2007
Assessment
Report

VICTORIAN CURRICULUM AND ASSESSMENT AUTHORITY

2007 Chemistry GA 1: Written examination 1

GENERAL COMMENTS

Students' performance at the top end of the mark range for this examination was very similar to that for the 2006 examination, with approximately 90 per cent needed to achieve an A+ and approximately 82 per cent needed to achieve an A. However, performance at the lower levels was not as good, as shown in the mean score of 59.2 per cent as against 61.1 per cent in 2006. The median score for the 2007 examination was 60.3 per cent. Both the mean and median scores for the 2007 examination corresponded to a grade of a high C^+.

Given that this was the last Unit 3 examination prior to the implementation of the reaccredited VCE Unit 3 and 4 course in 2008, this report will focus on areas that are relevant to the new study and which continue to prove challenging to a significant number of chemistry students.

A number of the multiple-choice questions provided useful insights into some common misunderstandings. Question 7, for which students needed to select the correct graphical representation of changes in the rates of forward and reverse reactions as a system approaches equilibrium, proved more challenging than was expected. Questions 15 and 16, both involving pH, were amongst the four most difficult questions. Question 18 tested understanding of the use of light in atomic absorption spectroscopy in a different context. Performance on Question 20 suggested that the majority of students focused on the carboxyl group and perhaps were not comfortable with the term 'repeating unit'.

The importance of reading the questions carefully can never be overemphasised. Despite the fact the words '**all bonds**' were highlighted in Question 5d. in Section B, the majority of students did not show the bond between O and H on the carboxyl group for propanoic acid. Teachers are encouraged to show students examples of structures that show all bonds to assist them in answering this type of question in future examinations.

Questions in which students are required to provide written explanations or reasoning provide excellent learning opportunities for future students. For Question 3c., the relatively common response 'there were other substances/impurities present in the rock' was not accepted because the impact on the calculated percentage depends on whether or not the 'impurities' react with the excess hydrochloric acid.

Many students continue to have difficulty with equation writing during the examination. Of particular concern was the fact that approximately half the students did not write correct equations for the oxidation of Ni to Ni^{2+} (Question 4ai.) or for the complete combustion of ethene (Question 5cii.).

Questions 6 and 7, the final questions on the paper, provided unfamiliar and familiar contexts respectively. Most students were relatively comfortable with the back titration context of Question 7, but many struggled to understand the links between absorbance data, equilibrium concentrations and reaction rate in Question 6. Teachers are encouraged to provide students with examples of contexts that are both familiar and new.

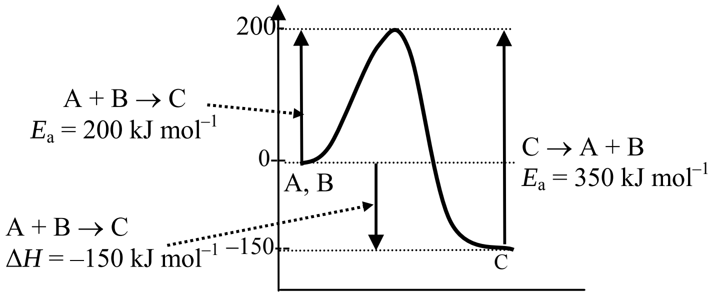
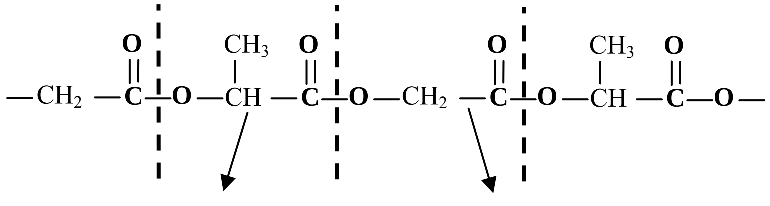
Although students are encouraged to practise relevant questions from past exams in 2008 and beyond, a strong focus on accurate interpretation of the questions and identifying the relevant key knowledge and skills is recommended. Teachers are encouraged to use the statistical data provided to each school to identify particular areas that their students found difficult and, where relevant to the reaccredited VCE Chemistry Units 3 and 4, make these areas a particular focus in 2008. A sample examination for the reaccredited VCE Unit 3 Chemistry course can be found on the VCAA website <www.vcaa.vic.edu.au>.

