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Examiners' Report
January 2010

GCE Chemistry 6CH01

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Introduction

The paper had many questions on familiar chemistry, but also contained challenges where candidates had to apply their knowledge in situations which looked unfamiliar. Good work was seen on many of the numerical questions. Some answers required clear use of language, and marks could not be given if the responses did not use terms such as molecules or ions correctly. Candidates should be reminded of the need of clear handwriting. Poor handwriting caused some candidates to lose marks when examiners could not read state symbols, or distinguish words like ethane and ethene. The extra time available compared to previous papers seemed a benefit. There were some blanks in answers to question 19(a) to (d), but answers to 19(e) were usually given, so lack of time was not an issue.

Question 16

The question was linked to practical work on preparation of a salt. The formula of magnesium chloride appeared early in the question, but some candidates did not use it in the first equation. The question also referred to the magnesium chloride solution, but many candidates used the state symbol (s) for magnesium chloride in the equation. This was not penalised unless there were other errors.

In (b) observations were required, and though most candidates realised that bubbles or effervescence would be seen, they found it harder to suggest a second observation.

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Examiner Tip

This question asks for TWO observations, so they must be distinctly different.

(b) Give TWO observations you would make when the reaction is taking place.

(2)

a gas would be given off and the solution would fiz and bubble.

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Examiner Comments

This answer has described one observation in two ways (fizzing and bubbling). Saying that a gas is given off is not an observation, as most gases are invisible.

(b) Give TWO observations you would make when the reaction is taking place.

(2)

There would be bubbles given off

The reaction would heat up (slightly exothermic)

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Examiner Comments

This answer has described two different observations. As candidates are unlikely to know whether a reaction is exothermic or endothermic they could just say that a temperature change occurs.

Many of the calculations in (c)(i) were well done, but failure to appreciate the 1:2 ratio when calculating the number of moles of magnesium carbonate in c(ii) was common. However, allowance was made for answers based on incorrect reacting ratios in the original equation.

Answers to (c)(iii) were sometimes imprecise, and it was not always clear that an excess of magnesium carbonate would use up all the acid.

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Examiner Tip

If an excess of magnesium carbonate is used, all the acid will be used up and the excess solid is easily filtered off to leave a pure solution of magnesium chloride.

(iii) Suggest why slightly more than this mass of magnesium carbonate is used in practice.

(1)

To ensure that the reaction compleetes fully

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Examiner Comments

This does not say what reacts fully. The magnesium carbonate will not react fully as it is in excess. The answer should say that all the acid reacts fully.

Answers to (c)(iv) often included heating or distillation, and were not based on removing the solid magnesium carbonate.

Calculating the percentage yield in (c)(v) caused difficulty, and some candidates simply divided the actual yield by the mass of magnesium carbonate they had calculated previously, without calculating the theoretical yield.

In (c)(vi) answers had to be related to the experimental procedure, not mistakes by the experimenter. Only a few candidates had a clear idea of the experimental limitations on yield, and there were many general answers. In questions like this comments should be specific about how the loss in yield occurs and it is not enough just to refer to human error.

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Examiner Tip

There are several possible answers as well as the one below. The answer could have referred to filtering. Solutions soak into filter paper, so the solute will be lost and the yield of crystals reduced. If hydrated crystals are heated too strongly when they are being dried, they would lose some of their water of crystallisation.

Some mass of either $MgCO_3$ or HCl may have spilt or may have been left behind in its container. Small errors like this can give lower *percentage yields less than 100%.

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Examiner Comments

This answer gets the mark for the idea that material is always lost when transferring chemicals from one container to another.

Answers to (d) required careful wording. A statement in (d)(i) that magnesium chloride was more ionic than covalent was not accepted. The data shows that the bonding is very close to the ionic model, but does not exactly match it. There are very many ways of expressing this but it had to be reflected in the answer. In (d)(ii) candidates often referred to the size of iodine molecules and atoms, but to gain credit it had to be clear that the ionic radius was what mattered. Again, there were many ways of expressing the idea of increased covalent character or polarisation of the iodide ion, when explaining the difference in theoretical and experimental lattice energies.

ResultsPlus Examiner Tip

Answers to this question need careful wording. In (d)(i) the data shows that the bonding is almost completely, but not 100% ionic. The different values for magnesium iodide occur because the iodide ion is larger than the chloride ion and the iodide ion becomes polarised. If magnesium chloride was described as having some covalent character in (i), the answer in (ii) had to make clear that this is increased in magnesium iodide.

