Mark Scheme (Results)

October 2017

Pearson Edexcel International Advanced Level Chemistry (WCH01) Paper 01
Unit 1: The Core Principles of Chemistry

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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 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	Mark
1	**1. The only correct answer is D** ***A*** *is not correct because both should be lower* ***B*** *is not correct because boiling temperature is lower* ***C*** *is not correct because density is lower*	**(1)**

Question Number	Correct Answer	Mark
2	**2. The only correct answer is C** **A** *is not correct because it is an empirical formula* ***B*** *is not correct because there are too few hydrogens* ***D*** *is not correct because there are too few hydrogens*	**(1)**

Question Number	Correct Answer	Mark
3	**3. The only correct answer is C** ***A*** *is not correct because it is too few* ***B*** *is not correct because it is too few* ***D*** *is not correct because it is too many*	**(1)**

Question Number	Correct Answer	Mark
4	**4. The only correct answer is A** **B** *is not correct as not a -2-ene* ***C*** *is not incorrect as not an E isomer* ***D*** *is not incorrect as not a -2-ene or an E isomer*	**(1)**

Question Number	Correct Answer	Mark
5	**5. The only correct answer is B** ***A*** *is not correct as not the main product* ***C*** *is not correct as not the main product* ***D*** *is not correct as not the main product*	**(1)**

Question Number	Correct Answer	Mark
6	6. **The only correct answer is C** ***A*** *is not correct because it contains spectator sulfate ions and incorrect state of product* ***B*** *is not correct because it contains spectator sulfate ions* ***D*** *is not correct because oxide ions are not involved in this way*	**(1)**

Question Number	Correct Answer	Mark
7	**7. The only correct answer is A** ***B*** *is not correct because as it is based on 1 neutron per molecule* ***C*** *is not correct because it is based on half a neutron per atom* ***D*** *is not correct because it is not multiplied by 6.0*	**(1)**

Question Number	Correct Answer	Mark
8	**8**. **The only correct answer is B** **A** *is not correct because it is has been divided by incorrect value* ***C*** *is not correct because it has been divided by only one HCl value* ***D*** *is not correct because it has been divided by only one NaCl value*	**(1)**

Question Number	Correct Answer	Mark
9	**9. The only correct answer is C** ***A*** *is not correct because the value has been incorrectly rounded* ***B*** *is not correct because the value has been incorrectly rounded and divided by 1000* ***D*** *is not correct because the value is divided by 1000*	**(1)**

Question Number	Correct Answer	Mark
10	**10. The only correct answer is B** **A** *is not correct because the volume of oxygen left has been ignored* **C** *is not correct because water has been included in the calculation and the volume of oxygen left ignored* **D** *is not correct because water has been included in the calculation*	**(1)**

Question Number	Correct Answer	Mark
11	**11. The only correct answer is C** ***A*** *is not correct because it has not been converted to* cm^3 ***B*** *is not correct because it has not been converted to* cm^3 *and twice the hydrogen moles have been used* ***D*** *is not correct because twice the hydrogen moles have been used*	**(1)**

Question Number	Correct Answer	Mark
12	**12. The only correct answer is A** ***B*** *is not correct because the mass of three oxygens are much greater than one oxygen and one carbon* ***C*** *is not correct because there is insufficient nitrogen* ***D*** *is not correct because there is insufficient nitrogen*	**(1)**

Question Number	Correct Answer	Mark
13	**13. The only correct answer is D** ***A*** *is not correct because it is too high* ***B*** *is not correct because it is too high* ***C*** *is not correct because it is too high*	**(1)**

Question Number	Correct Answer	Mark
14	**14. The only correct answer is D** ***A*** *is not correct because it is the opposite of D and both statements are incorrect* ***B*** *is not correct because it is not an exact value* ***C*** *is not correct because m is not an exact value*	**(1)**

