Introduction

These exemplar answers have been chosen from the summer 2017 examination series.

OCR is open to a wide variety of approaches and all answers are considered on their merits. These exemplars, therefore, should not be seen as the only way to answer questions but do illustrate how the mark scheme has been applied.

Please always refer to the specification [http://www.ocr.org.uk/qualifications/as-a-level-gce-chemistry-a-h032-h432-from-2015/] for full details of the assessment for this qualification. These exemplar answers should also be read in conjunction with the sample assessment materials and the June 2017 Examiners’ Report to Centres available on the OCR website [http://www.ocr.org.uk/qualifications/].

The question paper, mark scheme and any resource booklet(s) will be available on the OCR website from summer 2018. Until then, they are available on OCR Interchange (school exams officers will have a login for this).

It is important to note that approaches to question setting and marking will remain consistent. At the same time OCR reviews all its qualifications annually and may make small adjustments to improve the performance of its assessments. We will let you know of any substantive changes.
Question 1(a)

Within the permafrost in Arctic regions of the Earth, large amounts of methane are trapped within ice as ‘methane hydrate’, CH₄•xH₂O. Methane makes up about 13.4% of the mass of ‘methane hydrate’.

Scientists are concerned that global warming will melt the permafrost, releasing large quantities of methane into the atmosphere.

(a) The H–O–H bond angle in ice is about 109° but about 105° in gaseous H₂O.

Explain why there is this difference.

Mark(s): 2/3

Examiner commentary

This response identifies the presence of hydrogen bonding in ice and hints that electron pairs determine the bond angles. The candidate also states that lone pairs repel more than bonded pairs. Unfortunately, the critical number of bonded and lone pairs present has been omitted.

The response could have been improved had the key feature in the question (bond angles) have been addressed in terms of the number of electron pairs.
Question 1(b)

Why are scientists concerned about the release of methane into the atmosphere?

Mark(s): 1/1

Examiner commentary

Almost all candidates were awarding this straightforward mark for stating that methane is a greenhouse gas. A common error was the suggestion that methane contributes to depletion of the ozone layer and many candidates seem to treat global warming and ozone depletion as one and the same thing.
Determine the formula of ‘methane hydrate’, $\text{CH}_4 \cdot x\text{H}_2\text{O}$.

In the formula, show the value of $x$ to two decimal places.

formula = .........................................................

Mark(s): 2/2

Examiner commentary

This is an excellent response. The working is clear and the correct value of $x$ has been provided to two decimal places. Although many candidates were awarded both marks for 5.74, many spoiled their answers by rounding 5.74 to 6. Such responses only secured 1 of the available 2 marks. Candidates are advised to check any guidance in the question about the required number of decimal places or significant figures.
Question 1(d)

Calculate the volume of methane, in dm$^3$, that would be released from the melting of each 1.00 kg of ‘methane hydrate’ at 101 kPa and 0 °C.

Give your answer to three significant figures.

volume = ................................................. dm$^3$ [4]

Mark(s): 4/4

Examiner commentary

In this response, the candidate has carefully identified the key features of the problem. The candidate has listed the key data on the left-hand side and displays good understanding of conversions between cm$^3$, dm$^3$, and m$^3$ at the top right-hand side of the response. The calculation is clear and all four marks have been awarded for the correct answer of 188 dm$^3$.

The candidate has shown clear working throughout. This is an essential part of a good answer. Even if there were an error in the response, the marker can easily see the issue and identify whether credit can be applied by error carried forwards (ECF).
Question 1(e)

Suggest why some industries are interested in the presence of ‘methane hydrate’ in regions of the Earth.

Mark(s): 0/1

Examiner commentary

Most candidates suggested that industry might use methane as a fuel or as a chemical feedstock. The response here is concise and easily secures the mark.

