CAMBRIDGE INTERNATIONAL AS & A LEVEL CHEMISTRY · 9701

CHEMISTRY



MARK SCHEME

13 AN INTRODUCTION TO AS LEVEL ORGANIC CHEMISTRY

SCORE	PERCENTAGE
/	%

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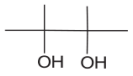
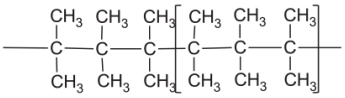
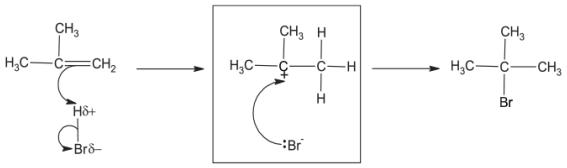
Paper 1 Multiple Choice Answers: An Introduction to AS Level Organic C

Question	Paper	Q. No.	Answer
741	9701_s21_qp_11	23	C
742	9701_m20_qp_12	2	D
743	9701_w20_qp_11	30	A
744	9701_s19_qp_11	21	A
745	9701_s19_qp_13	21	A
746	9701_w19_qp_12	21	A
747	9701_m18_qp_12	23	A
748	9701_s18_qp_11	2	D
749	9701_w17_qp_12	21	A
750	9701_w16_qp_12	21	C
751	9701_s15_qp_12	25	D
752	9701_w15_qp_11	9	B
753	9701_w15_qp_12	29	A
754	9701_m21_qp_12	22	D
755	9701_w18_qp_11	20	B
756	9701_w17_qp_11	24	B
757	9701_s21_qp_12	3	B
758	9701_s21_qp_12	4	C
759	9701_w21_qp_11	18	A
760	9701_m20_qp_12	30	D
761	9701_w20_qp_12	4	D
762	9701_m19_qp_12	5	B
763	9701_w19_qp_11	4	B
764	9701_w19_qp_12	20	D
765	9701_w18_qp_12	21	C
766	9701_m17_qp_12	5	C
767	9701_w16_qp_11	6	A
768	9701_w15_qp_11	23	B
769	9701_m22_qp_12	26	C
770	9701_m22_qp_12	36	A
771	9701_m21_qp_12	20	D
772	9701_s21_qp_11	22	B
773	9701_s21_qp_12	20	B
774	9701_s21_qp_13	20	B
775	9701_w21_qp_11	22	D
776	9701_w21_qp_12	20	C
777	9701_w21_qp_12	22	C
778	9701_m20_qp_12	20	B
779	9701_m20_qp_12	25	D
780	9701_s20_qp_11	21	C
781	9701_s20_qp_11	28	D
782	9701_s20_qp_12	26	B
783	9701_s20_qp_12	27	C
784	9701_s20_qp_13	20	C
785	9701_s20_qp_13	30	D
786	9701_w20_qp_11	20	D

Paper 1 Multiple Choice Answers: An Introduction to AS Level Organic C

Question	Paper	Q. No.	Answer
787	9701_w20_qp_12	20	B
788	9701_m19_qp_12	20	C
789	9701_s19_qp_11	20	D
790	9701_s19_qp_11	30	C
791	9701_s19_qp_12	21	A
792	9701_s18_qp_11	20	B
793	9701_s18_qp_13	20	C
794	9701_s18_qp_13	27	C
795	9701_w18_qp_11	21	A
796	9701_w18_qp_11	22	C
797	9701_w18_qp_12	20	A
798	9701_m17_qp_12	20	D
799	9701_m17_qp_12	21	D
800	9701_s17_qp_11	21	D
801	9701_s17_qp_12	21	D
802	9701_s17_qp_13	20	C
803	9701_s17_qp_13	21	C
804	9701_w17_qp_11	20	C
805	9701_w17_qp_12	20	C
806	9701_m16_qp_12	21	B
807	9701_s16_qp_11	20	D
808	9701_w16_qp_11	20	B
809	9701_w16_qp_11	21	A
810	9701_w16_qp_12	24	C
811	9701_w16_qp_12	30	B
812	9701_s15_qp_11	28	A
813	9701_s15_qp_13	27	B
814	9701_w15_qp_11	20	C
815	9701_w15_qp_11	29	B
816	9701_w15_qp_12	21	B