Question Number	Correct Answer	Mark
15	**15. The only correct answer is C** ***A*** *is not correct because the negative ion is slightly polarised* ***B*** *is not correct because positive ions cannot be polarised* ***D*** *is not correct because the negative ion is very polarised*	**(1)**

Question Number	Correct Answer	Mark
16	**16. The only correct answer is D** ***A*** *is not correct because the sign is incorrect* ***B*** *is not correct because there are no multiples and the sign is incorrect* ***C*** *is not correct because there are no multiples*	**(1)**

Question Number	Correct Answer	Mark
17	**17. The only correct answer is A** ***B*** *is not correct because it involves liquids* ***C*** *is not correct because it involves liquids* ***D*** *is not correct because it involves liquids*	**(1)**

Question Number	Correct Answer	Mark
18	**18. The only correct answer is D** ***A*** *is not correct because it would be true if 0.02 mol were added to 100 cm^3* ***B*** *is not correct because it would be true if 0.02 mol were added to 50 cm^3* ***C*** *is not correct because it would be true if 0.01 mol were added to 50 cm^3*	**(1)**

Question Number	Correct Answer	Mark
19	**19. The only correct answer is D** ***A*** *is not correct because they can be determined directly by experiment* ***B*** *is not correct because they can be determined directly by experiment* ***C*** *is not correct because they can be determined directly by experiment*	**(1)**

Question Number	Correct Answer	Mark
20	**20. The only correct answer is A** ***B*** *is not correct because oxygen contains a double bond* ***C*** *is not correct because carbon dioxide contains two double bonds* ***D*** *is not correct because* oxygen *contains one double bond and carbon dioxide contains two double bonds*	**(1)**

(TOTAL FOR SECTION A = 20 MARKS)

Section B

Question Number	Acceptable Answers	Reject	Mark
21(a)(i)	$3Fe^{2+} + NO_3^- + 4H^+ \rightarrow 3Fe^{3+} + NO + 2H_2O$ ALLOW Multiples H^+ shown as $H^+ + 3H^+$/ $2H^+ + 6H^+$ correct species **(1)** correct ratios **(1)** ALLOW Equal numbers of sulfate ions included on each side (3 or 6) scores (1) Equation with HNO_3 on left not ionised and correct H^+ from sulfuric acid scores (1) IGNORE state symbols even if incorrect	Eqs with iron ions cancelled out as spectators	**(2)**

Question Number	Acceptable Answers	Reject	Mark
21(a)(ii)	277.9 (g) ALLOW 278		**(1)**

Question Number	Acceptable Answers	Reject	Mark
21(a)(iii)	(0.050 x 277.9) = 13.895 /13.90 / 13.9 /14(g) TE from (a)(ii) IGNORE SF unless 1SF	13.89	**(1)**

Question Number	Acceptable Answers	Reject	Mark
21(a)(iv)	(From the equation 6 mol of $FeSO_4.7H_2O$ react with 3 mol H_2SO_4) 0.05 mol requires 0.025 mol **(1)** Volume = $(\frac{1000 \times 0.025}{2})$ = 12.5 (cm^3) / 0.0125 **dm^3** **(1)** OR 12.5 cm^3 of 2.0 mol dm^{-3} H_2SO_4 contains 12.5 x 2 / 1000 = 0.025 mol **(1)** (From the equation) this is equivalent to 0.05 mol of $FeSO_4.7H_2O$ **(1)**		**(2)**

Question Number	Acceptable Answers	Reject	Mark
21(a)(v)	teat pipette / measuring cylinder (small) ALLOW pipette/ dropping pipette/ dropper/ graduated pipette	Beaker/ Glass/ burette/ spatula/ flask	**(1)**

Question Number	Acceptable Answers	Reject	Mark
21(a)(vi)	(ionic) Precipitation ALLOW Precipitant/ precipitate		**(1)**

Question Number	Acceptable Answers	Reject	Mark
21(b)(i)	$2NH_3(aq) + H_2SO_4(aq) \rightarrow (NH_4)_2SO_4(aq)$ ALLOW $2NH_4OH(aq) + H_2SO_4(aq) \rightarrow (NH_4)_2SO_4(aq) + 2H_2O(l)$ Species **(1)** Balancing **and** state symbols **(1)**		**(1)**

