2013 Chemistry

Higher

Finalised Marking Instructions

Part One: General Marking Principles for Chemistry Higher

This information is provided to help you understand the general principles you must apply when marking candidate responses to questions in this Paper. These principles must be read in conjunction with the specific Marking Instructions for each question.

(a) Marks for each candidate response must always be assigned in line with these general marking principles and the specific Marking Instructions for the relevant question.

(b) Marking should always be positive ie, marks should be awarded for what is correct and not deducted for errors or omissions.

GENERAL MARKING ADVICE: Chemistry Higher

The marking schemes are written to assist in determining the “minimal acceptable answer” rather than listing every possible correct and incorrect answer. The following notes are offered to support Markers in making judgements on candidates’ evidence, and apply to marking both end of unit assessments and course assessments.

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.

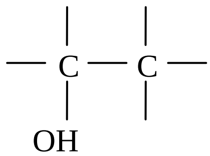
6 A half mark should be deducted for incorrect or missing units **only when stated in the marking scheme**. No marks should be deducted for incorrect or missing units at intermediate stages in a calculation.

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.

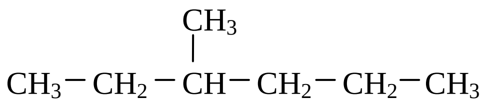
$$C_3H_8(g) + 5O_2(g) \longrightarrow 3CO_2(g) + 4H_2O(\ell)$$

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.

Part Two: Marking Instructions for each Question

Section A

Question			Acceptable Answer/s
1			A
2			C
3			B
4			B
5			D
6			A
7			D
8			C
9			B
10			A
11			B
12			C
13			D
14			C
15			D

Question			Acceptable Answer/s
16			D
17			A
18			A
19			C
20			B
21			D
22			B
23			D
24			B
25			C
26			A
27			D
28			B
29			A
30			A

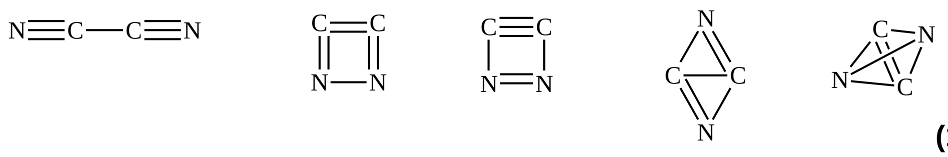
Question			Acceptable Answer/s
31			C
32			A
33			A
34			C
35			D
36			C
37			D
38			B
39			B
40			C

Question			Acceptable Answer/s	Max Mark	½ mark	Unacceptable
1	a		reforming / reformation	1		cracking
1	b		2,2,4-trimethylpentane **(1)** **or** isooctane **(1)** (General marking instruction 14 applies)	1		Octane 2,2-dimethyl-4-methylpentane
1	c		It has branches **(1)** **or** shorter chain **(1)**	1		Higher octane number Burns more smoothly Less prone to pre-ignition (& similar)
1	d		methanol toxic (or poisonous or makes you blind) **(1)** **or** CO_2 / CO emissions **(1)** **or** (burns to) produce greenhouse gases **(1)** **or** acidic emissions **(1)** **or** energy released by methanol is less than petrol **(1)** **or** fewer miles per gallon **(1)** **or** methanol is corrosive **(1)** **or** methanol is made from fossil fuels (or not renewable / limited) **(1)** **or** methanol is hygroscopic (absorbs water) **(1)** requires a bigger fuel tank **(1)**	1	Burns to produce harmful gases	Harmful to the environment (with no indication of how) Methanol is expensive

