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Mark Scheme (Results)

Summer 2015

IAL Chemistry (WCH01/01)

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Summer 2015
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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.
- Mark schemes will indicate within the table where, and which strands of QWC, are being assessed. The strands are as follows:

  i) ensure that text is legible and that spelling, punctuation and grammar are accurate so that meaning is clear
  ii) select and use a form and style of writing appropriate to purpose and to complex subject matter
  iii) organise information clearly and coherently, using specialist vocabulary when appropriate

Section A (multiple choice)

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

TOTAL FOR SECTION A = 20 MARKS

Section B

Question Number	Acceptable Answers	Reject	Mark
21(a)(i)	Alkane(s) **IGNORE** Any references to 'branched' / 'aliphatic' / 'hydrocarbons'		**1**

Question Number	Acceptable Answers	Reject	Mark
21(a)(ii)	2,3-**di**methyloctane **IGNORE** Incorrect or missing punctuation		**1**

Question Number	Acceptable Answers	Reject	Mark
21(a)(iii)	**1st mark:** (Isomers) **A and C** **(1)** **NOTE** If no isomers or isomers other than A & C have been chosen, then award one mark max providing both 2nd and 3rd marking points are evident. **2nd mark:** (They/A and C) have the same **molecular formula** / $C_{10}H_{22}$ / same number of C and H (atoms) **(1)** **3rd mark:** (They/A and C) have different structural formulae/displayed formulae / skeletal formulae / different structures/different arrangement of atoms **IGNORE** Any references to 'in space' / 'spatial' Any references to names Any references to general formulae **(1)**	'Different chemical formulae'	**3**

Question Number	Acceptable Answers	Reject	Mark
21(a)(iv)	$C_{12}H_{24}$ **1st mark:** C_{12} **(1)** **2nd mark:** H_{24} **(1)**		**2**

Question Number	Acceptable Answers	Reject	Mark
21(b)(i)	**A** OR **B** **ALLOW** lower case letters **IGNORE** any names or formulae		**1**

Question Number	Acceptable Answers	Reject	Mark
21(b)(ii)	**C** OR **D** **ALLOW** lower case letters **IGNORE** any names or formulae		**1**

Question Number	Acceptable Answers	Reject	Mark
21(c)	Any **one** of: (It improves engine performance by) Promoting efficient combustion OR Allowing smoother burning OR Increasing octane number OR Reduces knocking / prevents knocking OR Pre-ignition being less likely OR Being (more) efficient (fuels) OR Better burning / fuels easier to burn OR Combusting more easily OR Improving combustion / complete combustion OR Burns more cleanly OR More miles per gallon **IGNORE** any references to energy density / boiling temperature / volatility		**1**

Question Number	Acceptable Answers	Reject	Mark
21(d)	[FIRST, check the answer on the answer line IF answer = 48000 (kJ kg^{-1}) award **(3)** marks] **1st two marks** $\frac{1000}{170}$ **(1)** x 8086 **(1)** **OR** $\frac{8086}{170}$ **(1)** x 1000 **(1)** NOTE: second mark in both cases dependent on first mark unless one minor transcription error in first mark e.g. use of 110 rather than 170 **3rd mark** = 47564.70588 = 48000 **(1)** Answer must be to 2 sf **Ignore signs and / or incorrect units at any stage** 48 scores **(2)** 47.56 scores **(1)** 1374.6 scores **(0)** even if rounded to 2SF		**3**

(Total for Question 21 = 13 marks)

Question Number	Acceptable Answers	Reject	Mark
22(a)(i)	ΔH_2 ALLOW ΔH_2 = ……		**1**

Question Number	Acceptable Answers	Reject	Mark
22(a)(ii)	ΔH_5 ALLOW ΔH_5 = ……	$\frac{\Delta H_5}{2}$	**1**

Question Number	Acceptable Answers	Reject	Mark
22(a)(iii)	$\frac{\Delta H_6}{2}$ OR ΔH_6 / 2 OR $\Delta H_6 \div 2$ OR 0.5 ΔH_6	ΔH_6	**1**

