

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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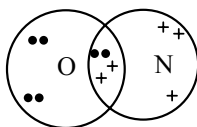


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- 1 (a) (i) the enthalpy change/released when **1 mole is formed** [1]
of ionic lattice **from the gas phase ions** [1]
(ii) $\text{Mg}^{2+} + \text{O}^{2-} \longrightarrow \text{MgO}$ [1]
[3]
- (b) measurements needed:
volume/mass/weight of water (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⁻¹** [3]
[3]
- (d) $\text{Na}_2\text{O(s)} + \text{H}_2\text{O(aq/l)} \longrightarrow 2\text{NaOH(aq)}$ [1]
 $\text{MgO(s)} + \text{H}_2\text{O(aq/l)} \longrightarrow \text{Mg(OH)}_2\text{(s) or Mg(OH)}_2\text{(aq)}$ [1]
pH 12.5-14 [NaOH] **AND** 8-10.5 [Mg(OH)₂] respectively [1]
[3]

[Total: 12]

2. (a) (i)



- (ii) -180 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 N₂ [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(NO) halves, rate decreases to $\frac{1}{4}$, **so order = 2** [1]
(from 1 and 3:) as p(H₂) halves, so does rate, **so order = 1** [1]
- (ii) $\text{rate} = k p_{\text{NO}}^2 \cdot p_{\text{H}_2}$ [1]
units (of k) are $\text{atm}^{-2} \text{ s}^{-1}$ [1]

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- (iii) add all three equations:
 $\text{NO} + \text{NO} + \text{H}_2 + \text{O} + \text{H}_2 + \text{N}_2\text{O} \rightarrow \text{N}_2\text{O} + \text{O} + \text{H}_2\text{O} + \text{N}_2 + \text{H}_2\text{O}$ [1]
 cross out all species common to both sides:
 $\text{NO} + \text{NO} + \text{H}_2 + \text{O} + \text{H}_2 + \text{N}_2\text{O} \rightarrow \text{N}_2\text{O} + \text{O} + \text{H}_2\text{O} + \text{N}_2 + \text{H}_2\text{O}$ [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 [1]
 O formed from NO [1]
or: step 3 since it involves H_2 [1]
 N_2O formed from NO [1]
[8]

- (c) (i) NO [1]

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

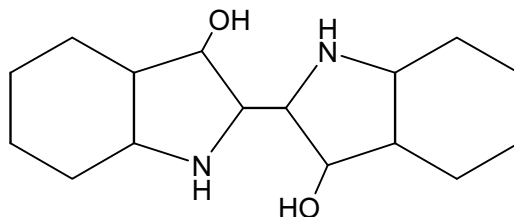
- (b) (i) reduction or redox [1]

- (ii) NaBH_4 or LiAlH_4 (**NOT** H_2 + 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 PCl_3 + 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]

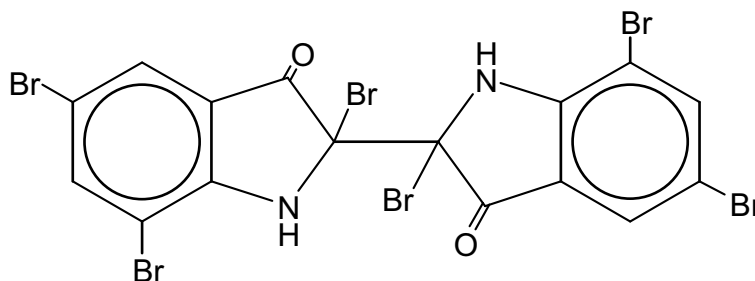
(1 mol indigo absorbs 9 mol of H_2)

so volume of $\text{H}_2 = 9 \times 24 - 9.54 \times 10^{-3} = 2.06 \text{ dm}^3$ (2060 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) CCl_4 does not react with water

[1]

CCl_4 unreactive due to no **d**-orbitals

[1]

GeCl_4 **and** 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 PbSO₄ and C is PbCl₂ [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]

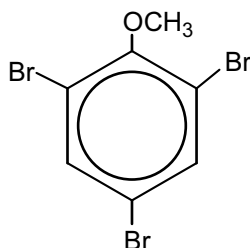
$\text{PbO}_2 + 6\text{HCl} \longrightarrow \text{H}_2\text{PbCl}_6 + 2\text{H}_2\text{O}$ [1]

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

[5 max 4]

