

- 1) C (1)
 2) A (1)
 3) D (1)
 4) C (1)
 5) C (1)
 6) B (1)
 7) B (1)
 8. a) C (1)
 8. b) D (1)
 9) D (1)
 10) B (1)
 11) C (1)
 12)

(a)(i)	$\text{(Amount CO}_2 = 0.0584 \text{ dm}^3 \div 24 \text{ dm}^3 \text{ mol}^{-1})$ $= 0.0024333/2.4333 \times 10^{-3} \text{ (mol)}$ <p>IGNORE sf except 1 No working needed Mark final answer</p>	$0.002/2 \times 10^{-3}$ <p>or any other value</p> <p>WRONG units with correct numerical answer scores (0)</p>	1
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Question number	Acceptable Answers	Reject	Mark
(a)(ii)	<p>First mark: amount CO₂ = amount NaHCO₃ OR use of candidate's answer to (a)(i) stated (or implied by final answer given) (1)</p> <p>Second mark: $\therefore \text{mass NaHCO}_3 = 0.0024333 \text{ (mol)} \times 84 \text{ (g mol}^{-1})$ $= 0.2044 \text{ (g)}$ ALLOW 0.2 (g)</p> <p>This mark is for evidence of multiplying their moles of NaHCO₃ by 84 (1)</p> <p>IGNORE sf including 1 sf</p> <p>Correct answer with no working scores (2)</p> <p>ALLOW consequentially from (i).</p>		2

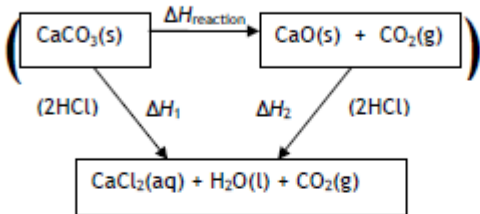
(a)(iii)	<p>% purity = $(0.2044 \text{ g} \times 100) \div 0.227 \text{ g} = 90.04 \%$ (1) = 90% (1) (2 sf only)</p> <p>ALLOW consequentially from (i) and (ii)</p> <p>NOTE: The second mark to be awarded for 2sf answers less than a 100% (e.g. 10% scores (1)). This is the percentage impurity</p> <p>Correct answer with no working scores (2)</p> <p>Can score both marks via moles rather than masses</p>	<p>Answers not to 2 sf or answers incorrectly rounded up do not score 2nd mark</p> <p>Answers > 100% score (0) overall</p>	2
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b)(i)	<p>$0.4 / 58.4 \times 100 = (\pm) 0.68493(\%)$ IGNORE sf (including 1 sf so $(\pm) 0.7 (\%)$ is OK here)</p>	<p>$(\pm) 1.37 (\%)$ etc., as the uncertainty should NOT be doubled Answers incorrectly rounded (e.g. 0.684 / 0.67 / 0.68492)</p>	1
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Question number	Acceptable Answers	Reject	Mark
b)(ii)	<p>Any one of:- CO₂ dissolves /soluble (in water) CO₂ reacts (with water) / CO₂ forms carbonic acid / $\text{CO}_2 + \text{H}_2\text{O} \rightarrow \text{H}_2\text{CO}_3$</p> <p>ALLOW CO₂ absorbed (by water)</p> <p>IGNORE suggestions to use a gas syringe</p>	<p>"CO₂ not the only gas given off"</p> <p>CO₂ diffuses/is lost/mixes with water</p> <p>"Water is also a product of the experiment"</p> <p>"Suck-back"</p>	1

13)

(a)(i)	$\text{CaCO}_3 + 2\text{HCl} \rightarrow \text{CaCl}_2 + \text{H}_2\text{O} + \text{CO}_2$ ALLOW multiples No other species to be allowed IGNORE state symbols even if incorrect	H_2CO_3 instead of " $\text{H}_2\text{O} + \text{CO}_2$ " on right hand side of equation	1
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Question number	Acceptable Answers	Reject	Mark
(a)(ii)	 <p>Mark each point independently</p> <p>First mark: All three formulae in box, ignoring state symbols (even if incorrect)</p> <p>This mark is stand alone, NOT to be marked CQ on answer to (a)(i) (1)</p> <p>Second mark: Two arrows, BOTH pointing downwards (1)</p> <p>Third mark: Left hand arrow labelled as ΔH_1 AND right hand arrow labelled ΔH_2 (whatever the direction of the arrows) (1)</p>	Any other formulae	3

