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Mark Scheme (Results)

January 2015

Pearson Edexcel International Advanced Subsidiary in Chemistry (WCH01) Paper 01

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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

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 <u>meaning</u> 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	Mark
1	C	**1**

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

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

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

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

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

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

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

Question Number	Correct Answer	Mark
9	C	**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	B	**1**

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

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

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

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

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

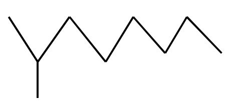
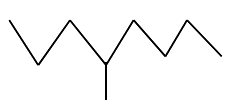
Question Number	Correct Answer	Mark
20	C	**1**

TOTAL FOR SECTION A = 20 MARKS

Section B

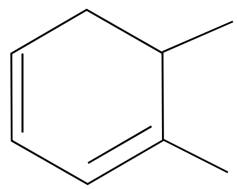
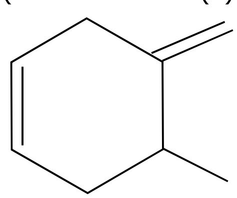
Question Number	Acceptable Answers	Reject	Mark
21(a)	Fractional distillation Both words needed		**1**

Question Number	Acceptable Answers	Reject	Mark
21(b)(i)	C_9H_{20}		**1**

Question Number	Acceptable Answers	Reject	Mark
21(b)(ii)	Correct skeletal formula **(1)** Correct name for the structure drawn providing that the structure is a branched-chain isomer of C_9H_{20} **NO TE for name if skeletal formula is incorrect** **ALLOW** Correct name, even if structural or displayed formula has been drawn **(1)** EXAMPLES of correct skeletal formulae and names  2-methyloctane  3-methyloctane  4-methyloctane	Structural or displayed formula	**2**

Question Number	Acceptable Answers	Reject	Mark
21(c)(i)	$C_{15}H_{32} \rightarrow C_{13}H_{28} + C_2H_4$ **IGNORE** State symbols, even if incorrect **ALLOW** Correct structural OR displayed OR skeletal OR mixture of these (as long as unambiguous)		**1**

Question Number	Acceptable Answers	Reject	Mark
21(c)(ii)	Any **carbon-carbon bond** (in the chain) can **break** OR The **carbon chain** can **break**/**split** in different places OR Carbon chain is cracked in many places / different places OR $C_{13}H_{28}$ / product will break down further **IGNORE** 'Molecule can break anywhere' / 'It breaks into smaller molecules' / 'large number of C atoms' / 'bonds break randomly' / 'hydrocarbon chain is long'		**1**

Question Number	Acceptable Answers	Reject	Mark
21(d)(i)	Two double bonds anywhere on the RING (allow them to be adjacent). e.g.  **ALLOW** One triple bond (instead of two double bonds) BUT not adjacent to a methyl group **ALLOW:** (ie double bond(s) on side-chain) 	If any other incorrect structure is included with the final answer Any 5-valent C atom in structure scores **(0)** If the methyl groups are joined by a bond **(0)** Benzene ring **(0)**	**1**

Question Number	Acceptable Answers	Reject	Mark
21(d)(ii)	**NOTE** The answer must relate to combustion or burning To promote efficient combustion OR To increase octane number OR To reduce knocking OR Pre-ignition less likely **ALLOW** To allow smoother burning OR More efficient fuels OR Better burning / fuels easier to burn OR Combust more easily OR Improves combustion **ALLOW** Reverse argument for straight-chain hydrocarbons **IGNORE** References to: 'less pollution' / 'burning more cleanly' / 'better fuels' / 'to form alkenes' / 'to form more useful products' /'branched chains form' / boiling point / volatility / 'to form H_2'	'Ignition less likely' **(0)**	**1**

(Total for Question 21 = 8 marks)