[Total: 11]

5 (a) (i)

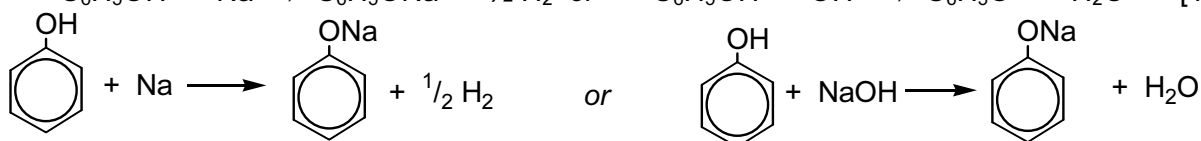


[1]

(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]



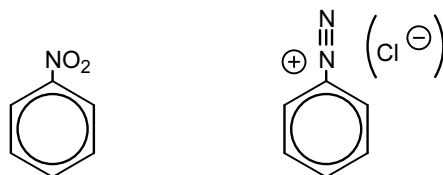
(neutral) iron(III) chloride [1]

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)



D

E

[1] + [1]

(ii) step 2: $\text{Sn} + \text{HCl}$ NOT LiAlH_4 , NaBH_4 [1]

conc. + reflux (warm is insufficient) [1]

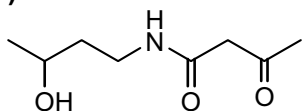
step 4 is conditional of structure E

step 4: warm + in H₂O [1]

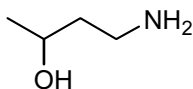
[5 max 4]

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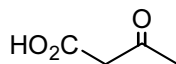
(c) (i)



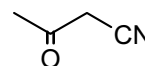
F



G



H



J

F must be an **amide**

[4]

- (ii) reaction 1: $\text{H}_2 + \text{Ni}$ or LiAlH_4
 reaction 2: heat + aqueous 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

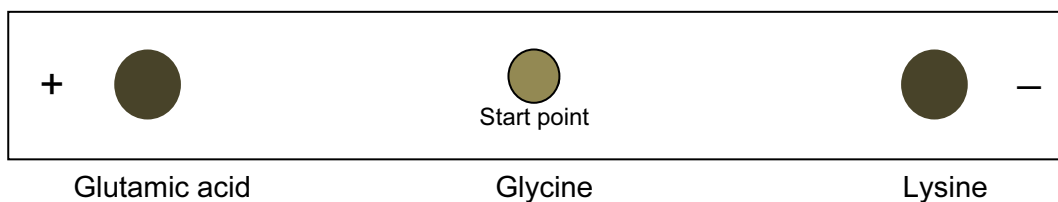
[1]

[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]

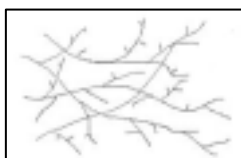
(c) (i) $156 = \text{C}_3\text{H}_6^{35}\text{Cl}^{79}\text{Br}^+$ [1]
 $158 = \text{C}_3\text{H}_6^{37}\text{Cl}^{79}\text{Br}^+$ [1]
 $158 = \text{C}_3\text{H}_6^{35}\text{Cl}^{81}\text{Br}^+$ [1]
 $160 = \text{C}_3\text{H}_6^{37}\text{Cl}^{81}\text{Br}^+$ [1]

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

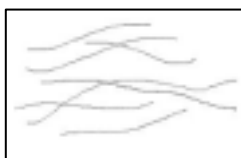
[Total: 10]

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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 ₂ O/HCl	small molecule /H ₂ 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 π bonds/p-orbitals overlap (with each other)

[1]

(iii) C₈H₆
C₄H₃

[2]

[5 max 4]

[Total: 10]

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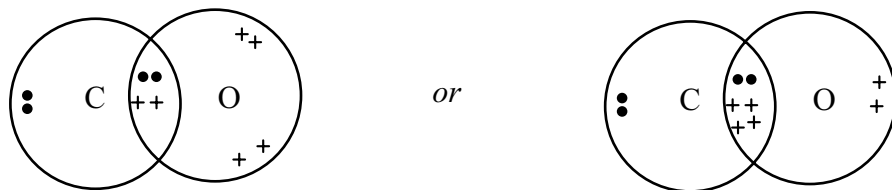


