Pearson

# Mark Scheme (Results)

## January 2018

Pearson Edexcel International Advanced Level In Chemistry (WCH01) Paper 01 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.

**Section A (multiple choice)**

| Question Number | Correct Answer | Mark |
|---|---|---|
| **1** | **The only correct answer is B**<br><br>***A*** *is not correct because this area is for ionisation*<br><br>***C*** *is not correct because this area is for deflection*<br><br>***D*** *is not correct because this area is for detection* | **(1)** |

| Question Number | Correct Answer | Mark |
|---|---|---|
| **2** | **The only correct answer is D**<br><br>***A*** *is not correct because this is for the +3 ion*<br><br>***B*** *is not correct because this is for the +2 ion*<br><br>***C*** *is not correct because this is for the atom* | **(1)** |

| Question Number | Correct Answer | Mark |
|---|---|---|
| **3(a)** | **The only correct answer is C**<br><br>***A*** *is not correct because this is an s block element*<br><br>***B*** *is not correct because this is a d block element*<br><br>***D*** *is not correct because this has 4 electrons in its p subshell* | **(1)** |

| Question Number | Correct Answer | Mark |
|---|---|---|
| **3(b)** | **The only correct answer is B**<br><br>***A*** *is not correct because W bonding type is incorrect*<br><br>***C*** *is not correct because WZ does not have covalent bonding*<br><br>***D*** *is not correct because Z is not ionic and WZ is not covalent* | **(1)** |

| Question Number | Correct Answer | Mark |
|---|---|---|
| **4(a)** | **The only correct answer is C**<br><br>***A*** *is not correct because this percentage is only for 3 oxygen atoms*<br><br>***B*** *is not correct because this percentage is only for 5 oxygen atoms*<br><br>***D*** *is not correct because this percentage uses 279.4 instead of 297.4* | **(1)** |

| Question Number | Correct Answer | Mark |
|---|---|---|
| **4(b)** | **The only correct answer is D**<br><br>***A*** *is not correct because this is only for one ion*<br><br>***B*** *is not correct because this is only for two ions*<br><br>***C*** *is not correct because this is only for three ions* | **(1)** |

| Question Number | Correct Answer | Mark |
|---|---|---|
| **4(c)** | **The only correct answer is D**<br><br>***A*** *is not correct because there are two moles of carbonate requiring neutralisation and not ½ mol*<br><br>***B*** *is not correct because there are two moles of carbonate requiring neutralisation and not one mol*<br><br>***C*** *is not correct because there are two moles of carbonate requiring neutralisation and not 1½ mol* | **(1)** |

| Question Number | Correct Answer | Mark |
|---|---|---|
| **5** | **The only correct answer is B**<br><br>***A*** *is not correct because the 4:6 ratio has been omitted*<br><br>***C*** *is not correct because the wrong ratio of 4:1 has been used*<br><br>***D*** *is not correct because the '4' of the 4:6 ratio has not been used* | **(1)** |

| Question Number | Correct Answer | Mark |
|---|---|---|
| **6** | **The only correct answer is C**<br><br>***A*** *is not correct because the number of moles 0.394 has been incorrectly divided by four and then used*<br><br>***B*** *is not correct because the wrong number of moles, 0.100, has been used*<br><br>***D*** *is not correct because 0.100 has been multiplied by four to give 0.400 and then used instead of the limiting 0.394 mol* | **(1)** |

| Question Number | Correct Answer | Mark |
|---|---|---|
| **7** | **The only correct answer is B**<br><br>**A** is not correct because lithium has weaker bonding than boron<br><br>**C** is not correct because nitrogen is a gas<br><br>**D** is not correct because neon is a gas | **(1)** |

| Question Number | Correct Answer | Mark |
|---|---|---|
| **8** | **The only correct answer is A**<br><br>***B*** *is not correct because gloves do not lower the risk of a gas*<br><br>***C*** *is not correct because goggles do not lower the risk of a gas*<br><br>***D*** *is not correct because this is not the best way to reduce the risk but exposes more to it* | **(1)** |

