AQA GCSE Chemistry | 8462

SPECIFICATION POINT 4.6.1.4

Catalysts

Mark schemes and examiner comments

Tier	**Higher**
Question groups	**48**
Available paper years	**2007–2025**

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.

4.6.1.4 Catalysts

Answer 01 · Mark scheme March 2007 | CHY1B | Original Q1 | Legacy

One	**A**	alkanes	**2**
	B	fuels	**1**
	C	monomers	**4**
	D	polymers	**3**

Answer 02 · Mark scheme June 2007 | CHY1A | Original Q8 | Legacy

Eight	**1**	**3**	**2**	**3**

Answer 03 · Mark scheme June 2007 | CHY1B | Original Q7 | Legacy

Seven	**1**	**3**	**3**	**2**

Answer 04 · Mark scheme June 2007 | CHY1H | Original Q5 | Legacy

The full source mark scheme begins on page 83. Follow original question 5 in that document.

Answer 05 · Mark scheme June 2008 | CHY1AP | Original Q4 | Legacy

Four	**2**	**4**	**2**	**2**

Answer 06 · Mark scheme June 2008 | CHY1BP | Original Q1 | Legacy

One	**A**	catalysis	**2**
	B	polymerisation	**3**
	C	combustion	**4**
	D	thermal decomposition	**1**

4.6.1.4 Catalysts

Answer 07 · Mark scheme

June 2008 | CHY2H | Original Q8 | Legacy

question	answers	extra information	mark
8(a)	25.4(%)	correct answer with **or** without working accept 25(%) accept 25.433……..(%) allow 26(%) for **1** mark if incorrect answer **1** mark for identification of 44 as M_r of useful product **or** 173 as total M_r of reactants / products	2
8(b)	any **two** sensible ideas from eg: • no / less waste • less materials / reactants needed / used • fewer / no environmental problems **or** less / no pollution • better for sustainable development / resources running out • more useful use of atoms • less purification / separation of products owtte	ignore references to energy / cheaper / profit / cost / efficient	2

Question 8 continued on next page…

4.6.1.4 Catalysts

Answer 07 · Mark scheme

COMPONENT NUMBER: CHY2H

COMPONENT NAME: Additional Science / Chemistry

STATUS: Final

DATE: June 2008

Question 8 continued...

question	answers	extra information	mark
8(c)	increase yield more (gaseous) reactant molecule than (gaseous) product molecule owtte	owtte accept more molecules on left hand side **or** converse accept Le Chatelier based answers for second mark ignore rate of reaction	1 1
8(d)	reduce yield **or** less product owtte	allow no yield ignore waste / less efficient	1
Total			**7**

4.6.1.4 Catalysts

Answer 08 · 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**

4.6.1.4 Catalysts

Answer 08 · Mark scheme June 2008 | CHY3H | Original Q7 | Legacy

COMPONENT NUMBER: CHY3H

COMPONENT NAME: Chemistry

STATUS: Final

DATE: June 2008

Answer 09 · Mark scheme March 2009 | CHY1BP | Original Q2 | Legacy

Two	**A** catalysed	**2**	
	B emulsified	**4**	
	C unsaturated	**1**	
	D hardened	**3**	

	A	**B**	**C**	**D**

Answer 10 · Mark scheme March 2009 | CHY1BP | Original Q6 | Legacy

Six	**4**	**1**	**4**	**2**

Answer 11 · Mark scheme June 2009 | CHY1BP | Original Q7 | Legacy

Seven	**2**	**1**	**1**	**3**

Answer 12 · Mark scheme November 2009 | CHY1BP | Original Q7 | Legacy

No matching mark scheme was available in the supplied archive for this question.

4.6.1.4 Catalysts

Answer 13 · Mark scheme

January 2010 | CHY2H | Original Q5 | Legacy

Question 5

question	answers	extra information	mark
5(a)(i)	0.2	correct answer gains **2** marks with or without working accept answer in table if answer incorrect 5/25 gains **1** mark	2
5(a)(ii)	any **one** from: • wider range of temperatures (owtte) • (repeat at the same temperature) to improve accuracy / reliability • reveal anomalous results (owtte) • so you can get an average / better average	 allow to make it reliable / accurate allow to eliminate random / human errors / to check results owtte ignore to make it a fair test / to get better results ignore precision and validity	1
5(b)	any **two** from: • particles gain energy / have more energy • particles move faster • particles collide more • more of the particles have the activation energy **or** more of the collisions are successful (owtte) **or** particles <u>collide</u> with more force / harder / more energy	allow atoms / molecules / they instead of particles throughout ignore increases particles activation energy ignore move more / vibrate more ignore increases / decreases activation energy allow more successful collisions alone for **1** mark	2
Total			**5**

4.6.1.4 Catalysts

Answer 13 · Mark scheme January 2010 | CHY2H | Original Q5 | Legacy

CHY2H

Answer 14 · Mark scheme March 2010 | CHY1BP | Original Q2 | Legacy

Two	**A** Ethane		**1**	
	B Ethene		**2**	
	C Ethanol		**4**	
	D Hydrogen		**3**	
	A	**B**	**C**	**D**

Answer 15 · Mark scheme March 2010 | CHY1BP | Original Q9 | Legacy

Nine	**3**	**2**	**2**	**2**

4.6.1.4 Catalysts

Answer 16 · Mark scheme

June 2010 | CHY2H | Original Q6 | Legacy

Question 6

question	answers	extra information	mark
6(a)	same number of (gaseous) molecules / moles / volume on both sides of the equation	allow particles for molecules do **not** accept atoms ignore amount	1
6(b)	(forward) reaction is exothermic	accept reverse answer	1
6(c)	any **three** from: • particles gain energy • particles move faster • particles collide more **or** more collisions • more of the collisions are successful **or** more of the particles have the activation energy **or** particles collide with more force / energy	 allow particles collide faster / quicker ignore move more / vibrate more	3

Question 6 continues on the next page

4.6.1.4 Catalysts

Answer 16 · Mark scheme

June 2010 | CHY2H | Original Q6 | Legacy

CHY 2H

Question 6 continued

question	answers	extra information	mark
6(d)	any **two** from: • more product (obtained in shorter time) • less fuel needed **or** lower fuel costs • less pollution caused by burning fuels **or** less specified type of pollution caused by producing heat / burning fuels • using less fuel conserves resources	 accept better yield (of product) accept less energy / heat / electricity needed ignore cheaper unqualified allow correct specified pollutants caused by burning fossil fuels eg CO_2 / greenhouse gases **or** correct effect of burning fossil fuels eg global warming accept thermal / heat pollution accept sustainable accept fossil fuels are non-renewable	2
Total			**7**

4.6.1.4 Catalysts

Answer 17 · Mark scheme

Question 4

question	answers	extra information	mark
4(a)	gives out heat / energy **or** energy / heat transferred to the surroundings	allow release / loses allow the products have less energy ignore temperature rises allow more energy given out in forming bonds than taken in to break bonds	1
4(b)(i)	speed up the reaction (owtte)	accept changes the rate accept lowers activation energy accept increases successful collisions accept allows reaction to take place at a lower temperature	1
4(b)(ii)	nitrogen (N_2) / oxygen (O_2) / products are safe **or** not harmful / pollutant / toxic / dangerous / damaging **or** (harmful) nitrogen monoxide / NO is not released into the air.	ignore releases nitrogen / oxygen unless qualified accept prevents / less acid rain ignore greenhouse gas / ozone layer	1
4(b)(iii)	2 and 2	accept correct multiples or fractions	1
4(b)(iv)	idea of catalyst not being used up	allow not changed by reaction ignore catalyst does not take part ignore catalyst not used in the reaction	1

Question 4 continues on the next page

4.6.1.4 Catalysts

Answer 17 · Mark scheme

CHY2H

Question 4 contd

question	answers	extra information	mark
4(b)(v)	idea of different reactions (require different catalysts)	accept catalysts work for specific reactions allow different gases	1
4(c)	• smaller / very small / or any indication of very small / 1–100 nanometres / a few (hundred) atoms • big(ger) surface area • less (catalyst) needed / small amount of catalyst needed	ignore just small ignore size of the converter	1 1 1
Total			**9**

4.6.1.4 Catalysts

Answer 17 · Mark scheme

January 2011 | CHY2H | Original Q4 | Legacy

CHY2H

Answer 18 · Mark scheme

November 2011 | CHY1BP | Original Q2 | Legacy

Two	**A**	Ethane			**4**
	B	Ethanol			**3**
	C	Ethene			**2**
	D	Poly(ethene)			**1**

	A	**B**	**C**	**D**

Answer 19 · Mark scheme

November 2011 | CHY1BP | Original Q5 | Legacy

Five	**1**	**4**	**1**	**4**

4.6.1.4 Catalysts

Answer 20 · Mark scheme

January 2012 | CH1HP | Original Q7 | Legacy

Question 7

question	answers	extra information	mark
7(a)(i)	$C_{11}H_{24}$ it does not have a (carbon carbon) double bond **or** it has only single (carbon carbon) bonds.	 linked to first mark point accept it is an alkane **or** it is (a) saturated (hydrocarbon) accept converse statement	1 1
7(a)(ii)	ethene 4 x single C-H bonds 1 x double C=C bond ethanol 5 x single C-H bonds 1 x single C-C bond	 if additional bonds are given on water molecule then both ethene and ethanol must be correct for **1** mark	1 1
7(b)	Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also refer to the information on page 2, and apply a 'best-fit' approach to the marking.		6

0 marks	Level 1 (1-2 marks)	Level 2 (3-4 marks)	Level 3 (5-6 marks)
No relevant content.	There is a simple description of advantages **and / or** disadvantages of environmental or economic or social factors why Brazil should produce ethanol from crude oil or from sugar cane. There is a weak or no conclusion.	There a clear description of advantages **and /or** disadvantages of environmental **and** economic or social factors why Brazil should produce ethanol from crude oil or from sugar cane. There is a conclusion based on the factors described.	There is a detailed description of the advantages **and / or** disadvantages of environmental **and** economic or social factors why Brazil should produce ethanol from crude oil or from sugar cane, considering both processes. There is a justified conclusion.

examples of the chemistry points made in the response			
Sugar cane		**Crude oil**	
Advantage **Environmental:** • it is renewable / sustainable • it grows absorbing CO_2 which makes it 'carbon neutral' **Economical / Social:** • growing it is labour intensive so provides (local, rural) employment • low amount of energy / fuel needed so process costs are low • simple / low technology process so process / investment costs are low		Disadvantage **Environmental:** • it is non-renewable / will run out • it contains 'locked up' carbon / CO_2 **or** when released increases global warming • destruction of marine habitats caused by accidents / spillages **Economical / Social:** • process requires small number of trained workers • high amount of energy / fuel needed so process costs are high • complex / high tech process so process / investment costs are high	
Disadvantage **Environmental:** • destruction of habitats / biodiversity to provide land to grow sugar cane **Economical / Social:** • land should be used to grow food (shortage / cost / population increase) • growing or process is slow / batch / unreliable (crop failure)		Advantage **Environmental:** • does not use land as it is offshore **Economical / Social:** • no loss of food crops • extracting or process is fast / continuous / reliable	
Total			**10**

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

4.6.1.4 Catalysts

Answer 21 · Mark scheme

Question 7

question	answers	extra information	mark
7(a)	C_2H_4 a correct other product **and** balanced eg C_4H_{10}		1 1
7(b)	bubbling / fizzing / frothing / effervescence	ignore gas given off **or** solution goes cloudy	1
7(c)	any **five** from the following bullet points: To gain full marks there should be both advantageous and disadvantageous issues and their importance **Advantageous issues using sugar cane:** • sugar cane/plants absorb carbon dioxide / photosynthesise • sugar cane / plants are renewable / sustainable • low energy process	allow converse for ethanol from crude oil ignore costs – unless specified ignore safety ignore simple/low technology process ignore labour intensive as an advantage **linked importance** so is carbon neutral **or** reduce global warming and so save resources / oil **or** crude oil is non-renewable and so it saves fuel **or** / making ethanol from crude oil needs fuel for fractional distillation / cracking	5

Question 7(c) continues on the next page . . .

