General Certificate of Education (A-level)
June 2013

Chemistry CHEM1

(Specification 2420)

Unit 1: Foundation Chemistry

Final

Mark Scheme

Mark schemes are prepared by the Principal Examiner and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all examiners participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the candidates' responses to questions and that every examiner understands and applies it in the same correct way. As preparation for standardisation each examiner analyses a number of candidates' scripts: alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, examiners encounter unusual answers which have not been raised they are required to refer these to the Principal Examiner.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of candidates' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

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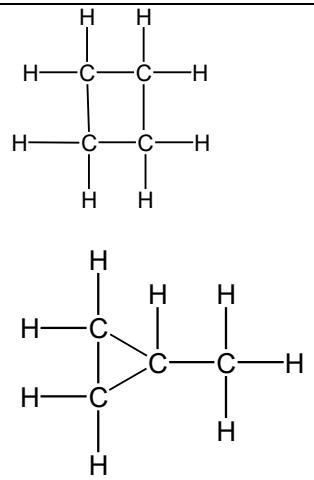
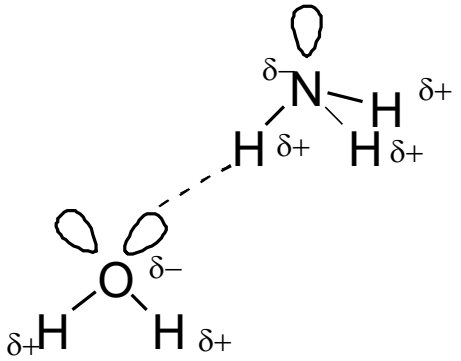
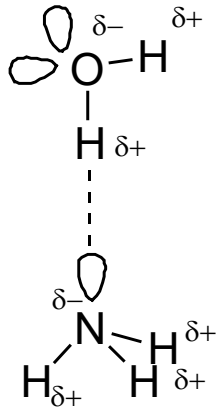
Question	Marking Guidance	Mark	Comments
1(a)	<u>Average/mean mass of 1 atom (of an element)</u> 1/12 mass of one atom of ^{12}C ***OR*** <u>Average/mean mass of atoms of an element</u> 1/12 mass of one atom of ^{12}C ***OR*** <u>Average/mean mass of atoms of an element x12</u> mass of one atom of ^{12}C ***OR*** <u>(Average) mass of one mole of atoms</u> 1/12 mass of one mole of ^{12}C ***OR*** <u>(Weighted) average mass of all the isotopes</u> 1/12 mass of one atom of ^{12}C ***OR*** Average mass of an atom/isotope (compared to C-12) on a scale in which an atom of C-12 has a mass of 12	1 1	If moles and atoms mixed, max = 1 Mark top and bottom line independently. All key terms must be present for each mark. This expression = 2 marks.
1(b)	$\frac{(70x3) + (72x4) + 73 + (74x5)}{13} = \frac{941}{13}$ $= \underline{72.4}$	1 1 1	72.4 only.
1(c)	$^{(72)}\underline{Ge^+}$ or <u>germanium$^+$</u>	1	Must show ‘+’ sign. Penalise wrong mass number.

1(d)	70 Lowest mass / lowest m/z	1 1	If M1 incorrect or blank CE = 0/2 Ignore symbols and charge even if wrong. Accept lightest. Accept fewest neutrons.
1(e)	Electron(s) transferred / flow (at the detector) (From detector / plate) to the (+) ion	1 1	M1 must refer to electron flow at the detector. If M1 incorrect CE = 0/2 Do not allow from a charged plate.
1(f)	They do not have the same electron configuration / they have different number of electrons (in the outer shell)	1	Ignore electrons determine the properties of an atom. Ignore they are different elements or different number of protons.

