AQA GCSE Chemistry | 8462

SPECIFICATION POINT 4.6.1.1

# Calculating rates of reactions

## Mark schemes and examiner comments

| | |
|---|---|
| Tier | **Foundation** |
| Question groups | **19** |
| Available paper years | **2008–2025** |

## Using this booklet

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

**Name:** _____ **Date:** _____

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

### 4.6.1.1 Calculating rates of reactions

**Answer 01 · Mark scheme**

January 2008 | CHY2F | Original Q6 | Legacy

**Question 6**

| question | answers | extra information | mark |
|---|---|---|---|
| (a) | sensible line of best fit which goes through or close to all the points **except** the anomalous point | allow wobbly / short double lines<br><br>± ½ square | 1 |
| (b) | loss of gas / loss of $CO_2$ | idea of gas produced / formed | 1 |

4.6.1.1 Calculating rates of reactions

Answer 02 · Mark scheme

June 2009 | CHY2F | Original Q7 | Legacy

## Question 7

| question | answers | extra information | mark |
|---|---|---|---|
| 7(a)(i) | a continuous straight line missing anomalous point | allow a line which does not start at zero / origin | 1 |
| 7(a)(ii) | any **two** sensible errors eg<br>• timing errors and / or example<br>• measurement errors and / or example<br>• apparatus errors and / or example<br>• human / experimental / random error and / or example or 'did not do it right'<br>• temperature fluctuation<br>• anomalous point<br>• results not recorded correctly<br>• plotting error<br>• rate calculated incorrectly | ignore systematic / zero error / weighing error **or** error unqualified<br>could be two from **same** category eg two timing errors – watch not started at the same time plus difficulty in deciding when the cross has disappeared.<br>accept outlier / wrong result<br>ignore 'not repeated' | 2 |
| 7(b)(i) | straight line<br>**or**<br>as concentration increases the rate goes up **or** converse | accept numerical example<br>accept positive correlation<br>accept same gradient<br>ignore 'most points near / on line of best fit' | 1 |

**Question 7 continues on the next page…**

**CHY2F**

**Question 7 Continued**

| question | answers | extra information | mark |
|---|---|---|---|
| **7**(b)(ii) | more collisions | accept greater chance of collisions<br><br>accept collide more successfully<br><br>accept alternative versions of collide eg 'bump / hit'<br><br>ignore references to energy / speed of particles / surface area | 1 |
| | more particles (in each volume of solution)(i.e. an attempt at defining concentration) | accept 'particles are closer together'<br><br>allow ions / atoms / molecules for particles ignore reactants<br><br>accept greater frequency of collisions **or** greater number of collisions per second for **2** marks | 1 |
| **Total** | | | **6** |

### 4.6.1.1 Calculating rates of reactions

**Answer 02 · Mark scheme**

June 2009 | CHY2F | Original Q7 | Legacy

**CHY2F**

### 4.6.1.1 Calculating rates of reactions

**Answer 03 · Mark scheme**

January 2013 | CH2FP | Original Q7 | Legacy

| question | answers | extra information | mark |
|---|---|---|---|
| **7(a)** | because sulfur / S forms<br>which is insoluble / a solid / a precipitate | | 1<br>1 |
| **7(b)(i)** | 32 | correct answer with or without working gains **2** marks<br>accept evidence of 31 + 33 / 2 for **1** mark<br>allow 35 for **1** mark | 2 |
| **7(b)(ii)** | reaction rate increases<br>because of more particles (per unit volume)<br>and because there is an increase in frequency of collisions | if incorrect reference to energy = max **2**<br>allow because particles are closer together<br>accept because particles are more likely to collide **or** higher chance of collision<br>ignore more (successful) collisions | 1<br>1<br>1 |
| **Total** | | | **7** |

### 4.6.1.1 Calculating rates of reactions

**Answer 03 · Mark scheme**



January 2013

**CH2FP**

4.6.1.1 Calculating rates of reactions

Answer 04 · Mark scheme

June 2013 | CH2FP | Original Q6 | Legacy

**Question 6**

| question | answers | extra information | Mark |
|---|---|---|---|
| 6(a) | any **two** from:<br>• effervescence / bubbles / fizzing<br>• magnesium disappears / dissolves<br>• heat given off / exothermic<br>• change in pH | <br>allow gas / hydrogen is given off<br>allow volume of gas<br>allow magnesium floats<br>allow change in mass of magnesium<br>allow temperature change<br>do **not** accept temperature decreases<br>do **not** accept pH decreases | 2 |

| 6(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. | | 6 |
|---|---|---|---|
| **0 marks** | **Level 1 (1-2 marks)** | **Level 2 (3-4 marks)** | **Level 3 (5-6 marks)** |
| No relevant content. | A simple plan without reference to changing any variable but should include an attempt at measuring rate **or** an attempt at fair testing | A plan including change of concentration / 'volume' of acid **and** should include an attempt at measuring rate **and / or** an attempt at fair testing | A workable plan including change of concentration **and** measurement of rate **and** fair testing |