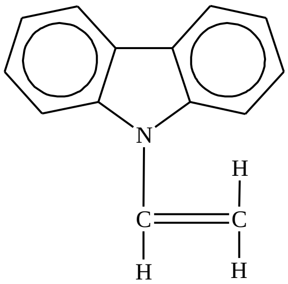
Question			Acceptable Answer/s	Max Mark	½ mark	Unacceptable
2	a		Purple/magenta/violet/lilac (pink) to colourless **(1)** **or** purple (pink) decolourises (disappears/goes away)) **(1)**	**1**	purple to clear or decolourises (with no mention of initial colour)	Indigo colourless to purple incorrect colour to colourless or purple to any colour purple/black or purple/blue
2	b	i	58 (^{o}C) (units not required. Incorrect units –½ mark)	**1**	Calculation of relative rate r = 1/25 = 0·04 **(½)** or 57 or 59 ^{o}C **(½)** or Reading the temperature associated with a calculated relative rate correctly from graph **(½)**	
2	b	ii	(colour) change too gradual (or similar) **(1)** **or** the colour changes too slowly **(1)** **or** end-point too difficult to see **(1)**	**1**		Reaction is too slow too cold/cool or does not react these temperatures not on graph
2	c		More molecules (particles) have <u>enough energy to collide successfully</u> **(1)** more molecules have <u>sufficient</u> energy to react **(1)** more molecules with (kinetic) energy <u>greater than the activation energy</u> **(1)** more molecules form the activated complex (1)	**1**	molecules collide with greater energy/force (harder) **(½)** more successful collisions **(½)**	more collisions molecules collide more often molecules move faster more energy with no mention of collisions or E_a

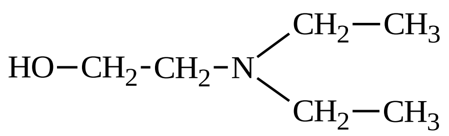
Question			Acceptable Answer/s	Max Mark	½ mark	Unacceptable
3	**a**		$3Al + 3NH_4ClO_4 \rightarrow Al_2O_3 + AlCl_3 + 3NO + 6H_2O$ (accept multiples and fractions)	**1**		
3	**b**		0·255 (g) or 0·26 (g) **(2)** (units not required. Incorrect units – ½ mark) 0·51 (g) **(1½)** Looking for four marking points for partial marking for use of $6{\cdot}02 \times 10^{23}$ / L **(½)** for recognition that there are $2Al^{3+}$ in each Al_2O_3 **(½)** for correct use of mass of one mole Al_2O_3 **(½)** for correct calc. of final mass Al_2O_3 **(½)** Examples <u>Method One</u> moles of Al^{3+} ions = $3{\cdot}01 \times 10^{21}$ $\underline{\div 6{\cdot}02 \times 10^{23}}$ **(½)** = 0·0050 moles of Al_2O_3 = 0·005 $\underline{\div 2}$ **(½)** = 0·0025 mass of Al_2O_3 = 0·0025 × <u>102·0</u> **(½)** = <u>0·255</u> g **(½)** <u>Method Two</u> Al^{3+} ions ↔ Mass of Al_2O_3 2 **(½)** × $6{\cdot}02 \times 10^{23}$ **(½)** ↔ 102·0 **(½)** 1 ↔ $\dfrac{102{\cdot}0}{2 \times 6{\cdot}02 \times 10^{-23}}$ $3{\cdot}01 \times 10^{21}$ ↔ $3{\cdot}01 \times 10^{21} \times \dfrac{102{\cdot}0}{2 \times 6{\cdot}02 \times 10^{-23}}$ $3{\cdot}01 \times 10^{21}$ ↔ <u>0·255</u> g **(½)**	**2**		

Question			Acceptable Answer/s	Max Mark	½ mark	Unacceptable
4	**a**	**i**	$K(g) \rightarrow K^+(g) + e^-$ **(1)** $K(g) \rightarrow K^+(g) + e$ **(1)**	**1**		Missing or incorrect state symbols
4	**a**	**ii**	Answers can be given either in terms of potassium or of chlorine Answers starting with "it" are assumed to refer to Potassium **Either** K has more shells/levels **or** electron further from nucleus or diagram showing this **(½)** Correct and clear use of greater shielding/screening (or clear explanation thereof) **(1)** So less energy required to remove electron /weaker attraction for the electron **(½)** **or** Cl has fewer shells **or** electron closer to nucleus **(½)** Correct and clear use of less shielding/screening (or clear explanation thereof) **(1)** So more energy required to remove electron / stronger attraction for the electron **(½)**	**2**		
4	**b**		8	**1**		Circling OH groups but not stating the number