Question 7(c) cont'd…

question	answers	extra information	mark
7(c)	**Disadvantageous issues using sugar cane:**	ignore fermentation releases carbon dioxide; destruction of habitats/land to build production plants; types of pollution; waste products	
	• large areas of land are needed	which leads to destruction of habitats / forest	
	• land could be used for food crops	may cause food shortages **or** increases the price of food **or** increasing world population	
	• slow process	so limits supply / production of ethanol	
	• ethanol is impure **or** contains 50% ethanol	so needs further separation or ethanol from crude oil is 100% pure	
	• batch process	so uses more labour	
	• the crop yield / supply of ethanol is unreliable	because growth is seasonal / weather dependent **or** possibility of crop failure	
	a justified conclusion	**compensation mark,** if no other mark awarded allow one mark for two or more issues	
Total			**9**

4.6.1.4 Catalysts

Answer 21 · Mark scheme

June 2012 | CH1HP | Original Q7 | Legacy

CH1HP

4.6.1.4 Catalysts

Answer 22 · Mark scheme

June 2012 | CH2HP | Original Q3 | Legacy

Question 3

question	answers	extra information	Mark
3(a)	gives out energy **or** heat		1
3(b)(i)		accept qualified answers in terms of volume of gas related to time	
	fast initially		1
	slows down		1
	reaction stops	accept reaction is now very slow	1
3(b)(ii)	21		1
3(b)(iii)	84	correct answer with or without working = **2** marks allow ecf from 3(b)(ii) correctly calculated for **2** marks allow evidence of 21/25 **or** 3(b)(ii)/25 for **1** mark	2
3(c)	because they / particles have more energy / move faster	ignore particles move more / vibrate	1
	(and so) particles collide more often / more frequently **or** particles more likely to collide	ignore collide faster ignore more collisions	1
	(and) more of the collisions are successful **or** particles collide with more energy / harder **or** more of the particles have the activation energy	accept more successful collisions	1
Total			**10**

4.6.1.4 Catalysts

Answer 22 · Mark scheme

June 2012 | CH2HP | Original Q3 | Legacy

CH2HP

4.6.1.4 Catalysts

Answer 23 · Mark scheme

June 2012 | CH2HP | Original Q4 | Legacy

Question 4

question	answers	extra information	mark
4(a)	118		1
4(b)	it loses / transfers electrons three electrons	it = Au / gold atom sharing / covalency = max **1** mark	1 1
4(c)(i)	O_2 **2** CO and **2** CO_2 **or** correct balancing of equation from O	 accept correct multiples / fractions throughout	1 1
4(c)(ii)	 because carbon dioxide is simple molecular / small molecules there are intermolecular forces (between the molecules) so a small amount of energy needed (to separate molecules) **or** (intermolecular forces) are weak	reference to incorrect bonding = **1** mark max allow intermolecular bonds	 1 1 1

Question 4 continues on the next page . . .

CH2HP

Question 4 cont'd…

question	answers	extra information	mark
4(d)	any **three** from: • gold is the only catalyst for some reactions • catalysts are not used up • improves speed of reaction • reduces amount of energy **or** process needs low(er) temperature • only small quantities (of catalyst) needed	if no mark awarded, allow catalyst reduce costs (of the process) for **1** mark	3
Total			**11**

4.6.1.4 Catalysts

Answer 23 · Mark scheme

June 2012 | CH2HP | Original Q4 | Legacy

CH2HP

4.6.1.4 Catalysts

Answer 24 · Mark scheme

January 2013 | CH2HP | Original Q4 | Legacy

question	answers	extra information	mark
4(a)	it is not used up	accept does not change accept reusable allow does not react	1
4(b)	they would melt **or** they have a low melting point	allow would lose their shape ignore soften	1
	because there are no cross links **or** there are weak intermolecular forces	accept there are weak bonds / forces between (polymer) chains	1
4(c)(i)		ignore reference to mass spectroscopy do **not** accept other incorrect process described	
	substances carried by gas	allow named gas	1
	(through) column / coil / tube **or** (through) solid (material) / powder		1
	at different speeds	accept different retention times	1
4(c)(ii)	(relative) molecular mass / M_r	allow (relative) formula mass **or** relative mass ignore relative atomic mass ignore identity of substance / molecule	1
Total			**7**

4.6.1.4 Catalysts

Answer 24 · Mark scheme

January 2013

CH2HP

4.6.1.4 Catalysts

Answer 25 · Mark scheme

June 2013 | CH3HP | Original Q6 | Legacy

Question 6

question	Answers	extra information	Mark
6(a)	air		1
6(b)	recycle (unreacted) nitrogen and hydrogen	allow re-use allow N_2 and H_2	1 1
6(c)	$N_2 + 3H_2 \rightarrow 2NH_3$	allow correct multiples	1
6(d)	 because a higher temperature would reduce (equilibrium) yield because a lower temperature would reduce rate	allow converse arguments ignore references to compromise allow higher temperature favours backward reaction	 1 1
6(e)(i)	(energy of) reactants greater than (energy of) products	allow converse allow (overall) energy decreases allow energy required to break bonds is less than the energy released making bonds	1
6(e)(ii)	line starting and finishing at same levels but with lower peak		1
Total			8

4.6.1.4 Catalysts

Answer 26 · Mark scheme

June 2014 | CH1HP | Original Q2 | Legacy

Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID
2(a)(i)	reaction with water / steam	allow add water / steam *(to produce ethanol)* *allow H_2O or hydrogen oxide for water* *ignore mix*	1	1 / 1.5.3a	E
2(a)(ii)	filter / decant (to remove the yeast)	*allow answers in either order* *accept description of decanting* *ignore sieve*	1	2 / 1.5.3b	E
	(fractional) distillation / distil	*accept evaporation then condensation*	1		

Answer 26 · Mark scheme

<table>
<tr><td colspan="4">2(b) Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also refer to the information on page 5, and apply a ‘best-fit’ approach to the marking.</td><td>1+2+3 / 1.4.3e</td><td>E</td></tr>
<tr><td>0 marks</td><td>Level 1 (1–2 marks)</td><td>Level 2 (3–4 marks)</td><td>Level 3 (5–6 marks)</td><td rowspan="2"></td><td rowspan="2"></td></tr>
<tr><td>No relevant content</td><td>There is a stated advantage or disadvantage of using biodiesel or petroleum diesel.</td><td>There is a stated advantage or disadvantage of using biodiesel or petroleum diesel with a linked consequence.</td><td>There is at least one stated advantage and at least one stated disadvantage of using biodiesel or petroleum diesel with a linked consequence for each.</td></tr>
<tr><td colspan="4">Examples of points made in the response could include:
Advantages of biodiesel:
• Produces less carbon dioxide
• Produces no sulfur dioxide
• Produces less particulates
• Sustainable / renewable
• Growing crops absorb carbon dioxide
• Carbon neutral
• Produces less acid rain
• Conserves the limited amount of petroleum diesel
Disadvantages of biodiesel:
• Produces more nitrogen oxides
• Deforestation for land
• Destruction of habitats for land
• Uses land that could be used for food crops
• Creates food shortages
• Crops are not reliable</td><td></td><td></td></tr>
</table>

Total			**9**

4.6.1.4 Catalysts

Answer 26 · Mark scheme

June 2014 | CH1HP | Original Q2 | Legacy



4.6.1.4 Catalysts

Answer 27 · Mark scheme June 2014 | CH2HP | Original Q3 | Legacy

Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID
3(a)	O_2 in correct space		1	2 / 2.4	E
	correct balancing	accept multiples	1		
3(b)(i)		*incorrect reference to energy = max **2***		1 / 2.4.1d	E
		ignore references to equilibrium			
	rate increases		1		
	because particles are closer together	accept because there are more particles (per unit volume)	1		
		allow particles have less space / room to move around			
	so frequency of collisions increases	*accept particles are more likely to collide*	1		
		ignore more collisions			
		ignore more successful collisions			
3(b)(ii)	has a greater surface area		1	3 / 2.4.1f/g	E
	so the reaction is faster	*accept so more frequent collisions*	1		
3(c)	the (minimum) amount of energy (particles must have) to react ***or*** *to start a reaction*	accept the energy needed to break bonds	1	1 / 2.4.1b	E
		ignore references to heat			
3(d)(i)	(potassium is) too / *very* reactive	*ignore potassium is a Group 1 / alkali metal*	1	1 + 2 / 2.6.1b	E
	so dangerous / *violent reaction*	accept hydrogen produced rapidly	1		
3(d)(ii)		accept products in either order		2 / 2.6.2b	E
		ignore names of substances			
		*do **not** accept brackets or charges in the formulae*			
	$ZnSO_4$		1		
	H_2		1		

4.6.1.4 Catalysts

Answer 27 · Mark scheme

3(d)(iii)	any **one** from: • increase concentration (of sulfuric acid) • increase temperature **or** heat it • increase surface area of zinc		1	1 / 2.4.1	E
Total			**13**		

4.6.1.4 Catalysts

Answer 27 · Mark scheme

June 2014 | CH2HP | Original Q3 | Legacy



4.6.1.4 Catalysts

Answer 28 · Mark scheme

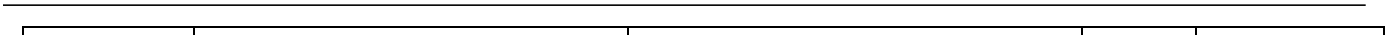
June 2015 | CH2HP | Original Q1 | Legacy

Question	Answers	Extra information	Mark	AO / Spec. Ref.
1(a)(i)	the higher the temperature, the greater the rate **or** at 40 °C rate is faster than at 20 °C	accept the higher the temperature, the faster the reaction	1	**AO3** 2.4.1c
1(a)(ii)	40 °C curve is steeper **or** correct comparison of data from the graph	accept the 40 °C line becomes horizontal sooner accept at higher temperatures the reaction finishes sooner accept reaction finishes sooner at 40 °C accept at higher temperatures the gas is produced faster	1	**AO3** 2.4.1c
1(a)(iii)	2		1	**AO2** 2.4.1a
1(b)(i)	Concentration of acid Mass of marble chips		2	**AO3** 2.4.1e
1(b)(ii)	increases rate (because of) more frequent collisions (between particles)	incorrect reference to energy = max **1** accept particles are more likely to collide ignore more collisions ignore more successful collisions	1 1	**AO1** 2.4.1f
1(c)	any **one** from: • increases rate of reaction • reduces energy required • lower temperature can be used • catalyst is not used up		1	**AO1** 2.4.1g,h
Total			**8**	

4.6.1.4 Catalysts

Answer 28 · Mark scheme

June 2015 | CH2HP | Original Q1 | Legacy



4.6.1.4 Catalysts

Answer 29 · Mark scheme

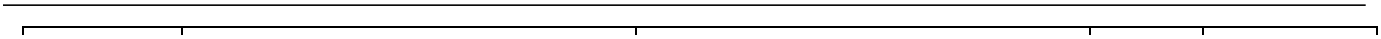
June 2015 | CH3HP | Original Q1 | Legacy

Question	Answers	Extra information	Mark	AO / Spec. Ref.
1(a)	Li **and** K	either order allow lithium **and** potassium	1	**AO1** 3.1.3.a
1(b)	Fe	allow iron	1	**AO1** 3.5.1.b
1(c)	N **and** As	either order allow nitrogen **and** arsenic	1	**AO2** 3.1.2.b
1(d)	Cu	allow copper	1	**AO1** 3.1.3.d
Total			**4**	

4.6.1.4 Catalysts

Answer 29 · Mark scheme

June 2015 | CH3HP | Original Q1 | Legacy



4.6.1.4 Catalysts

Answer 30 · Mark scheme

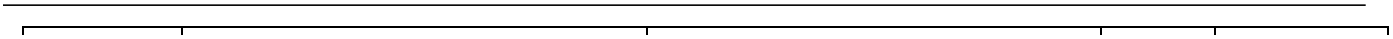
June 2015 | CH3HP | Original Q5 | Legacy

Question	Answers	Extra information	Mark	AO / Spec. Ref.
5(a)	any **two** from: • fuel • solvent • antiseptic	 allow source of energy allow perfume / aftershave allow antibacterial	2	**AO1** 3.6.1.b
5(b)	Hydrogen		1	**AO1** 3.6.1.b
5(c)(i)	oxidation	do **not** allow redox	1	**AO1** 3.6.1.c
5(c)(ii)	correct structure		1	**AO1** 3.6.2.a
5(c)(iii)	 ethanoic acid is a weak / weaker acid because it does not completely ionise.	it = ethanoic acid allow because it does not completely dissociate allow it has a lower concentration of hydrogen ions allow converse for hydrochloric acid do **not** allow ionising	 1 1	**AO1/ AO2** 3.6.2.b
5(d)(i)	ethyl ethanoate		1	**AO1** 3.6.2.b
5(d)(ii)	acid	allow any strong acid allow correct formulae	1	**AO1** 3.6.2.b
5(d)(iii)	evaporates easily / quickly	allow low boiling point do **not** allow flammable	1	**AO1** 3.6.3.a
Total			**10**	

