Pearson Edexcel

Mark Scheme (Results)

Summer 2025

Pearson Edexcel Level GCE Advance Subsidiary In Chemistry (8CH0)
Paper 02: Core Organic and Physical 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.

Question Number	Answer	Mark
1(a)	**The only correct answer is D** ($C_{10}H_{16}$) ***A*** *is incorrect because this answer miscounts both the number of carbon atoms in the skeletal formula and the number of hydrogen atoms in the skeletal formula, and it is the empirical formula* ***B*** *is incorrect because* C_5H_8 *is the empirical formula of myrcene* ***C*** *is incorrect because this answer miscounts the number of hydrogen atoms in the skeletal formula*	**(1)**

Question Number	Answer	Mark
1(b)	**The only correct answer is B** (3) ***A*** *is incorrect because there are three C=C double bonds where bromine could add* ***C*** *is incorrect because there are three C=C double bonds where bromine could add* ***D*** *is incorrect because this is the number of bromine atoms added and not the number of bromine molecules*	**(1)**

Question Number	Answer	Mark
1(c)	**The only correct answer is B** (2-methylbuta-1,3-diene) ***A*** *is incorrect because there are two double bonds and so there should be a di before the ene* ***C*** *is incorrect because the IUPAC system requires this to be named as substituted butadiene* ***D*** *is incorrect because this name indicates a total of 6 carbon atoms and a chain of 5 carbon atoms*	**(1)**

Question Number	Answer	Mark
1(d)	**The only correct answer is C** (acidified potassium manganate(VII)) ***A*** *is incorrect because this would produce an alkane* ***B*** *is incorrect because there would be no reaction* ***D*** *is incorrect because this would produce an alcohol*	**(1)**

(Total for Question 1 = 4 marks)

Question Number	Answer	Mark
2	**The only correct answer is B** (HOOC−CH_2−CBr=CH−COOH) ***A*** *is incorrect because this molecule is not unsaturated, i.e. it has no C=C so it cannot be named using either system* ***C*** *is incorrect because this molecule has two identical groups on one of the C=C carbons so it cannot be named using either system* ***D*** *is incorrect because this molecule has two identical groups on both C=C carbons so it can be named using either system*	**(1)**

(Total for Question 2 = 1 mark)

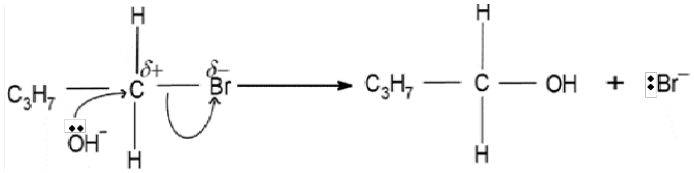
Question Number	Answer	Additional Guidance	Mark
3(a)	An answer that makes reference to the following point: • −3975 (kJ mol^{-1})	 Do not allow answers shown as positive, but ignore missing sign Allow answers in the range −3950 to −4010 (kJ mol^{-1})	(1)

