Cambridge International AS & A Level

**Cambridge International Examinations**
Cambridge International Advanced Subsidiary and Advanced Level

**CHEMISTRY** **9701/23**

Paper 2 AS Level Structured Questions **May/June 2017**

MARK SCHEME

Maximum Mark: 60

**Published**

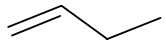
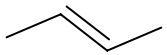
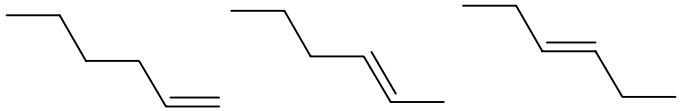
This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge will not enter into discussions about these mark schemes.

Cambridge is publishing the mark schemes for the May/June 2017 series for most Cambridge IGCSE®, Cambridge International A and AS Level and Cambridge Pre-U components, and some Cambridge O Level components.

| Question | Answer | Marks |
|---|---|---|
| 1(a) | (molecules / isomers with) the same molecular formula / same number of atoms of each element | **1** |
| | different structural / displayed formulae / different arrangement of bonds | **1** |
| 1(b)(i) | 4 | **1** |
| 1(b)(ii) | 6 | **1** |
| 1(b)(iii) | molecular = $C_4H_8$ | **1** |
| | empirical = $CH_2$<br><br>using alternative supplied data<br>molecular = $C_6H_{12}$<br><br>empirical = $CH_2$ | **1** |

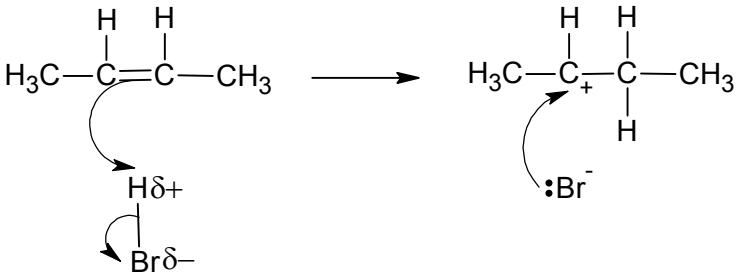
| Question | Answer | Marks |
|---|---|---|
| 1(b)(iv) |  | **1** |
| |  <br>alternative using supplied data: any two<br>  | **1** |
| 1(b)(v) | correct conversions of data to SI / consistent units<br>P = 100 000; V = $25 \times 10^{-6}$; T = 310 | **1** |
| | calculation of $n$ ( = $pV$ / $RT$)<br>$n = \frac{100 \times 10^3 \times 25 \times 10^{-6}}{8.31 \times 310}$ | **1** |
| | calculation of mass $m$ ( = $n \times M_r$) AND answer correct to **3sf**<br>$m = 9.705 \times 10^{-4} \times 56 = 0.0543$ (g) | **1** |
| | Alternative answer for using $C_6H_{12}$:<br>$m = 9.705 \times 10^{-4} \times 84 = 0.0815$ (g) | |
| | **Total:** | **11** |

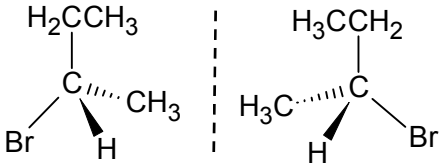
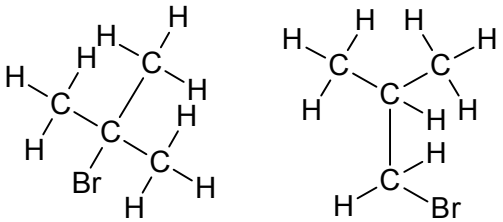
<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>2(a)(i)</td><td>
<table>
<tr><td>halogen</td><td>colour</td><td>state</td></tr>
<tr><td>chlorine</td><td>yellow / green</td><td>gas</td></tr>
<tr><td>bromine</td><td>red / brown / orange</td><td>liquid</td></tr>
<tr><td>iodine</td><td>grey / black</td><td>solid</td></tr>
</table>
</td><td>2</td></tr>
<tr><td rowspan="2">2(a)(ii)</td><td>increasing number of electrons</td><td>1</td></tr>
<tr><td>(gives) increasing strength of van der Waals' / id-id forces / London / dispersion forces</td><td>1</td></tr>
<tr><td rowspan="3">2(b)</td><td>oxidising power decreases down the group. ora</td><td>1</td></tr>
<tr><td>ability to accept electrons decreases (down the group) ora</td><td>1</td></tr>
<tr><td>because (outer shell experiences) more shielding<br>OR<br>increased distance from nucleus (to outer shell) (outweighs the increasing nuclear charge down the group) ora</td><td>1</td></tr>
<tr><td rowspan="2">2(c)(i)</td><td>solid sodium chloride: steamy / misty / white fumes</td><td>1</td></tr>
<tr><td>solid sodium iodide: purple fumes</td><td>1</td></tr>
<tr><td rowspan="2">2(c)(ii)</td><td>(conc sulfuric) not powerful enough oxidising agent (to oxidise chloride)<br>OR<br>chloride not powerful enough reducing agent (to reduce sulfuric acid)</td><td>1</td></tr>
<tr><td>iodide reduces sulfuric acid<br>OR<br>iodide / $I^-$ is oxidised<br>OR<br>sulfuric acid oxidises iodide</td><td>1</td></tr>
</table>