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- 1 (a) (i) enthalpy/energy change/released when 1 mol of ions... [1]
in the gas phase (are dissolved in) water [1]
- (ii) $\text{Mg}^{2+}(\text{g}) + \text{aq (or H}_2\text{O)} \rightarrow \text{Mg}^{2+}(\text{aq}) \text{ or } [\text{Mg}(\text{H}_2\text{O})_6]^{2+}$ [1]
- (iii) Mg^{2+} has a smaller radius/size or greater charge density than Ca^{2+} (**ions** required) [1]
- (iv) O^{2-} reacts with water to give OH^- *or equation: $\text{O}^{2-} + \text{H}_2\text{O} \rightarrow 2\text{OH}^-$* [1]
[5]
- (b) (apparatus: “insulated” calorimeter, water and thermometer)
- measure (known volume/mass of) water *or* stated volume of water (into calorimeter)
 - take the temperature (of the water – NOT the MgCl_2)
 - weigh out known mass of MgCl_2 *or* stated mass of MgCl_2
 - take final/highest/constant temperature *or* record temperature change/rise 4 × [1]
[4]
- (c) (i) $\Delta H^\circ_{\text{sol}} = 641 - 801 = -160 \text{ kJ mol}^{-1}$ [1]
- (ii) $\Delta H^\circ_{\text{hyd}} = (1890 - 2526 - 160)/2 = -398 \text{ kJ mol}^{-1}$ [2]
[3]
- (d)
- solubility: $\text{MgSO}_4 > \text{BaSO}_4$ *or* decreases down the group
 - because ΔH_{sol} is more endothermic for BaSO_4 *or* more exothermic for MgSO_4
 - due to larger r_{ion} *or* smaller charge density of Ba^{2+} (ion has to be mentioned)
 - leading to smaller LE and HE *or* LE and HE decrease
 - but difference in HE (between Mg^{2+} and Ba^{2+}) is larger than the difference in LE (between MgSO_4 and BaSO_4)
or HE is dominant *or* HE decreases more than LE any 4 points [4]
[4]
- [Total: 16]

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2 (a) (i)



[1]

(ii) incomplete combustion (of hydrocarbon fuels) *or* insufficient O₂/air

[1]

(iii) $\text{NO} + \text{CO} \rightarrow \frac{1}{2}\text{N}_2 + \text{CO}_2$
or $\text{CO} + \frac{1}{2}\text{O}_2 \rightarrow \text{CO}_2$
 equation needs to be balanced

[1]

[3]

(b) $\Delta H = 394 - 2 \times 111 = (+)172 \text{ kJ mol}^{-1}$

[2]

[2]

(c) (i) ligand exchange/displacement/replacement/substitution

[1]

(ii)

- d-orbitals are split (by the ligand field) *or* orbitals near ligands are at higher energy
- the splitting/energy gap depends on the ligands (surrounding the ion) *or* the metal (ion)
- when an electron moves from lower to higher orbital/energy level *or* is promoted/excited
- light/a photon is absorbed *or* colour seen/reflected/transmitted is complement of colour absorbed ("emitted" contradicts this mark)
- different energy gap means different frequency absorbed means different colour

5 × [1]

(iii) from rows 1 and 3: $\text{rate}_3/\text{rate}_1 = 2.0$ which also equals $[[\text{complex}]_3]/[[\text{complex}]_1]$ [1]
(or this working mark can be awarded for any valid calculation that shows that order w.r.t. complex is 1)

Thus order w.r.t. [complex] = 1 **and** order w.r.t. [CO] is zero

[1]

rate equation: **rate = k[complex]**

[1]

(iv) mechanism 2

[1]

it's the only one that does **not** involve CO in the rate determining step *or* rate depends on [complex] only.

[1]

[11 max 10]

[Total: 15]

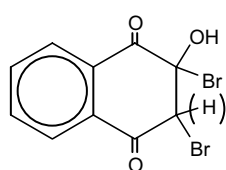
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- 3 (a) (i) ketone, alcohol, alkene, arene/aryl/benzene/phenyl. any three [2]
(if more than 3 are given, mark the first 3 the candidate has written)

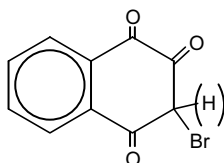
- (ii) (2,4-)DNPH/Brady's or FeCl_3 (aq or neutral) or $\text{Br}_2(\text{aq})$ [1]
 Lawsone $\Rightarrow$ orange/red, or purple/violet with **A**, or white ppt with **A**,
 (not yellow) ppt
 and **A** $\Rightarrow$ nothing or and nothing with Lawsone or and decolourises [1]
 with Lawsone