(i) What does this data indicate about the bonding in magnesium chloride?

(1)

Magnesium chloride is almost purely ionic.

*(ii) Explain why there is a greater difference between the experimental (Born-Haber) and theoretical lattice energies for magnesium iodide, MgI_2, compared with magnesium chloride.

(2)

Iodine ~~is~~ forms a larger ion than the chloride ion. Large ~~ions~~ anions are more easily polarized than smaller ones. MgI_2 has a slightly covalent character due to more polarisation of the iodide ion.

ResultsPlus Examiner Comments

This is a good answer scoring full marks.

(i) What does this data indicate about the bonding in magnesium chloride?

(1)

The bonding in $MgCl_2$ is stronger than in MgI_2 as there greater forces of attraction

*(ii) Explain why there is a greater difference between the experimental (Born-Haber) and theoretical lattice energies for magnesium iodide, MgI_2, compared with magnesium chloride.

(2)

~~[illegible]~~ There is a larger difference in size between Mg and I_2 compared to $MgCl_2$. Therefore there would be more covalency in MgI_2, hence a greater difference

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Examiner Comments

This doesn't state the type of bonding in magnesium chloride. In (ii), it does not refer to ions or state clearly that the iodide ion is larger than the chloride ion, though it would get a mark for the idea that there is more covalent character in magnesium iodide than in magnesium chloride.

The calculation on parts per million in (e)(i) was well done, and there were many sensible suggestions about use of magnesium chloride in (e)(ii).

Question 17

Calculating an empirical formula in (a) was a familiar task and well done. A number of candidates forgot to include the oxygen, but could earn the mark in (ii) by doubling their empirical formula, showing that its mass was close to half of the molar mass. Another error was to use atomic numbers instead of atomic masses.

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Examiner Tip

All the atoms in the compound must be included, so the percentage of oxygen has to be calculated. In (ii) the question asks for information to be used, so the answer should show that this has been done.

(a) Sulfamic acid contains 14.42% by mass of nitrogen, 3.09% hydrogen and 33.06% sulfur. The remainder is oxygen.

(i) Calculate the empirical formula of sulfamic acid.

(3)

N	H	S
$\frac{14.42}{14}$	$\frac{3.09}{1}$	$\frac{33.06}{32.1}$
1.03	3.09	1.03
1 :	3 :	1

H_3NS

(ii) The molar mass of sulfamic acid is 97.1 g mol^{-1}. Use this information to deduce the molecular formula of sulfamic acid.

(1)

$H_6N_2S_2$

$14 + 32.1 + 3 = 49.1$

$97.1 \div 49.1 = 1.978$

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Examiner Comments

This answer has omitted the oxygen so loses the third mark in (i). However the empirical formula mass has been calculated and shown to be close to half the molar mass, so the mark was given in (ii) for using information to deduce a molecular formula. In a perfect answer there would have been words or abbreviations showing what the numbers referred to.

The diagrams in (b)(i) had to show a workable method of collecting hydrogen, and a suitable method of measuring its volume. The diagram had to be good enough to show another person what to do, but tubing, bungs etc were not expected to be drawn to text-book standard. A number of diagrams showed hydrogen being collected in test tubes with no way of measuring the volume. More major errors suggested a lack of practical experience. Collection over water often showed worrying disregard for water levels or indeed the need for water at all! There were diagrams showing a gas being produced in a sealed container (other than a syringe) connected to a sealed flask, or with gas being produced in an open container from which it would have escaped, with a side arm leading to a collecting vessel.

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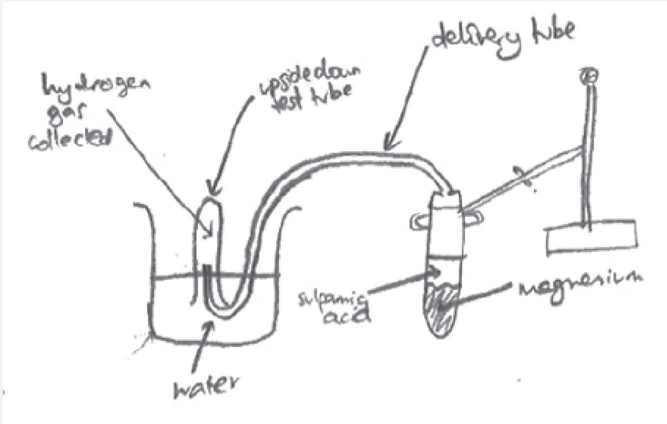
Examiner Tip

Diagrams should be clear enough for someone to work out how to set up apparatus, and they should show workable methods.