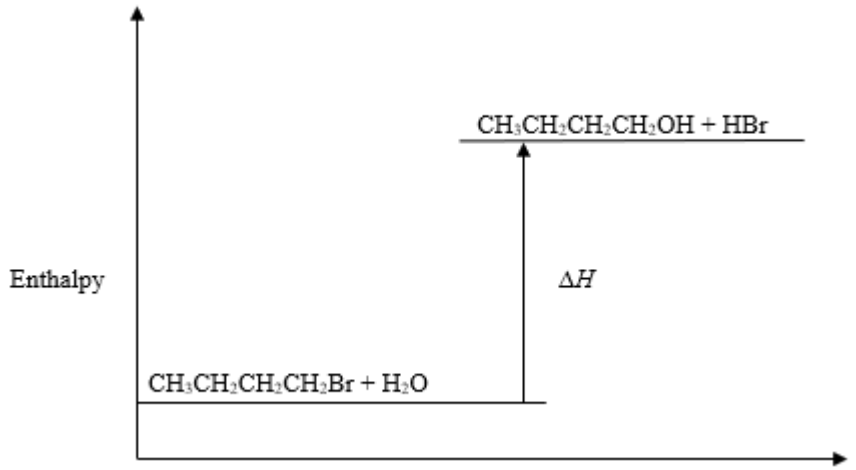
Question Number	Answer	Additional Guidance	Mark
3(b)	• mass of alcohol burned **(1)** • temperature difference **(1)** • energy change **(1)** • enthalpy change per mole with sign **(1)**	<u>Example of calculation</u> = 20.95 – 20.15 = 0.80 g = 48.3 – 21.0 = 27.3ºC Adding 273 subsequently (273+27.3 = 300.3) loses only M3 = 200 × 4.18 × 27.3 = 22 823 (J) / 22.823 (kJ) Ignore signs in M1 to M3 −22.823 ÷ 0.80 × 130 = −3708.7 / −3709 / −3710 (kJ mol^{-1}) Ignore SF except 1 SF Do not accept answers from moles rounded to 1 s.f. (e.g. 0.006) Correct answer with some working scores 4 marks (+) 3708.7 / 3709 / 3710 (kJ mol^{-1}) scores (3) If units are given, they must be correct Allow TE throughout	(4)

Question Number	Answer	Additional Guidance	Mark
3(c)	An explanation that makes reference to the following points: • the experimental value of $\Delta_c H^\ominus$ (octan-1-ol) will be less negative/exothermic **(1)** • because of heat (energy)/ loss/escaped / to the surroundings / the calorimeter **(1)**	Allow reverse argument Do not award smaller/ lower/ decreases/ more positive Do not accept just 'energy loss' /'dissipate' Do not award incomplete combustion Do not award specific heat capacity is an approximation Ignore reference to data book values being average values or mention of non-standard conditions	**(2)**

Question Number	Answer	Additional Guidance	Mark
3(d)	An explanation that makes reference to the following points: • the temperature recorded of the water will be higher (at the bottom of the beaker than the average temperature on stirring)/the temperature change would be larger **(1)** • so (calculated) $\Delta_c H^\ominus$ (octan-1-ol) will be more negative / exothermic/ bigger or higher in magnitude **(1)**	Do not award 'unreacted if not stirred' Allow (water at the) bottom hotter than at the top Do not award just 'there is a temperature difference' or 'uneven heat' M2 must follow from M1 or near miss Do not award just 'enthalpy (change of combustion) would be 'bigger/ larger on its own Accept 'enthalpy change value/number' or 'calculated enthalpy change/value' would be bigger/ greater/ larger	**(2)**

(Total for Question 3 = 9 marks)

Question Number	Answer	Additional Guidance	Mark
4(a)	An answer that makes reference to the following points:	Example of mechanism 	**(3)**
	• curly arrow from **lone pair** on OH^- to δ+ carbon **(1)**	Ignore K^+ on both sides but do not award if K - OH is the attacking species Do not award if charge is missing on OH^-	
	• curly arrow from C-Br bond to, or just beyond, Br **(1)**	Lone pair on Br^- not needed to score	
	• δ+ and δ− on relevant atoms of the C - Br bond **and** Br^- present as product **(1)**	Accept KBr as a product if K^+ is shown on the left Allow correct S_N1 mechanism to correct carbocation Penalise once in M1 to M3 incorrect structures for reactant and/or product	

Question Number	Answer	Additional Guidance	Mark
4(b)	• labelled y-axis identified as 'Enthalpy/energy' **and** reactants lower than products **(1)** • single headed arrow pointing upwards and correct formulae of reactants and products **(1)**	Example of enthalpy profile diagram  Do not award "enthalpy change/energy change" on y axis Ignore label on x-axis Allow molecules written in either form C_4H_9Br / $CH_3CH_2CH_2CH_2Br$ etc. Arrows must start and finish near lines Ignore + ΔH but penalise - ΔH Ignore state symbols even if incorrect Exothermic reaction scores (0) Ignore reaction curves or activation energy but Ea pointing downwards does not score M2	**(2)**