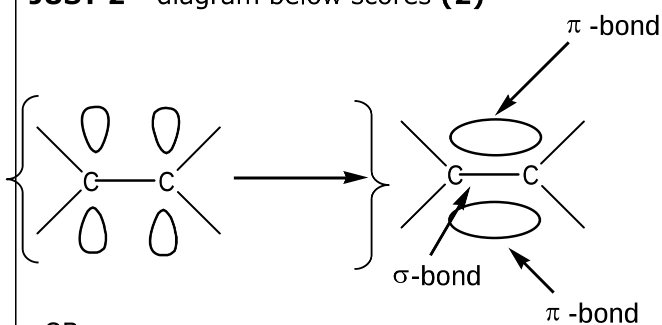
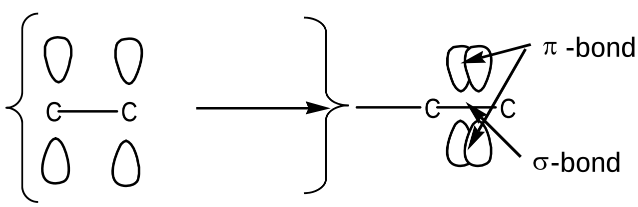
Question Number	Acceptable Answers	Reject	Mark
22(a)	**1st mark – idea of moles / amounts specified** (Enthalpy change when) the number of moles of reactants **ALLOW** (Enthalpy change when) the number of moles of products or substances / just molar quantities / just amounts / just moles **(1)** **2nd mark – idea of an equation** (react as specified in the balanced) **equation** **(1)** **IGNORE** references to (standard) conditions / just 'enthalpy change that occurs during a reaction'	'**One mole** of reactants' / '**One mole** of products' for 1st mark	**2**

Question Number	Acceptable Answers	Reject	Mark
22(b)(i)	(Heat energy absorbed = 100 x 4.2 x 5.5 =) 2310 (J) **ALLOW** 2.3(10) **kJ** IGNORE sign and sf except one sf		**1**

Question Number	Acceptable Answers	Reject	Mark
22(b)(ii)	(Moles NH_4CNS = $\frac{15.22}{76.1}$ =) 0.2(00) (mol) **IGNORE** sf **ALLOW** M_r = 76 for NH_4CNS to give 0.200(3) (mol)		**1**

Question Number	Acceptable Answers	Reject	Mark
22(b)(iii)	$\Delta H_{reaction} = +\frac{2.3(10)}{0.2(00)}$ **x2** = +23.1 (kJ mol^{-1}) = **+**23 (kJ mol^{-1}) to 2 sf **First mark – correct computation of $\Delta H_{reaction}$:** **2 x** [answer to (b)(i) in kJ ÷ answer to (b)(ii) in mol] **(1)** **Second mark – stand alone, for correct rounding:** A final answer to **two** sf **(1)** **Third mark – stand alone, for giving a + sign for endothermic reaction:** **+** sign in front of final answer **(1)** NOTE: **+**12 (kJ mol^{-1}) scores **(2)** (i.e. the 2nd and 3rd marks)	Incorrect units given by the candidate (no 3rd scoring point)	**3**

Question Number	Acceptable Answers	Reject	Mark
22(c)(i)	(Average amount of) energy/enthalpy required to **break one mole** of (covalent) **bonds** **ALLOW** Energy change/enthalpy change to **break one mole** of (covalent) **bonds** **(1)** (in the) **gas / gaseous** (state) **(1)**	Energy/enthalpy **released** OR 'Bonds **formed/made**' OR 1 mol of **compound** for 1st mark	**2**

