Pearson Edexcel

Mark Scheme (Results)

Summer 2024

Pearson Edexcel GCE
In Chemistry (8CH0)
Paper 02: Core Organic and Physical Chemistry

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General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

Using the Mark Scheme

Examiners should look for qualities to reward rather than faults to penalise. This does NOT mean giving credit for incorrect or inadequate answers, but it does mean allowing candidates to be rewarded for answers showing correct application of principles and knowledge. Examiners should therefore read carefully and consider every response: even if it is not what is expected it may be worthy of credit.

The mark scheme gives examiners:
- an idea of the types of response expected
- how individual marks are to be awarded
- the total mark for each question
- examples of responses that should NOT receive credit.

/ means that the responses are alternatives and either answer should receive full credit.
( ) means that a phrase/word is not essential for the award of the mark, but helps the examiner to get the sense of the expected answer.
Phrases/words in **bold** indicate that the meaning of the phrase or the actual word is **essential** to the answer.
ecf/TE/cq (error carried forward) means that a wrong answer given in an earlier part of a question is used correctly in answer to a later part of the same question.

Candidates must make their meaning clear to the examiner to gain the mark. Make sure that the answer makes sense. Do not give credit for correct words/phrases which are put together in a meaningless manner. Answers must be in the correct context.

Quality of Written Communication
Questions which involve the writing of continuous prose will expect candidates to:
- write legibly, with accurate use of spelling, grammar and punctuation in order to make the meaning clear
- select and use a form and style of writing appropriate to purpose and to complex subject matter
- organise information clearly and coherently, using specialist vocabulary when appropriate.

Full marks will be awarded if the candidate has demonstrated the above abilities.
Questions where QWC is likely to be particularly important are indicated (QWC) in the mark scheme, but this does not preclude others.

Question Number	Answer	Mark
1(a)	The only correct answer is **D** (volumetric flask) ***A*** *is not correct because this is used to measure volumes of liquids required in a reaction* ***B*** *is not correct because this is not a very accurate way to measure volumes* ***C*** *is not correct because this is used to measure fixed volumes of liquids, not to make up solutions*	**(1)**

Question Number	Answer	Mark
1(b)(i)	The only correct answer is **B** (2.45 cm^3) ***A*** *is not correct because the volume must be measured from the bottom of the meniscus* ***C*** *is not correct because this is the volume reading from the bottom of the burette, not the top* ***D*** *is not correct because this is reading from the bottom and not using the bottom of the meniscus*	**(1)**

Question Number	Answer	Additional Guidance	Mark
1(b)(ii)	• calculation of volume by subtracting the answer to (b)(i) from 26.50 cm^3	<u>Example of calculation</u> 26.50 – 2.45 = 24.05 (cm^3) Allow TE on incorrect answers to (b)(i)	**(1)**

Question Number	Answer	Additional Guidance	Mark
1(b)(iii)	An answer that makes reference to the following point: • sodium hydroxide solution can be added rapidly / not drop by drop to a volume a little below that of the rough titration (making the titration quicker)	Allow add acid dropwise / slow down as it gets close to / before the rough titration value / value in (b)(ii) Allow added rapidly to the volume given in (b)(ii) minus about 2 cm^3 or so Do not award slow down when you get to the rough titration value Do not award the rough titration is a value that you try to get as close to as possible	**(1)**

Question Number	Answer	Additional Guidance	Mark
1(c)(i)	• calculation of mean titre	<u>Example of calculation</u> $(23.30 + 23.35 + 23.25) \div 3 = 23.3(0)$ (cm^3) Correct answer with no working scores 1	**(1)**

Question Number	Answer	Additional Guidance	Mark
1(c)(ii)	• calculation of number of moles	<u>Example of calculation</u> $(23.30 \times 0.100) \div 1000 = 0.00233 / 2.33 \times 10^{-3}$ (mol) Allow TE on (c)(i)	**(1)**