- (iii) NaBH_4 or LiAlH_4 or SnCl_2 or $\text{Na} + \text{ethanol}$ or any suitable reducing agents with $E^\circ < 0.2\text{V}$, e.g. SO_2 . **NOT** $\text{H}_2 + \text{Ni}$ etc. [1]

(iv)



or

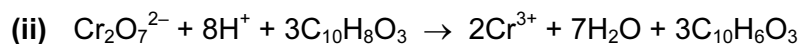


(One of the Br atoms in either formula could be an OH group instead. Br on the **benzene** ring negates this mark)

[1]

[6]

- (b) (i) $E_{\text{cell}} = 1.33 - 0.36 = (+)0.97(\text{V})$ [1]



3:1 ratio [1]
balancing [1]

- (iii) $= 0.05 \times 7.5/1000 = 3.75 \times 10^{-4} \text{ mol}$ [1]

$$n(\text{A}) = 3 \times 3.75 \times 10^{-4}$$

$$= 1.125 \times 10^{-3} \text{ in } 20 \text{ cm}^3$$

$$[\text{A}] = 5.63 \times 10^{-2} \text{ mol dm}^{-3} \text{ (allow 5.6, 5.62, 5.625 etc.)}$$

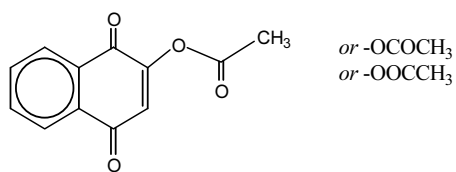
[1]

[5]

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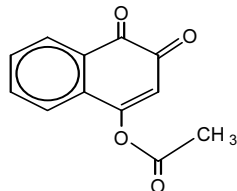
(c) (i) compound **C** is

[1]

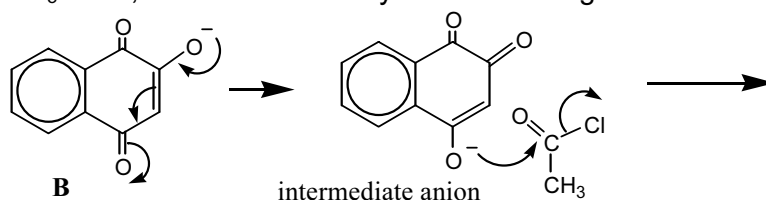


(ii) compound **D** is

[1]



(iii) mechanism: 3 curly arrows in **B** or correct intermediate anion [1]
a curly arrow from an O⁻ or an oxygen with a lone pair to the carbon of the C=O group in CH₃COCl, and a second curly arrow breaking the C-Cl bond [1]



[4 max 3]

[Total: 14]

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- 4 (a) volatility: $Cl_2 > Br_2 > I_2$ or boiling points: $Cl_2 < Br_2 < I_2$ or Cl_2 is (g); Br_2 is (l); I_2 is (s) [1]
 more electrons in X_2 down the group or more shells/bigger cloud of electrons [1]
 so there's greater van der Waals/dispersion/induced/temporary dipole force/attraction [1]
[3]
- (b) (i) $H_2O > H_2S$ (see * below for mark) [1]
 due to H-bonding in H_2O (none in H_2S) [1]
 diagram minimum is: $H_2O^{\delta-} \cdots^{\delta+} H-OH$ or $H_2O : H-OH$ [allow (+) for $\delta+$] [1]
- (ii) $CH_3-O-CH_3 > CH_3CH_2CH_3$ (see * below for mark) [1]
 due to dipole in CH_3-O-CH_3 (O is $\delta-$ not needed, but O is $\delta+$ negates) or CH_3OCH_3 is polar [1]
 * correct comparison of boiling points for **both** [1]
[4]
- (c) SF_6 has 6 bonding pairs/bonds and no lone pairs (bonds can be read into a diagram e.g. S-F, but 'no lone pairs' can *only* be read into a diagram showing 6 bonded pairs of electrons. [1]
clear diagram or 'shape is octahedral' [1]
[2]
- [Total: 9]**
- 5 (a) acidities: $CHCl_2CO_2H > CH_2ClCO_2H > CH_3CO_2H$ [1]
 due to Cl being (more) electronegative/electron withdrawing (than H). [1]
 this stabilises the anion or weakens the O-H bond [1]
[3]