Question Number	Answer	Additional Guidance	Mark
4(c)(i)	An explanation that makes reference to the following points: • the London forces/ instantaneous dipole-induced dipole/ dispersion forces increase because there are more electrons **(1)** • therefore more energy is required to break these intermolecular forces (so the melting temperature increases) **(1)**	Allow van der Waals' forces/ instantaneous dipole / temporary dipole Do not allow just 'dipole-dipole' Allow there is a 'greater surface area' or more 'points of contact' for more electrons Do not award references to breaking bonds Reference to giant covalent scores (0) Ignore references to hydrogen bonds or importance of LF relative to hydrogen bonding	**(2)**

Question Number	Answer	Additional Guidance	Mark
4(c)(ii)	An explanation that makes reference to the following points: • the boiling temperature decreases with increasing number of branches/ branching (from top to bottom) **(1)** • (increasing number of branches gives) smaller surface area / less contact between molecules so London forces are weaker **(1)**	Ignore reference to hydrogen bonds Ignore alcohols being 1^{o}, 2^{o} or 3^{o} Do not award change in the number of electrons or protons Allow reverse argument Accept "intermolecular forces" for LF Allow "linear molecules can pack closer" for greater surface area Do not award breaking of bonds/ H bonds for M2	**(2)**

(Total for Question 4 = 9 marks)

Question number	Answer	Additional Guidance	Mark
5(a)(i)	An answer that makes reference to the following point: • 116	Ignore units	(1)

Question Number	Answer	Additional Guidance	Mark
5(a)(ii)	An answer that makes reference to the following points: • CH_3 group identified **(1)** • positive charge on the ion **(1)**	$[CH_3]^+$ scores both marks Ignore absence of brackets Standalone mark	(2)

Question Number	Answer	Additional Guidance	Mark
5(a)(iii)	An answer that makes reference to the following point: • hexanoic acid / $C_5H_{11}COOH$	Allow $C_6H_{12}O_2$ or any other correct formula Only name or formula needed but, if both are given, they must both be correct.	(1)

Question Number	Answer	Additional Guidance	Mark
5(b)(i)	An explanation that makes reference to the following points: • infrared spectrum gives information about the bonds present in the molecule **(1)** • IR does not (easily) give information about the numbers of carbon atoms **(1)**	Allow 'functional groups' for bonds Ignore named bonds (e.g O – H, C =O) can belong to different functional groups. Ignore absorptions overlap or occur over a range Accept the chain length / how many of each bond/ molar mass/molecular or structural formulas Ignore just 'peaks cannot tell us which carboxylic acid it is' Accept "It is difficult to match the fingerprint region"	**(2)**

Question Number	Answer	Additional Guidance	Mark
5(b)(ii)	An answer that makes reference to the following point: • carbonyl group / C=O	Award name **or** formula of group Do not award 'carboxylic acids' on its own If C = O given, ignore names given in data booklet (e.g. carboxylic acids) but do not award wrong functional group e.g. ketone	**(1)**

Question Number	Answer	Additional Guidance	Mark
5(b)(iii)	An explanation that makes reference to the following points: • OH / O – H / hydroxyl group / bond **(1)** • hydrogen bonded **(1)**	Do not award -OH unless it is clear in the response that the relevant bond is between oxygen and hydrogen Ignore any other intermolecular forces/ Ignore any further explanations including references to O−H bond strength or the energy needed to break hydrogen bonds M1 (or near miss) needed to score M2	**(2)**

(Total for Question 5 = 9 marks)

Question Number	Answer	Mark
6(a)	**The only correct answer is A** ($C_4H_9OH + PCl_5 \rightarrow C_4H_9Cl + POCl_3 + HCl$) ***B*** *is incorrect because Cl_2 and PO are not products of the reaction* ***C*** *is incorrect because Cl_2, P and HOCl are not products of the reaction* ***D*** *is incorrect because water is not a product of the reaction*	**(1)**

