AQA GCSE Chemistry | 8462

SPECIFICATION POINT 4.5.1.3

The energy change of reactions (HT only)

Mark schemes and examiner comments

Tier	**Higher**
Question groups	**15**
Available paper years	**2008–2025**

Using this booklet

1. Booklet answer numbers match the question booklet.
2. Use the original question number within marking tables.
3. Examiner comments are included where available.

Name: _____ **Date:** _____

Where a precise marking extract is unavailable, the full source document is included in an appendix. Any missing mark scheme is explicitly identified.

4.5.1.3 The energy change of reactions (HT only)

Answer 01 · Mark scheme

June 2008 | CHY3H | Original Q7 | Legacy

question	answers	extra information	mark
7(a)(i)	energy / heat of products less than energy of reactants	owtte allow products are lower than reactants allow more energy / heat given out than taken in allow methanol is lower allow converse allow energy / heat is given out / lost allow ΔH is negative	1
7(a)(ii)	lowers / less activation energy	owtte allow lowers energy needed for reaction **or** it lowers the peak/ maximum do **not** allow just 'lowers the energy'	1
7(b)(i)	bonds broken: (2 × 435) + 498 = 1368 bonds made: (2 × 805) + (2 × 464) = 2538 energy change: 1368 – 2538 = (–)1170	 allow: (8 × 435) + 498 = 3978 allow: (6 × 435) + (2 × 805) + (2 × 464) = 5148 allow: 3978 – 5148 = (–)1170 ignore sign allow ecf correct answer (1170) = **3** marks	1 1 1
7(b)(ii)	energy released forming new bonds is greater than energy needed to break existing bonds owtte	allow converse do **not** accept energy needed to form new bonds greater than energy needed to break existing bonds	1
Total			**6**

4.5.1.3 The energy change of reactions (HT only)

Answer 01 · Mark scheme

June 2008 | CHY3H | Original Q7 | Legacy

COMPONENT NUMBER: CHY3H

COMPONENT NAME: Chemistry

STATUS: Final

DATE: June 2008

4.5.1.3 The energy change of reactions (HT only)

Answer 02 · Mark scheme

January 2010 | CHY3H | Original Q6 | Legacy

Question 6

question	answers	extra information	mark
6(a)	energy of product greater than energy of reactants	allow converse allow energy = heat do **not** accept temperature for energy allow product / nitrogen oxide is higher than reactants allow less energy / heat given out than taken in allow energy / heat is taken in / gained allow ΔH is positive	1
6(b)	(minimum) energy needed to start the reaction / overcome energy barrier	accept (minimum) energy needed for a collision to be successful	1
6(c)(i)	bonds broken = 945 + 498 = 1443 (kJ) bonds made = 2 × 630 = 1260 (kJ) energy change = 1443 – 1260 = (+) 183	correct answer with or without working = **3** marks ignore sign allow ecf	1 1 1
6(c)(ii)	energy released forming new bonds is less than energy needed to break existing bonds owtte	allow converse accept energy change(ΔH) is + / positive do **not** accept energy <u>needed to form new bonds</u> is less than energy needed to break existing bonds	1
Total			**6**

4.5.1.3 The energy change of reactions (HT only)

Answer 02 · Mark scheme January 2010 | CHY3H | Original Q6 | Legacy

CHY3H

4.5.1.3 The energy change of reactions (HT only)

Answer 03 · Mark scheme

January 2011 | CHY3H | Original Q7 | Legacy

Question 7

question	answers	extra information	mark
7(a)		correct answer with or without working = **3** marks	
	M1: (bonds broken) = 2148 (kJ)		1
	M2: (bonds made) = 2354 (kJ)		1
	M3: change in energy = (–) 206 (kJ)	ecf ignore sign	1
7(b)	energy released from forming new bonds is greater than energy needed to break existing bonds	allow the energy needed to break bonds is less than the energy released in forming bonds do **not** accept energy needed to form bonds	1
Total			**4**

4.5.1.3 The energy change of reactions (HT only)

Answer 04 · Mark scheme

June 2011 | CHY2H | Original Q4 | Legacy

Question 4

question	answers	extra information	mark
4(a)	gives out heat / energy **or** energy / heat transferred to surroundings	allow more energy given out in making bonds than is used in breaking bonds ignore light	1
4(b)	activation	allow phonetic spelling	1
4(c)(i)	2 crosses on inner circle **and** 8 crosses on outer circle	accepts dots / e / — for electrons	1
4(c)(ii)	opposite charges (attract)	allow electrostatic forces (attract) do **not** accept intermolecular attraction / shared electrons	1
Total			**4**

