Pearson Edexcel

Mark Scheme (Results)

October 2020

Pearson Edexcel GCE
In Chemistry (8CH0)
Paper 2: 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	Additional Guidance	Mark
1(a)	• CCl_2F_2 / CF_2Cl_2	Do not award Fl instead of F Allow elements in any order, e.g. Cl_2F_2C. Allow a displayed formula	**(1)**

Question Number	Answer	Additional Guidance	Mark
1(b)(i)	• calculate percentage of carbon **(1)** • division of all percentages by atomic mass **(1)** • find simplest ratio and give empirical formula **(1)**	Example of calculation: 100 – (34.0 + 54.5) = 11.5% Cl 34.0 / 35.5 = 0.95775 F 54.5 / 19.0 = 2.8684 C 11.5 / 12.0 = 0.95833 Cl (0.95775 / 0.95775 = 2.9949) = 1 F (2.8684 / 0.95775 = 2.9949) = 3 C (0.95833 / 0.95775 = 2.9949) = 1 So CF_3Cl / $CClF_3$ Allow any order Correct answer with no working scores (3) Ignore significant figures throughout.	**(3)**

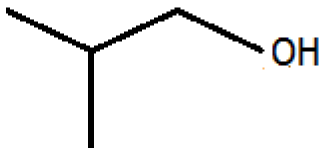
Question Number	Answer	Additional Guidance	Mark
1(b)(ii)	An answer that makes reference to the following points: • molecular ion peak at 104 / 106 (which matches the mass of the empirical formula)	Do not award statements stating that the molecular ion peak is at 105 or at 104.5, unless this is a calculated average.	**(1)**

Question Number	Answer	Additional Guidance	Mark
1(b)(iii)	• correct ion	CF_3^+ Do not award CF_3 with no plus.	**(1)**

Question Number	Answer	Additional Guidance	Mark
1(c)(i)	• correct equation	$CH_2F_2 + F_2 \rightarrow CHF_3 + HF$ Award correct equations with CF_2H_2 Ignore state symbols even if incorrect Do not award balanced equations with hydrogen as a product	**(1)**

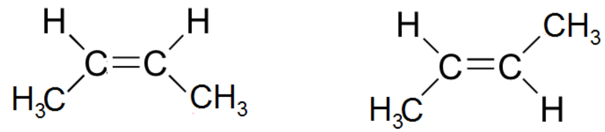
Question Number	Answer	Additional Guidance	Mark
1(c)(ii)	An answer that makes reference to the following points: • correct initiation step **(1)** • correct propagation step **(1)** • second correct propagation step **(1)**	 $F_2 \rightarrow 2F\bullet$ $F\bullet + CH_2F_2 \rightarrow \bullet CHF_2 + HF$ $\bullet CHF_2 + F_2 \rightarrow CHF_3 + F\bullet$ Ignore curly half arrows Propagation steps in the wrong order - loses 1 mark Penalise missing dot once only Penalise use of Cl once only Penalise use of CH_4 and CH_3X once only	**(3)**

(Total for Question 1 = 10 marks)

Question Number	Answer		Additional Guidance	Mark
2(a)	• butan-1-ol / 1-butanol	**(1)**	Do not award butanol	**(2)**
	• 	**(1)**	Award any type of structural formula i.e. displayed, condensed and skeletal and combinations. Do not award horizontal bond to HO	

Question Number	Answer	Mark
2(b)(i)	The only correct answer is **B** (elimination) ***A*** *is not correct because this is a typical reaction of alkenes, not a reaction to form alkenes* ***C*** *is not correct because alcohols are typically oxidised to aldehydes, ketones or carboxylic acids* ***D*** *is not correct because substitution removes just the –OH not an –H as well*	**(1)**