| Question Number | Correct Answer | Mark |
|---|---|---|
| **9** | **The only correct answer is B**<br><br>**A** is not correct because this is ionic bonding<br><br>**C** is not correct because this is covalent bonding<br><br>**D** is not correct because this is dative covalent bonding | **(1)** |

| Question Number | Correct Answer | Mark |
|---|---|---|
| **10** | **The only correct answer is A**<br><br>***B*** *is not correct because these are the spectator ions*<br><br>***C*** *is not correct because this equation includes the spectator ions*<br><br>***D*** *is not correct because this equation includes the spectator ions* | **(1)** |

| Question Number | Correct Answer | Mark |
|---|---|---|
| **11(a)** | **The only correct answer is C**<br><br>***A*** *is not correct because this is 50.5 as a percentage of all of the molar masses in the equation*<br><br>***B*** *is not correct because this is the atom economy for the production of hydrogen chloride instead of chloromethane*<br><br>***D*** *is not correct because this is 50.5 divided by the molar mass of chlorine* | **(1)** |

| Question Number | Correct Answer | Mark |
|---|---|---|
| **11(b)** | **The only correct answer is C**<br><br>***A*** *is not correct because this is the number of moles of the product times by one hundred*<br><br>***B*** *is not correct because this is the number of moles of the reactant times by one hundred*<br><br>***D*** *is not correct because this is the reactant mass as a percentage of the product mass* | **(1)** |

| Question Number | Correct Answer | Mark |
|---|---|---|
| **11(c)** | **The only correct answer is A**<br><br>***B*** *is not correct because there is no unpaired electron on the carbon*<br><br>***C*** *is not correct because this is the methane molecule*<br><br>***D*** *is not correct because this is the methyl anion* | **(1)** |

| Question Number | Correct Answer | Mark |
|---|---|---|
| **12** | **The only correct answer is A**<br><br>***B*** *is not correct because the* $\Delta H_3$ *should be subtracted not added*<br><br>***C*** *is not correct because the enthalpy values should not be halved*<br><br>***D*** *is not correct because enthalpy values should not be halved nor added* | **(1)** |

| Question Number | Correct Answer | Mark |
|---|---|---|
| **13** | **The only correct answer is C**<br><br>***A*** *is not correct because this is the use of only* ***3x****N-H instead of* ***6x***<br><br>***B*** *is not correct because this is the use of* ***2x****N≡N instead of* ***1x***<br><br>***D*** *is not correct because this is the use of only* ***2x****H-H instead of* ***3x*** | **(1)** |

| Question Number | Correct Answer | Mark |
|---|---|---|
| **14** | **The only correct answer is C**<br><br>***A*** *is not correct because* there will be significant heat loss<br><br>***B*** *is not correct because* there will be significant heat loss<br><br>***D*** *is not correct because* there will be significant heat loss | **(1)** |

| Question Number | Correct Answer | Mark |
|---|---|---|
| **15** | **The only correct answer is D**<br><br>***A*** *is not correct because the blue copper ions move towards the cathode*<br><br>***B*** *is not correct because the blue copper ions move towards the cathode and there are no yellow ions*<br><br>***C*** *is not correct because the sulfate ions are colourless and not yellow* | **(1)** |

**(TOTAL FOR SECTION A = 20 MARKS)**

**Section B**

| Question Number | Acceptable Answers | Reject | Mark |
|---|---|---|---|
| **16(a)(i)** | (Different) boiling temperatures / boiling points<br><br>IGNORE<br>Chain length/intermolecular forces/ mass of alkane | | **(1)** |