4.6.1.4 Catalysts

Answer 30 · Mark scheme

June 2015 | CH3HP | Original Q5 | Legacy



4.6.1.4 Catalysts

Answer 31 · Mark scheme

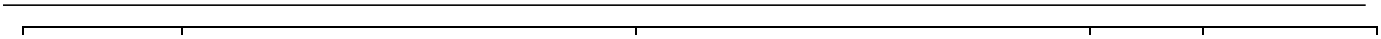
June 2015 | CH3HP | Original Q6 | Legacy

Question	Answers	Extra information	Mark	AO / Spec. Ref.
6(a)(i)	nothing can enter **and** nothing can leave the reaction	allow sealed reaction vessel	1	**AO1** 3.5.1.c
6(a)(ii)	forward and backward reactions have same rate so there is no (overall) change in quantities of reactants and products	 allow concentrations of reactants and products	1 1	**AO1/ AO2** 3.5.1.c
6(b)(i)	natural gas	allow methane / CH_4 allow fossil fuels / hydrocarbons allow water	1	**AO1** 3.5.1.a
6(b)(ii)	provides an alternative reaction pathway which has a lower activation energy	 ignore references to collisions	1 1	**AO1** 3.3.1.h
6(b)(iii)	the amount (of ammonia) increases the equilibrium moves to the side (of the equation) with fewer (gaseous) molecules / moles	allow yield increases allow it favours the forward reaction	1 1	**AO1/ AO2** 3.5.1.d/g
6(c)(i)	vertical arrow from reactants to maximum		1	**AO2** 3.3.1.e
6(c)(ii)	(energy of) products higher than (energy of) reactants	allow converse	1	**AO2** 3.3.1.d
6(c)(iii)	amount of hydrogen iodide decreases equilibrium moves in the direction of the endothermic reaction	 allow it favours the forward reaction	1 1	**AO1/ AO2** 3.5.1.d/e
Total			**12**	

4.6.1.4 Catalysts

Answer 31 · Mark scheme

June 2015 | CH3HP | Original Q6 | Legacy



4.6.1.4 Catalysts

Answer 32 · Mark scheme

June 2016 | CH2HP | Original Q3 | Legacy

Question	Answers	Extra information	Mark	AO / SpecRef
3(a)(i)	(mass number = 16) because there are 8 protons and 8 neutrons (in the nucleus)	accept mass number is total number of protons and neutrons for **1** mark	2	AO1/AO2 2.3.1a,b,c
3(a)(ii)	same number of protons **or** both have 6 protons	numbers, if given, must be correct accept same atomic number	1	2AO1 / 1AO2 2.3.1d
	^{12}C has 6 neutrons	accept different number of neutrons for **1** mark	1	
	^{14}C has 8 neutrons		1	
		incorrect reference to electrons = **max 2** marks		
3(b)(i)	2 bonding pairs	accept dot, cross or e or – or any combination additional unbonded electrons negates this mark	1	AO1 2.1
	4 unbonded electrons around oxygen		1	
3(b)(ii)	covalent		1	AO1 2.1.1g

Question 3 continues on the next page

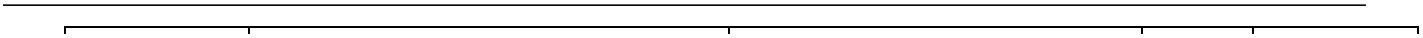
Question 3 continued

3(b)(iii)	any **one** from: • no delocalised / free electrons • no overall electric charge • no ions	do **not** accept any implications of the presence of ions ignore mobile electrons accept no charge (carriers)	1	AO1 2.2.1c
3(c)(i)	larger	accept the size of a few hundred atoms accept atoms are smaller (than nanoparticles) allow up to 1000 atoms	1	AO1 2.2.6a
3(c)(ii)	(nanoparticles have) large(r) surface area		1	AO2 2.2.6a
Total			**11**	

4.6.1.4 Catalysts

Answer 32 · Mark scheme

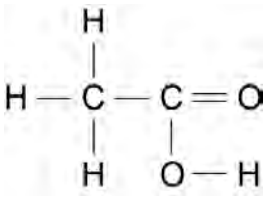
June 2016 | CH2HP | Original Q3 | Legacy



4.6.1.4 Catalysts

Answer 33 · Mark scheme

June 2016 | CH3HP | Original Q1 | Legacy

Question	Answers	Extra information	Mark	AO / SpecRef
1(a)(i)	fizz / effervescence / bubbles	allow calcium carbonate decreases in size or dissolves	1	AO2/AO3 3.4.1d, 3.6.2b
	because carbon dioxide produced / released	allow because gas produced / released	1	
	limewater turns cloudy / milky / white		1	
	because (a precipitate of or solid) calcium carbonate forms	allow because of carbon dioxide if not already credited	1	
1(a)(ii)		allow –OH do not allow lower case 'h'	1	AO1 3.6.2a
1(a)(iii)	acid	must be in this order ignore any name of an acid	1	AO1 3.6.2b
	ester(s)		1	
1(b)	white (precipitate) no change no change no change	all four correct 2 marks any two correct 1 mark	2	AO2 3.4.1e,f
1(c)(i)	lilac red	must be in this order allow purple	1 1	AO1 3.4.1a
1(c)(ii)	colours are masked / changed by each flame colour		1	AO3 3.4.1a
Total			12	

4.6.1.4 Catalysts

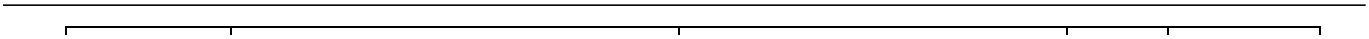
Answer 33 · Mark scheme

<table>
<tr><th>Question</th><th>Answers</th><th>Extra information</th><th>Mark</th><th>AO / SpecRef</th></tr>
<tr><td>2</td><td></td><td></td><td>6</td><td rowspan="6">2AO1 / 3AO2 / 1AO3 3.4.1g</td></tr>
<tr><td colspan="4">Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also refer to the information on page 5 and apply a ‘best-fit’ approach to the marking.</td></tr>
<tr><td colspan="4"><table>
<tr><th>0 marks</th><th>Level 1 (1–2 marks)</th><th>Level 2 (3–4 marks)</th><th>Level 3 (5–6 marks)</th></tr>
<tr><td>No relevant content.</td><td>There is a simple description of using some of the apparatus.</td><td>There is a description of an experimental method including addition of acid to alkali which may include an indicator or colour change and may include a measurement of volume.</td><td>There is a description of titrations that would allow a comparison to be made between the two solutions of hydrochloric acid.</td></tr>
</table></td></tr>
<tr><td colspan="4">examples of chemistry points made in the response could include:
• acid in burette or flask
• alkali/sodium hydroxide or acid in burette or flask
• volume of acid or alkali measured using the pipette
• indicator in flask
• white tile under the flask
• slow addition
• swirling/mixing
• colour change of indicator
• burette volume measured</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td>Total</td><td></td><td></td><td>6</td><td></td></tr>
</table>

4.6.1.4 Catalysts

Answer 33 · Mark scheme

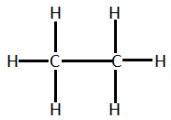
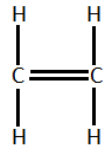
June 2016 | CH3HP | Original Q1 | Legacy



4.6.1.4 Catalysts

Answer 34 · Mark scheme

June 2017 | CH1HP | Original Q2 | Legacy

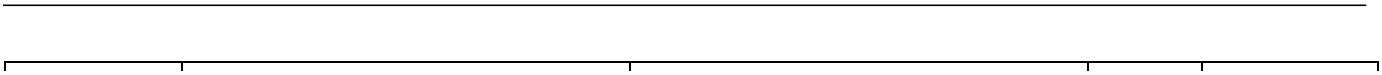
Question	Answers	Extra information	Mark	AO / Spec. Ref.
2(a)(i)	electronic structure drawn	allow any representation of an electron allow 2,4	1	AO2 1.1.1h
2(a)(ii)	six / 6 protons (protons) are positively charged	 do **not** allow electrons in nucleus otherwise ignore electrons do **not** allow nucleus is neutral allow (protons are) + / +1 / 1+ ignore statements about mass if no other mark awarded allow one mark for nucleus	1 1 1	AO1 AO2 1.1.1c;d;e
2(b)	(a hydrocarbon is) made up of hydrogen and carbon (atoms) only	do **not** allow mixture	1	AO1 1.4.1a;c
2(c)(i)	 	ethane correctly drawn with another hydrogen on each carbon and another three single bonds ethene correctly drawn with a double bond between the carbon atoms	1 1	AO1 1.4.2a 1.5.1c
2(c)(ii)	as the number of carbon atoms increases the boiling point increases	allow converse ignore alkene	1	AO3 1.4.2c

2(c)(iii)	the boiling points of alkanes are higher than the boiling points of alkenes that have the same number of carbon atoms **or** state a correct example	allow the boiling points of alkenes are lower than the boiling points of alkanes consequential on first marking point e.g. hexane has a higher boiling point than hexene **or** hexane boils at 69ºC hexene boils at 64ºC if no other mark awarded allow both alkanes and alkenes have the same pattern of the more carbon atoms the higher the boiling point for one mark	1 1	**AO2** 1.4.2b;c
2(d)	(alkane molecules are) cracked to produce small(er) molecules / alkanes / hydrocarbons and alkenes **or** a named alkene	allow break down / up **or** decompose **or** split up ignore separate allow short chain for small allow molecules that have a double bond **or** are unsaturated if no other mark awarded allow evaporate **or** boil for one mark ignore turns to gas	1 1 1	**AO1** **AO2** **AO3** 1.5.1a;b;d
Total			**13**	

4.6.1.4 Catalysts

Answer 34 · Mark scheme

June 2017 | CH1HP | Original Q2 | Legacy



4.6.1.4 Catalysts

Answer 35 · Mark scheme

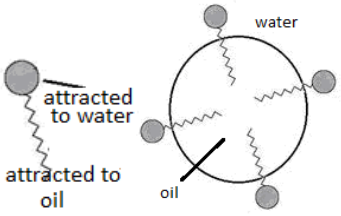
June 2017 | CH1HP | Original Q6 | Legacy

Question	Answers	Extra information	Mark	AO / Spec. Ref.
6(a)		accept reverse arguments about fossil diesel throughout		AO2 AO3
	biodiesel is carbon neutral	allow does not contribute to global warming **or** no extra carbon dioxide is released	1	1.4/1.4.3a;c;e
	because biodiesel releases the carbon dioxide that was used by the plants (during photosynthesis) OR biodiesel is renewable / sustainable (1) because crops can be replanted (to produce more biodiesel) (1) OR fossil diesel is non-renewable (1) because it takes millions of years to form (1)	ignore fossil diesel will run out	1	

4.6.1.4 Catalysts

Answer 35 · Mark scheme

June 2017 | CH1HP | Original Q6 | Legacy

6(b)	 <u>emulsifier</u> is shaken with **or** added to a mixture of water and oil the head (of the emulsifier molecule) **or** hydrophilic end dissolves in the water the tail (of the emulsifier molecule) **or** hydrophobic end dissolves in the oil so that a suspension **or** stable droplets of oil in water (or vice versa) is formed	allow diagrams for the last three marking points  (M2 + M3) (M2+M3+M4)	 1 1 1 1	**AO1** 1.6.2a;b
6(c)	orange to colourless	allow brown ignore clear / transparent allow decolourised	1 1	**AO1** 1.6.3a
6(d)	(hydrogen) adds to the (carbon-carbon) double bond (hydrogenated oils) have higher melting points so are hardened **or** are solid (at room temperature)	allow opens up / breaks ignore spreadable if no other mark awarded allow one mark for unsaturated oils become saturated	1 1 1	**AO1** 1.6.3a;b
Total			**11**	

4.6.1.4 Catalysts

Answer 36 · Mark scheme

June 2017 | CH2HP | Original Q1 | Legacy

The full source mark scheme begins on page 96. Follow original question 1 in that document.

