Version 2

General Certificate of Education (A-level)
January 2011

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)	Water or H_2O or molecules (in ice) are held further apart (than in liquid water)/(more) space/gaps/holes in structure/ Water or H_2O or molecules (in ice) are more spread out	1	Allow water (liquid) is more compact / less space/gaps/holes CE if holes filled with air, O_2 etc CE if macromolecule CE if atoms further apart (since ambiguous) Ignore spaces filled with H_2O Ignore reference to H bonds Allow better tessellation in liquid water
1(b)(i)	Hydrogen bonding	1	Allow H bonds Do not allow 'hydrogen' only but mark on
1(b)(ii)	Van der Waals' / VdW	1	Allow London forces, dispersion forces, temporary induced dipole forces

1(b)(iii)	Hydrogen bonding is stronger (than van der Waals forces) / IMF in ice stronger (than IMF in methane)/ H bonds take more energy to break	1	Not H Bonds are strong (needs comparison)
			If (b)(i) OR (ii) is incorrect, cannot award (b)(iii)
			If (b)(i) and /or (ii) is blank, can score (b)(iii)

1(c)(i)	Structure showing 3 bonds to H and 1 lone pair (trigonal) pyramid(al) /(distorted) tetrahedral	1 1	do not insist on the + sign Allow triangular pyramid Not square pyramid Ignore bond angles in structure M2 independent of M1
1(c)(ii)	107°	1	Allow range106 - 108° Ignore ° (C)
1(c)(iii)	NH_3 /ammonia	1	Contradictions (eg NH_4 ammonia) CE = 0
1(d)	3	1	Allow three/ III/ 3 lone pairs/ 3lp/ 3 lone pairs of electrons

Question	Marking Guidance	Mark	Comments
2(a)	$\underline{4d^{10}\,5s^2\,5p^1}$ in any order	1	Allow subscripts for numbers Allow capitals
2(b)(i)	Using an electron gun / (beam of) high energy/fast moving electrons	1	Ignore 'knocks out an electron'
2(b)(ii)	$In(g) + e^- \rightarrow In^+(g) + 2e^-$ ***OR*** $In(g) \rightarrow In^+(g) + e^-$ $In(g) - e^- \rightarrow In^+(g)$	1	The state symbols need not be present for the electron- but if they are they must be (g) No need to show charge on electron If I CE = 0 Ignore any equations using M
2(b)(iii)	So no more than 1 electron is knocked out/ so only one electron is knocked out/ prevent further ionisation	1	Allow stop 2+ and 3+/other ions being formed Not to get wrong m/z
2(b)(iv)	Any two processes from • Accelerate (owtte) • Deflect (owtte) • Detect (owtte)	2 max	Ignore wrong causes of process

2(c)(i)	<u>Average/mean mass of (1) atom(s) (of an element)</u> 1/12 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	Not average mass of 1 molecule Allow the wording Average mass of 1 atom of an element compared to 1/12 mass atom of ^{12}C (or mass 1/12 atom of ^{12}C) Allow if moles of atoms on both lines Accept answer in words Can have top line x 12 instead of bottom line ÷12 If atoms/moles mixed, max = 1
2(c)(ii)	$\frac{113x + 115y}{x + y} = 114.5$ ratio (113:115) = 1:3 **OR** 25:75 **OR** 0.5:1.5 etc	1 1	Allow idea that there are 4 x 0.5 divisions between 113 and 115 Correct answer scores M1 and M2 If 1:3 for In(115): In(113), max = 1
2(d)	None Same no of electrons (in the outer shell)/same electron configuration	1 1	 Ignore electrons determine chemical properties/ ignore protons M2 dependent on M1 being correct

2(e)	29.0% /29% O $\frac{69.2}{114.8/114.5}$ $\frac{1.8}{1}$ $\frac{29.0}{16}$ or 0.603 1.8 1.81 1 3 3 EF = In H_3O_3	1 1 1	If no O calculated, allow M2 if In and H divided by the correct A_r Allow $In(OH)_3$ Do not allow last mark just for ratio 1:3:3 If InO_3H_3 given with no working then allow 3 marks If I not In, lose M3