Question			Acceptable Answer/s	Max Mark	½ mark	Unacceptable
5	a		Any reasonable molecular structure consisting of two carbon and two nitrogen atoms in which each carbon forms four bonds and each nitrogen three bonds. For example  **(1)**	1		
5	b		Method for removal of carbon dioxide <u>which would work</u> (*eg* by bubbling through lime-water or any alkaline solution or passing over soda lime or lithium oxide etc.If the liquid is not labelled, assume it is NaOH as mentioned in the question) **(1)** Method for collection and <u>measurement</u> of gas which would work (*eg* in gas syringe or in an upturned measuring cylinder over water) **(1)** Do not award marks if delivery tube passes through the sides of measuring cylinders and beakers	2	Full 2 marks cannot be awarded unless the method would successfully measure the volume of <u>nitrogen</u>.	

Question			Acceptable Answer/s	Max Mark	½ mark	Unacceptable
6	**a**		Student wording may vary, markers should be looking for the key ideas expressed below. Trichloromethane is polar **or** tetrachloromethane is non-polar **(½)** trichloromethane is capable of forming (permanent) dipole/(permanent) dipole attractions **(½)** tetrachloromethane is only capable for forming Van der Waal's/London Dispersion Forces **(½)** water is polar solvent/forms (permanent) dipole/(permanent) dipole bonds/like dissolves like/is a good solvent for polar substances **(½)**	**2**		There is hydrogen bonding in water Trichloromethane or tetrachloromethane has polar (covalent) bonds- if mentioned without further explanation
6	**b**		absorbs (harmful) <u>UV</u> **or** reduces (or stops) <u>UV</u> reaching earth **or** protects (us) from <u>UV</u> **or** filters the UV	**1**		absorbs rays (or light) from Sun **or** anything to do with greenhouse effect **or** IR **or** absorbs harmful radiation **or** reflects (harmful) UV

Question			Acceptable Answer/s	Max Mark	½ mark	Unacceptable
7	a		Tollen's **or** acidified dichromate **or** fehling's **or** benedict's (accept other spellings if phonetically correct)	**1**		
7	b	i	8	**1**		
7	b	ii	Oxidation / oxidisation	**1**		
8	a		 Do not penalise for transcription errors in the carbazole part of the molecule.	**1**		
8	b		in photocopiers **or** in laser printers **or** as a photoconductive (material) **or** as something that conducts electricity when light shines on it **or** in light sensors **or** used in solar cells **or** solar powered calculators **or** any photoluminescent/ electroluminescent device **or** application Poly(vinylcarbazole) films give out a steady blue glow when an electric current is passed through them, but produce no heat, so have now found a lot of applications in illuminated signage etc.)	**1**		Photography calculators

Question			Acceptable Answer/s	Max Mark	½ mark	Unacceptable
9	a		Ethane-1,2-diol contains two/more –OH groups **or** ethane-1,2-diol forms more/ stronger hydrogen bonds **or** more energy needed to break the hydrogen bonds	1	Stronger intermolecular forces (no mention of type) **or** More energy needed to break <u>intermolecular</u> bonds (no mention of type)	Ethane-1,2-diol has larger molecular mass Ethane-1,2-diol has stronger van der Waal's interactions/ London Dispersion Forces
9	b		2-methylbut-2-ene or methylbut-2-ene	1		2-methylbutene methylbutene
9	c		benzene-1,3-dicarboxylic (acid)	1		benzenedicarboxylic acid 1,3-dicarboxybenzoic acid benzene-1,3-dicarboyl
10	a	i	amino group or amine group	1		amino acid group NH_2 group amide
10	a	ii	 Accept full or shortened structural formula. (general marking instruction 9 applies)	1		
10	b		25 (minutes) **or** 8·0 to 8·4 (minutes) (units not required. Ignore incorrect units)	1		