Question Number	Answer	Additional Guidance	Mark
2(b)(ii)	An explanation that makes reference to the following points: • compounds with the same structural formula **(1)** • where the atoms have a different arrangement in space **(1)**	Allow the bonds/groups have different spatial arrangements or orientation or configuration or 3D arrangement Allow have a different displayed formula Do not award where the molecules have a different arrangement in space Do not award a discussion of optical isomerism Do not award just 'cis/trans isomerism / *E*/*Z* isomerism'	**(2)**

Question Number	Answer	Additional Guidance	Mark
2(b)(iii)	• any two of structures and/or names correct **(1)** • both structures and names correct. **(1)**	 *Z*/cis-but-2-ene *E*/trans-but-2-ene Can be in either order. If the isomerism described in (b)(ii) is the position of the double bond allow but-1-ene and either *Z*/cis- or *E*/trans-but-2-ene here. Allow skeletal/displayed formulae	**(2)**

Question Number	Answer	Additional Guidance	Mark
2(b)(iv)	• geometric (isomerism)	Accept *cis-trans* / *E-Z*	**(1)**

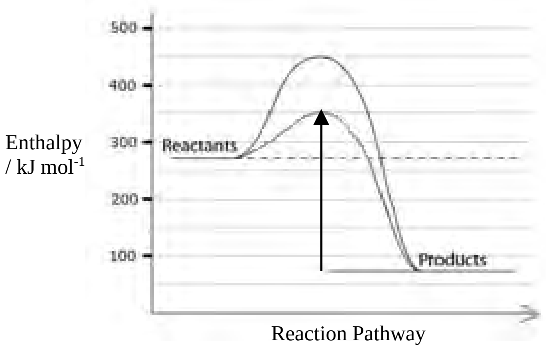
Question Number	Answer	Mark
2(c)	The only correct answer is **D** (nucleophile) ***A*** *is not correct because* OH^- *does not neutralise an acid in this reaction* ***B*** *is not correct because the* OH^- *ions are used up in this reaction* ***C*** *is not correct because* OH^- *is looking to react with an electron deficient area not an electron rich one*	**(1)**

Question Number	Answer	Additional Guidance	Mark
2(d)(i)	EITHER • correct equation **(1)** • butanal **(1)** • distil (off immediately) / distillation **(1)** OR • correct equation **(1)** • butanoic acid **(1)** • heat under reflux **(1)**	The condition mark is dependent on one of the other two marks being scored Allow 2 marks for correct use of propan-1-ol $CH_3CH_2CH_2CH_2OH + [O] \rightarrow CH_3CH_2CH_2CHO + H_2O$ $CH_3CH_2CH_2CH_2OH + 2[O] \rightarrow CH_3CH_2CH_2COOH + H_2O$ Allow just ‘reflux’ Award other correct formulae for butan-1-ol, butanal and butanoic acid, e.g. $C_3H_7CH_2OH$, C_3H_7CHO and C_3H_7COOH Do not award molecular formulae for butanal and butanoic acid	**(3)**

Question Number	Answer	Mark
2(d)(ii)	The only correct answer is **B** (green) ***A*** *is not correct because brown is not a colour which is associated with this reaction* ***C*** *is not correct because this is the colour of potassium dichromate*(VI) *before the reaction* ***D*** *is not correct because this is the colour of potassium chromate*(VI)	**(1)**

(Total for Question 2 = 13 marks)

Question Number	Answer	Mark
3(a)	The only correct answer is **D** (the minimum energy required for a reaction to occur) ***A*** *is not correct because it is the minimum energy of particles not the average* ***B*** *is not correct because that is the energy change for the reaction* ***C*** *is not correct because that will not necessarily result in a reaction if the energy is too small*	**(1)**

Question Number	Answer	Mark
3(b)(i)	The only correct answer is **C**  ***A*** *is not correct because this is the activation energy for the uncatalysed forward reaction* ***B*** *is not correct because this is the activation energy for the catalysed forward reaction* ***D*** *is not correct because this is the activation energy for the uncatalysed backward reaction*	**(1)**

