GCE

Edexcel GCE

Chemistry (8080, 9080)

6244/01

Summer 2005

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Mark Scheme (Results)

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IGNORE state symbols in all equations

1.	(a)	(i)	(Magnesium oxide is) ionic / electrovalent	**(1)**	
			(Sulphur dioxide is) covalent *NOT* giant / dative	**(1)**	**(2 marks)**
		(ii)	$MgO + H_2O \rightarrow Mg(OH)_2$ *OR* $MgO + H_2O \rightarrow Mg^{2+} + 2OH^-$	**(1)**	
			Contains/produces OH^- ions *This mark is dependent on an OH in the product of the equation*	**(1)**	
			$SO_2 + H_2O \rightarrow H_2SO_3$ *OR* $SO_2 + 2H_2O \rightarrow H_3O^+ + HSO_3^-$ *OR* $SO_2 + H_2O \rightarrow H^+ + HSO_3^-$ *OR* $SO_2 + H_2O \rightarrow 2H^+ + SO_3^{2-}$	**(1)**	
			Contains/produces H^+/H_3O^+ *If H_2SO_4 formed in equation, can score last mark*	**(1)**	**(4 marks)**
*QWC**		(iii)	(Silicon dioxide) giant covalent/ giant atomic/ giant molecular/ macromolecular	**(1)**	
			Strong/ covalent bonds (have to be) **broken** (for reaction) *Reference to Si=O or van der Waals' forces scores (0) for this mark*	**(1)**	
			(so reactants are) kinetically stable / activation energy too high (for reaction) / not enough energy released in bond formation to overcome energy required in bond breaking *IGNORE any references to reaction mechanism*	**(1)**	**(3 marks)**
	(b)	(i)	$[Al(H_2O)_6]^{3+} + H_2O \rightarrow / \rightleftharpoons [Al(H_2O)_5OH]^{2+} + H_3O^+$ *ACCEPT one more deprotonation of aluminium ions i.e.* $[Al(H_2O)_4(OH)_2]^+$		**(1 mark)**
		(ii)	$SiCl_4 + 2H_2O \rightarrow SiO_2 + 4HCl$ *ACCEPT products* $SiO_2.xH_2O$ / $Si(OH)_4$ *in a balanced equation*		**(1 mark)**
	(c)	(i)	(The trend is) increasing stability of the +2 state **relative** to the +4 state (or instability of +4 etc) *i.e. answer must be a comparison of oxidation states*		**(1 mark)**
		(ii)	(Tin(II) chloride will) reduce / be oxidised to Sn(IV)	**(1)**	
			(Fe^{3+} goes) to Fe^{2+}	**(1)**	
			Correct equation e.g. $2Fe^{3+} + Sn^{2+} \rightarrow 2Fe^{2+} + Sn^{4+}$ *scores both marks i.e. species (1) balancing (1).* *Do NOT penalise an unbalanced equation if 1st two marks are awarded*		
			(Lead(II) chloride has) no reaction	**(1)**	**(3 marks)**

Total 15 marks

2. (a) (i) (The first electron affinity) is the energy/ enthalpy/ heat change when 1 electron is added to each atom in 1 mole **(1)**

- must not imply endothermic process e.g. "energy required"

of gaseous atoms **(1)**

OR

energy change per mole **(1)**

(for) $A(g) + e^{-} \rightarrow A^{-}(g)$ **(1)** **(2 marks)**

(ii) Correct labelling of Ca(s) to Ca^{2+}(g) (+193, +590, +1150) **(1)**

Correct labelling of I_2(s) to $2I^{-}$(g) (+214, 2 x EA) **(1)**

Correct labelling of lattice energy and ΔH_f of CaI_2(s) (-2074, -534) **(1)**

<u>Labelling can be done with symbols, words or numbers</u> **(3 marks)**

(iii) *Mark consequentially on their labels in (ii)*

$\Delta H_f = \Delta H_a$ of calcium + 1st IE calcium + 2nd IE calcium + 2 x ΔH_a iodine + 2 x EA I(g) + LE CaI_2(s)

