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Examiners' Report June 2009

GCE

GCE Chemistry 6CH01/6CH02

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6CH01/01: The Core Principles of Chemistry

General

Many candidates appeared to have benefited from a further few months of studying AS Chemistry. Examiners noted an improvement in the way answers to calculation questions were set out and a better understanding of the energy changes associated with bond breaking and bond making.

For Section A (multiple choice questions), the average mark was just over 14/20.

Question 21

In (a)(i), many candidates suggested answers relating to either the ease of combustion of alkanes or safety measures rather than ease of transport or storage.

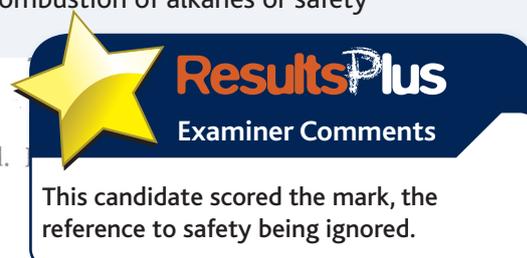
21 This question is about hydrocarbons.

(a) Liquefied petroleum gas (LPG) is a fuel sold as an alternative to petrol. It is a mixture of liquefied C_3 and C_4 alkanes.

(i) Suggest a reason why the alkanes are liquefied.

easier to trans and safer to
~~trans~~ store and transport

(1)



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Examiner Comments

This candidate scored the mark, the reference to safety being ignored.

In (a)(ii), it was clear that some candidates were unfamiliar with the concept of skeletal formulae. Naming of the two isomers was generally very good and some credit was awarded if a candidate drew two correct structural formulae instead of two skeletal formulae. Part (a)(iii) proved to be very straightforward.

In (b)(i), both the initiation step and the requirement for UV light were recalled accurately.

(b) Propane, C_3H_8 , reacts with chlorine, Cl_2 , in a substitution reaction.



The mechanism for this reaction is described in three stages.

(i) Give the **initiation step** for this reaction and state the condition necessary for this step to occur.

(2)

Initiation step



Condition

UV light

However, in (b)(ii), candidates found it more difficult to write two correct propagation steps. There appeared to be a lack of understanding that the propagation steps lead to the formation of more chlorine free radicals which keep the reaction going.

There was, in the vast majority of cases, a suitable use of dots to show free radicals. As shown in the response below, a sizeable number of candidates chose to write the propagation steps for the chlorination of **methane** rather than propane. One out of two marks was awarded if two correct steps were shown for methane reacting with chlorine.

(b) Propane, C_3H_8 , reacts with chlorine, Cl_2 , in a substitution reaction.



The mechanism for this reaction is described in three stages.

- (i) Give the **initiation step** for this reaction and state the condition necessary for this step to occur.

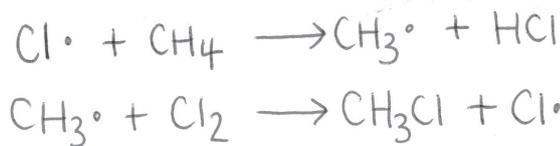
Initiation step



(2)

Condition ultraviolet light

- (ii) Give the **TWO propagation steps** for this reaction.



(2)

- (iii) Give a possible **termination step** for this reaction.



(1)



The candidate has not completed the termination step in (iii).

In (c)(iii), whilst many appreciated that the reaction of bromine with an alkene is an addition reaction, only relatively few candidates classified the process as electrophilic. In (c)(iv), calculating the number of moles in 0.72 dm^3 of hydrogen gas proved to be far more problematic than finding the number of moles of alkene in 1.36 g of myrcene.

- (iv) In an experiment, 1.36 g of myrcene (molar mass: 136 g mol^{-1}) was found to react with 0.72 dm^3 of hydrogen, H_2 , in the presence of a nickel catalyst.

Use this information to draw the structural formula of the product of the reaction between myrcene and hydrogen.

[Assume the molar volume of H_2 under the conditions of the experiment is $24 \text{ dm}^3 \text{ mol}^{-1}$.]

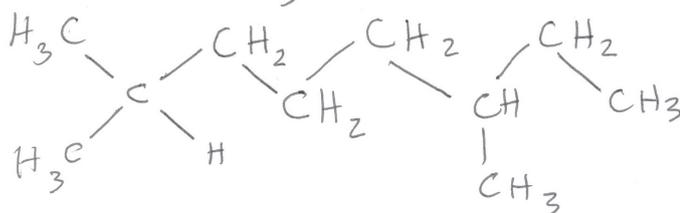
Calculation

$$1.36 \text{ g of myrcene} = \frac{1.36 \text{ g}}{136 \text{ g mol}^{-1}} = 0.01 \text{ mol} \quad (2)$$

$$0.72 \text{ dm}^3 \text{ of } \text{H}_2 = \frac{0.72 \text{ dm}^3}{24 \text{ dm}^3 \text{ mol}^{-1}} = 0.03 \text{ mol}$$

So 1 mol of myrcene reacts with 3 mol of H_2

Hence structural formula of the product



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Examiner Comments

This candidate has shown a meticulous approach so as to ensure all units are correct.

In a surprising number of cases, structural formulae of the product showed either carbon atoms that were not tetravalent or structures with not all methyl groups in the correct place, as illustrated below:-

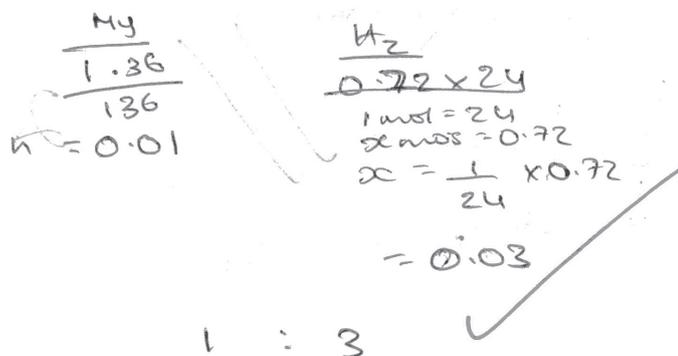
- (iv) In an experiment, 1.36 g of myrcene (molar mass: 136 g mol^{-1}) was found to react with 0.72 dm^3 of hydrogen, H_2 , in the presence of a nickel catalyst.