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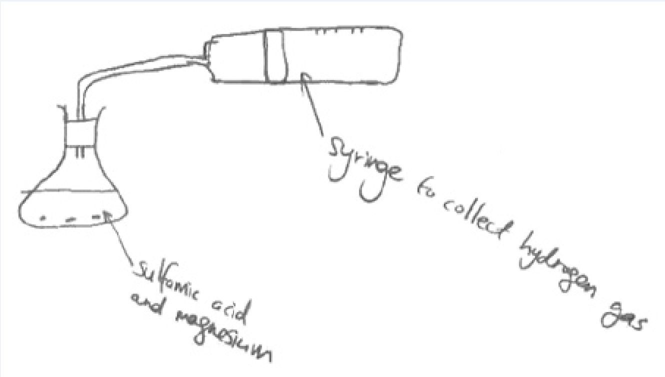
Examiner Comments

This gets one mark for showing a workable method of collecting hydrogen, but the test tube should be replaced by a measuring cylinder or inverted burette. The clamp stands need not be shown in diagrams like this.



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Examiner Comments

This scores both marks. The syringe is not very well drawn but it is labelled.

The number of moles of hydrogen in (b)(ii) was usually correct, the main error being to forget to convert the molar volume to cm^3. In (b)(iii) even those candidates who showed that two moles of sulfamic acid produced one mole of hydrogen found it difficult to see that each mole of hydrogen was equivalent to two hydrogen ions.

Candidates found the ionic equation in (c)(i) challenging. Candidates need to learn to balance both atoms and charges when writing these. Three possible answers were allowed. The equation could show either formation of water and carbon dioxide, formation of carbonic acid, or formation of hydrogen carbonate ions.

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Examiner Tip

Both atoms and charges must be balanced in the equation.

(i) Write an ionic equation for the reaction of hydrogen ions with carbonate ions.
State symbols are **not** required.

(1)

$$2H^+ + CO_3^- \rightarrow H_2O + CO_2$$

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Examiner Comments

This doesn't get the mark because the charge on the carbonate ion should be 2-. If the products are known, it is possible to work out that another negative charge is needed for balance.

In(c)(ii) few candidates thought about the advantages of a descaling agent being a solid, and most focussed on the acid strength or corrosive properties of the two acids.

Question 18

The test in (a) was very well known.

Diagrams of alkenes with four groups round the carbon-carbon double bond are helpful for identifying isomers and predicting the formulae of polymers, so it is a good technique to learn to draw them, but the double bond was often not on the second carbon atom.

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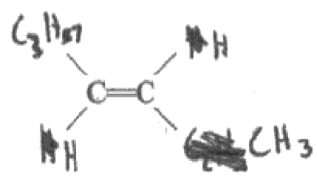
Examiner Tip

The question did not require the formula to be displayed to show all atoms, and it was enough to show the alkyl groups

(i) Complete the formula to show the structure of *E*-hex-2-ene.

(1



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Examiner Comments

This got the mark for showing the four groups round the double bond, even though it was not totally clear that the bond to the propyl group went to carbon rather than hydrogen.

The answer to (b)(ii) required clear use of language. The point about the carbon-carbon double bond restricting rotation was comparatively easy to express, but some candidates missed out the explanation of why hex-1-ene does not have stereoisomers. Others thought it was because the double bond was at the end of a chain, but did not explain that there must be two different groups on each end, as swapping the position of the two hydrogen atoms on the first carbon in hex-1-ene would not result in a different structure.

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Examiner Tip

When there are two parts to a question it is important to answer both. Stereoisomerism occurs because there is no free rotation about a double bond, so if there are different groups at each end of the bond, different structures would be produced when they swap positions. Hex-1-ene has two hydrogen atoms at one end of the double bond, so if these change positions there is no change in structure.

*(ii) Explain why stereoisomerism can occur in alkenes, and why hex-2-ene has stereoisomers but hex-1-ene does not.