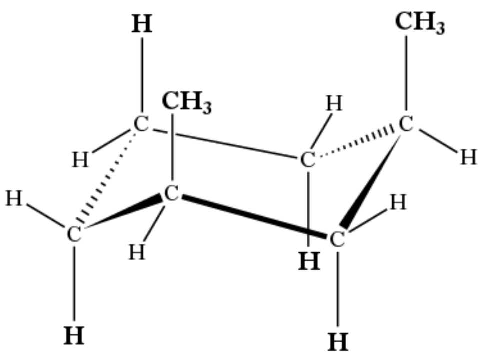
Question			Acceptable Answer/s	Max Mark	½ mark	Unacceptable
11	**a**		esterification or condensation	**1**		Ester exchange Condensation polymerisation
11	**b**		<u>Two common methods</u> 1 mol salicylic acid → 1 mol aspirin 138 g → 180 g 5·02 g → $\frac{180}{138} \times 5{\cdot}02$ **(½)** ⇒ Theoretical yield = 6·55 g **(½)** ⇒ % yield = $\frac{2{\cdot}62}{6{\cdot}55} \times 100$ **(½)** = 40% **(½)** 1 mol salicylic acid → 1 mol aspirin Number of moles of salicylic acid = 5.02/138 = 0.0364 (½) Number of moles of aspirin = 2.62 / 180 = 0.0146 (½) % yield = 0.0146 / 0.0364 x 100 (½) = 40 % (½)			% yield = $\frac{2{\cdot}62}{5{\cdot}02} \times 100$ **(0)** 52 % **(0)**
11	**c**		(It is a salt of a) strong base and a weak acid **or** a valid explanation of the equilibria involved	**1**	(aspirin) is weak acid **(½)** NaOH is a strong base **(½)** Can award both half marks	More OH^- than H^+ Ethanoic acid is a weak acid Excess OH^- ions
12	**a**		Mass number: 0 Atomic number: 1 **1 or 0** (Also accept 1/1760 or 1/1800 for mass number)	**1**		Atomic number of -1
12	**b**		$2{\cdot}52 \times 10^9$ years	**1**	Indication that two half lives have passed **(½)**	

Question			Acceptable Answer/s	Max Mark	½ mark	Unacceptable
13	**a**	**i**	Partially dissociated **(1)** **or** Not completely ionised **(1)**	**1**		
13	**a**	**ii**	Equilibrium would shift to right/forward **or** More products formed	**1**	NH_3 reacts with H^+	
13	**b**		0·29 g **(2)** 0·29 **(1½)** 290 g **(1½)** (79 cm^3 not converted into litres) 290 **(1)** <u>Units are required</u>, deduct ½ mark for missing or incorrect units <u>Method one</u> moles H_2S = $\frac{0{\cdot}079}{24}$ or 0·00329 **(½)** moles FeS = 0·00329 GFM FeS = 87·9 g **(½)** mass FeS = 87·9 × 0·00329 **(½)** mass Fe S = 0·29 g ½ mark <u>Method two</u> $\frac{\text{Vol. } H_2S}{24}$ $\frac{\text{Mass FeS}}{87{\cdot}9}$ **(½)** 1 $\frac{87{\cdot}9}{24}$ **(½)** 0·079 $\frac{87.9}{24}$ × 0·079 **(½)** 0·079 0·29 g **(½)**	**2**		

Question			Acceptable Answer/s	Max Mark	½ mark	Unacceptable
14	a	i	synthesis gas **(1)** **or** syngas **(1)**	**1**		Synthetic gas
14	a	ii	(+)206 (kJ mol^{-1} or kJ or KJ mol^{-1}) (2) (units not required, deduct ½ mark for incorrect units)	**2**	–803 **(½)** +726 **(½)** +283 **(½)** Further ½ mark for correct addition of three sensible numbers A final value of -206 is worth a total of ½ mark	
14	b		temperature: decrease/keep the same/increase pressure: decrease/keep the same/increase **(1)** for correct selection of both terms	**1**	½ for each correctly circled option	
15	a		$mc\Delta T$ = 0·050 × 4·18 × 4·5 (½ for 0·050 & ½ for other values) = ± 0·94 kJ (sign and units not required at this stage) Or $mc\Delta T$ = 50 × 4·18 × 4·5 (½ for 50 & ½ for other values) = ± 940 J (units not required at this stage) (Deduct ½ mark if incorrect units are given here only if this is the end of the candidate's answer) H_2O moles = 0·025 (½ for working out moles of water) ⇒ 0·025 mol ↔ ±0·94 kJ ⇒ 1 mol ↔ $\frac{\pm 0{\cdot}94}{0{\cdot}025}$ = ±38 kJ mol^{-1} **(½)** (Units not required, deduct ½ mark for incorrect units in the final answer) (Do not deduct ½ mark if negative sign missing from final answer)	**2**		