Question number	Acceptable Answers	Reject	Mark
(a)(iii)	$(\Delta H_{\text{reaction}}) = \Delta H_1 - \Delta H_2$ This is a stand alone answer NOT to be marked CQ on (a)(ii) and/or (a)(i)	Any other expression	1

14(b)	<p>Any two from: Heat /energy loss OR Heat /energy loss to surroundings OR Heat /energy loss to apparatus (1) Measured under non-standard conditions (1) Specific heat capacity of solutions is approximate (1) Density of solution assumed to be 1 g cm⁻³/same as (pure) water (1) Large relative error in temperature measurement (1)</p>	<p>"Incomplete reaction" "Incomplete combustion" "Inaccuracy of equipment/apparatus" "Human error" CO₂ escapes Bond enthalpies Impurity of reactants Transfer losses Side-reactions</p>	2
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14)

(a)(i)	$\text{CH}_3\text{CH}_3 + \text{Cl}\cdot \rightarrow \text{CH}_3\text{CH}_2\cdot + \text{HCl}$ OR $\text{CH}_3\text{CH}_2\cdot + \text{Cl}_2 \rightarrow \text{CH}_3\text{CH}_2\text{Cl} + \text{Cl}\cdot$		1
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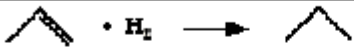

Question number	Acceptable Answers	Reject	Mark
(a)(ii)	$\text{CH}_3\text{CH}_2\cdot + \text{Cl}_2 \rightarrow \text{CH}_3\text{CH}_2\text{Cl} + \text{Cl}\cdot$ OR $\text{CH}_3\text{CH}_3 + \text{Cl}\cdot \rightarrow \text{CH}_3\text{CH}_2\cdot + \text{HCl}$ N.B. different answers for (i) and (ii) needed		1

Question number	Acceptable Answers	Reject	Mark
(a)(iii)	$2\text{CH}_3\text{CH}_2\cdot \rightarrow \text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3$ OR $\text{CH}_3\text{CH}_2\cdot + \text{Cl}\cdot \rightarrow \text{CH}_3\text{CH}_2\text{Cl}$	$\text{Cl}\cdot + \text{Cl}\cdot \rightarrow \text{Cl}_2$	1

Question number	Acceptable Answers	Reject	Mark
(a)(iv)	$\text{CH}_3\text{CH}_2\cdot + \text{Cl}\cdot \rightarrow \text{CH}_3\text{CH}_2\text{Cl}$ OR $2\text{CH}_3\text{CH}_2\cdot \rightarrow \text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3$ N.B. different answers for (iii) and (iv) needed		1

Question number	Acceptable Answers	Reject	Mark
5(b)	<p>First mark: Structural formula (enough to see the structure) of any polyhalogenated ethane derivative OR any polyhalogenated methane derivative</p> <p>ALLOW correct displayed or skeletal formula (1)</p> <p>Second mark: If first mark awarded the name must be consequentially correct</p> <p>IGNORE any missing or incorrect numbering in name (e.g. "dichloroethane" scores the mark)</p> <p>IGNORE missing or incorrect hyphens</p> <p>If first mark NOT awarded then only ALLOW correct name of any polyhalogenated ethane or polyhalogenated methane derivative (1)</p>	<p>Butane /C₄H₁₀ / CH₃CH₂CH₂CH₃ / chlorobutane / hexane / chloromethane</p>	2
5(c)(i)	<p>1st mark for HAZARD: This mark is for the idea of: (substance or procedure that) can cause harm/may cause harm/has the potential to do harm/can be dangerous</p> <p>ALLOW references to specific hazards such as toxic/flammable /harmful/ irritant /corrosive /oxidizing/ carcinogenic for the mark (1)</p> <p>2nd mark for RISK: This mark is for the idea of likelihood/probability/chance that harm will result (from the use of a substance or a procedure) (1)</p>	<p>Just "causes harm"/just "is a danger"</p>	2
5(c)(ii)	<p>fume cupboard OR gloves OR u.v. goggles</p>	<p>Just 'open windows'/Just well-ventilated lab/Just 'gas mask'/Just "use of smaller quantities"/closed system/closed experiment</p>	1