Use this information to draw the structural formula of the product of the reaction between myrcene and hydrogen.

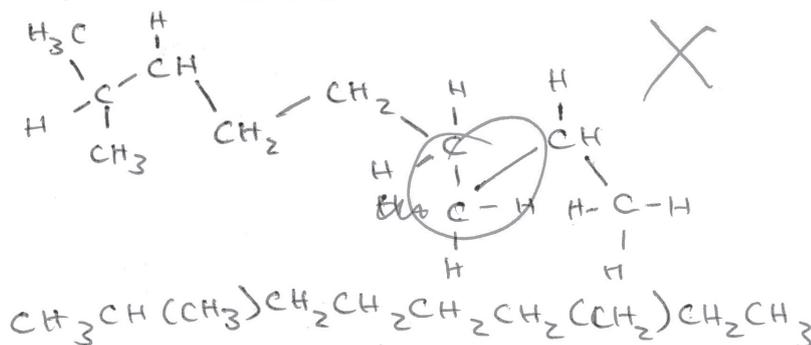
[Assume the molar volume of H_2 under the conditions of the experiment is $24 \text{ dm}^3 \text{ mol}^{-1}$.]

(2)

Calculation



Hence structural formula of the product



A minority of candidates obviated this difficulty by showing the correct skeletal formula of the product.

In (d), the majority of candidates were able to draw the repeat unit, although some drew a section of the polymer chain without then indicating what the repeat unit was.

Question 22

In (a)(i), it was pleasing to see the energy changes on the Born-Haber cycle identified correctly. Part (a)(ii) proved to be more demanding, with many candidates being unable to derive a correct expression for the first electron affinity of chlorine. Frequently, a candidate's working led to an answer of $+360 \text{ kJ mol}^{-1}$, which was then amended to a final answer of -360 kJ mol^{-1} without any comment.

The best answers started with an expression of the form " $D = \dots$ ", with subsequent rearrangement of the expression to find the unknown, F, as shown below:-

(ii) Calculate the first electron affinity of chlorine, in kJ mol^{-1} , from the data given. (2)

$$C + B + A + F + E = D$$

$$109 + 494 + 121 + F - 775 = -411$$

$$F - 51 = -411$$

$$F = -360 \text{ kJ mol}^{-1}$$

(ii) Calculate the first electron affinity of chlorine, in kJ mol^{-1} , from the data given. (2)

$$+411$$

$$109 + 494 + 121 + F - 775 = -411$$

$$F = -380 \text{ kJ mol}^{-1}$$

In the second example above, one out of the two available marks has not been awarded due to a transposition error. These occurred quite frequently. Consequential marking allowed the award of one mark for the subsequent value of the first electron affinity for chlorine.

In (b)(i), answers often contained a comment on the mathematical difference between the experimental and theoretical lattice energies rather than to the fact that the values were in close agreement and, therefore, that the bonding in sodium chloride is almost completely ionic. Part (b)(ii) revealed that some candidates did not understand the link between there being a significant difference in the lattice energies and the nature of the bonding in a compound.

Part (c) was extremely well-answered, with all the relevant factors being included, as illustrated in the response below:-

* (c) Suggest why the first ionization energies of the Group 1 elements decrease down the group.

The outermost electron in Group 1 atoms gets further away from the nucleus as you go down the group, and the extra shells increase the shielding between it and the nuclear charge. The ^{effective} nuclear charge on the other hand, does not increase because the increase in protons is balanced by increase in electrons.

(Total for Question 22 = 10 marks)

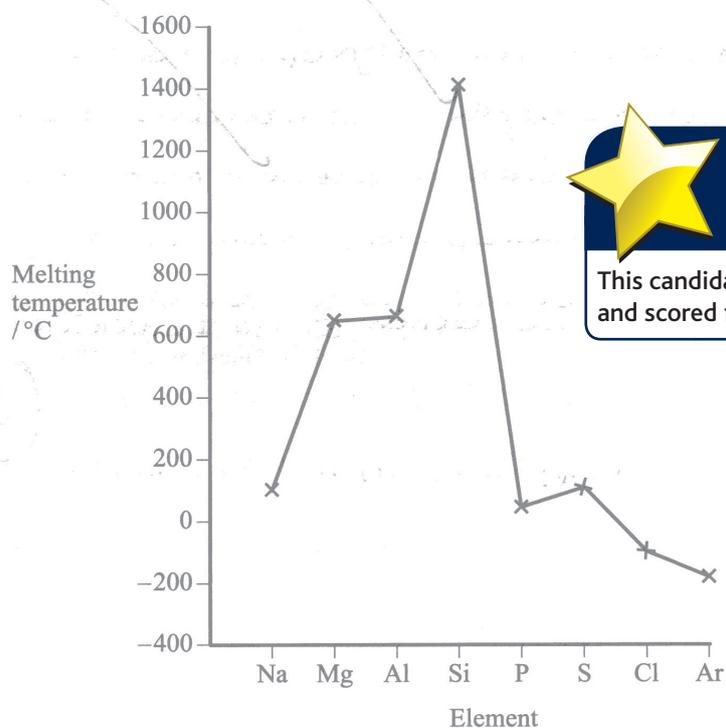
As a result, ~~the~~ the outermost electron is held more loosely, and IE decreases.

Question 23

Candidates found this question the most demanding on the paper.

In (a), a number of candidates seemed to be unclear as to what the term **structure** meant. As a result, shapes of molecules and electron configurations were frequently offered as answers. The bonding in sodium was often incorrectly described as being 'ionic', even when candidates had drawn a sketch of some metal cations in a sea of delocalized electrons next to their answer. There were, nonetheless, some excellent answers to this part.

23 The graph shows the variation in melting temperatures of the elements across Period 3 (Na to Ar) of the Periodic Table.



This candidate has provided an excellent answer and scored full marks.

(a) Complete the table below to show the type of structure and bonding for the elements shown.

Element	Structure	Bonding
sodium	metallic - positive ions in electrons	metallic ✓
silicon	giant molecular structure	covalent ✓
sulfur	simple molecular	covalent ✓

(3)

3

(a) Complete the table below to show the type of structure and bonding for the elements shown.