Question Number	Answer	Mark
3(b)(ii)	The only correct answer is **B** (100 kJ mol^{-1}) ***A*** *is not correct because this is the activation energy in the forward direction for the catalysed reaction* ***C*** *is not correct because this is the activation energy in the forward direction for the uncatalysed reaction* ***D*** *is not correct because this is the value of* ΔH	**(1)**

Question Number	Answer	Additional Guidance	Mark
3(c)	An answer that makes reference to the following points: • provides a surface for the reaction	Ignore References to lowering the activation energy Providing alternative route Details of adsorption, weakening of the bonds and desorption Easy to separate after the reaction	**(1)**

Question Number	Answer	Mark
3(d)(i)	The only correct answer is **C** (Y + Z) ***A*** *is not correct because this is the number of extra molecules which react when the catalyst is added* ***B*** *is not correct because Z should be added to Y, not subtracted from it* ***D*** *is not correct because this is the number of molecules which react without the catalyst added*	**(1)**

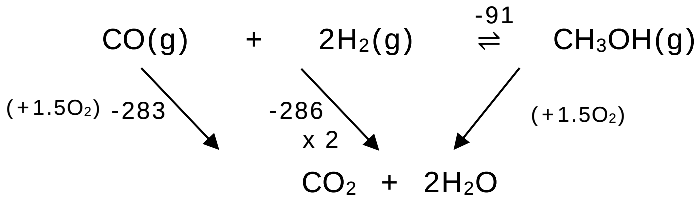
Question Number	Answer	Mark
3(d)(ii)	The only correct answer is **A** (Decreasing the temperature of the gas) ***B*** *is not correct because this will not change the number of molecules in area Y* ***C*** *is not correct because this will increase the number of molecules in area Y* ***D*** *is not correct because this will leave the number of molecules in area Y unchanged*	**(1)**

(Total for Question 3 = 6 marks)

Question Number	Answer	Additional Guidance	Mark
4(a)	An answer that makes reference to the following points: • calculation of the energy absorbed by water **(1)** • calculation of the number of moles of methanol **(1)** • calculation of the energy absorbed per mole of methanol **(1)** • gives enthalpy change of combustion to 2 or 3 SF and correct sign and units (either J mol^{-1} or kJ mol^{-1}) **(1)**	<u>Example of calculation</u> $Q = m \times c \times \Delta T$ $= 75.0 \times 4.18 \times 66.0$ $= 20\,691$ (J) $= \frac{2.08}{32.0} = 0.0650 / 0.065 / 6.50 \times 10^{-2}$ (mol) $= \frac{20\,691}{0.0650} = 318323$ (J mol^{-1}) $= -320 / -318$ kJ mol^{-1} $-320\,000 / -318\,000$ J mol^{-1} Do not award J/mol^{-1} Ignore sign until final answer when must be negative Ignore significant figures until final answer Allow TE throughout Correct answer with units and no working scores (4)	**(4)**

Question Number	Answer	Additional Guidance	Mark
4(b)(i)	An explanation that makes reference to the following points: • (increasing the pressure) decreases the yield **(1)** • as the right hand side / products contain more moles of gas **(1)** • (increasing the pressure) increases the rate of reaction **(1)** • as collisions occur at an increased frequency **(1)**	Award 4 moles of product formed from 2 moles of reactant Allow more particles in a given volume / particles are more likely to collide Ignore more collisions are of the correct orientation	**(4)**