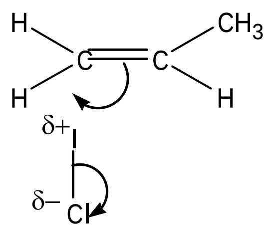
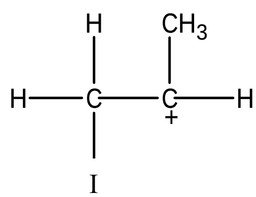
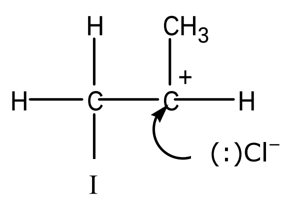
Question Number	Acceptable Answers	Reject	Mark
22(c)(ii)	For a pi/π-bond: Sideways overlap of p-orbitals / overlap of p-orbitals above and below stated or drawn on a diagram **(1)** For a sigma/σ-bond: Head-on overlap of any orbitals, stated or drawn on a diagram **(1)** **MAX (1)** if it is not specified/clear which type of overlap relates to which type of bond **IGNORE** Incorrect diagram **NOTE** **JUST 1st** diagram below scores **(1)** whereas **JUST 2nd** diagram below scores **(2)**  OR  **NOTE:** For the σ-bond, allow any form of 'end-on' overlap of orbitals **MAX (1)** if **only** an UNLABELLED but otherwise correct diagram is given (ie also no words)		**2**

Question Number	Acceptable Answers	Reject	Mark
22(c)(iii)	π-bond is weak(er) OR σ-bond is strong(er) OR The sideways overlap is less effective than the head-on overlap **ALLOW** The two bonds in the (C=C) double bond are not the same strength **IGNORE** References to C=C bond more reactive than C-C bond / 'restricted rotation'	π-bond is stronger than the σ-bond OR C=C bond weaker than C-C bond	**1**

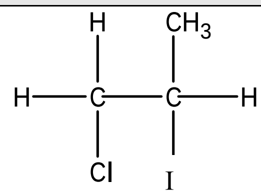
Question Number	Acceptable Answers	Reject	Mark
22(c)(iv)	[FIRST, check the answer on the answer line IF answer = **−1936** (kJ mol^{-1}) award **(3)** marks; **+1936** (kJ mol^{-1}) scores **(2)**] Bonds broken (6 x (C−H) = 6 x 413 + 1 x (C−C) = 1 x 347 + 1 x (C=C) = 1 x 612 + 4½ x (O=O) = 4½ x 498 =) (+)5678 **(1)** Bonds made (6 x (C=O) = 6 x −805 + 6 x (O−H) = 6 x −464 =) (−)7614 **(1)** $\Delta H_{reaction}$ = bonds broken + bonds made = (+)5678 + (−)7614 = −1936 (kJ mol^{-1}) **(1)** **NOTE** 3rd mark CQ on answers calculated for bonds broken and bonds made		**3**

Question Number	Acceptable Answers	Reject	Mark
22(c)*(v)	Under standard conditions/298 K water is a **liquid** OR (Calculations involving) bond energies refer to (water in) **gaseous** state **(1)** Energy released/given out on changing from gas to liquid OR Energy absorbed/taken in on changing from liquid to gas **(1)** **ALLOW max (1)** if state that 'bond energies are average values (from a range of compounds)' **IGNORE** References to 'heat losses' / 'incomplete combustion'		**2**

(Total for Question 22 = 17 marks)

Question Number	Acceptable Answers	Reject	Mark
23(a)(i)	Curly arrow from double bond towards iodine atom **AND** curly arrow from the I—Cl **bond** to the chlorine atom **(1)**  Carbocation intermediate **(1)**  Curly arrow from the chloride ion to the correct C^+ in the intermediate **(1)**  **NOTE** Curly arrow can originate from anywhere on the Cl^- ion in the final step. Do not have to have a lone pair of e^- on the Cl^- ion	δ^+ for + δ^- for – on Cl^-	**3**

Question Number	Acceptable Answers	Reject	Mark
23(a)(ii)	Electrophilic **(1)** Addition **(1)** ALLOW answers in either order IGNORE 'heterolytic'		**2**

Question Number	Acceptable Answers	Reject	Mark
23(a)(iii)	 ALLOW Correct structural OR displayed OR skeletal formula OR mixture of these (so long as unambiguous) Eg $CH_2ClCHICH_3$ IGNORE Any name given, even if incorrect		**1**