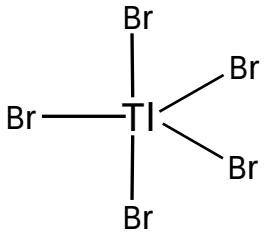
Question	Marking Guidance	Mark	Comments
2(a)(i)	(Compounds with the) same molecular formula But different structural formula / different displayed formula/different structures / different skeletal formula	1 1	Allow same number and type of atom for M1 Ignore same general formula. M2 dependent on M1 Not different positions of atoms/bonds in space.
2(a)(ii)	But-2-ene	1	Allow but-2-ene. Allow but 2 ene. Ignore punctuation.
2(a)(iii)	(2)-methylprop-(1)-ene	1	Do not allow 2-methyleprop-1-ene.
2(a)(iv)		1	Do not allow skeletal formulae. Penalise missing H and missing C
2(b)(i)	$C_4H_8 + 2O_2 \rightarrow 4C + 4H_2O$	1	Accept multiples.

2(b)(ii)	Exacerbates asthma / breathing problems / damages lungs / smog / smoke / global dimming	1	Ignore toxic / pollutant / soot / carcinogen. Do not allow greenhouse effect / global warming / acid rain / ozone.
2(c)(i)	$C_{16}H_{34}$	1	Allow $H_{34}C_{16}$ C and H must be upper case.
2(c)(ii)	Jet fuel / diesel / (motor) fuel / lubricant / petrochemicals / kerosene / paraffin / central heating fuel / fuel oil	1	Ignore oil alone. Not petrol / bitumen / wax / LPG / camping fuel.
2(d)(i)	$C_8H_{18} + 25NO \rightarrow 8CO_2 + 12.5\ N_2 + 9H_2O$	1	Accept multiples.
2(d)(ii)	Ir / iridium ***OR*** Pt / platinum ***OR*** Pd / palladium ***OR*** Rh / rhodium	1	

Question	Marking Guidance	Mark	Comments
3(a)	Giant covalent / giant molecular / macromolecular	1	Not giant alone. Not covalent alone.
3(b)	Shared pair of electrons / one electron from each C atom	1	
3(c)	No delocalised / free / mobile electrons	1	Allow all (outer) electrons involved in (covalent) bonds. Ignore ions.
3(d)	CH	1	Allow HC C and H must be capital letters.

Question	Marking Guidance	Mark	Comments
4(a)	Hydrogen bonding / hydrogen bonds / H-bonding / H-Bonds	1	Not just hydrogen.
4(b)	 ***OR*** 	3	One mark for minimum of 4 correct partial charges shown on the N-H and O-H One mark for the 3 lone pairs. One mark for H bond from the lone pair on O or N to the $H^{\delta+}$ The N-H-O should be linear but can accept if the lone pair on O or N hydrogen bonded to the $H^{\delta+}$ If wrong molecules or wrong formula, CE = 0/3

4(c)	(Phosphine) does not form hydrogen bonds (with water)	1	

Question	Marking Guidance	Mark	Comments
5(a)	$Al + 1.5Cl_2 \rightarrow AlCl_3$	1	Accept multiples. Also $2Al + 3Cl_2 \rightarrow Al_2Cl_6$ Ignore state symbols.
5(b)	Coordinate / dative (covalent) Electron pair on Cl^- donated to Al(Cl_3)	1 1	If wrong CE=0/2 if covalent mark on. QoL Lone pair from Cl^- not just Cl Penalise wrong species.
5(c)	Al_2Cl_6 or $AlBr_3$	1	Allow Br_3Al or Cl_6Al_2 Upper and lower case letters must be as shown. Not $2AlCl_3$
5(d)	$SiCl_4$ / silicon tetrachloride	1	Accept silicon(4) chloride or silicon(IV) chloride. Upper and lower case letters must be as shown. Not silicon chloride.
5(e)	 Trigonal bipyramid(al)	1 1	Accept shape containing 5 bonds and no lone pairs from Tl to each of 5 Br atoms. Ignore charge.