Question Number	Answer	Additional Guidance	Mark
1(c)(iii)	• calculation of number of moles of H_2A in 25.0 cm^3 **(1)** • calculation of relative molecular mass of H_2A **(1)** • calculation of value of n giving the answer as an integer **(1)**	Example of calculation Answer to (c)(ii) ÷ 2 = 0.001165 / 1.165 × 10^{-3} (mol) M_r = (1.54 ÷ 10) ÷ moles of H_2A in 25.0 cm^3 = 132 / 132.188/ 132.19 n = (132 – 90) ÷ 14 = 3 Correct answer with some working scores (3) Allow TE throughout (c) and from (c)(ii) Failure to divide by 10 in M2 gives n = 88 and scores (2) Ignore SF	**(3)**

(Total for Question 1 = 9 marks)

Question Number	Answer	Additional Guidance	Mark
2(a)(i)	An explanation that makes reference to the following points: • the mixture goes yellow **(1)** • as the equilibrium moves to the right **(1)** • because sodium hydroxide reacts with / neutralises H^+ lowering its concentration **(1)**	Allow less orange Ignore water formed during neutralisation increases the concentration of water moving the equilibrium to the right Do not award there are more reactants / the concentration of the reactants is higher	**(3)**

Question Number	Answer	Mark
2(a)(ii)	The only correct answer is **C** ($K_c = \frac{[CrO_4^{2-}]^2\,[H^+]^2}{[Cr_2O_7^{2-}]}$) ***A*** *is not correct because water is not included as it is in the liquid state* ***B*** *is not correct because water is not included and* $[CrO_4^{2-}]$ *and* $[H^+]$ *should be squared not multiplied by 2* ***D*** *is not correct because* $[CrO_4^{2-}]$*and* $[H^+]$ *should be squared not multiplied by 2*	**(1)**

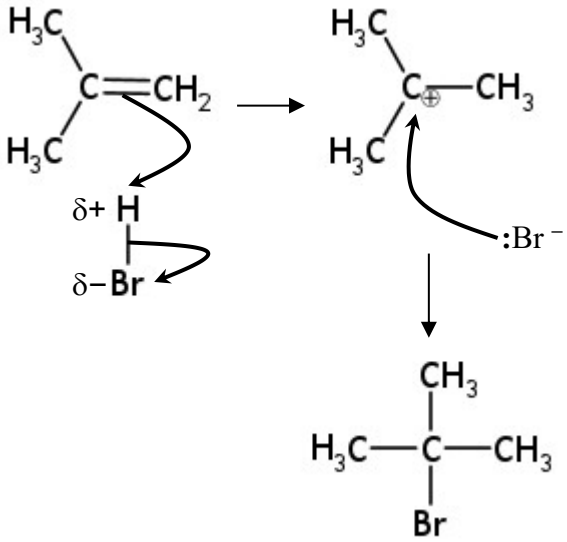
Question Number	Answer	Additional Guidance	Mark
2(b)(i)	An answer that makes reference to the following points: • initially the gas becomes lighter in colour as the nitrogen dioxide is spread over a larger volume **(1)** • gradually the mixture becomes darker in colour **(1)** • as the equilibrium shifts to the side with the larger number of moles of gas **(1)**	Allow more brown Allow goes from colourless to brown	**(3)**

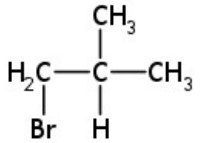
Question Number	Answer	Additional Guidance	Mark
2(b)(ii)	An explanation that makes reference to the following points: • (the concentration / amount of NO_2 increases with increasing temperature), so the equilibrium is shifting to the left **(1)** • (because) the equilibrium shifts in the endothermic direction or so the backward reaction is endothermic / forward reaction is exothermic **(1)**		**(2)**

(Total for Question 2 = 9 marks)