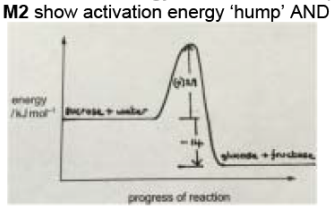
88. 9701_w16_ms_21 Q: 4

(a)(i)	4-methylhex-2-ene	1	**1**
(a)(ii)	(Molecules with the) same structural formula (and same molecular formula) with different arrangement of atoms/groups (in space)	1	**1**
(a)(iii)	4 double-bond / alkene (2) different groups on each double-bonded carbon (one) chiral carbon (centre) / (one) carbon atom has 4 different groups attached / is asymmetric / is chiral	1 1 1 1	**4**
(b)(i)	2,3-dimethylbut-2-ene	1	**1**
(b)(ii)		1	**1**
(b)(iii)	Propanone	1	**1**
(b)(iv)		1	**1**
(c)(i)	(2-)methylprop(-1-)ene	1	**1**
(c)(ii)		4	**4**
(c)(iii)	(tertiary carbocat)ion / (tertiary) intermediate is / C+ with least number of hydrogen atoms bonded to it is more stable (than primary) due to (positive) inductive effect of three/more methyl groups (cf one) / three / more electron releasing methyl groups three / more electron donating methyl groups reducing charge (density) on C+	1 1 1	**3**
	Total:		**18**

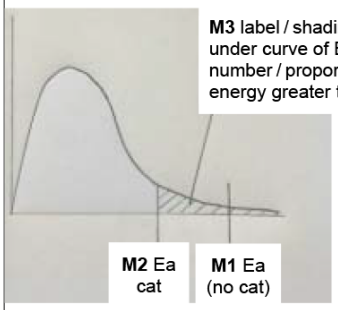
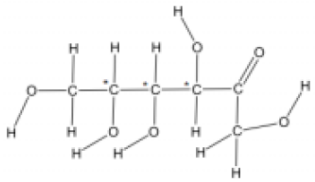
89. 9701_m20_ms_22 Q: 1

(a)(i)	$CaO + H_2O \rightarrow Ca(OH)_2$	**1**
(a)(ii)	OH^- / hydroxide	**1**
(b)	**M1** (decreasing melting point down the group because) lower forces of attraction / weaker bonds (between cations and anions / oxide / O^{2-}) **M2** larger cations and constant charge OR decreasing charge density of cation (down group)	**2**
(c)	high(er) activation energy / heating overcomes activation energy	**1**
(d)	180(°)	**1**
(e)(i)	reacts with / behaves as both acid and base	**1**
(e)(ii)	$BeO + 2OH^- + H_2O \rightarrow Be(OH)_4^{2-}$	**1**
(f)(i)	**M1** equal rates of forward and backward reactions **M2** closed system **OR** macroscopic properties unchanging	**2**
(f)(ii)	**M1** Cl_2 O_2 initial x 0 mol equilibrium $0.3x$ $0.35x$ mol **mol fraction** $\frac{6}{13}$ $\frac{7}{13}$ **M2** $K_p = \frac{100\,000 \times \frac{7}{13}}{\left(100\,000 \times \frac{6}{13}\right)^2} = 2.53 \times 10^{-5}$ **M3** Pa^{-1}	**3**
(g)(i)	–1	**1**
(g)(ii)	**M1** (enthalpy / energy change) when one mole of a compound / substance is formed **M2** from its elements in their standard states	**2**
(g)(iii)	$-(-602 + -188) + (\Delta H_f[MgO_2] + -286) = -96$ $\Delta H_f[MgO_2] = -600$ (kJ mol^{-1})	**2**
(g)(iv)	$-(-600) - (+602) = -2$ (kJ mol^{-1})	**1**

