

**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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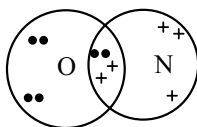
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- 1 (a) (i) the enthalpy change/released when **1 mole is formed** [1]  
of ionic lattice **from the gas phase ions** [1]  
(ii)  $\text{Mg}^{2+} + \text{O}^{2-} \longrightarrow \text{MgO}$  [1]  
[3]
- (b) measurements needed:  
**volume/mass/weight of water** (in calorimeter) [1]  
initial + final temperature/temperature change/temperature rise (of the water) [1]  
mass of Mg (used)/mass MgO [1]  
**Not** volume/moles/mass of oxygen used [3]
- (c)  $\Delta H = 148 + 736 + 1450 + 496/2 - 141 + 798 - 3791$   
= **-552 kJ mol<sup>-1</sup>** [3]  
[3]
- (d)  $\text{Na}_2\text{O}(\text{s}) + \text{H}_2\text{O}(\text{aq/l}) \longrightarrow 2\text{NaOH}(\text{aq})$  [1]  
 $\text{MgO}(\text{s}) + \text{H}_2\text{O}(\text{aq/l}) \longrightarrow \text{Mg}(\text{OH})_2(\text{s})$  or  $\text{Mg}(\text{OH})_2(\text{aq})$  [1]  
pH 12.5-14 [NaOH] **AND** 8-10.5 [Mg(OH)<sub>2</sub>] respectively [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<sub>2</sub> [1]
- (iv)  $-180 = 2 E(\text{NO}) - 994 - 496$  [1]  
 $E(\text{NO}) = \mathbf{+655 \text{ kJ mol}^{-1}}$  [1]  
[5]
- (b) (i) (from 1 and 2:) as  $p(\text{NO})$  halves, rate decreases to  $\frac{1}{4}$ , **so order = 2** [1]  
(from 1 and 3:) as  $p(\text{H}_2)$  halves, so does rate, **so order = 1** [1]
- (ii) rate =  $k p_{\text{NO}}^2 \cdot p_{\text{H}_2}$  [1]  
units (of k) are  $\text{atm}^{-2} \text{ s}^{-1}$  [1]

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- (iii) add all three equations:  

$$\text{NO} + \text{NO} + \text{H}_2 + \text{O} + \text{H}_2 + \text{N}_2\text{O} \rightarrow \text{N}_2\text{O} + \text{O} + \text{H}_2\text{O} + \text{N}_2 + \text{H}_2\text{O} \quad [1]$$
 cross out all species common to both sides:  

$$\text{NO} + \text{NO} + \text{H}_2 + \text{O} + \text{H}_2 + \text{N}_2\text{O} \rightarrow \text{N}_2\text{O} + \text{O} + \text{H}_2\text{O} + \text{N}_2 + \text{H}_2\text{O} \quad [1]$$

$$(\Rightarrow 2\text{NO} + 2\text{H}_2 \rightarrow \text{N}_2 + 2\text{H}_2\text{O})$$

- (iv) *either: step 2* since it involves  $\text{H}_2$  [1]  
 O formed from NO [1]  
*or: step 3* since it involves  $\text{H}_2$  [1]  
 $\text{N}_2\text{O}$  formed from NO [1]  
**[8]**

- (c) (i) NO [1]

- (ii) 
$$3\text{Fe}^{2+} + 4\text{H}^+ + \text{NO}_3^- \longrightarrow 3\text{Fe}^{3+} + \text{NO} + 2\text{H}_2\text{O} \quad [1]$$
 (allow  $\text{Fe}^{2+} + \text{H}^+ + \text{HNO}_2 \longrightarrow \text{Fe}^{3+} + \text{NO} + \text{H}_2\text{O}$ )

- (iii) dative/coordinate bonding [1]

- (iv)  $[\text{Fe}(\text{H}_2\text{O})_{6-n}(\text{NO})_n]^{2+}$  ( $n = 1-6$ ) [1]  
**[4]**

**[Total:17]**

3. (a) (i)  $\text{C}_{16}\text{H}_{10}\text{N}_2\text{O}_2$  [1]  
 (ii) ketone, alkene, amine, aryl (benzene/arene/phenyl) (any 3) [2]  
**[3]**

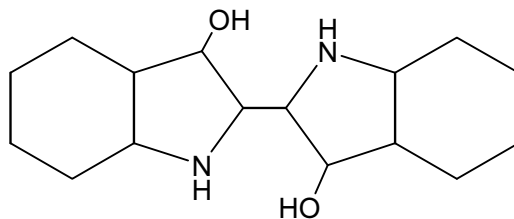
- (b) (i) reduction or redox [1]