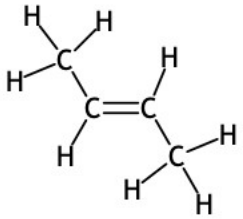
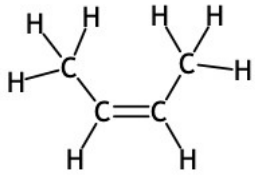
Question Number	Answer	Additional Guidance	Mark
3(a)	An answer that makes reference to the following points: • molecular formula, C_4H_8 **and** empirical formula, CH_2	Do not award CH_2 for the molecular formula Allow a calculation involved C_4H_8 eg $C_4H_8 \div 4 = CH_2$ as long as CH_2 given	**(1)**

Question Number	Answer	Mark
3(b)(i)	The only correct answer is **A** (electrophilic addition) ***B*** *is not correct because the reaction involves electrophilic not nucleophilic attack* ***C*** *is not correct because the reaction is an addition not a substitution* ***D*** *is not correct because the reaction is an addition reaction resulting from electrophilic attack*	**(1)**

Question Number	Answer	Additional Guidance	Mark
3(b)(ii)	An answer that makes reference to the following points: All marking points scores 4 marks 7 or 8 marking points scores 3 marks 5 or 6 marking points scores 2 marks 3 or 4 marking points scores 1 mark • correct structure for 2-methylpropene • dipole on HBr molecule • curly arrow from H–Br bond to Br • curly arrow from double bond to H atom of HBr / to the space between the double bond and the H atom of HBr • correct carbocation intermediate to form 2-bromo-2-methyl propane with + charge on correct carbon • charge on bromide ion • lone pair on bromide ion • curly arrow from Br to correct carbon / to the space between the Br and correct carbon • structure of product correct from either starting material or carbocation or 2-bromo-2-methylpropane	 Allow TE on an incorrect starting alkene structure Allow to the positive carbon of a carbocation even if incorrect This can be awarded if no lone pair is present on Br, but must be from the lone pair if a lone pair is present	**(4)**

Question Number	Answer	Additional Guidance	Mark
3(b)(iii)	An answer that makes reference to the following points: • structure of 1-bromo-2-methylpropane **(1)** Either • because it is formed via / the intermediate is a primary carbocation (not tertiary) Or • the carbocation has only one alkyl group attached and is not stabilised by the inductive effect of three methyl groups (as in the major product) **(1)** • the minor **carbocation** is **less stable** than the major carbocation **(1)**	 Allow skeletal / condensed / hybrid structures as long as structure is clear Allow a description of a primary carbocation and/or a tertiary carbocation Ignore discussions of Markovnikov's rule without explanation in terms of inductive effect or stability of carbocations Allow a tertiary carbocation is more likely to form than a primary one Allow a comparison of stability of secondary carbocations as a TE on M2 Do not award the primary halogenoalkane is less stable compared to the tertiary If M2 and M3 are not scored allow (1) for the carbocation is less stable	**(3)**

Question Number	Answer	Additional Guidance	Mark
3(b)(iv)	An answer that makes reference to the following point: • the movement of a pair / two electrons	 Accept the transfer of a pair / two electrons Allow movement of a bond pair / lone pair of electrons	**(1)**

Question Number	Answer	Additional Guidance	Mark
3(c)(i)	An answer that makes reference to the following points: • structure of both isomers correct **(1)** • names of both isomers correct **(1)**	Isomer 1  Name: *trans*-but-2-ene / *E*-but-2-ene Isomer 2  Name: *cis*-but-2-ene / *Z*-but-2-ene Allow name and structure of one isomer correct for (1) M2 dependent on M1 or near miss Allow CH_3 for the displayed methyl group Penalise connectivity of CH_3 once only	**(2)**

Question Number	Answer	Additional Guidance	Mark
3(c)(ii)	An explanation that makes reference to the following points: • because the C=C double bond has restricted rotation **(1)** • and there is a CH_3 group / H group on either side of the double bond **(1)**	Allow no rotation around C=C Allow limited rotation around C=C Allow the double bond in place of C=C Allow the double / C=C restricts rotation Allow there are two different groups attached to each carbon (of the C=C double bond) Allow priority groups being on the same or different sides	**(2)**