4.5.1.3 The energy change of reactions (HT only)

Answer 04 · Mark scheme

June 2011 | CHY2H | Original Q4 | Legacy

CHY2H

4.5.1.3 The energy change of reactions (HT only)

Answer 05 · Mark scheme

Question 4

question	answers	extra information	mark
4(a)	energy released from making (new) bonds is greater than the energy needed to break (existing) bonds	accept the energy needed to break (existing) bonds is less than the energy released in making (new) bonds do **not** accept energy needed to make bonds	1
4(b)(i)	energy / heat of products less than energy of reactants	accept products are lower than reactants **or** reactants higher than products accept more energy / heat given out than taken in **or** less energy / heat taken in than given out accept energy / heat is given out / lost (to the surroundings) allow produce heat ignore produce energy accept △H is negative **or** energy change / **A** is negative **or B** is less than **C**	1
4(b)(ii)	**B** is (very) high / large	it = **B** ignore energy change **C** is high	1
4(b)(iii)	(MnO_2) catalyst (is added) **or** reaction catalysed (by MnO_2) which lowers activation energy **or** which lowers (energy change) **B**	it = MnO_2 accept it is a catalyst do **not** accept MgO / magnesium oxide accept provides alternative / lower energy pathway if hydrogen peroxide is given as a catalyst instead of MnO_2 penalise once only in question	1 1

Question 4 continues on the next page

4.5.1.3 The energy change of reactions (HT only)

Question4 continued

question	answers	extra information	mark
4(c)	any **two** from: • (chemicals) not mixed / stirred • heat / energy lost (from apparatus) • (apparatus) not insulated **or** no lid • low amount / mass / not enough MnO_2 **or** low concentration H_2O_2 • thermometer read incorrectly	ignore other experimental error	2
Total			**7**

4.5.1.3 The energy change of reactions (HT only)

Answer 05 · Mark scheme

June 2011 | CHY3H | Original Q4 | Legacy

CHY3H

4.5.1.3 The energy change of reactions (HT only)

Answer 06 · Mark scheme

Question 7

question	Answers	extra information	Mark
7(a)(i)	ΔT = (64 – 17) = 47 °C		1
	750 x 4.2 x 47	allow ecf using their ΔT	1
	148 050	correct answer gains **3 marks** with **or** without working ignore sign allow 148.05kJ allow 148kJ	1
7(a)(ii)	1085.7	correct answer gains **2** marks with or without working. allow answer in range 1080 – 1089 for **2 marks** allow answer in range 1080000 – 1089000 for **1 mark** if answer is incorrect allow 6/44 = 0.136 mol for **1 mark** allow (44 x their 7(a)(i))/(6 x 1000) correctly calculated for **2 marks** allow (44 x their 7(a)(i))/6 correctly calculated for **1 mark** If they have used the given value of 144 000: Allow any answer in range 1051 - 1059 for **2 marks** with or without working. allow any answer in range 1051000 – 1059000 for **1 mark**	2

Question 7 continues on the next page

Question 7 continued

question	Answers	extra information	Mark
7(a)(iii)	repeat the experiment and then calculate the mean any **one** from: • use a lid • insulate the beaker • stir • prevent draughts	 do **not** allow flammable insulation	1 1
7(a)(iv)	inaccuracies likely to have similar effects	allow systematic errors	1
7(b)(i)	8530	correct answer gains 3 marks with or without working. If answer is incorrect; (6 x 803) = 4818 gains 1 mark (8 x 464) = 3712 gains 1 mark correct addition of their calculated values gains 1 mark (ecf)	3
7(b)(ii)	(6481 – 8530) = (-)2049	ignore sign allow ecf from 7(b)(i)	1
Total			**12**

UMS Conversion Calculator: www.aqa.org.uk/umsconversion

4.5.1.3 The energy change of reactions (HT only)

Answer 07 · Mark scheme June 2014 | CH3HP | Original Q6 | Legacy

Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID
6(a)	electrical		1	1 / 3.3.1i	G
6(b)	using hydrogen saves petrol / diesel / *crude oil* *using hydrogen (in fuel cells) does not cause pollution*	allow crude oil is non-renewable *ignore hydrogen is renewable* accept no carbon dioxide produced *allow less carbon dioxide produced* *allow hydrogen produces only water*	1 1	3 / 3.3.1i	E
6(c)(i)	(–)486	correct answer with or without working gains **3** marks if answer is incorrect: (2 x 436) + 498 **or** 1370 gains **1** mark 4 x 464 **or** 1856 gains **1** mark *correct subtraction of ecf* gains **1** mark	3	2 / 3.3.1f	E
6(c)(ii)	products lower than reactants *reaction curve correctly drawn* activation energy labelled		1 1 1	1 + 2 / 3.3.1d	E
Total			**9**		

4.5.1.3 The energy change of reactions (HT only)

Answer 07 · Mark scheme

June 2014 | CH3HP | Original Q6 | Legacy



4.5.1.3 The energy change of reactions (HT only)

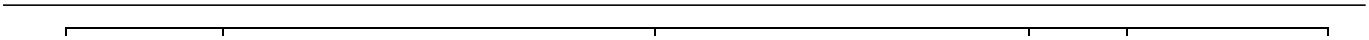
Answer 08 · Mark scheme June 2016 | CH3HP | Original Q5 | Legacy