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(b)

first compound	second compound	test	observation with first compound	observation with second compound
		Br ₂ (aq) [not (l)]	none	decolourises/white ppt.
		NaNO ₂ + HCl or HNO ₂ followed by phenol (+ NaOH)	none	yellow/orange/red ppt.
CH ₃ CH ₂ COC ₂ H ₅	CH ₃ COCH ₂ C ₂ H ₅	AgNO ₃ (aq)	(immediate) white ppt.	none
		add H ₂ O/ROH	steamy/misty/white fumes	none
		(2,4-)DNPH	none	orange ppt.
		I ₂ /OH ⁻	none	yellow ppt./antiseptic smell
CH ₃ CH ₂ CHO	CH ₃ COCH ₃	I ₂ /OH ⁻	none	yellow ppt./antiseptic smell
		Fehling's/Benedict's solution + warm	red ppt.	none
		Tollens' reagent + warm	silver/black ppt.	none
		Cr ₂ O ₇ ²⁻ + H ⁺ + warm	turns green	no change
		MnO ₄ ⁻ + H ⁺ + warm	decolourises	no change

three correct reagents

[3]

three correct positive results

[3]

three × 'none'

[1]

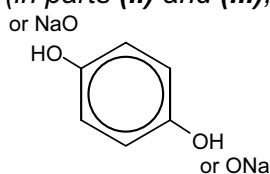
[7]

(c) (i) condensation

[1]

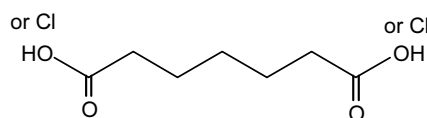
(ii) (in parts (ii) and (iii), allow structural formulae instead of skeletal formulae)

[1] + [1]



E

and



F

(N.B. letters E and F may be reversed.)

(iii) make acyl chloride from F (if not already there)

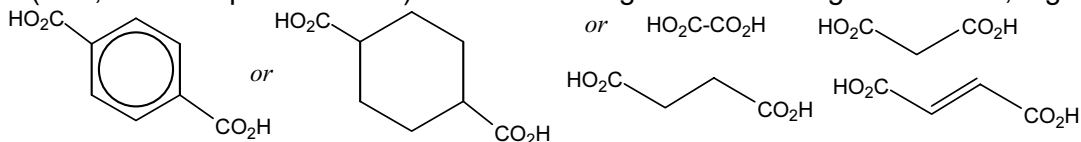
[1]

add that to a solution of E in NaOH(aq)

[1]

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(iv) F (or E, i.e. the aliphatic di-acid) should be changed to something less flexible, e.g.



(any size ring with $n < 6$; any orientation)

(but not $\text{HO}_2\text{C}(\text{CH}_2)_3\text{CO}_2\text{H}$ or longer)

(ignore side chains: length of chain is the important feature)

or allow a tri-carboxylic acid (or triphenol), i.e. one that will allow cross linking

[1]

[6]

[Total: 16]

6 (a)

amino acid	structure	type of interaction
alanine	$\text{H}_2\text{NCH}(\text{CH}_3)\text{CO}_2\text{H}$	van der Waals' (NOT hydrophobic)
cysteine	$\text{H}_2\text{NCH}(\text{CH}_2\text{SH})\text{CO}_2\text{H}$	disulfide bonds or S-S
lysine	$\text{H}_2\text{NCH}((\text{CH}_2)_4\text{NH}_2)\text{CO}_2\text{H}$	ionic/electrovalent hydrogen/H bonds
serine	$\text{H}_2\text{NCH}(\text{CH}_2\text{OH})\text{CO}_2\text{H}$	hydrogen/H bonds

[3]

[3]

(b) Iron – in haemoglobin or **red** blood cells; transport of oxygen/ CO_2

or in myoglobin; transport of oxygen (in muscle)

or in cytochromes; cell respiration

[1]

Potassium – in cell membranes/enzymes; controlling the flow of ions/water into or out of cells

or – in nerves; controlling nerve impulses

or – Na^+ – K^+ pump; nerve impulses/control of cell volume/active transport

[1]

Zinc acting as a cofactor in enzymes (or a named one, e.g. carbonic anhydrase);

or in making of insulin

[1]

