GCE MARKING SCHEME

CHEMISTRY
AS/Advanced

SUMMER 2014

INTRODUCTION

The marking schemes which follow were those used by WJEC for the SUMMER 2014 examination in GCE CHEMISTRY. They were finalised after detailed discussion at examiners' conferences by all the examiners involved in the assessment. The conferences were held shortly after the papers were taken so that reference could be made to the full range of candidates' responses, with photocopied scripts forming the basis of discussion. The aim of the conferences was to ensure that the marking schemes were interpreted and applied in the same way by all examiners.

It is hoped that this information will be of assistance to centres but it is recognised at the same time that, without the benefit of participation in the examiners' conferences, teachers may have different views on certain matters of detail or interpretation.

WJEC regrets that it cannot enter into any discussion or correspondence about these marking schemes.

GCE CHEMISTRY - CH1

SUMMER 2014 MARK SCHEME

SECTION A

Q.1 $1s^2 2s^2 2p^6 3s^2 3p^6$ [1]

Q.2 carbon-12 / ^{12}C [1]

Q.3 any example e.g. [1]
iron for Haber process / manufacture of ammonia
vanadium(V) oxide in Contact process / manufacture of sulfuric acid
platinum / palladium / rhodium in catalytic converters / to remove toxic gases from exhaust fumes
nickel in hydrogenation of alkenes / unsaturated oils

Q.4 (a) $M_r = 286.2$ allow 286 [1]

(b) mass = $\frac{286.2 \times 0.1}{4}$ = 7.155 / 7.16 allow 7.15 / 7.2 based on 286 [1]

Q.5 enthalpy changes = –110 [1]

Q.6 $^{234}_{90}Th$ (1) $^{234}_{91}Pa$ (1) (award 1 mark for 2 correct symbols) [2]

Q.7 portion to right of Ea_1 labelled as molecules that react / shaded [1]

Ea_2 marked, at lower energy than Ea_1, and portion to right labelled as molecules that react / shaded [1]

Section A Total [10]

SECTION B

Q.8 (a) same number of protons and electrons (1)

0, 1 and 2 neutrons (1) [2]

(b) (i) 3 energy levels between n = 2 and n = ∞
becoming closer together
first gap must be < that between n = 1 and n = 2 [1]

(ii) any arrow pointing upwards (1)

from n = 1 to n = ∞ (1) [2]

(c) (i) visible [1]

(ii) (not correct because) Balmer series corresponds to energy transitions involving n = 2 (1)

for ionisation energy need Lyman series / energy transitions involving n = 1 (1) [2]

(d) (i) $Q(g) \rightarrow Q^+(g) + e$ / accept any symbol [1]

(ii) Group 6 [1]

(iii) In T there is more shielding (1)

The outer electron is further from the nucleus (1)

The increase in shielding outweighs the increase in nuclear charge / there is less effective nuclear charge (1) [3]

Legibility of text; accuracy of spelling, punctuation and grammar; clarity of meaning QWC [1]

Total [14]

Q.9 (a) (i) line drawn that is deflected less by magnetic field [1]

(ii) increase strength of the magnetic field
allow decrease charge on charged plates [1]

(b) (i) 1+ (1)

^{37}Cl - ^{37}Cl (1) $^{37}Cl_2^+$ (2) [2]

(ii) line drawn as m/z 72 (1)

ratio height 6 (1) allow ½ square tolerance [2]

(c) (i) % H = 0.84 (1)

C : H : Cl = 10.04 / 12 : 0.84/ 1.01 : 89.12 / 35.5 (1)

= 0.84 : 0.83 : 2.51 = 1 : 1 : 3 empirical formula = $CHCl_3$ (1) [3]

(ii) the relative molecular mass / M_r / molar mass [1]

(iii) right hand / largest / heaviest m/z peak from mass spectrum [1]

Total [11]

Q.10 (a) (a reaction in which) the rate of the forward reaction is equal to the rate of the backward reaction [1]

(b) goes darker / more brown (1)

because the (forward) reaction has a +ve ΔH / is endothermic (1)

goes paler / less brown (1)

because there are more moles / molecules on RHS (1)

no change (because catalysts do not affect the position of an equilibrium) (1) [5]

(c) (i) moles N_2H_4 = 14000/32.04 = 437.0 (1)

this produces 437.0 × 3 = 1311 moles of gas (1)

volume = 1311 × 24 = 3.15×10^4 dm^3 (1) [minimum 2 sf] [3]

(ii) (large volume of) gas produced [1]

(d) (i) an acid is a proton / H^+ donor [1]

(ii) $\rightarrow NO_2^- + H_3O^+$ [1]

(iii) sulfuric acid is behaving as the acid / nitric acid is behaving as a base (1)

as it donates a proton / as it accepts a proton (1) [2]

