AQA GCSE Combined Science - Trilogy | 8464

SPECIFICATION POINT 5.8.1.2

Formulations

Mark schemes and examiner comments

Tier	**Higher**
Question groups	**4**
Available paper years	**2018–2025**

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.

5.8.1.2 Formulations

Answer 01 · Mark scheme

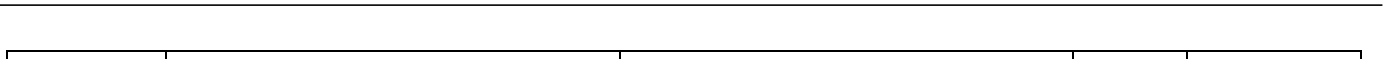
June 2018 | 8464/C/2H | Original Q4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	a mixture designed as a useful product		1	AO1 5.8.1.2
04.2		an answer of 1.8×10^2 (mol) gains **4** marks		AO2 5.8.1.2 5.3.2.1
	mass = 14 520 g		1	
	(=) $\frac{14\,520}{80\ (\text{mol})}$	allow correct substitution of incorrectly converted mass must use M_r given (80) to gain marks in steps 2 and 3	1	
	(=) 181.5 (mol)		1	
	(=) 1.8×10^2 (mol)	allow answer correctly given in standard form to correct sig figs from an incorrect calculation	1	
04.3		**max 2** marks for incorrect reference to bonding **or** structure **or** particles		AO1 5.2.2.3
	(giant) lattice	allow giant structure	1	
	ionic		1	
	strong bonds **or** strong electrostatic forces	do **not** accept strong intermolecular forces / bonds	1	
	large amounts of energy needed to overcome	ignore heat	1	
Total			**9**	

5.8.1.2 Formulations

Answer 01 · Mark scheme

June 2018 | 8464/C/2H | Original Q4



5.8.1.2 Formulations

Answer 02 · Mark scheme

June 2019 | 8464/C/2H | Original Q3

03.1	a mixture designed as a useful product		1	AO1 5.8.1.2
03.2	dyes distributed differently between the stationary and mobile phase	allow dyes have different solubilities allow dyes have different forces of attraction for stationary phase allow dyes have different forces of attraction for mobile phase allow dyes have different forces of attraction to the paper allow dyes have different forces of attraction to the solvent ignore density	1	AO1 5.8.1.3
	(so dyes) move up the paper at different speeds / rates	allow (so dyes) move different distances up the paper ignore references to time	1	
03.3	(because chromatogram has) different dots / colours		1	AO2 5.8.1.3
	in a (vertical) column	allow above the (original) spot	1	
03.4	run known dyes and food colouring (as a chromatogram)		1	AO2
	compare distances moved **or** compare R_f values		1	AO2
	(so) can identify those that move the same distance as known dyes **or** (so) can identify those that have the same R_f values as known dyes	allow (so) can identify those that move different distances as unknown dyes **or** allow (so) can identify those that have different R_f values as unknown dyes	1	AO2 5.8.1.3
Total			**8**	

5.8.1.2 Formulations

Answer 02 · Mark scheme

June 2019 | 8464/C/2H | Original Q3

Question	Answers	Extra information	Mark	AO / Spec. Ref.

5.8.1.2 Formulations

Answer 03 · Mark scheme

June 2023 | 8464/C/2H | Original Q3

Question 3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	(crude oil is a mixture but) not a useful product	allow (crude oil is) not designed for a specific purpose	1	AO2 5.7.1.1 5.8.1.2
	(and) not mixed in carefully measured quantities	allow not the same composition all the time	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.2	(crude oil) is heated to vaporise (the hydrocarbons)	allow (crude oil) is heated to evaporate the hydrocarbons	1	AO1 5.7.1.2
	temperature (of column) decreases from bottom to top	allow the column gets cooler going up	1	
	(so) the fractions / hydrocarbons condense at different heights (in the column)		1	
	(because) the fractions / hydrocarbons have different boiling points		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.3	(to make) smaller (hydrocarbon) molecules		1	AO1 5.7.1.4
	any **one** from: (which are) • more useful molecules • useful as fuels • starting materials	allow (which are) in higher demand allow (which are) alkenes for the production of other chemicals	1	

5.8.1.2 Formulations

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.4	(test) burning / lit splint	MP2 is dependent upon MP1 being awarded allow flame do **not** accept glowing splint	1	AO2
	(result) burns with a (squeaky) pop sound	allow pops	1	AO1 5.8.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.5	C_2H_4		1	AO2 5.7.1.1 5.7.1.4

Total Question 3	11

5.8.1.2 Formulations

Answer 04 · Mark scheme

Question 4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	a mixture that has been designed as a useful product		1	AO1 5.8.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.2	91 kJ/mol		1	AO2 5.6.2.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.3	Le Chatelier		1	AO1 5.6.2.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.4	the proportion of methanol decreases		1	AO2 5.6.2.4 5.6.2.6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.5	the proportion of methanol stays the same		1	AO3 5.6.1.4 5.6.2.4

