edexcel
advancing learning, changing lives

Mark Scheme (FINAL)
Summer 2008

GCE

GCE Chemistry (6245/01)

Edexcel Limited. Registered in England and Wales No. 4496750
Registered Office: One90 High Holborn, London WC1V 7BH

A PEARSON COMPANY

General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

Using the mark scheme

1 / means that the responses are alternatives and either answer should receive full credit.
2 ( ) means that a phrase/word is not essential for the award of the mark, but helps the examiner to get the sense of the expected answer.
3 [ ] words inside square brackets are instructions or guidance for examiners.
4 Phrases/words in **bold** indicate that the meaning of the phrase or the actual word is **essential** to the answer.
5 ecf/TE/cq (error carried forward) means that a wrong answer given in an earlier part of a question is used correctly in answer to a later part of the same question.

Quality of Written Communication

Questions which involve the writing of continuous prose will expect candidates to:

- show clarity of expression
- construct and present coherent arguments
- demonstrate an effective use of grammar, punctuation and spelling.

Full marks will be awarded if the candidate has demonstrated the above abilities.

Questions where QWC is likely to be particularly important are indicated "QWC" in the mark scheme BUT this does not preclude others.

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (a)	e.m.f. of a **half** cell relative/compared to a (standard) hydrogen electrode OR voltage produced from a **half** cell joined to a hydrogen electrode **(1)** (solutions at) 1 mol dm^{-3} concentration, (gases at) 1 atm/100 kPa/10^5Pa/ 1 Bar pressure and stated temperature **(1)** all 3 conditions needed STAND ALONE	Potential (difference) /voltage for emf emf of a cell with standard hydrogen as the left electrode A description of the half cell e.g. a metal dipping into a solution of its ions 101 kPa 298 K or 25 ^oC If any other temperature is quoted it must be as an example of a stated temperature	SHE 'constant' pressure "STP" Room temperature Just "273 K"	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (b)	Can only measure a potential **difference**/emf (if a reference electrode is present) OR voltmeter needs 2 connections OR Cannot measure the potential difference between a metal and a solution of its ions		Just "electron source and sink" to make comparisons between half cells	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (c)(i)	**1st mark** (simultaneous) oxidation and reduction of a (single) species/ substance/ reactant/compound/chemical **Or** the oxidation state/number is both increased and decreased of a (single) species/ substance/ reactant/ compound/chemical **Or** a (single) species/ substance/ reactant/compound/chemical both loses and gains electrons **(1)** **2nd mark** For a given type of **atom** within an ion/ molecule **Or** Illustrated by a suitable example in which the individual atom is identified **(1)**		oxidation and reduction occur at the same time oxidation state**s** are …	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (c)(ii)	$2H_2O_2 \rightarrow 2H_2O + O_2$ **(1)** E_{cell} = (+) 1.09 (V) **(1)** E_{cell} is positive/greater than 0 so the reaction is feasible **(1)** 3rd mark must be cq on sign of E_{cell}		$2H^+$ on both sides of equation Greater than any other stated number	3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (c)(iii)	activation energy of the reaction may be high OR reaction too slow to be observed		Just "Not enough energy to overcome the activation energy" Conditions are non-standard Just "kinetically stable"	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (a)(i)	second order **(1)** rate proportional to the square of the (partial) pressure of NO OR the rate doubles as the square of the (partial) pressure of NO doubles **(1)** Conditional on correct order			2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (a)(ii)	as (partial) pressure (of O_2) doubles rate doubles, so first order OR gradient of line is $k\ p(O_2)^x$ so if this doubles the order (w.r.t. O_2) must be 1	Concentration of O_2 instead of (partial) pressure		1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (a)(iii)	rate = $k\ p(NO)^2 p(O_2)$ Cq on orders in (i) and (ii)	rate = $k[NO]^2[O_2]$ "R" for "rate" "K" for lower case "k"	Any equation without k rate = $k\ p[NO]^2 p[O_2]$	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (a)(iv)	$atm^{-2}\ s^{-1}$ ALLOW this mark, even if $p[\ ]$ used in (iii) Cq on (iii) [if overall second order, unit is $atm^{-1}s^{-1}$. If overall first order unit is s^{-1}]	$mol^{-2}\ dm^6\ s^{-1}$ if concs used in (iii)		1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (a)(v)	partial pressure/concentration of NO is very small (so the collision frequency with O_2 molecules is very low)	chance of a 3-body collision is slight	Equilibrium reaction Temp is too low	1

