

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

9701/42

9701 CHEMISTRY

Paper 42 (A2 Structured Questions),
maximum raw mark 100

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

1 (a) Sulfates become **less soluble** down the group
 both lattice energy and hydration (are involved)
 but hydration energy decreases more than lattice energy
 or HE becomes less than LE or HE decreases whereas LE is almost constant
 (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 $0.945 \text{ mol} = 0.945 \times 233 = 220\text{g} \Rightarrow 100 \times 220/250 = \mathbf{88(.07)\%}$ [1]
 (or $0.9475 \text{ mol} \Rightarrow 220.8\text{g} \Rightarrow 88(.3)\%$)
 If RTP used answer is **90(.0)%** [4]

(c) (i) from data booklet, 1st IE = 502; 2nd 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 S²⁻ is bigger than O²⁻. [1]
 [4]

[Total: 11]

2 (a) ethylamine > NH₃, but phenylamine < NH₃

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

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) $K_c = \frac{[Ag(RNH_2)_2^+]}{[Ag^+][RNH_2]^2}$
units are mol⁻² dm⁶

[1]

[1]

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

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

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

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

$$= 0.091 \text{ mol dm}^{-3}$$

[1]

[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

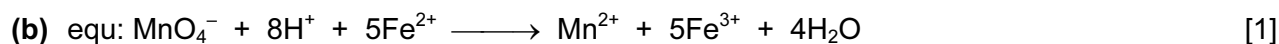
[1]

[5]

[Total: 13]

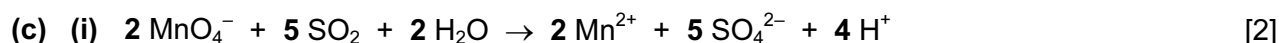
Page 4	Mark Scheme: Teachers' version	Syllabus
	GCE A/AS LEVEL – October/November 2009	9701

- 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]

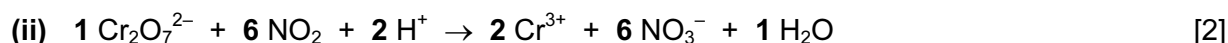


method: Take a known volume of $\text{Fe}^{2+}(\text{aq})$ in a pipette and place in (conical) flask
 Add an excess of (dil) H_2SO_4
 Titrate until end point is reached and note volume used
 End point is first permanent pink colour
 Repeat titration & take average of consistent readings

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]

- 4 (a) The energy required to break....
.....1 mole of bonds in the gas phase
- (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: $\text{Cl}_2 + \text{AlCl}_3 / \text{FeCl}_3 / \text{Fe} /$ 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
	GCE A/AS LEVEL – October/November 2009	9701

- 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 Sn + 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
	GCE A/AS LEVEL – October/November 2009	9701

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

(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]

