2011 Chemistry

Higher

Finalised Marking Instructions

Higher Chemistry

General information for markers

The general comments given below should be considered during all marking.

1 Marks should **not** be deducted for incorrect spelling or loose language as long as the meaning of the word(s) is conveyed.

Example: Answers like 'distilling' (for 'distillation') and 'it gets hotter' (for 'the temperature rises') should be accepted.

2 A right answer followed by a wrong answer should be treated as a cancelling error and no marks should be given.

Example: What is the colour of universal indicator in acid solution?

The answer 'red, blue' gains no marks.

3 If a right answer is followed by additional information which does not conflict, the additional information should be ignored, whether correct or not.

Example: Why can the tube not be made of copper?

If the correct answer is related to a low melting point, 'It has a low melting point and is coloured grey' would **not** be treated as having a cancelling error.

4 Full marks are usually awarded for the correct answer to a calculation on its own; the part marks shown in the marking scheme are for use when working is given. An exception is when candidates are asked to 'Find, by calculation, …..'.

5 A half mark should be deducted in a calculation for each arithmetic slip.

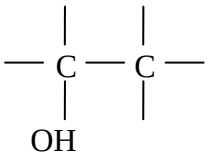
6 A half mark should be deducted for incorrect or missing units **only when stated in the marking scheme**. No marks should be deducted for incorrect or missing units at intermediate stages in a calculation.

7 Where a wrong numerical answer (already penalised) is carried forward to another step, no further penalty is incurred provided the result is used correctly.

8 Ignore the omission of one H atom from a full structural formula provided the bond is shown.

9 With structures involving an – OH or an – NH_2 group, a half mark should be deducted if the 'O' or 'N' are not bonded to a carbon, ie $OH–CH_2$ and $NH_2–CH_2$.

10 When drawing structural formulae, a half mark should be deducted if the bond points to the 'wrong' atom, eg



11 A symbol or correct formula should be accepted in place of a name **unless stated otherwise in the marking scheme**.

12 When formulae of ionic compounds are given as answers it will only be necessary to show ion charges if these have been specifically asked for. However, if ion charges are shown, they must be correct. If incorrect charges are shown, no marks should be awarded.

13 If an answer comes directly from the text of the question, no marks should be given.

Example: A student found that 0·05 mol of propane, C_3H_8 burned to give 82·4 kJ of energy.

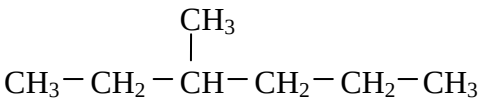
$$C_3H_8(g) + 5O_2(g) \longrightarrow 3CO_2(g) + 4H_2O(\ell)$$

Name the kind of enthalpy change which the student measured.

No marks should be given for 'burning' since the word 'burned' appears in the text.

14 A guiding principle in marking is to give credit for (partially) correct chemistry rather than to look for reasons not to give marks.

Example 1: The structure of a hydrocarbon found in petrol is shown below.



Name the hydrocarbon.

Although the punctuation is not correct, '3, methyl-hexane' should gain the full mark.

Example 2: A student measured the pH of four carboxylic acids to find out how their strength is related to the number of chlorine atoms in the molecule. The results are shown.

Structural formula	**pH**
CH_3COOH	1·65
$CH_2ClCOOH$	1·27
$CHCl_2COOH$	0·90
CCl_3COOH	0·51

How is the strength of the acids related to the number of chlorine atoms in the molecule?

Although not completely correct, an answer such as 'the more Cl_2, the stronger the acid' should gain the full mark.

15 Unless the question is clearly about a non-chemistry issue, eg costs in industrial chemistry, a non-chemical answer gains no marks.

Example: Why does the (catalytic) converter have a honeycomb structure?

A response such as 'to make it work' may be correct but it is not a chemical answer and the mark should not be given.

