chiral / has a chiral carbon / has a carbon attached to four different groups / has a chiral centre / is asymmetric (equal) chance of forming either (of the two optical isomers) / mechanism doesn't distinguish between the two (optical isomers) / able to form either / chance of forming / able to form 50:50</p> <p>OR</p> <p>because the carbonyl / molecule is planar / trigonal / flat OR because of the shape of the molecule (equal) chance of forming either (of the two optical isomers) / mechanism doesn't distinguish between the two (optical isomers) / able to form either / chance of forming / able to form 50:50</p>	<p>[1] [1]</p>	[2]
		[Total 13]	