edexcel
advancing learning, changing lives

Mark Scheme (Results)
June 2010

GCE

GCE Chemistry (6CH04/01)

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

A PEARSON COMPANY

Edexcel is one of the leading examining and awarding bodies in the UK and throughout the world. We provide a wide range of qualifications including academic, vocational, occupational and specific programmes for employers.

Through a network of UK and overseas offices, Edexcel's centres receive the support they need to help them deliver their education and training programmes to learners.

For further information, please call our GCE line on 0844 576 0025, our GCSE team on 0844 576 0027, or visit our website at www.edexcel.com.

If you have any subject specific questions about the content of this Mark Scheme that require the help of a subject specialist, you may find our Ask The Expert email service helpful.

Ask The Expert can be accessed online at the following link:

http://www.edexcel.com/Aboutus/contact-us/

Alternatively, you can speak directly to a subject specialist at Edexcel on our dedicated Science telephone line: 0844 576 0037

Summer 2010

Publications Code UA023636

Section A (multiple choice)

Question Number	Correct Answer	Mark
1 (a)	**D**	**1**

Question Number	Correct Answer	Mark
1 (b)	**D**	**1**

Question Number	Correct Answer	Mark
1 (c)	**A**	**1**

Question Number	Correct Answer	Mark
2	**B**	**1**

Question Number	Correct Answer	Mark
3	**C**	**1**

Question Number	Correct Answer	Mark
4	**D**	**1**

Question Number	Correct Answer	Mark
5	**B**	**1**

Question Number	Correct Answer	Mark
6	**A**	**1**

Question Number	Correct Answer	Mark
7 (a)	**C**	**1**

Question Number	Correct Answer	Mark
7 (b)	**B**	**1**

Question Number	Correct Answer	Mark
7 (c)	**D**	**1**

Question Number	Correct Answer	Mark
8	**B**	**1**

Question Number	Correct Answer	Mark
9	**D**	**1**

Question Number	Correct Answer	Mark
10	**D**	**1**

Question Number	Correct Answer	Mark
11	**B**	**1**

Question Number	Correct Answer	Mark
12	**A**	**1**

Question Number	Correct Answer	Mark
13	**B**	**1**

Question Number	Correct Answer	Mark
14	**C**	**1**

Question Number	Correct Answer	Mark
15	**C**	**1**

Question Number	Correct Answer	Mark
16	**A**	**1**

Section B

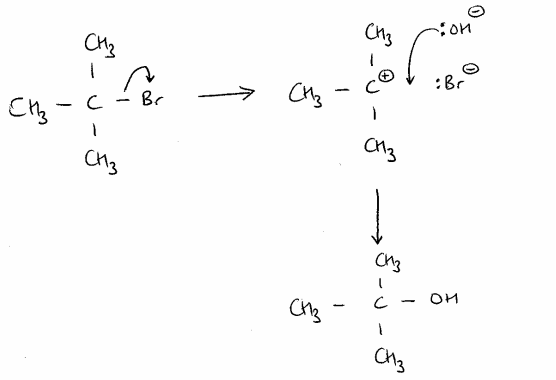
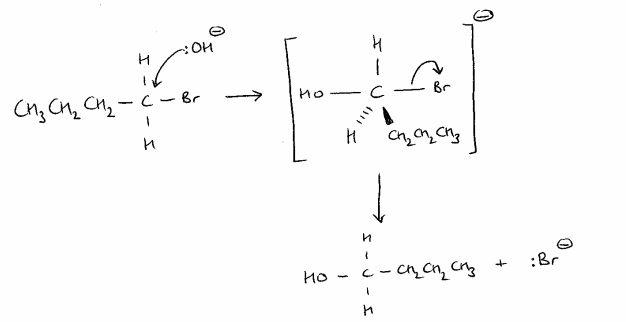
Question Number	Acceptable Answers	Reject	Mark
17 (a)(i)	5.7×10^{-5} / 5.71×10^{-5} / 5.714×10^{-5} / 0.000057 *IGNORE* SF except 1 (ie don't accept 6×10^{-5})		**1**