(2)

Stereoisomerism can occur in alkenes because of the pi bond. There structure is rigid and keeps the double bond in place but because ~~ere~~ all the other bonds are sigma, they can rotate. Hex-1-ene is still hex-1-ene no matter if the sigma bonds rotate.

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Examiner Comments

This gets the first mark for the idea of a rigid structure with no rotation, but does not explain why hex-1-ene is unchanged if the sigma bonds rotate.

*(ii) Explain why stereoisomerism can occur in alkenes, and why hex-2-ene has stereoisomers but hex-1-ene does not.

(2)

Stereoisomerism can occur in alkenes because they have ~~a~~ double bonds, and the atoms cannot rotate around them. Hex-1-ene does not have stereoisomers because its double bond is at the end of the chain and the first carbon only has hydrogen atoms attached to it

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Examiner Comments

This scores full marks. It is not enough to say that the double bond is at the end of the chain, but the answer has developed this and added that the first carbon has two hydrogen atoms on it.

The problem posed in (c)(i) was what number to use for mass. The temperature rise refers to the water, which is being heated up, but a significant number of candidates used the mass of hexane which was burnt. In (c)(ii) many forgot the negative sign in the final enthalpy change and missed the instruction to give the answer to two significant figures.

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Examiner Tip

The mass used in the given equation refers to the substance which gets hotter ie the water.

(i) Calculate the energy in joules produced by burning the hexane. Use the expression

energy transferred = mass × specific heat capacity × temperature change.

(1)

$= 50.32 \times 4.18 \times 46$

$= 9675.5296\ J$

$= 9675.5\ J$

(ii) Calculate the enthalpy change of combustion of hexane. The mass of 1 mole of hexane is 86 g.

Give your answer to TWO significant figures. Include a sign and units in your answer.

(3)

$n = \frac{m}{M_r}$

$= \frac{0.32}{86}$

$= 3.72 \times 10^{-3}$

energy change $= 9.6755\ kJ$

$\Delta H = \frac{9.6755}{3.72 \times 10^{-3}}$

$= -2600\ kJ\,mol^{-1}$

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Examiner Comments

This answer does not get the mark for (i) as the mass of the hexane is added to the mass of the water. However the method in (ii) is correct, including the sign, unit and significant figures in the final answer so it scores full marks.

Rounding the answer to –2600 kJ mol^{-1} in (c)(ii) is sensible because there are so many heat losses in the experiment, and these are not improved by a thermometer reading to 0.1°C. In (c)(iv) many answers stated correctly that use of this thermometer increased the precision of the reading, but did not gain marks as they did not explain why the accuracy of the result was not improved.

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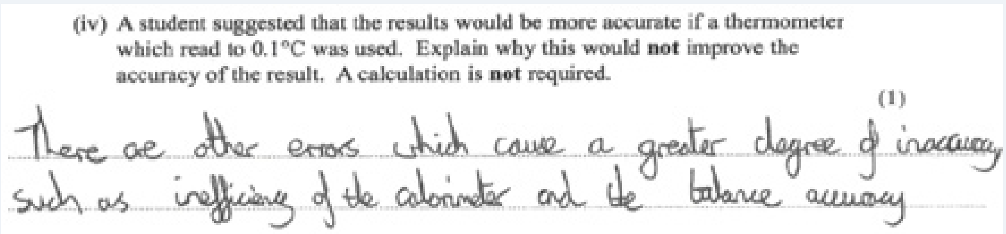
Examiner Tip

A thermometer reading to ±0.1°C in a reading of 68°C produces a smaller error than a balance reading to ±0.5g in a mass of 50g but both of these errors are small in relation to errors due to heat loss.



(iv) A student suggested that the results would be more accurate if a thermometer which read to 0.1°C was used. Explain why this would **not** improve the accuracy of the result. A calculation is **not** required. (1)

There are other errors which cause a greater degree of inaccuracy such as inefficiency of the calorimeter and the balance accuracy

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Examiner Comments

This is enough for the mark.

In (d)(ii) the question was about using data on enthalpy changes of combustion. Adding labels to arrows should have helped candidates to apply Hess' Law, and many scored full marks. A minority stated that the enthalpy change of a reaction equals the difference in enthalpy of formation of products and reactants. This is inappropriate for combustion data, and showed a need for more careful reading of the question and the type of data in it.