Question Number	Acceptable Answers	Reject	Mark
23(b)(i)	Ultraviolet / UV OR Sun (light) OR Light **ALLOW** **High** temperature / 300^{o}C (minimum) IGNORE Just heat / just radiation / rays	Mention of a 'catalyst'	**1**

Question Number	Acceptable Answers	Reject	Mark
23(b)*(ii)	**First mark:** (Free) radical substitution **(1)** **Second mark:** **Homolytic** (fission) **(1)** **Third mark:** **Initiation** **AND** $ICl \rightarrow I\bullet + Cl\bullet$ **(1)** BOTH needed for the 3rd mark **Fourth mark:** **Propagation** **(1)** **Fifth and sixth marks:** $CH_4 + Cl\bullet \rightarrow CH_3\bullet + HCl$ **(1)** $CH_3\bullet + ICl \rightarrow CH_3I + Cl\bullet$ **(1)** **IGNORE** $CH_4 + I\bullet \rightarrow CH_3\bullet + HI$ $CH_3\bullet + ICl \rightarrow CH_3Cl + I\bullet$ **Seventh mark:** $CH_3\bullet + I\bullet \rightarrow CH_3I$ OR $Cl\bullet + Cl\bullet \rightarrow Cl_2$ OR $CH_3\bullet + Cl\bullet \rightarrow CH_3Cl$ OR $CH_3\bullet + CH_3\bullet \rightarrow C_2H_6$ OR $I\bullet + Cl\bullet \rightarrow ICl$ ALLOW $I\bullet + I\bullet \rightarrow I_2$ **(1)** **IGNORE** **Any** INCORRECT termination step(s) **IGNORE** State symbols, even if incorrect Curly arrows / half curly arrows, even if incorrect	**Heterolytic** (fission) $H\bullet$ (the fifth and sixth marks cannot be awarded if $H\bullet$ appears in **either** propagation step)	**7**

(Total for Question 23 = 14 marks)

<table>
<tr><th>Question Number</th><th>Acceptable Answers</th><th>Reject</th><th>Mark</th></tr>
<tr><td>24(a)</td><td>
<table>
<tr><th>(Sub-atomic particle)</th><th>(Relative mass)</th><th>(Relative charge)</th></tr>
<tr><td>(proton)</td><td>1</td><td>+1/1+</td></tr>
<tr><td>(neutron)</td><td>1</td><td>0</td></tr>
<tr><td>(electron)</td><td>1/2000 to 1/1800
or
‘negligible’
or 0.0005 to 0.00056</td><td>—1/1—</td></tr>
</table>

(1) for each correct row

MAX (1) if only one COLUMN correct
IGNORE any masses in g or kg
IGNORE any charges in coulombs</td><td>Just “+” for proton charge

Just “neutral” for neutron charge

Just “—” for electron charge

“Zero” /”0” for mass of an electron</td><td>3</td></tr>
</table>

Question Number	Acceptable Answers	Reject	Mark
24(b)	**Atoms** with the same number of protons **(1)** IGNORE same number of electrons (but) different numbers of neutrons **(1)** IGNORE References to atomic number / mass number / ‘nucleons’ / **JUST** ‘atoms of the same element’	“**Element(s)** with the same number of protons”	**2**

Question Number	Acceptable Answers	Reject	Mark
24(c)(i)	Electron gun / high-speed electrons / high-energy electrons / fast-moving electrons / bombardment with electrons **(1)** Knock-out / remove electron(s) **(1)** IGNORE References to ionizing / forming ions / **just** equations such as $Rb(g) \rightarrow Rb^{+}(g) + e^{-}$ / other stages in the process of mass spectrometry	**Just** ‘electrons’ / ‘Highly-charged’ electrons	**2**