Question Number	Acceptable Answers	Reject	Mark
21(b)(ii)	25 cm^3 /0.025 dm^3 TE from (i) e.g. If ratio = 1:1 then 12.5 cm^3 / 0.0125 dm^3 If b(i) is blank allow 25 cm^3 / 0.025 dm^3		**(1)**

Question Number	Acceptable Answers	Reject	Mark
21(b)(iii)	For indicator tests the second mark can be allowed if solution is used. **MP1:** Spot onto **red** litmus **paper** ALLOW Use **red** litmus **paper** Dip **red** litmus **paper** into mixture **(1)** **Note: mark MP2 independently if a suitable indicator has been selected** **MP2:** Turns blue (when excess ammonia added) **(1)** OR other suitable indicator **papers**, including universal indicator / UI / pH paper **(1)** with alkaline colour (green/ blue/ purple) **(1)** OR Use a pH meter or UI paper **(1)** pH value > 7 **(1)**	Smell of ammonia/ Testing for ammonia with HCl fumes/ Using litmus on fumes from heating solution with NaOH or from just heating solution	**(2)**

Question Number	Acceptable Answers	Reject	Mark
21(c)(i)	Dip glass rod in solution (add to microscope slide), cool, crystals form ALLOW Observation of crystals starting to form around the edge of the solution / on surface/ in solution OR Reference to two thirds/ about half of volume (of solution) removed	Heat to constant mass/ heat until no more water is given off	**(1)**

Question Number	Acceptable Answers	Reject	Mark
21(c)(ii)	Let the mixture cool/evaporate slowly ALLOW Leave in the air (to dry)/ keep at low temperature/ leave a long time/ leave it to cool IGNORE Further filtering **after** crystal are formed. Comments on stirring	Any use of heat Filter concentrated solution	**(1)**

Question Number	Acceptable Answers	Reject	Mark
21(c)(iii)	Wash with (a small volume of cold) water **(1)** Dry crystals between filter papers/by dabbing with filter paper/ on filter paper/ with paper towel/ in a desiccator ALLOW Dry in the sun/ in an oven/ warm place IGNORE Leave to dry **(1)**	Just "drying"/ Just "dry on paper" In a hot oven	**(2)**

Question Number	Acceptable Answers	Reject	Mark
21(d)	(0.050 x 40/100) = 0.020 (mol) **(1)** 0.020 x 482 = 9.6(4) (g) **(1)** OR 0.050 × 482 = 24.1(g) **(1)** 24.1 × 40/100 = 9.6(4)(g) **(1)** ALLOW 40% of 482 = 192.8 **(1)** 192.8 X 0.05 = 9.6(4) (g) **(1)**		**(2)**

(Total for Question 21 = 19 marks)

Question Number	Acceptable Answers	Reject	Mark
22(a)(i)	C_2H_5 / H_5C_2 IGNORE Displayed formula	C_4H_{10} CH_3CH_2 C_nH_{2n+1}	**(1)**

Question Number	Acceptable Answers	Reject	Mark
22(a)(ii)	There is only one place a methyl group can be attached (without extending the carbon chain)/ If added to C1 or C3 it would not be branched/ If added to C1or C3 it would be butane/ Attachment of methyl to either end gives butane/ The methyl is on C2 counting from either end ALLOW There are no other isomers of methylpropane IGNORE methylpropane is symmetrical		**(1)**

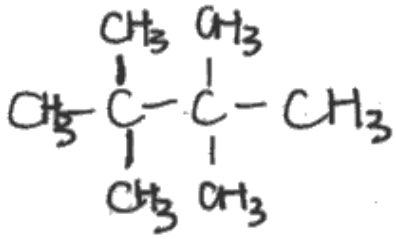
Question Number	Acceptable Answers	Reject	Mark
22(b)(i)	$C_4H_{10} + 6½O_2 \rightarrow 4CO_2 + 5H_2O$ ALLOW Multiples IGNORE state symbols even if incorrect	Incorrect alkane formula	**(1)**