15)

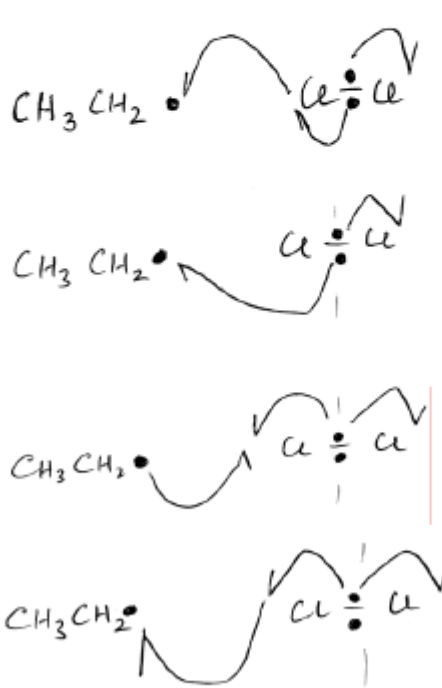
Question number	Acceptable Answers	Reject	Mark
(a)	<p>(C_nH_{2n} could be a) ring / cyclic (compound) ALLOW identification of any specific cyclic compound (e.g. cyclohexane)</p> <p>IGNORE any reference to "fewer hydrogen atoms"</p>		1
(b)(i)	 <p>All must be correct for the mark</p>		1
(b)(ii)	 <p>First mark:- An equation with the reactants shown correctly and EITHER 2-bromopropane OR 1-bromopropane shown as the product</p> <p>NOTE: The C-Br bond MUST be shown in the skeletal formula for the first mark</p> <p style="text-align: right;">(1)</p> <p>Second mark (stand alone, even if no equation attempted or left-hand side of equation incorrect):-</p> <p>Correct skeletal formula of 2-bromopropane</p> <p style="text-align: right;">(1)</p> <p>Penalise lack of skeletal formulae once only in (b)(i) and (b)(ii) when taken together</p>		2

mber i(c)	<p>both arrows (1)</p> <p>carbocation (1)</p> <p>attack of bromide ion (1)</p> <p>First mark: Curly arrow from C=C to H (in H-Br) AND curly arrow from bond in H-Br to the Br IGNORE polarity of HBr even if incorrect (1)</p> <p>Second mark: Structure of correct secondary carbocation (1)</p> <p>Third mark: Curly arrow from anywhere on the bromide ion towards the C⁺ on the carbocation</p> <p>NOTE: The bromide ion must have a full negative charge, but the lone pair of electrons on the Br⁻ NEED NOT be shown</p> <p>NOTE: A correct mechanism leading to the formation of 1-bromopropane scores the first and third marks only (so max (2))</p> <p>Skeletal formulae can be used</p>	3
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16)

