

**MARK SCHEME for the October/November 2009 question paper
for the guidance of teachers**

9701 CHEMISTRY

9701/41

Paper 41 (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.

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

CIE is publishing the mark schemes for the October/November 2009 question papers for most IGCSE, GCE Advanced Level and Advanced Subsidiary Level syllabuses and some Ordinary Level syllabuses.



Page 2	Mark Scheme: Teachers' version	Syllabus	Paper
	GCE A/AS LEVEL – October/November 2009	9701	41

- 1 (a) CO₂ is a gas (at room temperature); SiO₂ is a high melting solid [1]
CO₂: simple / discrete molecular / covalent [1]
SiO₂: giant covalent or macromolecular / giant molecular [1]
[3]
- (b) (a substance that is..) hard, high melting, electrical insulator any two [1]
SiO₂ has **strong covalent** bonds (can be in (a)) [1]
[2]
- (c) (i) amphoteric [1]
- (ii) 2NaOH + PbO → Na₂PbO₂ + H₂O [1]
(or NaOH + PbO + H₂O → NaPb(OH)₃ etc.) [2]
- (d) (i) Zn + Sn⁴⁺ → Zn²⁺ + Sn²⁺ [1]
- (ii) E^θ = 0.15 – (–0.76) = **0.91 V** [1]
E^θ = 1.52 – 0.15 = **1.37 V** [1]
- (iii) n(Sn²⁺) = 0.02 × 13.5/1000 × 5/2 = **6.75 × 10^{–4}** mol use of the 5/2 ratio [1]
correct rest of working [1]
n(Sn²⁺) = 0.02 × 20.3/1000 × 5/2 = **1.02 × 10^{–3}** mol [1]
- (iv) n(Sn⁴⁺) = 1.02 × 10^{–3} – 6.75 × 10^{–4} = 3.45 × 10^{–4} mol [1]
∴ ratio = 6.75/3.45 = 1.96:1 ≈ **2:1**
∴ formula is 2SnO + SnO₂ ⇒ **Sn₃O₄** (cond^l on calculation, but allow ecf) [1]
[8]
- (e) (i) volume = 1 × 1 × 1 × 10^{–5} = 1 × 10^{–5} m³ or **10 cm³** [1]
- (ii) mass = vol × density = 10 × 7.3 = **73 g** ecf [1]
moles = mass/A_r = 73/119 = **0.61 mol** ecf [1]
- (iii) Q = nFz = 0.61 × 9.65 × 10⁴ × 2 = **1.18 (1.2) × 10⁵** coulombs ecf [1]
[4]

[Total: 19]

Page 3	Mark Scheme: Teachers' version	Syllabus	Paper
	GCE A/AS LEVEL – October/November 2009	9701	41



(b) CaF_2 and CaS both have larger lattice energies (than CaCl_2) [1]

(i) F^{-} is smaller than Cl^{-} [1]

(ii) S^{2-} is more highly charged than Cl^{-} [1]
[3]

(c) $\text{LE} = -[178 + 590 + 1150] - [244 - 2 \times 349] - 796$ signs✓
 $\quad \quad \quad \checkmark \quad \quad \quad \checkmark$
 $\quad \quad \quad = -2260 \text{ (kJ mol}^{-1}\text{)}$ [3]
[3]

(d) (i) $\text{Ca} = 28.2/40.1 = 0.703 \Rightarrow 1$
 $\text{C} = 25.2/12 = 2.10 \Rightarrow 3$
 $\text{H} = 1.4/1 = 1.4 \Rightarrow 2$
 $\text{O} = 45.1/16 = 2.82 \Rightarrow 4$ (1 mark for initial step of calc'n)

formula is $\text{CaC}_3\text{H}_2\text{O}_4$ (1) [2]

(ii) malonic acid must be $\text{C}_2\text{H}_4\text{O}_4$, i.e. $\text{CH}_3(\text{CO}_2\text{H})_2$ (must be structural) [1]
[3]

[Total: 10]

3 (a) d-orbitals split into two / different levels
light is absorbed
electron is promoted from a lower to a higher level
colour observed is the complement of the colour absorbed
 $E = hf$ any 3 points [3]
[3]