Element	Structure	Bonding
sodium	metal lattice	metallic
silicon	giant macromolecule	covalent
sulfur	powder X	covalent

(3)

2


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Examiner Comments

This response scores 2 marks. There is a lack of awareness that the structure of sulfur is that of 'simple molecular' rather than powder.

In (b), candidates showed a much better understanding of the bonding in silicon than that in sulfur. However, some very clear and cogent responses were seen such as:-

(b) Explain why silicon has a much higher melting temperature than sulfur.

The giant / macromolecular structure of silicon is ~~not~~ difficult to break (~~and~~ thus making silicon difficult to melt) because of the large network of strong covalent bonds holding atoms in place. With sulfur, melting only involves breaking ^{weak} dispersion forces between molecules, so it has a ^{much lower} MP.

Descriptions of the nature of the bonding in sulfur often failed to distinguish between the bonds within S_8 molecules and the weak forces between the molecules. Frequently, any discussion of the bonding in sulfur was absent altogether as illustrated in the following example:-

(b) Explain why silicon has a much higher melting temperature than sulfur.

Each silicon atom forms a strong covalent bond with 4 other silicon atoms. There are a lot of bonds to be broken and covalent bonds are strong so a lot of energy is needed to make silicon melt.

Obtaining both marks for (c) was rarely achieved, as many candidates did not address either the decrease in size of the metal cation from sodium to aluminium or the increase in the charge of the cation formed from sodium to aluminium. A sizeable number of candidates confused the process of melting with that of ionization of the metal atoms.

*(c) Explain why the melting temperature increases from sodium to aluminium. (2)

The metallic ^{lattice} structure is held together by electrostatic attraction between metal cations and a sea of delocalised outer electrons. In Na, the cations have a charge of only 1+ and there is one delocalised electron per cation, whereas Al and Mg have greater charges on their cations, and more electrons per cation, so their bonding is stronger, and M.P. higher.

(d) Magnesium forms the basic oxide magnesium oxide, MgO. This oxide is almost insoluble in water. On gentle warming with dilute sulfuric acid, magnesium oxide



ResultsPlus

Examiner Comments

Some clear and concise answers to this part were also seen, as shown by this response which scored full marks.

Some answers did mention the increase in charge of the cation across the period, but then did not relate this to the increase in the strength of attraction between the cations and the delocalised electrons surrounding these ions, as illustrated in the response below:-

*(c) Explain why the melting temperature increases from sodium to aluminium. (2)

The cation gets more positive charge the further along the period (Na^+ , Mg^{2+} , Al^{3+}) and so they have a greater electron density, meaning that more energy is needed to overcome this.

In (d)(i), answers revealed a lack of recall of the steps carried out when preparing a soluble salt. A number of candidates regarded the process as similar to an organic preparation, with processes such as heating under reflux and fractional distillation being mentioned. Otherwise correct answers frequently failed to mention details of the final stages for obtaining dry crystals.

Electrons per cation, so their bonding is stronger and M.P. higher.
 (d) Magnesium forms the basic oxide magnesium oxide, MgO. This oxide is almost insoluble in water. On gentle warming with dilute sulfuric acid, magnesium oxide reacts to form aqueous magnesium sulfate solution.

* (i) Describe how you would use the above reaction to prepare a pure sample of magnesium sulfate.

React dilute H_2SO_4 acid with excess MgO by heating them in a ~~test~~ beaker in a ^w water bath. Add the MgO in small amounts to the acid, until no more reacts. Filter ~~out~~ the reaction mixture to remove excess MgO. Heat the ~~pure~~ $MgSO_4$ solution gently until it is about $\frac{1}{2}$ half its original volume. Leave the solution in an evaporating dish to obtain $MgSO_4$ crystals and remove excess water ~~by~~ using filter paper ~~papers~~ rounds.



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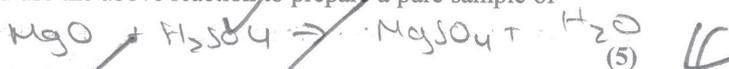
Examiner Comments

This candidate has given a well thought out answer, which recalls all the suitable techniques required.

The need to filter off the excess magnesium oxide, after reacting the acid and the base together, was often overlooked as illustrated below:-

(d) Magnesium forms the basic oxide magnesium oxide, MgO. This oxide is almost insoluble in water. On gentle warming with dilute sulfuric acid, magnesium oxide reacts to form aqueous magnesium sulfate solution.

(i) Describe how you would use the above reaction to prepare a pure sample of magnesium sulfate.



Heat the solution to evaporate ^{half some} some of the water and concentrate the solution.

Leave the rest for a few days, allowing crystals to form. Decant the crystals and dry between filter paper.

In (e)(i), a few candidates did not refer to the rubric of the question to deduce that the insoluble strontium sulfate formed would prevent further reaction between the acid and the strontium carbonate. It was often thought that the reaction stopped after a few seconds because there was a very fast reaction. Other candidates confused the reactivity of the element with that of its compounds. Some answers were very well expressed, such as:-

(e) The data in the table below will be useful when answering this question.