[3]

(c) (i) $\text{ATP} + \text{H}_2\text{O} \rightarrow \text{ADP} + \text{Pi}$

[1]

(ii) Hydrolysis or nucleophilic substitution

[1]

[2]

(d) (i) Sodium or chloride (sweat is salty) **and** Potassium (water retention in cells)

[1]

(ii) Hydrogen bonding **and** reference to water or bonding in mucous molecules

[1]

[2]

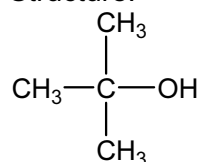
[Total: 10]

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- 7 (a) (i) + (ii) any two from:
- The nature/electronegativity of the atom the proton is attached to *or* is near *or* the electronic/chemical environment of the proton
 - The number/spin states of adjacent protons *or* protons attached to adjacent atoms
 - The (strength of) the applied/external magnetic field [1] + [1]
- [2]**

- (b) (i) Peak at 1.26δ = (3 ×) CH_3 *or* methyl **and** Peak at 2.0δ = $-\text{O}-\text{H}$ *or* alcohol [1]

Structure:



[1]

- | | | | |
|------|---|---|---|
| (ii) | Isomer | Isomer | Isomer |
| | $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{OH}$ | $(\text{CH}_3)_2\text{CHCH}_2\text{OH}$ | $\text{CH}_3\text{CH}_2\text{CH}(\text{CH}_3)\text{OH}$ |
| | 5 groups of peaks | 4 groups of peaks | 5 groups of peaks |

structures of any two isomers (Also allow both stereoisomers of butan-2-ol) [1] + [1]
correct assignation of no. of peaks [1] + [1]
[6]

- (c) (i) Phosphorus – it has more electrons *or* high electron density (NOT phosphate) [1]
- (ii) H atoms don't have enough electron density to show up *or* they only contain one e^- [1]
[2]

[Total: 10]

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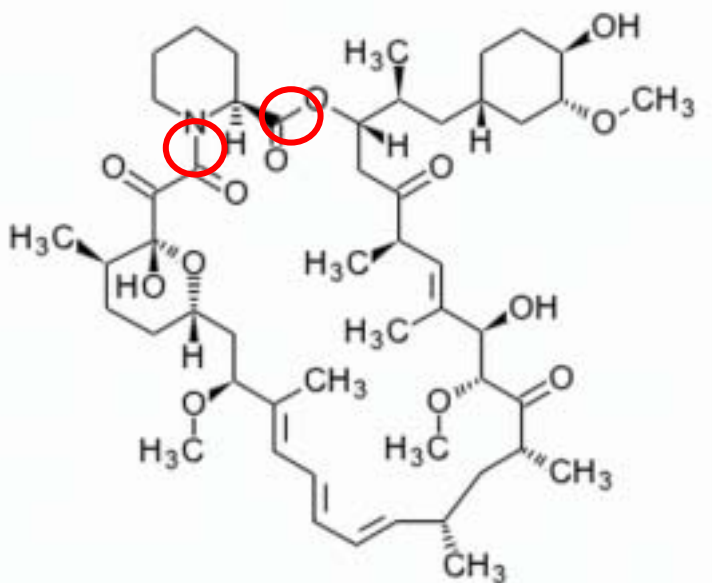
- 8 (a) (i) hydrophilic in area C [1]
fat-soluble in area B [1]

- (ii) A – region would be exposed to the atmosphere/water/enzymes or nothing the molecule can attach to at A [1]
[3]

- (b) (i) amide/peptide or ester [1]

- (ii) hydrolysis [1]

(iii)



[1] + [1]
[4]

- (c) (i) measured in nm, i.e. between 1 and 1000 nm (or 10^{-9} – 10^{-6} m). Any quoted value or range between these limits is acceptable [1]

- (ii) One or both of the –OH groups (NOT just 'oxygen' or 'O') [1]

- (iii) PEG can H-bond (with water) because it is hydrophilic/contains an OH group/contains lots of oxygen atoms [1]
[3]

[Total: 10]

MARK SCHEME for the May/June 2012 question paper
for the guidance of teachers

9701 CHEMISTRY

9701/43

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.

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

- Cambridge will not enter into discussions or correspondence in connection with these mark schemes.

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.