SPECIFIC INFORMATION

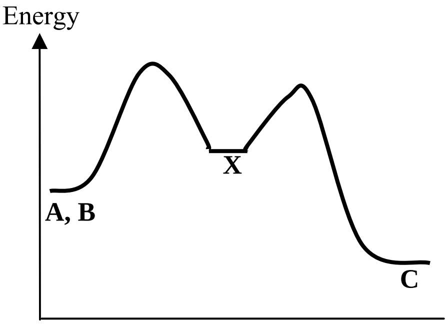
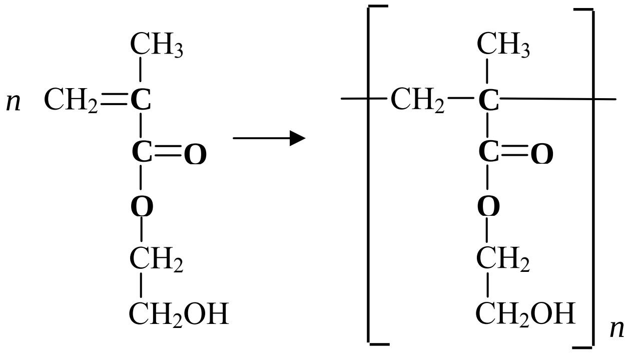
Section A – Multiple-choice questions

The table below indicates the percentage of students who chose each option. The correct answer is indicated by shading.

Question	% A	% B	% C	% D	Comments
1	6	6	**77**	11	R_f values are characteristic of paper or thin-layer chromatography. Retention times are characteristic of column chromatography, and in gas-liquid chromatography a non-reactive gas is used as the mobile phase.
2	**78**	5	9	9	Atomic absorption spectroscopy is used to determine the amount of a particular metal present in the sample being analysed.
3	17	**56**	12	15	The least number of molecules of NO corresponds with the least n(NO). Option A: $n(\text{NO}) = \frac{V}{V_m(\text{STP})} = \frac{6\times10^2}{22.4} = 27$ mol Option B: $n(\text{NO}) = 1$ mol Option C: $n(\text{NO}) = \frac{m}{M} = \frac{6\times10^2}{30.0} = 20$ mol Option D: $n(\text{NO}) = 6$ mol Many students either did not know how to solve such questions or had difficulty applying fundamental mole relationships.
4	18	**66**	9	6	The empirical formula reflects the mole ratio $n(\text{I}) : n(\text{Cl})$ $m(\text{I}) = 2.54 \text{ g} \rightarrow n(\text{I}) = \frac{2.54}{126.9}$ $= 2.00 \times 10^{-2}$ mol $m(\text{Cl}) = m(\text{product}) - m(\text{I})$ $= 4.67 - 2.54$ $= 2.13$ g $n(\text{Cl}) = \frac{2.13}{35.5}$ $= 6.00 \times 10^{-2}$ mol Ratio $n(\text{I}) : n(\text{Cl}) = 2.00 \times 10^{-2} : 6.00 \times 10^{-2}$ $= 2 : 6$ $= 1 : 3$ Hence, the empirical formula is ICl_3
5	11	9	**66**	14	The lower retention times evident on chromatogram 2 could only be caused by using a less tightly packed column, which would reduce interaction with the stationary phase and speed up progress through the column. Decreasing the pressure of the mobile phase or the temperature would slow down the movement of the mobile phase through the column and thus increase the retention times.
6	**62**	21	9	7	Since the forward reaction is exothermic ($\Delta H < 0$), the yield of propanone would increase at a lower temperature. With more particles on the product side, the yield of propanone would be increased by a change in pressure that would force the position of equilibrium to move to the side with more particles, i.e. by a decrease in pressure. Students who chose option B showed some confusion with the impact of changes in pressure in equilibrium systems.
7	11	18	23	**49**	As the reaction $C_3H_8O(g) \rightarrow C_3H_6O(g) + H_2(g)$ proceeds, its rate decreases due to the decreasing concentration/partial pressure of C_3H_8O. Simultaneously, as the concentrations/partial pressures of $C_3H_6O(g)$ and $H_2(g)$ increase, the rate of the reaction $C_3H_6O(g) + H_2(g) \rightarrow C_3H_8O(g)$ increases. When the two reactions are occurring at the same rate equilibrium has been established. This was one of the more challenging questions on the paper. Most students knew that ‘at equilibrium the rates of the forward and reverse reactions’ are equal, but many did not correctly identify the graphs for the forward and reverse reactions.