4.6.1.4 Catalysts

Answer 37 · Mark scheme

June 2018 | 8462/2H | Original Q7

Question	Answers	Extra information	Mark	AO/Spec. Ref.
07.1	incomplete combustion (because) insufficient / limited oxygen supply		1 1	AO1 4.9.3.1
07.2	any **two** from: • carbon monoxide toxic / poisonous • greater public concern / awareness about pollution • more cars so otherwise there would be more carbon monoxide entering atmosphere • improved engine technology • catalytic converters have been introduced	allow description of how carbon monoxide is toxic / poisonous ignore carbon monoxide is harmful / dangerous / deadly ignore comments about the effects of other pollutants ignore unspecified comments about carbon monoxide pollution	2	AO1 AO3 4.9.3.2
07.3	any **one** from: • (to reduce) health problems • (to reduce) global dimming	allow (to reduce) specified health problems eg breathing difficulties, asthma, lung cancer allow (to reduce) the effects of global dimming eg reduced light levels allow (to reduce) smog allow (to reduce) the formation of particulates ignore global warming do **not** accept to reduce soot	1	AO1 4.9.3.1 4.9.3.2

4.6.1.4 Catalysts

Answer 37 · Mark scheme

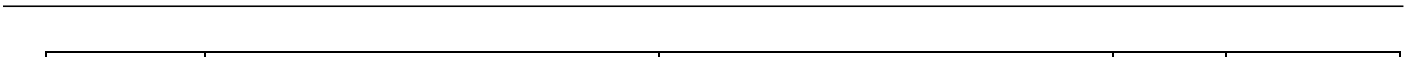
June 2018 | 8462/2H | Original Q7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.4	nitrogen (from atmosphere) reacts with oxygen (from atmosphere) at high temperature (in engine) **or** with a spark (from spark plug)	 ignore heat / hot	1 1	AO1 4.9.3.1
07.5	**2** $NO_2 \rightarrow N_2$ + **2** O_2	allow multiples if incorrect, allow N_2 for **1** mark	2	AO2 4.1.1.1 4.3.1.1
07.6	any **two** from: • acid rain • respiratory problems • carbon monoxide • global dimming **or** smog	**max 1** mark if global warming mentioned allow specific effects of acid rain allow specific respiratory problems eg breathing difficulties, asthma	2	AO1 4.9.3.2
07.7	transition metals		1	AO2 4.1.3.2
Total			**12**	

4.6.1.4 Catalysts

Answer 37 · Mark scheme

June 2018 | 8462/2H | Original Q7



4.6.1.4 Catalysts

Answer 38 · Mark scheme

June 2018 | 8462/2H | Original Q9

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.1	enzyme		1	AO2 4.6.1.4
09.2	2.0×10^3 moles		1	AO2 4.3.2.1
09.3	smaller yield (because) favours endothermic reaction	allow less methanol is produced allow (because) favours reverse reaction allow equilibrium / reaction shifts to the left allow equilibrium / reaction shifts to reduce the temperature ignore reference to forward reaction is exothermic ignore references to rate	1 1	AO2 4.6.2.4 4.6.2.6

4.6.1.4 Catalysts

Answer 38 · Mark scheme

June 2018 | 8462/2H | Original Q9

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.4	(yield) equilibrium position moves to the product side	allow converse arguments allow equilibrium / reaction moves to the right allow equilibrium / reaction shifts to reduce the pressure	1	AO2 4.6.1.3 4.6.2.4 4.6.2.7
	(because) fewer molecules / moles / particles on product side	allow (because) fewer molecules / moles / particles on the right allow (because) smaller volume on product side	1	
	(rate) more collisions per unit time	allow increases collision frequency / rate ignore more collisions alone ignore faster collisions do **not** accept any indication of more energetic / forceful collisions	1	
	(because) more molecules / particles per unit volume	allow (gas) molecules / particles closer together ignore more molecules / particles alone	1	
09.5	provides different reaction pathway	allow provides a different mechanism / route	1	AO1 4.6.1.4
	(which has a) lower activation energy	ignore references to collisions	1	

4.6.1.4 Catalysts

Answer 38 · Mark scheme

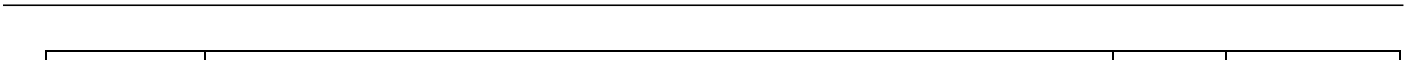
June 2018 | 8462/2H | Original Q9

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.6	less energy is needed	allow reduces the temperature required allow reduces costs ignore references to pressure ignore references to rate or time	1	AO2 4.6.1.4
09.7	no effect / change		1	AO3 4.6.1.4 4.6.2.3
Total			12	

4.6.1.4 Catalysts

Answer 38 · Mark scheme

June 2018 | 8462/2H | Original Q9

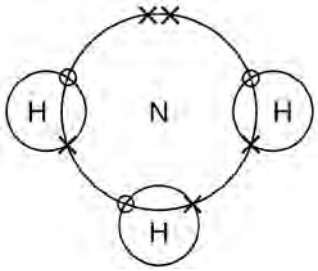


4.6.1.4 Catalysts

Answer 39 · 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	

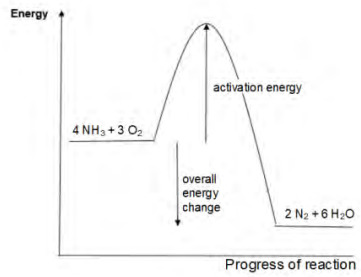
4.6.1.4 Catalysts

Answer 39 · 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

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**	

4.6.1.4 Catalysts

Answer 40 · Mark scheme

June 2019 | 8462/2H | Original Q9

Question 9

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.1	glowing splint	do **not** accept burning splint	1	AO1 4.8.2.2
	(which) relights	dependent on correct test in MP1 ignore with a pop	1	
09.2	place the conical flask in a water bath at constant temperature.		1	AO3 4.6.1.2
	use a mass of 1 g manganese dioxide each time.		1	
09.3		an answer of 0.092 (cm^3/s) scores **3** marks allow an answer of 0.091666 (cm^3/s) correctly rounded to at least 2 significant figures for **2** marks allow an answer of 0.033 (cm^3/s) for **2** marks allow an answer of 0.033333 (cm^3/s) for **1** mark		AO2 4.6.1.1
	11 (cm^3) **and** 120 (seconds)		1	
	(mean rate of reaction = $\frac{11}{120}$) = 0.09167	allow a correct calculation using incorrectly determined value(s) for difference in volume and / or time	1	
	= 0.092 (cm^3/s)	allow a correctly calculated answer given to 2 significant figures from an incorrect attempt at the rate equation	1	

4.6.1.4 Catalysts

Answer 40 · Mark scheme

June 2019 | 8462/2H | Original Q9

09.4	line starts at origin **and** less steep than solid line line levelling off at 40 (cm^3)	 allow a tolerance of ± ½ a small square	1 1	AO2 AO3 4.6.1.2
09.5	(because) surface area (of fine manganese dioxide powder) greater (so) more collisions (with hydrogen peroxide molecules / particles) per unit time	allow converse for coarse lumps do **not** accept references to changes in kinetic energy or speed (of molecules / particles) ignore references to activation energy.	1 1	AO2 4.6.1.2 4.6.1.3
Total			**11**	

4.6.1.4 Catalysts

Answer 41 · Mark scheme

June 2022 | 8462/2H | Original Q7

Question 7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.1	(nitrogen) air (hydrogen) natural gas	allow atmosphere allow methane allow water / steam	1 1	AO1 4.10.4.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.2	there is only one product		1	AO2 4.3.3.2 4.10.4.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.3	(mixture is) cooled (so that only) ammonia liquefies	 allow (so that only) ammonia condenses	1 1	AO1 4.10.4.1

4.6.1.4 Catalysts

Answer 41 · Mark scheme

June 2022 | 8462/2H | Original Q7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.4	scale labelled at 100, 200, 300 and 400 (atm)	allow scale labelled at 50, 150, 250 and 350 (atm)	1	AO2 4.10.4.1
	all five points plotted correctly	allow a tolerance of ± ½ a small square allow **1** mark for three / four points plotted correctly	2	
	line of best fit		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.5 View with Figure 5	extrapolation to 500 atmospheres		1	AO2 4.10.4.1
	percentage value at 500 atmospheres	allow a tolerance of ± ½ a small square	1	

4.6.1.4 Catalysts

Answer 41 · Mark scheme

June 2022 | 8462/2H | Original Q7

Question	Answers	Mark	AO / Spec. Ref.
07.6	**Level 3**: Relevant points (reasons/causes) are identified, given in detail and logically linked to form a clear account.	5–6	AO1 4.6.1.3 4.6.1.4 4.6.2.6 4.6.2.7 4.10.4.1
	Level 2: Relevant points (reasons/causes) are identified, and there are attempts at logical linking. The resulting account is not fully clear.	3–4	
	Level 1: Points are identified and stated simply, but their relevance is not clear and there is no attempt at logical linking.	1–2	
	No relevant content	0	
	Indicative content **rate** • higher temperature gives higher rate because of more frequent collisions • higher temperature gives higher rate because more particles have the activation energy • higher pressure gives higher rate because of more frequent collisions • use of catalyst gives higher rate because the activation energy is lowered **equilibrium** • higher temperature shifts the position of equilibrium to the left because reaction is exothermic • higher pressure shifts the position of equilibrium to the right because more molecules on left-hand side • use of catalyst has no effect on the position of equilibrium **other factors** • higher temperature (than 450°C) uses more energy so increases costs • higher pressure (than 200 atmospheres) uses more energy so increases costs • higher pressure (than 200 atmospheres) requires stronger reaction vessels so increases costs • use of a catalyst reduces energy costs **compromise** • the temperature chosen is a compromise between rate of reaction and position of equilibrium • the temperature chosen is a compromise between rate and cost • the pressure chosen is a compromise between yield / rate and cost		

Total Question 7		**17**

Answer 42 · Mark scheme

June 2023 | 8462/2H | Original Q7

Question 7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.1	(a catalyst) provides a different pathway for the reaction (which has a) lower activation energy		1 1	AO1 4.6.1.3 4.6.1.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.2	(oxygen is) a gas (which) escaped from the flask		1 1	AO2 4.3.1.3 4.6.1.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.3	correct value for *x* step **and** *y* step from tangent (rate =) $\frac{\text{value for } y \text{ step}}{\text{value for } x \text{ step}}$ correct calculation of rate answer to 2 significant figures	 allow correct use of incorrectly determined *x* and/or *y* step allow an answer correctly rounded to 2 significant figures from an incorrect calculation which uses values determined from the graph.	1 1 1 1	AO2 4.6.1.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.4	line starting at 0,0 which is less steep than existing line which becomes level at 0.80 g	 allow a tolerance of ± ½ a small square	1 1	AO2 4.3.4 4.6.1.2

Total Question 7	10

4.6.1.4 Catalysts

Answer 43 · Mark scheme

June 2023 | 8462/2H | Original Q9

Question 9

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.1	(mass of water in 4.68 g = 4.68 - 2.99) = 1.69 (g)		1	AO2 4.6.2.2
	(mass of water in 11.7 g =) $\frac{11.7}{4.68} \times 1.69$	allow correct use of an incorrectly determined mass of water in 4.68 g	1	
	= 4.23 (g)	allow 4.2 / 4.225 (g)	1	
	alternative approach: $\left(\text{mass of anhydrous compound} = \frac{11.7}{4.68} \times 2.99\right)$ = 7.475 (g) (1)			
	(mass of water =) 11.7 – 7.475 (1)	allow correct use of an incorrectly determined mass of anhydrous compound		
	= 4.23 (g) (1)	allow 4.2 / 4.225 (g)		

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.2	(energy =) $\frac{15.0}{2.99} \times 1.47$		1	AO2 4.6.2.2
	= 7.37 (kJ)	allow 7.37458194 correctly rounded to at least 2 significant figures	1	

4.6.1.4 Catalysts

Answer 43 · Mark scheme

June 2023 | 8462/2H | Original Q9

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.3	shifts to the left		1	AO2 4.6.2.1 4.6.2.4 4.6.2.6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.4	the mixture is a lighter shade of brown		1	AO2 4.6.2.4 4.6.2.7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.5	no effect (on equilibrium position) (because) there are equal numbers of (gas) moles / molecules on each side (of the equation)	allow (equilibrium position) stays the same	1 1	AO2 4.6.2.4 4.6.2.7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.6	no effect (on equilibrium position)	allow (equilibrium position) stays the same	1	AO2 4.6.2.3 4.6.2.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.7	add more hydrochloric acid		1	AO2 4.6.2.4 4.6.2.5