Soluble in water	Insoluble in water
MgSO ₄	MgCO ₃ SrCO ₃ SrSO ₄

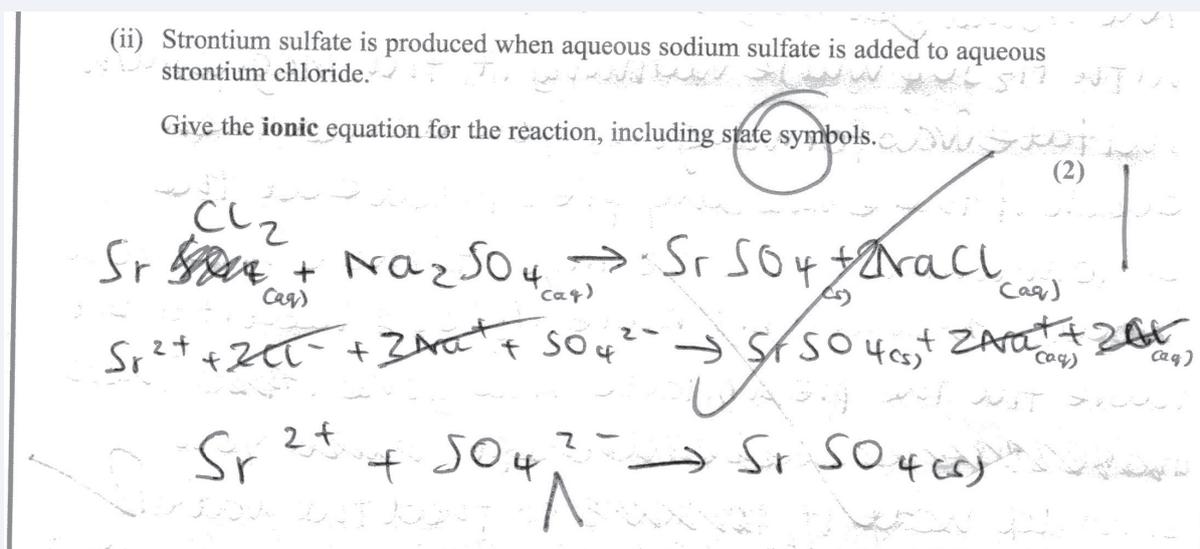
Magnesium carbonate reacts with dilute sulfuric acid.



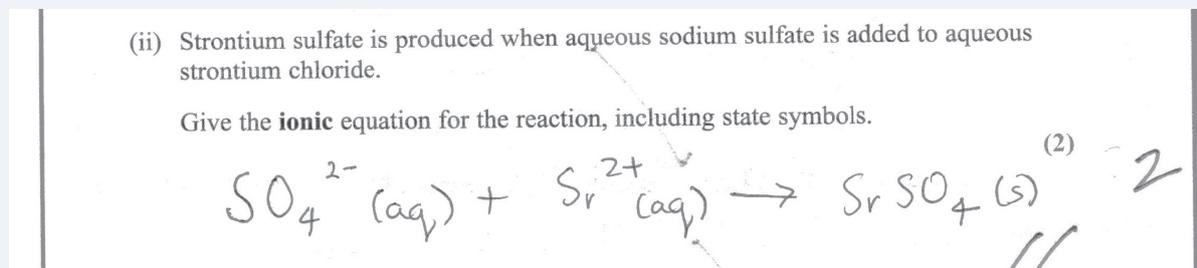
(i) Explain why the reaction between strontium carbonate and dilute sulfuric acid stops after a few seconds.

The strontium sulfate formed remains on the surface of the strontium carbonate (∵ SrSO₄ is insoluble) and so no more sulfuric acid can reach the SrCO₃.

Deriving the ionic equation for the precipitation reaction in (e)(ii) proved to be particularly discriminating. Better answers often showed "spectator ions" being deleted on both sides of the final equation, but good answers were sometimes spoilt by the omission of state symbols. Both these latter aspects are illustrated below:-



Other candidates appeared to be able to write the ionic equation without any working:-



Question 24

Part (a) elicited a full range of marks. All six marks were often awarded. Where they were not, it was often because in (a)(ii) the mass of fuel rather than the mass of water was used to calculate the energy transferred to the water. In (a)(iii), some candidates did not round up their answer to three significant figures, whilst others omitted the negative sign or did not give the correct units of kJ mol^{-1} .

24 Propanone, $\text{C}_3\text{H}_6\text{O}$, undergoes complete combustion to form carbon dioxide and water.



- (a) In an experiment to calculate the enthalpy change of combustion for propanone, 2.90 g of propanone was burned completely in oxygen.

The heat energy from this combustion raised the temperature of 200 g of water from 20.2°C to 78.4°C . (58.2°C)

The specific heat capacity of water is $4.18 \text{ J g}^{-1} \text{ }^\circ\text{C}^{-1}$.

- (i) Calculate the number of moles of propanone present in 2.90 g.

[The molar mass of propanone is 58 g mol^{-1} .]

$$n = \frac{2.90}{58} = 0.05 \text{ mol}$$

- (ii) Use the expression

$$\text{energy transferred (J)} = \text{mass} \times \text{specific heat capacity} \times \text{temperature change}$$

to calculate the heat energy transferred to raise the temperature of 200 g of water from 20.2°C to 78.4°C .

$$= 200 \times 4.18 \times 58.2$$

$$= 48655.2 \text{ J}$$

- (iii) Use your answers to (a)(i) and (ii) to calculate a value for the enthalpy change of combustion of propanone. Give your answer to **three significant figures** and include a sign and units.

$$48655.2 \text{ J} = 0.05 \text{ mol}$$

$$\times 3 = 1 \text{ mol}$$

$$\Delta H_c = \frac{48655.2}{0.05 \text{ mol}} = -973 \text{ kJ mol}^{-1}$$



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Examiner Comments

This response shows an example of a well set-out answer scoring full marks.

24 Propanone, C_3H_6O , undergoes complete combustion to form carbon dioxide and water.



- (a) In an experiment to calculate the enthalpy change of combustion for propanone, 2.90 g of propanone was burned completely in oxygen.

The heat energy from this combustion raised the temperature of 200 g of water from 20.2 °C to 78.4 °C.

The specific heat capacity of water is $4.18 \text{ J g}^{-1} \text{ °C}^{-1}$.

- (i) Calculate the number of moles of propanone present in 2.90 g.

[The molar mass of propanone is 58 g mol^{-1} .]

$$\begin{aligned} \text{Amount of } C_3H_6O &= \frac{2.90 \text{ g}}{58 \text{ g mol}^{-1}} \quad (1) \\ &= 0.05 \text{ mol.} \end{aligned}$$

- (ii) Use the expression

$$\text{energy transferred (J)} = \text{mass} \times \text{specific heat capacity} \times \text{temperature change}$$

to calculate the heat energy transferred to raise the temperature of 200 g of water from 20.2 °C to 78.4 °C.

$$\begin{aligned} \text{energy transferred} &= 200 \text{ g} \times 4.18 \text{ J g}^{-1} \text{ °C}^{-1} \times (78.4 - 20.2) \text{ °C} \quad (2) \\ &= 48655.2 \text{ J} \\ &= 48.7 \text{ kJ} \quad 3 \text{ sf} \end{aligned}$$

- (iii) Use your answers to (a)(i) and (ii) to calculate a value for the enthalpy change of combustion of propanone. Give your answer to **three** significant figures and include a sign and units.

$$\begin{aligned} \Delta H_c (C_3H_6O) &= \frac{\text{energy transferred}}{\text{no. of moles}} \quad (3) \\ &= \frac{48.6552 \text{ kJ}}{0.05 \text{ mol}} \\ &= 973 \text{ kJ mol}^{-1} \quad 3 \text{ sf} \end{aligned}$$



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Examiner Comments

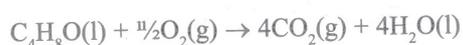
The candidate has missed the negative sign for an exothermic reaction in (iii).