Total [14]

Q.11 (a) (i) $2C(s) + 3H_2(g) + \frac{1}{2}O_2(g) \rightarrow C_2H_5OH(l)$ (state symbols needed)

C(s) allowed as C(gr) or C(graphite) [1]

(ii) (if these elements were reacted together) other products would form/ carbon does not react with hydrogen **and** oxygen under standard conditions [1]

(b) (i) energy = 100 × 4.2 × 54 =22680 [1]

(ii) moles ethanol = 0.81/46 = 0.0176 (1)

energy change = $\frac{22.68}{0.0176}$ $\Delta H = -1290$ (1)

–ve sign and correct to 3 sf (1) [3]

(c) internet value numerically larger (1)

heat losses / incomplete combustion / thermal capacity of calorimeter ignored (1) no credit for energy loss [2]

(d) (i) $C_3H_7OH + 4\frac{1}{2}O_2 \rightarrow 3CO_2 + 4H_2O$ (ignore state symbols) [1]

(ii) negative enthalpy change means energy in bonds broken is less than that in bonds made [1]

(iii) more bonds broken and made in propanol and therefore more energy released [1]

(e) any 4 from:

both conserve carbon / non-renewable fuel sources / fossil fuels / use renewable sources

(these gas / liquid) suitable for different uses e.g. ethanol to fuel cars

atom economy gasification is less (some C lost as CO_2) / CO_2 produced in gasification is a greenhouse gas

CO is toxic

gasification at high temperature / enzymes need low temperature

enzyme approach therefore saves fuel / gasification needs more energy [4]

3 max if any reference to destruction of ozone layer

QWC [2]
The candidate has selected a form and style of writing that is appropriate to purpose and complexity of the subject matter (1)

Answer has suitable structure (1)

Total [17]

Q.12 (a) to increase rate of reaction / to increase surface area [1]

(b) $MgCO_3 + 2HCl \rightarrow MgCl_2 + CO_2 + H_2O$ (ignore state symbols) [1]

(c) rate starts fast and gradually slows (1)

because concentration becomes less so fewer collisions (per unit time) / less frequent collisions / lower probability of collisions (1)

at time = 17/18 min rate = 0 (1) [3]

(d) all the solid would all have disappeared / if more carbonate is added further effervescence is seen [1]

(e) (i) volume CO_2 = 200 cm^3 (1)

moles CO_2 = 200 / 24000 = 0.008333 = moles $MgCO_3$ (1)
[minimum 2 sf] [2]

(ii) mass $MgCO_3$ = 0.008333 × 84.3 = 0.702 g (1)

$\% \ MgCO_3 = \frac{0.702}{0.889} \times 100 = 79.0\% / 79\%$ [2]

(e) carbon dioxide is soluble in water / reacts with water (1)

volume collected less therefore % / moles of $MgCO_3$ less (1) [2]

(f) use of 40.3 and 84.3 (1)

atom economy = 40.3 / 84.3 × 100 = 47.8% (1) [2]

Total [14]

Section B Total [70]

GCE CHEMISTRY - CH2

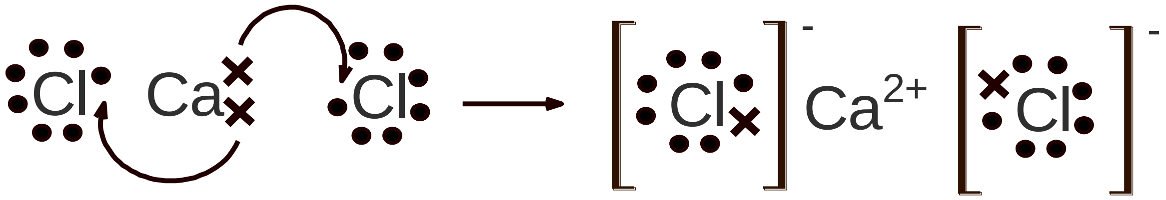
SUMMER 2014 MARK SCHEME

SECTION A

Q.1 Van der Waals' forces < Hydrogen bonds < Covalent bonds [1]

Q.2 2-methylpentan-1-ol allow 2-methyl-1-pentanol [1]

Q.3 1 mark showing movement of electrons; 1 mark showing dot and cross of $CaCl_2$ [2]



Q.4 (a) δ– N—H δ+ δ– O—Cl δ+ both for 1 mark [1]

(b) Difference in electronegativity is larger in aluminium oxide (so it is ionic) / the difference is smaller in aluminium chloride (so it is covalent) [1]

Q.5 Reagent: Bromine (water) (1)

Observation(s): hex-2-ene will turn bromine water from orange to colourless, no change for cyclohexane (1) [2]

Q.6 **C** (1) and **E** (1) – penalise one mark for each additional incorrect answer [2]

Section A Total [10]