- (ii)  $\text{NaBH}_4$  or  $\text{LiAlH}_4$  (NOT  $\text{H}_2 + \text{Ni}$ ) [1]  
**[2]**

- (c) 1. 2,4-DNPH [1] red/yellow-orange/orange ppt. [1] no reaction  
 2. Na metal [1] no reaction gas given off/fizzing [1]  
 or  $\text{PCl}_5/\text{SOCl}_2$  [1] no reaction steamy fumes/fizzing [1]  
 or  $\text{PCl}_3 + \text{warm}$  misty/white fumes  
 2 x "no reaction" must be linked to "correct reagent" [1]  
**[5]**

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(d) (i)



[1]

(ii)  $M_r = 262$ , so  $2.5 \text{ g} = 2.5/262 = 9.54 \times 10^{-3} \text{ mol}$ 

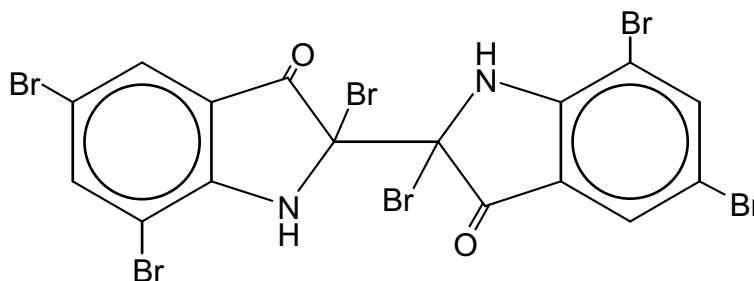
[1]

(1 mol indigo absorbs 9 mol of  $\text{H}_2$ )so volume of  $\text{H}_2 = 9 \times 24 - 9.54 \times 10^{-3} = \mathbf{2.06 \text{ dm}^3}$  (2060  $\text{cm}^3$ )

[1]

[3]

(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)  $\text{CCl}_4$  does not react with water

[1]

 $\text{CCl}_4$  unreactive due to no **d**-orbitals

[1]

 $\text{GeCl}_4$  **and**  $\text{PbCl}_4$  hydrolyse/react

[1]

 $\text{MCl}_4 + 2\text{H}_2\text{O} \longrightarrow \text{MO}_2 + 4\text{HCl}$  (M = Ge or Pb)

[1]

[7]

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(b) (i) B is  $\text{PbSO}_4$  **and** C is  $\text{PbCl}_2$  [1]

(ii)  $\text{SnO}_2 + 2\text{H}_2\text{SO}_4 \longrightarrow \text{Sn}(\text{SO}_4)_2 + 2\text{H}_2\text{O}$  [1]

$\text{PbO}_2 + \text{H}_2\text{SO}_4 \longrightarrow \text{PbSO}_4 + \text{H}_2\text{O} + \frac{1}{2} \text{O}_2$  [1]

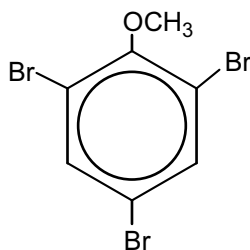
$\text{PbO}_2 + 6\text{HCl} \longrightarrow \text{H}_2\text{PbCl}_6 + 2\text{H}_2\text{O}$  [1]

$\text{H}_2\text{PbCl}_6 \longrightarrow \text{PbCl}_2 + 2\text{HCl} + \text{Cl}_2$  [1]

[5 max 4]

[Total: 11]

5 (a) (i)

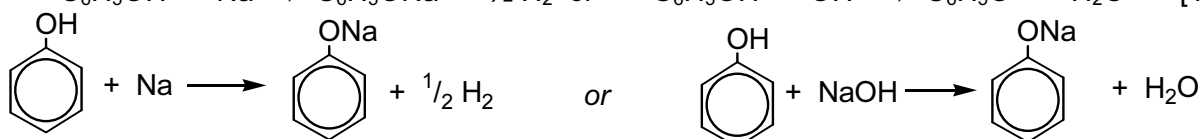


[1]

(ii) Na metal or NaOH [1]

Fizzes/gas given off with phenol or phenol dissolves (anisole doesn't) [1]

$\text{C}_6\text{H}_5\text{OH} + \text{Na} \rightarrow \text{C}_6\text{H}_5\text{ONa} + \frac{1}{2} \text{H}_2$  or  $\text{C}_6\text{H}_5\text{OH} + \text{OH}^- \rightarrow \text{C}_6\text{H}_5\text{O}^- + \text{H}_2\text{O}$  [1]