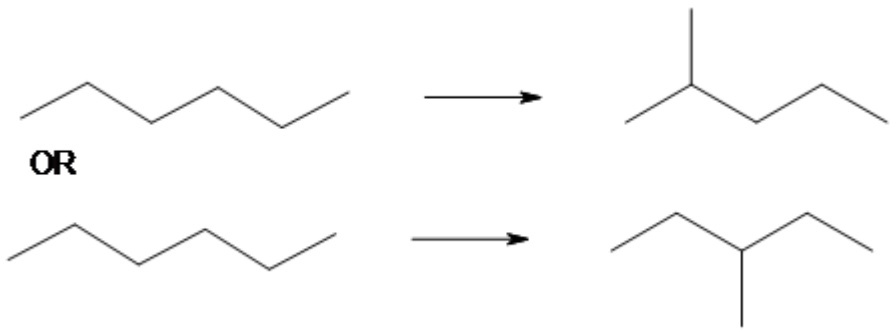
| Question Number | Acceptable Answers | Reject | Mark |
|---|---|---|---|
| **16(a)(ii)** | Methane/ethane/propane/butane/methylpropane<br><br>ALLOW<br>Formulae $CH_4$/ $C_2H_6$/ $C_3H_8$ /$C_4H_{10}$<br><br>If name and formula given then both must be correct<br><br>IGNORE<br>Refinery gas / natural gas / fuel gas / LPG | | **(1)** |

| Question Number | Acceptable Answers | Reject | Mark |
|---|---|---|---|
| **16(a)(iii)** | Insufficient petrol obtained (from fractional distillation)/<br>Not enough petrol is obtained to meet demand /<br>other fractions are surplus to requirements<br><br>ALLOW<br>There is a high demand for petrol /<br>other fractions are less useful<br><br>IGNORE<br>Higher yield / references to cost | | **(1)** |

| Question Number | Acceptable Answers | Reject | Mark |
|---|---|---|---|
| **16(b)(i)** | High temperature / Heat<br><br>ALLOW<br>Any value(s) ≥150°C<br><br>IGNORE<br>Pressure / steam / exclusion of oxygen /<br>just 'temperature' | Warm<br>UV light<br>High<br>Melting / boiling temp | **(1)** |

| Question Number | Acceptable Answers | Reject | Mark |
|---|---|---|---|
| **16(b)(ii)** | $C_{12}H_{26} \rightarrow C_8H_{18} + 2C_2H_4$<br>Correct formulae (1)<br>Balancing of correct formulae (1)<br><br>IGNORE<br>State symbols even if incorrect / any conditions above arrow | | **(2)** |

| Question Number | Acceptable Answers | Reject | Mark |
|---|---|---|---|
| **16(c)(i)** | Burns more 'smoothly'/<br>reduces/prevents 'knocking/pinking/pre-ignition'<br>OR<br>Has a higher octane rating<br><br>ALLOW<br>Burns more efficiently / burns more easily<br><br>IGNORE<br>references to incomplete combustion /less flammable / cleaner combustion / releases more energy | | **(1)** |

| Question Number | Acceptable Answers | Reject | Mark |
|---|---|---|---|
| **16(c)(ii)** |  <br>OR<br><br>**MP1**<br>Skeletal formula for hexane (1)<br>**MP2**<br>Skeletal formula for 2-methylpentane or 3-methylpentane (1)<br>**MP3**<br>Correct product name (1)<br><br>ALLOW<br>One mark for **MP1** and **MP2** if non-skeletal formulae used | | **(3)** |

