

## 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.

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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)
- (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<sub>4</sub> does not react or SiCl<sub>4</sub> does (or read into an equation) (1)  
 due to presence of available/low-lying/d-orbitals on Si (1)
- SiCl<sub>4</sub> + 2H<sub>2</sub>O → SiO<sub>2</sub> + 4HCl  
 (or SiCl<sub>4</sub> + 4H<sub>2</sub>O → Si(OH)<sub>4</sub> + 4HCl etc: also allow partial hydrolysis) (1) [3]
- (e) PbCl<sub>4</sub> + 8 Na + 4 C<sub>2</sub>H<sub>5</sub>Cl → Pb(C<sub>2</sub>H<sub>5</sub>)<sub>4</sub> + 8 NaCl (1)  
 Pb(C<sub>2</sub>H<sub>5</sub>)<sub>4</sub> = 207 + 4x29 = 323 (1)  
 323g needs 8 x 23 = 184g Na  
 ∴ 1000g needs 1000 x 184/323 = **569 or 570g** ecf from equn (1)  
 (correct ans = (2) marks)
- (alternative method:  
 1.0kg of Pb(C<sub>2</sub>H<sub>5</sub>)<sub>4</sub> is 3.096 moles (1)  
 ∴ we need 8 x 3.096 = 24.77 moles of Na, which is **569 or 570g**) (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 =  $0.15 \times (100/1000) \times 206 = 3.1$  g ecf (1)  
(correct ans = (2) marks)
- (iv)  $n(\text{NaOH}) = 0.1 \times 12/100 = 1.2 \times 10^{-3}$  moles (1)
- $n(\text{A}) = 0.6 \times 10^{-3}$ , so  $M_r = 0.1/(0.6 \times 10^{-3}) = 167$  (allow 166-170) (1)  
(correct ans = (2) marks)
- This fits with **HO<sub>2</sub>C-C<sub>6</sub>H<sub>4</sub>-CO<sub>2</sub>H** (which has  $M_r = 166$ ) (1) [7]
- (b) (i) ( $K_a =$ )  $[H^+][A^-]/[HA]$  (1)
- (ii)  $[H^+] = \sqrt{K_a \cdot c} = \sqrt{6.3 \times 10^{-6} \times 0.15} = 9.72 \times 10^{-4}$  (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 =  $pK_a + \log ([\text{base}]/[\text{acid}])$   
=  $7.2 + \log (.002/.005) = 6.8$  (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)  $2\text{Ca}(\text{NO}_3)_2 \longrightarrow 2\text{CaO} + 4\text{NO}_2 + \text{O}_2$  (or  $\times \frac{1}{2}$ ) (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/ $\text{NO}_3^-$ /nitrate** (1) [4]
- (b) "molar mass" of mixture =  $211.6 + 3 \times 12 = 247.6$  (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 =  $0.0404 \times 4 = 0.162$  moles (ecf: 0.189 mol)  
 $\therefore$  volume =  $0.1616 \times 24 = \mathbf{3.88 \text{ or } 3.9 \text{ dm}^3}$  (allow ecf for  $4.54 \text{ dm}^3$ ) (1)  
 (correct ans = (3) marks)
- (*alternative method:*  
 1 mole/247.6g of mixture will produce  $4 \times 24 = 96 \text{ dm}^3$  of gas (1)  
 $\therefore$  10g of mixture will produce  $96 \times 10/247.6 = \mathbf{3.88 \text{ or } 3.9 \text{ dm}^3}$ ) (1) [3]
- (c) (CO is poisonous...)  
 due to complexing/ligand exchange with (Fe of) haemoglobin (1)  
 (**NOT** redox involving  $\text{Fe}^{2+}/\text{Fe}^{3+}$ )  
 stopping  $\text{O}_2$  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]

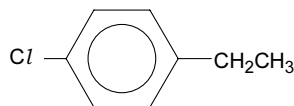
(b) (i)  $/OH^-(aq)/NaOH(aq)/aqueous\ alkali/ + heat$  [aq or solution or dil etc. needed] (1)

(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)

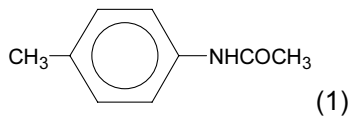
[3]

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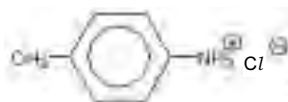
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5 (a) (i)  $\text{Br}_2(\text{aq})$  (or solution or in an inert solvent) [light or  $\text{AlCl}_3$  etc negates] (1)

(ii) G is



H is



[charges needed] (1)

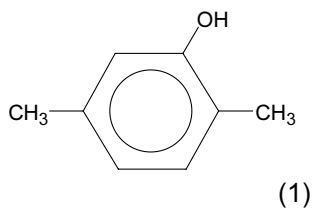
(iii) amide [NOT peptide] (1)

[4]

(b) IV:  $\text{H}^+/\text{HCl} + \text{NaNO}_2$  or  $\text{HNO}_2$ /nitrous acid (1)

$0^\circ\text{C} \leq T \leq 10^\circ\text{C}$  ["REFLUX" negates] (1)

V:



in  $\text{NaOH}(\text{aq})$  (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  $\text{H}_2\text{O}$ /glucose etc (1)

[2]

[Total: 10]