Question	Answers	Extra information	Mark	AO / SpecRef
5(a)	CH_4 + $2O_2$ → CO_2 + $2H_2O$	allow multiples	1	AO2 3.3.1a
5(b)	3444 J	if answer incorrect: one mark for temperature increase = 16.4 °C one mark for mass of water = 50 g ecf for one incorrect value gains two marks for correct calculation no ecf for two incorrect values	3	AO2 3.3.1a
5(c)(i)	1276 (kJ per mole)	ignore + or - if answer incorrect: [(5 x 413) + 347 + 358 +467] + [(3 x 495)] = 4722 (1 mark) [(4 x 799) + (6 x 467)] = 5998 (1 mark) correct subtraction of calculated energy values (1 mark)	3	AO2 3.3.1f
5(c)(ii)	because energy released when bonds form is greater than energy used when bonds broken	allow converse if no mark awarded allow one mark for energy is used to break bonds or one mark for energy is released when bonds form	2	AO1 3.3.1e,f
5(c)(iii)	products line lower than reactants activation energy labelled overall energy change labelled		1 1 1	2AO2 / 1AO3 3.3.1d
Total			**12**	

4.5.1.3 The energy change of reactions (HT only)

Answer 08 · Mark scheme

June 2016 | CH3HP | Original Q5 | Legacy



4.5.1.3 The energy change of reactions (HT only)

Answer 09 · Mark scheme June 2017 | CH3HP | Original Q6 | Legacy

Question	Answers	Extra information	Mark	AO / Spec. Ref.
6(a)(i)	natural gas or water / steam	allow methane / crude oil / petroleum ignore processes	1	**AO1** 3.5.1a
6(a)(ii)	cool to any temp in the range -33 to -196 °C because (at this temperature) ammonia becomes a liquid **or** ammonia condenses		1 1	**AO1** **AO3** 3.5.1b
6(b)(i)	81(kJ)	ignore sign ((4 x 391 + 160) =) 1724 for 1 mark, and ((2 x 432 + 941) =) 1805 for 1 mark correct subtraction using one correct value for 1 mark	3	**AO2** 3.3.1f
6(b)(ii)	because energy taken in to break bonds is less than energy given out when bonds form	allow converse	1 1	**AO1** 3.3.1e,f
Total			**8**	

4.5.1.3 The energy change of reactions (HT only)

Answer 10 · Mark scheme

June 2018 | 8462/1H | Original Q7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.1	potassium chloride **and** iodine	either order allow KCl for potassium chloride and I_2 for iodine	1	AO1 4.1.2.6
07.2		allow converse statements allow energy levels for shells throughout		AO1 4.1.2.6
	(chlorine's) outer electrons / shell closer to the nucleus	allow chlorine has fewer shells allow chlorine atom is smaller than iodine atom ignore chlorine has fewer outer shells	1	
	(so) the chlorine nucleus has greater attraction for outer electrons / shell	allow chlorine has less shielding do **not** accept incorrect types of attraction	1	
	(so) chlorine gains an electron more easily	**maxf 2** marks can be awarded if the answer refers to chloride / iodide instead of chlorine / iodine	1	
07.3	hydrogen chloride is made of small molecules	allow hydrogen chloride is simple molecular	1	AO1 4.1.2.6 4.2.1.4
	(so hydrogen chloride) has weak intermolecular forces	do **not** accept reference to bonds breaking unless applied to intermolecular bonds	1	4.2.2.4
	(intermolecular forces) require little energy to overcome		1	

4.5.1.3 The energy change of reactions (HT only)

Answer 10 · Mark scheme

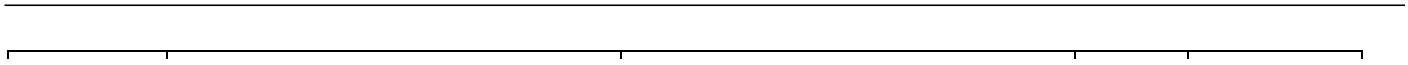
June 2018 | 8462/1H | Original Q7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.4		an answer of 290 (kJ/mol) scores **4** marks an answer of 188 (kJ/mol) scores **3** marks an incorrect answer for one step does **not** prevent allocation of marks for subsequent steps		AO2 4.5.1.3
	(bonds broken = 4(412) + 193 =)1841		1	
	(bonds formed = 3(412) + 366 + **X** =) 1602 + **X**		1	
	−51 = 1841 − (1602 + **X**)	allow use of incorrectly calculated values of bonds broken and / or bonds formed from steps 1 and 2 for steps 3 and 4	1	
	(X =) 290 (kJ/mol)	allow a correctly calculated answer from use of −51 = bonds formed – bonds broken	1	
	OR alternative method ignoring the 3 unchanged C–H bonds (412 + 193 =) 605 (1) 366 + **X** (1) −51 = 605 − (366 + **X**) (1) (**X** =) 290 (kJ/mol) (1)			
Total			**11**	