Question	Marking Guidance	Mark	Comments
3(a)(i)	$\underline{4.98 \times 10^{-3}}$	1	Only
3(a)(ii)	2.49×10^{-3}	1	Allow answer to 3(a)(i) ÷ 2 Allow answers to 2 or more significant figures
3(a)(iii)	2.49×10^{-2}	1	Allow 3(a)(ii) x 10 Allow answers to 2 or more significant figures
3(a)(iv)	138.2	1	3.44 divided by the candidate's answer to 3(a)(iii) 138.2 or 138.1 (i.e. to 1 d.p.)
3(a)(v)	(138 - 60) ÷ 2 = 39.1 K/ potassium	1 1	Allow 39 – 39.1 Allow ((a)(iv) – 60) ÷ 2 Allow consequential on candidate's answer to a(iv) and a(v) if a group 1 metal Ignore + sign

3(b)	PV = n RT or rearranged $T = \frac{0.022 \times 100000}{0.658 \times 8.31}$ 402(.3) K (or 129 ^{0}C)	1 1 1	If incorrectly rearranged CE = 0 Correct M2 also scores M1 allow 402- 403K or 129- 130^{0}C do not penalise ^{0}K M3 must include units for mark
3(c)	Pressure build up from gas/ may explode/ stopper fly out/glass shatters/breaks	1	Penalise incorrect gas
3(d)(i)	M_r =84.3 $\frac{6.27}{}$ = 0.074(4) 84.3	1 1	If 84 used, max 1 CE if not 84 or 84.3 Allow answers to 2 or more significant figures M2 = 0.074-0.075
3(d)(ii)	M1 M_r $MgSO_4$ = 120(.4) M2 Expected mass $MgSO_4$ =0.074(4) x120(.4)= 8.96 g M3 95% yield = $\frac{8.96 \times 95}{100}$ = 8.51 g Alternative method M2 0.074(4) x 95/100 = 0.0707 M3 0.0707 x 120(.4) = 8.51 g	1 1 1	allow 120.3 and 120.1 CE if wrong *M*r Allow 8.8 – 9.0 or candidate's answer to 3(d)(i) x 120(.4) Allow 8.3 – 8.6 M3 dependent on M2 Allow 3d(i) x 95/100 Allow 8.3 – 8.6 M3 dependent on M2

Question	Marking Guidance	Mark	Comments
4(a)	$C_{16}H_{34} + 24.5O_2 \rightarrow 16CO_2 + 17H_2O$	1	Allow multiples Ignore state symbols in equation
4(b)	Solidifies/freezes/goes viscous/waxing occurs	1	Allow does not vapourise/ less volatile Lack of Oxygen = 0 Apply list principle
4(c)(i)	$N_2 + O_2 \rightarrow 2NO$ Spark/ (very) high temp/ 2500 ^{o}C – 4000 ^{o} C	1 1	Allow multiples/ Ignore state symbols in equation Ignore pressure/catalyst/low % of oxygen Not just heat/hot Apply list principle eg if high temp 150^{o}C = 0
4(c)(ii)	$2CO + 2NO \rightarrow 2CO_2 + N_2$ **OR** $C_8H_{18} + 25NO \rightarrow 8CO_2 + 12.5\ N_2 + 9H_2O$ **OR** $C + 2NO \rightarrow CO_2 + N_2$ **OR** $2NO \rightarrow N_2 + O_2$ Pt/ Pd/ Rh/ Ir	1 1	Allow multiples/ Ignore state symbols in equation Allow other alkane reacting with NO in correctly balanced equation Penalise contradiction of name and symbol
4(c)(iii)	$4NO_2 + 2H_2O + O_2 \rightarrow 4HNO_3$	1	Allow multiples/ Ignore state symbols in equation

