Mark Scheme (Results)

January 2014

IAL Chemistry (WCH01/01)
The Core Principles of Chemistry

Edexcel and BTEC Qualifications

Edexcel and BTEC qualifications are awarded by Pearson, the UK's largest awarding body. We provide a wide range of qualifications including academic, vocational, occupational and specific programmes for employers. For further information visit our qualifications websites at www.edexcel.com or www.btec.co.uk. Alternatively, you can get in touch with us using the details on our contact us page at www.edexcel.com/contactus.

Pearson: helping people progress, everywhere

Pearson aspires to be the world's leading learning company. Our aim is to help everyone progress in their lives through education. We believe in every kind of learning, for all kinds of people, wherever they are in the world. We've been involved in education for over 150 years, and by working across 70 countries, in 100 languages, we have built an international reputation for our commitment to high standards and raising achievement through innovation in education. Find out more about how we can help you and your students at: www.pearson.com/uk

January 2014
Publications Code IA037624

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

Using the Mark Scheme

Examiners should look for qualities to reward rather than faults to penalise. This does NOT mean giving credit for incorrect or inadequate answers, but it does mean allowing candidates to be rewarded for answers showing correct application of principles and knowledge. Examiners should therefore read carefully and consider every response: even if it is not what is expected it may be worthy of credit.

The mark scheme gives examiners:
- an idea of the types of response expected
- how individual marks are to be awarded
- the total mark for each question
- examples of responses that should NOT receive credit.

/ means that the responses are alternatives and either answer should receive full credit.
( ) 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.
Phrases/words in **bold** indicate that the meaning of the phrase or the actual word is **essential** to the answer.
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.

Candidates must make their meaning clear to the examiner to gain the mark. Make sure that the answer makes sense. Do not give credit for correct words/phrases which are put together in a meaningless manner. Answers must be in the correct context.

Quality of Written Communication

Questions which involve the writing of continuous prose will expect candidates to:
- write legibly, with accurate use of spelling, grammar and punctuation in order to make the meaning clear
- select and use a form and style of writing appropriate to purpose and to complex subject matter
- organise information clearly and coherently, using specialist vocabulary when appropriate.

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.

Section A (multiple choice)

Question Number	Correct Answer	Reject	Mark
1	C		1

Question Number	Correct Answer	Reject	Mark
2	B		1

Question Number	Correct Answer	Reject	Mark
3	C		1

Question Number	Correct Answer	Reject	Mark
4	D		1

Question Number	Correct Answer	Reject	Mark
5(a)	B		1

Question Number	Correct Answer	Reject	Mark
5(b)	A		1

Question Number	Correct Answer	Reject	Mark
5 (c)	C		1

Question Number	Correct Answer	Reject	Mark
6	A		1

Question Number	Correct Answer	Reject	Mark
7	A		1

Question Number	Correct Answer	Reject	Mark
8	D		1

Question Number	Correct Answer	Reject	Mark
9	C		1

Question Number	Correct Answer	Reject	Mark
10	D		1

Question Number	Correct Answer	Reject	Mark
11	C		1

Question Number	Correct Answer	Reject	Mark
12	B		1

Question Number	Correct Answer	Reject	Mark
13	B		1

Question Number	Correct Answer	Reject	Mark
14	A		1

Question Number	Correct Answer	Reject	Mark
15(a)	B		

Question Number	Correct Answer	Reject	Mark
15(b)	C		1

Question Number	Correct Answer	Reject	Mark
15(c)	A		1

Question Number	Correct Answer	Reject	Mark
16	D		1

Section B

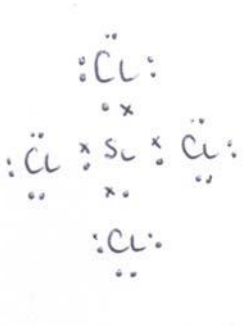
Question Number	Acceptable Answers	Reject	Mark
17(a)(i)	14p,14e,15n All correct		**1**