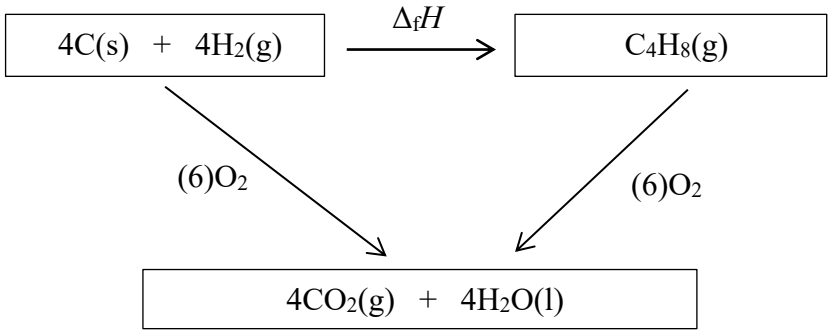
Question Number	Answer	Mark
3(d)(i)	The only correct answer is **B** () ***A*** *is not correct because this is a secondary alcohol* ***C*** *is not correct because this is a primary alcohol* ***D*** *is not correct because this is a primary alcohol*	**(1)**

Question Number	Answer	Additional Guidance	Mark
3(d)(ii)	An explanation that makes reference to the following points: (because oxidation requires a hydrogen to be attached to the carbon with the -OH group attached to it and) • tertiay alcohols have no hydrogen on the carbon with the -OH group attached to it / on the carbon to be oxidised **(1)** • whereas primary and secondary alcohols do have a hydrogen on the carbon with the -OH group attached to it / on the carbon to be oxidised **(1)**	The carbon with the -OH group attached to it need be mentioned in only one of the two marking points, the second can score just for the numbers of hydrogens Allow because a C-C bond would have to be broken Allow the carbon with the OH group attached is bonded to 3 alkyl groups / other carbons Ignore tertiary alcohols are bonded to three alkyl / methyl groups Allow reference to tertiary alcohols do not have a hydrogen but other alcohols do	**(2)**

(Total for Question 3 = 17 marks)

Question Number	Answer	Additional Guidance	Mark
4(a)(i)	Either • calculation of energy required to break two C=C **(1)** • calculation of energy required to make 4 C–C **(1)** • calculation of enthalpy change for the reaction including the minus sign **(1)** OR • calculation of energy required to break all bonds **(1)** • calculation of energy required to make all bonds **(1)** • calculation of enthalpy change for the reaction including the minus sign **(1)**	<u>Example of calculation</u> $2 \times 612 = 1224$ (kJ / kJ mol^{-1}) $4 \times 347 = 1388$ (kJ / kJ mol^{-1}) $1224 - 1388 = -164$ (kJ mol^{-1}) Correct answer with some correct working scores (3) Allow making and breaking all bonds $(8 \times 413) + (2 \times 612) = 4692$ (kJ / kJ mol^{-1}) $(8 \times 413) + (4 \times 347) = 4528$ (kJ / kJ mol^{-1}) $4528 - 4692 = -164$ (kJ mol^{-1}) Allow (2) for $+164$ (kJ mol^{-1}) with some working Allow TE throughout Correct answer with some working scores (3)	**(3)**

Question Number	Answer	Additional Guidance	Mark
4(a)(ii)	An explanation that makes reference to the following points: Either • (because) mean bond enthalpies are the average value for all bonds of that type **(1)** • bond enthalpy values are for a particular bond (in that molecule) **(1)** Or • (because) the bond enthalpy of a C-H / C-C / C=C is different in different molecules • so the mean is less accurate than using the actual bond enthalpies of each bond (in that molecule)	Allow mean bond enthalpies are averages Allow bond enthalpies are specifically for that reaction (and so are more accurate)	**(2)**