i(a)	$\text{C}_2\text{H}_6(\text{g}) + 3\frac{1}{2}\text{O}_2(\text{g}) \rightarrow 2\text{CO}_2(\text{g}) + 3\text{H}_2\text{O}(\text{l})$ <p>Formulae and states (1)</p> <p>Balancing of correct entities (1)</p>	2 Multiples
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(b)	<p>Notice the first mark is for the equation and there are 3 separate additional marks for the calculation</p> $ \begin{array}{ccc} \text{H} & \text{H} & \\ & & \\ \text{H}-\text{C}-\text{C}-\text{H} & + & \text{Cl}-\text{Cl} \rightarrow \text{H}-\text{C}-\text{C}-\text{Cl} + \text{H}-\text{Cl} \\ & & \\ \text{H} & \text{H} & \end{array} $ <p>Check all bonds displayed especially Cl-Cl and H-Cl</p> <p>Calculation marks:</p> <p>+413 + 243 (1) (-)(346 + 432) (1)</p> <p>OR 656 (1) (-) 778 (1)</p> <p>= -122 (kJ mol⁻¹) (1)</p> <p>Fully correct answer to calculation with no working (3)</p> <p>Extra 5x413 and 347 may be included on both sides, giving 3068 and (-)3190</p> <p>Allow other same values(s) missing from both sides</p> <p>Bonds breaking (1)</p> <p>Bonds making (1)</p> <p>[Bonds breaking - bonds making] to give correct answer with sign (1)</p>	<p>Incorrect / no sign and / or incorrect units</p> <p>Incorrect units loses this mark</p>	4
(c)(i)	<p>Initiation (1)</p> <p>Allow homolysis / atomization / homolytic (fission)</p> <p>Ignore any reference to free radical substitution</p> <p>UV / (sun)light (1)</p> <p>Ignore reference to high temperature</p>	<p>Free radical substitution alone</p> <p>Photolysis</p>	2

(c)(ii)	<p> $\text{CH}_3\text{CH}_2\cdot + \text{Cl}-\text{Cl} \rightarrow \text{CH}_3\text{CH}_2\text{Cl} + \text{Cl}\cdot$ OR $\text{CH}_3\text{CH}_2\cdot + \text{Cl}-\text{Cl} \rightarrow \text{C}_2\text{H}_5\text{Cl} + \text{Cl}\cdot$ Both products correct including dot (1) Two half headed arrows showing homolytic breaking of Cl-Cl bond (1) Half headed arrow from radical to pair with a Cl arrow OR One arrow from chlorine bond clearly to ethyl radical (1) Arrows must be single-headed  The two dots in the covalent bond do not have to be shown </p>	3
(c)(iii)	<p> $\text{Cl}\cdot + \text{Cl}\cdot \rightarrow \text{Cl}_2$ (1) $\cdot\text{CH}_2\text{CH}_3 + \cdot\text{CH}_2\text{CH}_3 \rightarrow \text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3 / \text{C}_4\text{H}_{10}$ (1) $\cdot\text{CH}_2\text{CH}_3 + \text{Cl}\cdot \rightarrow \text{CH}_3\text{CH}_2\text{Cl}$ (1) Penalise missing dots once Allow $\cdot\text{C}_2\text{H}_5$ for $\cdot\text{CH}_2\text{CH}_3$ Di and tri substitution steps </p>	<p> 2 C_4H_{12} $\text{CH}_3\text{CH}_2\text{CH}_3\text{CH}_2$ </p>
Question Number (d)	<p> Acceptable Answers $\text{C}_2\text{H}_6 \rightarrow \text{C}_2\text{H}_4 + \text{H}_2$ Allow $2\text{C}_2\text{H}_6 \rightarrow \text{C}_2\text{H}_4 + 2\text{CH}_4$ </p>	<p> Reject </p>

number			
(e)	<p>Any two from:</p> <p>(It) produces (more) petrol / gasoline / diesel / jet fuel / LPG / liquid petroleum gas / fuel (1)</p> <p>Short chain alkanes / lighter fractions are more useful products (1)</p> <p>Demand is greater for shorter chain alkanes / lighter fractions / smaller molecules OR converts surplus of low demand fractions (1)</p> <p>It produces ethane / short chain alkenes for making poly(ethene) / ethane-1,2-diol / ethanol / plastics / polymers (1)</p> <p>Smaller alkanes give less pollution/burn more efficiently (1)</p> <p>Recycles waste products (1)</p> <p>As a source of hydrogen (1)</p> <p>NB examiners need to look carefully at the vowel in the middle of alkane / alkene / ethane / ethene if not clear do not give BOD</p>	<p>Points based on atom economy / renewable fuels alone</p> <p>Easier to transport / store</p> <p>Short chain alkenes / ethene more useful alone</p> <p>Recycles alone</p>	2