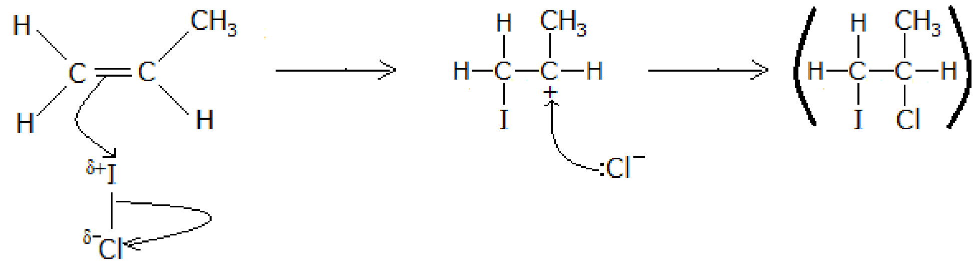
Question Number	Answer	Additional Guidance	Mark
4(b)(ii)	An explanation that makes reference to the following points: • at higher temperatures the yield of product would be less (as forward reaction is exothermic) **(1)** • at lower temperatures the reaction would be slower **(1)** • (500 K is a compromise) giving a reasonable yield at a reasonable rate / between yield and rate **(1)**		**(3)**

Question Number	Answer	Additional Guidance	Mark
4(c)	An answer that makes reference to the following points: • gives an equation linking the three values or processes together / constructs a Hess's Law cycle **(1)** • uses of numerical values in equation or on cycle, including use of 2 x $\Delta_c H(H_2)$ **(1)** • calculation of final value with correct sign **(1)**	<u>Example of calculation</u> $\Delta_c H\ (CH_3OH) = -\Delta H\ (\text{Step 2}) + \Delta_c H(CO) + 2\Delta_c H(H_2)$ or  Do not penalise lack of 2 in $2H_2O$ in cycle or in $2\Delta_c H(H_2)$ if M2 not scored. $\Delta_c H\ (CH_3OH) = 91 + -283 + 2(-286)$ $= -764\ (\text{kJ mol}^{-1})$ Correct answer with no working scores (3) Possible incorrect answers include: Award 2 marks for −478, −1424, (+)946, -855, (+)764 Award 1 mark for -946, (+)478, −946, (+)1424	**(3)**

(Total for Question 4 = 14 marks)

Question Number	Answer		Additional Guidance	Mark
5(a)	• calculation of energy required for breaking the bond in Cl_2 and I_2	(1)	<u>Example of calculation</u> $= 151 + 243 = 394$ (kJ mol^{-1})	(2)
	• calculation of energy in 2 moles of I-Cl bonds and divides by 2.	(1)	$= \frac{394 + 30}{2} = (+)212$ (kJ mol^{-1})	

Question Number	Answer	Additional Guidance	Mark
5(b)(i)	• diagram showing bond polarity using partial charges δ+ on iodine and δ- on chlorine	$\overset{\delta+}{\mathrm{I}}-\overset{\delta-}{\mathrm{Cl}}$	(1)

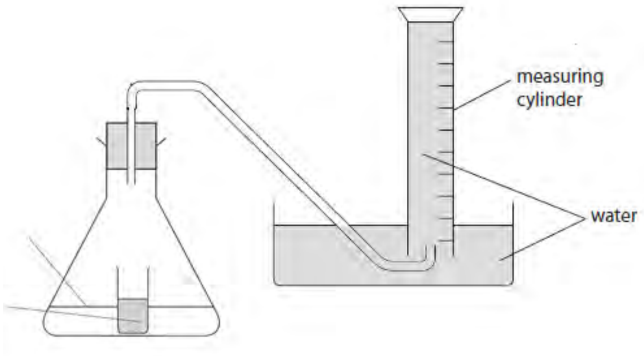
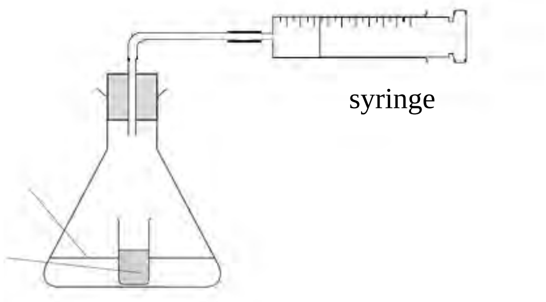
Question Number	Answer	Additional Guidance	Mark
5(b)(ii)			**(3)**
	• arrow from double **bond** to $I^{\delta+}$ and arrow from I–Cl **bond** to $Cl^{\delta-}$ **(1)**	Award M1 if dipoles are reversed in (b)(i) and arrow to $Cl^{\delta+}$ Arrows should come from, or very close to, bonds and go to, or very close to, atoms. Allow arrow to I with no δ+ if given correctly in (i)	
	• intermediate **secondary** carbocation with positive charge on carbon in the **2** position **(1)**	Mark is for secondary carbocation so **TE from (b)(i)** for carbocation from addition of Cl first in M1 Do not award δ+ instead of +	
	• arrow from **lone pair** on Cl^- to electron deficient carbon of carbocation **(1)**	Do not award δ- instead of – If dipole is reversed in (i) award mark for arrow from lone pair on I^- to electron deficient carbon of carbocation Ignore missing final product Allow M1 & M3 for minor product	