Question	% A	% B	% C	% D	Comments
8	18	71	5	6	Let the reaction be represented by A + B → C  Students could be encouraged to do a quick sketch of the energy profile when supplied with ΔH and activation energy data.
9	15	28	9	48	In a redox reaction between zinc metal and sulfuric acid, zinc metal would be the reductant (and be oxidised) and sulfuric acid would be the source of the oxidant (which will be reduced). In dilute sulfuric acid, the oxidant is H^+(aq), which is reduced to H_2 according to $2H^+(aq) + 2e^- \rightarrow H_2(g)$. In concentrated sulfuric acid the oxidant is H_2SO_4(l). When H_2SO_4 is reacting as an oxidant, and hence being reduced, the oxidation number of sulfur, which is +6, must decrease. The oxidation numbers of sulfur in the suggested products are H_2S – (–2); SO_2 – (+4); SO_3 – (+6). Hence SO_3 is unlikely to be a product of the reaction.
10	70	10	15	6	The repeating unit of the polymer contains ester groups each of which would have formed from reaction between a carboxyl (–COOH) and a hydroxy (–OH) group on adjacent monomers. Thus the –OH group on a lactic acid molecule must react with a –COOH group on a glycolic acid molecule, whilst the –COOH group on a lactic acid molecule must react with a –OH group on a glycolic acid molecule. So, glycolic acid molecules must contain both a –COOH group and –OH group. Expanding the repeating unit and focusing on the ester groups enables identification of the monomers. $-CH_2-C(=O)-O-CH(CH_3)-C(=O)-O-CH_2-C(=O)-O-CH(CH_3)-C(=O)-O-$ $HOCH(CH_3)COOH$ lactic acid $HOCH_2COOH$ glycolic acid
11	11	9	71	9	Since all members of an homologous series contain the same functional group (statement III) they will have similar chemical properties (statement II). However, since successive members of an homologous series differ by CH_2, they have different physical properties (e.g. boiling temperature) and different molecular formulae, therefore statements I and IV are incorrect.
12	13	77	6	4	1. $CH_2{=}CH_2 \xrightarrow{HBr} CH_3CH_2Br$ (bromoethane) – addition reaction 2. $CH_3CH_2Br \xrightarrow{OH^-} CH_3CH_2OH$ (ethanol) – substitution reaction 3. $CH_3CH_2COOH + CH_3CH_2OH \rightarrow \underset{\text{ethyl propanoate}}{CH_3CH_2COOCH_2CH_3} + H_2O$ This is a condensation reaction.
13	4	82	3	10	
14	16	10	17	56	Experiment 2 has a higher initial rate of reaction and so occurs at the higher temperature. Experiment 1 produces more HI by the time equilibrium is established, so the forward reaction is favoured at lower temperatures, indicating that the reaction is exothermic. A significant number of students struggled to accurately interpret the graphical representation of reaction conditions.