Question Number	Acceptable Answers	Reject	Mark
22(a)(iv)	ΔH_1 ALLOW ΔH_1 = ……	ΔH_7	**1**

Question Number	Acceptable Answers	Reject	Mark
22(b)(i)	(The energy change / enthalpy change that accompanies / energy released / enthalpy released) the formation of **one mole** of a(n ionic) compound **(1)** ALLOW as alternative for compound: lattice /crystal / substance / solid / product from its **gaseous ions** **(1)** *NOTE* 'one mole of gaseous ions' scores max **(1)** (ie 2nd mark only available) *IGNORE* References to 'constituent elements' References to 'standard conditions' **ALTERNATIVE RESPONSE** If no mark(s) already awarded from above, can answer by giving:- energy change / enthalpy change **per mole** **(1)** $Sr^{2+}(g) + 2Cl^{-}(g) \rightarrow SrCl_2(s)$ **ALLOW** Any correct 'generic' equation with state symbols included **(1)**	'Energy / enthalpy **required' / 'used'** 'molecule' **no 1st mark** 'gaseous atoms' **no 2nd mark**	**2**

Question Number	Acceptable Answers	Reject	Mark
22(b)(ii)	[FIRST, check the answer on the answer line IF answer = **—2153** (kJ mol^{-1}) then award **(2)** marks, with or without working] **1st Mark:** $\Delta H_1 = \Delta H_2 + \Delta H_3 + \Delta H_4 + \Delta H_5 + \Delta H_6 + \Delta H_7$ OR $\Delta H_7 = \Delta H_1 - [\Delta H_2 + \Delta H_3 + \Delta H_4 + \Delta H_5 + \Delta H_6]$ OR $\Delta H_7 = -829 - [164 + 550 + 1064 + (122 \times 2) + (2 \times -349)]$ **(1)** **2nd Mark:** $\Delta H_7 = -2153$ (kJ mol^{-1}) **(1)** **NOTE:** **The following answers score (1) mark with or without working** **+**2153 (kJ mol^{-1}) −2031 (kJ mol^{-1}) −2502 (kJ mol^{-1}) −2380 (kJ mol^{-1}) **NO OTHER TEs are allowed on an incorrect expression involving** ΔH_7		**2**

Question Number	Acceptable Answers	Reject	Mark
22*(c)	(Lattice energy of MgF_2 more exothermic than that of NaF because) **1st mark:** Mg^{2+} is smaller (than Na^+) **ALLOW** "Magnesium / Mg is smaller (than sodium / Na)" **(1)** **2nd mark:** Mg^{2+} higher charge / higher charge density (than Na^+) **ALLOW** Any reference to Mg^{2+} **and** Na^+ in answer for the 2nd mark, unless nuclear charge mentioned **(1)** **3rd mark:** (So electrostatic forces of) **attraction** between **ions** stronger in MgF_2 (than in NaF) **ALLOW** Strong**er** ionic bonds in MgF_2 / strong**er** ionic bonding in MgF_2 **(1)** OR reverse arguments	**No 1st mark** if only mention Mg **atom** or **atomic** radius "Mg^{2+} higher **nuclear** charge"	**3**

(Total for Question 22 = 11 marks)

Question Number	Acceptable Answers	Reject	Mark
23(a)	C_nH_{2n} ALLOW Letters other than *n*		**1**

ALLOW: (partially) displayed or skeletal formulae throughout **Q23(b)**
IGNORE: additional incorrect non-organic products

Question Number	Acceptable Answers	Reject	Mark
23(b)(i)	CH_3CH_3	C_2H_6	**1**

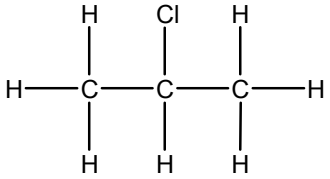
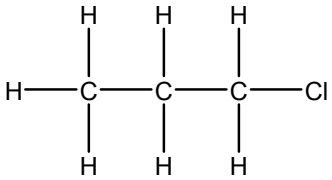
Question Number	Acceptable Answers	Reject	Mark
23(b)(ii)	$ClCH_2CH_2Cl$ / CH_2ClCH_2Cl	$C_2H_4Cl_2$	**1**