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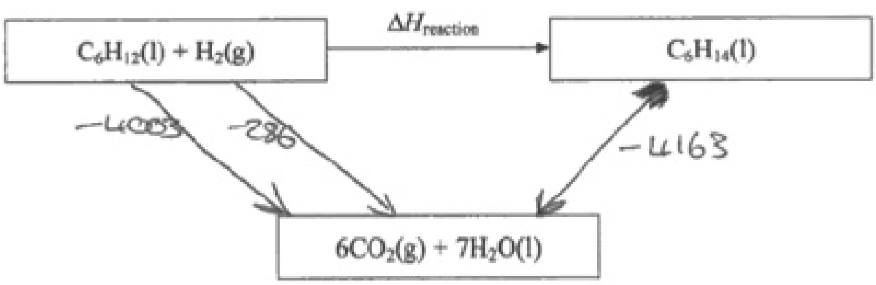
Examiner Tip

The question asked for arrows to be labelled. Combustion of hex-1-ene and hydrogen could be shown together on one arrow, or on two. Symbols on the arrows were accepted if their meaning was clear eg through a key.



−4003 − 286 + 4163 = −126

$\Delta H_{reaction}$ = −126 kJ mol^{-1}

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Examiner Comments

This scores full marks. Adding oxygen to balance the equations was not required in the question.

Part (d)(iii) was not well answered. Very few answers referred to bonds, and most just said that all the reactants were in the same homologous series, or that the same reaction occurred each time.

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Examiner Tip

Enthalpy changes are due to the difference in energy required to break bonds, and energy released making new ones. Each reaction shown involved addition of hydrogen to a C=C bond.

Explain why the values are so similar.

(1)

Because you are breaking and forming the same number of bonds in all of them and the same type of bonds.

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Examiner Comments

This is an alternative way of giving the answer, rather than specifying exactly which bonds are broken and formed.

Question 19

Parts (a) and (b)(i) were well answered, and it was pleasing to see how many candidates scored some of the marks for the mechanism in (b)(ii). Only a few drew free radical mechanisms. The starting and finishing positions of the curly arrow going from the H-Cl bond to the Cl atom were not always clear, and the chloride ion which attacks the carbocation was often shown with only a partial (δ-) charge.

In (c) the candidates who realised that the reaction with ethene gave both the higher atom economy and the higher percentage yield could usually explain why. Here again precision of language was important. Atom economy is high if atoms go into the desired product, but the statement that “all atoms in the reactants go into the products” is true but doesn’t answer the question.

Question 19(c)

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Examiner Tip

Comments on atom economy need to make clear that useful product, or only one product, is made.

(c) Which method of making chloroethane has

(3)

- a higher atom economy? ethene
- a higher percentage yield? ethene

Explain your answers.

Higher atom economy all ~~products~~ reactants used in reaction

Higher percentage yield much ~~product~~ product is lost.

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Examiner Comments

The answer scores the first mark. In any reaction all of the reactants are converted to the products so the second mark was not given. The reaction of ethane and chlorine does not stop with chloroethane formation, which is why the yield of chloroethane is low.

In the dot and cross diagram in (d)(i) the most common mistake was to forget to show the electrons on the chlorine. The diagram of the polymer in (d)(ii) should have shown how two repeat units link together, and one repeat unit in a bracket with the number 2 outside was not accepted.

The final question, (d)(iii), tested understanding of the term sustainable. This was interpreted as meaning the use of the Earth's natural resources in a way that avoids wasting them or totally depleting them. It was expected that general factors would be considered, as candidates would not have specific knowledge of the materials. If particular properties of the materials were quoted, they were given credit if they were correct and relevant.

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Examiner Tip

The answer should address the idea of using resources in a way which conserves them or avoids waste.

– Which material will last longer before it gets too worn and breakes / malfunctions.

– Which is cheaper to replace. ~~then~~

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Examiner Comments

A mark was given for the first comment because if the pipes last a long time, resources will not be needed to replace them. Their cost is not related to sustainability.

which requires more energy to make.
which last longer.
Are the resources used renewable or non renewable

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Examiner Comments

All three points in this are valid.

Grade boundaries for GCE 08 Chemistry

6CH01/01

Grade	Max. Mark	A	B	C	D	E
Raw boundary mark	80	48	41	35	29	23
Uniform boundary mark	120	96	84	72	60	48

Maximum Mark (Raw): the mark corresponding to the sum total of the marks shown on the mark scheme.

Boundary Mark: the minimum mark required by a candidate to qualify for a given grade.

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