UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the October/November 2006 question paper

9701 CHEMISTRY

9701/04 Paper 4 (Theory 2), maximum raw mark 60

This mark scheme is published as an aid to teachers and students, 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.

All Examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

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

The grade thresholds for various grades are published in the report on the examination for most IGCSE, GCE Advanced Level and Advanced Subsidiary Level syllabuses.

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1 (a) boiling points increase down the group (because of...) (1)

...larger van der Waals/intermolecular attractions *or* bigger induced dipoles (1)

due to more electrons per molecule (1) **[3]**

(b) tetrahedral - clear from diagram (1)
angles = 109°-110° (1) **[2]**

(c) **(i)** four bonded pairs + 2 lone pairs around Xe (1)
three lone pairs on at least one F atom (1)

(ii) square planar (can be read into **very clear** diagram in **(i)**) (1)
angles = 90° (1) **[4]**

(d) CCl_4 does not react *or* $SiCl_4$ does (*or* read into an equation) (1)

due to presence of available/low-lying/d-orbitals on Si (1)

$SiCl_4 + 2H_2O \longrightarrow SiO_2 + 4HCl$
(*or* $SiCl_4 + 4H_2O \longrightarrow Si(OH)_4 + 4HCl$ etc: also allow partial hydrolysis) (1) **[3]**

(e) $PbCl_4 + \_\_\mathbf{8}\_\_Na + \_\_\mathbf{4}\_\_C_2H_5Cl \longrightarrow Pb(C_2H_5)_4 + \_\_\mathbf{8}\_\_NaCl$ (1)

$Pb(C_2H_5)_4 = 207 + 4x29 = 323$ (1)

323g needs 8 x 23 = 184g Na

$\therefore$ 1000g needs 1000 x 184/323 = **569 or 570**g ecf from equn (1)
(correct ans = (2) marks)

(alternative method:
1.0kg of $Pb(C_2H_5)_4$ is 3.096 moles (1)
*$\therefore$ we need 8 x 3.096 = 24.77 moles of Na, which is **569 or 570**g)* (1) **[3]**

[Total: 15]

2 (a) (i) [one chiral centre only] (1)

(ii) $C_{13}H_{18}O_2$ (1)

(iii) M_r = 206 ecf (1)

mass = 0.15 x (100/1000) x 206 = **3.1** g ecf (1)
(correct ans = (2) marks)

(iv) n(NaOH) = 0.1 x 12/100 = 1.2×10^{-3} moles (1)

n(**A**) = 0.6×10^{-3}, so $M_r = 0.1/(0.6 \times 10^{-3})$ = **167** (allow 166-170) (1)
(correct ans = (2) marks)

This fits with **$HO_2C\text{-}C_6H_4\text{-}CO_2H$** (which has M_r = 166) (1) **[7]**

(b) (i) (K_a =) $[H^+][A^-]/[HA]$ (1)

(ii) $[H^+] = \sqrt{K_a}.c = \sqrt{6.3 \times 10^{-6} \times 0.15} = 9.72 \times 10^{-4}$ (1)

pH = **3.0** (1)
(correct ans = (2) marks) **[3]**

(c) (i) one that **resists/control/maintains** changes in pH (**NOT *no*** change in pH) (1)

when **small amounts** of acid/H^+ (or base/OH^-) are added. (1)

(ii) $HPO_4^{2-} + H^+ \longrightarrow H_2PO_4^-$ (1)
$H_2PO_4^- + OH^- \longrightarrow HPO_4^{2-} + H_2O$ (1)

(iii) pH = pK_a + log ([base]/[acid])
= 7.2 + log (.002/.005) = **6.8** (2)
(correct ans = (2) marks: deduct (1) for each error,
e.g. if ratio is upside down, hence pH = 7.6, answer is worth (1)) **[6]**

[Total: 16 max 15]

3 (a) (i) $2Ca(NO_3)_2 \longrightarrow 2CaO + 4NO_2 + O_2$ (*or* x ½) (1)

(ii) (Down the group the nitrates)

become more stable *or* are more difficult to decompose

or need a higher temperature (to decompose) (1)

because the radius of **cation/Group II ion//M^{2+}** increases
or charge density **of the cation** decreases (1)

thus causing less polarisation/distortion **of the anion/NO_3^-/nitrate** (1) **[4]**

(b) "molar mass" of mixture = 211.6 + 3 x 12 = 247.6 (1)

10 g is thus 10/247.6 = 0.040(4) moles (allow ecf for 0.047(3), from M_r = 211.6) (1)

no of moles of gas produced = 0.0404 x 4 = 0.162 moles (ecf: 0.189 mol)

∴volume = 0.1616 x 24 = **3.88 or 3.9** dm^3 (allow ecf for 4.54 dm^3) (1)
(correct ans = (3) marks)

(alternative method:
1 mole/247.6g of mixture will produce 4 x 24 = 96 dm^3 of gas (1)
*∴10g of mixture will produce 96 x 10/247.6 = **3.88 or 3.9** dm^3)* (1) **[3]**

(c) (CO is poisonous...)

due to complexing/ligand exchange with (Fe of) haemoglobin (1)
(**NOT** redox involving Fe^{2+}/Fe^{3+})

stopping O_2 being transported around body/in blood/to tissues/from lungs (1) **[2]**

[Total: 9 max 8]

4 (a) (i) light *or* heat [aq or $AlCl_3$ negates] (1)

(ii) $NaOH/KOH/alkali/OH^-$ (1)
in alcohol/ethanol + heat [aq negates] (1)

(iii) $[-CH_2CH(C_6H_5)-]$ [C-C not needed, but C=C is wrong] (1)

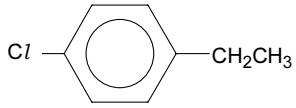
(iv) $CH_2=CHCN$ [C=C **is** needed here] (1) **[5]**

(b) (i) $/OH^-(aq)/NaOH(aq)$/aqueous alkali/ + heat [aq or solution or dil etc. needed] (1)

(ii) (pale) yellow ppt/crystals (**NOT** orange or orange-yellow) (1)

(iii) **C/D** is $C_6H_5CO_2Na$ ✓ **D/C** is CHI_3 ✓ (1) + (1) **[4]**

(c) (i)



(1)

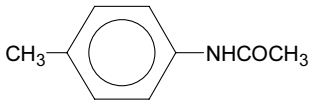
(ii) needs $AlCl_3$ or similar [light or aq negates] (1)

(iii) (hot) $KMnO_4(aq)$ + OH^- or H^+ [NOT $Cr_2O_7^{2-}$] (1) **[3]**

[Total: 12]

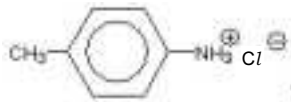
5 (a) (i) Br_2**(aq)** (*or* solution *or* in an inert solvent) [light or $AlCl_3$ etc negates] (1)

(ii) **G** is



(1)

H is



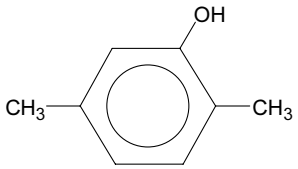
[charges needed] (1)

(iii) amide [NOT peptide] (1) **[4]**

(b) IV: H^+/HCl + $NaNO_2$ *or* HNO_2/nitrous acid (1)

$0°C \leq T \leq 10°C$ ["REFLUX" negates] (1)

V:



(1)

in NaOH(**aq**) (1) **[4]**

(c) To increase its solubility in water *or* to increase binding to food components (1)

due to ionic solvation *or* more oxygen atoms to H-bond to H_2O/glucose etc (1) **[2]**

[Total: 10]