4.6.1.4 Catalysts

Answer 43 · Mark scheme

June 2023 | 8462/2H | Original Q9

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.8	(because the) forward and reverse reactions are taking place at (exactly) the same rate	ignore references to closed systems allow for **1** mark (because) the reactions are taking place at (exactly) the same rate	2	AO1 4.6.2.3

Total Question 9	**13**

4.6.1.4 Catalysts

Answer 44 · Mark scheme

June 2024 | 8462/2H | Original Q2

Question 2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	to recycle (remaining) nitrogen and hydrogen	allow to recycle unreacted gases allow to return nitrogen and hydrogen to the reactor	1	AO1 4.10.4.1

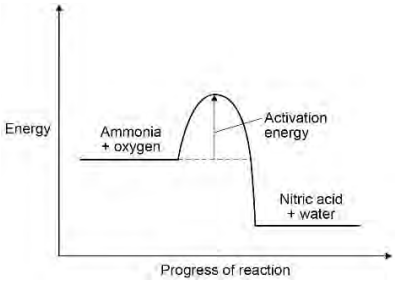
Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.2	iron	allow Fe	1	AO1 4.6.1.4 4.10.4.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.3	(test) glowing splint (result) (splint) relights	 MP2 is dependent upon MP1 being awarded	 1 1	AO1 4.8.2.2

4.6.1.4 Catalysts

Answer 44 · Mark scheme

June 2024 | 8462/2H | Original Q2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.4	labelled vertical arrow from dotted line to peak ammonia **and** oxygen on left **and** nitric acid **and** water on right	ignore arrow heads allow NH_3 for ammonia allow O_2 for oxygen allow HNO_3 for nitric acid allow H_2O for water an answer of  scores **2** marks	1 1	AO2 4.6.1.4 4.10.4.1 4.10.4.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.5	the line would reach a higher peak		1	AO1 4.6.1.4 4.10.4.1 4.10.4.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.6	fertilisers	allow explosives allow sports injury packs	1	AO3 4.10.4.1 4.10.4.2

Total Question 2	8

4.6.1.4 Catalysts

Answer 45 · Mark scheme

June 2024 | 8462/2H | Original Q7

Question 7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.1		ignore (hydrochloric / nitric / sulfuric) acid		AO1 4.8.3.5
	(test) add barium chloride (solution)	allow add barium nitrate (solution)	1	
	(result) white precipitate		1	
		MP2 is dependent upon MP1 being awarded		

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.2	the yield is smaller at higher temperatures because the reaction is exothermic		1	AO2 4.6.2.6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.3		allow converse		AO2 4.6.2.7
	there are more moles / molecules (of gas) on the left	ignore particles	1	
	(so the position of) equilibrium shifts to the right		1	

4.6.1.4 Catalysts

Answer 45 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.4	any **two** from: • the yield is already high • more energy required • risk of explosion is increased • higher income from increased yield is outweighed by the extra expenditure • increased cost of safety precautions	allow requires stronger vessels allow requires thicker walls	2	AO3 4.6.2.7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.5	vanadium (V)		1	AO3 4.1.3.2

Total Question 7	**8**

4.6.1.4 Catalysts

Answer 46 · Mark scheme

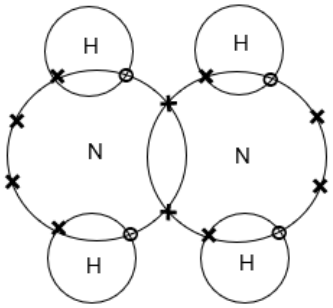
June 2025 | 8462/1H | Original Q7

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		

4.6.1.4 Catalysts

Answer 46 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.2	bonded pair of electrons in each overlap	allow any combination of x, o, $e^{(-)}$, ● for electrons	1	AO2 4.2.1.4
	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

4.6.1.4 Catalysts

Answer 46 · 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

4.6.1.4 Catalysts

Answer 47 · Mark scheme

June 2025 | 8462/2H | Original Q8

Question 8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.1	a gas was produced	allow oxygen for gas	1	AO2 4.3.1.3 4.6.1.4
	(and the gas) escaped from the flask		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.2	catalysts provide a different pathway for the reaction		1	AO3 4.6.1.3 4.6.1.4
	(and) the activation energy using **B** is lower	allow converse	1	
	(so) the rate of reaction is higher using **B**	allow converse allow (so) the reaction using **B** has more particles with an energy exceeding the activation energy	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.3	tangent at 60 s		1	AO2 4.6.1.1
	value for *x* step **and** *y* step from tangent	allow a tolerance of ± ½ a small square allow correct use of an incorrect tangent	1	
	(rate =) $\frac{\text{value for } y \text{ step}}{\text{value for } x \text{ step}}$	allow correct use of incorrectly determined *x* and / or *y* step from a drawn tangent	1	
	correct calculation of rate		1	
	answer in standard form	allow an answer correctly given in standard form from an incorrect calculation which uses values determined from the graph	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.4		allow converse		AO1 4.6.1.2 4.6.1.3
	the rate (of decomposition / reaction) increases at higher temperatures		1	
	(because) particles have more energy	allow (because) particles move faster	1	
	(so) collide more frequently	allow (and) a greater proportion collide with sufficient energy to exceed the activation energy	1	

Total Question 8	13

4.6.1.4 Catalysts

Answer 48 · Mark scheme

June 2025 | 8462/2H | Original Q9

Question 9

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.1	the forward reaction is endothermic		1	AO2 4.6.1.3 4.6.2.4 4.6.2.6
	(so high temperature) shifts the equilibrium (position) to the right		1	
	(which) increases the yield (of products)	allow (and a high temperature) increases the rate of reaction	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.2		allow converse		AO2 4.6.2.4 4.6.2.7
	(low pressure) shifts the equilibrium (position) to the right		1	
	(because) there are more moles on the right	allow (because) there are more molecules on the right	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.3	no effect on equilibrium position		1	AO3 4.6.1.4 4.6.2.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.4	(volume ~) $\frac{50 \times 100}{80}$	allow a value in the range 78.0 to 80.0 for percentage of nitrogen	1	AO2 4.9.1.1 4.10.4.1
	~ 62.5 (dm^3)		1	

4.6.1.4 Catalysts

Answer 48 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.5	(the reaction mixture is) cooled		1	AO1 4.10.4.1
	(so that) ammonia condenses / liquefies		1	
	(but) nitrogen **and** hydrogen are gases		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.6	any **three** from: • nitrogen is an abundant gas (in the air) • the use of nitrogen releases fewer greenhouse gases • the nitrogen released replaces that used to make ammonia • natural gas is a finite resource • (the use of hydrogen / methane releases) carbon dioxide which contributes to climate change	allow nitrogen is renewable allow (the use of hydrogen / methane releases) carbon dioxide contributes to global warming	3	AO3 4.10.1.1 4.10.4.1

Total Question 9	**14**

Version 1.0: 0707

ASSESSMENT and QUALIFICATIONS ALLIANCE

General Certificate of Secondary Education

Science B 4462 / Chemistry 4421

CHY1H Unit Chemistry 1

Mark Scheme

2007 examination - June series

4.6.1.4 Catalysts

Mark schemes are prepared by the Principal Examiner and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation meeting attended by all examiners and is the scheme which was used by them in this examination. The standardisation meeting ensures that the mark scheme covers the candidates' responses to questions and that every examiner understands and applies it in the same correct way. As preparation for the standardisation meeting each examiner analyses a number of candidates' scripts: alternative answers not already covered by the mark scheme are discussed at the meeting and legislated for. If, after this meeting, examiners encounter unusual answers which have not been discussed at the meeting they are required to refer these to the Principal Examiner.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of candidates' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

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Dr Michael Cresswell, Director General.

4.6.1.4 Catalysts

MARK SCHEME

Information to Examiners

1. General

The mark scheme for each question shows:

- the marks available for each part of the question
- the total marks available for the question
- the typical answer or answers which are expected
- extra information to help the Examiner make his or her judgement and help to delineate what is acceptable or not worthy of credit or, in discursive answers, to give an overview of the area in which a mark or marks may be awarded.

The extra information is aligned to the appropriate answer in the left-hand part of the mark scheme and should only be applied to that item in the mark scheme.

At the beginning of a part of a question a reminder may be given, for example: where consequential marking needs to be considered in a calculation; or the answer may be on the diagram or at a different place on the script.

In general the right hand side of the mark scheme is there to provide those extra details which confuse the main part of the mark scheme yet may be helpful in ensuring that marking is straightforward and consistent.

2. Emboldening

2.1 In a list of acceptable answers where more than one mark is available 'any **two** from' is used, with the number of marks emboldened. Each of the following lines is a potential mark.

2.2 A bold **and** is used to indicate that both parts of the answer are required to award the mark.

2.3 Alternative answers acceptable for a mark are indicated by the use of **or**. (Different terms in the mark scheme are shown by a / ; eg allow smooth / free movement.)

3. Marking points

3.1 Marking of lists

This applies to questions requiring a set number of responses, but for which candidates have provided extra responses. The general principle to be followed in such a situation is that 'right + wrong = wrong'.

Each error/contradiction negates each correct response. So, if the number of error/contradictions equals or exceeds the number of marks available for the question, no marks can be awarded.

However, responses considered to be neutral (indicated as * in example 1) are not penalised.

4.6.1.4 Catalysts

Example 1: What is the pH of an acidic solution? (1 mark)

Candidate	Response	Marks awarded
1	4,8	0
2	green, 5	0
3	red*, 5	1
4	red*, 8	0

Example 2: Name two planets in the solar system. (2 marks)

Candidate	Response	Marks awarded
1	Pluto, Mars, Moon	1
2	Pluto, Sun, Mars, Moon	0

3.2 Use of chemical symbols / formulae

If a candidate writes a chemical symbol / formula instead of a required chemical name, full credit can be given if the symbol / formula is correct and if, in the context of the question, such action is appropriate.

3.3 Marking procedure for calculations

Full marks can be given for a correct numerical answer, as shown in the column 'answers', without any working shown.

However if the answer is incorrect, mark(s) can be gained by correct substitution / working and this is shown in the 'extra information' column;

3.4 Interpretation of 'it'

Answers using the word 'it' should be given credit only if it is clear that the 'it' refers to the correct subject.

3.5 Errors carried forward

Any error in the answers to a structured question should be penalised once only.

Papers should be constructed in such a way that the number of times errors can be carried forward are kept to a minimum. Allowances for errors carried forward are most likely to be restricted to calculation questions and should be shown by the abbreviation e.c.f. in the marking scheme.

3.6 Phonetic spelling

The phonetic spelling of correct scientific terminology should be credited **unless** there is a possible confusion with another technical term.

3.7 Brackets

(…..) are used to indicate information which is not essential for the mark to be awarded but is included to help the examiner identify the sense of the answer required.

3.8 Unexpected Correct Answers not in the Mark Scheme

The Examiner should use professional judgement to award credit where a candidate has given an unexpected correct answer which is not covered by the mark scheme. The Examiner should consult with the Team Leader to confirm the judgement. The Team Leader should pass this answer on to the Principal Examiner with a view to informing all examiners.