5.8.1.2 Formulations

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.6	(increasing the pressure) increases the proportion of methanol		1	AO2 5.6.2.4 5.6.2.7
	(because) there are more molecules / moles of reactant (than product)		1	
	(so) the equilibrium (position) shifts to the side with fewer molecules / moles		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.7	(the catalyst) increases the rate of the reaction		1	AO1 5.6.1.4
	(by) providing an alternative pathway (for the reaction)		1	
	(with) a lower activation energy		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.8	reduces the costs		1	AO2 5.6.1.4 5.9.2.2
	(because) less energy is used		1	5.9.2.4
	OR			
	less fuels burned (1)			
	(so) less contribution to global warming (1)	allow (so) less carbon dioxide produced		

5.8.1.2 Formulations

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.9	$CO_2 + 3\,H_2 \rightarrow CH_3OH + H_2O$	allow multiples allow **1** mark for $CO_2 + H_2 \rightarrow CH_3OH + H_2O$ with no / incorrect balancing numbers	2	AO2 5.3.1.1

Total Question 4	**15**

5.8.1.2 Formulations

Answer 01 · Examiner comments

Question 4 (standard, standard / high & high demand)

04.1 22% of students knew the definition from the specification or were able to give an equivalent statement. Often students mentioned only that it was 'a mixture or chemicals mixed together' but omitted the idea of 'to form a useful product'. Some students were able to give examples, but not a definition.

As the question stem mentioned fertilisers, a few students answered the question with phrases such as a substance / something to help plants grow or to enhance plant growth.

04.2 5% of students achieved full marks but many students (63%) gained some credit for their calculation. The most common answers that achieved two marks were 0.18 or 0.1815, (not converting 14.52 kg to g and an omission or incorrect conversion of their calculation into standard form to two significant figures).

An answer of 1.8×10^{-1} achieved three marks, the calculation being correct, but the students had not undertaken the initial conversion of kg into g. Several students had multiplied an answer within their calculation by Avogadro's number.

04.3 51% of students achieved some credit on this question. However, there were many references to intermolecular forces (often strong intermolecular forces), covalent bonds and molecules, all of which limited the response to a maximum of two marks.

Many students described in detail how potassium, being in Group 1 of the periodic table would transfer one electron to chlorine which is in Group 7 to obtain full outer shells meaning that the compound would have a high melting point. 'Ionic bonds' was often seen but normally as part of a lengthy explanation of how and why potassium transfers one electron to chlorine.

1% of students achieved full marks, with 7% of students achieving three marks; the description of a 'lattice' or 'giant structure' was seldom seen.

5.8.1.2 Formulations

Answer 02 · Examiner comments June 2019 | 8464/C/2H | Original Q3

Question 3 (standard/high demand)

03.1 A minority of students knew the definition of a formulation from the specification or were able to give an equivalent statement. Often students mentioned that it was ‘a mixture’ or ‘chemicals mixed together’ but omitted the idea of ‘to form a useful product’. Some students were able to give examples, but not a definition.

03.2 A large number of students did not explain how chromatography separates the dye. Instead they explained in detail how a chromatography experiment would be undertaken to separate the dyes.

Just over a third of students gained some credit, mostly for the idea that different dyes had different solubilities. A significant number of students incorrectly stated the reason was related to the densities of the dyes. The second marking point was for conveying the idea that the different dyes travel up the chromatography paper at different rates/speeds or distances. However, there were many vague responses referring to different points or places.

Answer 02 · Examiner comments June 2019 | 8464/C/2H | Original Q3

03.3 The majority of students gained at least one mark but only a small minority gained both marks. Responses referred to the food colouring separating into more than one colour/spot/dot on the chromatogram but rarely indicated that these colours/spots would appear vertically above the original dye. Some students described how it was possible to identify the colours separated by ‘matching them against other colours’, which was not asked for in the question.

03.4 Many students failed to gain the first marking point due to not elaborating on ‘do the chromatography experiment’ rather than explain (as requested by the command word) how to conduct the experiment.

Students gained credit for stating that the distances travelled needed to be measured or the R_f values calculated, but then omitted to state how these values could be used to either confirm the identity of the unknown dyes or identify which dyes remained unidentified.

5.8.1.2 Formulations

Answer 03 · Examiner comments June 2023 | 8464/C/2H | Original Q3

Question 3

03.1 This question required an application of the definition of a formulation, which students found difficulty with. Only a quarter of students gained at least one mark, usually for the idea that a formulation is made for a specific purpose. Few went on to give the idea that crude oil has a variable composition.

03.2 The steps in fractional distillation were not well known and often produced muddled sequencing. Two thirds of students gained at least one mark, usually for the idea that fractions have different boiling points (though some referred to melting points). Fewer than two in five went on with further descriptions, and one in five gained either three or four marks.