Question Number	Acceptable Answers	Reject	Mark
17(a)(ii)	$(1s^2)\ 2s^2\ 2p^6\ 3s^2\ 3p^2$ Fully correct ALLOW Subscripts rather than superscripts SPD in capitals $2p_x^2\ 2p_y^2\ 2p_z^2$ and $3p_x^1\ 3p_y^1$ for 2p and 3p IGNORE $1s^2$ written again before $2s^2$		**1**

Question Number	Acceptable Answers	Reject	Mark
***17(b)(i)**	**First mark: Structure of silicon** • Silicon is **giant** covalent / **giant** atomic / **giant** molecular / macromolecular / **giant** structure / **giant** lattice **(1)** IGNORE **JUST** 'GIANT' OR **JUST** 'LATTICE' **Second mark: Structure of phosphorus** • Small molecules / simple molecules / P_4 molecules / molecular covalent / simple covalent / molecular **(1)** IGNORE **JUST** 'SIMPLE' /'SIMPLE STRUCTURE' **Third mark: Interactions overcome on melting** **BOTH** • (Breaking strong) **covalent bonds** in silicon **AND** • Between phosphorus molecules: weak forces / (weak) intermolecular forces / (weak) London forces / (weak) van der Waals' forces / (weak) dispersion forces / (weak) induced-dipole forces **(1)** [ALLOW "weak bonds" **IF** implies between phosphorus **molecules**]	Silicon "giant ionic" / silicon "giant metallic" Intermolecular forces broken in silicon Covalent bonds broken in phosphorus / weak bonds between phosphorus **atoms** / weak **covalent** bonds	**3**

Question Number	Acceptable Answers	Reject	Mark
***17(b)(ii)**	**ALLOW** reverse arguments in each case **PENALISE** Omission of 'atoms' or 'ions' / mis-use of 'atom' or 'ion' ONCE only where relevant **ANY TWO FROM:** • Magnesium atoms / magnesium ions are smaller (than sodium atoms/ions) **(1)** **NOTE:** Allow symbols (e.g. Mg or Mg^{2+}) • Magnesium ions are Mg^{2+} whereas sodium ions are Na^{+} **OR** Mg^{2+} /magnesium **ions** have a higher charge (density) than Na^{+}/sodium ions **(1)** **IGNORE** References to (effective) nuclear charge • Magnesium has more delocalised electrons (than sodium) /magnesium has more electrons (than sodium) in its sea of electrons **(1)** • Attraction between positive ions and (delocalised) electrons is stronger in magnesium (than in sodium) **(1)** **IGNORE** References to **JUST** 'more energy needed' (to break bonds in magnesium)	Attraction "between **nucleus** and (delocalised) electrons" Mention of "intermolecular forces" or "molecules" scores **(0)** overall for this question	**2**

Question Number	Acceptable Answers	Reject	Mark
17(c)	**1st mark:** More protons / increasing nuclear charge / increasing effective nuclear charge **(1)** **IGNORE** 'increasing atomic number' **2nd mark:** Same shielding (of outermost electrons) / same number of (occupied) shells **OR** (Outermost) electrons in same shell **OR** Greater attraction between nucleus and (outermost) electrons **(1)**	'Increasing charge densities' (Outermost) electrons in same **sub-shell**	**2**

Question Number	Acceptable Answers	Reject	Mark
17(d)	 Outer shell of Si with total of 8 electrons **(1)** Each Si electron sharing with one electron from an outer shell of 7 in chlorine **(1)** Comment Do not penalise if dots and crosses are reversed **MAX 1** if all dots or all crosses		**2**

Question Number	Acceptable Answers	Reject	Mark
17(e)(i)	**Al:** level of cross between Na and Mg (actual value 578) **Si:** level of cross anywhere above Al and Mg (actual value 789) Both needed for the mark		**1**