Question Number	Acceptable Answers	Reject	Mark
24(c)(ii)	[FIRST, check the answer on the answer line IF answer = 85.6 award **(3)** marks] **1st mark:** 85 x 2.5 + 87 x 1 OR 85 x 71.4 + 87 x 28.6 **(1)** **2nd mark:** ÷3.5 (can ÷7 if ratio given as 5:2) OR ÷100 ALLOW TE using incorrect % abundances or ratios **(1)** **3rd mark – stand alone for correct rounding (TE only if value calculated is between 85 and 87)** (= 85.57, but 'accurate' answer depends on rounding) Final answer rounded to **85.6** (ie 1 dp) Ignore units even if incorrect. **(1)** **NOTE** 85.5 without working scores **(0)**		**3**

Question Number	Acceptable Answers	Reject	Mark
24(d)	(Left-hand box) Delocalised electron(s) **BOTH these words needed** **(1)** (Right-hand box) Positive ion(s) / cation(s) / Rb^+ **ALLOW** metal ion(s) **(1)**	**Just** 'electrons' 'Negatively-charged ions' 'nuclei' / 'nucleus' / 'positive atoms' 'positively-charged lattice'	**2**

(Total for Question 24 = 12 marks)

Question Number	Acceptable Answers	Reject	Mark
25(a)(i)	$Mg^{+}(g) \rightarrow Mg^{2+}(g) + e^{(-)}$ OR $Mg^{+}(g) - e^{(-)} \rightarrow Mg^{2+}(g)$ OR $Mg^{+}(g) + e^{(-)} \rightarrow Mg^{2+}(g) + 2e^{(-)}$ **1st mark** Correct species for reactants **and** products **(1)** **2nd mark** Correct state symbols **This mark can only be awarded if first mark has already been awarded.** **(1)** **NOTE** Award state symbols mark if '$X^{+}(g)$' OR 'MG' used instead of 'Mg' $Mg(g) \rightarrow Mg^{2+}(g) + 2e^{(-)}$ **scores (0)**	"MG" for first mark	**2**

Question Number	Acceptable Answers	Reject	Mark
25(a)*(ii)	Any **TWO** from: Electron (in Mg^+) is being removed from a positive ion **(1)** Electron being removed is closer to the nucleus (in Mg^+) / Mg^+ is smaller (than Mg) **(1)** Proton: electron ratio greater (in Mg^+) / remaining e^- more tightly held (in Mg^+) **(1)** Greater (force of) attraction between nucleus and (outermost) electron (in Mg^+) **(1)** Electron repulsion is less in Mg^+ (than Mg) **(1)** **IGNORE** References to "effective nuclear charge (ENC)" / high charge-density in Mg^+ / references to shielding	"Mg^+ has more protons than Mg" scores **(0)** overall Electron is being removed from a new shell/different shell / 2nd shell scores **(0)** overall	**2**

Question Number	Acceptable Answers	Reject	Mark
25(a)(iii)	Any value in range 5000 to 9000 (kJ mol^{-1}) **NOTE** Actual value is 7730 (kJ mol^{-1})		**1**

Question Number	Acceptable Answers	Reject	Mark
25(b)(i)	(Phosphorus) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^3$ ALLOW p_x, p_y, p_z notation / upper case **(1)** (Sulfur) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^4$ ALLOW p_x, p_y, p_z notation / upper case **(1)** ALLOW Noble gas core: [Ne] for $1s^2\ 2s^2\ 2p^6$		**2**

Question Number	Acceptable Answers	Reject	Mark
25(b)(ii)	**1st mark – idea of paired e^- in S** In sulfur, spin-pairing has occurred / two electrons in the same orbital / paired e^- Note: **Just** $3p^4$ stated for S does not gain this mark. **ALLOW** an 'electrons-in-box' diagram, showing two electrons in the same orbital **(1)** **2nd mark – idea of repulsion** (resultant increase in) **repulsion** **(1)** **ALLOW** **Just** phosphorus has a half-filled sub-shell which is more stable (max **(1)**)		**2**

(Total for Question 25 = 9 marks)

TOTAL FOR SECTION B = 60 MARKS

TOTAL FOR PAPER = 80 MARKS

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