Question Number	Answer	Additional Guidance	Mark
4(b)(i)	All 8 points scores (4) 6 or 7 points scores (3) 4 or 5 points scores (2) 2 or 3 poinst scores (1) • one or two arrows going down from LHS • C and H_2 in reactants box • on the left-hand dotted line any one of (6)O_2 / –2720 / (4 ×) –394 and (4 ×) –286 / (4 ×) –680 / (4 ×) $\Delta_f H$ CO_2 and (4 ×) $\Delta_f H$ H_2O / (4 ×) $\Delta_c H$ C and (4 ×) $\Delta_c H$ H_2 $\Sigma \Delta_f H$ / $\Sigma \Delta_c H$ • CO_2 and H_2O in products box • balancing • correct state symbols in both boxes • one arrow going down from RHS • on the right-hand dotted line any one of (6)O_2 / –2721 / $\Delta_c H$ C_4H_8	 Do not award incorrect balancing numbers for O_2 except 1 Ignore multipliers other than 4 even if incorrect Ignore multipliers other than 4 even if incorrect Ignore multipliers other than 4 even if incorrect Ignore just $\Delta_f H$ / $\Delta_c H$ Dependent on substances in both boxes or near miss, e.g. H instead of H_2 Accept C(graphite) / C(s, graphite) for C(s) No TE NOTE: Ignore an additional arrow going up as working (see practice) Do not award incorrect balancing numbers for O_2 except 1 Allow just $\Delta_c H$	(4)

Question Number	Answer	Additional Guidance	Mark
4(b)(ii)	• calculation of enthalpy of formation of 4 moles of carbon dioxide and water **(1)** • calculation of enthalpy change of formation of cyclobutane **(1)**	<u>Example of calculation</u> $((4 \times -394) + (4 \times -286)) = -2720$ (kJ / kJ mol^{-1}) $-1576 + -1144 = -2720$ (kJ / kJ mol^{-1}) May be seen on the cycle $-2720 - -2721 = (+)1$ (kJ mol^{-1}) Allow TE on the arrow in the cycle Allow TE for M2 on adding 2721 to (subtracting -2721 from) the calculated value in M1 or a value from the cycle Allow (1) for $-2721 - -2720 = -1$ ($kJmol^{-1}$) Ignore SF Final answer with some working scores 2	**(2)**

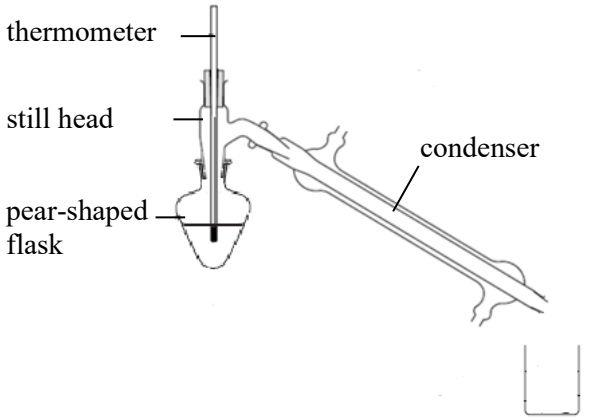
(Total for Question 4 = 11 marks)

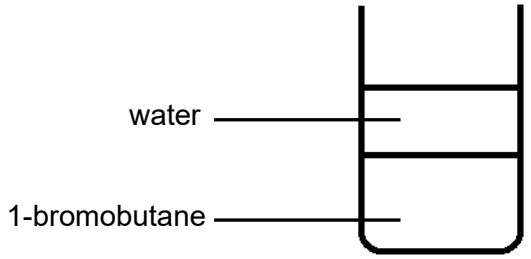
Question Number	Answer	Additional Guidance	Mark
5(a)(i)	An answer that makes reference to the following points: Either • the condenser prevents loss of reactants / reagents (to ensure a high yield of product) / to return reactants / reagents to the flask so it can fully react / to prevent loss of any products formed before Step 3 Or the condenser prevents the escape of flammable / corrosive / poisonous / acidic / toxic / harmful gases **(1)** • the still head prevents the build-up of pressure / risk of explosion **(1)**	Allow to prevent loss of (some of the) evapourated / volatile compounds Allow condenses gases back into liquids / flask Allow prevents loss of products Ignore just condenses gas Accept sprays instead of gases Ignore prevents boiling over Allow named / formula of gases **only** if they are likely to / might condense (e.g. bromine) Do not award toxic HBr / SO_2 / CO_2 as they will not condense Answer must include the hazard so do not award answers such as bromine might escape Do not award risk of explosion here Award the still head allows any uncondensed gas to escape Allow allows for the loss of gas (from the reflux) as it is open	**(2)**