SECTION B

Q.7 (a) (i)

	magnesium nitrate	*barium chloride*	*sodium hydroxide*
potassium carbonate	white precipitate	white precipitate	no visible change
sodium hydroxide	WHITE PRECIPITATE	NO VISIBLE CHANGE	
barium chloride	NO VISIBLE CHANGE		

All three correct for 2 marks, two correct for 1 mark [2]

(ii) Name of precipitate: Magnesium carbonate (1)
Ionic equation: $Mg^{2+} + CO_3^{2-} \rightarrow MgCO_3$ (1) [2]

(b) (i) Sodium hydroxide solution would turn blue/purple
[Ignore references to potassium carbonate] [1]

(ii) Potassium carbonate would give a lilac flame
Sodium hydroxide would give a golden yellow flame
Barium chloride would give an apple green flame
(2 for all correct, 1 mark for 2 correct)
1 max if any reference to white flame for magnesium [2]

(iii) Barium chloride (1) White precipitate (1) [2]

(c) (i) Sodium **ions** surrounded by $\delta-$ on oxygen atoms of water (1)
Bromide **ions** surrounded by $\delta+$ on hydrogen atoms of water (1)
Marks can be obtained from a labelled diagram – must show minimum of two oxygen/hydrogen atoms around sodium/bromide ions [2]

(ii) *Observation with sodium bromide* cream precipitate (1)

Observation with sodium iodide yellow precipitate (1) [2]

(iii) Reagent: (dilute) ammonia solution (1)
Observation with sodium bromide: precipitate dissolves in part
Observations with sodium iodide: precipitate does not change
both observations required for (1)
[If concentrated ammonia (1) used then sodium bromide will dissolve completely] [2]

(iv) $2NaI + Br_2 \rightarrow 2NaBr + I_2$ allow ionic equation [1]

Total [16]

Q.8 (a) Boiling temperatures increase with increasing chain length / number of carbon atoms / relative mass (1)
More carbon atoms leads to greater number of van der Waals' forces between molecules (1) [2]

(b) (i) Mass of petroleum gases = 1.2% × 145, 000 = 1740g (1)
Moles of butane = 1740 ÷ 58.1 = 30 mol (1)
Volume of butane = 30 × 24 = 720 dm^3 (1) [3]

(ii) I. ultraviolet light [1]
II. $Cl_2 \rightarrow 2Cl\bullet$ [1]
III. (Propane forms) propyl radicals / $C_3H_7\bullet$ (1)
Two $C_3H_7\bullet$ radicals combine together to make hexane (1) [2]

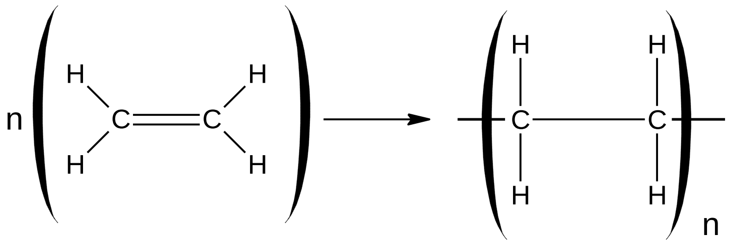
(c) Brent crude would be better as it has more naphtha (1)

Naphtha is cracked to produce alkenes (1)

Cracking is caused by heating / zeolites / aluminosilicates / porcelain (1)

Any valid equation that produces ethene e.g. $C_{10}H_{22} \rightarrow C_2H_4 + C_8H_{18}$ (1)

Polymerisation: Many small molecules joining together to make a large molecule (1)



(1)

Addition polymerisation (1)

e.g. polystyrene, PVC, PTFE and relevant monomer (1)

MAX 6 [6]

QWC: organisation of information clearly and coherently; use of specialist vocabulary where appropriate [1]

Total [16]

Q.9 (a) $1Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$ [1]

(b) Oxidation state of carbon at start = +2 and at end = +4 so it has been oxidised (1)
Oxidation state of iron at start = +3 and at end = 0 so it has been reduced (1)
Credit 1 mark if all oxidation states are given correctly with incorrect or no reference to what has been oxidised/reduced [2]

(c) (i) 6:6 [1]

(ii)

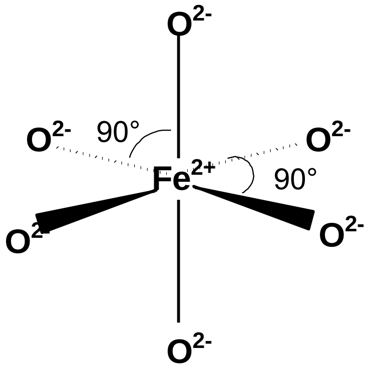


Diagram must be unambiguous, either by showing 3 dimensions, bond angles or through labelling, must identify iron and oxide as ions