Question Number	Acceptable Answers	Reject	Mark
17 (a)(ii)	C_4H_9Br: first order / 1 **(1)** (going from first to second experiment) rate doubles when concentration / number of moles doubles (and $[OH^-]$ constant)/ rate and concentration increase in proportion **(1)** *ALLOW* 'time halves' instead of 'rate doubles' OH^-: zero order / 0 **and** (going from second to third expt) as increase in concentration does not affect rate (and $[C_4H_9Br]$ constant) **(1)** *ALLOW* 'doubling in concentration of OH^- instead of 'increase in concentration' *ALLOW* time increases by the same factor as increase in hydroxide concentration (5/ 3) May refer to experiment number rather than concentrations		**3**

Question Number	Acceptable Answers	Reject	Mark
17 (a)(iii)	Rate = $k[C_4H_9Br]$ OR Rate = $k[C_4H_9Br]^1[OH^-]^0$ *ALLOW* k in lower or upper case Rate equation must be consistent with orders in (a)(ii) If no order is given for hydroxide in (ii) mark cannot be given		**1**

Question Number	Acceptable Answers	Reject	Mark
17 (a)(iv)	$k = \frac{2.9 \times 10^{-5}}{0.017}$ **=** 1.7×10^{-3} / 1.71×10^{-3} / $1.706 \times 10^{-3}\ s^{-1}$ *ALLOW* $k = 1.68 \times 10^{-3}$ (value obtained from experiment 2 or 3) value of k **(1)** units **(1) stand alone mark** *ALLOW* TE from (a)(iii) *IGNORE* SF except 1 Rate = $k[C_4H_9Br]^2$ gives k= 0.10036 $dm^3\ mol^{-1}s^{-1}$ Rate = $k[C_4H_9Br][OH^-]$ gives k= 1.42 $dm^3\ mol^{-1}s^{-1}$ *ALLOW* k=1.39 $dm^3\ mol^{-1}s^{-1}$ (value obtained from experiment 2 or 3) Rate = $k[C_4H_9Br][OH^-]^2$ gives k= 1184.6 $dm^6\ mol^{-2}s^{-1}$ Rate = $k[C_4H_9Br]^2[OH^-]$ gives k= 83.62 $dm^6\ mol^{-2}s^{-1}$		**2**

Question Number	Acceptable Answers	Reject	Mark
17(b)	$[OH^-]$ is (in chemical equation but) not in rate equation / not in rate determining step (so is in a step other than rate determining step) OR Only C_4H_9Br is in rate equation / rate determining step (so OH^- is in a step other than rate determining step)		**1**

Question Number	Acceptable Answers	Mark
17 (c)	**First mark** Choice of bromoalkane must be consistent with rate equation in (a)(iii). If $[OH^-]$ is not in rate equation, secondary/ tertiary bromoalkane. If $[OH^-]$ is in rate equation, primary/ secondary bromoalkane. **(1)** **Second and third marks** Either SN1 or SN2 mechanism can score **2 marks** regardless of choice of bromoalkane.  Lone pairs not required Curly arrow from C-Br **bond** to Br (making Br^-) **(1)** Curly arrow from anywhere on OH^-/ HO^- to C^+ in correct intermediate (making alcohol) **(1)** **OR**  Both curly arrows from OH^- and from C-Br bond to Br (may both be shown at start) **(1)** Transition state including minus charge (and product) **(1)** Do not penalise if C_2H_5 shown instead of C_3H_7. Bonds in transition state can be dotted. Do not penalise the missing H atoms in alkyl groups in **mechanism**.	**3**

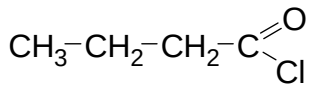
Question Number	Acceptable Answers	Reject	Mark
17 (d) **QWC**	(Primary and tertiary) carbocation intermediates have different stabilities **(1)** as (inductive effects of) alkyl groups stabilise tertiary carbocation **(1)** **OR** Steric hindrance differs for attack on primary and tertiary carbon (in the molecule) / less space available for attack by OH^- on tertiary carbon / more space for attack by OH^- on primary carbon **(1)** as bulky / three alkyl groups obstruct attack **(1)**	"Tertiary bromoalkanes react by SN1" without further explanation carbocation intermediates have different reactivity steric hindrance in carbocation	**2**