| Question | Answer | Marks |
|---|---|---|
| 2(c)(iii) | $2NaBr + 2H_2SO_4 \rightarrow Br_2 + SO_2 + Na_2SO_4 + 2H_2O$<br>OR<br>$NaBr + H_2SO_4 \rightarrow NaHSO_4 + HBr$ AND $2HBr + H_2SO_4 \rightarrow Br_2 + SO_2 + 2H_2O$<br>OR<br>$2NaBr + H_2SO_4 \rightarrow Na_2SO_4 + 2HBr$ AND $2HBr + H_2SO_4 \rightarrow Br_2 + SO_2 + 2H_2O$ | **2** |
| 2(d)(i) | AgI (and AgC*l* solid) / silver ions reacting with iodide ions | **1** |
| 2(d)(ii) | AgC*l* (precipitate) dissolves (in ammonia) owtte | **1** |
| | **Total:** | **15** |

| Question | Answer | Marks |
|---|---|---|
| 3(a)(i) | (enthalpy / energy change) when one mole of a compound is formed | **1** |
| | from its elements in their standard states / standard conditions | **1** |
| 3(a)(ii) | ($\Delta H_f = \sum \Delta H_f$ products $- \Sigma \Delta H_f$ reactants)<br>$-196 = 2\Delta H_f\ SO_3 - (2 \times -296.8)$<br>$2\Delta H_f\ SO_3 = -196 + (2 \times -296.8) = -789.6$ | **1** |
| | $\Delta H_f\ SO_3 = -394.8$ (kJ mol$^{-1}$) | **1** |
| 3(b)(i) | Mark to right of original $E_a$ | **1** |

| Question | Answer | Marks |
|---|---|---|
| 3(b)(ii) | 2 marks for any two points:<br>• Benefit of using a catalyst in terms of increasing rate or economic benefit i.e. (less heat required)<br>• Creates alternative pathway with lower $E_a$<br>• More molecules with $E > E_a$ | **2** |
| 3(b)(iii) | (rate) increases AND correct explanation in terms of 'more collisions' | **1** |
| | more successful collisions per unit time / higher chance of successful collisions per unit time / higher proportion of successful collisions per unit time | **1** |
| | (yield) increases and shifts equilibrium to the right / in the forward direction / towards $SO_3$ / towards the product / in exothermic direction | **1** |
| | to oppose the change or oppose the increase in pressure / fewer molecules on RHS so eqm moves to right (to oppose change) | **1** |
| 3(c)(i) | $SO_2 = 0.01$ (mol)<br>AND<br>$SO_3 = 0.99$ (mol) | **1** |
| 3(c)(ii) | $n_{TOT} = 1.505$ | **1** |
| | $pO_2 = 1.50 \times 10^5 \times (0.505 / 1.505) = 5.03 \times 10^4$ (Pa) | **1** |
| 3(d)(i) | $\left(K_p =\right)\dfrac{pSO_3^{\,2}}{pO_2 \times pSO_2^{\,2}}$ | **1** |
| 3(d)(ii) | 0.1946737305 | **1** |
| | $Pa^{-1}$ | **1** |
| | **Total:** | **17** |

| Question | Answer | Marks |
|---|---|---|
| 4(a) | cracking | **1** |
| 4(b) | **In any order**<br>$CH_2=CHCH_2CH_3$ / $CH_2CHCH_2CH_3$ / $CH_2CHC_2H_5$<br>AND<br>$CH_3CH=CHCH_3$ / $CH_3CHCHCH_3$<br>AND<br>$(CH_3)_2C=CH_2$ / $(CH_3)_2CCH_2$ | **1** |
| 4(c)(i) | (different) molecules with the same (molecular and) structural formula | **1** |
| | (due to) different arrangement in space caused by C=C / double bond | **1** |
| 4(c)(ii) |  <br>arrow from the C=C double bond drawn to the H | **1** |
| | dipole on H–Br in correct orientation AND arrow from the H-Br bond to the $Br^{\delta-}$ | **1** |
| | correct carbocation from the structure with C=C drawn | **1** |
| | $Br^-$ with lone pair, negative charge AND arrow from lone pair to the positively charged carbon atom of intermediate | **1** |

| Question | Answer | Marks |
|---|---|---|
| 4(d)(i) | a (tetrahedral) atom with four different groups / atoms / substituents attached<br>OR<br>a carbon (atom) with four different groups / atoms / substituents attached | **1** |
| 4(d)(ii) | but–1–ene | **1** |
| 4(d)(iii) |  <br><br>One 3D structure of 2–bromobutane which must have 2 bonds shown the same and two different, i.e. **three** bond types altogether, e.g. two solid lines, one wedge and one dash. If two bonds are drawn in the plane of the paper, i.e. single solid lines, they must **not** be at 180 degrees to each other. | **1** |
| | Second structure either mirror of first OR all bonds drawn the same with position of two groups swapped. | **1** |
| 4(d)(iv) | intermediate / (secondary carbo) cation from **X** is more stable ora<br>OR<br>charge density of $C^+$ (of the intermediate of **X**) is reduced | **1** |
| | (due to) electron-releasing character / (positive) inductive effect of alkyl groups /<br>/ due to electron releasing alkyl group | **1** |
| 4(e)(i) | (2–)methylpropene / (2–)methylprop–1–ene | **1** |
| 4(e)(ii) |  <br> | **2** |
| | **Total:** | **17** |