4.5.1.3 The energy change of reactions (HT only)

Answer 10 · Mark scheme

June 2018 | 8462/1H | Original Q7

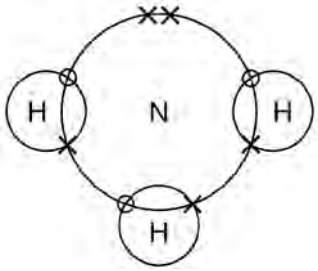


4.5.1.3 The energy change of reactions (HT only)

Answer 11 · Mark scheme

June 2019 | 8462/1H | Original Q5

Question 5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1		 scores **2** marks allow dots, crosses, circles or $e^{(-)}$ for electrons		AO1 4.2.1.4
	1 bonding pair of electrons in each overlap		1	
	2 non-bonding electrons on nitrogen	do **not** accept non-bonding electrons on hydrogen ignore inner shell electrons drawn on nitrogen	1	
05.2	does not show the shape **or** only two-dimensional	allow is not three-dimensional	1	AO1 4.2.1.4
05.3	(ammonia has) small molecules	allow (ammonia has) a simple molecular (structure)	1	AO1 4.2.2.1 4.2.2.4
	(ammonia has) weak intermolecular forces	allow (ammonia has) weak intermolecular bonds do **not** accept weak covalent bonds	1	
	(so) little energy is needed to overcome the intermolecular forces	allow (so) little energy is needed to break the intermolecular bonds allow (so) little energy is needed to separate the molecules do **not** accept references to breaking covalent bonds	1	

4.5.1.3 The energy change of reactions (HT only)

Answer 11 · Mark scheme

June 2019 | 8462/1H | Original Q5

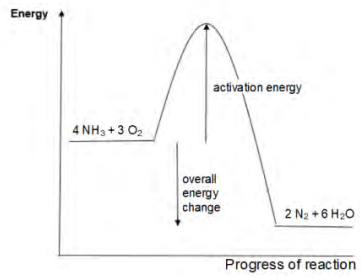
05.4	Cr_2O_3		1	AO2 4.1.3.2
05.5	(for bonds broken) ((12 x 391) + (3 x 498) =) 6186 (for bonds made) ((2 x 945) + (12 x 464) =) 7458 (overall energy change = 6186-7458 =) (-)1272 (kJ)	an answer of (-)1272 (kJ) scores **3** marks allow correct calculation using incorrectly calculated values from step 1 and/or step 2	1 1 1	AO2 4.5.1.3

4.5.1.3 The energy change of reactions (HT only)

Answer 11 · Mark scheme

June 2019 | 8462/1H | Original Q5

Question 5 continued

05.6	7458 (kJ) (released in making bonds) is greater than 6186 (kJ) (used in breaking bonds) **or** the products have 1272 (kJ) less energy than the reactants	allow ecf from question **05.5** allow the (overall) energy change is -1272 (kJ)	1	AO2 4.5.1.3
	(so) energy is released (to the surroundings)	dependent on MP1 being awarded allow (so) heat is released (to the surroundings) if no values given, allow **1** mark for more energy released in making bonds than used in breaking bonds	1	
05.7		 scores **2** marks allow discontinuous lines ignore arrow heads		AO1 4.5.1.2
	activation energy labelled		1	
	(overall) energy change labelled		1	
Total			**14**	

4.5.1.3 The energy change of reactions (HT only)

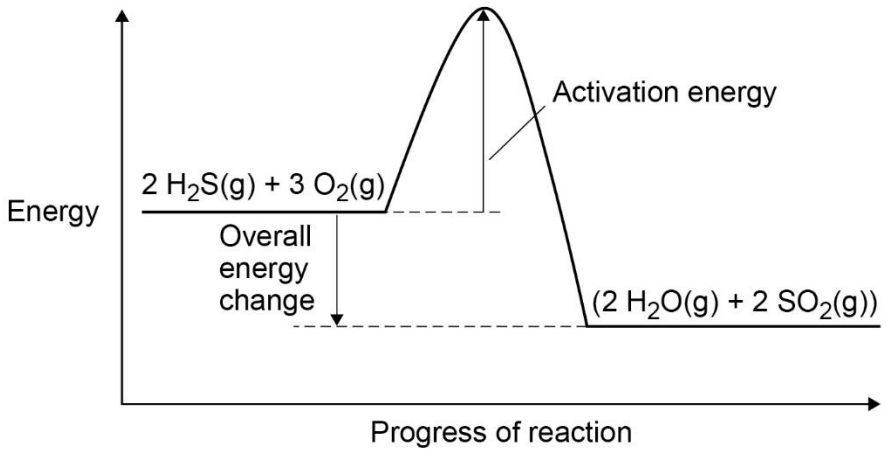
Answer 12 · Mark scheme

November 2021 | 8462/1H | Original Q8

Question 8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.1	water vapour	allow steam allow gaseous water	1	AO1 4.1.1.1 4.2.2.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.2	75 (cm^3)		1	AO2 4.3.5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.3	product level below reactants activation energy drawn and labelled overall energy change drawn and labelled  scores **3** marks	ignore labelling of products if endothermic profile drawn allow corresponding overall energy change	1 1 1	AO1 4.5.1.2