Question Number	Acceptable Answers	Reject	Mark
18 (a)(i)	(Acid) hydrolysis	substitution	**1**

Question Number	Acceptable Answers	Reject	Mark
18 (a)(ii)	$K_2Cr_2O_7$ / $Na_2Cr_2O_7$ / $Cr_2O_7^{2-}$ Potassium dichromate((VI)) / sodium dichromate((VI)) / dichromate((VI)) ions *ALLOW* manganate((VII)) ions, etc	Just "dichromate" chromates Correct formula with wrong name and vice versa Incorrect oxidation number	**1**

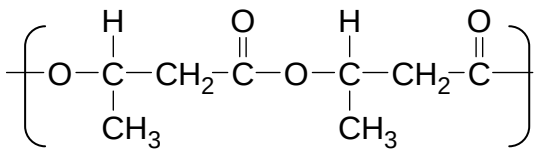
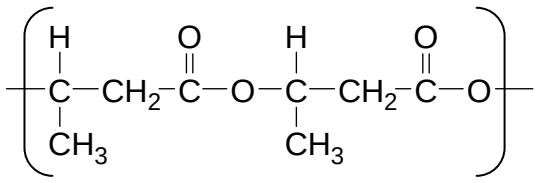
Question Number	Acceptable Answers	Reject	Mark
18 (a)(iii)	Lithium tetrahydridoaluminate/ lithium aluminium hydride/ $LiAlH_4$ (in dry ether)	Just [H^-]	**1**

Question Number	Acceptable Answers	Reject	Mark
18 (a)(iv)	Methyl butanoate **(1)** $CH_3CH_2CH_2COOH + CH_3OH \rightarrow$ $CH_3CH_2CH_2COOCH_3 + H_2O$ **(1)** *ALLOW* $\rightleftharpoons$ *IGNORE* state symbols even if wrong	Methyl butoate	**2**

Question Number	Acceptable Answers	Reject	Mark
18 (a)(v)	 Don't penalise undisplayed methyl groups as here. COCl must be displayed as above.	C_3H_7 for $CH_3CH_2CH_2$	**1**

Question Number	Acceptable Answers	Reject	Mark
18 (b)(i)	Nitrogen inert / unreactive / less reactive (than oxygen) **OR** Oxygen might react with chemicals going through column / sample might oxidise		**1**

Question Number	Acceptable Answers	Reject	Mark
18 (b)(ii)	Solubility (in liquid / stationary phase) **OR** Interaction with liquid / stationary phase **OR** Interaction between mobile and stationary phase **OR** Attraction for liquid / stationary phase **OR** **Strength** of (named) intermolecular forces **OR** Adsorption on liquid / stationary phase **OR** Absorption on liquid / stationary phase	Size of molecule / molar mass Polarity, unless with explanation Boiling point / volatility Viscosity Attraction for carrier gas Just a named intermolecular force Just 'retention time' Density	**1**

Question Number	Acceptable Answers	Reject	Mark
18 (c)(i)	 OR  Ester link including C=O **(1)** Rest of polymer with oxygens at end correct **(1)** All H atoms must be shown. *PENALISE* lack of displayed C=O once only *ACCEPT* Without brackets around formula but bonds at end should be shown More than two correct units *IGNORE* n after brackets		**2**

Question Number	Acceptable Answers	Reject	Mark
18 (c)(ii)	Hydrolysis **OR** Splits / breaks ester link **OR** polymer breaks down to monomers **OR** equation showing hydrolysis	Just 'breaks polymer down'	**1**

