Cambridge Assessment International Education
Cambridge Pre-U Certificate

CHEMISTRY	**9791/02**
Paper 2 Part A Written	**May/June 2019**
MARK SCHEME	
Maximum Mark: 100	

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.

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Generic Marking Principles

These general marking principles must be applied by all examiners when marking candidate answers. They should be applied alongside the specific content of the mark scheme or generic level descriptors for a question. Each question paper and mark scheme will also comply with these marking principles.

GENERIC MARKING PRINCIPLE 1: Marks must be awarded in line with: • the specific content of the mark scheme or the generic level descriptors for the question • the specific skills defined in the mark scheme or in the generic level descriptors for the question • the standard of response required by a candidate as exemplified by the standardisation scripts.
GENERIC MARKING PRINCIPLE 2: Marks awarded are always **whole marks** (not half marks, or other fractions).
GENERIC MARKING PRINCIPLE 3: Marks must be awarded **positively**: • marks are awarded for correct/valid answers, as defined in the mark scheme. However, credit is given for valid answers which go beyond the scope of the syllabus and mark scheme, referring to your Team Leader as appropriate • marks are awarded when candidates clearly demonstrate what they know and can do • marks are not deducted for errors • marks are not deducted for omissions • answers should only be judged on the quality of spelling, punctuation and grammar when these features are specifically assessed by the question as indicated by the mark scheme. The meaning, however, should be unambiguous.
GENERIC MARKING PRINCIPLE 4: Rules must be applied consistently e.g. in situations where candidates have not followed instructions or in the application of generic level descriptors.

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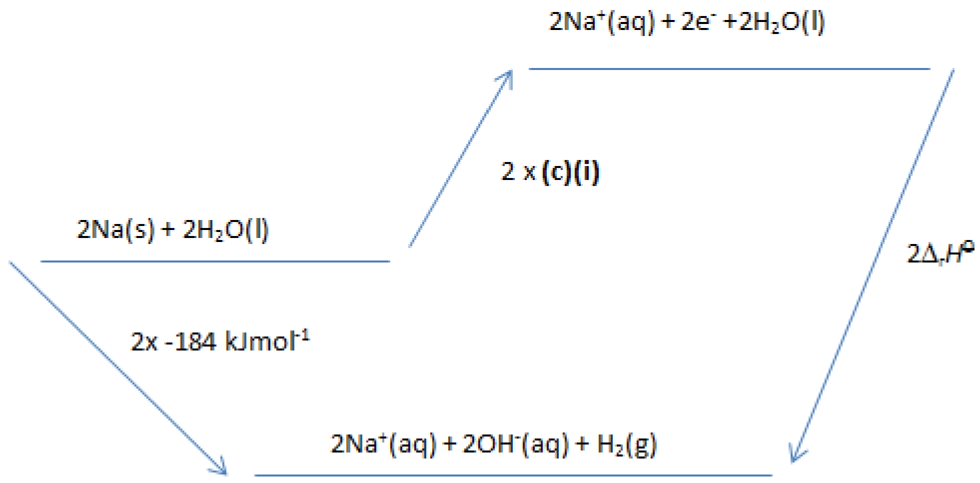
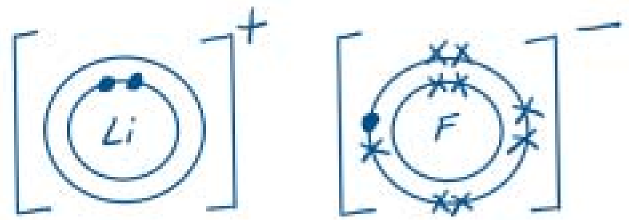
GENERIC MARKING PRINCIPLE 5: Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen).
GENERIC MARKING PRINCIPLE 6: Marks awarded are based solely on the requirements as defined in the mark scheme. Marks should not be awarded with grade thresholds or grade descriptors in mind.

Question	Answer	Marks
1(a)	(The enthalpy change when) One mole (1) Of gaseous ions (1) Form (one mole of) aqueous ions (1)	**3**
1(b)(i)	$M(g) \rightarrow M^{+}(g) + e^{-}$	**1**
1(b)(ii)	More (inner) shells / more shielding (1), <u>Atomic</u> radius increases / <u>Outer</u> electron further from nucleus (1), Less attraction to nucleus / closer to ionisation limit (1).	**3**
1(c)(i)	((+109 + 495 – 406) kJ mol^{-1} =) +198 (kJ mol^{-1})	**1**

Question	Answer	Marks
1(c)(ii)	 Diagram of cycle with arrows in correct direction, including correct stoichiometry (1) Correct state symbols on correct species (1) Use of 2 × –184 and 2 × **(c)(i)** (1) Correct answer (2 × (–382 kJ mol^{-1}) =) –764 (kJ mol^{-1}) (1)	**4**
1(d)	(–222 kJ mol^{-1} / 6.9 g mol^{-1} =) –32 (kJ g^{-1})	**1**
1(e)	M is oxidised and C is reduced. (1) 0 and +1 for M, +4 and 0 for C. (1)	**2**
1(f)(i)	$M_2CO_3 \rightarrow M_2O + CO_2$	**1**