**examples of chemistry points made in the response could include:**

**Plan:**

- add magnesium to acid
- time reaction / 'count bubbles' / measure volume of gas
- change concentration / 'volume' of acid

**Control Variables:**

- amount / mass / length / same 'size' of magnesium
- volume / amount of acid

| Total | | | 8 |
|---|---|---|---|

### 4.6.1.1 Calculating rates of reactions

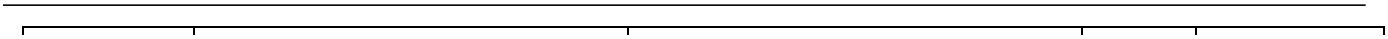
**Answer 05 · Mark scheme** June 2015 | CH2FP | Original Q5 | Legacy

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **5(a)(i)** | the higher the temperature, the greater the rate<br><br>**or**<br>at 40 °C rate is faster than at 20 °C | accept the higher the temperature, the faster the reaction | 1 | **AO3**<br>2.4.1c |
| **5(a)(ii)** | 40 °C curve is steeper<br><br>**or**<br>correct comparison of data from the graph | accept the 40 °C line becomes horizontal sooner<br><br>accept at higher temperatures the reaction finishes sooner<br><br>accept reaction finishes sooner at 40 °C<br><br>accept at higher temperatures the gas is produced faster | 1 | **AO3**<br>2.4.1c |
| **5(a)(iii)** | 2 | | 1 | **AO2**<br>2.4.1a |
| **5(b)(i)** | Concentration of acid<br>Mass of marble chips | | 2 | **AO3**<br>2.4.1e |
| **5(b)(ii)** | increases rate<br><br>(because of) more frequent collisions (between particles) | incorrect reference to energy = max **1**<br><br>accept particles are more likely to collide<br><br>ignore more collisions<br><br>ignore more successful collisions | 1<br><br>1 | **AO1**<br>2.4.1f |
| **5(c)** | any **one** from:<br>• increases rate of reaction<br>• reduces energy required<br>• lower temperature can be used<br>• catalyst is not used up | | 1 | **AO1**<br>2.4.1g,h |
| **Total** | | | **8** | |

### 4.6.1.1 Calculating rates of reactions

**Answer 05 · Mark scheme**

June 2015 | CH2FP | Original Q5 | Legacy



### 4.6.1.1 Calculating rates of reactions

**Answer 06 · Mark scheme**

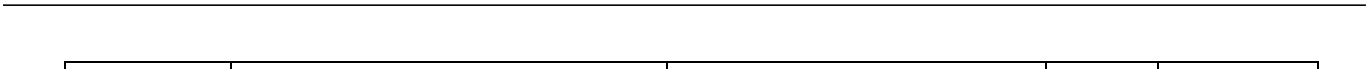
June 2016 | CH2FP | Original Q4 | Legacy

| Question | Answers | Extra information | Mark | AO / SpecRef |
|---|---|---|---|---|
| **4(a)** | sulfur dioxide | accept $SO_2$ | 1 | AO2<br>2.6.1a |
| **4(b)(i)** | curved line of best fit between the 4 non-anomalous points | | 1 | AO2<br>2.4.1a |
| **4(b)(ii)** | temperature was lower (than 40 °C) | accept student missed the moment when the cross disappeared<br>accept smaller volume of acid or acid more dilute | 1 | AO3<br>2.4.1c |
| **4(b)(iii)** | 0.005 **or** 1/200 | correct answer with or without working gains **2** marks<br>if answer incorrect, allow **1** mark for 0.32 / 64 | 2 | AO2<br>2.4.1a |
| **4(b)(iv)** | The particles move faster.<br>The particles collide with more energy. | | 1<br>1 | AO1<br>2.4.1c |
| **4(b)(v)** | activation | | 1 | AO1<br>2.4.1.b |
| **Total** | | | **8** | |

### 4.6.1.1 Calculating rates of reactions

**Answer 06 · Mark scheme**

June 2016 | CH2FP | Original Q4 | Legacy



4.6.1.1 Calculating rates of reactions

Answer 07 · Mark scheme

June 2017 | CH2FP | Original Q5 | Legacy

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| 5(a)(i) | a smooth curve through or close to all points except (30,12) | | 1 | AO2 2.4 |
| 5(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 |
| 5(a)(iii) | 45-50 (seconds) | | 1 | AO3 2.4 |
| 5(a)(iv) | line becomes less steep<br><br>because gas is produced more slowly | ignore line levels out or plateaus<br><br>allow examples with figures, eg 12 $cm^3$ gas from 0 to 20s but 1.5 $cm^3$ gas in last 20s<br>ignore reaction has stopped or no more gas produced | 1<br><br>1 | AO3 2.4 |
| 5(a)(v) | 0.6 ($cm^3$ per second) | allow 0.55 to 0.65 | 1 | AO2 2.4 |
| 5(b)(i) | <br><br>temperature<br>volume (of hydrogen peroxide) | concentration of hydrogen peroxide = max **1**<br><br><br>ignore amount (of hydrogen peroxide) | <br><br>1<br>1 | AO3 2.4 |
| 5(b)(ii) | <br><br>rate increases<br>because more particles (in the same volume)<br>so frequency of collisions increases | incorrect reference to energy = max **2**<br><br><br>accept particles closer together<br><br>allow greater chance of collisions<br>ignore more collisions | <br><br>1<br>1<br><br>1 | AO1 2.4.1e |