4.6.1.4 Catalysts

CHY1H Question 1

	answers	extra information	mark
(a)	any **two** from: • nitrogen • carbon dioxide • water (vapour) / steam	 accept formulae N / N_2 accept formula CO_2 ignore CO accept formula H_2O	2
(b)	any **three** from: <u>limestone</u> • abundant / local • natural material **or** no 'processing' needed • relatively easy to cut • appearance better <u>concrete</u> • <u>raw materials</u> are abundant • can be reinforced (by steel rods) / strong(er) / supported (by steel rods) • concrete mixture can be poured / moulded / constructed on site • less reactive with acid rain / weathering / erosion	no mark for 'limestone' or 'concrete' on first line – mark advantages only ignore ideas of speed of production or easier to use accept 'can build higher' ignore density / extraction / quarrying / pollution / cost	3
total			5

4.6.1.4 Catalysts

CHY1H Question 2

	answers	extra information	mark
(a)(i)	$Cu_2S + 2O_2 \rightarrow 2CuO + SO_2$	accept fractions and multiples	1
(ii)	any **two** from: • sulfur dioxide • causes acid rain • consequence of acid rain eg kills fish / plants	 accept sulphur dioxide / sulphur oxide / SO_2 ignore other comments eg global warming / ozone / global dimming / greenhouse effect	2
(b)	any **two** from: • heat (copper oxide with carbon) • oxygen is removed by carbon **or** carbon monoxide / carbon dioxide is produced **or** carbon displaces copper • because carbon is more reactive than copper	 accept copper (oxide) loses oxygen **or** carbon gains oxygen accept carbon oxide accept a correct word or balanced symbol equation allow a correct comparison of reactivity	2
(c)(i)	electrolysis	accept electroplating	1
(ii)	(electrical) wiring / appliances / coins / pipes / cladding for buildings / jewellery / making alloys **or** named alloys		1

Continued on next page

4.6.1.4 Catalysts

Question 2 continued

	answers	extra information	mark
(d)	any **three** explanations from: <u>for recycling</u> • less acid rain (pollution) • copper reserves last longer / conserved **or** do not run out • energy for extraction (saved) **or** less energy required • less mining / quarrying • less waste (copper) / electrical appliances dumped **or** less landfill <u>against recycling</u> • collection problems • transport problems • difficult to separate copper from appliances • energy used to melt the collected copper	ignore electrolysis / pollution ignore ideas about less machinery / plant ignore idea of cost	3
total			10

4.6.1.4 Catalysts

CHY1H Question 3

	answers	extra information	mark
(a)(i)	core		1
(ii)	plate (boundaries)	accept parts of the crust ignore crust alone	1
	sudden movement / colliding **or** normally move a few centimetres per year	accept movement but ignore movement apart accept continental drift	1
	convection currents / driven by heat from radioactive processes / decay	idea of source of energy for the movement	1
	the idea of uncertainty with an explanation eg scientists do not know (with any certainty) • what happens under the crust • where the forces / pressure are building up • we cannot measure the forces • when the forces reach their limit	ignore references to volcanoes	1
(b)(i)	78		1

Continued on next page

4.6.1.4 Catalysts

Question 3 continued

	answers	extra information	mark
(ii)	marks awarded for any 2 gases from the following 3 gases	max **3** marks from CO_2	
	any **four** from: carbon dioxide has decreased: • used by plants / bacteria (stromatolites) • during photosynthesis (must be linked to CO_2 decrease) • 'locked up' in (sedimentary) rocks / carbonates / fossil fuels • dissolved in oceans **and / or** oxygen has increased because: • released by plants / bacteria (stromatolites) • during photosynthesis (must be linked to O_2 increase) **and / or** nitrogen has increased because • ammonia reacted with oxygen (to release nitrogen) • nitrogen is released by bacteria	ignore references to respiration	4
total			10

4.6.1.4 Catalysts

CHY1H Question 4

	answers	extra information	mark
(a)	permitted additive / (added) chemicals **or** names / types of additives	accept the chemical name ignore food additive alone	1
(b)(i)	water and oil do not mix / are immiscible **or** don't dissolve each other	ignore density ignore emulsifier alone	1
(ii)	any **two** from: • emulsifier • forms an emulsion • holds the two components together • by lowering the surface tension	 accept description of an emulsion accept stops them separating / they mix allow bonds / binds for holds accept a description of how an emulsifier works for **two** marks eg 'tadpole' diagram or dispersal of oil drops	2
(c)(i)	(because they contain) a double (carbon carbon) bond	accept unsaturated ignore poly or mono	1
(ii)	results suggest sunflower oil is best **or** 'the one that took the least time' because (sunflower oil) has the highest amount of unsaturation / most double bonds / least saturated	 ignore uses up I_2 most quickly second mark is dependent on first	1 1

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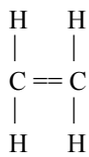
4.6.1.4 Catalysts

Question 4 continued

	answers	extra information	mark
(d)(i)	any **one** from: • have a higher melting point than (vegetable) oil • are solid at (room temperature) / hardened / harder	 accept useful as spreads **or** doesn't soak into bread ignore hard / soft(er)	1
(ii)	any **two** from: • hydrogen added • to carbon carbon double bond / to saturate • (nickel) catalyst / temperature 60 - 150°C	 do **not** accept 'water' wrong catalyst doesn't get this mark ignore high / warm temperature	2
total			10

4.6.1.4 Catalysts

CHY1H Question 5

	answers	extra information	mark
(a)(i)	by (fractional) distillation **or** fractionation	accept a description of the distillation process (heat and how separation works) eg heat **and** condense accept boil / vapourise etc for heat	1
(ii)	CO_2 H_2O	note the order of these products must be correct wrong way round = **1** mark	1 1
(b)(i)	(hexane) has been broken down (into smaller hydrocarbons / molecules)	accept (thermal) decomposition / cracked / split / broken up owtte	1
(ii)		accept $CH_2=CH_2$	1
(iii)	water / hydrogen oxide / steam	accept H_2O	1

Continued on next page

4.6.1.4 Catalysts

Question 5 continued

	answers	extra information	mark
(c)	candidates must include both sugar cane and crude oil in their evaluation **and** both an advantage and a disadvantage to gain full marks. if they do not then the maximum mark is three any **four** from: <u>advantages of using sugar</u> • country has no wealth to buy (large quantities of) crude oil • country has limited technological development **or** underdeveloped / third world country • able / suitable climate to grow sugar cane • enough land to grow sugar cane / land cannot be used to grow food / deforestation • sugar is a renewable source **or** crude oil is a non-renewable resource / finite resource / limited resources • CO_2 / carbon neutral <u>advantages of using alkanes:</u> • economic costs are low • continuous process • country has large oil resources • country has oil refineries / cracking plants • very pure product • faster process	not 'expensive' alone	4
total			10

4.6.1.4 Catalysts

GCSE

Additional Science / Chemistry

CH2HP
Final Mark scheme

4408 / 4402
June 2017

Version/Stage: v1.0

4.6.1.4 Catalysts

Mark schemes are prepared by the Lead Assessment Writer and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all associates participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the students' responses to questions and that every associate understands and applies it in the same correct way. As preparation for standardisation each associate analyses a number of students' scripts. Alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, associates encounter unusual answers which have not been raised they are required to refer these to the Lead Assessment Writer.

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4.6.1.4 Catalysts

Information to Examiners

1. General

The mark scheme for each question shows:

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- the total marks available for the question
- the typical answer or answers which are expected
- extra information to help the Examiner make his or her judgement and help to delineate what is acceptable or not worthy of credit or, in discursive answers, to give an overview of the area in which a mark or marks may be awarded
- the Assessment Objectives and specification content that each question is intended to cover.

The extra information is aligned to the appropriate answer in the left-hand part of the mark scheme and should only be applied to that item in the mark scheme.
At the beginning of a part of a question a reminder may be given, for example: where consequential marking needs to be considered in a calculation; or the answer may be on the diagram or at a different place on the script.
In general the right-hand side of the mark scheme is there to provide those extra details which confuse the main part of the mark scheme yet may be helpful in ensuring that marking is straightforward and consistent.

2. Emboldening and underlining

2.1 In a list of acceptable answers where more than one mark is available 'any **two** from' is used, with the number of marks emboldened. Each of the following bullet points is a potential mark.

2.2 A bold **and** is used to indicate that both parts of the answer are required to award the mark.

2.3 Alternative answers acceptable for a mark are indicated by the use of **or**.
Different terms in the mark scheme are shown by a / ; eg allow smooth/free movement.

2.4 Any wording that is underlined is essential for the marking point to be awarded.

3. Marking points

3.1 Marking of lists

This applies to questions requiring a set number of responses, but for which students have provided extra responses. The general principle to be followed in such a situation is that 'right + wrong = wrong'.

Each error/contradiction negates each correct response. So, if the number of error/contradictions equals or exceeds the number of marks available for the question, no marks can be awarded.

However, responses considered to be neutral (indicated as * in example 1) are not penalised.

Example 1: What is the pH of an acidic solution?

[1 mark]

Student	Response	Marks awarded
1	green, 5	0
2	red*, 5	1
3	red*, 8	0

Example 2: Name two planets in the solar system.

[2 marks]

Student	Response	Marks awarded
1	Pluto, Mars, Moon	1
2	Pluto, Sun, Mars, Moon	0

3.2 Use of chemical symbols/formulae

If a student writes a chemical symbol/formula instead of a required chemical name, full credit can be given if the symbol/formula is correct and if, in the context of the question, such action is appropriate.

3.3 Marking procedure for calculations

Full marks can be given for a correct numerical answer, without any working shown. However, if the answer is incorrect, mark(s) can be gained by correct substitution/working and this is shown in the 'extra information' column or by each stage of a longer calculation.

3.4 Interpretation of 'it'

Answers using the word 'it' should be given credit only if it is clear that the 'it' refers to the correct subject.

3.5 Errors carried forward

Any error in the answers to a structured question should be penalised once only. Papers should be constructed in such a way that the number of times errors can be carried forward are kept to a minimum. Allowances for errors carried forward are most likely to be restricted to calculation questions and should be shown by the abbreviation 'ecf' in the marking scheme.

3.6 Phonetic spelling

The phonetic spelling of correct scientific terminology should be credited **unless** there is a possible confusion with another technical term.

3.7 Brackets

(…..) are used to indicate information which is not essential for the mark to be awarded but is included to help the examiner identify the sense of the answer required.

3.8 Accept/allow

Accept is used to indicate an equivalent answer to that given on the left-hand side of the mark scheme. Allow is used to denote lower-level responses that just gain credit.

3.9 Ignore/Insufficient/Do not allow

Ignore or insufficient is used when the information given is irrelevant to the question or not enough to gain a marking point. Any further correct amplification could gain the marking point.
Do **not** allow means that this is a wrong answer which, even if the correct answer is given, will still mean that the mark is not awarded.

4 Quality of Written Communication and levels marking

In Question 2 students are required to produce extended written material in English, and will be assessed on the quality of their written communication as well as the standard of the scientific response.

Students will be required to:
- use good English
- organise information clearly
- use specialist vocabulary where appropriate.

The following general criteria should be used to assign marks to a level:

Level 1: Basic

- Knowledge of basic information.
- Simple understanding.
- The answer is poorly organised, with almost no specialist terms and their use demonstrating a general lack of understanding of their meaning, little or no detail.
- The spelling, punctuation and grammar are very weak.

Level 2: Clear

- Knowledge of accurate information.
- Clear understanding.
- The answer has some structure and organisation, use of specialist terms has been attempted but not always accurately, some detail is given.
- There is reasonable accuracy in spelling, punctuation and grammar, although there may still be some errors.

Level 3: Detailed

- Knowledge of accurate information appropriately contextualised.
- Detailed understanding, supported by relevant evidence and examples.
- Answer is coherent and in an organised, logical sequence, containing a wide range of appropriate or relevant specialist terms used accurately.
- The answer shows almost faultless spelling, punctuation and grammar.