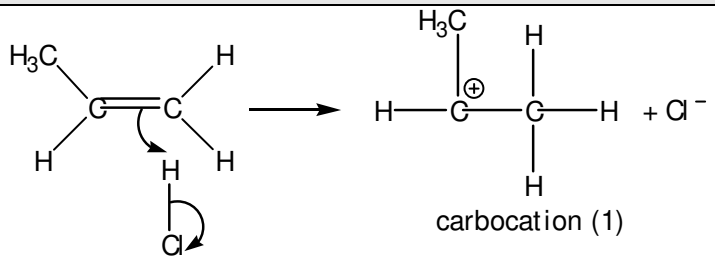
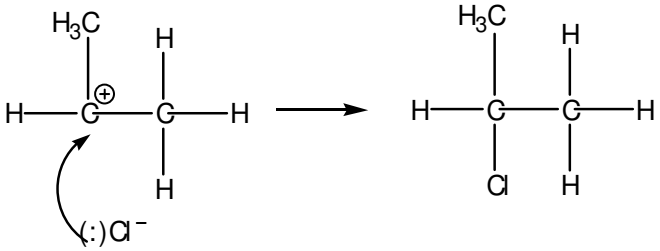
ONLY PENALISE <u>ONCE ONLY</u> in (b)(iii) & (b)(iv) THE CONNECTIVITY BETWEEN C and OH if CLEARLY a C to H covalent bond has been drawn

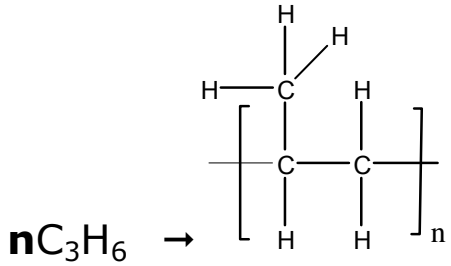
Question Number	Acceptable Answers	Reject	Mark
23(b)(iii)	**HO**CH_2CH_2OH / CH_2OHCH_2OH	$C_2H_6O_2$ / **OH**CH_2CH_2OH	**1**

Question Number	Acceptable Answers	Reject	Mark
23(b)(iv)	$HOCH_2CH_2Br$ / CH_2OHCH_2Br	$BrCH_2CH_2Br$ / C_2H_5OBr / $C_2H_4Br_2$	**1**

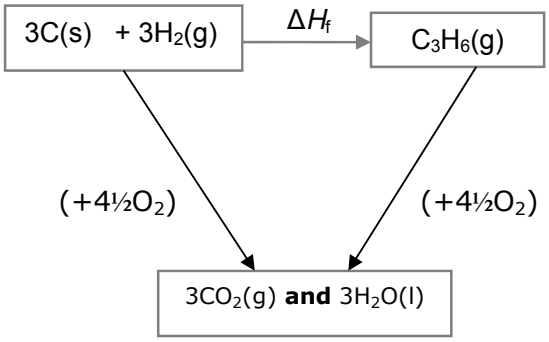
PENALISE USE OF Br instead of Cl once only in parts (c)(i) & (c)(ii)
PENALISE missing H atoms from displayed formulae once only in parts (c)(i) & (c)(ii)

Question Number	Acceptable Answers	Reject	Mark
23(c)(i)	 (Major product) **(1)**  (Minor product) **(1)** Both DISPLAYED structures, with all bonds and atoms shown but in the wrong boxes scores **(1)** **PENALISE** CH_3 not fully displayed **ONCE** only **So** $CH_3CH(Cl)CH_3$ and $CH_3CH_2CH_2Cl$ scores **(1)**		**2**