16 When it is very difficult to make a decision about a partially correct answer, a half mark can be awarded.

17 When marks have been totalled, a half mark should be rounded up.

2011 Chemistry Higher

Marking Scheme

Section A

1	D	11	C	21	B	31	B
2	A	12	C	22	A	32	D
3	A	13	A	23	C	33	D
4	D	14	D	24	B	34	A
5	B	15	C	25	D	35	B
6	D	16	D	26	D	36	C
7	B	17	D	27	B	37	C
8	C	18	A	28	B	38	A
9	C	19	C	29	D	39	B
10	A	20	B	30	C	40	A

Mark Scheme				Worth ½	Worth 0
1	**(a)**	Homogeneous	**1**		
	(b) **(i)**	Answer 0·0015 Units not required. (Incorrect units -½)	**1**	1·80 -1·20 ½ If correct calculation of average rate is carried out using values inaccurately read from the graph, worth ½	
	(ii)	New line should start **at same point as original** and should have a **steeper gradient** (both aspects required for mark) **1 or zero** (No need to consider where their sketched graph finishes/levels off etc)	**1**		

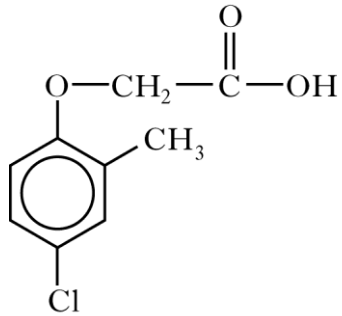
Mark Scheme				Worth ½	Worth 0
2	**(a)**	**(i)**	more protons or increasing nuclear charge **1**	More energy required to remove electron/harder to remove electron Or Bigger nuclear pull	Atomic size decreases Size of nucleus increases More electrons Bigger atomic charge
		(ii)	$Cl(g) \rightarrow Cl^+(g) + e^-$ **1** $Cl(g) - e^- \rightarrow Cl^+(g)$ (no penalty if negative sign omitted from electron)		$Cl(g) \rightarrow Cl^+ + e^-$
	(b)		Argon does not form (covalent) bonds **1** No electrons involved in bonding		It has full outer shell Unreactive/stable

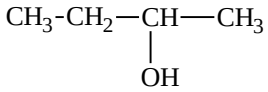
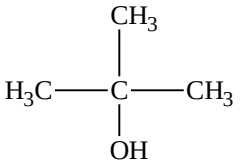
Mark Scheme			Worth ½	Worth 0
3	**(a)**	Covalent bonds not being broken **OR** Intermolecular bonds that are breaking **1** (accept alternative wording that demonstrates candidate recognises that covalent bonds are not broken when covalent substances melt/boil)		
	(b)	Formula refers to the ratio of Mg^{2+}:Cl^- ions (in lattice) (or alternative wording ie in the lattice there are twice as many chloride ions as magnesium ions) **OR** Mg^{2+} ions surrounded by > 2 Cl^- ions **OR** Cl^- surrounded by >1 Mg^{2+} **1** "chlorine ions" also acceptable	$MgCl_2$ has a lattice structure or sketch of lattice ½ mark for either	Magnesium chloride has the formula $MgCl_2$, because Mg has a valency of two and Cl has a valency of one. Magnesium chloride has the formula $MgCl_2$, because Mg atoms lose 2 electrons and Cl atoms gain one electron. Magnesium chloride has the formula $MgCl_2$, because Mg^{2+} ions have a charge of 2+ and Cl^- ions have a charge of 1-.

Mark Scheme				Worth ½	Worth 0
4	**(a)**	2,2,4-trimethylpentane (do not penalise omission of commas or hyphen)	**1**	2,2,4-TMP (½)	2,2,4-methylpentane 2,4,4-trimethylpentane
	(b)	It has more volatile (compounds)/vaporise more easily **OR** (hydrocarbons) boil more easily/lower boiling point **OR** more short chain compounds/lower GFM/more butane **OR** Less viscous (thinner)	**1**		Answers only talking about Octane numbers Answers only talking about more branched Answers only talking about how easily things burn