Question Number	Answer		Additional Guidance	Mark
6(b)(i)	• moles of sodium dichromate(VI) required • molar mass of sodium dichromate(VI) • mass required of sodium dichromate(VI)	**(1)** **(1)** **(1)**	Example of calculation = 0.150 ÷ 3 = 0.050 mol = 262 = 0.050 × 262 = 13.1 (g) Ignore SF except 1 SF Correct answer with some working scores (3) TE from incorrect molar mass and/or moles (do not accept 74 as Mr) e.g. 0.05 x 216 = 10.8 scores (2) 0.15 x 262 = 39.3 scores (2) 0.15 x 216= 32.4 scores (1)	**(3)**

<table>
<tr><th>Question Number</th><th>Answer</th><th>Additional Guidance</th><th>Mark</th></tr>
<tr>
<td>*6(b)(ii)</td>
<td>This question assesses a student's ability to show a coherent and logically structured answer with linkages and fully-sustained reasoning. Marks are awarded for indicative content and for how the answer is structured and shows lines of reasoning.

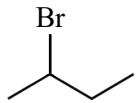
The following table shows how the marks should be awarded for indicative content.
<table>
<tr><th>Number of indicative marking points seen in answer</th><th>Number of marks awarded for indicative marking points</th></tr>
<tr><td>6</td><td>4</td></tr>
<tr><td>5-4</td><td>3</td></tr>
<tr><td>3-2</td><td>2</td></tr>
<tr><td>1</td><td>1</td></tr>
<tr><td>0</td><td>0</td></tr>
</table>
The following table shows how the marks should be awarded for structure and lines of reasoning.
<table>
<tr><th></th><th>Number of marks awarded for structure and sustained lines of reasoning</th></tr>
<tr><td>Answer shows a coherent and logical structure with linkages and fully sustained lines of reasoning demonstrated throughout.</td><td>2</td></tr>
<tr><td>Answer is partially structured with some linkages and lines of reasoning.</td><td>1</td></tr>
<tr><td>Answer has no linkages between points and is unstructured.</td><td>0</td></tr>
</table>
</td>
<td>The mark for indicative content should be added to the mark for lines of reasoning. For example, an answer with five indicative marking points that is partially structured with some linkages and lines of reasoning, scores 4 marks (3 marks for indicative content and 1 mark for partial structure and some linkages and lines of reasoning).

If there are no linkages between points, the same five indicative marking points would yield an overall score of 3 marks (3 marks for indicative content and no marks for linkages).

In general it would be expected that 5 or 6 indicative points would get 2 reasoning marks, and 3 or 4 indicative points would get 1 mark for reasoning, and 0, 1 or 2 indicative points would score zero marks for reasoning.

If there is any incorrect chemistry, deduct mark(s) from the reasoning. If no reasoning mark(s) awarded do not deduct mark(s).</td>
<td></td>
</tr>
</table>

***6(b)(ii)**	**Indicative content:** • **IP1** description of reflux • **IP2** description of apparatus • **IP3** description of distillation • **IP4** use of named drying agent • **IP5** separation of butanone from drying agent • **IP6** redistil dry product at 80°C / 353 K	Do not award unless it is the first step. Reagents not needed but, if given, they must be correct. If position of condenser not given or implied, accept it is vertical for this mark so accept as reflux A (vertical) condenser, flask (and reactants), anti-bumping granules and heat (allow small Bunsen flame but not roaring) Do not award thermometer, sealed condenser, still head or conical flask Distillation with a (sloping) condenser and still head/ receiver/ thermometer Ignore temperature here (Heat must be mentioned once in IP1 to IP3) (Anhydrous) calcium chloride is the usual drying agent but allow any of: sodium sulfate, calcium sulfate, magnesium sulfate Do not award unless drying the product of reflux or distillation Filtration or decantation Allow a range of up to ±4°C, with 84°C / 357 K as maximum allowable temperature (i.e. 76 – 84°C, 349 – 357 K) If no other mark, reflux followed by distillation scores 1 out of IP1 and IP2 IP2 and IP4 can be given, even if distillation comes before reflux Note: Ignore any additional purification steps	**(6)**