Question Number	Acceptable Answers	Reject	Mark
17(e)(ii)	**Al:** (3p) **electron/e^-** (lost is) from higher energy (level) / (more) shielded (by 3s electrons) / further from nucleus / from p orbital / from $3p_x$ **(1)** **Si:** more protons / extra proton / greater nuclear charge (compared to Al) **(1)**	If e^- lost from a **2p** orbital / if states that Al has **higher** ionization energy than Mg	**2**

Total for Question 17 = 14 marks

Question Number	Acceptable Answers	Reject	Mark
18(a)(i)	$BaCO_3 + 2H^+ \rightarrow Ba^{2+} + CO_2 + H_2O$ IGNORE state symbols even if wrong IGNORE charges $Ba^{2+}CO_3^{2-}$	Cl^- remains on both sides of equation, unless crossed out / "Ba^{2+} **+** CO_3^{2-}" on left-hand side	**1**

Question Number	Acceptable Answers	Reject	Mark
18(a)(ii)	Effervescence / fizzing / bubbles (of gas) **(1)** Solid disappears /dissolves **(1)** IGNORE Tests on gas / just 'vigorous reaction' / any references to temperature change	**Just** "Gas given off"	**2**

Question Number	Acceptable Answers	Reject	Mark
18(b)(i)	(25 x 2.00/1000) = 0.05 / 5 x 10^{-2} (mol) Ignore sf		**1**

Question Number	Acceptable Answers	Reject	Mark
18(b)(ii)	(0.5 x (5 x 10^{-2} x 197.3)) = 4.9325 / 4.933 / 4.93 / 4.9 (g) TE from (b)(i) Ignore SF except 1		**1**

Question Number	Acceptable Answers	Reject	Mark
18(b)(iii)	So that **all acid** was neutralized / **all acid** reacted / **all acid** used up / **all H^+** used up	So that reaction is complete /to get maximum reaction / "So that all the **$BaCO_3$** is used up" / **Just** "to neutralize the acid" / "To make sure all the **solid** reacts"	**1**

Question Number	Acceptable Answers	Reject	Mark
18(b)(iv)	Filtration/ centrifuging	Decanting	**1**

Question Number	Acceptable Answers	Reject	Mark
18(b)(v)	Theoretical yield = (244 x 5 x 10^{-2} x 0.5) = 6.1(0) (g) **(1)** TE from (b)(i) (244 x ans to b(i) x 0.5) % yield = (5.35 x 100 /6.10) = 87.70492 = 87.7/88% **(1)** OR Moles of crystals = (5.35/244 =) 0.02193 **(1)** % yield = ((0.02193x100/0.025) =) 87.7049 = 87.7/88% [NB If use moles crystals 0.0219 ans=87.6%] **(1)** TE for mol crystals/answer to (b)(i), so 43.9% etc gets **(1)** Correct final answer with no working shown scores both marks Ignore SF except 1	$\frac{4.93}{5.35}$ x 100% = 92% **(0)** $\frac{197.3}{244}$ x 100% = 80.9% **(0)** 87% (as rounding error)	**2**

Question Number	Acceptable Answers	Reject	Mark
18(b)(vi)	**ANY ONE OF:** Not all solid/product crystallizes Some barium chloride/product remains in solution Product lost during filtration Product/crystals left on filter paper ALLOW 'Transfer losses' / 'loss during the process' Product left on apparatus / product left on glass rod / product left on beaker **IGNORE** Spillages / 'blunders' **NOTE:** 'Loss of products during transfer and incomplete reaction' scores **(0)** as +1 – 1 = 0	Incomplete reaction / Equilibrium reaction / 'side products' / 'side reactions' / 'loss of **reactants** during transfer' / '**reactants** left on apparatus' / 'vapourisation of $BaCl_2$'	**1**