Question 8 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.4	(bonds broken = 4(364) + 3(498) =) 2950		1	AO2 4.5.1.3
	(bonds formed = 2950 + 1034 =) 3984	allow correct use of incorrectly calculated values of bonds broken	1	
	4**X** + 4(464) = 3984	allow correct use of incorrectly calculated values of bonds formed	1	
	4**X** = **(**3984 – 1856 =) 2128		1	
	X = 532 (kJ/mol)		1	
	alternative approach: (bonds broken = 4(364) + 3(498) =) 2950 (1)			
	(bonds formed = 4(464) + 4**X** =) 1856 + 4**X** (1)			
	(1856 + 4**X**) – 2950 = 1034 (1)	allow correct use of incorrectly calculated values of bonds broken and/or bonds formed		
	4**X** = (1034 + 2950 – 1856 =) 2128 (1)			
	X = 532 (kJ/mol) (1)			

Total			10

4.5.1.3 The energy change of reactions (HT only)

Answer 13 · Mark scheme

June 2023 | 8462/1H | Original Q4

Question 4

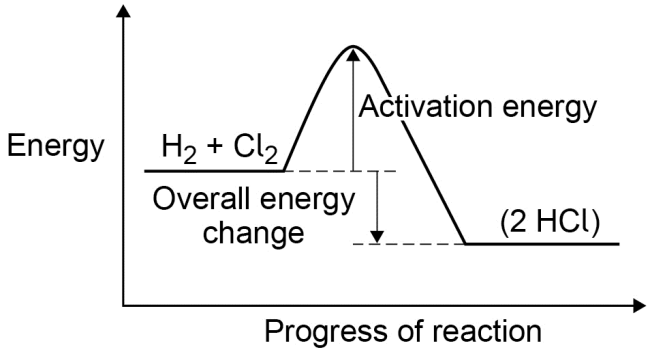
Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	436 + 346 − (2 × 432) kJ/mol		1	AO2 4.5.1.3

Question	Answers	Extra	Mark	AO / Spec. Ref.
04.2	energy is needed to break bonds **and** energy is released when bonds form		1	AO1 4.5.1.3
	(and) the energy released is greater than the energy needed	allow the energy transferred in bond making is greater than the energy transferred in bond breaking allow 2 x 432 (kJ/mol) is greater than 436 + 346 (kJ/mol) allow the overall energy change is negative	1	

4.5.1.3 The energy change of reactions (HT only)

Answer 13 · Mark scheme

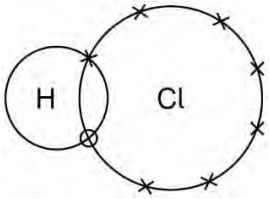
June 2023 | 8462/1H | Original Q4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.3		ignore arrow heads		
	profile completed with product energy below reactant energy		1	AO1
	activation energy labelled from reactant energy to top of curve		1	AO1
	overall energy change labelled from reactant energy to product energy		1	AO2 4.5.1.2
	an answer of  scores **3** marks			

4.5.1.3 The energy change of reactions (HT only)

Answer 13 · Mark scheme

June 2023 | 8462/1H | Original Q4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.4		allow any combination of x, o, $e^{(-)}$, • for electrons do **not** accept molecules containing more than 2 atoms		AO1 4.2.1.4
	bonded pair of electrons in the overlap		1	
	chlorine with 6 non-bonded electrons	do **not** accept if extra electrons on H an answer of  scores **2** marks **or** an answer of  scores **2** marks	1	

4.5.1.3 The energy change of reactions (HT only)

Answer 13 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.5	(methane) methane has (much) smaller molecules		1	AO1 4.2.2.4 4.2.2.5
	(so) has weaker intermolecular forces	do **not** accept reference to weak(er) covalent bonds	1	
	(so the intermolecular forces) need less energy to overcome	do **not** accept reference to breaking covalent bonds	1	
	(so) the boiling / melting point is lower (and methane is a gas) **OR** (poly(ethene)) poly(ethene) has (much) larger molecules (1)		1	
	(so) has stronger intermolecular forces (1)	do **not** accept reference to weak(er) covalent bonds		
	(so the intermolecular forces) need more energy to break (1)	do **not** accept reference to breaking covalent bonds		
	(so) the melting / boiling point is higher (and poly(ethene) is a solid) (1)			

Total Question 4	12

4.5.1.3 The energy change of reactions (HT only)

Answer 14 · Mark scheme

June 2024 | 8462/1H | Original Q8

Question 8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.1	propane is a small molecule	allow propane is a simple molecule	1	AO1 4.2.1.4 4.2.2.1 4.2.2.4
	(so) the forces between molecules are weak **or** (so) the intermolecular forces are weak	do **not** accept covalent bonds are weak	1	
	(which) require little energy to overcome	do **not** accept answers in terms of breaking covalent bonds	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.2	**B**		1	AO1 4.5.1.2