Question	Answer	Marks
1(f)(ii)	(Alkali metal) ions have lower charge (1) (Alkali metal) ions are larger (1) So the carbonate (ion) or anion is less polarised / distorted / has less weakening of bonds (1)	**3**
1(f)(iii)	(Li_2CO_3) because the Li^+ ion is the smallest / most charge dense / most polarising.	**1**

Question	Answer	Marks
2(a)(i)	High S–F bond energy / strong S–F bonds (1) The molecular is non-polar / has no net / permanent dipole. (1)	**2**
2(a)(ii)	SeF_6 has more electrons than SF_6 (1) So it has stronger IDID / London / dispersion forces (1)	**2**
2(b)(i)	Caesium Fluoride / CsF	**1**
2(b)(ii)	Non-overlapping shells and ionic charges shown (1) Correct numbers and types of electron (1) 	**2**

Question	Answer	Marks
2(c)(i)	-2934 kJ mol^{-1} = (+1209 –447 +(6×$\Delta_f H^{\ominus}$ (LiF))) (kJ mol^{-1}) (1) signs must be correct 6×$\Delta_f H^{\ominus}$ (LiF) = –3696 (kJ mol^{-1}) (1) $\Delta_f H^{\ominus}$ (LiF) = –616 (kJ mol^{-1}) (1)	**3**
2(c)(ii)	Because the gas is used up	**1**
2(c)(iii)	8Li(s) + SF_6(g) on a line above the level of a line with Li_2S(s) + 6LiF(s) with a vertical axis labelled as E/H/Energy or Enthalpy (1) E_a and ΔH arrows connecting correct levels (1) Arrows pointing in the correct direction (1)	**3**
2(c)(iv)	((–2934–(8×3)) kJ mol^{-1} =) –2958 (kJ mol^{-1}) Use of factor of 8 (1) Use of correct signs (1)	**2**
2(d)	Amount of gas per s = (1.8 dm^3 s^{-1} / 24 dm^3 mol^{-1} =) 0.075 mol s^{-1} (1) ΔH per s = (0.075 mol s^{-1} × –2934 kJ mol^{-1}) = –220.05 kJ s^{-1} (1) Power = 2.2 × 10^5 (W) (1)	**3**

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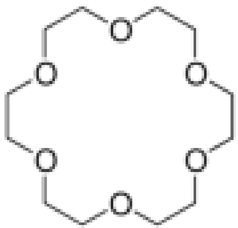
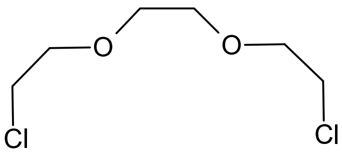
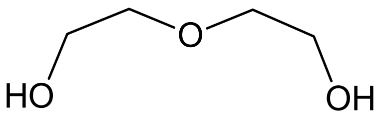
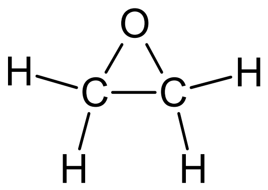
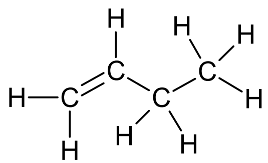
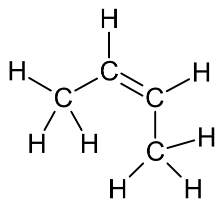
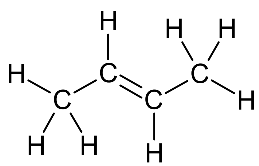
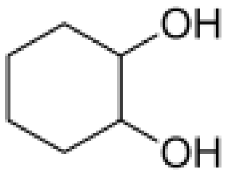
Question	Answer	Marks
3(a)(i)	(100% × 28.1 / 60.1 =) 46.8%	**1**
3(a)(ii)	Amount of A*l* in 100 g = 1.22 g / 27 g mol^{-1} = 0.04519 mol (1) Amount of Al_2O_3 in 100 g = 0.04519 mol / 2 = 0.022595 mol % mass of Al_2O_3 = 0.022595 mol × 102 g mol^{-1} = 2.30(%) (1) Alternative method: % mass of A*l* in Al_2O_3 = 100% × 54 / 102 = 52.94% (1) % mass of A*l* in Pyrex® = 1.22% / 0.5294 = 2.30%	**2**
3(a)(iii)	% mass of SiO_2 = (100 – **(a)(ii)** –13.0 – 4.00=) 80.7% % Si = (**(a)(i)** × 80.7% =) 37.7% (1) % O = ((100–1.22–4.03–2.97–37.7)% =) 54.0% (1) OR (summing the % mass of O in Pyrex® of each oxide): (2.30% × 48 / 102) + (13.0% × 48 / 69.6) + (4.0% × 16 / 62) + (80.7% × 32 / 60.1) = 54.0% OR (for all the components M_xO_y in Pyrex®, subtract the % mass of X from the % mass of M_xO_y and sum all the %O values): (2.30 – 1.22) + (13.0 – 4.03) + (4.00 – 2.97) + ((1 – 0.468) × 80.7) = = 54.0%	**2**
3(b)	B or Boron (oxide)	**1**
3(c)(i)	$SiO_2 + 2NaOH \rightarrow Na_2SiO_3 + H_2O$	**1**
3(c)(ii)	Silicon dioxide is acidic	**1**