Candidates do need to be careful that they do not just reword the question. Vague responses, such as ‘methane has industrial uses,’ were not credited.
A student plans to determine the enthalpy change of reaction 3.1 shown below.

\[
\text{Na}_2\text{O}(s) + 2\text{HCl}(aq) \rightarrow 2\text{NaCl}(aq) + \text{H}_2\text{O}(l) \quad \text{reaction 3.1}
\]

This enthalpy change can be determined indirectly using Hess’ Law from the enthalpy changes of reaction 3.2 and reaction 3.3 shown below.

\[
\text{Na}_2\text{O}(s) + \text{H}_2\text{O}(l) \rightarrow 2\text{NaOH}(aq) \quad \text{reaction 3.2}
\]

\[
\text{HCl}(aq) + \text{NaOH}(aq) \rightarrow \text{NaCl}(aq) + \text{H}_2\text{O}(l) \quad \Delta H = -57.6 \text{ kJ mol}^{-1} \quad \text{reaction 3.3}
\]

The student will determine the enthalpy change of reaction 3.2 as outlined below.

- Weigh a bottle containing \( \text{Na}_2\text{O}(s) \) and weigh a polystyrene cup.
- Add about 25 cm\(^3\) of water to the polystyrene cup and measure its temperature.
- Add the \( \text{Na}_2\text{O}(s) \), stir the mixture, and measure the maximum temperature reached.
- Weigh the empty bottle and weigh the polystyrene cup with the final solution.

**Mass readings**

- Mass of bottle + \( \text{Na}_2\text{O}(s) \) = 16.58 g
- Mass of empty bottle = 15.34 g
- Mass of empty polystyrene cup = 21.58 g
- Mass of polystyrene cup + final solution = 47.33 g

**Temperature readings**

- Initial temperature of water = 20.5 °C
- Maximum temperature of final solution = 55.5 °C

The density and specific heat capacity, \( c \), of the solution are the same as for water.

(a)* Calculate the enthalpy change of reaction 3.2 and the enthalpy change of reaction 3.1.

Show all your working. [6]
1

\[ \Delta T = (27.3 + 55.5) - (27.3 + 20.5) = 25.5^\circ \]

\[ c = \frac{4.18}{25.5} \]

\[ m = 4\times 47.33 - 21.58 = 25.75 \]

\[ q = (25.75)(4.18)(35) \]

\[ = 8767.225 \text{ J} \]

\[ \text{Mass eq. Na}_2O = 16.38 - 13.84 = 1.24 \text{ g} \]

\[ \text{Mr eq. Na}_2O = 2(23)+16 = 62 \]

\[ \text{mol eq. Na}_2O = \frac{1.24}{62} = 0.02 \text{ mol} \]

\[ \Delta H_{\text{reaction}} = -3767.225 \]

\[ = 188.36 \text{ J mol}^{-1} \]

\[ = -188.4 \text{ kJ mol}^{-1} \]

\[ \Delta H_{\text{formation}} \text{ Na} = -188.4 \times 2(-87.6) \]

\[ = -303.7 \text{ kJ mol}^{-1} \]

2

\[ \Delta T = 35^\circ \]

Mass of Water = 25 g

Mass of NaCl = 1.24 g

Mass of Solution = 25.75 g

\[ Q = 25.75 \times 35 \times 4.18 \times \frac{1000}{1000} \]

\[ = 3767225 \text{ J mol}^{-1} \]

\[ \Delta h = 3767225 \]

\[ \Delta h = 41.35 \text{ kJ mol}^{-1} \]

\[ = 2.78 \]
**Examiner commentary**

This part was marked by level of response. Candidates were required to interpret the experimental results to determine two enthalpy changes, one directly from the experimental results, the other indirectly using Hess’ Law.

The first response shows a clear method, first using \( mc\Delta T \) to calculate the energy change in the experiment, and then converting this value to an enthalpy change of reaction. The candidate then uses Hess’ Law to calculate a second enthalpy change of \(-303.7 \text{ kJ mol}^{-1}\) indirectly. The response is clear, all calculations are correct and Level 3 has been achieved.