Question Number	Answer	Additional Guidance	Mark
6(c)	An answer that makes reference to the following point: • skeletal formula	 Do not award structural or displayed formulae Ignore any inorganic products shown Ignore names, even if incorrect	**(1)**

Question Number	Answer		Additional Guidance	Mark
6(d)(i)	• calculation of moles of PI_3 • calculation of moles of iodine molecules • number of iodine molecules	**(1)** **(1)** **(1)**	<u>Example of calculation</u> $= 22.1 \div 411.7 = 0.053680$ (mol) $= 0.053680 \times 3/2 = 0.080520$ (mol) $= 0.080520 \times 6.02 \times 10^{23} = 4.8473 \times 10^{22}$ Ignore SF except 1SF. Allow TE throughout Correct answer with some working scores (3)	**(3)**

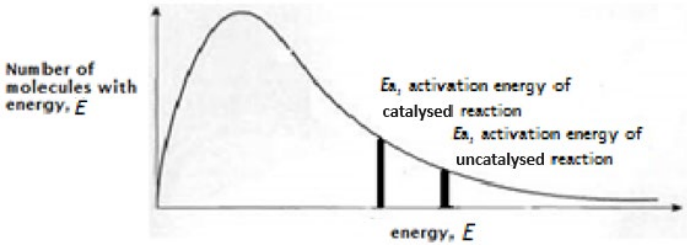
Question Number	Answer		Additional Guidance	Mark
6(d)(ii) Clip with (d)(i)	**EITHER using mass**		Example of calculation	(3)
	• moles of butan-2-ol	**(1)**	11.9 ÷ 74 = 0.16081 (mol)	
	• theoretical mass of 2-iodobutane produced	**(1)**	0.16081 × 183.9 = 29.573 (g)	
	• percentage yield	**(1)**	% yield = experimental mass / theoretical mass × 100 = 22.8 ÷ 29.573 × 100 = 77.097% Ignore SF except 1 SF Correct answer without working scores (3)	
	OR using moles			
	• moles of butan-2-ol = theoretical moles of 2-iodobutane	**(1)**	11.9 ÷ 74 = 0.16081 (mol)	
	• experimental moles of 2-iodobutane	**(1)**	22.80 ÷ 183.9 = 0.12398 (mol)	
	• percentage yield	**(1)**	% yield = experimental moles / theoretical moles × 100 = 0.12398 ÷ 0.16081 × 100 = 77.097% Allow TE throughout	

Question Number	Answer	Additional Guidance	Mark
6(e)	An answer that makes reference to the following points: • structural formula of butanal (from the partial oxidation of butan-1-ol) **(1)** **and** structural formula of butanone (from the oxidation of butan-2-ol) • molecular formula of butanal = C_4H_8O molecular formula of butanone = C_4H_8O **(1)** **and** (molecular formulae are the same so) are (structural/functional group) isomers	$CH_3CH_2CH_2CHO$ Do not award use of COH or HCO for aldehyde $CH_3COCH_2CH_3$ Do not award displayed, semi-displayed or skeletal formulas but ignore these if correct structural formula is shown. Type of isomerism not needed for M2 but penalise if incorrect M2 cq on M1 Accept just one C_4H_8O if stated they have the same molecular formula	**(2)**

(Total for Question 6 = 19 marks)

Question Number	Answer		Additional Guidance	Mark
7(a)(i)	An explanation that makes reference to the following points: • high(er) temperature gives faster reaction because more particles have energy greater than E_a • a lower temperature gives greater yield because the reaction is exothermic/eqm shifts to the rhs • compromise temperature needed between rate and yield	**(1)** **(1)** **(1)**	Allow reverse argument Allow particles have more energy/there are more frequent or successful collisions 'Shift in equilibrium' without effect on yield does not score Ignore references to cost Do not award compromise unless it relates to rate vs yield	**(3)**