Question	% A	% B	% C	% D	Comments
15	10	8	39	42	pH 12 $\rightarrow \left[H_3O^+\right] = 10^{-12}$ M $\left[OH^-\right] = \frac{10^{-14}}{10^{-12}} = 10^{-2}$ M = 0.01 M pH 13 $\rightarrow \left[H_3O^+\right] = 10^{-13}$ M $\left[OH^-\right] = \frac{10^{-14}}{10^{-13}} = 10^{-1}$ M = 0.1 M Since the volume of solution is one litre, $n(OH^-)$ increases by 0.1 – 0.01 = 0.09 mol. 0.09 mol KOH must be added. Students who chose option D recognised that pH 13 $\rightarrow \left[OH^-\right] = 0.10$ M but did not effectively link the change in pH to the change in $n(OH^-)$ present.
16	27	21	23	29	pH 12 $\rightarrow \left[H_3O^+\right] = 10^{-12}$ M $\left[OH^-\right] = \frac{10^{-14}}{10^{-12}} = 10^{-2}$ M = 0.01 M pH 2 $\rightarrow \left[H_3O^+\right] = 10^{-2}$ M = 0.01 M Enough HCl must be added to neutralise the OH^- initially present (i.e. 0.01 mol) and to then increase the amount of H_3O^+ present to 0.01 mol. So the total $n(HCl)$ required = 0.01 + 0.01 = 0.02 mol This proved to be the most difficult multiple-choice question on the paper. The relatively equal popularity of each option suggests that students were generally unsure of how to solve this problem.
17	13	9	27	51	For the same volume of different gases, at the same temperature, the pressure exerted by each gas depends on the number of moles present in the sample. $n(\text{Ar}) = \frac{m\ (\text{Ar})}{M\ (\text{Ar})} = \frac{10}{39.9} = 0.2506$ mol $n(\text{Ne}) = \frac{m\ (\text{Ne})}{M\ (\text{Ne})} = \frac{10}{20.1} = 0.498$ mol The number of Ne atoms present in bottle II is approximately double the number of Ar atoms present in bottle I, so the pressure in bottle II is higher than the pressure in bottle I.
18	26	30	14	30	Light is emitted from a sodium lamp as electrons in excited sodium atoms move from higher energy levels to lower energy levels. The wavelengths of light emitted correspond to the energy needed to promote electrons in sodium atoms from lower energy levels to higher energy levels. So, when light from a sodium lamp is passed through a container of sodium vapour, the intensity of the light decreases as electrons in the sodium vapour absorb energy in moving from lower to higher energy levels. Most students were unable to apply the principles of light absorption during atomic absorption spectroscopy to the situation described in the question.

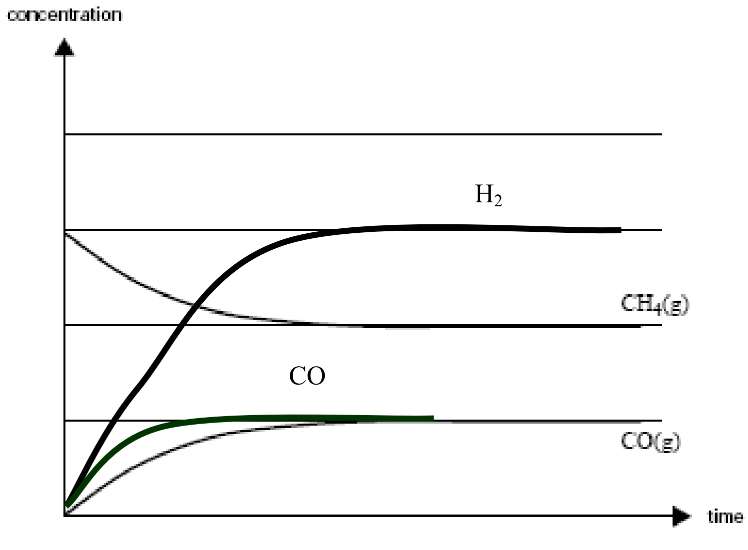
Question	% A	% B	% C	% D	Comments
19	9	4	8	79	The reaction A + B → C; (Δ*H* negative) is exothermic, so on an energy profile the product (C) is below the reactants (A, B). The reaction A + B → X; (Δ*H* positive) is endothermic, so on an energy profile the product (X) is above the reactants (A, B). The reaction X → C; (Δ*H* negative) is exothermic, so on an energy profile the product (C) is below the reactant (X). 
20	30	27	21	22	The polymer shown would be formed by addition polymerisation according to  Responses suggested that the majority of students were distracted by the ester group in the structure as shown.