The second response is far weaker. This candidate has used the correct value for \( m \) but then uses 2.78, rather than the 0.02 mol of Na\(_2\)O to calculate the enthalpy change. The candidate makes no attempt at the second enthalpy change. This response is at Level 1. The candidate appears to be poorly prepared for this stock enthalpy calculation.
Question 2(b)

The uncertainty in each temperature reading is ±0.1 °C.
The uncertainty in each mass reading is ±0.005 g.
Determine whether the mass of Na₂O or the temperature change has the greater percentage uncertainty.
Show all your working.

Mark(s): 2/2

Examiner commentary

This response takes into account that two readings are needed to obtain the mass and temperature change. Any value obtained by difference requires the uncertainty in each reading to be doubled.

A common error ignored that two readings are required and subsequent answers then showed half the value of the correct uncertainties. Such a response would be credited with one out of the available two marks.

When calculating percentage uncertainties, candidates should consider whether a value is obtained from a single reading or from the difference between two readings.
Question 2(c)

Suggest a modification to this experiment, using the same apparatus, which would reduce the percentage errors in the measurements.

Explain your reasoning.

Mark(s): Exemplar 1 – 2/2 and Exemplar 2 – 0/2

Examiner commentary

The first response suggests increasing the mass of Na$_2$O to reduce the percentage uncertainty in mass. The candidate also recognises that a larger temperature change would be produced, reducing its percentage uncertainly.

Many candidates resorted to the panacea of repeating the experiment to obtain an average value, as shown by the second response which receives no marks.

Despite the question stating that the same apparatus was to be used, many candidates suggested using a balance or thermometer that would read to more decimal places – a case of not reading the information in the question.
Question 2(d)(i)

Sodium oxide, $\text{Na}_2\text{O}$, can be prepared by the redox reaction of $\text{NaNO}_2$ and sodium metal. Nitrogen gas is also formed.

(i) What is the systematic name for $\text{NaNO}_2$?

Mark(s): 0/1

Examiner commentary

The examiners were expecting an answer of sodium nitrate(III) but sodium nitrite was also allowed or very few would have scored this mark.

The most common incorrect response was sodium nitrate as in the response here. There were also many inventive names, such as sodium nitrogen dioxide.

The large number of incorrect responses seen suggested that candidates need more practice in writing names incorporating oxidation states.
Question 2(d)(ii)

(ii) Using oxidation numbers, with signs, show the element that is oxidised and the element that is reduced in this reaction.

Element oxidised ..................................

Oxidation number change from ........... to ...........

Element reduced ..............................

Oxidation number change from ........... to ...........

Mark(s): 2/2

Examiner commentary

This part was generally answered well, as in this response, with correct elements and oxidation numbers with signs.

Correct assignment of oxidation numbers is a key principle in chemistry and must be mastered to succeed at this level.
Question 2(d)(iii)

(iii) Construct the equation for this reaction.

Equation ...................................................................................................................... [1]

Mark(s): 1/1

Examiner commentary

Candidates were required to write a correct balanced equation for an unfamiliar reaction. This part discriminated extremely well with the most able candidates obtaining a correct equation using whole balancing numbers, as in this response, or the half-multiple version including $\frac{1}{2}N_2$. Weaker candidates seemed to guess one or more of the species in the reaction, despite the four species being stated in the question. Many questions contain clues and these do need to be used.
**Question 3(a)(i)**

This question is about reactions of hydrogen peroxide, H$_2$O$_2$.

(a) Hydrogen peroxide, H$_2$O$_2$, iodide ions, I$^-$, and acid, H$^+$, react as shown in the equation below.

\[
H_2O_2(aq) + 2I^-(aq) + 2H^+(aq) \rightarrow I_2(aq) + 2H_2O(l)
\]

A student carries out several experiments at the same temperature, using the initial rates method, to determine the rate constant, $k$, for this reaction.

The results are shown below.

