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General Certificate of Education (A-level)
June 2012

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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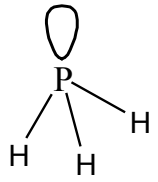
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Question	Marking Guidance	Mark	Comments
1(a)	37 48	1 1	These answers only. Allow answers in words. Ignore any sum(s) shown to work out the answers.
1(b)(i)	Electron gun / high speed/high energy electrons Knock out electron(s)	1 1	Not just electrons. Not highly charged electrons. Remove an electron.
1(b)(ii)	$Rb(g) \rightarrow Rb^{+}(g) + e^{(-)}$ ***OR*** $Rb(g) + e^{(-)} \rightarrow Rb^{+}(g) + 2e^{(-)}$ ***OR*** $Rb(g) - e^{(-)} \rightarrow Rb^{+}(g)$	1	Ignore state symbols for electron.
1(c)	Rb is a bigger (atom) / e further from nucleus / electron lost from a higher energy level/ More shielding in Rb / less attraction of nucleus in Rb for outer electron / more shells	1	Answer should refer to Rb not Rb molecule. If converse stated it must be obvious it refers to Na Answer should be comparative.
1(d)(i)	s / block s / group s	1	Only
1(d)(ii)	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^{10}\ 4p^6\ 5s^1$	1	Allow $3d^{10}$ before $4s^2$ Allow in any order.

1(e)	$\frac{(85 \times 2.5) + 87 \times 1}{3.5}$ = 85.6 ***OR*** $\frac{(85 \times 5) + 87 \times 2}{7}$ = 85.6	1 1 1 1 1 1	M1 is for top line Only ***OR*** M1 ^{85}Rb 71.4% and ^{87}Rb 28.6% M2 divide by 100 M3 = 85.6
1(f)	Detector Current / digital pulses / electrical signal related to abundance	1 1	Mark independently. Allow detection (plate). Not electrical charge.
1(g)	Smaller Bigger nuclear charge / more protons in Sr Similar/same shielding	1 1 1	Chemical error if not smaller, CE = 0/3 If blank mark on. Not bigger nucleus. QWC (Outer) electron entering same shell/sub shell/orbital/same number of shells. Do not allow incorrect orbital.

Question	Marking Guidance	Mark	Comments
2(a)(i)	C_nH_{2n} / C_xH_{2x}	1	
2(a)(ii)	Fractional distillation / GLC / gas liquid chromatography / fractionation	1	Do **not** allow cracking / distillation
2(b)(i)	But-1-ene / but1ene	1	Ignore hyphens and commas Do **not** allow butene-1 / but-2-ene / butane / butane /alkene / C_4H_8 / propene / straight-chain alkene
2(b)(ii)	A structure of cyclobutane or methyl-cyclopropane	1	Allow skeletal formula.
2(c)(i)	$C_{15}H_{32} \rightarrow 2C_4H_8 + C_7H_{16}$	1	Do not accept multiples.
2(c)(ii)	Thermal cracking To produce products that are in greater demand / more valuable / more expensive / more profitable	1 1	Not catalytic cracking or cracking. The (unsaturated) alkene or the (unsaturated) molecule or X produced can be polymerised or can be made into plastics. Ignore more useful products.
2(c)(iii)	Break (C-C or C-H) bonds	1	Allow to overcome the activation energy. Allow to break the carbon chain. Penalise breaking wrong bonds.
2(d)(i)	H_2	1	Only.

2(d)(ii)	Fuel / LPG	1	Allow camping gas, lighter fuel, propellant, refrigerant, cordless appliances. Do not allow petrol or motor fuel. Ignore natural gas.
2(d)(iii)	$C_4H_{10} + 2.5O_2 \rightarrow 4C + 5H_2O$	1	Accept multiples.
2(d)(iv)	SO_2 / sulfur dioxide	1	If other sulfur oxides, mark on.
	Calcium oxide / CaO / lime / quicklime	1	Allow $CaCO_3$ / allow $Ca(OH)_2$ or names. Allow any solid base. M2 dependent on M1. Do not allow limewater.
2(d)(v)	Neutralisation	1	Allow acid-base reaction. Allow flue gas desulfurisation / FGD
2(e)	(Molecules) are similar sizes / have similar M_r / have similar number of electrons	1	Chemical error CE = 0/2 if breaking bonds. Allow similar number of carbon and hydrogen atoms / similar surface area / similar chain length. Can accept same number of carbon atoms. Do not accept same number of H atoms / same number of bonds. Ignore similar amount of bonds.
	Similar van der Waals forces <u>between molecules</u> / similar <u>intermolecular</u> forces (IMF)	1	Not similar incorrect IMF eg dipole-dipole

Question	Marking Guidance	Mark	Comments
3(a)		1	Need to see 3 P-H bonds and one lone pair (ignore shape).
3(b)	Coordinate / dative Pair of electrons on P(H_3) donated (to H+)	1 1	If not coordinate / dative then chemical error CE=0 unless blank or covalent then M1 = 0 and mark on. Do not allow a generic description of a coordinate bond.
3(c)	109.5° / 109½ / 109° 28’	1	Allow answers in range between 109° to 109.5°
3(d)	Difference in electronegativity between P and H is too small	1	Allow P not very electronegative / P not as electronegative as N, O and F / P not electronegative enough / P not one of the 3 most electronegative elements. Do not allow phosphine is not very electronegative.

