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General Certificate of Education (A-level)
January 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 students' 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 students' 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 students' 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)	(Total number of) protons and neutrons (in nucleus of atom)	1	(number of) nucleons
1(b)	Zn	1	Do not allow Zn^{-1} or Zn^{+1} or ZN Ignore numbers
1(c)(i)	P = ionise (sample) Q = accelerate (sample)	1 1	Allow removing an electron / forms (+) ions Allow speeds (ions) up Penalise molecules / atoms
1(c)(ii)	m/z (relative) abundance / (relative) intensity	1 1	Allow mass / charge QoL Allow M1 + M2 in any order
1(d)(i)	$\frac{206 + 207 + (208 \times 2)}{4} = \frac{(829)}{4}$ $= 207.3$	1 1 1	M1 = topline M2 = ÷ 4 Only 207.3 = 3 marks
1(d)(ii)	Lead/Pb	1	Not PB
1(d)(iii)	Same number of electrons (in outer shell) / same electronic configuration	1	Ignore electrons determine chemical properties Ignore reference to p and n if correct Penalise if incorrect

Question	Marking Guidance	Mark	Comments
2(a)(i)	Higher than P	1	
2(a)(ii)	$1s^2\ 2s^2 2p^6 3s^1$	1	Allow any order
2(a)(iii)	$Al^+(g) + e^{(-)} \longrightarrow Al^{2+}(g) + 2e^{(-)}$ ***OR*** $Al^+(g) \longrightarrow Al^{2+}(g) + e^{(-)}$ ***OR*** $Al^+(g) - e^{(-)} \longrightarrow Al^{2+}(g)$	1	
2(a)(iv)	Electron in Si (removed from) (3)p orbital / electron (removed) from higher energy orbital or sub-shell / electron in silicon is more shielded	1	Accept converse arguments relating to Al Penalise incorrect p-orbital
2(b)	Sodium / Na Electron (removed) from the 2nd shell / 2p (orbital)	1 1	Allow Na^+ M2 is dependent on M1 Allow electron from shell nearer the nucleus (so more attraction)
2(c)	Silicon / Si	1	Not SI
2(d)	Heat or energy needed to overcome the attraction between the (negative) electron and the (positive) nucleus or protons Or words to that effect eg electron promoted to higher energy level (infinity) so energy must be supplied	1	Not breaking bonds QoL

Question	Marking Guidance	Mark	Comments
3(a)(i)	The power of an atom or nucleus to withdraw or attract electrons ***OR*** electron density ***OR*** a pair of electrons (towards itself) In a covalent bond	1 1	Ignore retain
3(a)(ii)	More protons / bigger nuclear charge Same or similar shielding / electrons in the same shell or principal energy level / atoms get smaller	1 1	 Not same sub–shell Ignore more electrons
3(b)	Ionic Strong or many or lots of (electrostatic) attractions (between ions) Between + and – ions / between Li^+ and F^- ions / oppositely charged ions	1 1 1	If not ionic then CE = 0/3 If blank lose M1 and mark on If molecules / IMF / metallic / atoms lose M2 + M3, penalise incorrect ions by 1 mark Allow strong (ionic) bonds for max 1 out of M2 and M3
3(c)	Small electronegativity difference / difference = 0.5	1	Must be comparative Allow 2 non-metals
3(d)(i)	(simple) molecular	1	Ignore simple covalent
3(d)(ii)	$OF_2 + H_2O \longrightarrow O_2 + 2HF$	1	Ignore state symbols Allow multiples Allow OF_2 written as F_2O

3(d)(iii)	45.7% O (O F) (45.7 54.3) (16 19) (2.85 2.85) (1 1) EF = OF or FO MF (= 70.0/35) = O_2F_2 or F_2O_2	1 1 1 1	If students get M2 upside down lose M2 + M3 Check that students who get correct answer divide by 16 and 19 (not 8 and 9). If dividing by 8 and 9 lose M2 and M3 but could allocate M4 ie max 2 Calculation of OF by other correct method = 3 marks Penalise Fl by 1 mark

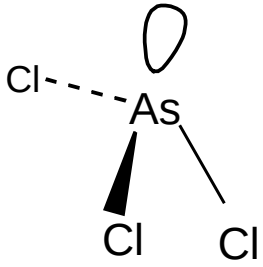
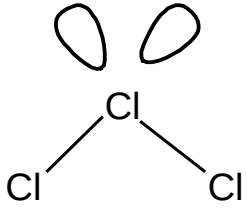
Question	Marking Guidance	Mark	Comments
4(a)	Fractional distillation / fractionation / GLC / gas liquid chromatography	1	
4(b)	C_4H_{10} Because it has a higher bp / has stronger IMF / larger molecule / longer chain / larger surface (area)	1	Need C_4H_{10} **and** the reason for the mark
4(c)	$C_4H_{10} + 6½\ O_2 \longrightarrow 4CO_2 + 5H_2O$	1	Accept multiples Ignore state symbols
4(d)	CO_2 or H_2O evolved is a greenhouse gas / CO_2 or H_2O evolved contribute to global warming / the products are greenhouse gases	1	Ignore climate change
4(e)	$CH_3CH_2CH_2CH_3 + 3.5O_2 \longrightarrow C_2H_2(CO)_2O + 4H_2O$	1	Accept multiples Allow with or without a number 1 before the organic molecules
4(f)(i)	$C_2H_5SH + 4.5O_2 \longrightarrow 2CO_2 + 3H_2O + SO_2$	1	Accept multiples
4(f)(ii)	Calcium oxide / calcium carbonate Neutralises the SO_2 / acid base reaction / it is a base	1 1	Allow any base or alkali Allow correct formulae Can only score M2 if base or alkali used in M1 Allow M2 if blank in M1