4.5.1.3 The energy change of reactions (HT only)

Answer 14 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.3	(bonds broken = 2(347) + 8**X** + 5(498) =) 3184 + 8**X**		1	AO2 4.5.1.3
	(bonds made = 6(805) + 8(464) =) 8542		1	
	(energy released = bonds made – bonds broken =) 2219 = 8542 – (3184 + 8**X**)	allow correct use of incorrectly determined values of bonds broken and/or bonds made	1	
	(8**X** =) 3139 (kJ/mol)	allow correct evaluation of the expression energy released = bonds broken – bonds made	1	
	(**X** =) 392 (kJ/mol)	allow 392.375 correctly rounded to at least 3 significant figures allow correct use of an incorrectly determined value for 8**X**	1	

Total Question 8	9

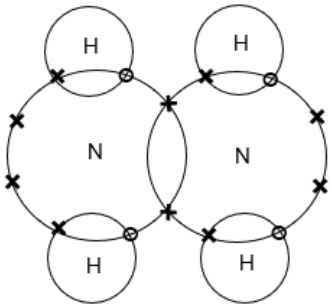
Question 7

Question	Answers	Mark	AO / Spec. Ref.
07.1	**Level 2:** A judgement, strongly linked and logically supported by a sufficient range of correct reasons, is given.	3–4	AO3 4.5.2.2
	Level 1: Some logically linked reasons are given. There may also be a simple judgement.	1–2	
	No relevant content	0	
	Indicative content • hydrazine is liquid so easier to store / transport o because takes up less space • both have significant dangers • both produce harmless products • hydrazine produces a higher voltage so fewer cells will be needed (to produce the same voltage) o so the battery would be lighter • hydrazine needs no catalyst so costs may be less • hydrogen uses platinum as a catalyst which is a rare metal • judgement		

4.5.1.3 The energy change of reactions (HT only)

Answer 15 · Mark scheme

June 2025 | 8462/1H | Original Q7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.2		allow any combination of x, o, $e^{(-)}$, ● for electrons		AO2 4.2.1.4
	bonded pair of electrons in each overlap		1	
	each nitrogen atom with 2 non-bonded electrons	do **not** accept if extra electrons on hydrogen atom(s) MP2 is dependent upon the award of MP1 an answer of  scores **2** marks	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.3	(the ball and stick model) shows the shape (of the molecule) **or** (the ball and stick model) is 3-D		1	AO1 4.2.1.4

4.5.1.3 The energy change of reactions (HT only)

Answer 15 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.4	(bonds broken = (4 × 391) + 498 + **X** =) 2062 + **X**		1	AO2 4.5.1.3
	(bonds formed = 945 + (4 × 464) =) 2801		1	
	581 = 2801 - (2062 + **X**)	allow correct use of incorrectly determined values of bonds broken and / or bonds made	1	
	(X =) 158 (kJ/mol)		1	

Total Question 7	11

Answer 10 · Examiner comments

June 2018 | 8462/1H | Original Q7

Question 7 (standard / high and high demand)

07.1 This question was answered well by the majority of students, with 68% giving a correct answer. The most common error was to give only one of the products, usually potassium chloride.

07.2 Although this historically is a well-known area of the specification, lack of precision in answers cost some students greatly. 16% of students achieved all three marks, with 72% gaining some credit.

The electrons are not (all) closer to the nucleus in chlorine – the **outer** electrons are. The relevant force of attraction is between the **outer** electrons and the **nucleus**, and is not intermolecular, magnetic or gravitational. Attracting another electron is not the same as **gaining** it.

07.3 This was another difficult question with 51% of students gaining no marks at all. 9% of students achieved all three. Few described the structure correctly. 'Simple covalent' only refers to the bonding; the structure needed to be described as small molecules, as in the specification, or as simple molecular (to distinguish it from large molecules or giant structures).

Some answers started well, referring to weak intermolecular forces, but then moved into talking about breaking bonds, for example 'it has weak intermolecular forces so little energy is needed to break the bonds'. Again, language was an issue, with statements such as 'hydrogen chloride is a covalent bond' failing to gain any credit. Some students stated that hydrogen chloride is ionic (but often then referred to intermolecular forces), or did not refer to hydrogen chloride at all, instead couching their answer in terms of hydrogen and chlorine.

07.4 This question was answered well, with 73% students achieving three or four marks.

It was often difficult to give partial credit as working was difficult to follow. Many students worked out the sum of the bonds broken as 1841 kJ/mol, but then said that the sum of the bonds made was 1602 kJ/mol rather than (1602 + X) kJ/mol. Many students then calculated their final answer based on energy change = bonds made – bonds broken, rather than the other way round.