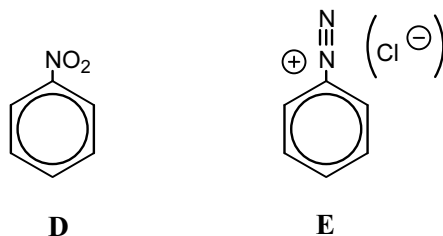
(neutral) iron(III) chloride [1]

Solution goes purple/violet [1]

$3\text{C}_6\text{H}_5\text{OH} + \text{FeCl}_3 \rightarrow \text{Fe}(\text{OC}_6\text{H}_5)_3 + 3\text{HCl}$  [1]

[4]

(b) (i)



[1] + [1]

(ii) step 2:  $\text{Sn} + \text{HCl}$  **NOT**  $\text{LiAlH}_4$ ,  $\text{NaBH}_4$  [1]  
 conc. + reflux *(warm is insufficient)* [1]

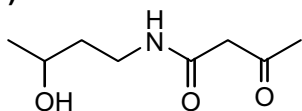
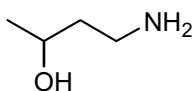
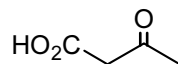
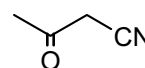
**step 4 is conditional of structure E**

step 4: warm + in  $\text{H}_2\text{O}$  [1]

[5 max 4]

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(c) (i)

**F**F must be an **amide****G****H****J**

[4]

- (ii) reaction 1:  $\text{H}_2 + \text{Ni}$  or  $\text{LiAlH}_4$   
 reaction 2: heat + aqueous  $\text{HCl}$

[1]

[1]

[6]

[Total: 14]

6 (a) (i) Condensation [1]

(ii) ala-ala, gly-gly, ala-gly [2]

[3]

(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]

[4]

(c) (i) Some amino acids have more than one (triplet) code [1]

(ii) loss/disruption of ionic bonding/hydrogen bonding [1]

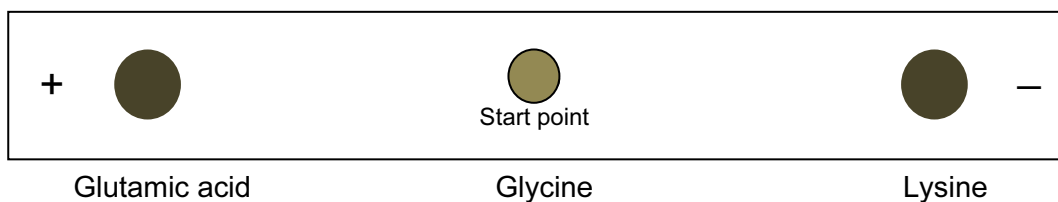
(iii) There would be a potential loss of all tertiary structure  
*or*  
frameshift – deletion of a base changes protein structure [1]

[3]

[Total: 10]

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7 (a)



- Glutamic acid between + and start point [1]  
 Lysine between – and start point [1]  
 Glycine at, or very close to, start point [1]  
**[3]**

(b) (i) Ratio of the concentration 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]

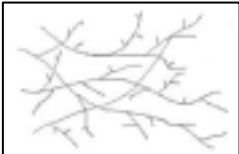
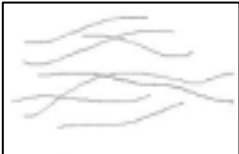
They dissolve preferentially in fats/oils [1]  
**[3]**

(c) (i)  $156 = \text{C}_3\text{H}_6^{35}\text{Cl}^{79}\text{Br}^+$  [1]  
 $158 = \text{C}_3\text{H}_6^{37}\text{Cl}^{79}\text{Br}^+$  [1]  
 $158 = \text{C}_3\text{H}_6^{35}\text{Cl}^{81}\text{Br}^+$  [1]  
 $160 = \text{C}_3\text{H}_6^{37}\text{Cl}^{81}\text{Br}^+$  [1]

(ii)  $m/e = 15$  Species =  $\text{CH}_3^+$  [1]  
**[5 max 4]**

**[Total: 10]**

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- 8 (a)  
- LDPE HDPE minimum of 2 chains suitable sketches [1]
- (The close packing of unbranched side chains means)  
 LDPE **more space** between the chains/polymers or HDPE less empty space between the chains [1]  
 [2]

- (b) van der Waals' (VDW) forces are weaker [1]  
 [1]  
 [2]

(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]  
 [2]

- (d) (i) (through its long chain of) delocalised electrons/mobile electrons  
*free electrons is not sufficient* [1]
- (ii) planar [1]  
 the  $\pi$  bonds/p-orbitals overlap (with each other) [1]
- (iii) C<sub>8</sub>H<sub>6</sub>  
 C<sub>4</sub>H<sub>3</sub> [2]

[5 max 4]

[Total: 10]