4(f)(iii)	Ethanol contains Hydrogen bonding Which is stronger than IMF (VDW / dipole-dipole forces) in ethanethiol/ (H bonding) is the strongest IMF	1 1	Breaking covalent bonds CE = 0/2 Only award M2 if M1 given, but allow IMF in ethanol are stronger than in ethanethiol for maximum 1 mark
4(g)(i)	(2,2-)dimethylpropane	1	Ignore punctuation
4(g)(ii)	Because molecule is smaller / less polarisable / has less surface (area)/ is more spherical / molecules can't get as close to one another (to feel the vdW forces) vdW intermolecular forces or vdW force between molecules are weaker or fewer	1 1	Allow converse answers referring to straight chain isomers CE = 0/2 if breaking bonds Need vdW rather than just IMF
4(g)(iii)	1 or one	1	
4(h)(i)	C_9H_{20}	1	$H_{20}C_9$
4(h)(ii)	Thermal (cracking) High pressure AND high temperature ***OR*** Pressure of ≥ 10 atm, ≥ 1 MPa ≥ 1000 kPa AND temp of 400 ^{0}C ≤ T ≤ 1000 ^{0}C or 650 K ≤ T≤ 1300 K	1 1	If not thermal cracking CE = 0/2 If blank mark on Allow high P and T Do not allow high heat If no units for T, then range must be 650-1000

Question	Marking Guidance	Mark	Comments
5(a)	P = 100 000 Pa and T = 298 K	1	Wrong conversion of V or incorrect conversion of P/T lose M1 + M3
	$n = \frac{PV}{RT}$ or $\frac{100\,000 \times 4.31}{8.31 \times 298}$	1	If not rearranged correctly then cannot score M2 and M3
	n(total) = 174(.044)	1	
	n (NO) = $\frac{69.6}{}$	1	Allow student's M3 x 4/10 but must be to 3 significant figures
5(b)(i)	$\frac{3000}{17}$	1	Allow answer to 2 significant figures or more
	176.5	1	Allow 176–177 But if answer = 0.176 – 0.18 (from 3/17) then allow 1 mark

5(b)(ii)	176.47 x 46 = 8117.62 8117.62 x $\frac{80}{100}$ (= 6494 g) $\frac{6494}{1000}$ = 6.5 ***OR*** If 163 mol used: 163 x 46 = 7498 (1) 7498 x $\frac{80}{100}$ = 5998.4 g (1) 6.00 kg (1)	1 1 1	M1 is for the answer to (b)(i) x 46. But lose this mark if 46 ÷ 2 at any stage However if 92 ÷ 2 allow M1 M2 is for M1 x 80/100 M3 is for the answer to M2 ÷ 1000 to min 2 significant figures (kg)

5(c)	0.543 x $\frac{2}{3}$ (= 0.362) 0.362 x $\frac{1000}{250}$ = 1.45 (mol dm^{-3})	1 1	If not x $\frac{2}{3}$ CE = 0/2 Allow 1.447-1.5 (mol dm^{-3}) for 2 marks
5(d)	NO_2 contributes to acid rain / is an acid gas / forms HNO_3 / NO_2 is toxic / photochemical smog	1	Ignore references to water, breathing problems and ozone layer. Not greenhouse gas
5(e)	Ensure the ammonia is used up / ensure complete reaction or combustion ***OR*** Maximise the yield of nitric acid or products	1	
5(f)	Neutralisation	1	Allow acid vs alkali or acid base reaction

Question	Marking Guidance	Mark	Comments
6(a)		1	Mark is for 3 As-Cl bonds and 1 lone pair
	(Trigonal) pyramid(al) / tetrahedral	1	Allow triangular pyramid
		1	Mark is for 2 Cl-Cl bonds and 2 lone pairs Do not penalise if + not shown
	Bent / V-shaped / triangular	1	Not trigonal
6(b)	There are 4 bonds or 4 pairs of electrons (around As)	1	Can show in a diagram. If lone pair included in shape, CE = 0/2
	(Electron pairs / bonds) repel equally	1	QoL

General principles applied to marking CHEM1 papers by CMI+ (January 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 student 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 (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.

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** x x **OR** x x **OR** x x **OR**

Reagents

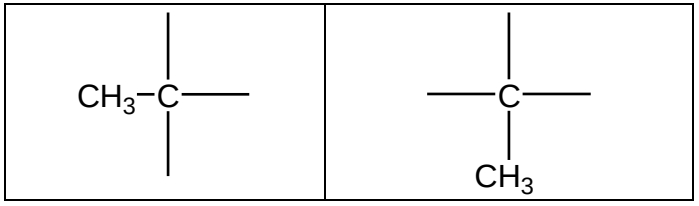
The command word "Identify", allows the student to choose to use **either** the name or the formula of a reagent in their answer. In some circumstances, the list principle may apply when the name and formula contradict. Specific details will be given in mark schemes.

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 student has made an arithmetic 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:-