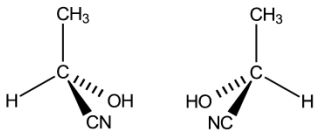
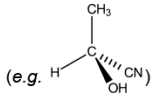
90. 9701_s20_ms_22 Q: 3

(a)	hydrolysis	**1**
(b)	**M1** both have molecular formula - $C_6H_{12}O_6$ **M2** *idea that in glucose and fructose there are the same number and type of atoms present but the atoms are arranged in a different order ie* one has a carbonyl group at the end of the chain/molecule and the other has a carbonyl group in the middle of the chain/molecule	**2**
(c)(i)	*value for the activation energy for the reaction **A** (no enzyme) compared to reaction **B** (with enzyme)* value / range of values that are more (+) 29 kJ mol^{-1}	**1**
(c)(ii)	*value for the enthalpy change for reaction **A** (no enzyme) compared to reaction **B** (with enzyme)* -14 kJ mol^{-1}	**1**
(c)(iii)	**M1** show the energy of the reactants > products AND label ΔH using the predicted value given in **(ii)** **M2** show activation energy 'hump' AND label using the value given in **(i)** 	**2**
(d)(i)	**M1** (enthalpy change) when 1 mole of sucrose **M2** burns/combusts/reacts in excess air/oxygen **OR** completely burns/combusts/reacts in air/oxygen	**2**
(d)(ii)	**M1** *for finding amount of energy released per gram of sucrose using* ΔH /Q = mcΔT OR ΔH = – mcΔT = (-)250x4.18x(40.7-25) = (-)16406.5 J per gram OR(-)16.4065 kJ / g **M2** *for finding amount (mol) sucrose in1g = 1/342 mol* ***M3** = M1 / (M2x1000)* ΔH = - 5610 kJ mol^{-1} (3 sig figs) OR -5611 kJ mol^{-1} (4 sig figs)	**3**

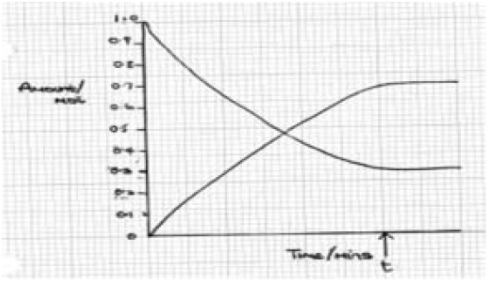
91. 9701_s20_ms_23 Q: 3

(a)(i)	hydrolysis	1
(a)(ii)	 **M3** label / shading indicating greater area under curve of Ea(cat) AND state greater number / proportion of sucrose molecules have energy greater than Ea(cat) (so faster rate)	3
(b)(i)	an atom which is bonded to four different substituents / groups / atoms	1
(b)(ii)	ALL three chiral carbons need to be shown by * 	1
(b)(iii)	*empirical formula of fructose* CH_2O	1
(c)(i)	**M1** (enthalpy change) when 1 mole of a substance **M2** burns/combusts/reacts in excess air/oxygen **OR** completely burns/combusts/reacts in air/oxygen	2
(c)(ii)	$C_{12}H_{22}O_{11} + 12\ O_2 \rightarrow 12CO_2 + 11H_2O$	1
(c)(iii)	**M1** $\Delta H = -5643 - (-2805 + -2810)$ **M2** $= -28\ kJ\ mol^{-1}$	2

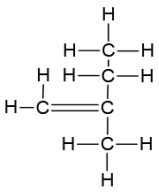
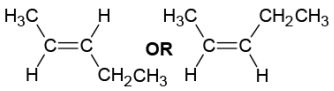
92. 9701_s19_ms_21 Q: 5