Question Number	Acceptable Answers	Reject	Mark
18(c)(i)	Lattice energy for barium chloride **E** Enthalpy change of atomization of barium **D** Enthalpy change of atomization of Cl_2 to 2Cl **A** First ionization energy of barium **C** Second ionization energy of barium **B** Enthalpy change of formation of barium chloride **F** All correct (3) 4 or 5 correct (2) 2 or 3 correct (1) **CHECK TO SEE IF ANSWERS ANNOTATED ON SCRIPT AT TOP OF PAGE 14**		**3**

Question Number	Acceptable Answers	Reject	Mark
18(c)(ii)	Twice the (first) electron affinity OR (First) electron affinity (of chlorine/Cl)	If mention of Cl_2 /chlor**ide** / Cl^-	**1**

Question Number	Acceptable Answers	Reject	Mark
18(c)(iii)	180 + 243.4 + 503 + 965 – 697.6 + lattice energy = −858.6 OR **F** = **D** + **C** + **B** + **A** + **X** + **E** OR **E** = **F** – **D** – **C** – **B** – **A** – **X** **(1)** Lattice energy = −2052.4/−2052/−2050 (kJ mol^{-1}) **(1)** Correct answer, with or without working scores 2 Correct method with incorrect final answer scores (1) +2052.4/+2052/+2050 (kJ mol^{-1}) **(1)**	335.2 / −335.2 / −162.5 score **(0)** overall	**2**

Question Number	Acceptable Answers	Reject	Mark
18(c)(iv)	**1st mark:** Bonding is (almost) 100% ionic / bonding is (almost) purely ionic /there is no covalent character / little covalent character **(1)** **2nd mark:** (Chloride) **ion(s)** are not polarized / (both) ions are spherical / charge density of Ba^{2+} too low (to polarize anion) **(1)** **ALLOW** 'Very little distortion of (electron) cloud by Ba^{2+} ion' / 'Very little polarization of chloride (ion)'	**Just** "no polarization is taking place" / "no polarization of the bond" / "little distortion from electric cloud" / "barium and chlorine are not easy to polarize" / **just** "not much distortion" / use of **Ba** or **Cl** (as implies atoms)	**2**

Total for Question 18 = 18 marks

Question Number	Acceptable Answers	Reject	Mark
19(a)	200 / 2 x 10^2 (ppm)		**1**

Question Number	Acceptable Answers	Reject	Mark
19(b)(i)	$CH_3OH(l) + 3/2O_2(g) \rightarrow CO_2(g) + 2H_2O(l)$ Formulae **(1)** Balancing and state symbols **(1)** Allow multiples 2nd mark dependent on 1st	CH_3OH(**aq**) / (**g**) / $2H_2O$(**g**)	**2**

Question Number	Acceptable Answers	Reject	Mark
19(b)(ii)	Carbon / C / soot AND carbon monoxide / CO **Both needed**	Graphite	**1**

Question Number	Acceptable Answers	Reject	Mark
19(c)(i)	(150 x 4.18 x 15.8) = 9906.6 / 9907 / 9910 (J) / 9.9066 **kJ** Ignore sf except 1 sf / Ignore signs here	kJ **mol^{-1}**	**1**

Question Number	Acceptable Answers	Reject	Mark
19(c)(ii)	(0.64/32) = 0.02(00) (mol)		**1**

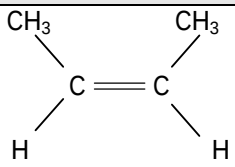
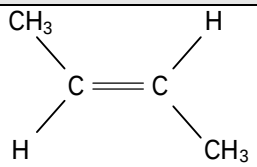
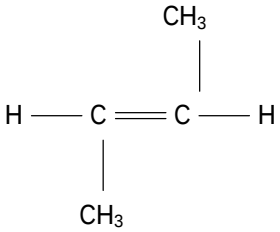
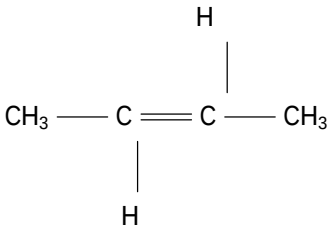
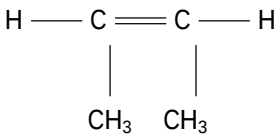
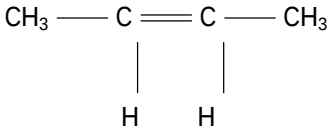
Question Number	Acceptable Answers	Reject	Mark
19(c)(iii)	(9.9066/0.0200) = 495.33 ΔH = -495 (kJ mol^{-1}) Value **(1)** Sign and 3sf **(1)** Allow TE from (c)(i) and / or (c)(ii) (answer to (c)(i) in kJ/ answer to (c)(ii)) No 2nd mark if units given are incorrect e.g. kJ mol or kJ/mol^{-1}		**2**