Question Number	Answer	Additional Guidance	Mark
5(c)(i)	• calculation of moles of iodine monochloride added to the unsaturated oil **(1)** • calculation of moles of sodium thiosulfate reacting with iodine liberated **(1)** • calculation of moles of iodine monochloride reacted **(1)**	Example of calculation $= \frac{25.0}{1000} \times 0.100 = 0.00250 / 2.50 \times 10^{-3}$ (mol) (ans(1)) $= \frac{32.65}{1000} \times 0.100 = 0.003265 / 3.265 \times 10^{-3}$ (mol) (ans(2)) = ans(1) – (ans(2) / 2) = 0.00250 – 0.0016325 = 0.0008675 / 8.675×10^{-4} (mol)	**(3)**

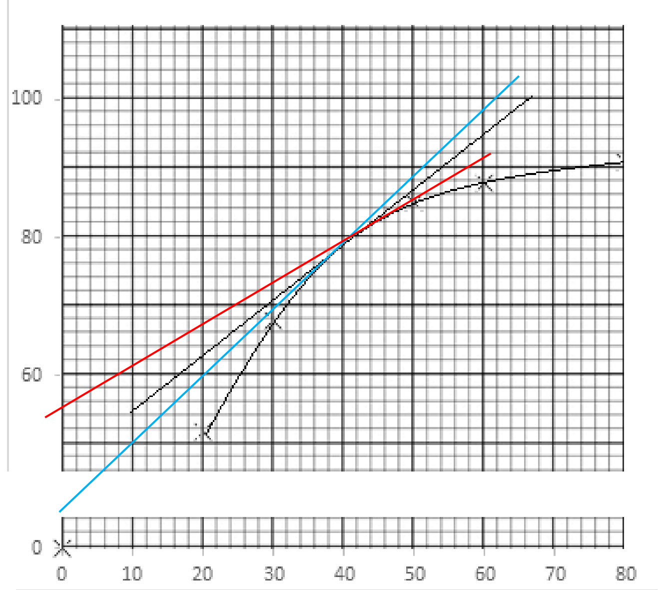
Question Number	Answer	Additional Guidance	Mark
5(c)(ii)	• calculation of mass of iodine equivalent to moles of iodine monochloride in (c)(i) **(1)** • find mass of iodine equivalent to 100 g of oil AND select nearest oil **(1)**	<u>Example of calculation</u> = ans(c)(i) x 253.8 = 0.2201715 (g) (ans(3)) Award = ans(c)(i) x 254 = 0.220345 (g) (ans(3)) = ans(3) x 400 = 88.0686 (g) So peanut oil / 84 – 106 Allow TE on all parts of (c)(i) and (c)(ii) for the oil	**(2)**