Question Number	Acceptable Answers	Reject	Mark
22(b)(ii)	2-methylpropane is (in)flammable / could be ignited (by an electric spark) / explosive ALLOW Catches fire easily IGNORE Volatile/ it is a gas/ toxic	It may be burned/ "easy to burn"/ "takes part in combustion reactions" "impurities cause explosions" Greenhouse gas Corrosive Irritant	**(1)**

Question Number	Acceptable Answers	Reject	Mark
22(c)(i)	(Free) radical **(1)** Substitution **(1)** ALLOW In either order IGNORE Homolytic fission/ halogenation		**(2)**

Question Number	Acceptable Answers	Reject	Mark
22(c)(ii)	 $Cl - Cl \rightarrow 2Cl\cdot$ / $Cl\cdot + Cl\cdot$ Arrows must start from near bond and finish on or just beyond Cl. One arrow above and one below bond. ALLOW Omission of unpaired electron in this part Electron pair shown in Cl-Cl bond All outer shell electrons shown	Full arrows Cl^- ions	**(1)**

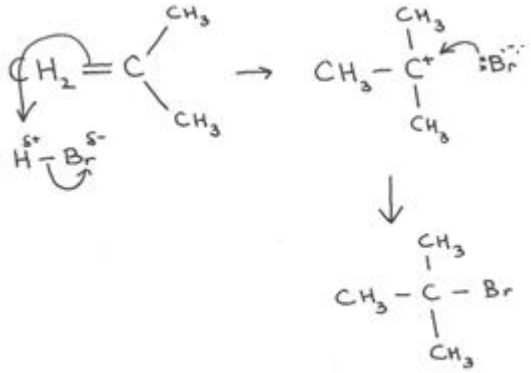
Question Number	Acceptable Answers	Reject	Mark
22(c)(iii)	$Cl\cdot + C_4H_{10} \rightarrow C_4H_9\cdot + HCl$ **(1)** $C_4H_9\cdot + Cl_2 \rightarrow C_4H_9Cl + Cl\cdot$ **(1)** In any order ALLOW Skeletal, displayed, structural Use of incorrect alkane score max (1) Penalise omission of unpaired electron dot once only in this part IGNORE Curly arrows		**(2)**

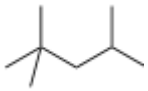
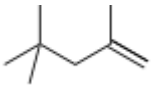
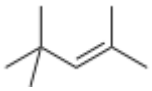
Question Number	Acceptable Answers	Reject	Mark
22(d)(i)	$(CH_3)_3C\text{-}C(CH_3)_3$ / $(CH_3)_3CC(CH_3)_3$ ALLOW $CH_3C(CH_3)_2C(CH_3)_2CH_3$ $CH_3C(CH_3CH_3)C(CH_3CH_3)CH_3$  IGNORE Fully displayed/ skeletal/ extra brackets	End CH_3 fully displayed	**(1)**

Question Number	Acceptable Answers	Reject	Mark
22(d)(ii)	Termination/ Termination step/ Termination reaction/ Chain termination/ Terminal (step) IGNORE Formulae/ equations		**(1)**

Question Number	Acceptable Answers	Reject	Mark
22(d)(iii)	Two (radicals) $(CH_3)_3C\cdot$ combine / react/ join OR two radicals $(CH_3)_3C$ combine OR the equation $2C_4H_9^{\bullet} \rightarrow C_8H_{18}$ Allow any valid response with variables of $(CH_3)_3C$ eg C_4H_9		**(1)**

Question Number	Acceptable Answers	Reject	Mark
22(e)(i)	Dehydrogenation Elimination (of hydrogen) ALLOW Oxidation (Catalytic) cracking	Hydrogenation Reforming Reduction Redox Decomposition	**(1)**