OR

-534 = +193+590+1150+2x107+ *2 × EA* + (-2074) **(1)**

OR

EA = ½(2074-534-193-590-1150-214) **(1)**

= -303.5 / -304 (kJ mol^{-1})

Other possible answers:

One EA and +107on cycle gives EA = -500 (2)

One EA and +214 on cycle, but 2EA shown in working gives EA = -303.5 / -304 (2)

One EA and +214 on cycle but EA shown in working gives EA = -607 (1) **(2 marks)**

(b) (i) Potassium **ion** / K^+ larger than Ca^{2+} **(1)**
Must not refer to atoms

*QWC** K^+ smaller charge than Ca^{2+} **(1)**
Must not refer to atoms, but CAN say "potassium" has a smaller charge (than "calcium")

Charge density of K^+ is less than charge density for Ca^{2+} without explanation is worth **(1)** *out of these 1st two marks*

Less **attraction** between (K^+ and I^-) **ions** **(1)**
NOT just "weaker bonds"

ACCEPT reverse argument **(3 marks)**
IGNORE references to extent of covalency

(ii) Potassium **ion** / K^+ **less** polarising (than Ca^{2+}) **(1)**

KI (close to) 100 % ionic / no covalent character **(1)**

CaI_2 partially/ significantly covalent
OR
Correct description of anion polarisation in CaI_2 **(1)** **(3 marks)**
NOT just 'distortion' of anion

Total 13 marks

3. (a) Ethylmagnesium bromide or formula, or any other halide *NOT* C_2H_5BrMg, **(1)**
Dry ether/ ethoxyethane
Followed by hydrolysis/ acid/ water **(1)**

Grignard reagent/ named reagent with incorrect alkyl group scores (0) for reagent but can score both condition marks. **(1)**
If halogenoalkane given as reagent, can score 1st mark if Mg included under conditions. **(3 marks)**

(b) (i) <u>Observation</u>
<u>*effervescence/ bubbles/ fizzing*</u> **(1)**
<u>NOT *gas evolved*</u>

$2C_2H_5COOH + Na_2CO_3 \rightarrow 2C_2H_5COONa + CO_2 + H_2O$ **(1)** **(2 marks)**

(ii) <u>Observation</u>
steamy/ misty/ white fumes **(1)**
NOT smoke
$C_2H_5COOH + PCl_5 \rightarrow C_2H_5COCl + POCl_3 + HCl$ **(1)** **(2 marks)**

(c) Reagents potassium dichromate ((VI)) / $K_2Cr_2O_7$, **(1)**
sulphuric acid/ H_2SO_4/ hydrochloric acid/ HCl but conseq. on an oxidising agent **(1)**
ALLOW acidified potassium dichromate / H^+ and $Cr_2O_7^{2-}$ **(2)**
ALLOW acidified dichromate ions **(2)**
Acidified dichromate (without ion) scores just **(1)**
ACCEPT
Potassium manganate(VII) / potassium permanganate/ $KMnO_4$ / Tollens' * / Fehling's* **(1)**
Acidified /alkaline*/neutral **(1)**
* need to acidify to liberate free acid for 2nd mark **(2 marks)**

(d) (i)

<u>*Reagent*</u> *(any one of)*	<u>*Condition*</u> *(to match)*
HCN	and KCN
HCN **or** KCN	(buffered between) pH between 6 and 9
KCN	+ acid /H^+ *NOT* excess
HCN	+ base / OH^- *NOT* excess

(2)

<u>Type of reaction</u>
Nucleophilic addition - *both words needed* **(1)** **(3 marks)**

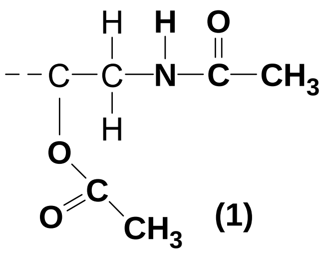
(ii)