### 4.6.1.1 Calculating rates of reactions

**Answer 07 · Mark scheme**



| | | | | |
|---|---|---|---|---|
| **5(c)** | (increasing the amount of catalyst) increases rate<br><br>same final volume of gas | accept steeper graph or graph levels off earlier | 1<br><br>1 | **AO2**<br>2.4.1g |
| **Total** | | | **13** | |

4.6.1.1 Calculating rates of reactions

Answer 07 · Mark scheme

June 2017 | CH2FP | Original Q5 | Legacy

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| 6 | | | 6 | AO1<br>2.1.1h<br>2.2.4b,c<br>2.2.5a,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.

| 0 marks | Level 1 (1–2 marks) | Level 2 (3–4 marks) | Level 3 (5–6 marks) |
|---|---|---|---|
| no relevant information given | a statement about the structure or a property of a metal<br>**or**<br>a statement about the structure or a property of a polymer | a statement about the structure or a property of a metal<br>**and**<br>a statement about the structure or a property of a polymer | a statement about the structure or a property of a metal<br>**and**<br>a statement about the structure or a property of a polymer<br>**and**<br>at least one statement linking structure and property |

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.

**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

Answer 07 · Mark scheme



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

| | | | |
|---|---|---|---|
| **Total** | | | **6** |

### 4.6.1.1 Calculating rates of reactions

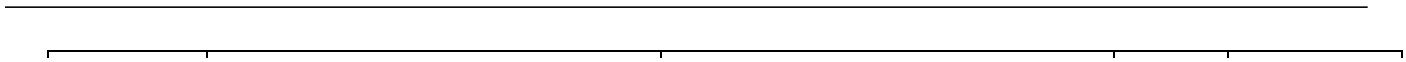
**Answer 08 · Mark scheme** June 2017 | CH3FP | Original Q3 | Legacy

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **3(a)(i)** | air | allow air circled in the box | 1 | **AO1** 3.5.1.a |
| **3(a)(ii)** | tick (✓) by:<br>lowers the activation energy | | 1 | **AO1** 3.3.1h |
| **3(a)(iii)** | (gases) cooled<br>(ammonia) condensed | <br>ignore turn to a liquid<br><br>if no other mark, allow fractional distillation for 1 mark | 1<br>1 | **AO1**<br>**AO2** 3.5.1b |
| **3(b)** | hydrogen<br>ammonia | must be in correct order | 1 | **AO1** 3.5.1b |
| **3(c)(i)** | all points correctly plotted | allow 1 mark for **3** correct points<br>allow +/- one small square | 2 | **AO2** 3.5.1b |
| **3(c)(ii)** | correctly drawn line | | 1 | **AO2** 3.5.1b |
| **3(c)(iii)** | line extrapolated to at least 300°C<br>0.50 - 0.60 | | 1<br>1 | **AO2** 3.5.1b |
| **3(c)(iv)** | increases | | 1 | **AO2** 3.5.1b |
| **Total** | | | **11** | |

### 4.6.1.1 Calculating rates of reactions

**Answer 08 · Mark scheme**

June 2017 | CH3FP | Original Q3 | Legacy



### 4.6.1.1 Calculating rates of reactions

**Answer 09 · Mark scheme** June 2018 | 8462/2F | Original Q7

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **07.1** | 83 ($cm^3$) | allow 83.0 / 83.00 | 1 | AO2<br>4.6.1.2 |
| **07.2** | mass of magnesium powder<br><br>temperature of hydrochloric acid | | 1<br><br>1 | AO1<br>4.6.1.2 |
| **07.3** | <br><br>$\frac{(46 + 47 + 49)}{3}$<br><br>= 47 ($cm^3$) (2 sf) | an answer of 47 ($cm^3$) scores **2** marks<br><br>allow 47.3(333) ($cm^3$) for **1** mark<br><br>an answer of 43 ($cm^3$) scores **1** mark | <br><br>1<br><br>1 | AO2<br>4.6.1.1<br>4.6.1.2 |
| **07.4** | all points plotted correctly (inc 0,0) | allow a tolerance of ± ½ a square<br>allow ecf from question **07.3**<br>ignore line<br><br>allow **1** mark for four points plotted correctly | 2 | AO2<br>4.6.1.1<br>4.6.1.2 |
| **07.5** | <br><br>$\frac{80}{50}$<br><br>= 1.6 ($cm^3$/s) | an answer of 1.6 ($cm^3$/s) scores **2** marks<br><br>allow 80 ± 2<br><br>allow 1.60 ± 0.04 | <br><br>1<br><br>1 | AO2<br>4.6.1.1 |
| **07.6** | rate is greatest at start<br><br>(then) rate decreases<br><br>reaction stops | allow rate is faster at start<br><br>allow (then) rate slows down | 1<br><br>1<br><br>1 | AO2<br>4.6.1.1<br>4.6.1.2 |