Some students missed out on putting brackets around their (1602 + X) in their overall expression, making it incorrect. A decent number divided the bond enthalpies by 2 then subtracted one from another to get the difference, which they then added to another halved bond energy. This perhaps shows a misconception that the bond energy is associated with an atom rather than a bond.

Answer 11 · Examiner comments

June 2019 | 8462/1H | Original Q5

Question 5 (standard, standard / high and high demand)

05.1 Approximately three-quarters of students were able to complete the dot and cross diagram correctly.

The mark for the bonding electrons was scored more often than the mark for the non-bonding electrons.

05.2 Only a small proportion of students were able to give a limitation of a dot and cross diagram.

The most common correct response was that the molecule was not shown in 3 dimensions.

Common responses seen that were not credited included:

- only shows the outer electrons
- does not show the structure
- does not show the intermolecular forces.

05.3 Students found this question difficult.

The mark for indicating the presence of weak intermolecular forces was most often awarded. However, some students referred to 'intermolecular forces' incorrectly, for example, weak intermolecular forces between the atoms / bonds.

A common misconception was that covalent bonds are weak and that it is these bonds that are broken when ammonia boils.

Ammonia consisting of small molecules was the mark least often awarded.

05.4 Students found identification of a metal oxide most likely to be used as a catalyst difficult.

The correct answer, the transition metal oxide, Cr_2O_3, was the most common choice of catalyst but the other 3 options were all chosen in significant numbers, especially MgO.

05.5 Approximately two-thirds of students correctly calculated the overall energy change.

The most common error was to incorrectly determine, or not determine, the number of each type of bond from the given equation.

05.6 Students found this question challenging. In particular, students did not always use values from their previous calculation as instructed in the question. A common non-scoring response was simply to define an exothermic reaction.

Few students compared their calculated values for bond breaking and bond making as was intended. Some referred in general terms to these processes but often used incorrect terms, for example, more energy was <u>needed</u> for making bonds than used for breaking bonds.

4.5.1.3 The energy change of reactions (HT only)

Answer 11 · Examiner comments June 2019 | 8462/1H | Original Q5

05.7 The completion of the energy profile was often done well with almost two-thirds of students scoring both marks.

Some students were imprecise with the positioning of their lines.

Other common errors included:

- Not drawing a line for activation energy, just labelling the peak.
- Drawing a line from the peak to the products line for 'overall energy change'.

Answer 12 · Examiner comments November 2021 | 8462/1H | Original Q8

Question 8 (standard, standard / high and high demand)

08.3 Whilst there were many excellent answers, many were very carelessly drawn, with arrows for activation energy and overall energy change being placed so that their start and end were only vaguely near the correct levels. Dotted lines should be drawn to clarify the energy gaps. Some drew the profile for an endothermic change, rather than exothermic, and some did not complete the profile, leaving out the energy level of the products. Some appeared to think that the activation energy is the energy at the peak, rather than the difference between the energy of the reactants and the peak.

08.4 A good number of students were successful with this calculation, although some failed to count all of the bonds correctly. Where students made a slip of this nature, or an arithmetic error, it was sometimes impossible to award marks for following through with the method, since there was often a jumble of numbers scattered over the page with no words to explain what was going on. 'Bonds broken' and 'bonds made' should be stated in calculations of this type. Many students did not use the value of 1034 kJ/mol provided.

4.5.1.3 The energy change of reactions (HT only)

Answer 13 · Examiner comments

June 2023 | 8462/1H | Original Q4

Question 4 (standard and standard/high demand)

04.1 The great majority of students gave the correct answer, with most of the rest split evenly between the first option (adding the three bond energies together) and the third (subtracting only one H—Cl bond).

04.2 This question discriminated well and there were some excellent answers that described the energy released in making new bonds being greater than the energy required to break old bonds. However, some implied that energy is required in both steps, and others only referred to the bond making process, omitting a consideration of the bond breaking process. There were misconceptions with some students referring to gases being lost and taking energy with them, and others responding that an exothermic reaction is one that loses matter, rather than energy.

04.3 This question discriminated well; half of the students were awarded all three marks, while nearly all scored one mark. Most students drew an exothermic profile, but fewer labelled the products. Those who drew an endothermic profile could still access the second and third marking points. A few did not complete the profile so were only able to access the mark for the activation energy. There were some arrows for the activation energy and overall energy change that were untidily drawn which made it impossible to judge whether they started and finished at the correct place. This is one example where using a ruler really does help the student. A few labelled the top of the curve as the activation energy, rather than the gap between the energy of the reactants and the top of the curve.

04.4 Nearly three quarters of students scored both marks. Many fully correct diagrams were seen. The majority of students chose to use the format with a ring around each atom, but answer without rings were equally acceptable. A few students drew an extra electron on either hydrogen or carbon, and some drew ions instead of a molecule.

04.5 This question proved to be difficult, with few students giving fully correct answers to gain all 4 marks and with a third of students gaining no credit.