(b) (i) $[\text{Cu}(\text{H}_2\text{O})_6]^{2+}$ is pale blue [1]
 $[\text{Cu}(\text{NH}_3)_4(\text{H}_2\text{O})_2]^{2+}$ is deep / dark blue or purple [1]

(ii) because it has a larger absorbance peak or a larger ϵ_o value [1]
because λ_{max} is in the visible region (hence more visible light is absorbed) [1]

(iii) curve will have λ_{max} between >600 nm and 800 nm [1]
with maximum ϵ_o in between the other two [1]
[6]

(c) (i) $K_c = [\text{CuCl}_4^{2-}]/([\text{Cu}^{2+}][\text{Cl}^{-}]^4)$ units are $\text{mol}^{-4} \text{ dm}^{12}$ [1] + [1]

(ii) $[\text{CuCl}_4^{2-}]/[\text{Cu}^{2+}] = K_c[\text{Cl}^{-}]^4 = 672$ (no units) [1]
[3]

[Total: 12]

Page 4	Mark Scheme: Teachers' version	Syllabus	Paper
	GCE A/AS LEVEL – October/November 2009	9701	41

- 4 (a) (cyclohexanol & phenol) hydrogen bonding to (solvent) water molecules [1]
 due to OH group [1]
 [2]

- (b) phenoxide anion is more stable (than cyclohexoxide) / OH bond is weaker [1]
 due to delocalisation of charge / lone pair over the ring [1]
 [2]

(c)

reagent	product with cyclohexanol	product with phenol
Na(s)	RONa or RO ⁻ Na ⁺	ArONa or ArO ⁻ Na ⁺
NaOH(aq)	no reaction	ArONa or ArO ⁻ Na ⁺
Br ₂ (aq)	no reaction	tribromophenol
I ₂ (aq) + OH ⁻ (aq)	no reaction	no reaction
an excess of acidified Cr ₂ O ₇ ²⁻ (aq)	cyclohexanone	no reaction

five correct products 5 × [1]

five correct "no reaction"s [2]

(4 correct = [1]; 3 correct = [0])

[7]

- (d) *either* Br₂(aq): no reaction with cyclohexanol; decolourises *or* white ppt with phenol

or Cr₂O₇²⁻ + H⁺: turns from orange to green with cyclohexanol; no reaction with phenol

correct reagent chosen **and** the correct "no reaction" specified [1]

correct positive observation [1]

[2]

[Total: 13]

Page 6	Mark Scheme: Teachers' version	Syllabus	Paper
	GCE A/AS LEVEL – October/November 2009	9701	41

- 6 (a)** All three amino acids correctly paired (2)
Two amino acids correctly paired (1)
One labelled H-bond between strands (1) [3]
- (b) (i)** tRNA – each amino acid has its own specific / appropriate tRNA (1)
– carry amino acids to ribosomes / mRNA (1)
– contains a triplet code / anticodon (1)
- (ii)** ribosome – attaches / moves along / binds to mRNA (1)
– assemble amino acids in correct sequence for / synthesises protein (1) [5]
- (c) (i)** Base miscopied / deleted (1)
- (ii)** Sequence of bases is changed (1)
This may result in different amino acid sequence – different protein (1)
Can affect shape / tertiary structure of protein (1) [Max 3]

[Total: 12 max 11]

Page 7	Mark Scheme: Teachers' version	Syllabus	Paper
	GCE A/AS LEVEL – October/November 2009	9701	41

- 7 (a) (i) Positions of atomic nuclei / atoms (1)
- (ii) Insufficient electrons / electron density / electron cloud (around H atom) (1) [2]
- (b) X-ray crystallography can show the geometry of the arrangement of atoms / bonding between atoms / shape of atoms (1)
- This can help explain how e.g. enzymes work (any reasonable example) (1) [2]
- (c) (i) Nuclear spin (1)
- (ii) (If M : M+1 gives a ratio 15 : 2)
- Then $x = \frac{100 \times 2}{1.1 \times 25} = 7$ (1)
- Single peak at 3.7 δ due to $-\text{O}-\text{CH}_3$ (1)
- Single peak at 5.6 δ due to phenol / OH (1)
- 1,2,1 peak at 6.8 δ due to hydrogens on benzene ring (1)
- Pattern suggests 1,4 substitution (1)
- (x = 7,) y = 8, z = 2 (1)
- Compound is 4-methoxyphenol (1)
- Max 5 [6]