Question Number	Answer		Additional Guidance	Mark
7(a)(ii)	An explanation that makes reference to the following points: • high(er) pressure gives faster reaction / greater rate (of reaction) • high(er) pressure gives greater yield of products **and** the equilibrium favours the side with the least number of moles of gas • 140 atm is expensive because of energy cost to maintain a high pressure/ equipment cost to withstand high pressure **so** (140 atm) not used/lower pressure is used/ 90 atm is a compromise between rate/yield and cost.	 **(1)** **(1)** **(1)**	Allow reverse argument If reason is given, it must be correct Accept (equilibrium) shifts to the right/ 4 mol of gas goes to 2 mol of gas on the right 'higher pressure gives greater yield' without explanation does not score Must give a reason for high cost (either energy or equipment) to score. Do not award just 'compromise' It must relate to cost vs rate and/or yield Ignore references to danger or safety	**(3)**

Question Number	Answer	Additional Guidance	Mark
7(b)(i)		Example of suitable Maxwell-Boltzmann diagram  	(4)
	• vertical axis labelled: number of molecules (with energy, *E*) **(1)**	Accept fraction/amount for number Allow proportion Allow particles/atoms for molecules	
	• horizontal axis labelled: **(1)**	Accept (kinetic) energy, (*E*)/ E_k	
	• approx. correct shape of curve: **(1)** (i) asymmetric and starts at origin (ii) approaches E axis asymptotically	Line must not touch axis	
	• $\boldsymbol{E}_a$(cat) and $\boldsymbol{E}_a$(uncat) both identified, with E_a(uncat) at a higher E than E_a(cat) **(1)**	Ea not near maximum If more than one curve is shown only M1 and M2 can score Energy level diagrams do not score	

Question Number	Answer		Additional Guidance	Mark
7(b)(ii) **Clip with (b)(i)**	An explanation that makes reference to the following points: • greater proportion / area of graph beyond catalysed Ea (compared to uncatalysed Ea) • (so) more molecules will have sufficient **energy** to react/ have **E** > E_a	**(1)** **(1)**	Must refer to the graph for mark Do not award if more than one curve shown in (i) 'Catalyst reduces E_a by providing alternative pathway' on its own does not score. allow "more molecules have the activation energy (or greater)" Need to mention energy to score Both points may be shown on the diagram but shaded areas on their own do not score – there needs to be a suitable label or a comment	**(2)**

(Total for Question 7 = 12 marks)

Question Number	Answer	Mark
8(a)(i)	**The only correct answer is C** ($K_c = \frac{[H_2]^3[CO]}{[H_2O][CH_4]}$) ***A*** *is incorrect because the concentration of H_2 should be cubed* ***B*** *is incorrect because the concentration of H_2 should be cubed and the expression is inverted* ***D*** *is incorrect because the expression is inverted*	**(1)**

Question Number	Answer	Mark
8(a)(ii)	**The only correct answer is C** (6) ***A*** *is incorrect because this is the quantity made in an 8 hour period without the catalyst* ***B*** *is incorrect because this is the quantity made in an 8 hour period with the catalyst divided by the quantity made in the same period without a catalyst* ***D*** *is incorrect because this is the quantity made in an 8 hour period with the catalyst*	**(1)**

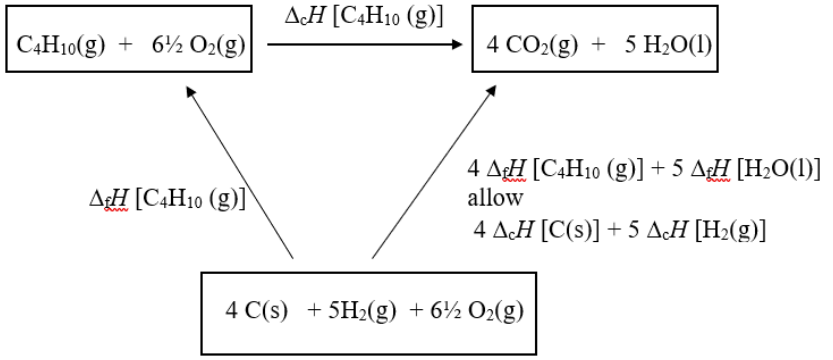
Question Number	Answer	Additional Guidance	Mark
8(b)(i)	An answer that makes reference to the following point: • heterogeneous means the catalyst is in a different state / phase to the reactants	Allow solid rather than gas but do not award just 'solid'	**(1)**