<table>
<thead>
<tr>
<th>Experiment</th>
<th>Initial concentrations</th>
<th>Rate $\times 10^{-6}$ mol dm$^{-3}$s$^{-1}$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>[H$_2$O$_2$(aq)] / mol dm$^{-3}$</td>
<td>[I$^-$(aq)] / mol dm$^{-3}$</td>
</tr>
<tr>
<td>1</td>
<td>0.0100</td>
<td>0.0100</td>
</tr>
<tr>
<td>2</td>
<td>0.0100</td>
<td>0.0200</td>
</tr>
<tr>
<td>3</td>
<td>0.0200</td>
<td>0.0100</td>
</tr>
<tr>
<td>4</td>
<td>0.0200</td>
<td>0.0100</td>
</tr>
</tbody>
</table>

(i) Determine the rate equation and calculate the rate constant, $k$, including units.

**Mark(s): Exemplar 1 – 3/3 and Exemplar 2 – 2/3**

\[
I^- = 1^{st} \text{ order}
\]

\[
H_2O_2 = 1^{st} \text{ order}
\]

\[
H^+ = 0 \text{ order}
\]

\[
\text{rate} = k \cdot [I^-]^1 \cdot [H_2O_2]^1 \cdot [H^+]^0
\]

\[
k = \frac{(2 \cdot 00 \times 10^{-6})}{[0.0100]^1 \cdot [0.0100]^1 \cdot [0.100]^0}
\]

\[
k = 2,0000 \quad \text{mol dm}^{-3} \cdot \text{s}^{-1}
\]

\[
k = \frac{2,0000}{10^{-6} \text{ mol dm}^{-3} \cdot \text{s}^{-1}} \quad \text{units} \quad \text{dm}^3 \cdot \text{mol}^{-1} \cdot \text{s}^{-1}
\]

[3]
Examiner commentary

Most candidates find the determination of orders from initial rates data a straightforward task.

The first response is clear and obtains all three marks for the rate equation, value and units.

The candidate for the second response has determined an incorrect rate equation. Despite this, error carried forward for both the calculated value of $k$ and its units allowed two marks to be awarded. This shows the merits of a clear method.
Question 3(a)(ii)

(ii) The rate constant, \( k \), for this reaction is determined at different temperatures, \( T \).

Explain how the student could determine the activation energy, \( E_a \), for the reaction graphically using values of \( k \) and \( T \).

Mark(s): 3/3

Examiner commentary

Most candidates recognised that the Arrhenius equation was required and that a graph of \( \ln k \) against \( 1/T \) would produce a gradient of \(-E_a/R\). This is shown by the clear response which secures all three marks.
Question 3(b)

Solutions of hydrogen peroxide decompose slowly into water and oxygen:

$$2\text{H}_2\text{O}_2(\text{aq}) \rightarrow 2\text{H}_2\text{O}(\text{l}) + \text{O}_2(\text{g})$$

This reaction is catalysed by manganese dioxide, $\text{MnO}_2(\text{s})$.

Standard electrode potentials are shown below.

$$\text{O}_2(\text{g}) + 2\text{H}^+(\text{aq}) + 2\text{e}^- \rightleftharpoons \text{H}_2\text{O}_2(\text{aq}) \quad E^\circ = +0.70 \text{V}$$

$$\text{MnO}_2(\text{s}) + 4\text{H}^+(\text{aq}) + 2\text{e}^- \rightleftharpoons \text{Mn}^{2+}(\text{aq}) + 2\text{H}_2\text{O}(\text{l}) \quad E^\circ = +1.51 \text{V}$$

$$\text{H}_2\text{O}_2(\text{g}) + 2\text{H}^+(\text{aq}) + 2\text{e}^- \rightleftharpoons 2\text{H}_2\text{O}(\text{l}) \quad E^\circ = +1.78 \text{V}$$

Using the electrode potentials, explain how $\text{MnO}_2$ is able to act as a catalyst for the decomposition of hydrogen peroxide.

You answer should include relevant equations.
Examiner commentary

Many candidates find the prediction of reactions from electrode potentials a challenging task and this part discriminated extremely well.

This response is excellent, clearly linking the direction of half equations from the electrode potential data to produce two equations, and showing the role of MnO₂ as a catalyst.