Question	Answer	Marks
4(a)	One bonding pair between O and H 3 non-bonding pairs of electrons on O (1) Negative charge shown (1)	**2**
4(b)(i)	The carbon is electron deficient **or** δ+ **or** at the positive end of a dipole.	**1**
4(b)(ii)	$CH_3CH_2Cl + NaOH \rightarrow CH_3CH_2OH + NaCl$	**1**
4(c)(i)	The lone pairs	**1**
4(c)(ii)	100% × 74 / (74 + 58.5) = 55.8%	**1**
4(c)(iii)	The C–F bond is (too) strong	**1**
4(d)	To remove H^+ from OH (groups)	**1**
4(e)(i)	$C_{12}H_{24}O_6$	**1**
4(e)(ii)		**1**
4(e)(iii)	**Y** is  **Z** is 	**2**
4(e)(iv)	1	**1**
4(e)(v)	1,4,7,10,13-pentaoxacyclopentadecane	**1**
4(e)(vi)	Na^+ matches the smaller (15-crown-5) cavity (1)	**1**

Question	Answer	Marks
4(f)(i)	C_2H_4O	**1**
4(f)(ii)		**1**
4(g)(i)	$C_4H_9Cl + NaOH \rightarrow C_4H_8 + NaCl + H_2O$	**1**
4(g)(ii)	Alcohol / ethanolic (solvent) (1) High(er) temperature (1)	**2**
4(g)(iii)	But-1-ene **and**  (1) Cis but-2-ene **and**  (1) Trans but-2-ene **and**  (1)	**3**

Question	Answer	Marks
5(a)	$C_6H_{12}O_2$	**1**
5(b)(i)	(No) alkeno group / C=C bond (1) (No) carbonyl group / C=O bond (1)	**2**
5(b)(ii)	Presence of a primary or secondary alcohol group	**1**
5(c)	One (carbon singly) bonded to oxygen (of an OH group) (1) Two (carbons each singly) bonded to C (1)	**2**
5(d)	 Any cyclohexanediol (1) 1,2-cyclohexanediol (1)	**2**

Question	Answer	Marks
6(a)	To <u>oxidise</u> the iodide (to iodine)	**1**
6(b)(i)	To allow the (slow) reaction to go to completion	**1**
6(b)(ii)	To remove soluble impurities	**1**
6(b)(iii)	To dry the product	**1**
6(c)	Recrystallisation	**1**

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Question	Answer	Marks
6(d)(i)	Filtration (and drying)	**1**
6(d)(ii)	Check the melting point (is at (a narrow range close to) 119 °C)	**1**
6(d)(iii)	Step 3 **or** when the iodoform is filtered off	**1**
6(e)(i)	Gloves	**1**
6(e)(ii)	Use a heating mantle or water / oil / sand bath or keep away from naked flame	**1**
6(f)(i)	Mass of ethanal = (1.10 $cm^3 \times 0.788\ g\ cm^{-3}$ =) 0.867 g (1) Amount of ethanal = (0.8677 g / 44.0 $g\ mol^{-1}$ =) 0.0197 mol (1) Mass of iodoform = (0.0197 mol × 393.7 $g\ mol^{-1}$ =) 7.76 g (1)	**3**
6(f)(ii)	Mass of NaC*l*O = (0.070 mol × 74.5 $g\ mol^{-1}$ =) 5.215 g (1) Volume = (5.215 g × 1000 $cm^3\ dm^{-3}$ / 150 $g\ dm^{-3}$ =) 35 cm^3 (1) OR Molar conc of NaC*l*O = 150 $g\ dm^{-3}$ / 74.5 $g\ mol^{-1}$ = 2.013 $mol\ dm^{-3}$ (1) Volume = 0.07 mol / 2.013 $mol\ dm^{-3}$ = 0.035 dm^3 = 35 cm^3 (1)	**2**
6(g)	Ethanol / water (1) Ethanal (1)	**2**
6(h)	I_2 is (more) soluble as a triiodide **or** I_2 is more soluble in KI (than in water)	**1**
6(i)(i)	The NaC*l*O is a better oxidising agent (than iodine)	**1**
6(i)(ii)	It contains the $CH_3CH(OH)$ group	**1**
6(j)(i)	$3I_2 + 6NaOH \rightarrow 5NaI + NaIO_3 + 3H_2O$	**1**
6(j)(ii)	The oxidation number of an element both increases and decreases	**1**

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