In (b)(ii), contradictory answers were seen particularly when the difference was described as “higher” or “lower” (although “lower” was accepted as a response).

When comparing the degree of exothermicity of two reactions, answers such as “less exothermic” or “less negative” are much preferred as they lack ambiguity.

A pleasing number of candidates were aware that the vaporization of water is endothermic and, therefore, that less heat energy would be released if water were formed in the gaseous state.

(ii) This Data Book value ($-2440 \text{ kJ mol}^{-1}$) refers to the following equation.



How would the value be different if it referred to the formation of water in the gaseous state? Justify your answer.

(2)

Difference: the value would be lower

Justification: Part of the energy released during the reaction would be used in ~~the~~ converting the water from liquid to gas, so the overall energy released would be lower.

(c) Standard enthalpy changes of combustion can be used to calculate the standard enthalpy change of formation of a compound.

(i) Define the term **standard enthalpy change of formation**, making clear the meaning of **standard** in this context.

ΔH_f^\ominus of a compound is the enthalpy change ^{(3) per mole} involved in the formation of 1 mol of a compound from its constituent elements in their standard states ~~at 298 K~~ (i.e. their states at ^{standard} ~~298 K~~ temp.) in standard conditions (i.e. 1.0 atm pressure and 298 K temp.)

3



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Examiner Comments

Many excellent answers were seen to (c)(i), with all three scoring points addressed as shown in this example.

A common error, however, was to refer to 'energy required' or 'energy released', implying that the standard enthalpy change of formation had to be endothermic or exothermic, respectively. One mole of "a substance" or "a compound" was accepted in this definition, but not one mole of "a product", as seen below. This response has also neglected to mention formation from **elements** (Note: the slight error of the standard conditions not being at **100 kPa** has been ignored as 1 atmosphere pressure has also been included):-

(c) Standard enthalpy changes of combustion can be used to calculate the standard enthalpy change of formation of a compound.

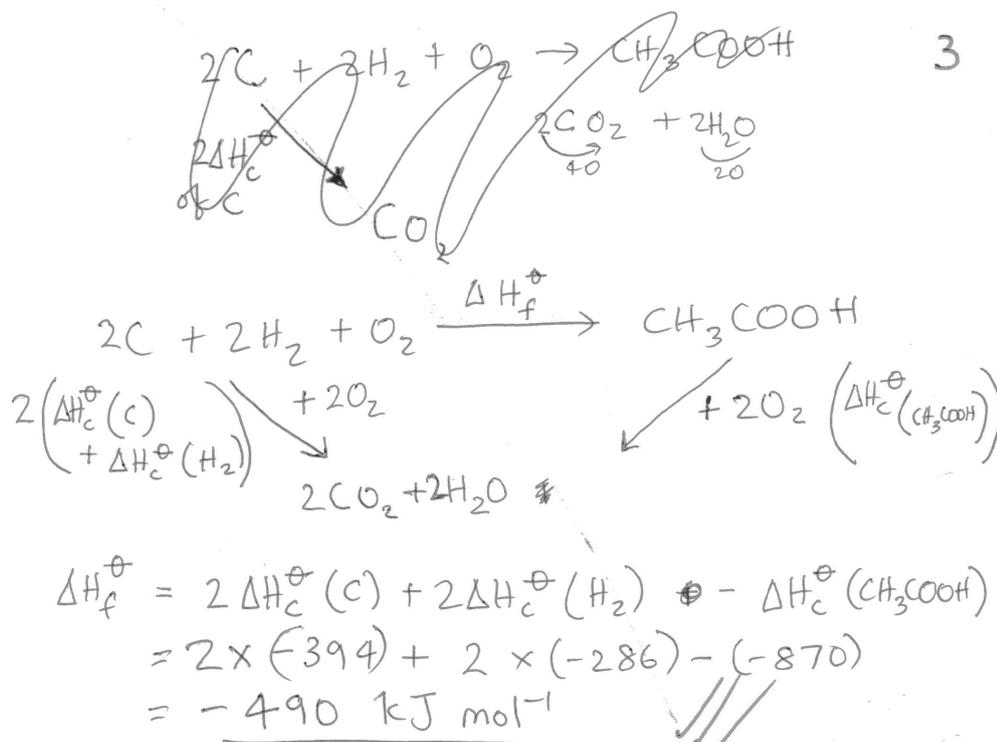
(i) Define the term **standard enthalpy change of formation**, making clear the meaning of **standard** in this context.

(3)

Standard enthalpy of formation is the enthalpy change for the formation of 1 mole of product under standard conditions (298k, 100 000 kPa or 1 atmosphere).

- (ii) Use the standard enthalpy changes of combustion, ΔH_c^\ominus , given in the table below to find the standard enthalpy change of formation for ethanoic acid, CH_3COOH , in kJ mol^{-1} .

Substance	ΔH_c^\ominus / kJ mol^{-1}
C(s, graphite)	-394
$\text{H}_2(\text{g})$	-286
$\text{CH}_3\text{COOH}(\text{l})$	-870



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Examiner Comments

This example is one of many fully correct answers seen for (c)(ii), showing a sound knowledge of how to construct a Hess cycle.