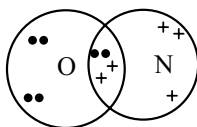


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- 1 (a) (i) the enthalpy change/released when **1 mole is formed** [1]
of ionic lattice **from the gas phase ions** [1]
(ii) $\text{Mg}^{2+} + \text{O}^{2-} \longrightarrow \text{MgO}$ [1]
[3]
- (b) measurements needed:
volume/mass/weight of water (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⁻¹** [3]
[3]
- (d) $\text{Na}_2\text{O(s)} + \text{H}_2\text{O(aq/l)} \longrightarrow 2\text{NaOH(aq)}$ [1]
 $\text{MgO(s)} + \text{H}_2\text{O(aq/l)} \longrightarrow \text{Mg(OH)}_2\text{(s) or Mg(OH)}_2\text{(aq)}$ [1]
pH 12.5-14 [NaOH] **AND** 8-10.5 [Mg(OH)₂] respectively [1]
[3]

[Total: 12]

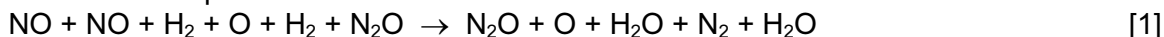
2. (a) (i)



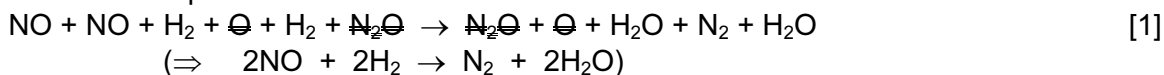
- [1]
- (ii) -180 kJ mol^{-1} [1]
- (iii) (formation of NO is endothermic) so high T **and** equilibrium pushed over to NO side.
or high T **and** needed to break N-N bond in N₂ [1]
- (iv) $-180 = 2 E(\text{NO}) - 994 - 496$ [1]
 $E(\text{NO}) = \mathbf{+655 \text{ kJ mol}^{-1}}$ [1]
[5]
- (b) (i) (from 1 and 2:) as p(NO) halves, rate decreases to 1/4, **so order = 2** [1]
(from 1 and 3:) as p(H₂) halves, so does rate, **so order = 1** [1]
- (ii) $\text{rate} = k p_{\text{NO}}^2 \cdot p_{\text{H}_2}$ [1]
units (of k) are $\text{atm}^{-2} \text{ s}^{-1}$ [1]

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(iii) add all three equations:



cross out all species common to both sides:



(iv) *either: step 2* since it involves H_2

O formed from NO

or: *step 3* since it involves H_2

N_2O formed from NO

[1]

[1]

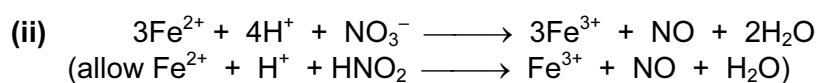
[1]

[1]

[8]

(c) (i) NO

[1]



(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) NaBH_4 or LiAlH_4 (NOT H_2 + Ni)

[1]

[2]

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

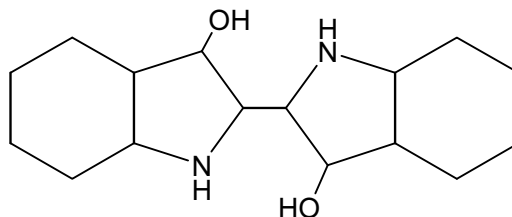
2. Na metal [1] no reaction gas given off/fizzing [1]

or $\text{PCl}_5/\text{SOCl}_2$ [1] no reaction steamy fumes/fizzing [1]
 or PCl_3 + 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]

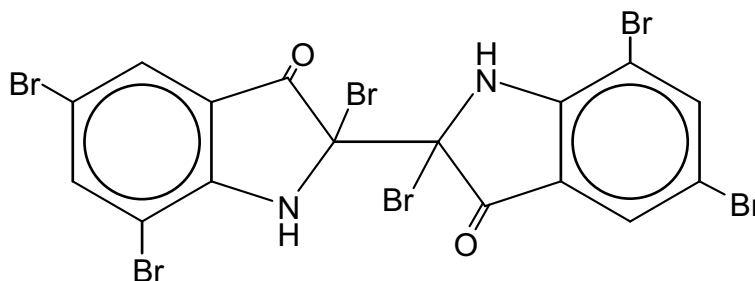
(1 mol indigo absorbs 9 mol of H_2)

so volume of $\text{H}_2 = 9 \times 24 - 9.54 \times 10^{-3} = 2.06 \text{ dm}^3$ (2060 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) CCl_4 does not react with water

