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

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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]

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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]

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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]

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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)

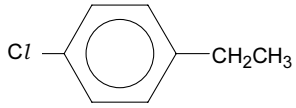
(iv) $CH_2=CHCN$ [C=C **is** needed here] (1) **[5]**

(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]

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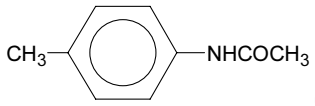
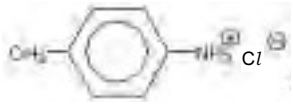
5 (a) (i) Br_2**(aq)** (*or* solution *or* in an inert solvent) [light or $AlCl_3$ etc negates] (1)

(ii) **G** is



(1)

H is



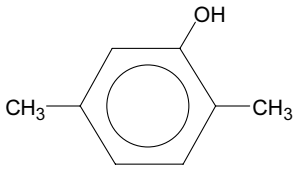
[charges needed] (1)

(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]

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