Question Number	Acceptable Answers	Reject	Mark
19 (a)(i)	(K_p =) $\frac{pCH_3CO_2H}{pCH_3OH\ (x)\ pCO}$ Partial pressure symbol can be shown in various ways, eg pp, p_{CO}, (CO)p, etc *ALLOW* p in upper or lower case, round brackets *IGNORE* units	[ ] State symbols given as (l) + in bottom line	**1**

Question Number	Acceptable Answers	Reject	Mark
19 (a)(ii)	P CH_3OH = 4.9 (atm) **(1)** P CO = 4.9 (atm) **(1)** 1 mark for recognition that pressures are equal *IGNORE* units		**2**

Question Number	Acceptable Answers	Reject	Mark
19 (a)(iii)	K_p = ((22.2)/ $(4.9)^2$) = 0.925 **(1)** atm^{-1} **(1) stand alone mark but must match expression used in (a)(iii)** **OR** $9.25 \times 10^4\ Pa^{-1}$ / 92.5 kPa^{-1} **(2)** *ALLOW* TE from (a)(i) if inverted and/ or (a)(ii)	Answers to other than 3 significant figures	**2**

Question Number	Acceptable Answers	Reject	Mark
19 (b)(i)	CH_3OH: 3.2 CO : 3.2 **(1)** for both values CH_3CO_2H: 46.8 **(1)** *ALLOW* TE for moles of ethanoic acid based on numbers of methanol and carbon monoxide used, as long as moles of methanol and carbon monoxide are equal and moles ethanoic acid + moles methanol = 50		**2**

Question Number	Acceptable Answers	Reject	Mark
19 (b)(ii)	$\left(\frac{46.8 \times 32}{53.2}\right)$ = 28.2 / 28.1504 (atm) *IGNORE* sf except 1 Value = 28.16 if mol fraction rounded *ALLOW* TE from (b)(i)	28.1 $\frac{46.8 \times 32}{50}$ = 29.95 (atm)	**1**

Question Number	Acceptable Answers	Reject	Mark
19 (b)(iii)	exothermic as yield / pp of ethanoic acid / conversion of reactants/ K_p is higher at lower temperature / as equilibrium moves (right) at lower temperature *ALLOW* if partial pressure of ethanoic acid < 22.2 atm in (b)(ii), endothermic as yield / pp of ethanoic acid / conversion of reactants/ K_p is lower at lower temperature		**1**

Question Number	Acceptable Answers	Reject	Mark
19 (c)(i)	No effect **and** other concentrations change to keep K_p constant / K_p is only affected by temperature/ as equilibrium moves (right) to keep K_p constant / **change** in pressure does not change K_p	As K_p is a constant	**1**

Question Number	Acceptable Answers	Reject	Mark
19 (c)(ii)	Yield **increased** to restore fraction / quotient / partial pressure ratio back to K_p *ALLOW* (equilibrium moves) to use up the methanol / answers based on entropy or Le Chatelier Correct prediction in (c)(i) and (c)(ii) with inadequate explanations scores **1 mark** in (c)(ii)	Just 'equilibrium moves to the right'	**1**

Question Number	Acceptable Answers	Reject	Mark
19 (d)	Mark independently Reaction can occur at lower temperature / has lower activation energy / requires less energy **(1)** less fuel needed / fewer emissions (from fuels) / fewer raw materials needed / less natural resources used **(1)** **OR** Enables use of an alternative process with higher atom economy **(1)** fewer raw materials needed / less natural resources used **(1)**	Answer based on car exhaust emissions	**2**

Question Number	Acceptable Answers	Reject	Mark
20 (a)(i)	Correct answer with or without working scores **2 marks** $[H^+] = (1.00 \times 10^{-14} / 0.250) = 4 \times 10^{-14}$ **(1)** pH = (13.39794 =) 13.4 **(1)** **OR** pOH = -log 0.250 = 0.602 **(1)** pH = (13.39794 =)13.4 **(1)** *ALLOW* TE in second mark if error in $[H^+]$ calculation gives pH more than 7 3 or more sf *IGNORE* rounding errors e.g. accept 13.39		**2**