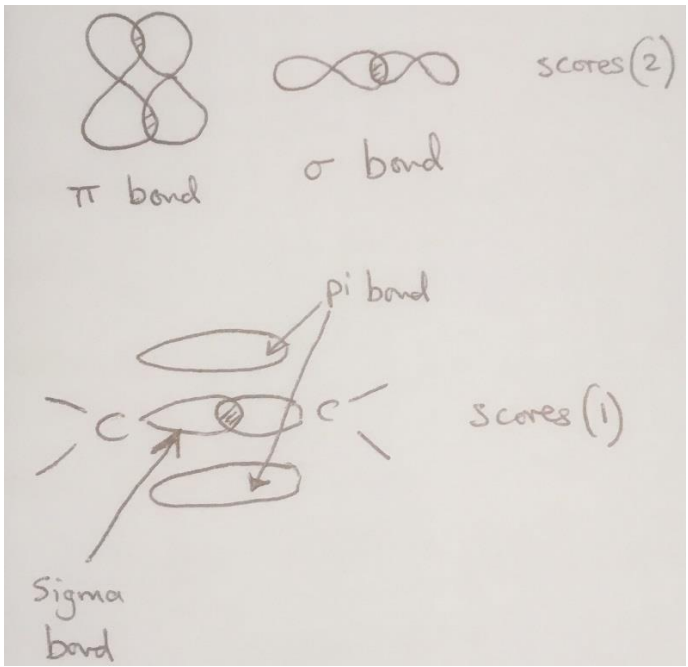
| Question Number | Acceptable Answers | Reject | Mark |
|---|---|---|---|
| **16(c)(iii)** | (+) $H_2$/H−H<br><br>IGNORE<br>State symbols, even if incorrect | 2H /<br>$2H_2$ /<br>$3H_2$<br>etc. | **(1)** |

| Question Number | Acceptable Answers | Reject | Mark |
|---|---|---|---|
| **16(d)(i)** | **MP 1** (multiplication by 10)<br>$m(C_5H_{12})$ =0.626 x 10 = 6.26 (g) (1)<br><br>**MP 2** (division by 72)<br>$n(C_5H_{12})$ = 6.26 ÷ 72 = 0.08694…. (mol) (1)<br><br>**MP 3** (multiplication by 5)<br>$n(CO_2)$ = 5 x 0.08694….= 0.43472… (mol) (1)<br><br>**MP 4** (multiplication by 24000 and to 3SF)<br>$V(CO_2)$ = 0.43472… x 24000 = 10433.333 $cm^3$<br>= 10400 ($cm^3$) / 10.4 $dm^3$<br>Answer must be to 3SF (1)<br><br>Correct answer without working scores (4)<br><br>TE throughout | | **(4)** |

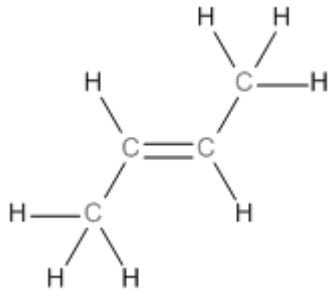
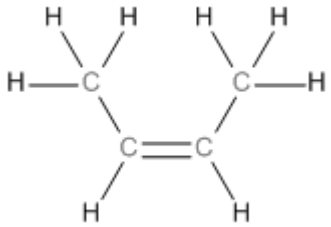
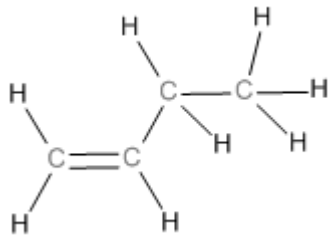
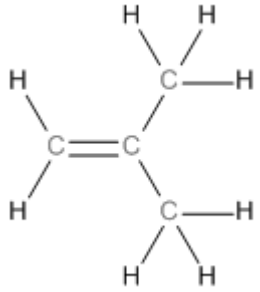
| Question Number | Acceptable Answers | Reject | Mark |
|---|---|---|---|
| **16(d)(ii)** | $C_5H_{12} + 5½O_2 \rightarrow 5CO + 6H_2O$<br><br>Allow multiples<br><br>IGNORE<br>State symbols even if incorrect | | **(1)** |