4.6.1.4 Catalysts

Question	Answers	Extra information	Mark	AO / Spec. Ref.
1(a)(i)	a smooth curve through or close to all points except (30,12)		1	AO2 2.4
1(a)(ii)	correct reading from the curve in 1(a)(i) (cm^3)	allow a tolerance of +/- 0.5 cm^3	1	AO2 2.4
1(a)(iii)	45-50 (seconds)		1	AO3 2.4
1(a)(iv)	line becomes less steep because gas is produced more slowly	ignore line levels out or plateaus allow examples with figures, eg 12 cm^3 gas from 0 to 20s but 1.5 cm^3 gas in last 20s ignore reaction has stopped or no more gas produced	1 1	AO3 2.4
1(a)(v)	0.6 (cm^3 per second)	allow 0.55 to 0.65	1	AO2 2.4
1(b)(i)	 temperature volume (of hydrogen peroxide)	concentration of hydrogen peroxide = max **1** ignore amount (of hydrogen peroxide)	 1 1	AO3 2.4
1(b)(ii)	 rate increases because more particles (in the same volume) so frequency of collisions increases	incorrect reference to energy = max **2** accept particles closer together allow greater chance of collisions ignore more collisions	 1 1 1	AO1 2.4.1e

4.6.1.4 Catalysts

1(c)	(increasing the amount of catalyst) increases rate same final volume of gas	accept steeper graph or graph levels off earlier	1 1	**AO2** 2.4.1g
Total			**13**	

4.6.1.4 Catalysts

<table>
<tr><th>Question</th><th>Answers</th><th>Extra information</th><th>Mark</th><th>AO / Spec. Ref.</th></tr>
<tr><td>2</td><td></td><td></td><td>6</td><td rowspan="6">AO1
2.1.1h
2.2.4b,c
2.2.5a,b</td></tr>
<tr><td colspan="4">Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also refer to the information on page 5 and apply a ‘best-fit’ approach to the marking.</td></tr>
<tr><td colspan="4"><table>
<tr><th>0 marks</th><th>Level 1
(1–2 marks)</th><th>Level 2
(3–4 marks)</th><th>Level 3
(5–6 marks)</th></tr>
<tr><td>no relevant information given</td><td>a statement about the structure or a property of a metal
or
a statement about the structure or a property of a polymer</td><td>a statement about the structure or a property of a metal
and
a statement about the structure or a property of a polymer</td><td>a statement about the structure or a property of a metal
and
a statement about the structure or a property of a polymer
and
at least one statement linking structure and property</td></tr>
</table></td></tr>
<tr><td colspan="4">Statements shown as HT only are credited on both FT and HT.
However, HT only means that these statements are not expected in a FT answer.</td></tr>
<tr><td colspan="4">Examples of chemistry points made in response

Metal:

Properties
shiny
hardness
(tensile) strength
melting point/boiling point
density
malleable/flexible
ductile
conduct electricity or thermal energy</td></tr>
</table>

Structure • metals contain atoms /((positive) ions HT only) • (the atoms/(positive) ions/particles are) closely packed / in a regular pattern / in a giant structure/in layers / in a lattice • strong bonds/(electrostatic attractions HT only) • (metal has delocalised electrons HT only) **Polymer:** **Properties** • flexible • melting/boiling point • density • can be shaped/moulded • poor conductor of electricity or thermal energy **Structure** • polymer consists of chains • polymer chains may be tangled • polymer has no cross links. • (polymer has weak intermolecular forces HT only) **Level 3:** **Examples of linked statements:** • metal can be bent and shaped because the layers can slide • some metals are soft because layers can slide • some metals are hard because they have strong bonds and/ or (the atoms/(positive) ions/particles) are closely packed / in a regular pattern / in a giant structure/ in a lattice • metal has high melting/boiling point because they have strong bonds and/ or (the atoms/(positive) ions/particles) are closely packed / in a regular pattern / in a giant structure / in a lattice • metal is strong because of strong bonds • some metals are dense because the atoms are closely packed • (metal can conduct thermal energy and electricity because metal has delocalised electrons HT only) • thermosoftening polymer melts when heated because it has no cross-links (or has weak intermolecular forces HT only) • thermosoftening polymer is flexible because the chains can move over each other	

Total			**6**

4.6.1.4 Catalysts

Question	Answers	Extra Information	Mark	AO / Spec. Ref
3(a)(i)	2 bonding pairs 4 unbonded electrons on each atom	accept dots, crosses, e, - or any combination ignore any electrons on any inner shells if no other mark awarded allow **1** mark for 1 bonding pair and 6 unbonded electrons on each atom	1 1	**AO2** 2.1.1g
3(a)(ii)	covalent	allow convalent and covelant ignore single or double ignore shared, shared bond or sharing	1	**AO1** 2.1.1g
3(a)(iii)	weak intermolecular forces require little energy to overcome	reference to weak covalent or weak ionic bonds = **0** accept weak intermolecular bonds MP2 dependent on MP1 if no other mark awarded allow 1 mark for simple/small molecules	1 1	**AO1** **AO2** 2.2.1a,b

4.6.1.4 Catalysts

3(b)(i)	**2** Mg + O_2 → **2** MgO	accept multiples	1	**AO2** 2.2.2
3(b)(ii)		reference to incorrect particles **or** incorrect bonding **or** incorrect structure = max **2**		**AO1** **AO2** 2.1.1a,b,c,f
	magnesium loses (electrons) **and** oxygen gains (electrons)		1	
	two (electrons transferred)		1	
	noble gas structure **or** 8 electrons in outer shells **or** (electrostatic) attraction between ions **or** forms ionic bonds	accept full outer shell (of electrons)	1	
3(b)(iii)	particles 1-100 nm in size	accept contain a few hundred atoms/ions accept have a high surface area to volume ratio ignore reference to (very) small particles do **not** accept smaller than an atom/ion	1	**AO1** 2.2.6a

3(c)	has a high melting point	allow will not melt allow a lot of energy needed to melt ignore boiling point reference to incorrect particles or incorrect bonding or incorrect structure = max **1** from MP2 and MP3	1	**AO1** **AO2** 2.2.3a
	because all atoms linked to other atoms	allow giant structure/lattice ignore many bonds	1	
	by covalent bonds	allow strong bonds allow a lot of energy needed to break bonds accept giant covalent structure for MP2 and MP3	1	
Total			**13**	

4.6.1.4 Catalysts

Question	Answers	Extra Information	Mark	AO / Spec. Ref
4(a)	add copper oxide and (sulfuric) acid		1	**AO1** **AO2** 2.6.1b,c
	excess (copper oxide)		1	
	filter (to remove excess)	ignore impurities	1	
	heat /boil / evaporate / leave (to crystallise)	do **not** accept to dryness	1	
4(b)	(M_r CuO =) 79.5		1	**AO2** 2.3.3c
	24.95/249.5 **or** 0.1 **OR** 79.5/249.5 **or** 0.3186…	allow ecf for M_r CuO from step 1 allow correct rounding to min 2SF	1	
	(24.95/249.5 x 79.5=) 7.95	allow ecf for M_r CuO from step 1 allow ecf from step 2 of incorrect calculation/ rounding of correct ratio allow correct rounding to min 2SF correct answer with or without working gains 3 marks	1	
4(c)(i)	as wealth decreases, ethene production decreases (with the exception of country C or D)	accept converse	1	**AO2** **AO3** 2.6
	sulfuric acid production is not linked to wealth		1	

4.6.1.4 Catalysts

4(c)(ii)	use of products of ethene has increased	allow use of polymers / plastics / ethanol / poly(ethene) has increased ignore use of ethene as a (bio)fuel ignore cost	1	**AO3** 2.2.5
Total			**10**	

4.6.1.4 Catalysts

Question	Answers	Extra Information	Mark	AO / Spec. Ref
5(a)(i)	draw line on paper put (dots of) inks on line place (bottom of) paper in solvent / water any **one** from: line drawn in pencil allow dots of ink to dry line above solvent lid		1 1 1 1	**AO1** 2.3.2b
5(a)(ii)	any **two** from: • A has 3 colours **and** B has 4 colours • 2 colours are the same • **A** has 1 colour not in **B and B** has 2 colours not in **A**	accept 3 colours are different if no other mark awarded allow **one** more colour in ink **B** than in ink **A** (or converse)	2	**AO3** 2.3.2b
5(b)(i)	substances carried by gas through column / tube / coil (packed with solid) (different substances move through the column) at different speeds	 accept (different) substances come out at different times or have different retention times	1 1 1	**AO1** 2.3.2c
5(b)(ii)	(relative) molecular mass	allow (relative) formula mass allow RFM, RMM, M_r	1	**AO1** 2.3.2c
Total			**10**	

4.6.1.4 Catalysts

Question	Answers	Extra Information	Mark	AO / Spec. Ref
6(a)(i)	tick (✓) by: the initial temperature reading was too low		1	AO3 2.5
6(a)(ii)	the reaction is exothermic	allow energy is given out	1	AO3 2.5.1b
6(b)(i)	(positive/hydrogen) ions gain electrons hydrogen is below sodium in the reactivity series so hydrogen / H_2 is produced	accept (positive/hydrogen) ions are reduced accept reference to high reactivity of sodium If no other mark awarded allow hydrogen (and sodium) ions **or** positive ions are attracted to negative electrode for **1** mark	1 1 1	AO1 AO2 2.7.1c,f,i
6(b)(ii)	**2** (Cl^-) → **Cl_2 + 2e^-**	must be completely correct allow multiples	1	AO1 2.7.1g
6(b)(iii)	solution is alkaline because sodium hydroxide / NaOH is produced **or** sodium hydroxide / NaOH is left over	accept hydroxide (ions) / OH^- is produced **or** hydroxide (ions) / OH^- is left over	1 1	AO1 AO2 2.7.1i; 2.6.2d
Total			8	

4.6.1.4 Catalysts

Answer 37 · Examiner comments

June 2018 | 8462/2H | Original Q7

Question 7 (standard & standard / high demand)

07.1 This was generally well answered with 72% of students achieving one or two marks. The mark most commonly not achieved was for an insufficient or limited oxygen supply. This was usually because the students either did not mention oxygen or failed to say the supply was limited. However a number of students did not achieve the mark by stating that **no** oxygen was present. Global warming was a frequent response but was not creditworthy.

07.2 This was less well answered with 5% of students achieving both marks. Many students realised that CO is toxic in some way, but were too vague using words like 'harmful' or 'dangerous'. However this was the mark which was most frequently awarded.

Many students struggled to find a second reason. Again specific responses were required. Responses such as 'improved technology', 'more efficient cars' were not, on their own, sufficient to gain the 'improved engine technology' mark.

Although the question specifically mentioned new cars, responses comparing old cars to new cars did not normally contain creditworthy material.

07.3 This was not well answered with 11% of students achieving the mark. Most students did not appear to have realised that the question was asking about unburned hydrocarbons. Many who did were side-tracked into talking about wasting petrol / resources, or the flammability of unburned hydrocarbons. Again, global warming was a frequent response which did not gain credit.

07.4 There were a few good responses, but many that were not. 11% of students achieved both marks.

Students did not have to state where the oxygen and nitrogen came from, but when they did this needed to be correct. Nitrogen coming from the petrol or from combustion was not an acceptable response. The second mark was frequently not given because of the use of vague terms such as 'hot', rather than naming the conditions required ('high temperature')

07.5 This was generally well answered, although ‘2N’ was a common incorrect response. Students need to remember that gases such as nitrogen, hydrogen and oxygen normally exist as diatomic molecules. 61% of students achieved both the marks.

07.6 Again global warming and other associated responses were frequently seen, and in this case lost credit. Vague responses were also frequently seen. However most responses referred correctly to acid rain and one mark was often awarded. Some good responses included details about the pollutants that contribute to these effects. 56% of students were able to gain at least one mark.

07.7 61% of students knew that the transition metal block was the most likely source of catalysts.

Answer 38 · Examiner comments

June 2018 | 8462/2H | Original Q9

Question 9 (standard, standard / high & high demand)

09.1 88% of students could identify an enzyme as a (biological) catalyst.

09.2 64% of students could use the equation to work out that 2.0×10^3 moles of carbon monoxide would react.

09.3 The endothermic nature of the backwards reaction was often identified as the reason the equilibrium position moved to the left; however many made no comment about the yield of methanol. Many students thought there would be a higher yield. 39% of students achieved both marks.

09.4 While many students did well, there were many others who demonstrated partial knowledge or who did not express themselves clearly. Many thought that an increase in pressure caused an increased yield of methanol because it was an exothermic reaction, rather than because the equilibrium moved to the position of fewer moles / molecules / particles.

The increased rate of reaction was better understood; students usually gave some indication that the particles are closer or there are **more particles** in a **fixed** volume or there are the **same number of particles** in a **smaller** volume. Simply saying there were more particles was insufficient.

In addition, students needed to link collisions **and** time to gain credit, usually by saying that the particles collide more often or there are more frequent collisions. Simply saying **more collisions** alone was insufficient. The idea that an increase in pressure supplied energy (and therefore increased the speed of the particles) was discounted.

73% of students were able to achieve some credit, with 12% of students achieving full marks.

09.5 Higher-attaining students achieved both marks for stating that catalysts reduce the activation energy by providing an alternative route or pathway, though the second point was less well known than the first. Sometimes one or other of these points was omitted. A popular incorrect idea was that catalysts supply energy.

09.6 47% of students knew that catalysts reduce costs, save energy or allow lower temperatures to be used. Others just mentioned that catalysts can be reused or that they speed up the reaction.

09.7 The effect of a catalyst on the equilibrium yield of methanol was not well understood. It was widely thought that a catalyst increased the yield of methanol because the reaction was faster and would, therefore, produce more of the product. 24% of students answered correctly.

4.6.1.4 Catalysts

Answer 39 · 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.

4.6.1.4 Catalysts

Answer 39 · 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 41 · Examiner comments June 2022 | 8462/2H | Original Q7

Question 7 (Standard, standard/high and high demand)

07.1 This was well answered with around half of the students scoring both marks. Incorrect responses included the atmosphere being a source of the hydrogen as well as the nitrogen. There were far fewer responses stating that biogas of any kind was suitable for the large-scale production of ammonia than in previous years.