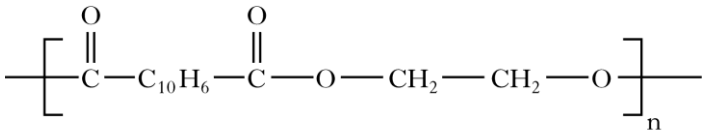
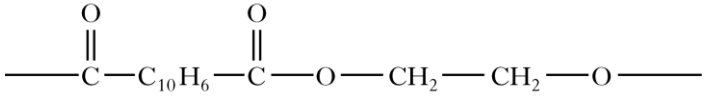
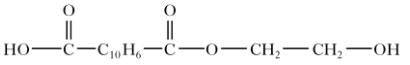
Mark Scheme		Worth ½	Worth 0
(c) ½ mark for safe heating method (no flame)/water bath ½ mark for condenser of some type ½ mark for methanol and stearic acid or "reactants" ½ mark for (concentrated) sulphuric acid in test tube ½ mark for pouring the mixture into a carbonate solution or solid carbonate added <u>after</u> esterification (correctly labelled diagram acceptable)	**2**		Acid catalyst (0)

Mark Scheme	Worth ½	Worth 0
5 (a) 1 mole $Ca(OCl)_2 \rightarrow$ 2 moles Cl_2 143 g (½) → 48 litres (½) $\frac{0{\cdot}096}{48} \times 143$ (½) correct substitution = **<u>0·286 g or 0·29 g</u>** (½) (deduct half mark for missing or incorrect unit) NB If 24 l is used in 1st step (i) then answer is 0·572 g (worth 1½) **OR** moles of Cl_2 $\frac{0{\cdot}096}{24} = 0{\cdot}004$ (½) moles of $Ca(OCl)_2$ $\frac{0{\cdot}004}{2} = 0{\cdot}002$ (½) mass of $Ca(OCl)_2$ = 0·002 × <u>143 g</u> (½ for gfm) **<u>= 0·286 g</u>** (½) **2** (deduct half mark for missing or incorrect unit)		

Mark Scheme	Worth ½	Worth 0
(b)  **1** Accept full/shortened/partially shortened structural formulae		

Mark Scheme			Worth ½	Worth 0
6	**(a)**	 correct full/shortened/partially shortened structural formula **1**	butan-2-ol	
	(b)	triethanol amine has <u>hydrogen bonds</u> (½) (between the molecules) triisopropyl amine molecules has van der Waals/or permanent dipole/permanent dipole attractions or doesn't have H-bonds (½) H-bonds strong(er) (than the dipole/dipole) (½) more energy/higher temp required (to overcome/ break <u>intermolecular forces)</u> (½) **2**		

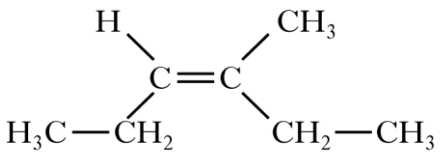
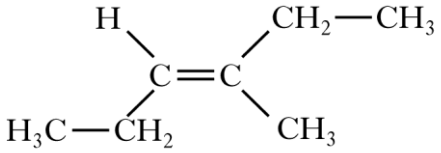
Mark Scheme			Worth ½	Worth 0
7	**(a)** $C_8H_9NO_2$ (any order)	**1**		
	(b) amino acids	**1**	Amines (½) Carboxylic/alkanoic acids (½) Thioethers (½) Sulphides (½) **NB Only one half mark available from this list**	protein
	(c) 0·0225 or 0·022 or 0·023 (can be rounded to 0·02 if working shown) deduct ½ for incorrect units	**1**	$\frac{0{\cdot}9}{1{\cdot}6} \times 0{\cdot}04$ (½)	265 0·02 with no working

Mark Scheme	Worth ½	Worth 0
8 (a)  **OR**  **1**	 (½)	Any structure containing greater or fewer atoms than in the answers shown to the left
Candidates may choose to start the repeating unit at any point along the polymer backbone The mark is for the correct structure of the repeating unit, disregard how the candidate has/hasn't chosen to draw any brackets, "n" etc.	If correct repeating unit shown, but without the open bonds at each end. ½	

Mark Scheme	Worth ½	Worth 0
(b) EITHER 1 mole glycerol → 1 mole ethane-1,2-diol 92 g → 62 g (½) 27·6 kg → 18·6 kg (½) theoretical yield % yield = $\frac{13{\cdot}4}{18{\cdot}6} \times 100$ (½) % yield = 72 % (½) **OR** moles of glycerol = $\frac{27600}{92}$ moles of glycerol = 300 (½) actual moles ethane-1,2-diol = $\frac{13400}{62}$ actual moles of ethane-1,2-diol = 216·13 (½) % yield = $\frac{216{\cdot}13}{300} \times 100$ (½) % yield = 72 % (½) **2**		% yield = $\frac{13{\cdot}4}{27{\cdot}6} \times 100$ **OR** % yield = 48·6%