5(f)(i)	Cl—— Tl —— Cl	1	Accept this <u>linear</u> structure only with no lone pair on Tl

5(f)(ii)	(Two) bonds (pairs of electrons) repel equally / (electrons in) the bonds repel to be as far apart as possible	1	Dependent on linear structure in 5(f)(i). Do not allow electrons /electron pairs repel alone.

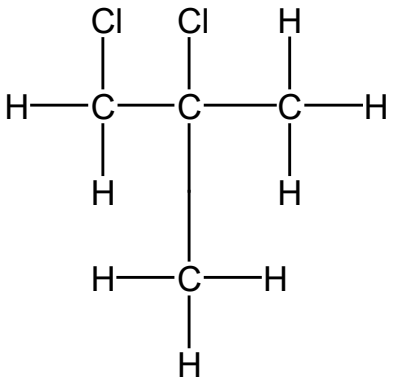
5(g)	Second	1	

Question	Marking Guidance	Mark	Comments
6(a)	Carbon / C	1	If M1 incorrect, CE = 0/3
	Fewest protons / smallest nuclear charge / least attraction between protons (in the nucleus) and electrons / weakest nuclear attraction to electrons	1	Allow comparative answers. Allow converse answers for M2
	Similar shielding	1	Allow same shielding.
6(b)	<u>Increase</u>	1	
	Oxygen / O	1	If not oxygen, then cannot score M2, M3 and M4
	<u>Paired</u> electrons in a (2)<u>p</u> orbital	1	If paired electrons in incorrect p orbital, lose M3 but can award M4
	(Paired electrons in a p orbital) repel	1	
6(c)	$C(g) \rightarrow C^{+}(g) + e^{(-)}$ ***OR*** $C(g) + e^{(-)} \rightarrow C^{+}(g) + 2e^{(-)}$ ***OR*** $C(g) - e^{(-)} \rightarrow C^{+}(g)$	1	Ignore state symbols for electron.
6(d)	(More energy to) remove an electron from a (more) positive ion / cation	1	Allow electron closer to the nucleus in the positive ion.
6(e)	Lithium / lithium / Li	1	If formula given, upper and lower case letters must be as shown.

Question	Marking Guidance		Mark	Comments
7(a)	Method 1	Method 2		
	Mass of H_2O = 4.38-2.46 (= 1.92 g)	Percentage of H_2O = 44%	1	If there is an AE in M1 then can score M2 and M3 If M_r incorrect can only score M1
	$ZnSO_4$ H_2O $\frac{2.46}{161.5}$ $\frac{1.92}{18}$ (0.0152 0.107) (1 : 7)	ZnSO4 H2O $\frac{56}{161.5}$ $\frac{44}{18}$ (0.347 2.444) (1 : 7)	1	
	x = 7	x = 7	1	If x = 7 with working then award 3 marks. Allow alternative methods. If M1 incorrect due to AE, M3 must be an integer.
7(b)	Moles HCl = 0.12(0)		1	
	mol $ZnCl_2$ = 0.06(0) ***OR*** 0.12 / 2		1	If M2 incorrect then CE and cannot score M2, M3 and M4.
	mass $ZnCl_2$ = 0.06 × 136.4		1	Allow 65.4 + (2 × 35.5) for 136.4
	= 8.18(4) (g) ***OR*** 8.2 (g)		1	Must be to 2 significant figures or more. Ignore units.