[1]

CCl_4 unreactive due to no **d**-orbitals

[1]

GeCl_4 **and** 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 PbSO_4 and C is 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]

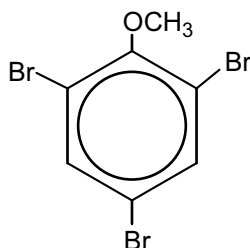
$\text{PbO}_2 + 6\text{HCl} \longrightarrow \text{H}_2\text{PbCl}_6 + 2\text{H}_2\text{O}$ [1]

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

[5 max 4]

[Total: 11]

5 (a) (i)

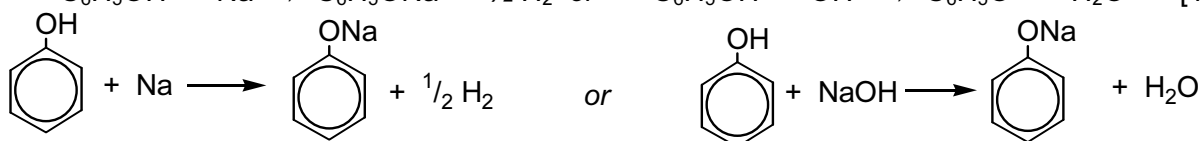


[1]

(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]



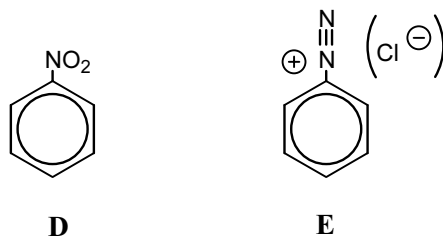
(neutral) iron(III) chloride [1]

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 LiAlH_4 , NaBH_4 [1]
 conc. + reflux (warm is insufficient) [1]

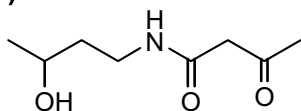
step 4 is conditional of structure E

step 4: warm + in H_2O [1]

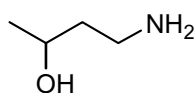
[5 max 4]

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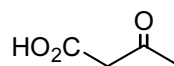
(c) (i)



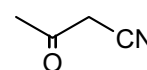
F



G



H



J

F must be an **amide**

[4]

- (ii) reaction 1: $\text{H}_2 + \text{Ni}$ or LiAlH_4
 reaction 2: heat + aqueous 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

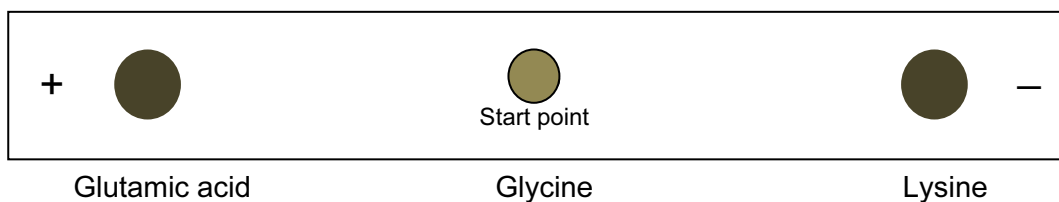
[1]

[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]

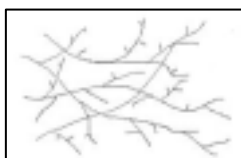
(c) (i) $156 = \text{C}_3\text{H}_6^{35}\text{Cl}^{79}\text{Br}^+$ [1]
 $158 = \text{C}_3\text{H}_6^{37}\text{Cl}^{79}\text{Br}^+$ [1]
 $158 = \text{C}_3\text{H}_6^{35}\text{Cl}^{81}\text{Br}^+$ [1]
 $160 = \text{C}_3\text{H}_6^{37}\text{Cl}^{81}\text{Br}^+$ [1]

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

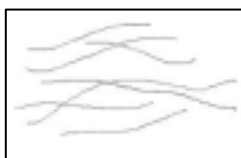
[Total: 10]

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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 ₂ O/HCl	small molecule /H ₂ 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 π bonds/p-orbitals overlap (with each other)

[1]

(iii) C₈H₆
C₄H₃

[2]

[5 max 4]

[Total: 10]