[1]

(d) Moles FeO = 20,000 ÷ (55.8 +16) = 278.6 mol (1)
Moles Fe = moles FeO = 278.6 mol (1)
Mass Fe = 278.6 × 55.8/1000 = 15.5 kg (1) [3]

(e) Pair of shared electrons in both (1)

Covalent – 1 electron from each atom **and**
Co-ordinate – 2 electrons from same atom (1) [2]

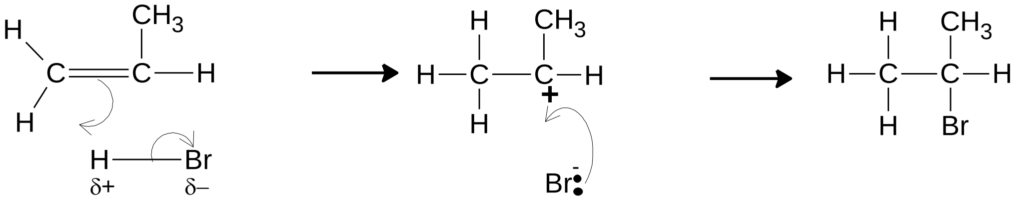
(f) Lattice / regular arrangement of positive ions (1)
Sea of delocalised electrons (1)
Electrons can move to form an electrical current (1)
Strong forces / bonds between the delocalised electrons and the metal ions require a lot of energy to break / high temperature to overcome (1) [4]
QWC: selection of a form and style of writing appropriate to purpose and to complexity of subject matter [1]

Total [15]

Q.10	(a)	(i)	**Aqueous** sodium hydroxide (1) Heat [below 110°C] (1)	[2]
		(ii)	Bromobutane cannot form hydrogen bonds (1) Butan-1-ol can form hydrogen bonds due to its —OH (1) Hydrogen bonds between butan-1-ol and water molecules allow butan-1-ol to dissolve (1)	[3]
	(b)	(i)	Acidified dichromate(VI) / acidified manganate(VII) (1) Heat (1)	[2]
		(ii)	Butanoic acid can form hydrogen bonds between molecules (1) Bromobutane has van der Waals' forces between the molecules (1) Hydrogen bonds are stronger than van der Waals' so require more energy to break these (1)	[3]
		(iii)	Fractional distillation	[1]

Total [11]

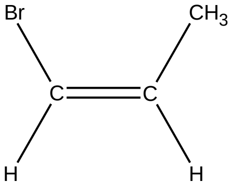
Q.11 (a) (i) 1 mark for arrows in first diagram; 1 mark for arrow in second diagram; 1 mark for all charges



2 max if incorrect isomer given [3]

(ii) 2-bromopropane formed from a secondary carbocation (1)
Secondary carbocations are more stable than primary carbocations (1)
[2]

(b) Empirical formula = C_3H_5Br (1)
Molecular formula = C_3H_5Br
(must show use of mass spectrum to gain this mark) (1)
Two molecular ion peaks as there are two isotopes of bromine (1)
Peaks at 15 = CH_3^+ and 41 = $C_3H_5^+$ (1)
550 cm^{-1} = C–Br 1630 cm^{-1} = C=C 3030cm^{-1} = C–H (1)
Molecule is:



(1) [6]

QWC: legibility of text, accuracy of spelling, punctuation and grammar, clarity of meaning [1]

Total [12]

Section B Total [70]

GCE CHEMISTRY – CH4

SUMMER 2014 MARK SCHEME

SECTION A

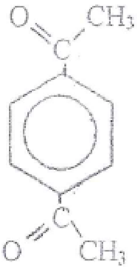
Q.1 (a) (i) $CH_3CH_2CH_2CH_2CH_3 + Cl_2 \rightarrow CH_3CH_2CH_2CH_2CH_2Cl + HCl$ [1]

(ii) $CH_3CH_2CH_2\overset{\bullet}{C}HCH_3$ [1]

(b) (Anhydrous) aluminium chloride / iron(III) chloride allow $AlCl_3$ / $FeCl_3$ [1]

(c) (i) orange / red precipitate [1]

(ii)



(1) —$COCH_3$ groups in any positions

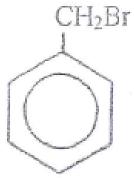
It must contain a C=O group but it is not an aldehyde as it does not react with Tollens' reagent (1) [2]

(d) (i) (Alkaline) potassium manganate(VII) (solution) allow $KMnO_4$ / MnO_4^- [1]

(ii) Dilute acid allow HCl / H^+ [1]

(iii) Lithium tetrahydridoaluminate(III) / lithium aluminium hydride allow $LiAlH_4$ [1]

(iv)