7(c)	Moles $ZnCl_2$ = $\frac{10.7}{136.4}$ (= 0.0784) ***OR*** moles Zn = 0.0784 Mass Zn reacting = 0.0784 × 65.4 = (5.13 g) % purity of Zn = $\frac{5.13}{5.68}$ × 100 = 90.2% ***OR*** 90.3%	1 1 1 1	 M2 is for their M1 × 65.4 M3 is M2 × 100 / 5.68 provided M2 is < 5.68 Allow alternative methods. M1 = Moles $ZnCl_2$ = $\frac{10.7}{136.4}$ (= 0.0784) M2 = Theoretical moles Zn = $\frac{5.68}{65.4}$ (= 0.0869) M3 = M1 × 100 / M2 = (0.0784 × 100 / 0.0869) M4 = 90.2% ***OR*** 90.3%

7(d)	Ionic Strong (electrostatic) attraction (between ions) between oppositely charged ions / + and – ions / F^- and Zn^{2+} ions	1 1 1	If not ionic CE = 0/3 If IMF, molecules, metallic bonding implied CE = 0/3

Question	Marking Guidance	Mark	Comments
8(a)	2-bromo-2,3-dimethylbutane	1	Ignore punctuation.
	$C_nH_{2n+1}Br$ or $C_nH_{2n+1}X$ or $C_xH_{2x+1}Br$	1	Any order.
	Stronger / more <u>vdw</u> (forces) <u>between molecules</u>	1	QoL
	(of 1-bromohexane)		Allow converse arguments for Z
			Not just more IMF.
			Ignore size of molecule.
8(b)		1	
	C_2H_4Cl	1	Any order.

General principles applied to marking CHEM1 papers by CMI+ (June 2013)

It is important to note that the guidance given here is generic and specific variations may be made in the mark scheme.

Basic principles

- **Examiners should note that throughout the mark scheme, items that are underlined are required information to gain credit.**
- **Occasionally a response involves incorrect chemistry and the mark scheme records CE = 0, which means a chemical error has occurred and no credit is given for that section of the clip or for the whole clip.**

The "List principle" and the use of "ignore" in the mark scheme

If a question requires **one** answer and a candidate gives two answers, no mark is scored if one answer is correct and one answer is incorrect. There is no penalty if both answers are correct.

N.B. Certain answers are designated in the mark scheme as those that the examiner should "Ignore". These answers are not counted as part of the list and should be ignored and will not be penalised.

Incorrect case for element symbol

The use of an incorrect case for the symbol of an element should be penalised **once only** within a clip.

For example, penalise the use of "h" for hydrogen, "CL" for chlorine or "br" for bromine.

Spelling

In general

- The names of organic chemical compounds and functional groups **must be spelled correctly,** when specifically asked for, to gain credit.
- Phonetic spelling may be acceptable for some chemical compounds (e.g. amonia would be phonetically acceptable. However, ammoniam would be unacceptable since it is ambiguous).

N.B. Some terms may be required to be spelled correctly or an idea needs to be articulated with clarity, as part of the "Quality of Language" (**QoL**) marking. These will be identified in the mark scheme and marks are awarded only if the QoL criterion is satisfied.

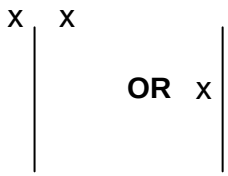
Equations

In general

- Equations **must** be balanced.
- State symbols are <u>generally</u> ignored, unless specifically required in the mark scheme

Lone Pairs

The following representations of lone pairs in structures are acceptable.

 with or without the 2 electrons shown **OR**  **OR** x x **OR** x x **OR** 

Reagents

The command word “Identify”, allows the candidate to choose to use **either** the name or the formula of a reagent in their answer. In some circumstances, the list principle may apply when the name and formula contradict. Specific details will be given in mark schemes.

Marking calculations

In general

- A correct answer alone will score **full marks** unless the necessity to show working is specifically required in the question.
- If a candidate has made an arithmetical error or a transcription error deduct one mark, but continue marking (error carried forward).

Organic structures

In general

- Displayed formulae must show all of the bonds and all of the atoms in the molecule, but need not show correct bond angles.
- Bonds should be drawn correctly between the relevant atoms.
- Latitude should be given to the representation of C ─ C bonds in structures, given that CH_3─ is considered to be interchangeable with H_3C─ even though the latter would be preferred.

- The following representations are allowed:-