| Question Number | Acceptable Answers | Reject | Mark |
|---|---|---|---|
| ***16(e)** | Non-renewable means that it is a finite resource/it takes millions of years to produce/ it will 'run out' / being used up faster than it is made<br><br>ALLOW<br>Not a sustainable resource (1)<br><br>IGNORE<br>Just 'it's not renewable' / 'can't be made again'<br><br>Impact on climate change:<br>(Increase in) global warming due to (increase in) $CO_2$ emissions<br>OR<br>(Increased) $CO_2$ causes stated effect of global warming, e.g. melting of polar ice caps/rise in sea levels/disrupted weather patterns<br>OR<br>(Increased) $CO_2$ absorbs infrared / traps heat (1)<br>IGNORE<br>Reference to acid rain / references to water<br>Reference to methane production / greenhouse effect | Only be used once<br><br>ozone layer<br><br>UV light absorption<br><br>CO / carbon monoxide | **(2)** |

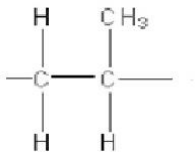
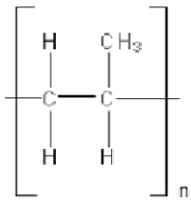
**(Total for Question 16 = 18 marks)**

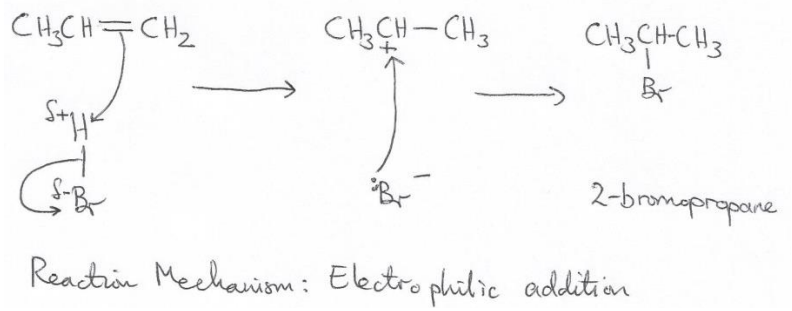
| Question Number | Acceptable Answers | Reject | Mark |
|---|---|---|---|
| **17(a)(i)** | A sigma bond has a single area of orbital overlap **and** a pi bond has two areas of orbital overlap (1)<br><br>A sigma bond has axial/end-on/head-on /direct/horizontal overlap **and** a pi bond has lateral/sideways/parallel overlap (1)<br><br>These points can be awarded for suitable labelled diagrams for example<br>  <br><br>ALLOW two correct statements from the list above about either sigma or pi bonds for (1)<br><br>IGNORE<br>Reference to the extent of overlap | | **(2)** |

| Question Number | Acceptable Answers | Reject | Mark |
|---|---|---|---|
| **17(a)(ii)** | Lack of rotation (about the bond)/<br>restricted rotation (about the bond)/<br>barrier to rotation (about the bond)<br><br>ALLOW<br>No rotation (about the bond)<br><br>IGNORE<br>References to the groups attached to the double bond | Lack of molecular rotation | **(1)** |

<table>
<tr><th>Question Number</th><th>Acceptable Answers</th><th>Reject</th><th>Mark</th></tr>
<tr><td>17(a)(iii)</td><td>E isomer<br>  <br>(1)</td><td>Z isomer<br>  <br>(1)</td><td rowspan="3">(2-)methylprop-2-ene</td><td rowspan="3">(4)</td></tr>
<tr><td>Either<br>  <br>OR<br>  <br>(1)</td><td>But-1-ene<br><br>OR<br><br>(2-)methylpropene<br><br>ALLOW<br>(2-)methylprop-1-ene (1)</td></tr>
<tr><td colspan="2">ALLOW<br>Skeletal formulae<br>Non-displayed $CH_3$/$CH_3CH_2$/$C_2H_5$<br><br>Award one mark out of two if E-Z isomers are drawn the wrong way round<br><br>ALLOW<br>MP4 can be awarded for the name of correct structure with minor error in MP3 e.g. missing H atom / extra H atom<br>MP4 can be awarded for the correct name if no structure has been drawn for MP3</td></tr>
</table>