Use of either the expression $\Delta H_{\text{reaction}} = \Delta H_c [\text{products}] - \Delta H_c [\text{reactants}]$ or incorrect algebraic expressions lead to an incorrect answer of $+490 \text{ kJ mol}^{-1}$, which was awarded one out of the three marks available as illustrated below:-

Substance	ΔH_c^\ominus / kJ mol^{-1}
C(s, graphite)	-394
H ₂ (g)	-286
CH ₃ COOH(l)	-870



$$\begin{aligned}
 (-394 \times 2) + (2 \times -286) + \Delta H_c &= -870 \quad (3) \\
 -788 + -572 + \Delta H_c &= -870 \\
 -1360 + \Delta H_c &= -870 \\
 \Delta H_c &= -870 + 1360 \\
 &= 490 \text{ kJ mol}^{-1}
 \end{aligned}$$

✓ ~~XX~~

Even in other incorrect or incomplete answers, candidates were aware of the necessity to double the standard enthalpies of combustion of both carbon and hydrogen in this calculation.

Please note that the duration of this paper will be changed to 1 hour 30 minutes, from January 2010.

6CH02/01: Application of Core Principles of Chemistry

Section A appeared to be handled well by many candidates (the average score being approximately 13 marks). Sections B and C proved more challenging. There was some evidence to suggest that candidates found it very difficult to relate the ideas from some areas of the specification to unfamiliar situations. As marks for this skill make up 50% of this paper, candidates will need to develop strategies to engage with the ideas during their revision. Candidates should try not to spend more than 20 minutes on Section A as advised in the paper.

Question 20

Candidates found this question challenging both in terms of the ability to apply core ideas to an unfamiliar scenario and to communicate chemical ideas with precision. Responses to Q20(a)(i) revealed that candidates were able to recognise the two reaction types. Probably the most common way to lose marks was the inclusion of spurious incorrect information. For instance some candidates suggested 'electrophilic substitution' for reaction one. In (a)(ii) responses to reaction one acted as a useful discriminator. Weaker candidates didn't appear to use the guidance from the question and simply described in words what the equation(s) already showed or used imprecise language with respect to particles, particularly with regard to reaction two.

Reaction 1 In this reaction, the water would have reacted with the 2-chloro-2-methylpropane to form the product HCl, leaving the organic product with OH 1



Candidate simply describes the changes that occur in the reaction by repeating information from the question so does not receive any credit.

Reaction 2 The water has removed the Cl allowing the carbon to form a double bond. The water also removed a hydrogen. 2



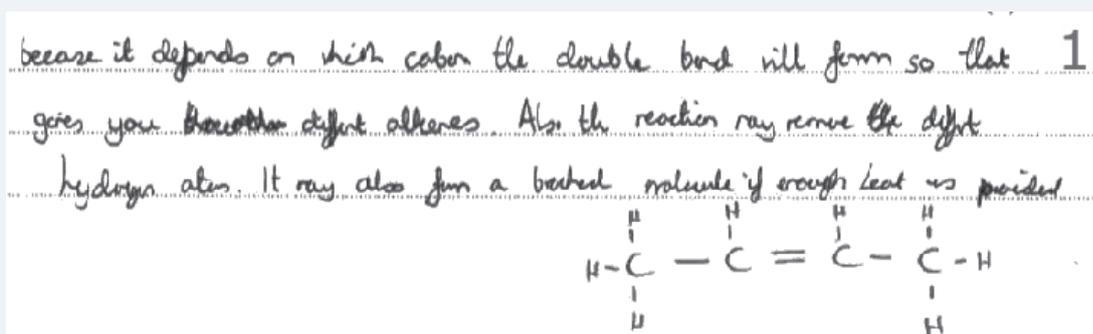
Again the response reformats information from the question. However a bit more precision here may have scored credit, as 'removal of a hydrogen ion' would have correctly described basic behaviour.

Better candidates did attempt to consider the specific role of water and recognised it as a nucleophile, either directly or by suggesting it formed hydroxide ions. Given the expected prior knowledge of the candidates,

the latter point was an allowable response. Although such candidates were then often able to accurately describe the attack of the positive carbon, a minority only described attack of the C-Cl bond, leaving examiners unclear as to whether the candidates believed the carbon or the chlorine was subject to attack.

In (b) about half of the candidates recognised the bond breaking as heterolytic. Part (b)(ii) showed that the more able candidates had an appreciation of the mechanism involved, though recognition of 1-chlorobutane as a primary halogenoalkane enabled many candidates to score one mark. Whilst such questions are valid, the ability to explain why a particular mechanism occurs, which requires a deeper understanding of that mechanism, is more helpful to candidates when they meet unfamiliar processes.

Part (c) enabled candidates to show some understanding of isomers, with many candidates drawing structures for two correct alkenes. Commonly the third structure proposed was a branched chain alkene and a minority of responses still included a chlorine atom in the structure. Written explanations tended to be ambiguous with a number of responses simply suggesting the double bond could form between two different carbon atoms, which were not precise enough to score credit. (see 1 below)



Those candidates who recognised both geometric isomers did not always realise that this was due to the lack of rotation about the double bond.

Candidates often suggested that the greater strength of the C-F bond slowed down the reaction in part (d) and although many suggested an acceptable alternative reagent, a minority proposed using sulfuric acid.

Question 21

Most candidates correctly identified hydrogen bonds in (a)(i) and were able to recognise that fluorine has the greater electronegativity. However some candidates seemed to think a description of the electronegativity trend was sufficient to explain this observation and made no reference as to why fluorine is so effective at attracting electrons towards itself (see 1). In a similar vein, candidates often tried to use recall of the atoms that can form hydrogen bonds as an explanation, without attempting to explain why (see 2).

The electronegativity of fluorine is greater than the electronegativity of bromine. This is because fluorine is the most electronegative element in the periodic table.¹ Hydrogen fluoride has hydrogen bonding because this type of bonding occurs between H-F, H-O and H-N but not H-B, therefore hydrogen bromide cannot have hydrogen bonding.²

The temperature was often correctly predicted in (a)(iii) though a small number lost the mark through use of degrees Celsius as units.

Candidates found it difficult to justify the ability of propanone to dissolve a wide range of substances in Q21(b). Some answers simply said 'because it's polar' with no consideration as to why it might dissolve non-polar species and others used the generic term 'organic solvent' without any amplification as to what they meant by that.

It is organic and so can dissolve in organic solvents.
It is polar and so can dissolve in polar solvents.