### 4.6.1.1 Calculating rates of reactions

**Answer 09 · Mark scheme**

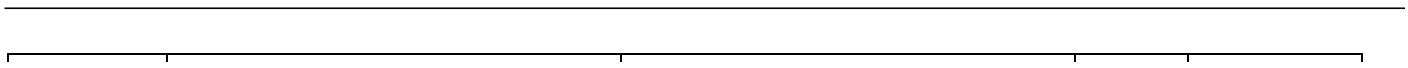


| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **07.7** | there are more particle collisions each second<br><br>there are more particles in the same volume | | 1<br><br>1 | AO1<br>4.6.1.3 |
| **07.8** | (gas is) not carbon dioxide | ignore does not react with limewater | 1 | AO3<br>4.8.2.3 |
| **07.9** | hydrogen<br><br>pop sound | allow $H_2$ | 1<br><br>1 | AO1<br>4.8.2.1 |
| **Total** | | | **17** | |

### 4.6.1.1 Calculating rates of reactions

**Answer 09 · Mark scheme**

June 2018 | 8462/2F | Original Q7



4.6.1.1 Calculating rates of reactions

Answer 10 · Mark scheme

June 2019 | 8462/2F | Original Q7

## Question 7

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **07.1** | a glowing splint | | 1 | AO1<br>4.8.2.2 |
| **07.2** | student **A** should measure the mass of manganese dioxide. | | 1 | AO3<br>4.6.1.1<br>4.6.1.2 |
| **07.3** | calculate a mean but do not include any anomalous results. | | 1 | AO3<br>4.6.1.1<br>4.6.1.2 |
| **07.4** | | an answer of 0.173 ($cm^3$/s) scores **4** marks | | AO2<br>4.6.1.1 |
| | (volume of oxygen formed =) (58 - 20 =) 38 ($cm^3$) | allow values between 36 ($cm^3$) and 40 ($cm^3$) inclusive | 1 | |
| | (time taken = 250 – 30 =) 220 (s) | | 1 | |
| | $\frac{38}{220}$ **or** 0.1727 ($cm^3$/s) | allow a correct calculation using an incorrectly determined value for volume and / or time | 1 | |
| | = 0.173 ($cm^3$/s) | allow a correctly calculated answer given to 3 significant figures from an incorrect attempt at the rate equation | 1 | |
| **07.5** | line starts at the origin **and** steeper than existing line<br><br>final volume same as existing line | allow a tolerance of ± ½ a small square | 1<br><br>1 | AO2<br>4.6.1.1 |
| **07.6** | fine manganese dioxide powder has a larger surface area | | 1 | AO3<br>4.6.1.2<br>4.6.1.3 |
| **Total** | | | **10** | |

4.6.1.1 Calculating rates of reactions

Answer 11 · Mark scheme

June 2019 | 8462/2F | Original Q10

## Question 10

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **10.1** | (aq) | allow aqueous / aq | 1 | AO1<br>4.2.2.1<br>4.2.2.2 |
| **10.2** | (gas) syringe<br><br>stopclock / stopwatch | allow measuring cylinder (and water trough)<br>allow balance<br><br>allow timer / clock / watch | 1<br><br>1 | AO1<br>4.6.1.1 |
| **10.3** | all points plotted correctly<br><br>line of best fit | allow a tolerance of ± ½ a small square<br><br>allow at least 3 points plotted correctly for **1** mark.<br><br>allow correctly drawn line of best fit for incorrectly plotted points | 2<br><br>1 | AO2<br>4.6.1.1 |
| **10.4** | (rate) decreases<br><br>(rate decreases) more slowly as time increases<br><br>(rate) becomes zero at 60 s | allow slows down<br><br>allow (rate decreases) at a non-linear rate<br><br>allow the reaction stops at 60 s<br>allow ecf from question **10.3** | 1<br><br>1<br><br>1 | AO3<br>4.6.1.1 |
| **10.5** | more bubbles were produced in the first 10 seconds<br><br>the magnesium was used up more quickly | | 1<br><br>1 | AO2<br>4.6.1.2 |
| **Total** | | | **11** | |

4.6.1.1 Calculating rates of reactions

Answer 12 · Mark scheme

November 2020 | 8462/2F | Original Q3

## Question 3

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **03.1** | measuring cylinder | allow pipette / burette | 1 | AO3<br>4.6.1.1 |
| **03.2** | limewater turns milky | | 1 | AO1<br>4.8.2.3 |
| **03.3** | all six points plotted correctly<br><br>line of best fit | allow a tolerance of ± ½ a small square<br>allow **1** mark for four or five points plotted correctly | 2<br><br>1 | AO2<br>4.6.1.1 |
| **03.4** | (volume =) 48 ($cm^3$)<br><br>(rate=) $\frac{48}{60}$<br><br>= 0.8 ($cm^3/s$) | <br><br>allow correct use of an incorrectly determined value for volume | 1<br><br>1<br><br>1 | AO2<br>4.6.1.1 |
| **03.5** | (between 0 and 20 seconds)<br>(volume of gas) increases<br><br>(between 80 and 100 seconds)<br>no change (in volume of gas) | <br><br>allow reaction stops | 1<br><br>1 | AO2<br>4.6.1.1 |