The question does ask for relevant equations but many candidates produced none or simple copied the equations provided in the information.
Peroxycarboxylic acids are organic compounds with the COOOH functional group.
Peroxyethanoic acid, CH$_3$COOOH, is used as a disinfectant.

(i) Suggest the structure for CH$_3$COOOH.

The COOOH functional group must be clearly displayed.

Mark(s): Exemplar 1 – 1/1 and Exemplar 2 – 0/1

Examiner commentary

This part was answered well with several alternative structures being allowed.

The first response shows the COOOH functional group clearly displayed but the second response ignores this requirement. This is another example of not reading the question.
Question 3(c)(ii)

Peroxyethanoic acid can be prepared by reacting hydrogen peroxide with ethanoic acid. This is a heterogeneous equilibrium.

\[
\text{H}_2\text{O}_2(\text{aq}) + \text{CH}_3\text{COOH}(\text{aq}) \rightleftharpoons \text{CH}_3\text{COO}^-\text{H}(\text{aq}) + \text{H}_2\text{O}(\text{l}) \quad K_c = 0.37 \text{ dm}^3\text{mol}^{-1}
\]

A 250 cm\(^3\) equilibrium mixture contains concentrations of 0.500 mol dm\(^{-3}\) \(\text{H}_2\text{O}_2(\text{aq})\) and 0.500 mol dm\(^{-3}\) \(\text{CH}_3\text{COOH}(\text{aq})\).

Calculate the amount, in mol, of peroxyethanoic acid in the equilibrium mixture.

\[
\text{amount} = \text{............................................ mol} [3]
\]

Mark(s): 3/3
Examiner commentary

The candidate in this response has obtained all three marks using a correct method throughout. The $K_c$ expression gives a clue to the commonest error: inclusion of $[H_2O]$. The mark scheme allowed for this error with several alternative answers gaining some credit by error carried forwards.

Candidates should be reminded that solid and liquid species are omitted when writing the $K_c$ expression for a heterogeneous equilibrium.
This question is about weak acids.

(a) Compound A is a weak monobasic acid.

A student is supplied with a 250.0 cm$^3$ solution prepared from 2.495 g of A.

The student titrates 25.0 cm$^3$ samples of this solution with 0.0840 mol dm$^{-3}$ HNO$_3$ in the burette.

The student carries out a trial, followed by the three further titrations. The diagrams show the initial burette readings and the final burette readings for the student’s three further titrations.

All burette readings are measured to the nearest 0.05 cm$^3$.

<table>
<thead>
<tr>
<th>Titration 1</th>
<th>Titration 2</th>
<th>Titration 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial reading</td>
<td>Final reading</td>
<td>Initial reading</td>
</tr>
<tr>
<td>0</td>
<td>23</td>
<td>23</td>
</tr>
<tr>
<td>24</td>
<td>24</td>
<td>46</td>
</tr>
<tr>
<td>25</td>
<td>47</td>
<td>11</td>
</tr>
</tbody>
</table>

(i) Record the student’s readings and the titres in an appropriate format.

Calculate the mean titre that the student should use for analysing the results.

mean titre = .............................................. cm$^3$ [4]
Examiner commentary

The first response obtains all 4 marks, showing correct readings and titres throughout, to 2 decimal places, in a conventional table format. All readings are clearly labelled with units.

Unfortunately, the majority of responses scattered unlabelled numbers around, often with a final ‘0’ omitted. Units were often omitted and the mean titre was often calculated from all three titres. It is good practice to show how the mean titre has been calculated, as shown in this response.

The second response shows the final ‘0’ omitted on two occasions, and there are no headings or units.

Candidates need to appreciate the importance of communicating their results in a clear and comprehensive way with headings and units, and showing numerical values to the accuracy of the apparatus used.
Question 4(a)(ii)

The structure of compound A is shown below.

![Compound A structure](image)

Compound A has four optical isomers.

Using this information and the student’s results, answer the following.

- Determine the molar mass of A and the formula of the alkyl group R.
- Draw the structure of compound A and label any chiral carbon atoms with an asterisk*.

