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 must be read in conjunction with the question papers and the report on the examination.

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Cambridge is publishing the mark schemes for the May/June 2012 question papers for most IGCSE, GCE Advanced Level and Advanced Subsidiary Level syllabuses and some Ordinary Level syllabuses.
1 (a) (i) the enthalpy change/released when 1 mole is formed

of ionic lattice from the gas phase ions

(ii) \( \text{Mg}^{2+} + \text{O}^{2-} \rightarrow \text{MgO} \)

(b) measurements needed:

- volume/mass/weight of water (in calorimeter)
- initial + final temperature/temperature change/temperature rise (of the water)
- mass of Mg (used)/mass MgO

Not volume/moles/mass of oxygen used

(c) \( \Delta H = 148 + 736 + 1450 + 496/2 - 141 + 798 - 3791 = -552 \text{ kJ mol}^{-1} \)

(d) \( \text{Na}_2\text{O}(s) + \text{H}_2\text{O}(aq/l) \rightarrow 2\text{NaOH}(aq) \)

\( \text{MgO}(s) + \text{H}_2\text{O}(aq/l) \rightarrow \text{Mg(OH)}_2(s) \text{ or } \text{Mg(OH)}_2(aq) \)

pH 12.5-14 [NaOH] AND 8-10.5 [Mg(OH)_2] respectively

[Total: 12]

2. (a) (i)

\[ \begin{array}{c}
\text{O} \\
\text{N}
\end{array} \]

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

(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 \( \text{N}_2 \)

(iv) \(-180 = 2 \ E(\text{NO}) - 994 - 496 \)

\( E(\text{NO}) = +655 \text{ kJ mol}^{-1} \)

(b) (i) (from 1 and 2:) as p(NO) halves, rate decreases to ¼, so order = 2

(from 1 and 3:) as p(H\(_2\)) halves, so does rate, so order = 1

(ii) rate = \( kp_{\text{NO}}^2 \cdot p_{\text{H}_2} \)

units (of k) are atm\(^{-2}\) s\(^{-1}\)
(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 H$_2$
O formed from NO

or: step 3 since it involves H$_2$
N$_2$O formed from NO

(c) (i) NO

(ii) $3\text{Fe}^{2+} + 4\text{H}^+ + \text{NO}_3^- \rightarrow 3\text{Fe}^{3+} + \text{NO} + 2\text{H}_2\text{O}$
(allow $3\text{Fe}^{3+} + \text{H}^+ + \text{HNO}_2 \rightarrow \text{Fe}^{3+} + \text{NO} + \text{H}_2\text{O}$)

(iii) dative/coordinate bonding

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

[Total: 17]

3. (a) (i) \ce{C_{16}H_{10}N_2O_2} [1]

(ii) ketone, alkene, amine, aryl (benzene/arene/phenyl) (any 3) [2]

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

(ii) NaBH$_4$ or LiAlH$_4$ (NOT H$_2$ + Ni) [1]

(c) 1. 2,4-DNPH [1] red/yellow-orange/orange ppt. [1] no reaction


or $\text{PCl}_5/\text{SOCl}_2$ [1] no reaction steamy fumes/fizzing [1]
or $\text{PCl}_5$ + warm must be linked to “correct reagent” [1]

2 x “no reaction” must be linked to “correct reagent” [5]

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(d) (i)

\[
\begin{align*}
\text{[Diagram of molecule]} \\
\end{align*}
\]

(ii) \( M_r = 262 \), so \( 2.5 \text{ g} = \frac{2.5}{262} = 9.54 \times 10^{-3} \text{ mol} \) 
(1 mol indigo absorbs 9 mol of \( \text{H}_2 \))
so volume of \( \text{H}_2 = 9 \times 24 - 9.54 \times 10^{-3} = 2.06 \text{ dm}^3 \) (2060 cm\(^3\))

(e)

\[
\begin{align*}
\text{[Diagram of molecule]} \\
\text{2 x Br on C=C} & \quad \text{[1]} \\
\text{a Br on each ring} & \quad \text{[1]} \\
\text{TWO non-adjacent Br on each ring} & \quad \text{[1]} \\
\end{align*}
\]

[Total: 16]

4 (a) (i) volatilities decrease down the group 
\( \text{due to greater van der Waals (VDW) forces (intermolecular is not sufficient)} \) 
\( \text{due to larger no of electrons} \) 

(ii) \( \text{CCl}_4 \text{ does not react with water} \) 
\( \text{CCl}_4 \text{ unreactive due to no d-orbitals} \) 
\( \text{GeCl}_4 \text{ and PbCl}_4 \text{ hydrolyse/react} \) 
\( \text{MCl}_4 + 2\text{H}_2\text{O} \rightarrow \text{MO}_2 + 4\text{HCl} \text{ (M = Ge or Pb)} \)
(b) (i) B is PbSO₄ and C is PbCl₂

(ii) SnO₂ + 2H₂SO₄ → Sn(SO₄)₂ + 2H₂O

PbO₂ + H₂SO₄ → PbSO₄ + H₂O + ½ O₂

PbO₂ + 6HCl → H₂PbCl₆ + 2H₂O

H₂PbCl₆ → PbCl₂ + 2HCl + Cl₂

[5 max 4]

[Total: 11]

5 (a) (i)

(ii) Na metal or NaOH

Fizzes/gas given off with phenol or phenol dissolves (anisole doesn’t)

C₆H₅OH + Na → C₆H₅ONa + ½ H₂ or C₆H₅OH + OH⁻ → C₆H₅O⁻ + H₂O

OH OH OH OH

+ Na → + ½ H₂ or + NaOH → + H₂O

(neutral) iron(III) chloride

Solution goes purple/violet

3C₆H₅OH + FeCl₃ → Fe(OC₆H₅)₃ + 3HCl

[4]

(b) (i)

(ii) step 2: Sn + HCl NOT LiAlH₄, NaBH₄

conc. + reflux (warm is insufficient)

step 4 is conditional of structure E

step 4: warm + in H₂O

[5 max 4]
6 (a) (i) Condensation  
(ii) ala-ala, gly-gly, ala-gly

(b) (i) Correct sugar-phosphate backbones  
(with two sugars and one phosphate attached)  
C – G pair correct or A – T pair correct  
deoxyribose label and all bases coming from sugars

(ii) Replication would be slower/difficult  
because the DNA/strands could not be separated

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

(ii) loss/disruption of ionic bonding/hydrogen bonding

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

[Total: 10]
7 (a)

Glutamic acid  Glycine  Lysine

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

(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]

(c) (i)  $156 = \text{C}_3\text{H}_6^{35}\text{Cl}^{79}\text{Br}^*$ [1]
$158 = \text{C}_3\text{H}_6^{37}\text{Cl}^{76}\text{Br}^*$ [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]
8 (a) LDPE and 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 |
<table>
<thead>
<tr>
<th></th>
<th></th>
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<tbody>
<tr>
<td>requires C=C/double bond</td>
<td>does not need C=C/double bond</td>
</tr>
<tr>
<td>uses the same functional group</td>
<td>needs two different functional groups</td>
</tr>
<tr>
<td>same general (empirical) formula as monomer</td>
<td>different formula</td>
</tr>
<tr>
<td>no loss of small molecule/H₂O/HCl</td>
<td>small molecule /H₂O/HCl is formed</td>
</tr>
</tbody>
</table>

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 π bonds/p-orbitals overlap (with each other) [1]

(iii) $C_6H_6$
$C_4H_3$ [2]

[5 max 4]

[Total: 10]