**Question 3 (continued)**

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **03.6** | systematic error | | 1 | AO3<br>4.6.1.1 |
| **03.7** | (area of one face = 2 x 2 =) 4 ($mm^2$)<br><br>(total surface area =) 4 x 6<br><br>= 24 ($mm^2$) | <br><br>allow correct use of an incorrectly calculated area of one face<br><br> | 1<br><br>1<br><br>1 | AO2<br>4.6.1.2 |
| **03.8** | faster | | 1 | AO1<br>4.6.1.3 |
| **Total** | | | **15** | |

4.6.1.1 Calculating rates of reactions

Answer 13 · Mark scheme

November 2021 | 8462/2F | Original Q4

## Question 4

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| 04.1 | (equation contains the symbol)<br>⇌ | allow description of arrow / symbol | 1 | AO1<br>4.6.2.1 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| 04.2 | the mass of each substance does not change<br><br>the rates of the forward reaction and reverse reaction are equal | | 1<br><br>1 | AO3<br><br>AO1<br><br>4.6.2.3 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| 04.3 | the mixture will have become a paler purple | | 1 | AO3<br>4.6.2.3 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| 04.4 | increases<br><br>decreases<br><br>increases | must be in this order | 1<br><br>1<br><br>1 | AO1<br>4.6.1.2<br>4.6.1.3 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| 04.5 | change the temperature<br><br>**or**<br><br>add a catalyst | ignore references to pressure | 1 | AO1<br>4.6.1.2<br>4.6.1.3 |

| Total | | | 8 |
|---|---|---|---|

4.6.1.1 Calculating rates of reactions

Answer 14 · Mark scheme

November 2021 | 8462/2F | Original Q5

## Question 5

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| 05.1 | (diagram)<br>gas syringe<br>**or**<br>inverted measuring cylinder over water | | 1 | AO3<br>4.6.1.2<br>RPA5 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| 05.2 | (error)<br>(delivery) tube is in (sulfuric) acid<br><br>(problem)<br>(sulfuric) acid will travel up tube<br>**or**<br>no hydrogen / gas will be collected | | 1<br><br>1 | AO3<br>4.6.1.2<br>RPA5 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| 05.3 | line of best fit | must include 0, 0 | 1 | AO2<br>4.6.1.1<br>4.6.1.2<br>RPA5 |

**Question 5 continued**

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **05.4** | (volume of gas =) 45 ($cm^3$) | allow a tolerance of ± ½ a small square<br><br>allow volume from drawn curve | 1 | AO2<br>4.6.1.1<br>4.6.1.2<br>RPA5 |
| | (rate =) $\frac{45}{60}$ | allow correct use of incorrectly determined volume at 60 seconds | 1 | |
| | = 0.75 | | 1 | |
| | $cm^3/s$ | | 1 | |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **05.5** | the line of best fit for higher concentration would have a steeper slope | | 1 | AO1<br>4.6.1.1<br>4.6.1.2<br>RPA5 |

| Total | | | 9 |
|---|---|---|---|

4.6.1.1 Calculating rates of reactions

Answer 15 · Mark scheme

November 2021 | 8462/2F | Original Q7

## Question 7

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **07.1** | fuel | | 1 | AO1<br>4.7.1.2 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **07.2** | propene | | 1 | AO2<br>4.7.2.1<br>4.7.3.1 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **07.3** | (percentage yield =) $\frac{380}{400} \times 100$<br><br>= 95 (%) | | 1<br><br>1 | AO2<br>4.3.3.1 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **07.4** | some ethanol changes back into ethene and steam<br><br>some ethanol escapes from the apparatus | | 1<br><br>1 | AO2<br>4.3.3.1 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **07.5** | $C_2H_5OH$ + **3** $O_2$ → 3 $H_2O$ + 2 $CO_2$ | allow multiples | 1 | AO2<br>4.1.1.1<br>4.3.1.1<br>4.7.2.3 |