Section B – Short answer questions

Asterisks (*) are used in some questions to show where marks were awarded.

Question 1a.

Marks	0	1	2	Average
%	28	32	40	**1.2**



Students showed varying levels of familiarity with concentration–time graphs. Although most students showed the effect of the catalyst, many did not recognise that the equilibrium [H_2] would be three times the equilibrium [CO].

Question 1b.

Marks	0	1	Average
%	27	73	0.8

K_1 is smaller than K_2 (or $K_1 < K_2$ or $K_2 > K_1$).

Question 1c.

Marks	0	1	2	3	Average
%	1	16	42	41	2.3

Statement	True	False
i. Endothermic reactions are always slower than exothermic reactions.		✓
ii. All particles have the same kinetic energy at a fixed temperature.		✓
iii. Reactant particles need to collide with sufficient energy at a fixed temperature.	✓	
iv. The rate of a reaction at a constant temperature increases as the reaction proceeds.		✓
v. Increasing the temperature increases the fraction of collisions with energy above the activation energy.	✓	

Three marks were awarded if all five statements were correct; two marks if four were correct; and one mark if two or three were correct.

This question was generally well handled, with the most common error occurring in part ii. Students should be aware that particles in a gas sample collide and hence change speed. At a given temperature, not all particles have the same kinetic energy or will be moving at the same speed. The 'average' kinetic energy is proportional to temperature (K).

Question 2a.

Marks	0	1	Average
%	9	91	0.9

$$K_a = \frac{\left[B^-\right]\left[H^+\right]}{\left[BH\right]}$$

Question 2bi.

Marks	0	1	2	Average
%	35	9	56	1.3

$\left[BH\right] = \left[B^-\right]$, so

$$K_a = \left[H^+\right]^* \rightarrow \left[H^+\right] = 6.3 \times 10^{-5}\ M$$

$$pH = -\log_{10}\left(6.3 \times 10^{-5}\right)$$

$$= 4.2\ *$$

Question 2bii.

Marks	0	1	Average
%	68	32	0.3

pH 7 → $[H^+] = 10^{-7}$ M

$$K_a = \frac{[B^-][H^+]}{[BH]}$$

$$6.3 \times 10^{-5} = \frac{[B^-] \times 10^{-7}}{[BH]}$$

$$[B^-]/[BH] = \frac{6.3 \times 10^{-5}}{10^{-7}}$$

$$= 630 \left(6.3 \times 10^2 \text{ or } 6 \times 10^2\right)$$

The majority of students did not recognise that the required ratio $[B^-]/[BH]$ was incorporated in the K_a expression and the K_a and $[H^+]$ were given. Some students tried to incorporate the normal weak acid assumption that $[B^-] = [H^+]$ to calculate the [BH] and then work out the required ratio.

Question 2biii.

Marks	0	1	Average
%	64	36	**0.4**

Blue. The concentration of the (blue species) B^- is greater than that of the (yellow species) BH.

The link between the ratio determined in part ii. and the colour of the indicator at pH 7 was not well recognised. Some students returned to the stem of the question and argued that, as the pH increases, the position of equilibrium moves to the right and so the indicator becomes bluer.

Question 3a.

Marks	0	1	2	Average
%	21	22	57	**1.4**

$$m(CaCO_3) = 8.64 - 1.55$$

$$= 7.09 \text{ g } *$$

$$\% \; CaCO_3 = \frac{7.09}{8.64} \times 100$$

$$= 82.1\% *$$

This question tested fundamental data handling skills.

Question 3b.

Marks	0	1	2	3	Average
%	31	15	16	39	**1.7**

$$n(CaO) = \frac{3.87}{56.1}$$

$$= 0.0690 \text{ mol}$$

$$n(CaCO_3) = 0.0690 \text{ * mol}$$

$$m(CaCO_3) = 0.0690 \times 100.1$$

$$= 6.91 \text{ g}$$

$$\% \; CaCO_3 = \frac{6.91}{8.64} \times 100$$

$$= 79.9\% \; *$$

Answers of 79.8 and 80.0 were also accepted. The third mark was awarded for the answer being given to the correct number of significant figures (three).