Question Number	Acceptable Answers	Reject	Mark
20 (a)(ii)	$(K_a =) \frac{[CH_3COO^-][H^+]}{[CH_3COOH]}$ **(1)** *ALLOW* H_30^+ instead of H^+ $\frac{[A^-][H^+]}{[HA]}$ if key to symbols given *IGNORE* state symbols	$\frac{[H^+]^2}{[CH_3COOH]}$	**1**

Question Number	Acceptable Answers	Reject	Mark
20 (a)(iii)	Correct answer with or without working scores **2 marks** $1.7 \times 10^{-5} = \frac{[H^+]^2}{0.125}$ **(1)** $[H^+] = 1.46 \times 10^{-3}$ pH = 2.84/ 2.8 **(1)** no TE from an incorrect $[H^+]$		**2**

Question Number	Acceptable Answers	Reject	Mark
20 (a)(iv)	pH = 4.8 / 4.77 **(1)** pH = pK_a / $[H^+] = K_a$ (when acid is half neutralized) **(1)**	 $H^+ = K_a$	**2**

Question Number	Acceptable Answers	Reject	Mark
20 (a)(v)	Sigmoid curve starting between pH 2 and 4 (2.8), ending between pH 12 and 14 inclusive **(1)** with steep rise (may be vertical or gently sloping) of between 3 – 7 units between pH 6 and 12. Sloping section should not extend over more than 5cm^3. **(1)** When 12.5 cm^3, NaOH added. **(1)** *ALLOW* tolerance for grid Reverse curves lose first mark		**3**

Question Number	Acceptable Answers	Reject	Mark
20 (a)(vi)	**First mark** Thymolphthalein more suitable as it changes (from colourless to blue) in steep region of titration (pH 8.3 to 10.6)/ at the equivalence point / at the end point OR thymolphthalein has pH range in steep region of titration **(1)** **Second mark** Methyl yellow changes (from red to yellow at pH 2.9 to 4) before equivalence point / before the end point / doesn't change in steep section OR Methyl yellow has pH range before / outside steep region of titration **(1)** *ALLOW* 'Thymolphthalein more suitable as it changes at the equivalence point but methyl yellow does not.' This scores **2 marks** **OR** **First mark** pK_{in} ± 1 must lie within vertical region on titration curve **(1)** **Second mark** hence thymolphthalein is suitable and methyl yellow is not **(1)**		**2**

Question Number	Acceptable Answers	Reject	Mark
20 (b)	Sodium ethanoate/ CH_3COONa Potassium ethanoate / CH_3COOK *ALLOW* other cations as alternatives to sodium	Use of sodium hydroxide (because it's in food)	**1**

Question Number	Acceptable Answers	Reject	Mark
21 (a)(i)	$\Delta S^{\ominus}_{system}$ = 109.2 + (6x 69.9) – 343 **(1)** =(+)185.6(J mol^{-1} K^{-1}) / (+)186 (J mol^{-1} K^{-1}) **(1)** **OR** (+)0.186 (kJ mol^{-1} K^{-1}) **(2)** IGNORE units even if incorrect correct answer with no working scores 2 Value using 1 for H_2O = -163.9 scores 1 Use of value for $H_2O(g)$ (188.7) gives 898.4 (J mol^{-1} K^{-1}) **(1)** correct value with incorrect sign scores 1	185	**2**

Question Number	Acceptable Answers	Reject	Mark
21 (a)(ii)	Yes as (solid and) liquid forms (from solid) / number of moles increases **OR** If $\Delta S^{\ominus}_{system}$ in (i) is negative the sign is not as expected as liquid forms from solid / number of moles increases	Disorder increases, with no ref to liquid or number of moles	**1**

Question Number	Acceptable Answers	Reject	Mark
21 (a)(iii)	**First mark** $\Delta S^{\ominus}_{surroundings} = \frac{-88.1 \times (1000)}{298}$ **(1)** **Second mark** = -295.6375 = -295.6 J mol^{-1} K^{-1} **(1)** correct units must be shown but order not important **OR** -0.2956 kJ mol^{-1} K^{-1} **(1)** correct units must be shown but order not important correct answer with or without working and correct units scores **(2)** ignore sf except 1 correct value with positive sign scores 1		**2**