[Total: 10]

Page 8	Mark Scheme: Teachers' version	Syllabus	Paper
	GCE A/AS LEVEL – October/November 2009	9701	41

8 (a) Graphite / graphene (1)

(b) They do not exist as sheets / layers of carbon atoms (1)

(c) The lengths of nanotubes are much shorter than the curvature of the paper / they are so small that they are not effected by rolling (1)

(d) Any molten ionic salt (or plausible organic ionic compounds) (1)

[Total: 4]

9 (a) (i) Covalent / co-ordinate (1)

(ii) Mechlorethamine – binds the two chains together (1)
– prevents unravelling (1)

Cis-platin – binds to two Gs / bases in one chain (1)
– so they are not available for base pairing (1)

[Total: 5]

**MARK SCHEME for the October/November 2009 question paper
for the guidance of teachers**

9701 CHEMISTRY

9701/42

Paper 42 (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.

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

CIE is publishing the mark schemes for the October/November 2009 question papers for most IGCSE, GCE Advanced Level and Advanced Subsidiary Level syllabuses and some Ordinary Level syllabuses.



Page 2	Mark Scheme: Teachers' version	Syllabus	Paper
	GCE A/AS LEVEL – October/November 2009	9701	42

- 1 (a) Sulfates become **less soluble** down the group [1]
both lattice energy and hydration (are involved) [1]
but hydration energy decreases more than lattice energy
or HE becomes less than LE or HE decreases whereas LE is almost constant [1]
(due to cationic radius increasing) [3]
- (b) (i) $n(\text{CO}) = pV/RT = 1.01 \times 10^5 \times 140 \times 10^{-3} / (8.31 \times 450) = \mathbf{3.78}$
or $= 140 \times (273/450) / 22.4 = \mathbf{3.79}$
allow $= 140 \times (298/450) / 24.0 = 3.86$ [1]
- (ii) $n(\text{BaSO}_4) = n(\text{CO})/4 = \mathbf{0.945}$ moles (or 0.9475) [1]
If RTP used answer is **0.966**
- (iii) $M_r = 233$, [1]
so $0.945 \text{ mol} = 0.945 \times 233 = 220\text{g} \Rightarrow 100 \times 220/250 = \mathbf{88(.07)\%}$
(or $0.9475 \text{ mol} \Rightarrow 220.8\text{g} \Rightarrow 88(.3)\%$) [1]
If RTP used answer is **90(.0)%** [4]
- (c) (i) from data booklet, 1^{st} IE = 502; 2^{nd} IE = 966; sum = 1468 kJ mol^{-1}
so $-460 = 1468 + 180 + 279 - 200 + 640 + \text{LE}$
 $-460 = 2367 + \text{LE}$
 $\text{LE} = \mathbf{-2827 \text{ kJ mol}^{-1}}$
(–1 for each error) [3]
- (ii) LE of BaS should be smaller than that of BaO, since S^{2-} is bigger than O^{2-} . [1]
[4]

[Total: 11]

Page 3	Mark Scheme: Teachers' version	Syllabus	Paper
	GCE A/AS LEVEL – October/November 2009	9701	42

2 (a) ethylamine > NH₃, but phenylamine < NH₃ [1]

in ethylamine, the alkyl group donates electrons to the N, making lone pair more available [1]

in phenylamine, the lone pair is delocalised over the ring, so is less available [1]
[3]

(b)

halide	observation when AgNO ₃ (aq) is added	observation when dilute NH ₃ (aq) is added	observation when concentrated NH ₃ (aq) is added
chloride	white ppt	dissolves	dissolves
bromide	cream ppt	no reaction / slightly dissolves	dissolves
iodide	(pale) yellow ppt	no reaction	no reaction

[1]

[1]

[1]

[3]

(c) (i) $[Ag^+(aq)] = \sqrt{K_{sp}} = \sqrt{(5 \times 10^{-13})} = 7.1 \text{ (7.07)} \times 10^{-7} \text{ mol dm}^{-3}$ [1]

(ii) AgBr will be **less soluble** in KBr, due to common ion effect *or* equilibrium is shifted to the left / or by Le Chatelier's principle [1]
[2]