07.2 About 25% of the students scored this mark. 'No by-products' was seen quite often and others stated there were the same number of atoms on both sides, which just means that the equation is balanced, not necessarily that there is only 1 product.

07.3 Roughly 1 in 10 students gained both marks. Many scored the second mark, but far fewer the first. This was often due to imprecise language rather than misunderstanding, but many stated that 'ammonia is cooled'. The distinction between **all** the gases being cooled but only ammonia condensing is important. A large proportion did not mention cooling at all. Some negated the second mark by stating that ammonia has a lower boiling point than the other two gases.

4.6.1.4 Catalysts

Answer 41 · Examiner comments

June 2022 | 8462/2H | Original Q7

07.4 Labelling the scale and the plotting of the given points was nearly always correct. Some did not label on the major gridlines, while a few got the scale completely wrong by labelling the major gridlines in multiples of 60 atmospheres, which did not match the pre-plotted points and therefore denied access to the plotting marks. Most students drew good best-fit curves, although some inappropriately drew a straight line. Over half of the students gained all four marks.

07.5 Most students extrapolated their line correctly and read off the value of the percentage at 500 atmospheres. About two-thirds of the students scored both marks.

07.6 This high demand extended response question gave students the opportunity to demonstrate their knowledge of collision theory, Le Chatelier's Principle and catalytic action in the context of the Haber Process.

More able students seemed to understand that they needed to consider cost implications. Explaining that a compromise is made in the choice of the temperature and the pressure was important in accessing Level 3.

The compromises made for temperature and pressure that were related to cost were more commonly stated than the compromise for temperature in relation to rate and position of equilibrium.

There was a high proportion of responses with additional material producing comprehensive, high-scoring responses. There were also a good number of weaker responses containing isolated statements, most commonly relating the conditions to rate, or more rarely position of equilibrium, but without explaining these relationships. Such responses were usually confined to Level 1. The ratio of Level 1:2:3 marks was roughly 40:20:20 with the remainder failing to gain any marks on this question.

4.6.1.4 Catalysts

Answer 42 · Examiner comments — June 2023 | 8462/2H | Original Q7

Question 7 (standard, standard / high and high demand)

07.1 The effect of a catalyst on the rate of a reaction was generally well known. Most correct answers referred to the lowering of the activation energy. Many students also referred to the catalyst providing a different pathway for the reaction. References to changes in the number of collisions were insufficient as they did not answer the question. Over one-third of responses gained two marks, and around two-thirds of responses gained one mark.

07.2 Many responses correctly referred to a gas being produced in the reaction. However, as oxygen was given as a product in the stem of the question, if another gas, such as hydrogen or carbon dioxide, was referred to, then the first mark was not awarded. 'The gas was released' was not sufficient for the second marking point but 'being released into the air' or 'released into the surroundings' gained credit. The idea that a gas evaporates from the flask negated the idea of escape in marking point two. Nearly half of the students gained both marks.

07.3 Many students correctly used the tangent to the line drawn in the question to calculate the rate of reaction at 75 seconds.

If the tangent was not used then only MP4 was available for a correct rounding of data obtained correctly from the graph to 2 significant figures. This commonly involved the use of the student reading the y-axis value from a vertical line at 75 seconds.

For the first mark there had to be clear evidence from the graph or data put into the equation, that values for *x* and *y* were chosen from the graph. Some students counted the squares in the *y* and *x* axes and did not score MP1 but the remaining marks were still accessible.

Answer 42 · Examiner comments — June 2023 | 8462/2H | Original Q7

A small number of students added extra calculation steps after evaluating values in an equation. This often meant the second and third marking points were contradicted and therefore those marks could not be awarded.

If *x* and *y* values were awarded but the equation was inverted, only MP1 and MP4 were available.

Over half the students scored all four marks.

07.4 The award of both marks for this question was not often seen. The idea of a line that was less steep than the line given was often credited. However, the second marking point was not awarded on many occasions as the line sketched by the student did not level off at 0.80 g. The link between the only difference between the experiments being a halving of the concentration of hydrogen peroxide solution as the only reactant using a manganese dioxide catalyst was not recognised, resulting in a variety of incorrect responses. The most common answer was for the sketch line to finish at 1.60 g. Around 25% of students scored both marks.

4.6.1.4 Catalysts

Answer 43 · Examiner comments

June 2023 | 8462/2H | Original Q9

Question 9 (standard, standard / high and high demand)

09.1 This question was well done by a large proportion of the students. There was an understanding of how to calculate the mass of water obtained from 4.68 g of hydrated copper(II) sulphate and use this to calculate the mass of water from 11.7 g hydrated copper(II) sulphate. The alternative method on the mark scheme was less popular with the students. Over two-thirds of students scored all three marks.

09.2 This question proved to be more difficult for many of the students. It was noticeable that rather than using the value 2.99 g in the calculation a large proportion of the students used 4.68 grams without understanding that the calculation was about the reverse reaction. Just under half of the students gained both marks.

09.3 Around two-thirds of the students gained this multiple-choice mark. Most who did not score selected 'shifts to the right' instead.

09.4 Around 40% of the students gained this multiple-choice mark. Most who did not score selected 'the mixture is a darker shade of brown' instead.

09.5 Large numbers of the students did not recognise that there were the same number of moles on each side of the equation. Quite a number of students stated that the equilibrium shifts to the side with the least moles and then said that the equilibrium shifts to either the left or the right showing a lack of understanding of the stoichiometry of written chemical equations. Around one-third of the students gained both marks.

09.6 There were a lot of answers relating to the effect of a catalyst on the rate of a chemical reaction without any mention of the effect on equilibrium position. There was a common misconception that increasing the rate of reaction increased the yield of products and therefore stated that the equilibrium shifts to the right. Around one-third of the students gained both marks.

09.7 More than 80% of the students gained this multiple-choice mark. 'Add more water' was occasionally seen but 'leave the reaction mixture for 30 minutes' was rarely seen.

09.8 This question was not well done. Students appear not to understand what is happening at equilibrium and responses did not relate to the rate of reaction. Around one-quarter of students gained this mark.

4.6.1.4 Catalysts

Answer 44 · Examiner comments June 2024 | 8462/2H | Original Q2

Question 2 (standard demand)

02.1 Around two-fifths of students gained credit on this question. Some students referred to both hydrogen and nitrogen gases being recycled or reused. A few referred to only one of the gases or unspecified unreacted gases.

A number of students referred to excess gases or gases alone. In addition, some students focused their answer on the condenser part of the flow chart and responded with the idea that uncondensed gases needed to be recycled.

02.2 This question was answered well by the majority of students, with roughly two-thirds of students gaining the mark.

02.3 Although this question was answered well, some students referred to a splint being lit initially and then blown out. These students did not often mention the splint was still glowing. The majority of students who stated glowing splint also gained the second marking point. Around three-quarters of students gained both marks; of those who did not, most described the test for hydrogen.

02.4 There were many variations of drawing the arrow for the activation energy. A number of students labelled the activation energy with abbreviations such as E_a. The majority of students correctly named the reactants and products and placed them above and below the lines, with a few using arrows to point out their positions. More than 60% of students gained both marks.

02.5 This multiple-choice question was well answered, with around 70% of students gaining credit. The most popular distractor was that the peak would be lower rather than higher.

02.6 This question was answered extremely well with fertiliser or NPK fertiliser. A small minority stated farming or agricultural use unqualified. Only a handful of students identified its use in explosives or sports injury packs.

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Answer 45 · Examiner comments June 2024 | 8462/2H | Original Q7

Question 7 (standard, standard / high and high demand)

07.1 Around 40% of students scored two marks for this question. However, many students were not able to name the correct reagent for the test. White precipitate was often given as the result of the test, but this answer was not creditworthy unless the correct reagent had been named. Sodium hydroxide and silver nitrate were the most common incorrect reagents. A significant number of students left the answer space blank.

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4.6.1.4 Catalysts

Answer 45 · Examiner comments June 2024 | 8462/2H | Original Q7

07.2 This multiple-choice question was well answered with two-thirds of students gaining the mark.

07.3 Around 30% of students scored both the marks on this question. Clear descriptions about the numbers of moles / molecules on each side of the equation and the resulting shift in the position of equilibrium at higher pressure were seen. A number of students failed to score the first marking point because they did not give a comparison of the number of moles or molecules of gas on each side of the equation. Answers that focused on changes in the rate of reaction or particle collisions were not creditworthy, nor were those which stated that the equilibrium shifted to the side with lower pressure.

07.4 This question was not well answered and only around 2% of students were awarded both marks. The most common creditworthy responses were based on the idea that a higher pressure is not used because the yield is already high or because more energy would be required to achieve a higher pressure. Many answers could not be given credit because they were not comparative. Higher risk of explosion or higher cost of safety precautions were creditworthy responses that focused on the consequences of using higher pressure compared to using a lower pressure.

07.5 This multiple-choice question was answered correctly by around a quarter of students who used their periodic table to locate and identify vanadium as a transition metal.

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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

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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.

4.6.1.4 Catalysts

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Question 8

08.1 Three quarters of students described correctly how gas escaped from the flask to cause the decrease in mass, however, students did not always say that the gas was a product of the reaction which was marking point 1. A few students incorrectly said that the gas evaporated, which was not accepted.

08.2 Three quarters of students described how catalysts provide an alternative pathway for the reaction. A description of a shorter pathway is not equivalent to an

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alternative pathway. Marking points 2 and 3 needed comparative statements between catalyst A and B. Some students just described in general how catalysts lower activation energy. This was not enough for these two marking points. Students needed to say the activation energy was lower using B. Saying catalyst B requires a lower activation energy was also not accepted, because a catalyst provides or allows a lower activation energy rather than requiring or needing one.

08.3 This style of question is becoming more familiar to students, with over 4 in 5 gaining at least 2 marks, which would require the drawing of a tangent. Over half of all students went on to correctly calculate the rate and give the answer in standard form. Answers were often well set out showing clearly which graph points had been used to calculate the gradient. Students could successfully quote the number in standard form. There were still quite a few students who just read the value of mass and time from the graph. Without a tangent, students could only gain the mark for an answer given in standard form.

08.4 Over 40% of students gave good answers that scored full marks. Students are well versed in describing how particles have more energy at higher temperatures. The idea of particles colliding more frequently was still a stumbling block for some; some students forgetting to include the word frequently. Very few students used the idea of a greater chance of collision that is not equivalent to frequency, which is a positive sign.

4.6.1.4 Catalysts

Answer 48 · Examiner comments

Question 9

09.1 Three quarters of students scored at least one mark on this item. This was for either identifying the forward reaction as endothermic, or giving the allow statement for marking point 3, that a high temperature increases the rate. The answers for marking point 2 were often quite vague, talking about the reaction moving to the right-hand side, rather than the position of the equilibrium. Many students gave answers in terms of the Haber process, rather than the given reaction, so answers that suggest an increase in the yield of ammonia were incorrect.

09.2 Fewer than half of students scored either or both marks for this high demand item. The most common response was for identifying that the equilibrium position moved to the right, with far fewer giving the link to the number of molecules on either side of the equation. Many incorrect answers were seen in terms of rate of reaction, or because safety is a factor.

09.3 Two thirds of students correctly identified that catalysts have no effect on the position of the equilibrium.

09.4 It is quite rare to ask for an estimate in a calculation question and this was included because the percentage of nitrogen in the air is given as four fifths in the specification. Around 40% of students recognised that nitrogen makes up between

4.6.1.4 Catalysts

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78 and 80% of the atmosphere, so would require between 62 and 65 dm^3 of air to produce 50 dm^3 of nitrogen. Where students did not score was because they did not know the percentage of nitrogen in the air.

09.5 Around half of students gained at least one mark on this item, usually for the idea that ammonia condenses. Far fewer students knew that this is done by cooling the mixture or that both nitrogen and hydrogen stay as gases and are recycled, many only mentioning recycling, which was given in the diagram.

09.6 Around two-thirds of students gained at least one mark for this high demand interpretation question. The most common answer was for linking carbon dioxide to climate change. Many students did not gain this mark as there was a need to mention that the production of hydrogen causes this, if further detail was given. Mant talked about hydrogen producing carbon dioxide, which is incorrect and did not gain credit. The next most common response was for the idea that nitrogen was abundant in the atmosphere.

4.6.1.4 Catalysts

Mark Ranges and Award of Grades

Grade boundaries and cumulative percentage grades are available on the Results Statistics page of the AQA Website.