Students who struggled with this question generally did not recognise the direct link between the $n(CaO)$ eventually collected and the $n(CaCO_3)$ in the rock sample.

Question 3c.

Marks	0	1	Average
%	70	30	**0.3**

Possible answers included:

- not all of the precipitate ($CaC_2O_4.H_2O$) was collected
- the $CaC_2O_4.H_2O$ was slightly soluble
- some precipitate was lost during washing
- there were other carbonates/soluble salts in the rock sample.

This question provided insight into student ‘awareness’ of the impact of possible errors on experimental outcome. ‘Other substances present in the rock sample’ was a relatively common incorrect response. Given the experimental technique, ‘other substances’ would have made the calculated percentage in part a. either higher (if they were soluble in the hydrochloric acid) or lower (if they were insoluble).

Question 4ai.

Marks	0	1	Average
%	43	57	**0.6**

$Ni \rightarrow Ni^{2+} + 2e^-$

Question 4aii.

Marks	0	1	Average
%	59	41	**0.5**

$SO_4^{2-} + 4H^+ + 2e^- \rightarrow SO_2 + 2H_2O$
$H_2SO_4 + 2H^+ + 2e^- \rightarrow SO_2 + 2H_2O$

Question 4aiii.

Marks	0	1	2	Average
%	36	25	39	**1.1**

$Ni(s) + SO_4^{2-}(aq) + 4H^+(aq) \rightarrow Ni^{2+}(aq) + SO_2(g/aq) + 2H_2O(l)$
$Ni(s) + H_2SO_4(aq) + 2H^+(aq) \rightarrow Ni^{2+}(aq) + SO_2(g/aq) + 2H_2O(l)$

Students are expected to be able to write half-equations at VCE level. While the reduction half-equation involving sulfuric acid (part ii.) was challenging, a greater proportion of students should have correctly written the half-equation for the oxidation of nickel. States were checked in part iii. of this question.

Question 4b.

Marks	0	1	Average
%	51	49	**0.5**

No; there is no change in oxidation numbers (or nothing is oxidised or reduced).

Students needed to give an appropriate explanation to be awarded the mark for this question. Applying oxidation numbers to check whether or not a reaction is a redox reaction is a fundamental requirement at this level.

Question 4c.

Marks	0	1	Average
%	24	76	**0.8**

Any one of:

- H_2SO_4
- SO_3
- $H_2S_2O_7$
- $(NH_4)_2SO_4$

This question provided interesting insights into how students interpret questions, especially with respect to phrases such as ‘chemicals of industrial importance’. A significant number of students simply included the equation for the conversion of SO_2 to SO_3 as per the Contact process. Although this was accepted, students should be encouraged to answer the question being asked. The most common answers were H_2SO_4 and SO_3.

Question 4d.

Marks	0	1	2	3	Average
%	14	24	26	36	**1.9**

4di.

1. The product of this reaction is **sulfur trioxide**.
2. At constant temperature, the chemical energy of the product is **less than** the chemical energy of the reactants.

4dii.

1. The equilibrium yield of product is **increased** as temperature decreases at constant pressure.
2. The equilibrium yield of product is **increased** as pressure increases at constant temperature.

4diii.

1. The reaction rate is increased as the temperature **increased** at constant pressure.
2. The activation energy of the reaction is **decreased** by the presence of vanadium (V) oxide.

A small number of students wrote the answers in the spaces provided rather than following the instruction to ‘circle the most appropriate words’. Students should ensure that they read each question carefully.

Question 5ai.

Marks	0	1	Average
%	28	72	**0.7**

cracking (or thermal/steam/catalytic cracking)

Question 5aii.

Marks	0	1	Average
%	20	80	**0.8**

It acts as a catalyst (or increases reaction rate, etc.).

Question 5b.