(d) (i) $K_c = [Ag(RNH_2)_2^+]/[Ag^+][RNH_2]^2$ [1]
units are mol⁻² dm⁶ [1]

(ii) assume that most of the Ag⁺(aq) has gone to the complex, then

$$[Ag^+(aq)] = 7.1 \times 10^{-7}$$

$$[Ag(NH_3)_2^+] = 0.1$$

$$\text{and } [NH_3] = \sqrt{\{[Ag(NH_3)_2^+]/(K_c[Ag^+])\}} = \sqrt{\{0.1/(1.7 \times 10^7 \times 7.1 \times 10^{-7})\}} \quad [1]$$

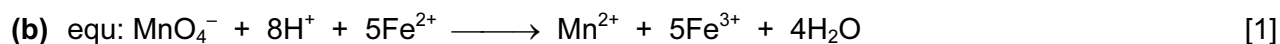
$$= 0.091 \text{ mol dm}^{-3} \quad [1]$$

(iii) When R = C₂H₅, K_c is likely to be greater, since the ethyl group will cause the lone pair on N to be more available / nucleophilic / increases basicity [1]
[5]

[Total: 13]

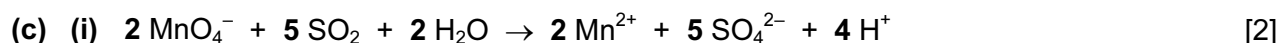
Page 4	Mark Scheme: Teachers' version	Syllabus	Paper
	GCE A/AS LEVEL – October/November 2009	9701	42

- 3 (a)** Any two from: high(-ish) density of metal
variable oxidation states
ability to form complexes
formation of coloured compounds
incomplete d subshell
high m.p. / b.p. [1] + [1]
[2]

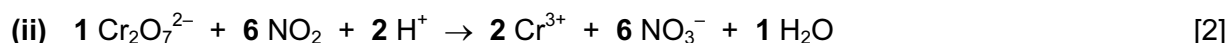


method: Take a known volume of $\text{Fe}^{2+}(\text{aq})$ /in a pipette and place in (conical) flask
Add an excess of (dil) H_2SO_4
Titrate until end point is reached and note volume used
End point is first permanent pink colour
Repeat titration & take average of consistent readings

any 3 points [3]
[4]



oxidation numbers: **+7** **+4** **+2** **+6** [1]



oxidation numbers: **+6** **+4** **+3** **+5** [1]

([2] marks for each equation: [1] for balancing of redox species,
[1] for total balancing: i.e. H_2O and H^+)

[6]

- (d)** Fe^{3+} is a homogeneous (catalyst)
 Fe^{3+} oxidised I^- (and is reduced to Fe^{2+})
 Fe^{2+} reduces $\text{S}_2\text{O}_8^{2-}$ (and is oxidised to Fe^{3+})
or equations showing this

any two points [2]
[2]

[Total: 14]

Page 5	Mark Scheme: Teachers' version	Syllabus	Paper
	GCE A/AS LEVEL – October/November 2009	9701	42

- 4 (a) The energy required to break.... [1]
.....1 mole of bonds in the gas phase [1]
[2]

- (b) HCl: nothing happens AND HI: purple fumes (at a low temperature) [1]
purple is **iodine** formed (or in an equation: $2\text{HI} \longrightarrow \text{H}_2 + \text{I}_2$) [1]
H-X bond energy becomes smaller/weaker down the group [1]
[3]

- (c) data needed: F-F = 158
Cl-Cl = 244
 $6 E(\text{Cl-F}) - 328 = 3 \times 158 + 244$
 $E(\text{Cl-F}) = +174 \text{ (kJ mol}^{-1}\text{)}$ [2]
[2]

[Total: 7]

- 5 (a)

compound	all carbon atoms can be coplanar	not all carbon atoms coplanar
A	✓	
B		✓
C	✓	
D	✓	
E	✓	

all 5 correct [3]
(4 correct: [2], 3 correct: [1], <3 correct: [0]) [3]

- (b) reaction I: $\text{Cl}_2 + \text{AlCl}_3 / \text{FeCl}_3 / \text{Fe} / \text{or bromides of Al or Fe}$ [1]
reaction II: $\text{Cl}_2 + \text{heat} / \text{light} / \text{uv} / \text{hf}$ [1]
[2]