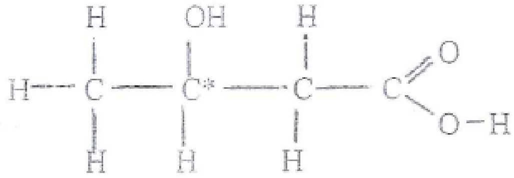


[1]

(e) Only the infrared spectrum of benzoic acid would have a peak at 1650–1750 cm^{-1} (1)
This is due to the carbonyl group present in the benzoic acid (1) [2]

Total [12]

Q.2 (a)



[1]

(b) (i) Acidified potassium dichromate allow H^+, $Cr_2O_7^{2-}$ [1]

(ii) I An equimolar mixture of two enantiomers / optical isomers
do not accept ‘equal mixture’ [1]

II It has no (apparent) effect on the plane of polarised light [1]

(c) (i) But-2-enoic acid; this is because each of the carbon atoms of the double bond has two different groups / atoms
allow reason based on the other isomer [1]

(ii) Any TWO from the following for (1) each
reagent used / temperature / quantities / time of reaction / catalyst / solvent [2]

(d) Reagent(s) KOH / I_2 or NaOCl / KI (1) allow names
Observation Yellow precipitate (1) [2]

(e) The NMR spectrum will consist of two peaks, as there are two discrete ‘areas’ of protons; these will be seen at between 2.0 to 2.5 (CH_3) and between 2.5 to 3.0 (CH_2) (1)
The peak area ratio will be 3:2 for the CH_3 and CH_2 protons respectively (1)
There will be no splitting of either signal as the protons causing these signals are not bonded directly to other carbon atoms that also have protons (1)

1 max if only one peak described correctly [3]

QWC *Legibility of text; accuracy of spelling, punctuation and grammar; clarity of meaning.* [1]

Total [13]

Q.3 (a) (i) 2 mol of ethanol gives 1 mol of ethoxyethane (1)

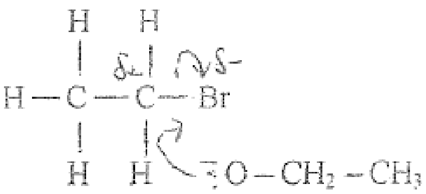
Moles of ethanol $= \frac{69}{46} = 1.5$

$\therefore$ Moles of ethoxyethane if theoretical yield $= 0.75$
$\therefore$ Moles of ethoxyethane if 45% yield $= 0.75 \times 0.45 = 0.34$ (1)

Mass of ethoxyethane $= 0.34 \times 74 = 25$g (1) allow error carried forward
[3]

(ii) Ethene / C_2H_4 [1]

(iii)

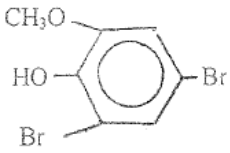


$\longrightarrow$ products

(1) for correct curly arrows (1) for correct δ^+ and δ^- [2]

(iv) They need to have an N–H / O–H / F–H bond / a highly electronegative atom bonded to hydrogen [1]

(b) (i) For example



[1]

Accept any polybrominated species
Do not accept a monobrominated species

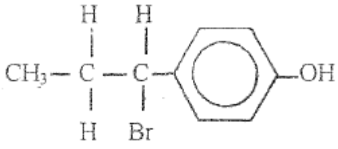
(ii) Bromine decolorised / orange to colourless / white solid [1]

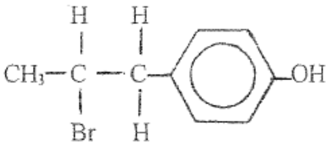
(c) Reagent Iron(III) chloride solution / $FeCl_3$ (1)

Observation Purple coloration / solution (1) [2]

(d) (i) $C_{10}H_{12}O_1$ [1]

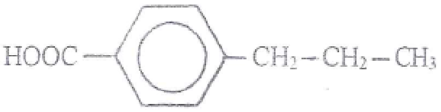
(ii)





[1]

(e) Displayed formula, for example



(1)

Functional group carboxylic acid (1) [2]

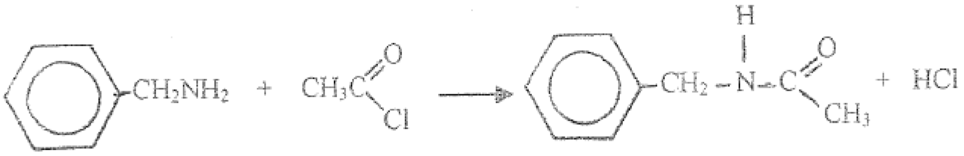
Total [15]

SECTION B

Q.4 (a) (i) (Fractional) distillation / (preparative) gas chromatography / HPLC / TLC column chromatography / solvent extraction [1]

(ii) the fragmentation pattern would be different / valid examples given [1]

(iii) I



[1]