Question Number	Acceptable Answers	Reject	Mark
23(c)(ii)	 both arrows (1) carbocation (1)  attack of chloride ion (1) **1st mark:** Curly arrow from C=C to H (in H—Cl) **AND** curly arrow from bond in H—Cl to the Cl (dipole not reqd) Curly arrows must start from the bonds **NOT** the atoms **(1)** **2nd mark:** Structure of correct secondary carbocation **(1)** **3rd mark:** Curly arrow from anywhere on the chloride ion (including the minus sign) towards the C+ on the carbocation **(1)** **NOTE:** The chloride ion must have a full negative charge, but the lone pair of electrons on the Cl^- need not be shown **ALLOW:** TE on major product given in (c)(i) Skeletal formulae can be used **Mark the three points independently**	Full + and – charges on HCl Incorrect polarity on HCl Extra / spare bond dangling from the C+ carbon δ- on chloride ion instead of Cl^-	**3**

Question Number	Acceptable Answers	Reject	Mark
23(d)(i)	 $\mathbf{n}C_3H_6 \rightarrow$ TWO 'n' in the equation and a correct formula (molecular or structural) for propene on the left-hand side of the equation **(1)** **One** correct repeating unit, with the methyl branch shown **(1)** **ALLOW** CH_3 fully displayed or just as CH_3 **BOTH** continuation bonds (with or without bracket shown) **(1)** If C=C bond left in polymer on right-hand side, then max (1) **Mark the three points independently**		**3**

Question Number	Acceptable Answers	Reject	Mark
23(d)(ii)	Non-biodegradable IGNORE References to toxicity of poly(propene) / flammability IGNORE Litter / pollution / waste of resources / costs **ALLOW** People are reluctant to recycle OR Harmful to marine life / harmful to wildlife OR References to 'landfill' OR References to 'incineration' producing toxic fumes/toxic gases / CO_2 / Greenhouse gases OR References to use of **energy**/**fuel** used in transport (of waste) OR It takes a long time to degrade		**1**

Question Number	Acceptable Answers	Reject	Mark
23(e)(i)	 Both arrows in the correct direction **AND** $3CO_2$ **and** $3H_2O$ in lowest box IGNORE state symbols, even if incorrect IGNORE extra O_2 molecules in box or alongside arrows		**1**

Question Number	Acceptable Answers	Reject	Mark
23(e)(ii)	**1st mark** (−394 x 3) + (−286 x 3) OR = −2040 (kJ mol^{-1}) **(1)** **2nd mark:** ΔH_f = −2040 – (−2058) = (+)18 (kJ mol^{-1}) **(1)** **NOTE:** **The following answers score (1) mark** **with or without working** **−**18 (kJ mol^{-1}) (+)1378 (kJ mol^{-1}) (+)806 (kJ mol^{-1}) (+)590 (kJ mol^{-1}) −4098 (kJ mol^{-1}) IGNORE units even if incorrect		**2**

(Total for Question 23 = 17 marks

Question Number	Acceptable Answers	Reject	Mark
24(a)	$F(g) \rightarrow F^{+}(g) + e^{(-)}$ OR $F(g) - e^{(-)} \rightarrow F^{+}(g)$ Species **(1)** State symbols IGNORE Any state symbols on electrons **(1)** 2nd mark is dependent on the first **NOTE:** $F(g) + e^{(-)} \rightarrow F^{+}(g) + 2e^{(-)}$ Use of 'Fl' **max (1)**	Electron affinity equation (0) overall Equations with $F_2(g)$ score **(0)** overall	**2**

Question Number	Acceptable Answers	Reject	Mark
24*(b)	**1st mark:** Number of protons increases / increasing nuclear charge / increasing effective nuclear charge **IGNORE** Just 'the atomic number increases' **(1)** **2nd mark:** Same shielding / same number of (occupied) shells / electron removed from the same shell / atomic radius decreases **(1)** **3rd mark:** Greater (electrostatic) attraction between nucleus / protons and (outermost) electron **(1)**	'Shielding increases' **(0)** for 2nd mark	**3**