| Question Number | Acceptable Answers | Reject | Mark |
|---|---|---|---|
| **17(b)(i)** | Answers reading clockwise from top left:<br><br>ALLOW<br>Skeletal/displayed formulae<br><br>$CH_3CHBrCH_2Br$ (1)<br><br>$H_2$ **and** Ni/ Pt<br>OR<br>Hydrogen **and** Nickel/Platinum (1)<br><br>$CH_3CH(OH)CH_2OH$ (1)<br><br>IGNORE<br>Names for organic species even if incorrect | $CH_2BrCH_2CH_2Br$<br><br>$CH_2OHCH_2CH_2OH$ | **(3)** |

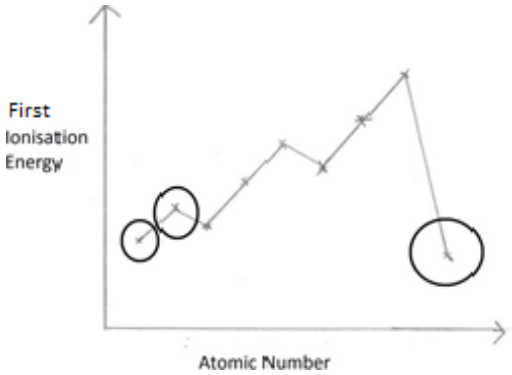
| Question Number | Acceptable Answers | Reject | Mark |
|---|---|---|---|
| **17(b)(ii)** |  <br>ALLOW<br>  <br><br>The methyl group can be displayed, given on either carbon of the repeat unit and drawn either on the top or the bottom<br><br>Two or more correct repeat units | | **(1)** |

| Question Number | Acceptable Answers | Reject | Mark |
|---|---|---|---|
| **17(c)** | Reaction mechanism, e.g.<br>  <br><br>Reaction Mechanism: Electrophilic addition<br>**MP1** Curly arrow from C=C in correctly drawn propene to ($^{\delta+}$)H (1)<br>**MP2** H−Br dipole **and** curly arrow from H−Br bond to Br or just beyond (1)<br>**MP3** Structure of carbocation (1)<br>**MP4** Curly arrow from lone pair on bromide **ion** to C+ **and** correct structure of product (1)<br>**MP5** Reaction mechanism: Electrophilic addition (1)<br>**MP6** Name of product: 2-bromopropane (1)<br>Penalise formation of minor product 1-bromopropane in MP3 only | 'Spare' bond on C+ | **(6)** |

**(Total for Question 17 = 17 marks)**

| Question Number | Acceptable Answers | Reject | Mark |
|---|---|---|---|
| **18(a)** | In one mole (of atoms) / per mole (of atoms) (1)<br><br>In the gaseous state<br><br>ALLOW<br>Reference to gaseous ions (1)<br><br>IGNORE<br>Any equations | | **(2)** |

| Question Number | Acceptable Answers | Reject | Mark |
|---|---|---|---|
| **18(b)** | To overcome the (electrostatic) attraction/force of the nucleus/protons for the electron(s)<br><br>IGNORE<br>Just 'energy is needed'<br>Just 'overcome the attraction' | | **(1)** |