**Question 7 continued**

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **07.6** | (advantages)<br><br>(fermentation) low energy usage<br><br>(fermentation) uses renewable raw materials<br><br>(disadvantages)<br><br>(fermentation) produces impure ethanol<br><br>(fermentation) slow rate of reaction | | <br><br>1<br><br>1<br><br><br><br>1<br><br>1 | AO3<br>4.7.2.2<br>4.7.2.3<br>4.10.1.1 |

| | | | |
|---|---|---|---|
| **Total** | | | **11** |

4.6.1.1 Calculating rates of reactions

Answer 16 · Mark scheme

June 2022 | 8462/2F | Original Q6

## Question 6

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **06.1** | $Na_2S_2O_3 + 2\,HCl \rightarrow$ **2** $NaCl + H_2O + SO_2 + S$ | allow multiples | 1 | AO2<br>4.1.1.1<br>4.3.1.1<br>4.6.1.2<br>RPA5 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **06.2** | (s) | | 1 | AO1<br>4.2.2.2<br>4.6.1.2<br>RPA5 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **06.3** | a cross on a piece of paper | | 1 | AO1<br>4.6.1.2<br>RPA5 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **06.4** | the rate of reaction decreased | | 1 | AO3<br>4.6.1.1<br>4.6.1.2<br>RPA5 |

### 4.6.1.1 Calculating rates of reactions

**Answer 16 · Mark scheme**

June 2022 | 8462/2F | Original Q6

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **06.5** | one of the reactants was used up | | 1 | AO3<br>4.6.1.2<br>RPA5 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **06.6** | initially the line of best fit would be steeper | | 1 | AO2<br>4.6.1.2<br>RPA5 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **06.7** | fewer reactant particles have the activation energy<br><br>the reactant particles move more slowly | | 1<br><br>1 | AO2<br>4.6.1.2<br>4.6.1.3 |

| | | |
|---|---|---|
| **Total Question 6** | | **8** |

4.6.1.1 Calculating rates of reactions

Answer 17 · Mark scheme

June 2023 | 8462/2F | Original Q8

## Question 8

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| 08.1 | to reduce the escape of gas | | 1 | AO3<br>4.6.1.1<br>RPA5 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| 08.2 | (mean rate =) $\frac{0.78 + 0.81 + 0.81}{3}$ | allow $\frac{0.78 + 0.81 + 0.68 + 0.81}{4}$ | 1 | AO3 |
| | 0.80 ($cm^3$/s) | = 0.77 ($cm^3$/ s) for **1** mark | 1 | AO2 |
| | $0.80 = \frac{20}{\text{mean time taken}}$ | allow correct use of incorrectly determined mean rate | 1 | AO2 |
| | (mean time taken =) $\frac{20}{0.80}$ | | 1 | AO2 |
| | = 25 (s) | | 1 | AO2<br>4.6.1.1<br>RPA5 |
| | **alternative approach:**<br>$0.78 = \frac{20}{\text{time}}$<br>**or**<br>$0.81 = \frac{20}{\text{time}}$ (1) | | | |
| | (trial 1 time = $\frac{20}{0.78}$ =) 25.6 (1) | | | |
| | (trial 2 and 4 time = $\frac{20}{0.81}$ =) 24.7 (1) | | | |

### 4.6.1.1 Calculating rates of reactions

**Answer 17 · Mark scheme** June 2023 | 8462/2F | Original Q8

| | | | | |
|---|---|---|---|---|
| | (mean time =) $\frac{25.6 + (2 \times 24.7)}{3}$ (1)<br><br>= 25 (s) (1) | allow correct use of incorrectly determined value(s) for time<br><br>allow $\frac{25.6 + 29.4 + (2 \times 24.7)}{4}$<br>= 26.1 (s)<br>for **1** mark | | |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **08.3** | use a lower temperature<br><br>use sulfuric acid of a lower concentration | | 1<br><br>1 | AO1<br>4.6.1.2<br>RPA5 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **08.4** | (test)<br>burning / lit splint<br><br>(result)<br>burns with a (squeaky) pop sound | MP2 is dependent upon MP1 being awarded<br><br>allow flame<br>do **not** accept glowing splint<br><br>allow pops | <br><br>1<br><br>1 | AO1<br>4.8.2.1 |

| **Total Question 8** | **10** |
|---|---|

### 4.6.1.1 Calculating rates of reactions

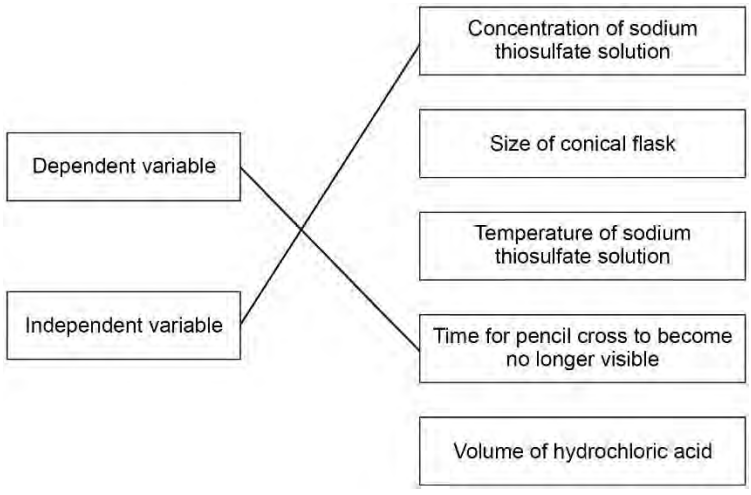
Answer 18 · Mark scheme

June 2024 | 8462/2F | Original Q5

## Question 5

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **05.1** | volume (of reactants) is 90 $cm^3$<br><br>(so conical) flask will overflow | allow volume (of reactants) is greater than 50 $cm^3$<br><br>allow (so) solutions will not fit (in conical flask) | 1<br><br>1 | AO3<br>4.6.1.2<br>RPA5 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **05.2** | measuring cylinder | allow (volumetric / graduated) pipette<br>allow burette | 1 | AO1<br>4.6.1.2<br>RPA5 |