<u>*Reagent*</u> *(any one of)*	<u>*Condition*</u> *(to match)*
Hydrogen	Pt / Ni / Pd (catalyst) – *IGNORE ref to temp.*
Sodium	(in) ethanol
Lithium aluminium hydride	**dry** ether/ ethoxyethane
Sodium borohydride	(in) aqueous/ water/ ethanol/ methanol

(2)

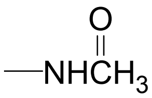
<u>Type of reaction</u>
Reduction
ACCEPT redox / hydrogenation (not addition)
ACCEPT nucleophilic addition if metal hydrides used **(1)** **(3 marks)**

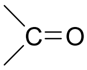
(e) (i)



(1)

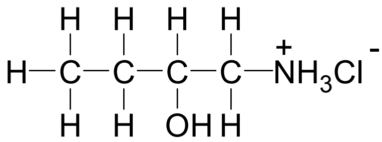
(1)

ALLOW 

If  *represented as CO, penalise once only*

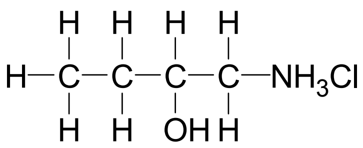
(2 marks)

(ii)

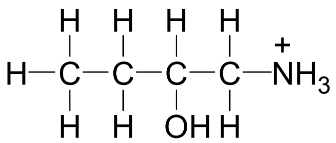


OR $—NH_3^+\ Cl^-$

OR

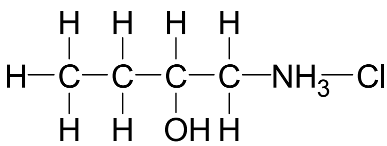


OR

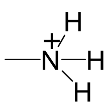


OR $—NH_3^+$

NOT



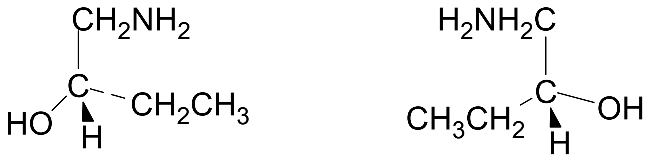
If show all bonds in $\overset{+}{NH_3}$*, + charge must be shown on N atom*

ie 

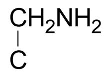
(1 mark)

(f) Optical

NOT stereo **(1)**



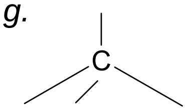
OR



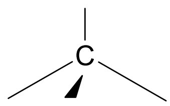
ALLOW -C_2H_5 for -CH_2CH_3

MUST show the two as object and mirror image

e.g.

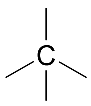


OR



are acceptable **(2)**

but NOT



C must not be bonded to H in OH group

Near-miss molecule plus mirror image **(1)**

The two solid lines in 3D structure must not be at 180°

(3 marks)

Total 21 marks

4. (a) (i) $K_p = p(CO_2)$ *allow without brackets, IGNORE* p[ ] **(1 mark)**

(ii) 1.48 (atm)

Penalise wrong unit

Answer is consequential on (a)(i) e.g. $\frac{1}{1.48}$ *must have* atm^{-1} **(1 mark)**

(b) (i) $K_p = \frac{p(Cl_2) \times p(NO)^2}{(p(NOCl))^2}$ *allow without brackets, penalise* [ ] **(1 mark)**

(ii)

	$2NOCl$	$\rightleftharpoons$ $2NO$	+ Cl_2	
Start	1	0	0	
Δ	-0.22	+0.22	+0.11	
eq moles	0.78	0.22	0.11	**(1)**

total moles of gas 1.11

mole fractions above values ÷ 1.11 **(1)**

0.7027 0.1982 0.09910

partial pressure / atm above values x 5.00 **(1)**

3.51 0.991 0.495

$K_p = \frac{0.495 \text{ atm} \times (0.991 \text{ atm})^2}{(3.51 \text{ atm})^2}$ **(1)**

= 0.0395/ 0.0394 atm **(1)**

range of answers 0.0408/0.041 → 0.039/0.0392 NOT 0.04

ACCEPT ≥2 S.F

Correct answer plus some recognisable working **(5)**

Marks are for processes

- *Equilibrium moles*
- *Dividing by total moles*
- *Multiplying by total pressure*
- *Substituting equilibrium values into expression for K_p* **(5 marks)**

Calculating the value of K_p with correct consequential unit.