Mark Scheme			Worth ½	Worth 0
9	**(a)**	Palm oil has lower degree of unsaturated/palm oil less unsaturated/palm oil more saturated/palm oil contains more saturates/fewer double bounds **OR** Molecules in palm oil can pack more closely together **1** "It" is taken to refer to Palm oil if ambiguous	Intermolecular forces stronger in palm oil (½) The are more intermolecular forces in palm oil (½)	
	(b)	Polyunsaturated **1**		
	(c)	Soap/emulsifying agent/detergent/washing/cleaning **1**		

Mark Scheme					Worth ½	Worth 0
10	**(a)**	**(i)**	$O_3 + 2KI + H_2O \rightarrow I_2 + O_2 + 2KOH$ (or any multiples of the above equation) (ignore state symbols)	**1 or 0**		
		(ii)	purple or blue/black or black or blue (only final colour required – ignore any initial colours)	**1 or 0**		Yellow/orange
	(b)		power supply/battery/lab pack (½) (dilute sulphuric) acid labelled (½) Method for collecting O_3 which would work (½) at positive electrode (½) (If gas being collected at both electrodes, to get this mark the diagram or text must clearly identify that ozone collected at positive electrode)	**2**	If a valid experiment which would produce and collect ozone is described in text, but no accompanying diagram, award **1 mark only**	AC power supply (no ½ for power supply) Text description- no diagram – doesn't work – **0 mark**

Mark Scheme			Worth ½	Worth 0
(c)	**(i)**	acidified dichromate (solution) **1 or 0**		Dichromate solution **(0)**
	(ii)		3 – methylhex – 3 – ene (½)	
		OR		
				
		Correct full/shortened/partially shortened structural formula		

Mark Scheme					Worth ½	Worth 0
11	**(a)**		Partially ionised/not completely dissociated	**1 or 0**		
	(b)	**(i)**	Contains more H^+ ions/higher concentration of H^+ ions	**1 or 0**	Because HCl is fully dissociated/ionised Because HCl has more ions	Because it is a strong acid
		(ii)	Because it is diprotic/dibasic/has two hydrogens Or balanced equations for the reactions Or sulphurous acid has more hydrogens Or sulphurous acid has a high power of hydrogen	**1 or 0**		Because sulphurous acid has more <u>H^+ ions</u>
		(iii)	pH = 13	**1**	1×10^{-13} OR $[H^+][OH^-] = 10^{-14}$	

Mark Scheme				Worth ½	Worth 0
12	**(a)**	Neutron to proton ratio (is unstable) proton to neutron ratio (is unstable) OR they have too many/few neutrons Wrong number of neutrons for number of protons	**1 or 0**		Answers mentioning numbers of electrons
	(b)	$^{131}_{53}I \rightarrow {}^{131}_{54}Xe + {}^{0}_{-1}e$ **(1)** $^{131}_{53}I \rightarrow {}^{131}_{54}Xe + {}^{0}_{-1}e^{-}$ **(1)** $^{131}I \rightarrow {}^{131}Xe + e^{-}$ **(1)** $^{131}I \rightarrow {}^{131}Xe + e$ **(1)** $^{131}I \rightarrow {}^{131}Xe + \beta$ **(1)**	**1 or 0**		
	(c)	**(i)** 8 days Deduct ½ for incorrect or missing unit	**1 or 0**		
		(ii) correct data from graph 70 (½) conversion to mole (÷ 131) $5{\cdot}343 \times 10^{-13}$ (½) use of $6{\cdot}02 \times 10^{23}$ (½) answer $3{\cdot}22 \times 10^{11}$ (ions) (½)	**2**	If convert to moles by dividing by GFM for sodium iodide (154) then $2{\cdot}74 \times 10^{11}$ 1½ mark $3{\cdot}321 \times 10^{11}$ 1½ (use RAM I) $3{\cdot}22 \times 10^{23}$ 1½ marks (using 70 g in place of 70 pg)	

