## 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

9701/41

Paper 4 (A2 Structured Questions), maximum raw mark 100

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.

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1 (a) (i) the enthalpy change/released when 1 mole is formed

of ionic lattice from the gas phase ions

[1]

(ii) 
$$Mg^{2+} + O^{2-} \longrightarrow MgO$$

[1] **[3]** 

[1]

(b) measurements needed:

mass of Mg (used)/mass MgO

Not volume/moles/mass of oxygen used

[3]

[1]

[1]

[1]

(c) 
$$\Delta H = 148 + 736 + 1450 + 496/2 - 141 + 798 - 3791$$
  
= -552 kJ mol<sup>-1</sup>

[3]

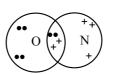
(d) Na<sub>2</sub>O(s) + H<sub>2</sub>O(aq/l)  $\longrightarrow$  2NaOH(aq) MgO(s) + H<sub>2</sub>O(aq/l)  $\longrightarrow$  Mg(OH)<sub>2</sub>(s) or Mg(OH)<sub>2</sub>(aq) pH 12.5-14 [NaOH] **AND** 8-10.5 [Mg(OH)<sub>2</sub>] respectively

[1] [1] [1]

[3]

[Total: 12]

2. (a) (i)



[1]

(ii)  $-180 \text{ kJ mol}^{-1}$  [1]

(iii) (formation of NO is endothermic) so high T and equilibrium pushed over to NO side. or high T and needed to break N-N bond in  $N_2$  [1]

[1]

(iv) 
$$-180 = 2 E(NO) - 994 - 496$$
  
  $E(NO) = +655 \text{ kJ mol}^{-1}$ 

[1] **[5]** 

(b) (i) (from 1 and 2:) as p(NO) halves, rate decreases to  $\frac{1}{4}$ , so order = 2 [1] (from 1 and 3:) as p(H<sub>2</sub>) halves, so does rate, so order = 1 [1]

(from 1 and 3:) as  $p(H_2)$  halves, so does rate, **so order = 1** 

[,]

(ii) rate =  $k p_{NO}^2 . p_{H2}$ units (of k) are atm<sup>-2</sup> s<sup>-1</sup>

[1] [1]

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	(iii	NO cros	+ NO + s out a	+ H <sub>2</sub> + all spe + H <sub>2</sub> +	cies comn	non to both sid	+ + + + + + + + + + + + + + + + + + +	_			[1] [1]
	(iv	O fo or:	rmed f	rom N 3 sin	ce it involv						[1] [1] <i>[1]</i> <i>[1]</i>
(с	) (i)	NO									[1]
	(ii)		3Fe <sup>2+</sup> w Fe <sup>2+</sup>	+ 4H + H	+ + NO <sub>3</sub> - + + HNO <sub>2</sub>	$\longrightarrow$ 3Fe <sup>3+</sup> $\longrightarrow$ Fe <sup>3+</sup>	<sup>3+</sup> + NO + 2H <sub>2</sub> O + NO + H <sub>2</sub> O)				[1]
	(iii	) dati	ve/coo	ordinat	e bonding						[1]
	(iv	<b>)</b> [Fe(	H <sub>2</sub> O) <sub>6-r</sub>	n(NO)r	] <sup>2+</sup> (n :	= 1-6)					[1] <b>[4]</b>
										[Tota	l:17]
3. (a	) (i)	C <sub>16</sub> F	1 <sub>10</sub> N <sub>2</sub> O	2							[1]
	(ii)	keto	ne, alk	kene, a	amine, ary	l (benzene/ar	ene/phenyl)			(any 3)	[2] <b>[3]</b>
(b	) (i)	redu	iction o	or redo	Х						[1]
	(ii)	NaB	H₄ or l	LiA <i>ī</i> H₄	(NOT H <sub>2</sub>	<sub>2</sub> + Ni)					[1] <b>[2]</b>
(c	) 1.	2,4-	DNPH	[1]		red/yellow-or	ange/orange ppt.	[1]	no	reaction	
	2.	Na r	netal	[1]		no reaction			gas given o	off/fizzing	[1]
			SOCl <sub>2</sub> - warm			no reaction		S	steamy fume misty/whi	_	[1]
	2)	("no r	eactior	า"			must be	linked	d to "correct	reagent"	[1] <b>[5]</b>

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(d) (i)

[1]

(ii) 
$$M_r = 262$$
, so 2.5 g = 2.5/262 = 9.54 × 10<sup>-3</sup> mol (1 mol indigo absorbs 9 mol of H<sub>2</sub>) so volume of H<sub>2</sub> = 9 × 24 – 9.54 × 10<sup>-3</sup> = **2.06 dm³** (2060 cm³)

[1]

[3]

[1]

(e)

2 x Br **on C=C** [1]

a Br on each ring [1]

TWO non-adjacent Br on each ring [1]

[3]

[Total: 16]

4 (a) (i) volatilities decrease down the group

[1]

due to greater van der Waals (VDW) forces (intermolecular is not sufficient)

[1]

due to larger no of electrons

[1]

(ii) CCl<sub>4</sub> does not react with water

[1]