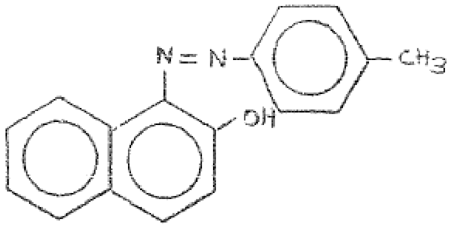
II Heated electrically / by a naked flame with a water bath (1)
Add compound **G** to the ethanol until the hot ethanol will (just) not dissolve any more solute (1)
Filter hot (1)
Allow to cool (1)
Filter (1)
Dry in air / window sill / < 60 ^{o}C in an oven (1) [5]

Maximum 4 out of 5 total if second marking point not given
Note 5 marks maximum here

QWC Information organised clearly and coherently, using specialist vocabulary where appropriate [1]

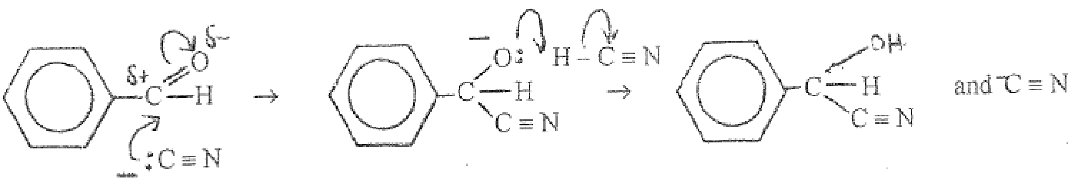
(iv) I The amine is reacted with sodium nitrite / HCl(aq) or nitrous acid (1)
at a temperature of < 10 ^{o}C (1) [2]

II



[1]

(b) (i) Nucleophilic addition (1)

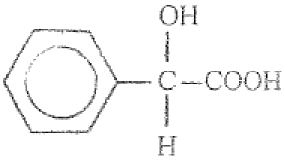


Accept a mechanism that shows HCN polarisation and nucleophilic addition as a concerted process

polarisation / charges shown (1) curly arrows on first structure (1)
regeneration of $^{-}C\equiv N$ or capture of H^+ and curly arrow (1) [4]

(ii) Chromophores (1)
The colour will be black (1) as the compound absorbs blue / other colours (1)
[3]

(iii)



[1]

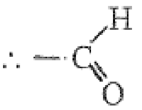
Total [20]

Q.5 (a)

	C 71.3	H 9.6	∴ O 19.1 (1)
÷ by A_r	$\frac{71.3}{12} = 5.94$	$\frac{9.6}{1.0} = 9.6$	$\frac{19.1}{16} = 1.193$
÷ smallest	$\frac{5.94}{1.193} = 5$	$\frac{9.6}{1.193} = 8$	$\frac{1.193}{1.193} = 1$ (1)

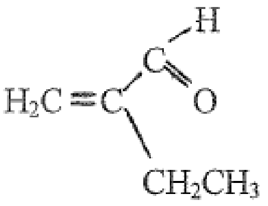
Only one oxygen atom per molecule

∴ Molecular formula is C_5H_8O (1)

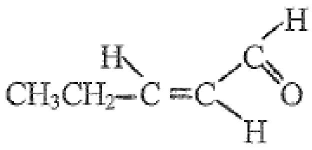
Silver mirror produced ∴  present (1)

Ion m/z 29 suggests ethyl group present / CH_3CH_2 (1)

Structure must be



or



(1)

[6]

(b) (i) $C_{11}H_{24} \longrightarrow C_6H_{14} + C_2H_4 + C_3H_6$ [1]

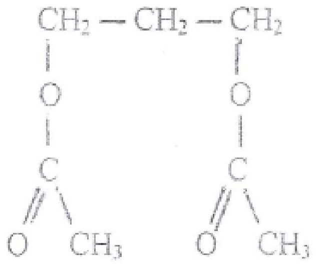
(ii) Total peak areas 26 + 13 + 46 = 85

% propene = $\frac{13 \times 100}{85}$ = 15.(3) [1]

(iii) Any THREE points for (1) each [3]

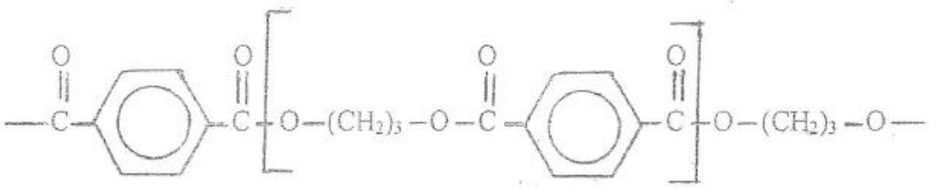
e.g. can it run at a lower temperature (reducing energy costs)
is the yield comparable / better than the yield from the propene process
is the time taken comparable / better than used in the propene process
is there a continued availability of starting materials
can the product be easily / better separated from the reaction mixture
is relatively more expensive equipment needed
is it a batch or continuous process