- (c) (i) H is $\text{C}_6\text{H}_5\text{CH}_2\text{Cl}$ [1]
(ii) reaction III: $\text{KMnO}_4 + \text{heat} (+ \text{OH}^-)$ [1]
reaction V: NaOH in water + heat [1]
reaction VI: conc $\text{H}_2\text{SO}_4 + \text{heat}$ [1]
(iii) reaction III: oxidation [1]
reaction V: hydrolysis or nucleophilic substitution [1]
[6]

[Total: 11]

Page 6	Mark Scheme: Teachers' version	Syllabus	Paper
	GCE A/AS LEVEL – October/November 2009	9701	42

- 6 (a) L is $\text{CH}_3\text{CH}_2\text{Br}$
M is $\text{CH}_3\text{CO}_2\text{H}$
N is $\text{CH}_3\text{CH}_2\text{NH}_2$
Q is $\text{CH}_3\text{CH}_2\text{CO}_2\text{H}$
P is $\text{CH}_3\text{CH}_2\text{CH}_2\text{NH}_2$
J is $\text{CH}_3\text{CH}_2\text{CONHCH}_2\text{CH}_3$
K is $\text{CH}_3\text{CONHCH}_2\text{CH}_2\text{CH}_3$ [7]
[7]
- (b) reaction I: KCN, heat NOT H^+ OR HCN aq negates [1]
reaction II: SOCl_2 or PCl_5 or PCl_3 BUT aq negates [1]
reaction IV: $\text{H}_2 + \text{Ni}$ or LiAlH_4 or NaBH_4 NOT $\text{Sn} + \text{HCl}$ [1]
[3]
- (c) reaction IV: reduction [1]
reaction VI: nucleophilic substitution or condensation reaction [1]
[2]
- (d) (i) amide [1]
(ii) amine [1]
[2]
- [Total: 14]
- 7 (a) Primary: Covalent bond (ignore amide, peptide etc.) [1]
Diagram showing peptide bond: $(-\text{CHR}-)\text{CONH}(-\text{CHR}-)$ [1]
- Secondary: Hydrogen bonds (NOT between side chains) [1]
Diagram showing $\text{N}-\text{H}\cdots\text{O}=\text{C}$ [1]
- Tertiary: **Two** of the following:
 - hydrogen bonds (diagram **must** show H-bonds *other* than those in α -helix or β -pleated sheet – e.g. ser-ser)
 - electrostatic/ionic attraction,
 - Van der Waals'/hydrophobic forces/bonds,
 - (covalent) disulphide (links/bridges) [1] + [1]
Suitable diagram of **one** of the above [1]
(for disulphide: S-S **not** S=S or SH-SH)
[**max 6**]
- (b) Substrate binds to the active site of the enzyme [1]
Interaction with site causes a specific bond to be weakened, (which breaks)
Or change in shape weakens bond(s) / lowers activation energy [1]
[2]
- (c) Non-competitive inhibition [1]
Rate never reaches V_{max} [1]
[2]
- [Total: 10]

Page 7	Mark Scheme: Teachers' version	Syllabus	Paper
	GCE A/AS LEVEL – October/November 2009	9701	42

- 8 (a) Ratio of the concentrations of a solute / distribution of solute [1] in two immiscible liquids [1]
[2]

(b) $K_c = \frac{[\text{pesticide in hexane}]}{[\text{pesticide in water}]}$ hence $8.0 = \frac{[\text{pesticide in hexane}]}{0.0050 - [\text{pesticide in hexane}]}$ [1]

Therefore $[\text{pesticide in hexane}] = x = 0.040 - 8x$

Hence $x = 0.0044(\text{g})$

[1]

[2]

- (c) (i) Ratio would be 3 : 1 [1]

(ii) Each chlorine atom could be ^{35}Cl or ^{37}Cl

Only way of getting M+4 is for both chlorines to be ^{37}Cl (1 in 9 chance)

[1]

Ratio of peaks M M+2 M+4
 9 6 1

[1]

[3]

- (d) (i) Accept dioxins and furans (without specifying) [1]

(ii) PCBs (but don't penalise non-specified dioxins and furans) [1]

(iii) Allow : pollution control / environmental legislation / removal of dioxins and furans / mill closed down (owtte) [1]

(iv) Five [1]

[4]

[Total: 11]