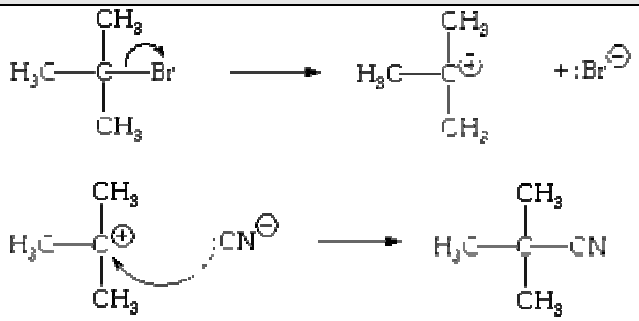
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (b)(i)	plot ln *k* vs 1/T **(1)** giving straight line of gradient – E_a/R OR E_a = -gradient x R **(1)** STAND ALONE MARKS [2nd mark could be scored from (ii) if no reference to gradient here in (i) provided a clear expression is stated]	If plot 1/T vs ln *k* **and** gradient is -R/E_a **(2)** If plot ln *k* vs 1/RT **and** gradient – E_a **(2)**	"log"	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (b)(ii)	E_a = 2.95x10 ^{4} x 8.314 **(1)** (= 245,145 J mol^{-1}) = 245 (kJ mol^{-1}) **(1)** Correct answer with no working **(2)** Answers **not** to 3 SF can only score the 1st mark Note: —245 (kJ mol^{-1}) **(1)** but must be 3SF 245,000 **kJ** (mol^{-1}) **(1)** but must be 3SF —245,000 **kJ** mol^{-1} **(0)** If 245 or —245 is given, units are **not** needed If 245,000 is given, units are **essential** DO **NOT** PENALISE K^{-2} OR K^{-1} **in any unit**	245,000 **J** (mol^{-1}) **(2)** [Note to examiners: if candidate uses 2.95 x10^{-4} or 1/2.95 x10^4 send to review]		2

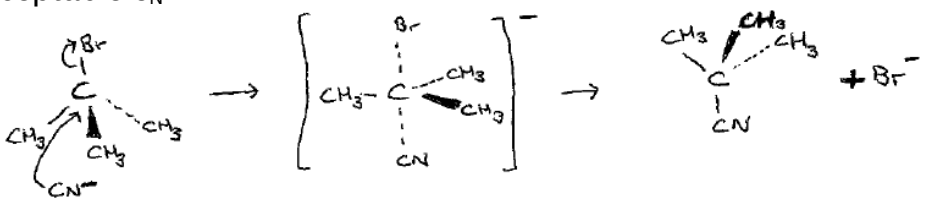
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (b)(iii)	**B**			1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (a)	(aqueous) ethanol /ethanolic solution	ethanol alcohol propanone		1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (b)(i)	**1st Mark** S_N1 **Or** must be (at least) two steps **(1)** **2nd Mark** **only** the halogenoalkane is involved in the r.d.s. **OR** CN^- is **not** involved in rds **(1)**			2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (b)(ii)	 first arrow must start from bond, not the carbon atom and not end past the bromine atom **(1)** structure of carbocation **(1)** Br^- not essential attack by cyanide, arrow must start from C or –ve charge on C **not** N and –ve charge must be present somewhere on ion; lone pair not essential **(1)** IGNORE any references to rates of the steps	$(CH_3)_3C$-Br completely correct S_N2 version scores **(1)** **See below**		3