Question Number	Answer	Additional Guidance	Mark
5(a)(ii)	An answer that makes reference to the following point: • (concentrated / conc) sulfuric acid / H_2SO_4	Ignore H^+ Do not award dilute H_2SO_4	**(1)**

Question Number	Answer	Additional Guidance	Mark
5(a)(iii)	An answer that makes reference to the following points: • bromine / Br_2 / sulfur dioxide / SO_2 **(1)** • butanal / butanoic acid / $CH_3CH_2CH_2CHO$ / $CH_3CH_2CH_2COOH$ **(1)**	Ignore carbon dioxide / CO_2 Allow any type of structural formula, but do not award molecular formulae Ignore but-1-ene For all substances if name and formula are given, both must be correct	**(2)**

Question Number	Answer	Additional Guidance	Mark
5(a)(iv)	An answer that makes reference to the following point: • (lower temperature means) less / fewer collisions have sufficient energy (to overcome the activation barrier) or (lower temperature means) the rate of reaction will decrease / the reaction will slow	Accept lowers the energy of collisions Allow no collisions have enough energy (to overcome the activation barrier) Allow the reactants do not have enough energy to react Allow the reactants / reaction / mixture does not have the activation energy Allow not enough energy for the reaction to take place Allow it prevents the oxidation of bromide ion to bromine Allow the reaction will stop	**(1)**

Question Number	Answer	Additional Guidance	Mark
5(b)	An answer that makes reference to the following points: • (the condenser is removed and) the **still head** is put in the **pear-shaped flask /** a **round-bottomed flask** **(1)** • a **thermometer** is added to the top of the still head (using a quickfit adaptor) **(1)** • a **condenser** is added to the still head at the side / added to the still head diagonally / added to the still head horizontally / added to the still head at a downward angle (and a small beaker is placed below the other end of the condenser) **(1)**	Allow three marks may be awarded with a labelled diagram showing labelled thermometer, condenser and still head.  Allow a **stopper / bung** in place of a thermometer, but must be named Do not penalise a second collecting vessel (e.g round bottomed flask) attached to the condenser if there is a way for pressure to escape	**(3)**

Question Number	Answer	Additional Guidance	Mark
5(c)(i)	An answer that makes reference to the following point: • a diagram of a beaker showing an upper aqueous layer / water and a lower organic layer / 1-bromobutane	 Do not award a diagram of a separating funnel Do not award diagrams of other glassware except beaker / conical flask	**(1)**

Question Number	Answer	Additional Guidance	Mark
5(c)(ii)	An answer that makes reference to the following point: • use a (teat) pipette / syringe to remove the upper layer / aqueous layer / water (which is discarded)	Allow use a (teat) pipette / syringe to remove the lower layer is removed and discard (the remaining) aqueous layer Allow transfer to a separating funnel and let out the lower layer Allow TE on the use of a separating funnel instead of a beaker in (c)(i) if the layers are correct by opening the tap to separate the bottom layer Do not award just use a separating funnel without transfer Ignore decanting Allow TE on reversed layers in (c)(i)	**(1)**

Question Number	Answer	Additional Guidance	Mark
5(c)(iii)	An answer that makes reference to the following point: • separating funnel / dropping funnel	 Allow tap funnel Ignore burette	**(1)**

(Total for Question 5 = 12 marks)