Show all your working.
Examiner commentary

This part required candidates to determine an unknown formula from their titration result. The response shows clear working to obtain a \( C_4H_9 \) alkyl group. Unfortunately, this candidate has ignored the information that compound A has four optical isomers and consequently will have two chiral carbon atoms. The candidate has drawn a straight side chain rather than the branched \( \text{CH(CH}_3\text{)CH}_2\text{CH}_3 \), which contains the second chiral carbon atom. This was a very common error.

Mark(s): 5/6
Question 4(b)(i)

The structural formula of compound A is repeated below.

![Structural formula of compound A](image)

Two reactions of compound A are carried out.

Suggest an equation for each reaction and state the type of reaction.

In your equations, draw structures for organic compounds.
You can use R for the alkyl group.

(i) Magnesium ribbon is added to a solution of compound A.
Gas bubbles are seen and the magnesium slowly dissolves.

Equation

Type of reaction ................................. [3]

Mark(s): 3/3

Examiner commentary

This response shows the correct organic product with a correct equation. The use of charges shows that the candidate clearly understands the species present. The reaction type has been correctly identified as redox so that all three marks can be awarded.

Many candidates, however, failed to score the first two marks by starting from the incorrect formula of the magnesium salt.

Candidates should always go back to the basics of writing the formula of an ionic compound from the charges on its ions.
Question 4(b)(ii)

Compound A is heated with a few drops of concentrated sulfuric acid as a catalyst.
A cyclic ‘dimer’ of compound A forms.

Equation

Type of reaction ................................................................. [3]

Mark(s): Exemplar 1 – 3/3 and Exemplar 2 – 2/3

Examiner commentary

Candidates found this question difficult and many failed to score any marks.

The first response shows good understanding of this novel problem, with the correct structure of the dimer, a correctly balanced equation and correct type of reaction.

The second response still shows good understanding but the equation has not been balanced for the starting organic compound.

Esterification or condensation were creditworthy answers for the reaction type.
Question 4(c)(i)

Chromium(III) picolinate, shown below, is a neutral complex that can be prepared from the weak acid, picolinic acid.

Chromium(III) picolinate is used in tablets as a nutritional supplement for chromium.

(i) Draw the structure of the ligand in chromium(III) picolinate.

Mark(s): 1/1

Examiner commentary

This response shows the expected structure and obtains the mark.

Common errors included the absence of a negative charge or two charges, on the COO\(^-\) and the N atom. This error could have been avoided by examining the structure of the complex. With a 3+ charge from Cr(III), each ligand must have had one 1– charge. This could not be on the N, which contained 3 bonds already.
A typical tablet of chromium(III) picolinate contains 200 µg of chromium.

Calculate the mass, in g, of chromium(III) picolinate in a typical tablet.
1 µg = 10^{-6} g.

Give your answer to three significant figures.

mass = ...................................................... g [2]

**Examiner commentary**

This candidate has calculated the correct mass from the moles of chromium and the molar mass of the complex and two marks could be awarded. The only criticism is the use of 0.0000038 in the working, a truncated version of 0.00000385 (to 3 significant figures). From the final value shown, the candidate must have been using the values stored in the calculator and these will always give the most accurate final answer, with rounding only then being applied.

Better working would either have used an unrounded value or a value to more significant figures (e.g. 0.000038462 or 0.00000385).
Question 5(a)(i)

This question is about organic molecules that have a strong smell.

(a) Thiols are foul-smelling, organic sulfur compounds with the functional group \(-\text{SH}\).

Butane-1-thiol, shown below, contributes to the strong smell of skunks.

(i) Thiols are weak acids.

Write the expression for the acid dissociation constant, \(K_a\), for butane-1-thiol.

Mark(s): Exemplar 1 – 1/1 and Exemplar 2 – 0/1

Examiner commentary

This part was very well answered as seen in the first response. The candidate in the second response has confused an equilibrium equation with an expression.