Mark Scheme	Worth ½	Worth 0
13 **(a)** On addition of NaOH(s)… • OH^- react with H^+ (½) • concentration of H^+ decreases (½) • equilibrium position to shift to the left (½) • CrO_4^{2-} ion concentration increases (½) **2** [Any three from the list above for up to 1½] Final half mark for solution becomes more yellow/ less orange(½)		
(b) **(i)** Looking for two key points • mention of <u>washings/rinsings</u> (1) • make the (standard) flask up to the mark with water (1)/add water until desired volume reached **2**		

Mark Scheme	Worth ½	Worth 0
(ii) EITHER moles $FeSO_4$ $0{\cdot}02 \times 0{\cdot}0274 = 0{\cdot}000548$ (½) moles of CrO_4^{2-} $\frac{0{\cdot}000548}{3} = 0{\cdot}000183$ (½) Concentration of CrO_4^{2-} $\frac{0{\cdot}000183}{0{\cdot}050}$ (½) $= 0{\cdot}00365$ or $0{\cdot}004$ (mol l^{-1}) (½) **OR** Candidates may use a "titration" formula of which an example is shown below. $\frac{C_1V_1}{b_1} = \frac{C_2V_2}{b_2}$ For inserting the correct "stoichiometric" values in this equation award (½) [eg $b_1 = 1$ if $b_2 = 3$ if the student had decided to make substance "one" the CrO_4^{2-} ion] $\frac{C_1 \times 50{\cdot}0}{1} = \frac{0{\cdot}0200 \times 27{\cdot}4}{3}$ For inserting the correct pairings of concentrations and volumes (volumes can be in litres or in cm^3) (½) $C_1 = \frac{0{\cdot}0200 \times 27{\cdot}4}{3 \times 50{\cdot}0}$ For correct rearrangement (½) Concentration of $CrO_4^{2-} = 0{\cdot}00365$ (mol l^{-1})(½) **2**		

Mark Scheme				Worth ½	Worth 0
14	**(a)**	Answer within range -2640 to -2690 No units required	**1 or 0**		Answer within range 2640 to 2690
	(b)	E = mc∆T = 0·2 (½ mark) × 4·18 × 40 = 33·44 (½) 74 g gives 33·44 × 74 = 2475/2477 kJ Enthalpy of comb. = -2475/-2477 (1) (-½ if incorrect sign) No units required Deduct ½ for incorrect units	**2**		
	(c)	½ mark for each of the three correctly signed enthalpy change values +354 (½) -5 × 394 or -1970 (½) -6 × 286 or -1716 (½) Addition -3332 (½) Only award addition mark if three “sensible” values used. 3 sensible numbers required to get ½ for the addition based on follow through No units required Deduct ½ for incorrect units	**2**		

Mark Scheme				Worth ½	Worth 0
15	**(a)**	precipitation	**1 or 0**		
	(b)	compound Z is water, accept H_2O, steam, hydrogen oxide	**1 or 0**		
	(c)	**(i)** The chlorine gas produced during the electrolysis of cerium chloride can be recycled/ reused (back into stage 4) (in words or indicated on the flow diagram) a substance may be added to reduce the temperature at which $CeCl_3$ melts $CeCl_3$ can be electrolysed in solution (to avoid heating costs for $CeCl_3(\ell)$ electrolysis)	**1**		
		(ii) Q = It Q = 4000 × 10 × 60 Q = 2400000C (½) $Ce^{3+} + 3e^- \rightarrow Ce$ $\underline{3 \times 96500C}$ (½) → 140·1 g (½) 2400000 C → 1161·45 g or 1·16 kg (½) No units required Deduct ½ for incorrect units Accept answers of 1·16 or 1·2 without units for (2)	**2**	3·484 or 3484 g worth 1½ 0·019 or 19·4 g worth 1½	

Mark Scheme			Worth ½	Worth 0
16	**(a)** 3	**1**		
	(b) 0·204**(**°C**)** Also accept 0·2 **(**°C)	 **1**	0·51 × 0·1 × 4 (½)	

[END OF MARKING INSTRUCTIONS]