| Question | Answers | Mark | AO / Spec. Ref. |
|---|---|---|---|
| **05.3** | <br>allow **1** mark if dependent variable and independent variable are identified the wrong way round<br><br>do **not** accept more than **one** line drawn from a box on the left | 1<br><br>1 | AO1<br>4.6.1.2<br>RPA5 |

4.6.1.1 Calculating rates of reactions

Answer 18 · Mark scheme

June 2024 | 8462/2F | Original Q5

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **05.4** | the time taken will increase | | 1 | AO3<br>4.6.1.2<br>RPA5 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **05.5** | 32 g/dm$^3$ | | 1 | AO3<br>4.6.1.1<br>4.6.1.2<br>RPA5 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **05.6** | the particles are closer together<br><br>the particles collide more frequently | | 1<br><br>1 | AO1<br>4.6.1.3<br>RPA7 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **05.7** | decreases<br><br>increases | | 1<br><br>1 | AO2<br>4.6.1.2<br>4.6.1.3<br>RPA5 |

| **Total Question 5** | **11** |
|---|---|

4.6.1.1 Calculating rates of reactions

Answer 19 · Mark scheme

June 2025 | 8462/2F | Original Q2

## Question 2

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **02.1** | propene | | 1 | AO1<br>4.7.2.1 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **02.2** | 9 | | 1 | AO2<br>4.1.1.1<br>4.7.2.1 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **02.3** | making a polymer | | 1 | AO1<br>4.7.1.4 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **02.4** | (*y*-axis 0, 20), 40, 60, 80, (100) | ignore intermediate values | 1 | AO2<br>4.7.2.1 |
| | carbon bar drawn to 86% | allow a tolerance of ± ½ a small square | 1 | |
| | carbon bar labelled | | 1 | |

4.6.1.1 Calculating rates of reactions

Answer 19 · Mark scheme



| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| 02.5 | (test)<br>add bromine (water)<br><br>(result)<br>(bromine water) turns (from orange to) colourless | <br><br><br>allow (bromine water) decolorises<br><br>ignore clear<br><br>MP2 is dependent upon MP1 being awarded | 1<br><br>1 | AO1<br>4.7.1.4 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| 02.6 | $C_{10}H_{22} \longrightarrow C_3H_6 + C_7H_{16}$ | | 1 | AO2<br>4.1.1.1<br>4.7.1.4 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| 02.7 | fuels | | 1 | AO1<br>4.7.1.4 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| 02.8 | the molecules collide more frequently at 750 °C | | 1 | AO2<br>4.6.1.3 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| 02.9 | (at 750 °C the rate of reaction is) higher | allow (at 450 °C the rate of reaction is) lower | 1 | AO2<br>4.6.1.2 |

| Total Question 2 | 12 |
|---|---|

4.6.1.1 Calculating rates of reactions

Answer 09 · Examiner comments

June 2018 | 8462/2F | Original Q7

# Question 7 (low demand)

**07.1** 88% of students read the volume correctly. As for incorrect readings, '80.3 ($cm^3$)' was the most common.

**07.2** This question was found to be fairly difficult, with 31% of students correctly identifying both of the control variables.

**07.3** This calculation challenged many students as they often ignored the instruction to not include the anomalous result (30) or included the time (40). Many did not give their answers to two significant figures. 41% of students achieved full marks.

**07.4** Generally the graph points were accurately plotted although the final point was occasionally mistakenly taken as 110 (rather than 100). More commonly the origin was omitted. A few students also misread the question and either plotted all the data points rather than just the mean and / or drew a line of best fit.

**07.5** The calculation was completed correctly by students who read the volume at 50 seconds, but many chose a different time to that in the question. A significant minority inverted the expression, 50 ÷ 80 rather than 80 ÷ 50.

**07.6** Generally, students showed a notable lack of understanding in this question. The graph was volume against time, but the question asked how the rate changed with time. Most responses were either wholly or partially about volume rather than rate. 10% of students achieved full marks, while 14% achieved two.

**07.7** Again, this was challenging, with 38% of students correctly identifying both of the reasons for the faster rate of reaction.

4.6.1.1 Calculating rates of reactions

**Answer 09 · Examiner comments** June 2018 | 8462/2F | Original Q7

**07.8** Most appeared to know that limewater was used to test for carbon dioxide, although many answers did not appear to realise that it was necessary to name the gas that was being tested for.

**07.9** The burning splint test was commonly identified correctly as the test for hydrogen and incorrectly for oxygen, carbon dioxide and a whole range of other substances, many of which are not gases.