Acceptable S_N2



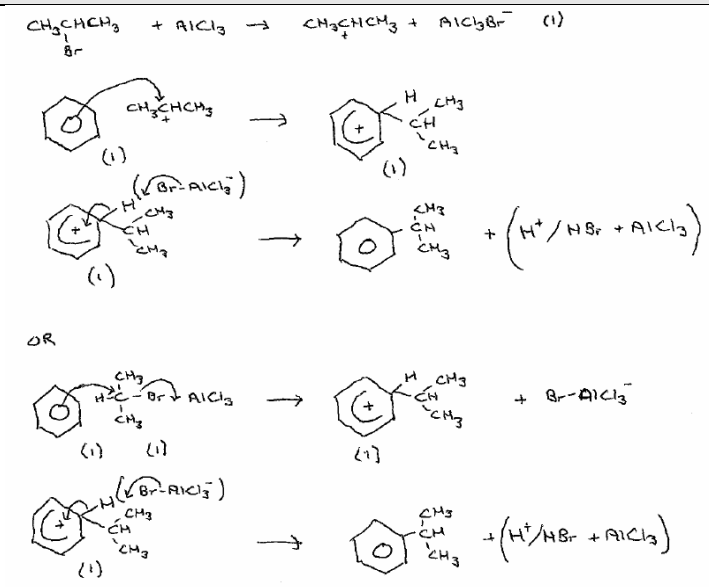
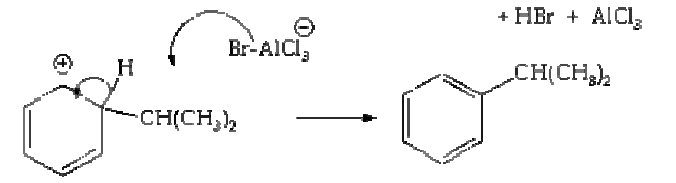
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (c)	yes, because the CN group will cause a different chemical shift **(1)**	no, because the proton/ H atom environment has not changed (so the nmr spectra will be the same)	Just 'No' any mention of more than one peak	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (d) **QWC**	**1st mark** (heat with) NaOH / sodium hydroxide (solution) OR heat to red heat with sodium and drop into water **(1)** **2nd mark** acidify / add excess / neutralise with nitric acid / HNO_3 **(1)** If HCl is added here, only the 1st mark can score **3rd mark** add silver nitrate (solution) /$AgNO_3$ **(1)** **4th mark** cream ppt **(1)** IGNORE reference to ammonia unless incorrect (e.g. soluble in dilute ammonia) Note: If no NaOH used only the 2nd, 3rd and 4th marks can score If no acid is added, or if it is added before NaOH, only 3rd and 4th marks can score If order of addition is NaOH, $AgNO_3$, excess HNO_3, can score all marks If no NaOH and no HNO_3, can score 3rd and 4th marks If any reagent other than $AgNO_3$, including ammoniacal $AgNO_3$, is used, only 1st and 2nd marks can score. **OR** Mass spectroscopy **(1)** A doublet **(1)** of equal heights **(1)** in molecular ion peak **(1)** **OR** Mass spectroscopy **(1)** loss of m/e of 79 **(1)** and 81 **(1)** from molecular ion **(1)** **OR** Infrared spectroscopy **(1)** Measure/record wavenumber **(1)** Absorption due to C-Br stretch **(1)** Compare wavenumber with data book **(1)**	Names or formulae can be used, but if both used both must be correct Dilute sulphuric acid for nitric	add HNO_3 concentrated HNO_3 Yellow /off-white ppt	4

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (e)(i)	**dilute** acid/(dilute) hydrochloric acid/**dilute** sulphuric acid / **dilute** nitric acid OR aqueous NaOH followed by dilute acid **(1)** $(CH_3)_3CCOOH$ **(1)** STAND ALONE	$H_3O^+(aq)/H^+(aq)$ $(CH_3)_3CCO_2H$; displayed formulae	concentrated acid OR Just "water" $C_3H_{10}O_2$	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (e)(ii)	$(CH_3)_3CCOOH+CH_3CH_2OH \rightleftharpoons (CH_3)_3CCOOCH_2CH_3+H_2O$ **(1)** for ethanol provided it is reacting with a carboxylic acid or acid chloride **(1)** for remainder of equation correct ALLOW $(CH_3)_3CCOCl+CH_3CH_2OH \rightarrow (CH_3)_3CCOOCH_2CH_3+HCl$ **(2)** if acid chloride is produced in first step	"$-CO_2-$" for "–COO-"; "$\rightarrow$" for "$\rightleftharpoons$" full structural formulae "C_2H_5" for "CH_3CH_2"	$CH_3CH_2\underline{HO}$	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (a)(i)	(anhydrous) aluminium chloride [Name or formulae]	Al_2Cl_6 $AlBr_3$ $FeBr_3$ $FeCl_3$	Fe	1