CCl<sub>4</sub> unreactive due to no **d**-orbitals

[1]

GeCl<sub>4</sub> and PbCl<sub>4</sub> hydrolyse/react

[1]

$$MCl_4 + 2H_2O \longrightarrow MO_2 + 4HCl (M = Ge or Pb)$$

[1]

[7]

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(b) (i) **B** is PbSO<sub>4</sub> and **C** is PbC $l_2$ 

(ii) 
$$SnO_2 + 2H_2SO_4 \longrightarrow Sn(SO_4)_2 + 2H_2O$$
 [1]

$$PbO_2 + H_2SO_4 \longrightarrow PbSO_4 + H_2O + \frac{1}{2}O_2$$
 [1]

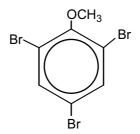
$$PbO_2 + 6HCl \longrightarrow H_2PbCl_6 + 2H_2O$$
 [1]

$$H_2PbCl_6 \longrightarrow PbCl_2 + 2HCl + Cl_2$$
 [1] [5 max 4]

[Total: 11]

[1]

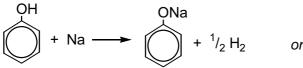
5 (a) (i)



[1]

(ii) Na metal or Fizzes/gas given off with phenol or  $C_6H_5OH + Na \rightarrow C_6H_5ONa + \frac{1}{2}H_2$  or OH

NaOH [1] phenol dissolves (anisole doesn't) [1]  $C_6H_5OH + OH^- \rightarrow C_6H_5O^- + H_2O$  [1]



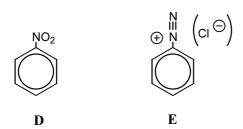
OH ONa + H<sub>2</sub>O

(neutral) iron(III) chloride Solution goes purple/violet  $3C_6H_5OH + FeCl_3 \rightarrow Fe(OC_6H_5)_3 + 3HCl$ 

[1] [1] **[4]** 

[1]

(b) (i)



[1] + [1]

(ii) step 2: Sn + HC
$$l$$
 NOT LiA $l$ H<sub>4</sub>, NaBH<sub>4</sub> [1] conc. + reflux (warm is insufficient)

step 4 is conditional of structure E

step 4: warm + in  $H_2O$  [1] [5 max 4]

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F must be an amide

(ii) reaction 1:  $H_2$  + Ni or LiAlH $_4$  [1] reaction 2: heat + aqueous HCl [1] [6]

[Total: 14]

[4]

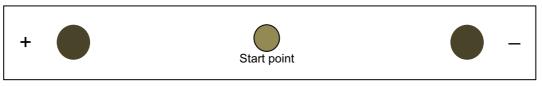
- 6 (a) (i) Condensation [1]
  - (ii) ala-ala, gly-gly, ala-gly [2]
    - (b) (i) Correct sugar-phosphate backbones
      (with two sugars and one phosphate attached)
      [1]
      - C G pair correct **or** A T pair correct [1]
      - deoxyribose label **and** all bases coming from sugars [1]
      - (ii) Replication would be slower/difficult because the DNA/strands could not be separated [1]
    - (c) (i) Some amino acids have more than one (triplet) code [1]
      - (ii) loss/disruption of ionic bonding/hydrogen bonding [1]
      - (iii) There would be a potential loss of all tertiary structure or frameshift deletion of a base changes protein structure [1]

[Total: 10]

[3]

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7 (a)



Glutamic acid Glycine Lysine

- (b) (i) Ratio of the <u>concentration</u> of a solute in each of two solvents or equilibrium constant representing the distribution of a solute between two solvents. [1]
  - (ii) illustration of some method of getting into our body via the food chain [1]

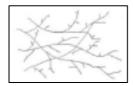
(c) (i) 
$$156 = C_3H_6^{35}Cl^{79}Br^+$$
 [1]  $158 = C_3H_6^{37}Cl^{79}Br^+$  [1]  $158 = C_3H_6^{35}Cl^{81}Br^+$  [1]  $160 = C_3H_6^{37}Cl^{81}Br^+$  [1]

(ii) 
$$m/e = 15$$
 Species =  $CH_3^+$  [1] [5 max 4]

[Total: 10]

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**8** (a)





LDPE HDPE minimum of 2 chains suitable sketches

(The close packing of unbranched side chains means)

LDPE **more space** between the chains/polymers or HDPE less empty space between the chains [1]

(b) van der Waals' (VDW) forces are weaker

[1] [1]

[2]

[1]

(c)

Addition OR	condensation	
requires C=C/double bond	does not need C=C/double bond	
uses the same functional group	needs two different functional groups	
same general (empirical) formula as monomer	different formula	
no loss of small molecule/H <sub>2</sub> O/HCl	small molecule /H <sub>2</sub> O/HCl is formed	

Any two differences [1]

(d) (i) (through its long chain of) delocalised electrons/mobile electrons [1] free electrons is not sufficient

(ii) planar [1]

the  $\pi$  bonds/p-orbitals overlap (with each other) [1]

(iii)  $C_8H_6$   $C_4H_3$  [2]

[5 max 4]

[Total: 10]