Marks	0	1	Average
%	22	78	**0.8**

$C_{17}H_{36}(g/l) \rightarrow C_{15}H_{32}(g/l) + C_2H_4(g)$
$C_{17}H_{36} \rightarrow C_{17-2n}H_{36-4n} + nC_2H_4$
e.g. $C_{17}H_{36} \rightarrow C_7H_{16} + 5C_2H_4$

Correct semi-structural formulae were accepted.

Question 5c.

Marks	0	1	Average
%	32	68	**0.7**

$C_2H_4(g) + Br_2(g) \rightarrow C_2H_4Br_2(g)$ *or* $CH_2{=}CH_2 + Br_2 \rightarrow CH_2BrCH_2Br$

Question 5cii.

Marks	0	1	Average
%	52	48	**0.5**

$C_2H_4(g) + 3O_2(g) \rightarrow 2CO_2(g) + 2H_2O(g)$

Question 5ciii.

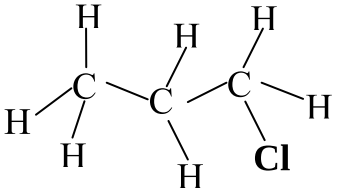
Marks	0	1	Average
%	55	45	**0.5**

$C_2H_4(g) + H_2O(g) \rightarrow C_2H_6O(g)$ *or* $CH_2{=}CH_2 + H_2O \rightarrow CH_3CH_2OH$

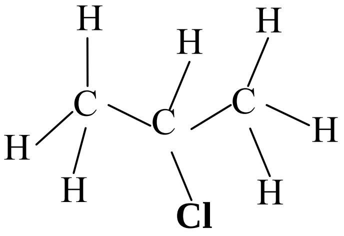
The equations for the combustion of ethene and the reaction of ethene with steam proved challenging for most students. Some students proposed polyethylene as the product in part iii., perhaps because they focused on the catalyst.

Question 5di.

Marks	0	1	2	3	4	Average
%	29	15	15	7	35	**2.1**



1-chloropropane



2-chloropropane

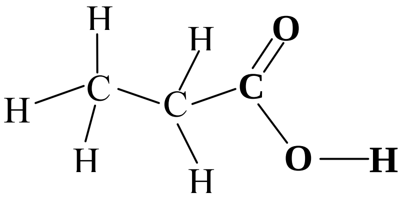
- Since A and B have the same molar mass, they are most likely to be structural isomers.
- Alkanes react with Cl_2 to form chloroalkanes.
- M(chloroalkanes) = 78.5 g $mol^{-1} \rightarrow M_r$(chloroalkanes) = 78.5.
- Since A_r(Cl) = 35.5, each chloroalkane molecule contains one Cl atom.
- The hydrocarbon component of each molecule has $M_r = 43$, hence the two compounds formed are chloropropanes.

Where both an exact structure and name were given for an incorrect chloroalkane, students were awarded one mark.

Students who had a good knowledge of structural isomerism in chloroalkanes may have immediately opted for chloropropanes. However, the popularity of HCl as one of the compounds formed suggested that many students did not realise that the compounds were structural isomers.

Question 5dii.

Marks	0	1	2	Average
%	50	9	41	**1.0**



propanoic acid

$CH_3CH_2CH_2Cl \xrightarrow{OH^-} CH_3CH_2CH_2OH \xrightarrow{Cr_2O_7^{2-}/H^{+-}} CH_3CH_2COOH$

If an 'incorrect' chloroalkane was given in part i. but the structural formula and name of the carboxylic acid in part ii. was consistent with that chloroalkane, students were awarded both marks for this question.

Despite the clear instruction to 'show all bonds' many students did not show the O–H bond in the acid.

Question 6a.

Marks	0	1	Average
%	49	51	**0.5**

Absorbance at equilibrium = 0.250

$$[X] = \frac{0.250}{4.15}$$
$$= 0.0602 \left(6.0\times10^{-2}\right)\text{M}$$

Many students did not seem to realise that constant absorbance between four minutes and eight minutes is an indication that equilibrium had been achieved.

Question 6b.

Marks	0	1	Average
%	37	63	0.6

$$[X] = 0.110\text{ M}$$
$$\text{Absorbance} = 4.15 \times 0.110$$
$$= 0.457$$

Question 6c.