Question Number	Answer	Additional Guidance	Mark
6(a)	An answer that makes reference to the following point: • sulfur is insoluble in water / precipitates	Allow sulfur forms a yellow solid / comes out of solution / does not dissolve Allow just 'sulfur is formed'	**(1)**

Question Number	Answer	Mark
6(b)(i)	The only correct answer is **C** (0.21) ***A*** *is not correct because this is the concentration in the first experiment which is diluted with water and acid* ***B*** *is not correct because this is the concentration in the most concentrated of the experiments and is diluted with acid* ***D*** *is not correct because this is the ratio of the volumes of thiosulfate and total volume in the reaction = 5/7*	**(1)**

Question Number	Answer	Additional Guidance	Mark
6(b)(ii)	An answer that makes reference to the following point: • so that the total volume of the reaction mixture is kept constant / 70 cm^3	Accept the volume of sodium thiosulfate and water is kept constant / 50 cm^3 Allow the same volume of 70 cm^3 / 50 cm^3	**(1)**

Question Number	Answer	Additional Guidance	Mark
6(c)(i)	• find the value of 1/time for the concentration of 0.10 mol dm^{-3} **and** calculates time	Example of calculation 1/time = 0.03 (s^{-1}) time = 1 ÷ 0.03 = 33.3 / 33.333 (s) Ignore SF except 1SF Allow ± ½ small square so range can be up to time = 1 ÷ 0.0305 = 32.79 / 32.8 (s)	**(1)**

Question Number	Answer	Additional Guidance	Mark
6(c)(ii)	An answer that makes reference to the following point: • (directly) proportional **and** because the graph is a **straight** line (which passes through the origin)	 Allow just directly proportional Allow as concentration doubles rate doubles Allow linear Ignore increasing concentration increases rate	**(1)**

Question Number	Answer	Mark
6(d)	The only correct answer is **A** (rinsing the flask with deionised water before each new experiment) ***B*** *is not correct because any effect on the rate of the reaction will be equal in each case* ***C*** *is not correct because each cylinder is the same size so will measure with the same accuracy* ***D*** *is not correct because this will not affect the rate of the reaction*	**(1)**

Question Number	Answer	Mark
6(e)	The only correct answer is **B** (the time taken will decrease using the 100 cm^3 flask) ***A*** *is not correct because the depth of the solution has increased so more solid is between the eye and the cross* ***C*** *is not correct because the depth of the solution has increased so more solid is between the eye and the cross* ***D*** *is not correct because the depth of the solution has increased so more solid is between the eye and the cross*	**(1)**

(Total for Question 6 = 7 marks)

<table>
<tr><th>Question Number</th><th>Acceptable Answer</th><th>Additional Guidance</th><th>Mark</th></tr>
<tr>
<td>*7</td>
<td>
This question assesses a student's ability to show a coherent and logically structured answer with linkages and fully-sustained reasoning.

Marks are awarded for indicative content and for how the answer is structured and shows lines of reasoning.

The following table shows how the marks should be awarded for indicative content.

<table>
<tr><td>Number of indicative marking points seen in answer</td><td>Number of marks awarded for indicative marking points</td></tr>
<tr><td>6</td><td>4</td></tr>
<tr><td>5–4</td><td>3</td></tr>
<tr><td>3–2</td><td>2</td></tr>
<tr><td>1</td><td>1</td></tr>
<tr><td>0</td><td>0</td></tr>
</table>

The following table shows how the marks should be awarded for structure and lines of reasoning.

<table>
<tr><td></td><td>Number of marks awarded for structure of answer and sustained line of reasoning</td></tr>
<tr><td>Answer shows a coherent and logical structure with linkages and fully sustained lines of reasoning demonstrated throughout.</td><td>2</td></tr>
<tr><td>Answer is partially structured with some linkages and lines of reasoning.</td><td>1</td></tr>
<tr><td>Answer has no linkages between points and is unstructured.</td><td>0</td></tr>
</table>
</td>
<td>
Guidance on how the mark scheme should be applied:

The mark for indicative content should be added to the mark for lines of reasoning.