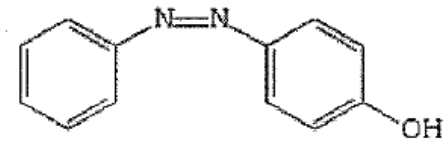
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (a)(ii)	 OR OR    Equation for formation of electrophile **(1)** IGNORE if incorrect arrows added at this point First arrow must be from C=C or from or within ring to C with + and can point to + **(1)** Correct intermediate as shown in mechanism above **(1)** Second arrow from C-H bond into ring **(1)**	either a delocalised or Kekule ring If $CH_3CHBrCH_3 \rightarrow CH_3CH^+CH_3 + Br^-$ loses 1st mark but can score 2nd, 3rd and 4th marks		4

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (b)(i)	$CH_3CH_2CH_2^+$	$C_2H_5CH_2^+$	$C_3H_7^+$	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (b)(ii)	secondary carbocation is more stable than primary **(1)** primary carbocation ($CH_3CH_2CH_2^+$) rearranges to produce a secondary carbocation OR primary carbocation ($CH_3CH_2CH_2^+$) turns into a secondary carbocation OR a description of the rearrangement e.g. a hydrogen atom moves from the middle to the end **(1)**		any reference to stability of intermediate /product	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (c)(i)	**First mark** sodium nitrite /sodium nitrate(III)/$NaNO_2$ **(1)** **Second mark** hydrochloric acid / HCl(aq) **(1)** IGNORE concentration of acid 2nd mark is conditional on $NaNO_2$ or HNO_2		HNO_2 HCl/hydrogen chloride	2