Question Number	Acceptable Answers	Reject	Mark
***22(e)(ii)**	 **MP1:** Curly (not half headed) arrow from C=C to H **and** Curly arrow from bond in H-Br to Br **(1)** **MP2:** Tertiary carbocation **(1)** **MP3:** Br must have lone pair **and** negative charge **and** Curly arrow from (lone pair) on Br^- to C^+ **(1)** ALLOW From anywhere on the Br^- **MP4:** Dipole on HBr bond, **and** correct final product ALLOW TE from incorrect carbocation **(1)** Formation of primary bromoalkane loses second mark Mechanism for propene going to 2-bromopropane scores max (3) for MP1, MP2 and MP3, propene to 1-bromopropane scores max (2) for MP1 and MP3	H missing from bonds $C^{\delta+}$ $Br^{\delta-}$	**(4)**

Question Number	Acceptable Answers	Reject	Mark
22(e)(iii)	(2,2,4-trimethylpentane:)  **(1)** (Dimers:)  OR  **(1)** ALLOW CH_3 on branches of skeletal formula / Structural/displayed formulae for both IGNORE Bond angles/ orientation		**(2)**

Question Number	Acceptable Answers	Reject	Mark
22(f)(i)	Isooctane is a branched chain molecule (and heptane is a straight chain molecule) ALLOW Isooctane has branches/ is branched / has branched chains. IGNORE The chain is longer/ has more C atoms/ is more stable / more chains		**(1)**

Question Number	Acceptable Answers	Reject	Mark
22(f)(ii)	They reduce pre-ignition/ knocking/ pinking OR More efficient combustion Less incomplete combustion/ More energy produced **per mole**/ Less carbon monoxide produced/ Cleaner combustion/ More miles per gallon ALLOW smooth combustion IGNORE More volatile Highly flammable	Less global warming/ Cheaper/ Slower rate of combustion	**(1)**

(Total for Question 22 = 21 marks)

Question Number	Acceptable Answers	Reject	Mark
23(a)(i)	Argon is a gas (in its standard state) ALLOW Argon is a noble gas **(1)** Argon exists as single atoms/ is monatomic ALLOW Ar molecules are monatomic IGNORE Argon is unreactive **(1)**	Just "Argon consists of atoms"	**(2)**

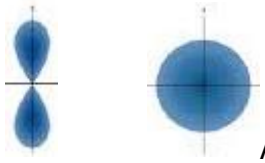
Question Number	Acceptable Answers	Reject	Mark
***23(a)(ii)**	**MP1:** Recognition that Ar would come after K in the Periodic Table (because Ar has greater atomic mass) OR K has smaller atomic mass than Ar / Ar has greater atomic mass than K IGNORE Atomic masses vary because of different proportions of isotopes. **(1)** **MP2:** One of the following explanations: chemical properties would not match other Group 1/0 elements it would put K with noble gases it would put Ar with alkaline metals elements in the Groups (1/0) would not have similar properties This would break periodic trends in properties e.g trend in ionisation energies Number of electrons in the outer shell would be out of order **(1)**		**(2)**

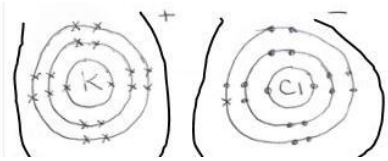
Question Number	Acceptable Answers	Reject	Mark
23(b)(i)	^{35}Cl consists of 17 protons and 18 neutrons ^{37}Cl consists of 17 protons and 20 neutrons **(1)** Isotopes have the same number of protons (and electrons) but different numbers of neutrons OR Isotopes have the same atomic number but different mass number **(1)**	17 electrons	**(2)**