Question Number	Acceptable Answers	Reject	Mark
21 (a)(iv)	(185.6–295.6) **= -110 (J mol^{-1} K^{-1})** OR **-0.110 (kJ mol^{-1} K^{-1})** could use 186 or 296 etc TE from (a)(i) and (iii) **(+)602.8 (J mol^{-1} K^{-1}) if value for $6H_2O(g)$ was used in (a) (i)** **-459.5 (J mol^{-1} K^{-1}) if value for one H_2O was used in (a) (i)**	Answers where values in J are added to kJ	**1**

Question Number	Acceptable Answers	Reject	Mark
21 (a)(v)	Decomposition (at 298 K) will not occur as $\Delta S^{\ominus}_{total}$ is negative / Reactions are only spontaneous if total entropy change is positive / decomposition not thermodynamically feasible / (hydrated cobalt chloride) is thermodynamically stable TE if answer to (a)(iv) is positive showing decomposition (at 298 K) may occur **OR** Positive total entropy change doesn't indicate rate of reaction		**1**

Question Number	Acceptable Answers	Reject	Mark
21 (b)(i)	**First mark** Thermometer **(1)** **Second mark** (dependent on first) depends on choosing thermometer as temperature change is small / (%) error in balance smaller than for temperature reading (%) error in pipette smaller than for temperature reading (can be shown by calculation) / as scale with greater degree of precision needed / scale with more graduations needed **(1)** *IGNORE* any references to 'accurate thermometer'		**2**

Question Number	Acceptable Answers	Reject	Mark
21 (b)(ii)	Use more cobalt chloride / less water **(1)** To increase temperature rise **(1)** Mark independently	Just 'use more reactants' Use more cobalt chloride and more water repeat expt add a lid or extra insulation to beaker use distilled water	**2**

Question Number	Acceptable Answers	Reject	Mark
21 (c)(i) QWC	Radius (of cation) increases (down group) OR any **two** values of radius: Mg^{2+} = 0.072, Ca^{2+} = 0.100 / Sr^{2+} = 0.113 (nm) data may be shown beside the table **(1)** Radius Co^{2+} = 0.065 nm OR Co^{2+} radius smaller than other ions **(1)** Data on **EITHER** Co^{2+} **OR** data showing increase in radius down Group II required for **BOTH** of first two marks Force of attraction between ions decreases (as radius of ions increases) / charge density of ions decreases / negative ion can come closer to nucleus of positive ion **(1)** *ALLOW* "weaker ionic bonds" Predict lattice energy –2550 to -2900 (kJ mol^{-1}) **(1)** IGNORE sign	Atomic radii unless ionic radii also given Radius of cobalt chloride Polarising power decreases	**4**

Question Number	Acceptable Answers	Reject	Mark
21 (c)(ii) QWC	**First mark** Reference to enthalpy of hydration (may be in equation $\Delta H_{solution}$ = -LE + $\Delta H_{hydration}$) **(1)** **Second mark** Solubility depends on relative size of lattice energy and enthalpy of hydration **(1)** **Third mark** **EITHER** Solubility more likely if $\Delta H_{solution}$ is negative **OR** (If $\Delta H_{solution}$ is positive,) may / will dissolve if ΔS_{total} is positive *ACCEPT* solvation instead of hydration		**3**

Question Number	Acceptable Answers	Reject	Mark
21 (d) QWC	**First mark** **Third** ionization energy **high(er)** for Mg / Mg = 7733 kJ mol^{-1}, (third ionization energy for Co = 3232 kJ mol^{-1}) **(1)** **Second mark** (Third ionization energy for Mg is high) because the electron is being removed from an inner shell / full shell / 2p level / 2p orbital **(1)** **OR** Not compensated by higher lattice energy for Mg^{3+} (and so $\Delta H_{formation}$ of $MgCl_3$ would be highly endothermic) **(1)**		**2**