Marks	0	1	2	Average
%	54	20	26	0.8

$$n(\text{X})\text{ converted} = 0.110 - 0.0602$$
$$= 0.0498 * (0.050)\text{ mol}$$
$$\%\text{ X converted} = \frac{0.0498}{0.110}\times100 *$$
$$= 45.3\ \%$$

A number of students worked out the percentage of X present at equilibrium, which was awarded one mark. A few students intuitively, and correctly, used the initial absorbance and the change in absorbance in reaching equilibrium.

Question 6d.

Marks	0	1	2	Average
%	49	24	27	0.8

$$[X]\text{ initially} = 0.110\text{ M}$$
$$\text{Absorbance at 6.00 s} = 0.430$$
$$[X]\text{ at 6.00 s} = \frac{0.430}{4.15}$$
$$= 0.1036\text{ M (0.104)}$$
$$\Delta[X] = 0.110 - 0.1036*$$
$$= 0.0064\text{ M}$$
$$\text{Rate of }\Delta[X] = \frac{0.0064}{6.00}\ *$$
$$= 0.0011\text{ Ms}^{-1}$$

This question was well done by students who performed well on most other questions.

Students who had made some progress through parts a. and b. of Question 6 often did not attempt parts c. and/or d.

Question 7a.

Marks	0	1	2	3	Average
%	14	10	24	52	2.3

$$\begin{aligned} n(\mathrm{SO_2}) &= 2\times n(\mathrm{Na_2S_2O_5}) \\ &= 2\times\frac{250}{190}\ * \\ &= 2.63\text{ mol} \end{aligned}$$

$$\begin{aligned} \mathrm{V(SO_2)} &= \frac{nRT}{p} \\ &= \frac{2.63\times 8.31\times 288}{101.3}\ * \\ &= 62.2\ *\text{ L} \end{aligned}$$

The most common error for this question was not recognising that $n(SO_2) = 2 \times n(Na_2S_2O_5)$.

Question 7bi.

Marks	0	1	2	Average
%	22	35	43	**1.3**

Equation: $SO_2 + 2H_2O + I_3^- \rightarrow 3I^- + 4H^+ + SO_4^{2-}$
Reductant: SO_2

Identifying the reductant proved problematic for some students, possibly the same students who confused oxidation and reduction in Question 4. A number of students identified the reductant as S rather than the 'substance' in the reaction; that is, SO_2.

Question 7bii.

Marks	0	1	Average
%	27	73	**0.7**

$$\begin{aligned} n(\mathrm{I_3^-}) &= 0.0125\ \times\ 50.0\times 10^{-3} \\ &= 6.25\times 10^{-4}\ (0.000625)\text{ mol} \end{aligned}$$

Question 7biii.

Marks	0	1	2	3	Average
%	31	16	20	32	**1.6**

$$\begin{aligned} n\left(\mathrm{I_3^-}\right)\text{in excess} &= n\mathrm{S_2O_3}^{2-} \\ &= 0.00850\times 14.70\times 10^{-3} \\ &= 0.000125*\ \left(1.25\times 10^{-4}\right)\text{ mol} \end{aligned}$$

$$\begin{aligned} n\left(\mathrm{I_3^-}\right)\text{ reacting with }\mathrm{SO_2} &= n\left(\mathrm{I_3^-}\right)\text{ initially} - n\left(\mathrm{I_3^-}\right)\text{ in excess} \\ &= 6.25\times 10^{-4} - 1.25\times 10^{-4}\ * \\ &= 5.00\times 10^{-4}\text{ mol} \end{aligned}$$

$$\begin{aligned} n(\mathrm{SO_2}) &= 5.00\times 10^{-4}\text{ mol} \\ c(\mathrm{SO_2}) &= \frac{5.00\times 10^{-4}}{50.0\times 10^{-3}}\ * \\ &= 0.0100\text{ M} \end{aligned}$$

The last question on the paper was well done. Students seemed to understand the principles of simple back-titrations. A common error was to use the total solution volume rather than that of the original solution when calculating the $c(SO_2)$.