Some candidates made careless errors such as omitting the negative charge, getting the wrong number of carbon atoms in the formulae, omitting square brackets or showing \([\text{H}^+]\) as numerator rather than \([\text{C}_4\text{H}_9\text{S}^-][\text{H}^+]\). Candidates are advised to carefully check organic formulae as mistakes are so easy to make.
**Question 5(a)(ii)**

(ii) Thiols react with carboxylic acids to form thioesters.

Write an equation for the reaction of butane-1-thiol with ethanoic acid.

Use structures for all organic compounds with the functional groups clearly displayed.

---

**Mark(s): Exemplar 1 – 2/2 and Exemplar 2 – 2/2**

1. 

   \[
   \begin{align*}
   \text{C}_4\text{H}_9\text{SH} + \text{C}_2\text{H}_3\text{COOH} & \rightarrow \\
   \text{C}_4\text{H}_9\text{SOH} + \text{CH}_3\text{COOH}
   \end{align*}
   \]

2. 

   \[
   \begin{align*}
   \text{C}_4\text{H}_9\text{SH} + \text{C}_2\text{H}_3\text{COOH} & \rightarrow \\
   \text{C}_4\text{H}_9\text{SOH} + \text{CH}_3\text{COOH}
   \end{align*}
   \]

---

**Examiner commentary**

Candidates needed to apply their knowledge and understanding of esterification to thiols and thioesters. The first candidate has drawn a correct thioester structure with the balanced equation to obtain both marks.

The second response has retained the O atom from the OH in the carboxyl group to form –COOS– and the equation is balanced by forming H₂ rather than H₂O as the second product.

Candidates are advised to apply known knowledge to a new situation. In this example, the equation is really esterification with the alcohol ‘O’ being replaced by ‘S’.
Question 5(a)(iii)

(iii) When beer is exposed to light, 3-methylbut-2-ene-1-thiol is formed, which gives an unpleasant smell and flavour to the beer.

Draw the **skeletal** formula for 3-methylbut-2-ene-1-thiol.

Mark(s): 1/1

Examiner commentary

This candidate has drawn the correct structure, displaying a good understanding of interpreting organic nomenclature.

An otherwise good response was often spoilt by showing the methyl branch as CH₃, rather than a 'stick': a mixture of a skeletal and structural formula. The CH₂ adjacent to the terminal –SH group was also commonly omitted.

Candidates are encouraged to count the number of carbon atoms in the zigs and zags of a skeletal formula as a final check.
Question 5(a)(iv)

(iv) Propane-1,3-dithiol reacts with carbonyl compounds in a condensation reaction to form a cyclic organic sulfur product.

Write an equation for the reaction of propane-1,3-dithiol with propanone.

Use structures for organic compounds.

Mark(s): 1/2

Examiner commentary

This question required two skills: drawing structures for organic compounds from names, and predicting products from supplied information.

This candidate has scored the first mark for drawing structures for the two named reactants. The second mark for the novel cyclic compound and water was much more difficult, typically being obtained by only the very best candidates, as in this response.

Although this candidate has used displayed formulae, many used skeletal formulae, perhaps as the question provided the skeletal formula of butane-1-thiol which acted as a clue. The skeletal option is likely to lead to fewer errors and overcomes any missed H atoms, commonly seen in displayed formulae.
(b)* The structures for six naturally occurring organic compounds with pleasant smells, B–G, are shown below. The common names in brackets relate to their source and smell.

Explain how chemical tests would allow each compound to be distinguished from the other compounds.

In your answer, include essential details for all test procedures and observations.

Details of apparatus and quantities are not required.

[6]
Examiner commentary

This part was marked by level of response. Candidates were required to develop a plan to distinguish between the six organic compounds using simple chemical tests.

This plan is concise and successfully identifies each compound by a process of elimination. There are clear details of each test and the observations show how the tests lead to identification. The best plans were brief and very clear adopting an elimination approach to identify all the compounds. Such responses often obtained Level 3.

Many candidates leapt straight into their response without thinking about a genuine plan, with some responses extending to several pages. There is a lot to be said for formulating a plan before putting pen to paper.
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