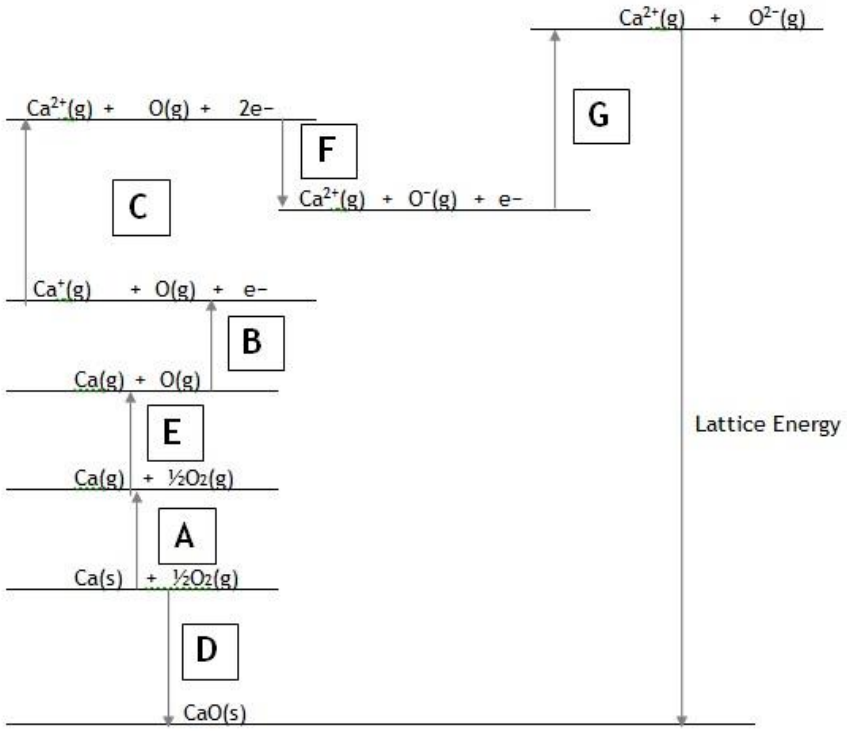
| Question Number | Acceptable Answers | Reject | Mark |
|---|---|---|---|
| **18(c)(i)** | Sketch encircled, e.g.<br>  <br><br>Circle of the last cross to the right (1)<br><br>Circles of the first two crosses on the left<br><br>ALLOW<br>One circle around both crosses on the left (1)<br><br>Three correct circles and one incorrect scores one. | | **(2)** |

| Question Number | Acceptable Answers | Reject | Mark |
|---|---|---|---|
| **18(c)(ii)** | Single figure of eight shape in any orientation, e.g.<br>  <br><br>IGNORE<br>Any axes given | 2 or 3 orbitals on the same diagram | **(1)** |

| Question Number | Acceptable Answers | Reject | Mark |
|---|---|---|---|
| ***18(d)** | (Gradual) increase in first three ionisation energies (1)<br><br>Big jump from third to fourth ionisation energy (so it is in Group 3) (1) | | **(2)** |

| Question Number | Acceptable Answers | Reject | Mark |
|---|---|---|---|
| **18(e)** | Electrons (in the same orbital) repel each other/ repulsion is minimised<br><br>ALLOW<br>To avoid/prevent repulsion / so there is no repulsion (between electrons)<br>OR<br>(Electron) pairing causes repulsion<br><br>IGNORE<br>Just 'energetically more favourable'<br>Just 'Hund's Rule' | | **(1)** |

**(Total for Question 18 = 9 marks)**

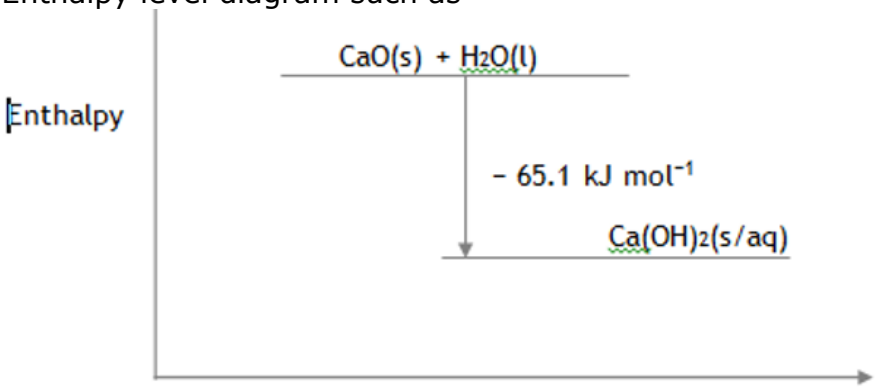
| Question Number | Acceptable Answers | Reject | Mark |
|---|---|---|---|
| **19(a)** | Diagram similar to:<br>  <br><br>Arrows upwards for first and second ionization energies for calcium and correct labels B and C in boxes (1)<br><br>Arrow downwards for first electron affinity of oxygen and arrow upwards for second electron affinity of oxygen **and** correct labels F and G in boxes (1)<br><br>Correct entities and state symbols on horizontal lines<br><br>ALLOW<br>Omission of negative sign on electrons / inclusion of (g) for electrons (1) | | **(1)** |