(iii) As the reaction is endothermic - *stand alone* **(1)**

the value of K_p will increase (as the temperature is increased) - **(1)**
consequential on 1st answer (if exothermic (0) then K_p decreases (1))
For effect on K_p mark, must have addressed whether reaction is endothermic or exothermic **(2 marks)**

(iv) **Because** (as the value of K_p goes up), the value of $pCl_2 \times (pNO)^2/(pNOCl)^2$ (the quotient) **must also** go up **(1)**

and so the position of equilibrium moves to the right - *stand alone* **(1)**

But mark consequentially on change in K in (iii)

If "position of equilibrium moves to right so K_p increases" **(max 1)** **(2 marks)**

IGNORE references to Le Chatelier's Principle

Total 12 marks

5. (a) CH_3COOH labelled as base and linked to $CH_3COOH_2^+$ labelled (conjugate) acid **(1)**
H_2SO_4 labelled acid and linked to HSO_4^- labelled (conjugate) base **(1)**
If acids and bases correct but not clearly or correctly linked **1 (out of 2)**
Just link but no identification of acids and bases (0) **(2 marks)**

(b) (i) (pH) more than 7/ 8-9 **(1)**

Indicator: phenolphthalein ALLOW thymolphthalein OR thymol blue
(mark consequentially on pH) **(1)**
Mark consequentially on pH but if pH7 do not allow either methyl orange or phenolphthalein **(2 marks)**

QWC* (ii) As OH^- / base removes H^+ ions / ΔH_{neut} is per mole of H_2O produced / $H^+ + OH^- = H_2O$ **(1)**
the equilibrium shifts to the right **(1)**
and so **all** the ethanoic acid reacts (not just 1% of it) **(1)**
OR
Endothermic (OH) bond breaking **(1)**
is compensated for **(1)**
by exothermic hydration of ions **(1)**
OR
ΔH for $CH_3COOH + H_2O \rightarrow CH_3COO^- + H_3O^+ = +2\ kJ\ mol^{-1}$ / almost zero / very small **(1)**
$\therefore\ \Delta H_{neut}\ [CH_3COOH] = +2 + \Delta H_{neut}\ [HCl]$ **(1)**
≈ the same (for both acids) **(1)**
OR
ΔH_{neut} is per mole of H_2O produced **(1)**
(heat) energy required for full dissociation (of weak acid) **(1)**
so ΔH_{neut} slightly less exothermic (for weak acid) **(1)** **(3 marks)**

(iii) $[H^+]^2 = K_a\ [CH_3COOH] = 1.74 \times 10^{-5} \times 0.140 = 2.44 \times 10^{-6}$
$[H^+] = 0.00156$ (mol dm^{-3}) **(1)**

pH = 2.81 *consequential on [H⁺] but not pH>7* **(1)**
ACCEPT 2.80/2.8 (answers to 1 or 2 dp)

The assumptions are **two** from:
$[H^+] = [CH_3COO^-]$ - *this mark can be earned from working* /
negligible $[H^+]$ from ionisation of water **(1)**

$[CH_3COOH] = 0.140 - [H^+] \approx 0.140$ (mol dm^{-3}) / ionisation of acid negligible **(1)**
solution at 25 °C **(1)** **max (2)** **(4 marks)**

(iv) $$1.74 \times 10^{-5} = \frac{[H^+]\ [salt]}{[acid]}$$ **(1)**

$$[H^+] = 1.74 \times 10^{-5} \times \frac{0.070}{0.100} = 1.22 \times 10^{-5}$$ **(1)**

pH = 4.91 / 4.9 / 4.92 *NOT 5*
Max 2 *if 0.140 / 0.200 is used* **(1)** **(3 marks)**

Total 14 marks

TOTAL FOR PAPER: 75 MARKS