Question Number	Answer	Additional Guidance	Mark
8(b)(i)	An answer that makes reference to the following point: • heterogeneous means the catalyst is in a different state / phase to the reactants	Allow solid rather than gas but do not award just 'solid'	**(1)**

Question Number	Answer		Additional Guidance	Mark
8(b)(ii)	A description that makes reference to the following points:			**(2)**
	• (catalyst) provides a surface for the reaction to occur	**(1)**	Accept reactants adsorbed on surface /reactants bind to the surface	
	• lowers the activation energy / weakens the bonds/ holds reactants in place (to make collisions easier)	**(1)**	Just "different pathway with lower Ea" does not score M2 unless M1 scored	

Question Number	Answer	Additional Guidance	Mark
8(b)(iii)	An answer that makes reference to three of the following points: • nitrogen oxides are converted to nitrogen (and oxygen) **(1)** • carbon monoxide is converted to carbon dioxide **(1)** • (unburnt) hydrocarbons are converted to carbon dioxide and water **(1)** • Particulates/carbon/soot are converted to carbon dioxide **(1)**	Any / each marking point may be shown using a chemical equation Accept formulas instead of names Allow changed / reduced Do not award N for nitrogen Allow changed / oxidised Allow named hydrocarbons Allow changed / oxidised Allow changed / oxidised $2NO + 2CO \rightarrow N_2 + 2CO_2$ or reaction in words scores M1 and M2 If the products are not given, or if no marks are scored, then allow 2 marks for four named pollutants (including CO_2 and SO_2) or 1 mark for three named pollutants	**(3)**

(Total for Question 8 = 8 marks)

Question Number	Answer	Additional Guidance	Mark
9(a)(i)	• correct elements and states **(1)** • balancing **(1)** • arrows in the correct directions **(1)** • labelling of the arrows **(1)**	<u>Example of suitable enthalpy cycle</u>  $4C(graphite/s) + 5H_2(g) + 6½O_2(g)$ For M1 and M2 allow 6 ½ O_2 next to arrows instead but O_2 must be present and balanced correctly Both arrows pointing upwards Accept one or two arrows on the right hand side but only one on the left Allow values from the table instead of expressions Penalise incorrect balancing once only in M2 or M4	**(4)**

Question Number	Answer	Additional Guidance	Mark
9(a)(ii)	• ΔH for right hand side arrow **(1)** • correct use of data **(1)** • correct evaluation and sign and units **(1)**	<u>Example of calculation</u> $(4 \times -394) + (5 \times -286) = -3006$ (kJ mol^{-1}) Can be shown in equation No TE for incorrect cycle $-3006 + 2877$ (kJ mol^{-1}) TE from M1 -129 kJ mol^{-1} TE from M1 only -129 kJ mol^{-1} with some working scores (3) (+)129 kJ mol^{-1} scores (2)	**(3)**

Question Number	Answer	Additional Guidance	Mark
9(b)	An answer that makes reference to two of the following points: • pressure = 100 / 10^2 kPa **(1)** • reactants and products in their normal/standard states (under standard conditions) **and** specified temperature / 298 K **(1)**	Accept 100 000 Pa /101 000 Pa/ 101 kPa / 1 atm If more than one temperature or pressure given, then both must be right Ignore reference to concentration of solutions Ignore moles of reactants/products	**(2)**

(Total for Question 9 = 9 marks)

TOTAL FOR PAPER = 80 MARKS

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