| Question Number | Acceptable Answers | Reject | Mark |
|---|---|---|---|
| **19(b)** | (U = −(635+178 +249+590+1145−141+798=) −3454 kJ $mol^{-1}$<br>Correct answer scores (2)<br><br>ALLOW one mark for<br>−2184 kJ $mol^{-1}$<br>OR<br>−3736 kJ $mol^{-1}$<br>OR<br>(+)3454 kJ $mol^{-1}$ | | **(2)** |

| Question Number | Acceptable Answers | Reject | Mark |
|---|---|---|---|
| ***19(c)** | (Theoretical lattice energies are calculated using an ionic model)<br><br>The bonding in CaO is (almost purely/100%) ionic (1)<br><br>The bonding in $CaI_2$ is partially covalent (1)<br><br>The iodide (anion) is larger (than the oxide anion) (1)<br><br>The iodide (anion) is (more) polarised (by the calcium ion) / the electron cloud is (more easily) distorted<br>(by the calcium ion, resulting in a more negative lattice energy)<br><br>ALLOW<br>So the bonding is stronger than expected (in $CaI_2$) (1) | Just 'covalent'<br><br>Atomic radius<br><br>Weaker bond | **(4)** |

| Question Number | Acceptable Answers | Reject | Mark |
|---|---|---|---|
| **19(d)(i)** | **MP1** (calculation of Q)<br>Q =(200 x 4.18 x 40=) 33440 (J)<br>ALLOW<br>33.44 **kJ** (1)<br><br>IGNORE<br>Any sign given<br><br>**MP2** (division by enthalpy change)<br>n= (33440 ÷ 65100=) 0.51367 …… (mol) (1)<br><br>**MP3** (multiplication by molar mass)<br>m = (0.51367 … x 56.1=) 28.817 …/28.82/ 28.8 (g) (1)<br>Correct answer with or without working scores (3)<br><br>IGNORE<br>SF except 1 SF but penalise once only<br><br>ALLOW TE throughout | | 3 |

| Question Number | Acceptable Answers | Reject | Mark |
|---|---|---|---|
| **19(d)(ii)** | To keep the drink at the required temperature/to minimise heat loss<br>ALLOW<br>To keep the drink hot/warm (1)<br><br>To allow the can to be handled safely<br>ALLOW<br>To prevent hands from being burnt (1) | | **(2)** |

| Question Number | Acceptable Answers | Reject | Mark |
|---|---|---|---|
| **19(d)(iii)** | Enthalpy level diagram such as<br>  <br><br>There are four requirements for the two marks:<br>• Arrow downwards with −65.1 (kJ mol$^{-1}$)<br>ALLOW<br>Double-ended arrow/arrow that goes down but does not go exactly from the reactant line to the product line<br>IGNORE<br>Activation energy hump and labels even if incorrect<br>• Y axis label<br>ALLOW<br>Energy for enthalpy<br>• Reactant and product formulae<br>• Reactant and product state symbol<br>4 correct scores 2 marks<br>2 or 3 correct scores 1 mark<br>1 correct scores 0 mark | Enthalpy change / ΔH / heat<br>Additional compounds | **(2)** |

**(Total for Question 19 = 16 marks)**

**(TOTAL FOR SECTION B = 60 MARKS)**

**TOTAL FOR PAPER = 80 MARKS**