Question Number	Acceptable Answers	Reject	Mark
24(c)*(i)	For aluminium **1st mark:** (Electron lost from) (3)**p**-subshell / (3)**p**-orbital ALLOW Correct electron configuration for Al: $1s^2 2s^2 2p^6 3s^2 3p^1$ or $[Ne]3s^2 3p^1$ or drawn as electrons-in-boxes **(1)** **NOTE** First mark must refer to aluminium **2nd mark:** at higher energy / further from the nucleus / (more) shielded (by 3s) OR Magnesium electron is at lower energy / closer to the nucleus / less shielded **(1)** **IGNORE** References to stability of $3s^2$ or full s-orbitals / full s sub-shell in Mg	Mention of **2**p, no 1st mark	**2**

Question Number	Acceptable Answers	Reject	Mark
24(c)*(ii)	For sulfur **1st mark:** (Electron lost from a) pair of electrons / an orbital with electrons (spin-) paired / a full (p) orbital **ALLOW** Mention of (3)p^4 OR Correct electron configuration for S:$1s^2 2s^2 2p^6 3s^2 3p^4$ or [Ne]$3s^2 3p^4$ or drawn as electrons-in-boxes **(1)** **2nd mark:** (increase in) **repulsion** (allows e^- to be removed more easily) **(1)** If no correct reference to Sulfur, then allow one mark for P (atom) has half-filled p sub-shell / p^3 (arrangement) is stable.		**2**

Question Number	Acceptable Answers	Reject	Mark
24(d)(i)	(Al) (Si) (P) (S) high high low low Four correct **(2)** Three correct **(1)**		**2**

Question Number	Acceptable Answers	Reject	Mark
24(d)(ii)	(Na) (Al) (Si) (P) (S) giant (giant) giant giant molecular molecular ALLOW 'giant molecular' for Si ALLOW 'simple molecular' for P and/or S Five correct **(2)** Four correct **(1)**		**2**

Question Number	Acceptable Answers	Reject	Mark
24(d)(iii)	(Na) (Al) (Si) (P) (S) high (high) high **X** low low All four must be correct **IGNORE** Any word written over **X** in the Si box		**1**

Question Number	Acceptable Answers	Reject	Mark
24(e)(i)	($\frac{2.76}{23.0}$) = 0.12(0) (mol)		**1**

Question Number	Acceptable Answers	Reject	Mark
24(e)(ii)	Moles H_2 = ½ x mol Na **(1)** Volume H_2 = 0.06(0) x 24 = 1.44 (dm^3) **(1)** ALLOW ECF from moles of Na in (e)(i) ALLOW Both marks if answer given 1440 **cm^3** Correct answer, no working scores **(2)** **NOTE:** **The following answers score (1) mark with or without working** 2.88 (dm^3) / 2880 **cm^3** 5.76 (dm^3) / 5760 **cm^3** However, check as 2.88 could score 2 as a TE of 0.24 mol from (e)(i) IGNORE SF except 1 SF		**2**

Question Number	Acceptable Answers	Reject	Mark
24(e)(iii)	**1st mark:** Moles NaOH = moles of Na **(1)** Can be implied by use of value from (e)(i) **2nd mark:** ($\frac{0.12}{0.500}$) = 0.24(0) (mol dm^{-3}) **(1)** ALLOW TE from moles of Na in (e)(i) Correct answer, no working scores **(2)** IGNORE SF except 1 SF NOTE: TE from first mark to second mark only if answer from (e)(i) has been used in some way e.g. answer to (e)(i) × 2 would not score mark 1, but could then be used to score mark 2 as a TE	No 2nd mark if give wrong units, e.g "mol/dm^{-3}" "dm^3/mol"	**2**

(Total for Question 24 = 19 marks)

TOTAL FOR SECTION B = 60 MARKS

TOTAL FOR PAPER = 80 MARKS

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