To answer the question, students needed to compare the size of the molecules, hence the strength of the intermolecular forces, hence the energy required to break those forces and hence the boiling/melting points. However, many students did not mention molecules at all, seeming to believe that the polymer is a giant structure. There was much confusion between bonds and intermolecular forces. Students sometimes think that by including both intermolecular forces and covalent bonds they will cover all eventualities, but this often results in contradictions which lose marks. Students often thought intermolecular forces had to be broken in methane but bonds had to be broken in poly(ethene). Many did not refer to the energy requirement or to the melting or boiling point.

4.5.1.3 The energy change of reactions (HT only)

Answer 14 · Examiner comments June 2024 | 8462/1H | Original Q8

Question 8 (standard, standard/high and high demand)

08.1 This question discriminated very well. Whilst more than a half of students scored at least one mark, only one in seven scored all three. Few students recognised that it is the structure of propane as small molecules that is important rather than it being a hydrocarbon with single bonds. Most did not mention the structure at all. Although many students used the term intermolecular forces, it was clear that many did not know what this phrase means as they referred to 'intermolecular forces between atoms' or 'between bonds.' These students did not gain credit for the forces being weak or needing little energy to overcome. Some, who correctly referred to intermolecular forces being weak, then described little energy being needed to break bonds rather than to break the intermolecular forces. This is a question where clear and precise use of language is absolutely critical.

08.2 Over three quarters of students identified the correct reaction profile. The most popular distractors were **A** and **D**.

08.3 Over a quarter of students gained full marks on this high demand question, with half of students gaining at least 4 marks. Sometimes working was very difficult to follow; there was a page full of additions and subtractions with no words to explain what these represented. Just the words 'broken' and 'made' would have clarified the working enormously. The students who scored 4 marks had usually failed to recognise that the reaction is exothermic and therefore 2219 (the magnitude of the energy change) is given by (bonds made – bonds broken) since the energy for bonds made must be the larger value in an exothermic reaction. It should be noted that ΔH and its sign convention are not in the GCSE specification. Other common errors included: not including the C—C bonds: counting 3 C—C bonds instead of 2; complete omission of the value of the energy change.

Answer 15 · Examiner comments June 2025 | 8462/1H | Original Q7

Question 7 (standard/high and high demand)

07.1 Whilst the majority of students reached level 1, only one in eight gave sufficient linked reasons to reach level 2. This was a high demand extended response question with the command word 'evaluate'. Merely making comparisons from the information in the table was insufficient to gain credit. Consequences of those comparisons were necessary to count as linked reasons. An overall judgement or several individual judgements were necessary to reach Level 2, but many answers contained no judgement at all.

Many students were able to link the states at room temperature to a consequence such as hydrazine being easier to store or transport. Many were also able to link the need for

Answer 15 · Examiner comments

a catalyst to potential extra costs. However, they had difficulty with consequences of the other information in the table. Most students do not realise that when comparing data in an AO3 question, sometimes there is no real advantage of one option over the other and that is a valid point to make. Many tried to justify why being explosive was more dangerous than being toxic or vice versa, instead of simply deducing that both were dangerous in different ways. A large proportion of students seem to think that nitrogen is harmful in some way, rather than deducing that neither fuel cell produces harmful products. Few students deduced that the larger voltage from hydrazine means that fewer fuel cells would need to be used in a battery; instead, they merely stated that more power would be produced from a single hydrazine fuel cell. Some students tried to refer to atom economy, which is not relevant in this context as there is no 'desired product'.

07.2 More than half of students scored both marks, and nearly two thirds scored at least one. A common error was to draw two pairs of electrons in the overlap between the two N atoms, despite the ball and stick model above showing all single bonds. Some miscounted the electrons on the two N atoms because they used the same symbol for the electrons from both. Some avoided this by using a combination of dots, crosses and open circles or other symbols. The question was not attempted by some students, suggesting that they did not read the question because there were no answer lines and therefore did not realise, they had to do something.

07.3 The question asked for an advantage of the ball and stick model; those answers which referred only to a disadvantage of the dot and cross diagram did not gain credit. Fewer than half gave one of the expected answers, in terms of the ball and stick model being 3-D rather than 2-D or showing the shape of the molecule. Answers that did not gain credit included the idea that the ball and stick model shows: the structure (both do); the arrangement of atoms (both do); the relative sizes of the atoms (both do), or referred to showing the atoms, rather than the molecule, in 3-D. Other vague responses such as 'better visual representation' did not gain credit.

07.4 There were many fully correct answers, with working set out clearly; nearly a half scored full marks. Those who did not complete the calculation correctly could score partial credit for working out that the energy to break bonds is 2062 + **X** kJ/mol and / or that the energy involved in forming bonds is 2801 kJ/mol. Credit was also given for correct use of incorrect values of these totals. Common errors were: leaving out the **X** for the bonds broken; ignoring the overall energy change of 581 completely; adding the 581 to the bonds formed instead of subtracting it or adding it to the bonds broken.