(a)	**M1** a lone pair / electron pair donor	1
	M2 $(:)CN^-$ / $^-(:)CN$ / cyanide ion	1
(b)(i)	optical	1
(b)(ii)	 **M1** one 3-D structure of **correct** molecule shown.	1
	M2 a mirror image of the molecule drawn in **M1 OR** same profile with two groups swapped (*e.g.* )	1
	M3 central chiral C shown as *	1
(c)	$CH_3CH(OH)CO_2H$ **OR** $HO_2CCH(OH)CH_3$	1

93. 9701_s19_ms_22 Q: 1

(a)(i)	C_4H_{10} / same molecular formula /	1
	OR	
	same number of carbon (atoms) and hydrogen (atoms)	
	different structural formula	1
	OR	
	description of different structural formula which does not imply stereoisomerism	
(a)(ii)	structural / chain	1
(b)	(forward reaction is) exothermic reaction	1
	the proportion of methylpropane / product decreases	1
	OR	
	the proportion of butane / reactant increases	
(c)(i)	*t* shown on graph which corresponds to start of the horizontal part of both curves. 	1
(c)(ii)	concentration of butane = 0.3 mol dm^{-3}	1
	AND	
	concentration of methylpropane = 0.7 mol dm^{-3}	
(c)(iii)	[methylpropane] / [butane]	1
	OR	
	$[(CH_3)_2CHCH_3]$ / $[CH_3(CH_2)_2CH_3]$	
(c)(iv)	**M1** *value for* K_c	1
	$K_c = \frac{\text{value of methylpropane in (ii)}}{\text{value of butane in (ii)}} = 0.7 / 0.3 = 2.3$ (3)	
	M2 *units consistent with expression used in* M1	1
	no units / dimensionless / none	

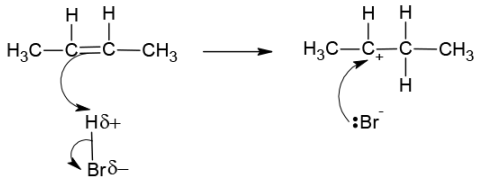
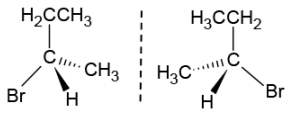
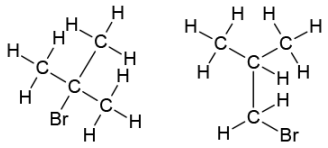
94. 9701_s18_ms_23 Q: 2

(a)(i)	(molecules / isomers with) the same molecular formula / same number of atoms of each element	**1**
	different structural formulae / different structures	**1**
(a)(ii)	(Molecules / isomers) with the same (molecular and) structural formula	**1**
	different arrangement of atoms in space / different spatial arrangement of atoms.	**1**
(b)(i)	two Hs on one of the C=C carbons / terminal C / C–1	**1**
	no chiral C / no C with 4 different groups / atoms / chains attached has a super(im)posable mirror image	**1**
(b)(ii)		**1**
	2-methylbut-1-ene	**1**
(b)(iii)	structure 	**1**
	trans–pent–2–ene or or *E*– cis–pent–2–ene or *Z*–	**1**

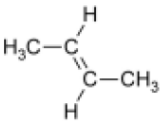
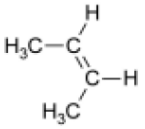
95. 9701_s17_ms_23 Q: 3

(a)(i)	(enthalpy / energy change) when one mole of a compound is formed	1
	from its elements in their standard states / standard conditions	1
(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
(b)(i)	Mark to right of original E_a	1
(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
(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
(c)(i)	$SO_2 = 0.01$ (mol) AND $SO_3 = 0.99$ (mol)	1
(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
(d)(i)	$\left(K_p =\right) \frac{pSO_3^{\ 2}}{pO_2 \times pSO_2^{\ 2}}$	1
(d)(ii)	0.1946737305	1
	Pa^{-1}	1
	Total:	**17**