Question Number	Acceptable Answers	Reject	Mark
19(c)(iv)	Mark the two points **independently** **1st mark:** Evaporation of alcohol (from burner) / alcohol is volatile /CH_3OH is volatile ALLOW H_2O forms as steam, not water **IGNORE** Water evaporates (from apparatus) **(1)** **2nd mark:** (Actual) mass/moles (methanol) burned is less **and** (so) enthalpy change will be less negative/less exothermic / less / smaller **OR** Estimate of mass/moles (methanol) burned is too high **and** (so) enthalpy change will be less negative/less exothermic / less / smaller **OR** Temperature rise will be less than it should be **and** (so) enthalpy change will be less negative/less exothermic / less / smaller **(1)** **IGNORE** Any mention of specific heat capacity	Weighing errors / Other equipment errors (eg distance between calorimeter and spirit burner) Any answers that suggest lab value more exothermic / greater value of enthalpy change	**2**

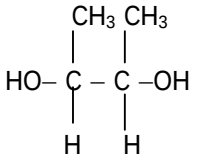
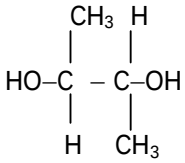
Question Number	Acceptable Answers	Reject	Mark
19(d)	**Mark each point independently** **1st mark:** **ANY ONE OF:** Bond enthalpies vary with environment Mean bond enthalpies do not equal actual bond enthalpies (for these reactants) / mean bond enthalpies are not exact values Bond enthalpies used are average values (from a range of compounds) **(1)** **2nd mark:** **ANY ONE OF:** Bond enthalpies refer to gases OR Bond enthalpies refer to gaseous bonds OR Methanol is a liquid OR Water is a liquid (under standard conditions) **(1)** IGNORE References to 'non-standard conditions' / 'incomplete combustion' / 'not in same state'		**2**

Total for Question 19 = 12 marks

Question Number	Acceptable Answers	Reject	Mark
20(a)	**Any ONE of :** Contains a carbon-carbon double bond / C=C OR Contains a carbon-carbon triple bond OR Does not contain the maximum number of hydrogen atoms/hydrogen(s) OR Can undergo addition reactions	Just 'carbon double bond' / Just 'contains a double bond' / 'contains a double bond between carbon **molecules**'/'contains **more than** one carbon-carbon double bond'	**1**

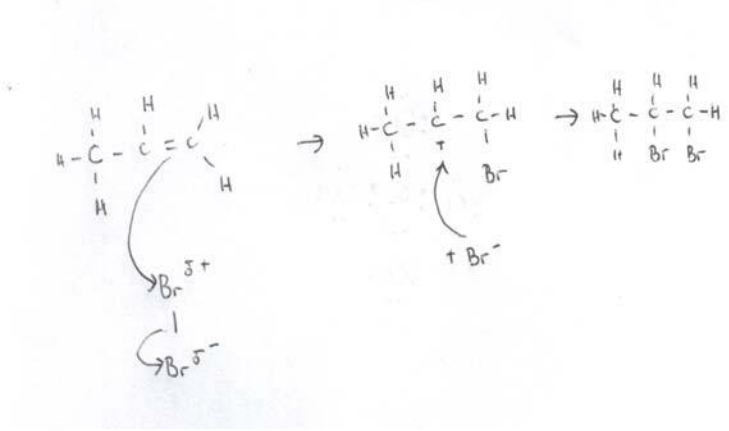
Question Number	Acceptable Answers	Reject	Mark
20(b)(i)	 *Z*-but-2-ene  *E*-but-2-ene IGNORE references to *cis*-*trans* isomerism BOTH correct structures drawn **(1)** *E*-isomer **and** *Z*-isomer correctly identified **(1)** **but-2-ene** written for each isomer **(1)** **IGNORE** missing hyphens Allow angles shown as right angles **CH_3 does not have to be displayed in full** Allow for *E*:  OR  Allow for *Z*:  OR  H atoms must be shown	If propene is drawn **(0) overall**	**3**