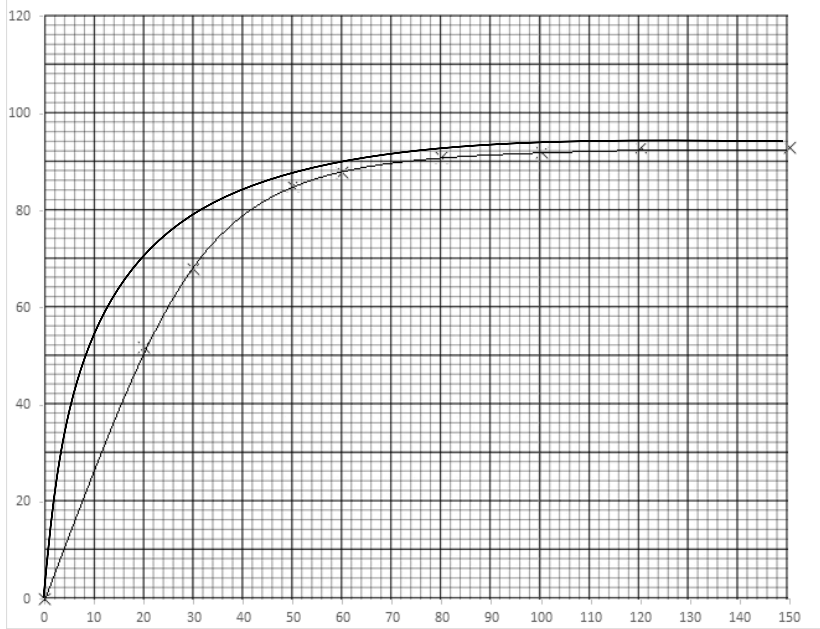
Question Number	Answer	Additional Guidance	Mark
5(c)(iii)	An answer that makes reference to the following point: • iodine monochloride has permanent dipole but iodine does not OR $\delta+$ on iodine makes it a better electrophile / more susceptible to nucleophilic attack / better at accepting electrons	Must be a comparison or implied comparison Award iodine monochloride is more polar Do not award just 'iodine monochloride is polar / has a permanent dipole' without reference to or comparison with iodine Ignore comments about bond energy/strength	**(1)**

(Total for Question 5 = 12 marks)

Question Number	Answer	Additional Guidance	Mark
6(a)	• collection over water **(1)** • use of scaled measuring glassware shown on diagram (see example) or label for measuring cylinder / burette (see example) **(1)** **OR** • use of gas syringe (no need for scale) **(1)** • gas syringe and plunger reasonably distinct **(1)**	Example of diagrams  Do not award M1 for significant gaps or delivery tube through the side of the trough  Do not award M1 for significant gaps	**(2)**

Question Number	Answer	Additional Guidance	Mark
6(b)(i)	• calculation of the rate of reaction **and** units	Example of calculation $= \frac{51}{20} = 2.55\ cm^3\ s^{-1}$ / $2.55\ cm^3/s$ Do not award cm^3/s^{-1} Allow $= \frac{50}{20} = 2.5\ cm^3\ s^{-1}$ Ignore SF except 1SF	(1)

Question Number	Answer	Additional Guidance	Mark
6(b)(ii)	• draw suitable tangent **(1)** • calculation of gradient **(1)**	 Example of calculation = $\frac{100 - 54}{66 - 10}$ = 0.82143 ($cm^3\ s^{-1}$) Ignore units even if incorrect Ignore SF Correctly calculated values in a range 0.950 – 0.600 score (2) (approx. blue line – red line) Values outside this range max (1).	**(2)**

Question Number	Answer		Additional Guidance	Mark
6(b)(iii)	• line rising more steeply than original line of best fit, always above / to the left	(1)		(2)
	• finishing at a volume slightly above the original but less than 100.	(1)	Do not award if the volume exceeds 100 cm^3	