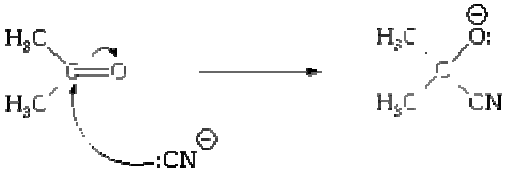
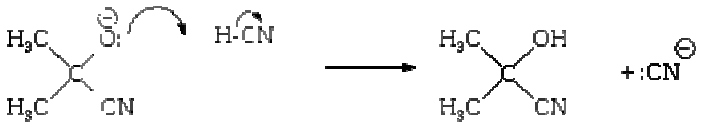
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (c)(ii)	below 0 ^oC reaction is too slow **(1)** above 10 ^oC the product/benzenediazonium ions decomposes /hydrolysed **(1)**	 HNO_2 decomposes		2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (c)(iii)	 N=N link, can be shown linear **(1)** IGNORE other atoms Remainder correct **(1)**	IGNORE position of OH group. —ONa or O^- instead of OH	—N=N—O—	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (c)(iv)	the bonds around the —N=N— bond are not linear (because of lone pairs) **(1)** Note: this could be shown on the diagram restricted rotation/no (free) rotation **around** the —N=N— **(1)**		different groups on each N atom	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (d)(i) QWC	**First two marks** add 2,4-dinitrophenylhydrazine/Brady's reagent **(1)** orange/yellow ppt **(1)** Allow this second mark if the name of the reagent is slightly incorrect e.g. 2,4-diphenylhydrazine OR IR absorption due to C=O stretch **(1)** at 1700 cm^{-1} **(1)** **Third mark** Does not give a silver mirror with ammoniacal silver nitrate (or Tollens' reagent) OR no red ppt/stays blue with Fehling's or Benedict's solution OR $H^+/Cr_2O_7^{2-}$ does not change from orange to green/stays orange OR H^+/MnO_4^- does not change from purple to colourless/stays purple **(1)**	2,4-dnp(h) Any combination of yellow and orange Must be ppt No change with Tollens'	Just "Red ppt" "solid" for "ppt" Iodoform	3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (d)(ii)	the C=O group is polar **and** the nucleophile attacks the δ^+ carbon **(1)** whereas C=C is non-polar/electron-rich, the double bond/π-bond is attacked by electrophiles **(1)** OR C=O is polar **and** C=C is non-polar **(1)** Nucleophile attacks the δ^+ carbon in C=O **and** electrophiles attack the π/double bond in C=C, which is electron rich/non-polar **(1)**			2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (d)(iii)	  **both** curly arrows in 1st diagram, attack by cyanide, arrow must start from C or –ve charge on C **not** N and –ve charge must be present somewhere on ion; lone pair not essential. Arrow must start from bond between C and O and point towards the O **(1)** Intermediate – lone pair not essential but negative charge is essential **(1)** Arrow from O (lone pair not needed) or negative charge to HCN or H^+, this can be shown on the diagram of the intermediate **(1)** If HCN is used the arrow from H-CN bond is required Any other ketone or aldehyde, **max (2)**	curly arrow from O to H^+		3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (a)(i)	Cr: [Ar] $3d^5 4s^1$ Cu: [Ar] $3d^{10} 4s^1$ **Both needed for the mark**	$4s^1 3d^5$ $4s^1 3d^{10}$ [Ar] written in full		1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (a)(ii)	all the others are $4s^2$ / have full 4s orbital **(1)** The d subshell is more stable when either half or fully filled OR A specific example of chromium having half-filled or copper having filled d sub-shell/**set** of d orbitals which is more stable **(1)**	Cr and Cu/they do not have a full 4s orbital sub-energy levels d shell	Just 'only have one electron in 4s' OR Have incomplete 4s orbital Half-filled or filled d-**orbital(s)**	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (b)(i)	Octahedral drawn must be 3-D IGNORE any or no charge	$-H_2O$ (bond to H) except on water molecules on left of Cr		1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (b)(ii)	Dative bond formed from electron pair/lone pair on oxygen (of the water molecule) to the ion This could be shown on a diagram	A clear description of the dative bond	'dative' alone or from water Just "dative bond formed from oxygen"	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (b)(iii)	$[Cr(H_2O)_6]^{3+} + OH^- \rightarrow [Cr(H_2O)_5OH]^{2+}$ **+** H_2O OR $[Cr(H_2O)_6]^{3+} + 2OH^- \rightarrow [Cr(H_2O)_4(OH)_2]^{+}$ **+** $2H_2O$ OR $[Cr(H_2O)_6]^{3+} + 3OH^- \rightarrow Cr(OH)_3$ **+** $6H_2O$ OR $[Cr(H_2O)_6]^{3+} + 3OH^- \rightarrow [Cr(H_2O)_3(OH)_3]$ **+** $3H_2O$ **First mark** is for the correct Cr product **Second mark** is conditional on the first and is for the rest of the equation correct and balanced			2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (b)(iv)	Forms a **green precipitate (1)** IGNORE initial colour of solution (which reacts or dissolves or changes to) a **green solution** (with excess reagent) **(1)** 2nd mark is conditional on an initial ppt	any shade of green		2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (b)(v)	acid / acidic	Amphoteric/able to be deprotonated	Coloured ions/ligand exchange/ deprotonation /partially filled d orbitals	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (c)(i)	**Check working – correct answer can be obtained by not dividing by 2 for 2nd mark and not multiplying by 2 for 4th mark** amount thiosulphate in titre = 0.0372 dm^3 x 0.100 mol dm^{-3} = 3.72 x 10^{-3} mol **(1)** amount I_2 = $\frac{3.72 \times 10^{-3}}{2}$ **(1)** =1.86 x10^{-3} mol 2nd mark cq on amount thiosulphate amount dichromate in 25 cm^3 = $\frac{1.86 \times 10^{-3}}{3}$ **(1)** = 6.2 x10^{-4} mol 3rd mark cq on amount I_2 Total mass Cr = 6.2 x10^{-4} mol x 2 x 10 x 52 g mol^{-1} **(1)** = 0.645 g 4th mark cq on amount dichromate % of Cr = 64.5 % **(1)** IGNORE SF unless rounded to 1 SF cq on mass Cr, provided less than 1 g OR amount thiosulphate for whole sample = 0.0372 dm^3 x 0.100 mol dm^{-3} x 10 = 3.72 x 10^{-2} mol **(1)** amount I_2 = 1.86 x10^{-2} mol **(1)** amount dichromate = 6.2 x10^{-3} mol **(1)** mass Cr = 6.2 x 10^{-3} mol x 2 x 52 g mol^{-1} **(1)** = 0.645 g % of Cr = 64.5% **(1)** IGNORE SF unless rounded to 1sf Mark consequentially, as above **Note:** Correct answer with no working **(3)**	64.48 %		5

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (c)(ii)	Colour at the end point would be green which would prevent the loss of iodine colour being seen OR colour change at end point would be disguised by the colour of Cr^{3+}	Chromium instead of Cr^{3+}	end point disguised by colour of $Cr_2O_7^{2-}$ /orange	1