For example, an answer with five indicative marking points, which is partially structured with some linkages and lines of reasoning, scores 4 marks (3 marks for indicative content and 1 mark for partial structure and some linkages and lines of reasoning).

If there are no linkages between points, the same five indicative marking points would yield an overall score of 3 marks (3 marks for indicative content and no marks for linkages).

In general it would be expected
that 5 or 6 indicative points would get 2 reasoning marks, and 3 or 4 indicative points would get 1 mark
for reasoning, and 0, 1 or 2
indicative points would score zero marks for reasoning.

Reasoning marks may be reduced for extra incorrect chemistry
</td>
<td>(6)</td>
</tr>
</table>

Question Number	Acceptable Answer	Additional Guidance	Mark
***7 contd**	**Indicative content:** IP1 A higher temperature increases the rate of reaction and decreases the yield of methanol IP2 The reaction is exothermic in the forward direction so the backward reaction is favoured by a higher temperature IP3 A greater proportion of the molecules have more energy than the activation energy IP4 An increase in pressure increases the yield of methanol and would increase the rate of reaction IP5 The forward reaction yields fewer moles of gas molecules IP6 The frequency of collisions increases (because there are more molecules per unit volume)	Ignore increasing frequency of collisions (as a result of increased kinetic energy) Ignore there are more collisions without a reference to frequency or time	**(6)**

(Total for Question 7 = 6 marks)

Question Number	Answer	Additional Guidance	Mark
8(a)(i)	• substances **(1)** • state symbols and balancing **(1)**	$CH_3OH(l) + 1.5O_2(g) \rightarrow CO_2(g) + 2H_2O(l)$ Do not award multiples	**(2)**

Question Number	Answer	Additional Guidance	Mark
8(a)(ii)	• calculation of moles of methanol burnt **(1)** • calculation of expected energy transferred by multiplying by number of moles and scaling to match units **(1)** • calculation of temperature change by dividing by 836 **(1)** • calculation of expected final temperature by adding 20.5 **(1)**	<u>Example of calculation</u> (152.2 – 150.2) ÷ 32.0 = 0.0625 (mol) 726 × 0.0625 = 45.375 (kJ) Award 726 000 × (ans 1) = 45 375 (J) 45.375 ÷ (200 × 0.00418) = 54.276 / 54.3 (ºC) / 45.375 ÷ 0.836 = 5 4.276 / 54.3 (ºC) Award 45 375 ÷ (200 × 4.18) = 54.276 / 54.3 (ºC) 45375 ÷ 836 = 54.276 / 54.3 (ºC) 54.3 + 20.5 = 74.8 (ºC) Allow TE throughout Ignore SF except 1 SF	**(4)**

Question Number	Answer	Additional Guidance	Mark
8(a)(iii)	• calculation of percentage error	Example of calculation experimental temperature rise – theoretical temperature rise × 100 = theoretical temperature rise ((52.5 – 20.5) – 54.3) ÷ 54.3 × 100 = (–) 41.068 / (–) 41% 32 – 54.3 = 22.3 22.3 ÷ 54.3 × 100 = (–) 41.068 / (–) 41% Allow (54.3 – (52.5 – 20.5)) ÷ 54.3 × 100 = 41.068 / 41% Allow TE on temperature rise from (a)(ii) Ignore SF except 1SF	**(1)**

Question Number	Answer	Additional Guidance	Mark
	An answer that makes reference to the following points: • (there is no need to use a balance with greater precision because) the uncertainty of the 1 dp balance is very small (compared to the percentage error) **(1)** • (in thermochemistry experiments the random error associated with) the heat lost to the surrounding causes a much bigger uncertainty in the final value (than the balance) or the increased precision will not lead to greater accuracy / the accuracy of the experiment is poor so a high degree of precision will not give a better result **(1)**	Allow the perentage error in the temperature change is so high it would not lead to greater accuracy	**(2)**

(Total for Question 8 = 9 marks)

TOTAL FOR PAPER = 80 MARKS

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