ResultsPlus

Examiner Comments

The candidate has used the idea that propanone is 'organic' and implies this enables interaction with other organic solvents, but has not emphasised that the molecule has non-polar regions which enable this interaction to occur.

In (b)(ii) some failed to recognise that propanone could hydrogen bond with water and a number of those who did, thought this could occur via one of propanone's hydrogen atoms (see 1). However these candidates often then went on to realise that the interaction between octane and propanone would be London forces so scored one out of two (see 2).

Water Hydrogen bonding + hydrogen from propanone molecules 1 are attracted to the lone pair on oxygen in water molecules - forming hydrogen bonding.

Octane ~~Induced~~ ^{Induced} dipole bonding ^(London forces) between C=O and as O is more electronegative than C. Doesn't dissolve too well in octane, because of different intermolecular forces.

Question 22

Many candidates were able to correctly identify the key ideas of breakdown due to application of heat in (a)(i) and over half gave a completely error free equation in (a)(ii). Those who identified the correct trend in (a)(iii) often went on to present very lucid and well argued justifications in terms of trend in cationic size and effect on the ability to polarise the carbonate anion (see 1, 2 and 3 below).

The group 2 carbonates become more thermally stable down the group.¹ This is because the carbonate ion is large and easily distorted by the small 2+ cations such as magnesium. As the size of the cation increases, there is less distortion so the carbonates become more stable.³

Some answers received less credit as imprecise language led to use of terms such as atoms or elements when referring to the ions. Whilst in some cases such errors can be overlooked, in this case they are critical to the explanation of the trend. A small number of answers attempted to use lattice energies to explain their trend but very often did little more than provide some numerical data to restate rather than explain the trend. Generally those who decided the stability decreased did so as they seem to be confusing the stability of the compound with that of the metallic element.

The thermal stability of carbonates decreases as you go down group 2, as the atoms have more and more electrons and therefore more shells/orbitals to hold them in. This means the distance between the nucleus and the outermost shell increases and the forces between attraction decrease. The outer electrons are therefore much easier to remove further down the group.¹



ResultsPlus

Examiner Comments

Candidate appears to be justifying the increasing likelihood of a metallic element forming a cation, rather than the stability of the metal carbonate.

Better candidates could identify the correct colour of methyl orange at the end point of the titration in (b)(i), however weaker candidates gave completely unrelated colours. The structure given in parts (b)(ii) to (iv) enabled most candidates to get some credit for determining the number of moles of hydrochloric acid (see 1). However fewer managed to relate these values to the number of moles of calcium oxide and the subtraction from the initial number of moles of hydrochloric acid was needed for credit, although some did at least use the reaction ratio to get 0.0025 moles (see 2).

$$\frac{50 \times 0.100}{1000} = 0.005 \text{ Moles}$$

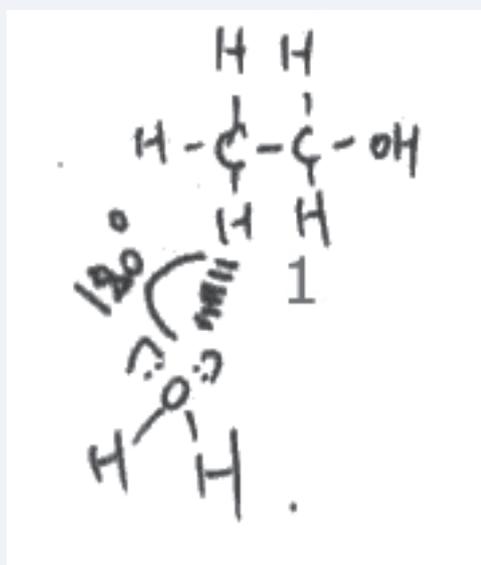
$$\text{ratio} = 2:1 \rightarrow \frac{0.005}{2} = 0.0025 \text{ Moles}$$

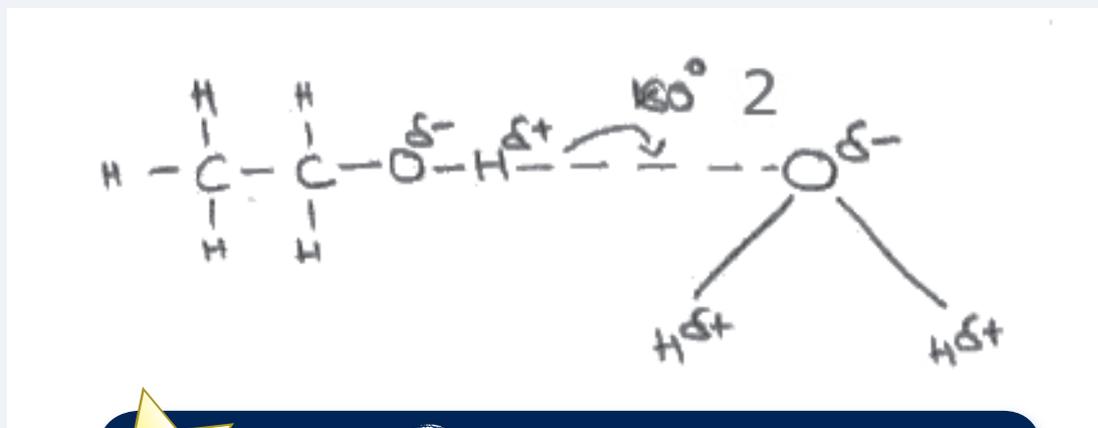
Those who did carry this error forward were then confronted by a % purity of greater than 100%. Those who did this were far more likely to mistrust their technique for determining the purity than their answer to (b)(iii) so simply reversed their quotient to give a value of less than 100%.

Most candidates managed to get two out of three marks in part (c)(i) and a large number of very good answers conveyed both the use of concentrated acid to clean the inert metal and to form the more volatile chloride. The most common error was omission of an appropriate support for the sample, either because a generic 'metal wire' or 'inoculating loop' was suggested or in a minority of cases because the candidates simply lit a wooden spill dipped in the sample. Barium was correctly identified by the majority of candidates in (c)(ii).

Question 23

Many candidates did correctly show a hydrogen bond between ethanol and water, though a minority still seem to believe any hydrogen can be involved so showed an interaction between water and the methyl hydrogen atoms, receiving no credit (see 1).