03.3 About one third of students gained two marks, with a further one in five getting one mark. This was usually for the idea that cracking produces smaller molecules. A specific use such as fuels or as a starting material for making polymers was credited for the second mark, whilst many students said that smaller molecules were more useful, were more in demand, or had more uses, all of which were creditworthy.

03.4 About half of students were able to describe the test for hydrogen, which had to be identified from the given equation. The gas tests are not well known and need to be learnt, so that they are expressed clearly.

03.5 Four in five students correctly identified the alkene.

5.8.1.2 Formulations

Answer 04 · Examiner comments

Question 4 (Standard, Standard/High and High demand)

04.1 Although well attempted, only a third of students were able to accurately describe a formulation. Several students knew that it was a mixture but did not expand on this any further to give the reason for the mixture. Several knew that you needed to add a number of substances together for a purpose but did not know that this would then be a mixture.

04.2 Well over half of students were able to select the correct response of 91 kJ/mol.

04.3 Half of all students could identify Le Chatelier as the scientist, although there were a variety of spellings offered.

04.4 Half of all students were able to select the correct response of 'the proportion of methanol decreases'. The most common incorrect answer was the opposite, being the proportion of methanol increases.

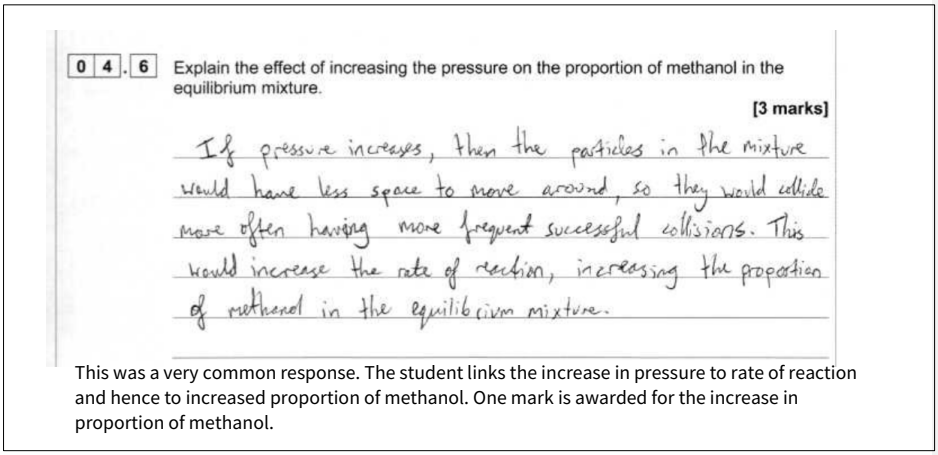
04.5 Again, half of all students were able to select the correct response of the proportion of methanol stays the same. A significant number however selected the proportion of methanol increases.

04.6 Students found equilibrium difficult. A large number of students related the increase in pressure to an increase in energy and number of collisions and hence an increase in the rate of reaction, but did not make any link to the effect on equilibrium.
A common misconception appeared to be that the proportion of methanol in the mixture was equivalent to the yield of methanol. Only a quarter of students gained 1 mark, with very few scoring 2 or 3.

© 2024 AQA and its licensors. All rights reserved.

5.8.1.2 Formulations

Answer 04 · Examiner comments June 2025 | 8464/C/2H | Original Q4



0 4 . 6 Explain the effect of increasing the pressure on the proportion of methanol in the equilibrium mixture.

[3 marks]

If pressure increases, then the particles in the mixture would have less space to move around, so they would collide more often having more frequent successful collisions. This would increase the rate of reaction, increasing the proportion of methanol in the equilibrium mixture.

This was a very common response. The student links the increase in pressure to rate of reaction and hence to increased proportion of methanol. One mark is awarded for the increase in proportion of methanol.

04.7 Most students were able to state that a catalyst will increase the rate of a reaction. Less were able to explain that this is due to a lowered activation energy, and even fewer could link this to an alternative reaction pathway.
There was a common misconception that catalysts increase the rate of a reaction due to there being more frequent collisions, as this is a common explanation for how changing other factors affects the rate of reaction. Some students also incorrectly stated that catalysts cause the particles to gain energy.

04.8 Only half of all students answered this question well. Most of these identified that less energy used would be cheaper, but very few linked the idea of less fuels burning and the reduced contribution to global warming.
Some students gave ideas around the speed of the reaction decreasing at a lower temperature so the reaction could be controlled/monitored/more accurate results, lower temperatures being safer to work with, or lower temperatures resulting in less evaporation of methanol.

04.9 Just under a third of students gained both marks.
A large number of students did not know the formula for hydrogen and 6H was commonly used instead of $3H_2$
A small number of students could not gain marks due to errors in the size of the letter used eg Co_2 rather than CO_2 and $H2o$ rather than H_2O.
Students are expected to use subscript, superscript and size of letters appropriately.