**Answer 16 · Examiner comments** June 2022 | 8462/2F | Original Q6

**Question 6 (Low and standard demand)**

**06.1** The equation was correctly balanced by about three-quarters of the students.

**06.2** Over 80% of the students knew that (s) represents a solid reactant.

**06.3** The use of a cross on paper to monitor the turbidity of the sulfur produced was known by over 70% of the students, although use of a gas syringe was a common incorrect response.

**06.4** Over 80% of the students gained the mark, by associating a drop in gradient on the graph with a fall in the rate of reaction.

**06.5** Many deduced that one of the reactants was used up, with over 60% of the students gaining a mark. A sizeable number asserted that no light was reaching the sensor, even though the graph did not reach $y = 0$.

**06.6** Over 60% of the students gained a mark, but most of the remainder thought that the line would be less steep at the start.

**06.7** Over 50% of the students gained two marks. However, there was a wide range of incorrect response combinations, the most common of which used the two responses which were linked to a higher temperature rather than a lower one.

4.6.1.1 Calculating rates of reactions

Answer 17 · Examiner comments

June 2023 | 8462/2F | Original Q8

**Question 8 (Standard demand)**

**08.1** Around 10% of students gained this mark by recognising that adding the stopper would reduce the loss of gas. Weaker responses tended to be absolutes including stating that no gas would escape.

**08.2** The calculation discriminated well. Approximately 30% of students successfully completed the calculation, usually showing full details of their working. Most students gained the first 2 marking points by discarding the anomalous result and calculating the mean. The alternative approach detailed in the mark scheme was seldom seen.

**08.3** 25% of students gained both marks and more than 45% gained 1 mark. The most frequently seen incorrect responses were those that identified factors that would increase rather than decrease the rate of reaction.

Answer 17 · Examiner comments

June 2023 | 8462/2F | Original Q8

**08.4** Only 25% of students were able to give the correct test and result for hydrogen gas. Weaker responses failed to include the test and only described the result usually as a squeaky pop and gained no marks. Incorrect tests were less commonly seen but the most frequent incorrect test used was a glowing splint.

### 4.6.1.1 Calculating rates of reactions

**Answer 18 · Examiner comments** June 2024 | 8462/2F | Original Q5

**Question 5 (low and standard demand)**

05.1 One in two students were able to correctly explain why a 50 $cm^3$ flask is unsuitable for use in the method provided and obtain both marks. A further one in four achieved one mark for recognising that the flask was too small but did not provide a reason as to why this would be a problem.

05.2 More than 65% of students were able to correctly name a suitable piece of apparatus for measuring volume. The vast majority of students answered measuring cylinder with burette being a popular second choice. Care should be taken over the spelling of burette to avoid the incorrect response biuret.

05.3 Just over one third of students achieved both marks in this question and a further third achieved one mark. Students appeared to struggle to recognise and correctly identify both the independent and dependent variables. A sizeable number of students identified the independent and dependent variables the wrong way around achieving the compensation mark. It is important that students read the question carefully as there was a significant number of students who drew multiple lines from each box.

05.4 Over 4 in 5 students correctly identified that the time taken for the cross to disappear would increase.

05.5 Over 75% of students correctly identified the concentration of sodium thiosulfate that had the highest rate of reaction.

05.6 This question was well answered with over 90% of students being able to identify at least one correct statement to explain the effect of increasing the concentration. Almost 50% of students correctly identified both statements.

05.7 Just over 60% of students correctly identified what would happen to the time taken for the cross to disappear for both of the changes made to the investigation with a further 10% of students correctly identifying the effect of just one change. The most common incorrect response was to reverse the order.

4.6.1.1 Calculating rates of reactions

**Answer 19 · Examiner comments** June 2025 | 8462/2F | Original Q2

## Question 2

02.1 Half of the students correctly identified the alkene as propene. Both butene and ethene were commonly seen.

02.2 Over 80% of students were able to give the number of atoms in the molecule as 9.

02.3 Over two thirds of students correctly identified the use of alkenes.

02.4 Nearly 80% of students scored all three marks for plotting the bar chart. Of the remaining students, most scored two marks, the most common error was to plot the bar at 92, rather than 86.

02.5 The test for alkenes is not well known. Slightly more than 1 in 10 students scored either mark on this question. A full range of tests was seen, with nearly 30% of students did not attempt this item.

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**Answer 19 · Examiner comments** June 2025 | 8462/2F | Original Q2

02.6 Nearly two thirds of students correctly completed the formula in the equation. Many students recognised that the number should be 7, but did not follow the conventions of writing formulas, so did not gain the mark because the 7 was too large. When writing formulas, it is expected that the tops of numbers are discernibly below the tops of upper-case letters.

02.7 Over half of students correctly identified the use of alkanes as fuels. Both distractors were frequently seen.

02.8 Nearly 90 % of students correctly answered this item.

02.9 Three quarters of students correctly compared the rates, with many explaining why the rate changes using the ideas from the previous item.