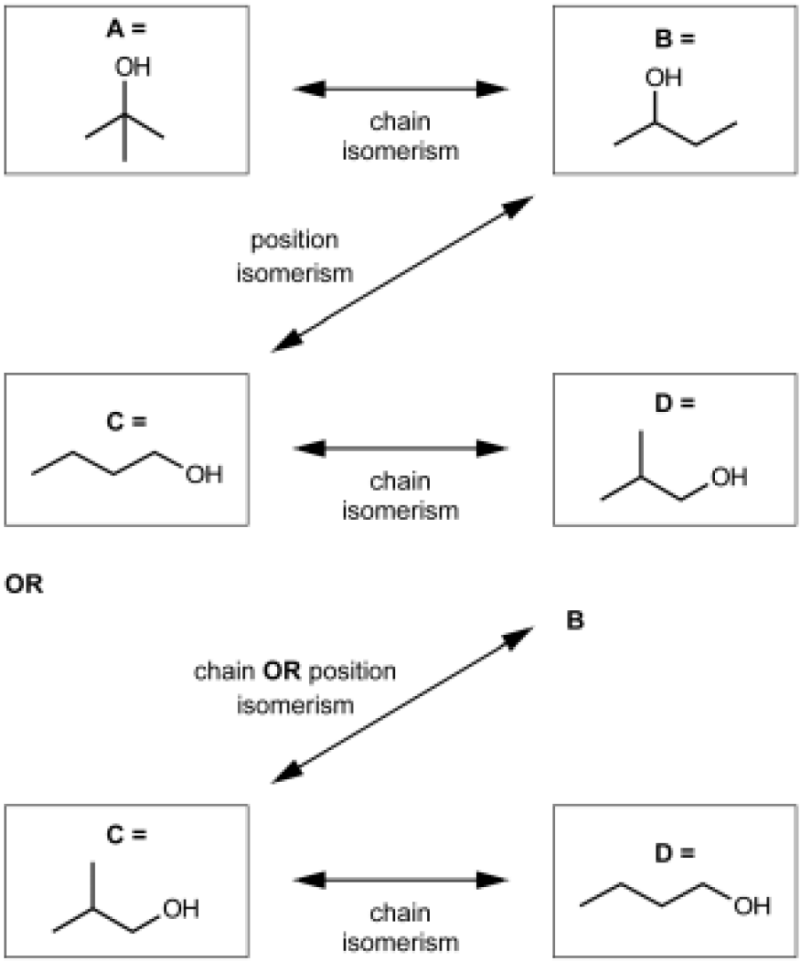
96. 9701_s17_ms_23 Q: 4

(a)	cracking	**1**
(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**
(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**
(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**
(d)(i)	a (tetrahedral) atom with four different groups / atoms / substituents attached OR a carbon (atom) with four different groups / atoms / substituents attached	**1**
(d)(ii)	but–1–ene	**1**
(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**
(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**
(e)(i)	(2–)methylpropene / (2–)methylprop–1–ene	**1**
(e)(ii)		**2**
	Total:	**17**

97. 9701_s16_ms_21 Q: 4

(a)	$CH_2=CHCH_2CH_3$ / $CH_2CHCH_2CH_3$ AND $CH_3CH=CHCH_3$ / $CH_3CHCHCH_3$	[1]
(b)	$CH_2=CHCH_2CH_3$ / $CH_2CHCH_2CH_3$ AND $(CH_3)_2C=CH_2$ / $(CH3)_2CCH_2$	[1]
(c)	  *trans*-but-2-ene (or *E*) *cis*-but-2-ene (or *Z*)	[1] [1]
(d)	**B** is $CH_2=CHCH_2CH_3$ OR $CH_3CH=CHCH_3$ OR $(CH_3)_2C=CH_2$ distinguished by addition of bromine brown/red/orange/yellow to colourless/decolourises with **B** (but not **A**)	[1] [1] [1]

98. 9701_S15_ms_21 Q: 4

(a)		[1] [1] [1] [1] [1] [1] [1]
(b) (i)	but-1-ene / 1-butene but-2-ene / 2-butene	[1] [1]
(ii)	but-2-ene **AND** two different groups on each carbon (of C=C) double bond means no free rotation	[1] [1]
(iii)	 and (either way round)	[1+1]