(iv)



[1]

(c) (i)



[1]

(ii) The production of PTT is an example of condensation polymerisation (1)
The production of poly(propene) is an example of addition polymerisation (1)
Condensation polymerisation needs bifunctional compounds / COOH,OH etc (1)

Addition polymerisation needs a  present in the monomer (1)

Addition polymerisation has an atom economy of 100% (1)
Condensation polymerisation has an atom economy of < 100%
(as a co-product is formed) (1) [6]

QWC Selection of a form and style of writing appropriate to purpose and to complexity of subject matter [1]

Total [20]

GCE CHEMISTRY – CH5

SUMMER 2014 MARK SCHEME

SECTION A

Q.1 (a) (i) $NH_4^+(aq) + OH^-(aq) \rightleftharpoons NH_3(aq) + H_2O(l)$

Acid 1 Base 2 Base 1 Acid 2 [2]

(1 mark for each pair)

(b) (i)

	$[NH_4^+(aq)]$/mol dm^{-3}	$[NO_2^-(aq)]$/mol dm^{-3}	Initial rate/mol dm^{-3} s^{-1}
1	0.200	0.010	4.00×10^{-7}
2	**0.100**	0.010	2.00×10^{-7}
3	0.200	**0.030**	1.20×10^{-6}
4	0.100	0.020	$\mathbf{4.00 \times 10^{-7}}$

(1 mark for each correct answer) [3]

(ii) $k = \dfrac{4.00 \times 10^{-7}}{0.200 \times 0.010} = 2.0 \times 10^{-4}$ (1)

Units = mol^{-1} dm^{3} s^{-1} (1) [2]

(iii) No change [1]

(iv) Increases

If temperature is increased rate increases (1)

and since concentrations do not change the rate constant must increase (or similar) (1) [2]

Total [10]

Q.2 (a) $K_w = [H^+][OH^-]$ (1)

Units = $mol^2\ dm^{-6}$ (1) [2]

(b) (i) In pure water $[H^+] = [OH^-]$ or $[H^+] = \sqrt{1.0 \times 10^{-14}}$ (1)

pH = $-\log 10^{-7} = 7$ (1) [2]

(ii) Final volume of solution is 1000 cm^3 so acid has been diluted by a factor of 100 so final concentration of acid is 0.001

or moles acid = $\frac{0.1 \times 10}{1000} = 0.001$ (1)

pH = $-\log 0.001 = 3$ (1) [2]

(c) $1.78 \times 10^{-5} = \frac{[H^+] \times 0.02}{0.01}$ (1)

$[H^+] = 8.90 \times 10^{-6}$ (1)

pH = 5.05 allow 5 or 5.1 (1) [3]

(d) The solution is a buffer (1)

Solution contains a large amount of CH_3COOH and CH_3COO^- ions

(Accept correct equations) (1)

When an acid is added, the CH_3COO^- ions react with the H^+ ions, removing them from solution and keeping the pH constant (1) [3]

Total [12]

Q.3 (a)

$$\begin{array}{c} \cdot\cdot\ \ \cdot\cdot \\ H : O : O : H \\ \cdot\cdot\ \ \cdot\cdot \end{array}$$ [1]

(b) 20 dm^3 oxygen = 0.83 mol (1)

Moles H_2O_2 = 1.67 and $[H_2O_2]$ = 1.67 mol dm^{-3} (1) [2]

(c) (i) Variable oxidation states / partially filled 3d energy levels /ability to adsorb 'molecules' / form complexes (or temporary bonds) with reacting molecules
(Accept any two answers)
Do not accept 'empty / unfilled d-orbitals' [2]

(ii) 3d orbitals split by ligands (1)

Three d-orbitals have lower energy, two have higher energy (1)

Electrons absorb (visible light) energy to jump from lower level to higher level (1)

The colour is that due to the remaining / non-absorbed frequencies (1)
(Appropriate diagrams are acceptable alternatives)
[4]

QWC Legibility of text; accuracy of spelling, punctuation and grammar, clarity of meaning [1]

(d) (i) $MnO_4^- + 8H^+ + 5e^- \longrightarrow Mn^{2+} + 4H_2O$ [1]

(ii) $5H_2O_2 + 6H^+ + 2MnO_4^- \longrightarrow 2Mn^{2+} + 5O_2 + 8H_2O$ [2]

(Mark consequentially from (i) – 1 mark if formulae correct but equation not balanced properly)

(iii) Moles $MnO_4^- = \frac{0.02 \times 14.8}{1000} = 2.96 \times 10^{-4}$ (1)

Moles H_2O_2 = 7.40×10^{-4} (1)