4(d)(i)	High temp/ anywhere in range 400 ^{o}C – 900 ^{o} C/ anywhere in range 670-1200K / high pressure/ anywhere in range 5000 kPa up to 8000 kPa/	1	Not catalyst/heat
4(d)(ii)	$C_{16}H_{34} \rightarrow C_6H_{14} + 2C_4H_8 + C_2H_4$ Or $C_{16}H_{34} \rightarrow C_6H_{14} + C_4H_8 + 3C_2H_4$	1	Do not allow multiples Ignore state symbols in equation
4(d)(iii)	Polymers/plastics/ named polymer	1	Allow polyesters or polyamides Ignore object made from polymer

Question	Marking Guidance	Mark	Comments
5(a)	Macromolecular/giant covalent/ giant molecular / giant atomic	1	If IMF/H-bonds/Ionic/metallic CE =0/3 covalent bond between molecules CE = 0/3 If giant unqualified M1 = 0 but mark on
	Many/strong covalent bonds	1	M2 and M3 can only be scored if covalent mentioned in answer Ignore metalloid and carbon Ignore bp
	Bonds must be broken/overcome	1	Ignore numbers of bonds and references to energy
5(b)	(Simple) <u>molecular</u>	1	QoL Do not allow simple covalent for M1 Giant covalent/ionic/metallic, CE = 0 If breaking covalent bonds CE= 0/3
	S bigger <u>molecule</u> (than P) or S_8 and P_4 references	1	QoL Allow more electrons in sulfur <u>molecule</u> or S_8 Do not allow S is bigger then P Allow S <u>molecule</u> has a bigger M_r Do not allow contradictions
	So more/ stronger <u>van der Waals</u>' forces (to be broken or overcome)	1	Not just more energy to break

5(c)	Regular arrangement of minimum of 6 particles in minimum of 2 rows + charge in each one (of 6) Rows/planes/sheets/layers (of atoms/ions) can slide (owtte) over one another	1 1 1	Ignore e- Do not allow ring arrangements OR structures bonded with electrons Allow +, (1+, 2+ or 3+) in ions/or in words M3 independent If ionic bonding/molecules/IMF/vdw/covalent, penalise M3 Ignore layers of electrons sliding

5(d)	Bigger charge (3+ compared to 1+) ***OR*** smaller atom/ion in Al / more protons/bigger nuclear charge More free /delocalised electrons (in Al)/bigger sea of electrons in Al Stronger metallic bonding/ stronger (electrostatic) attraction between the (+) ions or nuclei and the (delocalised) electrons (or implied)	1 1 1	CE = 0 if molecules, ionic, covalent, IMF (Allow Al^{2+}) Accept 2 or 3 delocalised electrons compared to 1 in Na Must be implied that the electrons are the delocalised ones not the electrons in the shells. Accept converse arguments

Question	Marking Guidance	Mark	Comments
6(a)	• (Same) General formula /allow a named homologous series with its general formula • Chemically similar/same (chemical) reactions • Same functional group • Trend in physical properties/ eg inc bp as M_r increases • (Molecules) increase by CH_2/M_r = *14*	2	Any two points
6(b)	Fractional distillation/ fractionation/ chromatography	1	Allow GLC
6(c)	(Molecules/compounds/substances) with the same molecular formula / same number and type of atoms but different structural formula/ different displayed formula/ different arrangement of atoms/different structures 2,4-dimethylhexane C_4H_9	1 1 1 1	Allow alkanes with same molecular formula Allow same chemical formula in M1 = 0 but can allow M2 Not different positions in space M2 dependent on M1 Ignore the absence of dash and/or commas

6(d)	less surface contact / less surface area/ less polarisable molecule	1	Allow more spherical or fewer ponts of contact Not smaller molecule/ not more compact molecule/ not shorter chain Allow converse arguments
	so fewer/weaker/less Van der Waals'/vdw forces	1	Must be comparative answer ie not just few VDW forces QoL Assume 'it' refers to the branched isomer

General principles applied to marking CHEM1 papers by CMI+ (January 2011)

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.**

A. 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.

B. 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.

C. 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 (eg 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.

D. Equations

In general

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

E. Lone Pairs

The following representations of lone pairs in structures are acceptable.

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

F. 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.

G. 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 arithmetic error or a transcription error deduct one mark, but continue marking (error carried forward).

H. 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:-