Question	Marking Guidance	Mark	Comments
4(a)(i)	Macromolecular / giant covalent / giant molecular / giant atomic	1	If covalent, molecular, giant, lattice, hexagonal or blank mark on. If metallic, ionic or IMF chemical error CE = 0 for 4(a)(i), 4(a)(ii) and 4(a)(iii).
4(a)(ii)	Delocalised electrons / free electrons Able to move / flow (through the crystal)	1 1	 Allow M2 for electrons can move / flow. Ignore electrons can carry a current / charge.
4(a)(iii)	Covalent bonds Many /strong / hard to break / need a lot of energy to break	1 1	 M2 dependent on M1. Ignore van der Waals' forces.
4(b)(i)	(Giant) metallic / metal (lattice)	1	If FCC or BCC or HCP or giant or lattice, mark on. If incorrect 4(b)(i), chemical error CE for 4(b)(ii) and 4(c)(ii).
4(b)(ii)	Nucleus / protons / positive ions and delocalised electrons (are attracted) Strong attraction	1 1	QWC Must be delocalised electrons – not just electrons. Chemical error = 0/2 for 4(b)(ii) if other types of bonding or IMF mentioned. Allow strong metallic bonding for one mark if M1 and M2 are not awarded.
4(c)(i)	Layers of atoms/ions slide (over one another)	1	Do not allow just layers.

4(c)(ii)	(Strong) (metallic) bonding re-formed / same (metallic) bonding / retains same (crystal) structure / same <u>bond strength</u> / same attraction between protons and delocalised electrons as before being hammered or words to that effect	1	If IMF, molecules, chemical error CE = 0/1 for 4(c)(ii). If metallic not mentioned in 4(b)(i) or 4(b)(ii) it must be mentioned here in 4(c)(ii) to gain this mark. Do not allow metallic bonds broken alone. Ignore same shape or same strength.
4(d)	(giant) Ionic Between + and – ions / oppositely charged ions or Mg^{2+} and O^{2-} <u>Strong attraction</u>	1 1 1	If not ionic, chemical error CE = 0/3 If molecules mentioned in explanation lose M2 and M3 Allow one mark for a strong attraction between incorrect charges on the ions.

Question	Marking Guidance	Mark	Comments
5(a)	P = 100 000 (Pa) and V = 5.00 x 10^{-3} (m^3)	1	M1 is for correctly converting P and V in any expression or list Allow 100 (kPa) and 5 (dm^3) for M1.
	$n = \frac{PV}{RT} = \frac{100\,000 \times 5.00 \times 10^{-3}}{8.31 \times 298}$ = 0.202 moles (of gas produced)	1	M2 is correct rearrangement of PV = nRT This would score M1 and M2.
	Therefore $\frac{0.202}{5}$ = 0.0404 moles B_2O_3	1	M3 is for their answer divided by 5
	Mass of B_2O_3 = 0.0404 x 69.6	1	M4 is for their answer to M3 x 69.6
	= 2.81 (g)	1	M5 is for their answer to 3 sig figures. 2.81 (g) gets 5 marks.
5(b)	B + 1.5 Cl_2 → BCl_3	1	Accept multiples.
	3 bonds	1	
	Pairs repel equally/ by the same amount	1	Do not allow any lone pairs if a diagram is shown.

5(c)(i)	43.2/117.3 (= 0.368 moles BCl_3)	1	
	0.368 x 3 (= 1.105 moles HCl)	1	Allow their BCl_3 moles x 3
	Conc HCl = $\frac{1.105 \times 1000}{500}$	1	Allow moles of HCl x 1000 / 500
	= 2.20 to 2.22 mol dm^{-3}	1	Allow 2.2 Allow 2 significant figures or more
5(c)(ii)	$H_3BO_3 + 3NaOH \rightarrow Na_3BO_3 + 3H_2O$	1	Allow alternative balanced equations to form acid salts. Allow $H_3BO_3 + NaOH \rightarrow NaBO_2 + 2H_2O$
5(d)	$\frac{10.8}{120.3}$ (x 100)	1	Mark is for both M_r values correctly as numerator and denominator.
	8.98(%)	1	Allow 9(%).
	Sell the HCl	1	

5(e)	Cl = 86.8% B Cl $\frac{13.2}{10.8}$ $\frac{86.8}{35.5}$ 1.22 2.45 or ratio 1:2 or BCl_2 BCl_2 has M_r of 81.8 so 81.8 x 2 = 163.6 Formula = B_2Cl_4	1 1 1 1	Alternative method Cl = 142 g B Cl $\frac{21.6}{10.8}$ $\frac{142}{35.5}$ 2:4 ratio B_2Cl_4 Allow 4 marks for correct answer with working shown. Do not allow $(BCl_2)_2$

General principles applied to marking CHEM1 papers by CMI+ (June 2012)

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.

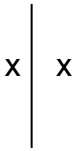
D. Equations

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**  **OR**  **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:-