Concentration $H_2O_2 = \frac{7.40 \times 10^{-4}}{0.020}$ = 0.037 mol dm^{-3} (1) [3]

(e) Oxidation state of oxygen starts at –1 (in peroxide) (1)
Oxidation state in water is –2 (reduced)
oxidation state in oxygen is 0 (oxidised) (1) [2]

Total [18]

SECTION B

Q.4 (a) (i) Oxidising agent [1]

(ii) A = lead(II) chloride / $PbCl_2$ (1)
B = chlorine / Cl_2 (1) [2]

(iii) $[Pb(OH)_6]^{4-}$ / $[Pb(OH)_4]^{2-}$ / $Na_4[Pb(OH)_6]$ etc. [1]

(iv) Yellow [1]

(v) $PbO + 2HNO_3 \longrightarrow Pb(NO_3)_2 + H_2O$ [1]

(b) (i) Each C atom covalently bonded to three other C atoms forming layers (1)

Layers held together by weak intermolecular forces (1)

BN is isoelectronic with C so it forms similar structures (1)

Graphite conducts electricity since electrons are delocalised but in BN, each N has a full unbonded p-orbital and each B has an empty unbonded p-orbital so it does not conduct electricity (1) [4]

(Accept electrons are not delocalised in BN so it does not conduct electricity)

QWC The information is organised clearly and coherently, using specialist vocabulary where appropriate [1]

(ii) Wear-resistant coatings/catalyst support/for mounting high power electronic components / drills in industry / cutting instruments [1]

(c) (i) $\Delta G = \Delta H - T\,\Delta S$ ($\Delta G = 0$ for reaction to be spontaneous) (1)

$T = \frac{1.92}{0.0067}$ (1)

T = 286.6 K (1) [3]

(ii) Changes in temperature (above or below 286.6 K) caused the tin to change form making it unstable (and causing it to disintegrate) [1]

(d) (i) (At the anode) $H_2 \longrightarrow 2H^+ + 2e^-$ (1)

(At the cathode) $O_2 + 4H^+ + 4e^- \longrightarrow 2H_2O$ (1)

(Overall reaction) $2H_2 + O_2 \longrightarrow 2H_2O$ (1)

[3]

(ii) Hydrogen is difficult to store / takes up large volume / too flammable / explosive / produced from fossil fuels which leads to a net energy loss / Pt electrodes very expensive [1]

Total [20]

Q.5 (a) (i) Cold $Cl_2 + 2NaOH \longrightarrow NaCl + NaClO + H_2O$ (1)

Warm $3Cl_2 + 6NaOH \longrightarrow 5NaCl + NaClO_3 + 3H_2O$ (1)

[2]

(ii) Disproportionation [1]

(b) P can (extend the normal octet of electrons) by using 3d orbitals /
P can promote 3s electron to 3d orbital (1)
N cannot do this since it is in the second period / 3d orbitals not available (1)
[2]

(c) The terms involved are: lattice breaking enthalpy which is endothermic (1)

and hydration enthalpy which is exothermic (1)

ΔH solution = ΔH lattice breaking + ΔH hydration (or similar) (1)

If ΔH solution is negative then the ionic solid will be soluble (1)

[4]

QWC Selection of a form and style of writing appropriate to purpose and to complexity of subject matter [1]

(d) (i) Iodide (1)
Only one with less positive standard potential than
Fe^{3+}, Fe^{2+} half-cell (1) [2]
(2^{nd} mark can be obtained from calculation value and statement)

(ii) $Pt(s)\,|\,Fe^{2+}(aq), Fe^{3+}(aq)\,||\,Ce^{4+}(aq), Ce^{3+}(aq)\,|\,Pt(s)$ (1)

EMF = 1.45 – 0.77 = 0 .68 V (1) [2]

(e) (i) $K_c = \dfrac{[CH_3COOCH_3][H_2O]}{[CH_3COOH][CH_3OH]}$ (1)

No units (1) [2]

(ii) moles = $\dfrac{1.25 \times 32.0}{1000}$ = 0.04(0) [1]

(iii) $[CH_3COOH]$ = 0.04, therefore 0.06 used in reaction and

$[CH_3COOCH_3]$ = 0.06, $[H_2O]$ = 0.06 and

$[CH_3OH]$ = 0.083 – 0.06 = 0.023 (1)

$K_c = \dfrac{0.06 \times 0.06}{0.04 \times 0.023} = 3.91$ (1) [2]

(iv) Value of K_c decreases since the equilibrium shifts to the left /
the forward reaction is exothermic [1]

Total [20]

WJEC
245 Western Avenue
Cardiff CF5 2YX
Tel No 029 2026 5000
Fax 029 2057 5994
E-mail: exams@wjec.co.uk
website: www.wjec.co.uk