ResultsPlus

Examiner Comments

Many candidates found it hard to show the angle 'between the molecules' and did not show an angle across three atoms (see 2), thus missing the second mark.

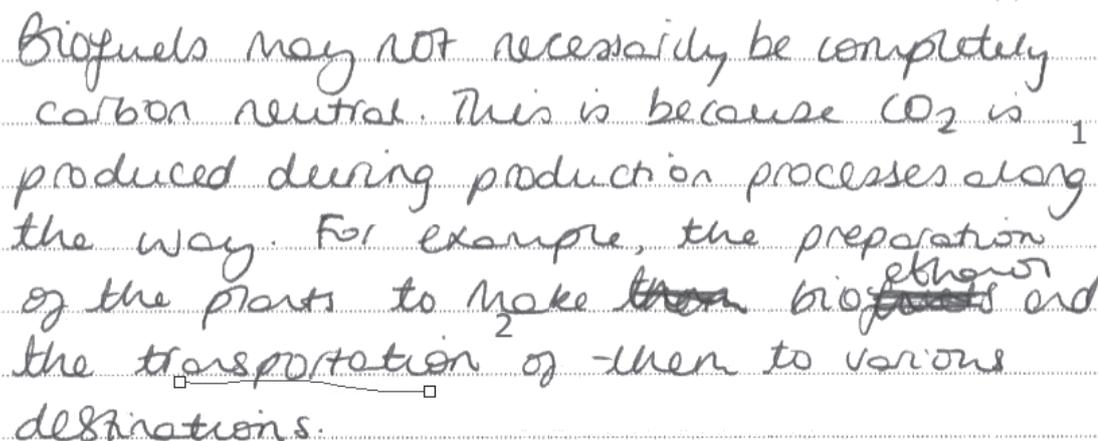
Candidates could generally identify errors with the diagram of the apparatus in (b) but had difficulty in describing what effect these errors would have. Candidates need to appreciate why the apparatus is used in the way it is. A small number of candidates seemed not to read the question and simply gave a written description of the faults they'd already identified in the diagram, with no attempt to explain the effect.

Common misunderstandings were that the thermometer should be in the liquid, the incorrect water flow would completely stop any condensation, the apparatus should be open at the still head to prevent pressure build up and that the anti-bumping beads would somehow prevent the separation from occurring. Whilst recall of how to carry out a particular technique is important, candidates also need to appreciate why and how a technique works. In (c) quantifying the error was beyond most candidates and only better candidates in (d) were able to make the link between practical work they are likely to have done (for instance preparation of a halogenoalkane, 2.10 2 c in the specification) to suggest a suitable drying agent.

However (e) was well recalled by many candidates, the majority choosing to use phosphorous pentachloride. A number of candidates still persist in offering an inference rather than an observation in such questions and comments such as 'HCl is produced' did not score.

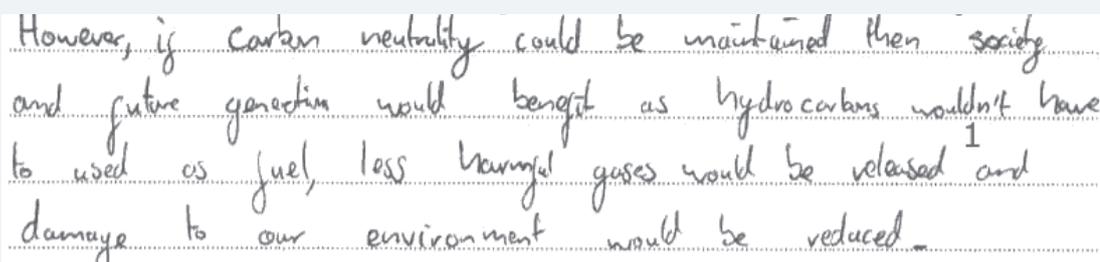
In (f)(i) candidates often managed to convey the idea that carbon neutral fuels absorb as much carbon dioxide as they grow as they release during combustion. Some particularly good answers even related this to a time scale to prevent confusion between plants that grew a long time ago to form fuels such as coal.

In (f)(ii) weaker answers tended to over generalise and make little or no use of the information in the passage.



Biofuels may not necessarily be completely carbon neutral. This is because CO₂ is produced during production processes along the way. For example, the preparation of the plants to make ~~them~~ ^{ethanol} biofuels and the transportation of them to various destinations.

For instance at 1 above, the candidate has recognised that CO₂ could be given off during production but has made no use of the passage to illustrate this. Energy use resulting in CO₂ release could have linked to the distillation of the bioethanol or the hydrolysis of biodiesel, both mentioned in the passage. This candidate has, however, (see 2) recognised that transportation is likely to release CO₂, which would have received credit.



However, if carbon neutrality could be maintained then society and future generation would benefit as hydrocarbons wouldn't have to be used as fuel, less harmful gases would be released and damage to our environment would be reduced.

In the example above the candidate is trying to justify increased use of biofuels in terms of the positive effect on the environment. This was an acceptable route to score marks but this answer is too general and makes no attempt to specify which harmful gases would be produced (see 1) and what affect this would have.

Some weaker answers misinterpreted parts of the passage. For instance some candidates seemed to assume that elephant grass was burnt with coal and a significant minority seemed to believe that the figure of 96% yield for the bioethanol distillation was somehow related to atom economy.

The best answers made clear reference to processes that would use energy and therefore probably produce carbon emissions, such as distillation and transportation. Such candidates also tended to pick up the idea that at least two of the biofuels are potentially also food crops and could suggest the effect this might have on food supply. The best answers also often chose the simplest approach to justify potentially the most sustainable crop, by linking the quick growth and high yield of elephant grass to sustainability.

Please note that the duration of this paper will be changed to 1 hour 30 minutes, from January 2010.

GCE2008 Chemistry 6CH01 & 6CH02 Grade boundaries

6CH01/01

Grade	Max. Mark	A	B	C	D	E
Raw boundary mark	80	57	51	45	39	34
Uniform boundary mark	120	96	84	72	60	48

6CH02/01

Grade	Max. Mark	A	B	C	D	E
Raw boundary mark	80	49	43	37	32	27
Uniform boundary mark	120	96	84	72	60	48

Notes

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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