Cambridge International AS & A Level

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CHEMISTRY **9701/23**

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

MARK SCHEME

Maximum Mark: 60

Published

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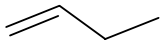
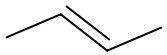
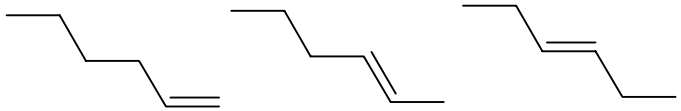
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Question	Answer	Marks
1(a)	(molecules / isomers with) the same molecular formula / same number of atoms of each element	**1**
	different structural / displayed formulae / different arrangement of bonds	**1**
1(b)(i)	4	**1**
1(b)(ii)	6	**1**
1(b)(iii)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

Question	Answer	Marks
1(b)(iv)		**1**
	 alternative using supplied data: any two 	**1**
1(b)(v)	correct conversions of data to SI / consistent units P = 100 000; V = 25×10^{-6}; T = 310	**1**
	calculation of n (= pV / RT) $n = \frac{100 \times 10^3 \times 25 \times 10^{-6}}{8.31 \times 310}$	**1**
	calculation of mass m (= $n \times M_r$) AND answer correct to **3sf** $m = 9.705 \times 10^{-4} \times 56 = 0.0543$ (g)	**1**
	Alternative answer for using C_6H_{12}: $m = 9.705 \times 10^{-4} \times 84 = 0.0815$ (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
OR
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)
OR
chloride not powerful enough reducing agent (to reduce sulfuric acid)</td><td>1</td></tr>
<tr><td>iodide reduces sulfuric acid
OR
iodide / I^- is oxidised
OR
sulfuric acid oxidises iodide</td><td>1</td></tr>
</table>

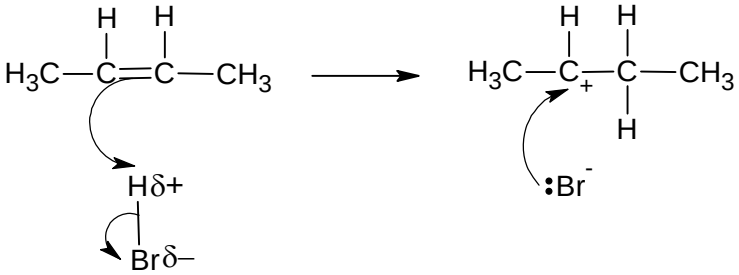
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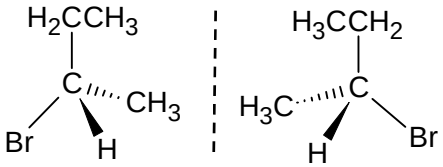
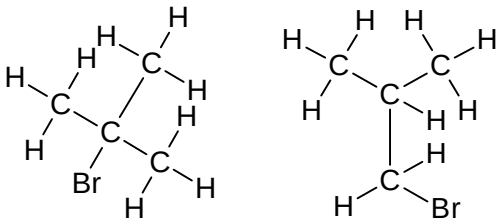
Question	Answer	Marks
2(c)(iii)	$2NaBr + 2H_2SO_4 \rightarrow Br_2 + SO_2 + Na_2SO_4 + 2H_2O$ OR $NaBr + H_2SO_4 \rightarrow NaHSO_4 + HBr$ AND $2HBr + H_2SO_4 \rightarrow Br_2 + SO_2 + 2H_2O$ OR $2NaBr + H_2SO_4 \rightarrow Na_2SO_4 + 2HBr$ AND $2HBr + H_2SO_4 \rightarrow Br_2 + SO_2 + 2H_2O$	**2**
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)	($\Delta H_r = \sum \Delta H_f$ products $- \Sigma \Delta H_f$ reactants) $-196 = 2\Delta H_f\ SO_3 - (2 \times -296.8)$ $2\Delta H_f\ SO_3 = -196 + (2 \times -296.8) = -789.6$	**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: • Benefit of using a catalyst in terms of increasing rate or economic benefit i.e. (less heat required) • Creates alternative pathway with lower E_a • 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) AND $SO_3 = 0.99$ (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**

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Question	Answer	Marks
4(a)	cracking	**1**
4(b)	**In any order** $CH_2=CHCH_2CH_3$ / $CH_2CHCH_2CH_3$ / $CH_2CHC_2H_5$ AND $CH_3CH=CHCH_3$ / $CH_3CHCHCH_3$ AND $(CH_3)_2C=CH_2$ / $(CH_3)_2CCH_2$	**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)	 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 OR a carbon (atom) with four different groups / atoms / substituents attached	**1**
4(d)(ii)	but–1–ene	**1**
4(d)(iii)	 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 OR charge density of C^+ (of the intermediate of **X**) is reduced	**1**
	(due to) electron-releasing character / (positive) inductive effect of alkyl groups / / due to electron releasing alkyl group	**1**
4(e)(i)	(2–)methylpropene / (2–)methylprop–1–ene	**1**
4(e)(ii)	 	**2**
	Total:	**17**