Question Number	Acceptable Answers	Reject	Mark
20(b)(ii)	From purple/ (pale) pink to colourless Both needed Accept to brown	Clear for colourless/violet for purple	**1**

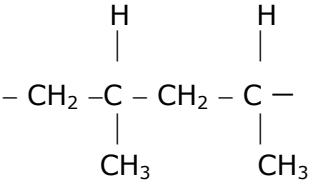
Question Number	Acceptable Answers	Reject	Mark
20(b)(iii)	 **OR**  Ignore bond angles and orientation		**1**

Question Number	Acceptable Answers	Reject	Mark
20(b)(iv)	Breaking a C-C bond/ breaking the molecule into a smaller molecule/ breaking the hydrocarbon into a smaller hydrocarbon **ALLOW** **Any mention** of 'breaking' or 'splitting' (molecule or compound or hydrocarbon) or 'large to small' **IGNORE** **Just** '**cracking** to form an alkane and an alkene'	Any mention of 'breaking down into fractions' / forms **branched** molecules / splitting of **crude oil** (into smaller molecules)	**1**

Question Number	Acceptable Answers	Reject	Mark
20(b)(v)	$C_8H_{18} \rightarrow C_4H_8 + C_4H_{10}$ **OR** Equations with correct structural or displayed formulae **IGNORE** State symbols, even if incorrect Names, even if incorrect		**1**

Question Number	Acceptable Answers	Reject	Mark
20(c)	Electrophilic (addition) **(1)** **IGNORE** 'heterolytic' Name of final product = 1,2-dibromoprop**a**ne **(1)** No TE on naming a product shown incorrectly in equation.  Both curly arrows in first step **(1)** The structure of the intermediate carbocation $CH_3CH^+–CH_2Br$ **(1)** Allow $CH_3CHBr–CH_2^+$ as intermediate Curly arrow from $Br^–$ to C^+ **(1)** Partial (δ+ and δ-) charges are not required Lone pair on bromide ion not required	If curly arrow from $Br^–$ to a C^+ with a Br already attached to it	**5**

Question Number	Acceptable Answers	Reject	Mark
20(d)(i)	100% as only one product / 100% as no by product(s) / 100% as addition reaction / 100% as no waste product (formed)	**Just** "atom economy is **high**" / no mention of 100%	**1**

Question Number	Acceptable Answers	Reject	Mark
20(d)(ii)	 CH_3 groups may be on C2 and C4 OR C1 and C3 **IGNORE** brackets **IGNORE** 'n' **BOTH continuation bonds are essential**	**Just** repeating unit / one repeating unit drawn with an 'n' or a '2' next to it	**1**

Question Number	Acceptable Answers	Reject	Mark
20(d)(iii)	Not sustainable as poly(propene) not made from a renewable resource / Not sustainable as made from non-renewable resource / not sustainable as made from crude oil. Not sustainable as crude oil is not renewable/ Not sustainable as crude oil finite resource **ALLOW** Is sustainable if linked to recycling **IGNORE** References to non-biodegradability / long-lasting in use		**1**

Total for Question 20 = 16 marks