Question			Acceptable Answer/s	Max Mark	½ mark	Unacceptable
15	**b**		Lid added / use polystyrene (plastic) cup / insulate beaker / closed container heatproof container	**1**		Use a copper can Use a draught shield Use a digital thermometer Cotton wool plug
15	**c**		Initial temperature of (both) solutions **or** the average start temperature **(½)** Maximum/final/end temperature (of mixture) **(½)**	**1**		
16	**a**		$I_2 + 2e^- \rightarrow 2I^-$ **(1)** **or** $I_2 + 2e \rightarrow 2I^-$ **(1)** Ignore state symbols Allowing reversible arrows providing the equation is written the correct way round.	**1**		
16	**b**	**i**	first titre is a rough (or approximate) result / practice **or** first titre is not accurate / not reliable / rogue **or** first titre is too far away from the others **or** you take average of concordant/close results **(1)**	**1**		

Question			Acceptable Answer/s	Max Mark	½ mark	Unacceptable
16	b	ii	0·045 or 0·05 (mol l^{-1}) <u>if working correct</u> **(2)** **Either** moles S_2O_3 $0{\cdot}10 \times 0{\cdot}01815 = 0{\cdot}001815$ **(½)** moles of I_2 $\dfrac{0{\cdot}001815}{2} = 0{\cdot}0009075$ **(½)** concentration I_2 $\dfrac{0{\cdot}0009075}{0{\cdot}0200}$ **(½)** concentration I_2 0·045 **(½)** (units not required, deduct ½ mark for incorrect units) **or** Candidates may use a "titration" formula of which an example is shown below. $\dfrac{c_1V_1}{b_1} = \dfrac{c_2V_2}{b_2}$ For inserting the correct "stoichiometric" values in this equation award **(½)** [eg $b_1 = 1$ if $b_2 = 2$ if the student had decided to make substance "one" iodine] For inserting the correct pairings of concentrations and volumes (volumes can be in litres or in cm^3) **(½)** $\dfrac{c_1 \times 20}{1} \quad \dfrac{0{\cdot}10 \times 18{\cdot}15}{2}$ For correct rearrangement **(½)** $c_1 = \dfrac{0{\cdot}10 \times 18{\cdot}15 \times 1}{2 \times 20}$ concentration I_2 0·045 **(½)** (units not required, deduct ½ mark for incorrect units)			0·04 with no working because can be arrived at from 0·020 litres × 2

Question			Acceptable Answer/s	Max Mark	½ mark	Unacceptable
17	**a**		Q = It $Q = 0{\cdot}5 \times 2 \times 60 \times 60$ Q = 3600C **(½)** Charge → Mass of Pb 2×96500C **(½)** → 207·2 g **(½)** 3600 C → 3·86 g **(½)** (No units required – deduct ½ for incorrect units)	**2**		
17	**b**		$PbO_2(s) + SO_4^{2-}(aq) + \mathbf{4H^+ + 2e^-} \rightarrow PbSO_4(s) + \mathbf{2H_2O}$ Ignore state symbols. Ignore missing charge on electron.	**1**		Equations with H with no positive charge
18	**a**		 **or** equivalent 1,3-dimethylcyclohexane structure with both methyl groups in axial positions **Suspend General Marking Instruction 10 for this question**	**1**		Structures with missing H-atoms Any structure with a methyl group in the equatorial position.

Question			Acceptable Answer/s	Max Mark	½ mark	Unacceptable
18	**b**	**i**	The bigger the group the greater the strain **or** The larger the (halogen) atom the greater the strain **or** The more atoms in a group, the greater the strain **or** Any other statement which is consistent with the values presented	**1**		Incorrect reference to a group as a "molecule"
18	**b**	**ii**	7·6 (kJ mol^{-1}) (Units not required, ignore incorrect units)	**1**		

[END OF MARKING INSTRUCTIONS]