Question Number	Answer	Additional Guidance	Mark
6(b)(iv)	An explanation that makes reference to the following points: EITHER • the rate of reaction is faster (at a higher temperature) / more gas is produced at a given time **(1)** • because there is a greater proportion of collisions with energy greater than the activation energy (for the reaction) **(1)** OR • the volume is higher than before because of the increased temperature **(1)** • the volume of gases increases with temperature **(1)**	Allow the gradient / line is steeper Allow just particles have more energy Award converse arguments for lower temperature Ignore just more collisions Do not award just ‘more gas is produced’	**(2)**

Question Number	Answer	Additional Guidance	Mark
6(c)	A description that makes reference to the following points: • filter the solid from the solution after the experiment **(1)** • (rinse with solvent / water and) dry **(1)** • reweigh the solid (it should weigh 0.25 g) **(1)** • repeat the experiment to see if identical results occur / to check catalyst still works **(1)**	Do not award measure the volume of catalyst	**(4)**

(Total for Question 6 = 13 marks)

Question Number	Answer	Additional Guidance	Mark
7(a)(i)	• ethanol is added to dissolve both the halogenoalkane and water / to allow the halogenoalkane and water to mix / to form a homogeneous mixture / to act as a co-solvent	Allow silver nitrate as an alternative to water Allow so the halogenoalkane becomes soluble in water Do not award descriptions of dissolving one of the two reactants but not the other Do not award ethanol is a solvent Do not award to allow the halogens to mix	**(1)**

Question Number	Answer	Additional Guidance	Mark
7(a)(ii)	• so they are the same temperature OR • so only the type of halogen affects the rate of reaction **(1)**	Allow to ensure the temperature remains constant Allow heat for temperature Ignore constant conditions Ignore to make it a fair test	**(1)**

Question Number	Answer	Additional Guidance	Mark
7(a)(iii)	• To ensure the reactants are mixed (thoroughly)	Allow so the mixture is homogeneous Ignore so the particles collide Ignore to form the precipitate Do not award references to kinetic energy of the molecules	**(1)**

Question Number	Answer	Additional Guidance	Mark
7(b)(i)	• chloride white precipitate **and** bromide cream precipitate **and** iodide yellow precipitate	Penalise the incorrect use of chlorine, bromine and iodine once only in 7(b)(i) and 7(b)(ii) Accept Off-white or (very) pale yellow Do not award pale yellow	**(1)**

Question Number	Answer	Additional Guidance	Mark
7(b)(ii)	• use of dilute **and** concentrated ammonia solution / aqueous ammonia (1) • silver chloride / precipitate from 1-chlorobutane is soluble in dilute (and concentrated ammonia) **and** silver bromide / precipitate for 1-bromobutane is soluble only in concentrated ammonia **and** silver iodide / precipitate from 1-iodobutane is insoluble in both dilute and concentrated ammonia (1)	Allow partially soluble	**(2)**

<table>
<tr><th>Question Number</th><th>Acceptable Answer</th><th>Additional Guidance</th><th>Mark</th></tr>
<tr>
<td>*7(c)</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>
</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).</td>
<td>6</td>
</tr>
</table>

<table>
<tr>
<td>*7(c) contd</td>
<td>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>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></td>
</tr>
</table>

	Indicative content: • IP1 Use equal amounts / numbers of moles / volumes of either halogenoalkane or silver nitrate solution • IP2 and IP3 Use isomeric primary, secondary and tertiary bromoalkanes e.g 1-bromobutane or 1-bromo-2-methylpropane **and** 2-bromobutane **and** 2-bromo-2-methylpropane • IP4 Time how long it takes for a precipitate to form / observe the order in which the precipitates form • IP5 Shorter the time the faster the rate • IP6 Correct order of precipitation given / tertiary forms before secondary before primary	Allow ethanol Do not award equal masses Ignore lack of ethanol Any two scores IP2 All 3 scores IP3 provided they are isomers Accept names or formulae but if both given they must both be correct 1 ÷ time = rate of reaction	

(Total for Question 7 = 12 marks)
(Total for paper = 80 Marks)

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