Question Number	Acceptable Answers	Reject	Mark
23(b)(ii)	**MP1** Let y be percentage abundance of 35 $\frac{35y + (100 - y)37}{100} = 35.453$ **(1)** **MP2** 35y + 3700 – 37y = 3545.3 154.7 = 2y 77.35 = y ^{35}Cl = 77.35(%) ^{37}Cl = 22.65(%) **(1)** **OR MP1** y may be taken as a fraction in which case 35y + (1 – y)37 = 35.453 **(1)** **MP2** 0.7735 = y ^{35}Cl = 77.35(%) ^{37}Cl = 22.65(%) **(1)** Correct answer with no working **(2)**		**(2)**

Question Number	Acceptable Answers	Reject	Mark
23(c)(i)	$Cl(g) \rightarrow Cl^+(g) + e^-$ OR $Cl(g) - e^{(-)} \rightarrow Cl^+(g)$	Cl_2	**(1)**

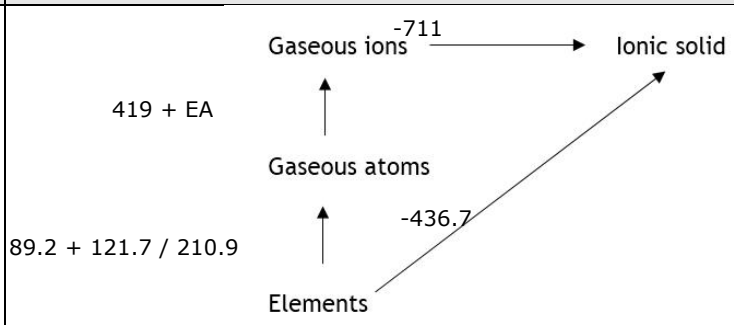
Question Number	Acceptable Answers	Reject	Mark
***23(c)(ii)**	**MP1** **Nuclear** charge/number of protons is increasing **(1)** **MP2** While electron is removed from the same quantum shell (so greater attraction) / Electron has same amount of shielding IGNORE The outer shell in argon is full. Electrons in argon are all paired in orbitals. Chlorine has an unpaired p electron. The atomic radius of argon is smaller. Comments on charge density. **(1)**	Less shielding in Ar	**(2)**

Question Number	Acceptable Answers	Reject	Mark
23(c)(iii)	Argon **(1)** Potassium **(1)**  Axes need not be shown (3)p (4)s ALLOW Any orientation of p orbital More than one p orbital for Ar 2 correct diagrams without labels scores (1) IGNORE Electrons in boxes diagrams Dot and cross diagrams		**(2)**

Question Number	Acceptable Answers	Reject	Mark
23(d)(i)	 **(1)** **(1)** Brackets not essential 1 Max if changes not shown ALLOW All crosses or all dots Diagram showing outer shells only; potassium may be shown with 0 or 8 electrons and charges correct. Scores (1)	Covalent bonding	**(2)**

Question Number	Acceptable Answers	Reject	Mark
23(d)(ii)	All three have the same number of electrons/ have 18 electrons/ are isoelectronic/ have the same electron configuration/ have configuration 2,8,8/ have the configuration of argon/ have 8 outer shell electrons ALLOW Have full outer shells/ Have the same number of outer shell electrons		**(1)**

Question Number	Acceptable Answers	Reject	Mark
23(e)(i)	Hess's law / Hess Law **and** The total enthalpy change (in a reaction) is independent of the route	Conservation of energy	**(1)**

Question Number	Acceptable Answers	Reject	Mark
23(e)(ii)	 One mark for labels for arrows with or without EA being shown **(1)** Electron affinity = -436.7 – [89.2 + 419 + 121.7 + (-711)] {Hess applied correctly} **(1)** = -355.6 / -356 (kJ mol^{-1}) **(1)** Correct answer with no working scores both calculation marks. +355.6 / +356 (kJ mol^{-1}) scores 1 calculation mark ALLOW TE from a transcription error of one of the data or from 2x121.7 (gives -477.3)	EA in wrong place Use of 2x121.7	**(3)**

(Total for Question 23 = 20 marks)

TOTAL FOR SECTION B = 60 MARKS

TOTAL FOR PAPER = 80 MARKS