A-LEVEL CHEMISTRY

CHEM1 – FOUNDATION CHEMISTRY

Mark Scheme

June 2016

Version: 1.0 Final

Mark schemes are prepared by the Lead Assessment Writer 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 associates 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 associate understands and applies it in the same correct way. As preparation for standardisation each associate 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, associates encounter unusual answers which have not been raised they are required to refer these to the Lead Assessment Writer.

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.

Further copies of this mark scheme are available from aqa.org.uk

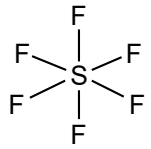
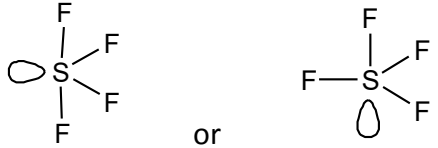
Question	Marking Guidance	Mark	Comments
1(a)	<u>Average/mean mass of 1 atom (of an element)</u> 1/12 mass of one atom of ^{12}C ***OR*** <u>Average/mean mass of atoms of an element</u> 1/12 mass of one atom of ^{12}C ***OR*** <u>Average/mean mass of atoms of an element x12</u> mass of one atom of ^{12}C ***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/all isotopes (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)(i)	Magnetic field	1	
1(b)(ii)	(Ions hit) <u>plate/detector</u> causing movement of <u>electrons</u> or (ions hit) <u>plate/detector</u> accept <u>electrons</u> current generated	1 1	Do not allow electron flow in wrong direction Allow M1 for ions hit detector and cause current

1(c)	(27.976 x 92.23) + (28.976 x 4.67) + (29.973 x 3.10) / 100 (= 28.084607) <u>28.085</u>	1 1	Correct answer with or without working scores 2 marks

1(d)	**Similarities**: (Some) peak(s) at same m/z same sample / element (is being ionised and detected) **Differences**: Additional peak(s) at ½ *m/z* value Two electrons knocked out	 1 1 1 1	Mark all independently Allow main peaks Not same height/abundance/A_r/M_r Not same number peaks (not same no isotopes) / not same molecular ion peak Allow 1/3 (or more) Allow 3 (or more)

Question	Marking Guidance	Mark	Comments
2(a)	Electron movement in first molecule / temporary dipole Induces a dipole in another molecule (induced-temporary) attraction or δ+ attracts δ- in different/adjacent molecules	1 1 1	allow description allow description M3 dependent on M1 and M2 allow electrostatic attraction M3 could be scored in diagram If other type of force / metallic / ionic / polar bonds / permanent dipoles / difference in electronegativity mentioned CE = 0
2(b)(i)	(methanol) H-bonds / hydrogen bonding (methanethiol) dipole-dipole forces or van der Waals H-bonds are a stronger / are the strongest IMF	1 1 1	 Allow H-bonds require more energy to overcome If M1 and M2 not scored, allow 1 for methanol has stronger IMFs If breaking covalent bonds then CE=0
2(b)(ii)	(Fractional) distillation	1	Allow description Do not allow heating unqualified

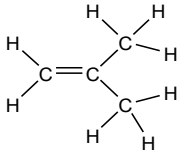
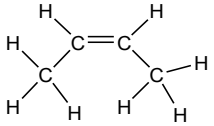
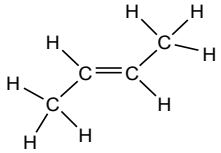
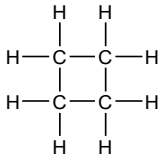
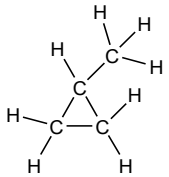
2(c)	(Methaneselenol is a) bigger molecule / larger Mr / larger no of electrons / Se bigger atom With <u>stronger/more</u> <u>vdw</u> forces <u>between molecules</u>	1 1	 If breaking covalent bonds then CE=0

2(d)(i)		1	diagram showing 6 bond pairs
	(bond angle) 90° for SF_6	1	ignore 180°
	Octahedral	1	
		1	diagram showing 4 bond pairs <u>and 1 lone pair</u>
	(bond angles) for SF_4 Any **two** from: • Allow 85 – 89° • Allow 100 – 119° • Allow 170 – 179°	 2	If shape of SF_4 is not based on 4 bond pairs <u>and 1 lone pair</u> cannot score M4 or M5 Do not allow 90° Do not allow 120° Do not allow 180°

2(d)(ii)	NaCl **(**as product in any equation) $3\ SCl_2 + 4\ NaF \rightarrow SF_4 + S_2Cl_2 + 4\ NaCl$	1 1	 Allow multiples Ignore states

Question	Marking Guidance	Mark	Comments
3(a)(i)	$H_2O + CO_2$ (as products in any equation) $Cu_2(OH)_2CO_3 + 4HCl \rightarrow 2CuCl_2 + 3H_2O + CO_2$	1 1	Allow $H_2O + H_2CO_3$ Allow multiples Ignore states
3(a)(ii)	bubbles or fizzing or effervescence or solid disappears or blue(-green) solution	1	Do not allow dissolves Ignore CO_2 gas or gas evolved
3(b)(i)	Simplest (whole-number) ratio of atoms of each element in a compound	1	Allow atoms of Cu, H & O in this compound
3(b)(ii)	Mass of copper = 2.765 dividing masses by A_r Cu C H O $\frac{2.765}{63.5}$ (= 0.0435) $\frac{0.348}{12.0}$ (= 0.029) $\frac{0.029}{1.0}$ (= 0.029) $\frac{1.858}{16.0}$ (= 0.116) Correct whole number ratio of integers or Cu:C:H:O 3:2:2:8 or correct empirical formula $Cu_3C_2H_2O_8$	1 1 1	 Any order Ignore $Cu_3(OH)_2(CO_3)_2$

Question	Marking Guidance	Mark	Comments
4(a)(i)	Alk**a**ne(s)	1	Ignore C_nH_{2n+2}
4(a)(ii)	$C_8H_{18} + 12.5O_2 \rightarrow 8CO_2 + 9H_2O$	1	Allow multiples
4(a)(iii)	2, 2, 4-trimethylpentane	1	
4(b)(i)	But-1-ene	1	Ignore (E or Z)
4(b)(ii)	$C_{14}H_{30}$	1	
4(b)(iii)	Thermal High pressure / 7000kPa / 70 atms and High temperature/temperature in range 400-1000°C (673–1273K)	1 1	If catalytic CE = 0 (allow ≥1000 kPa or ≥10 atms – no upper value) Allow high temperature and pressure or high pressure and temperature If no units for temperature allow 673-1000

4(b)(iv)			Must show unambiguous structure Penalise lack of displayed formula once only
		1	
	 	1	
	 	1	

Question	Marking Guidance	Mark	Comments
5(a)	General increase	1	If not increase then CE
	Greater nuclear charge / more protons	1	
	Same shielding / electrons added to same shell	1	allow similar
	Stronger attraction (from nucleus) for outer electron(s)	1	Allow electron in outer shell
5(b)			CE if not Al or S
	Aluminium / Al (lower than Mg)	1	
	(outer) electron in (3)p orbital / sub-shell (level)	1	If 2p or 4p orbital lose M2 and M3
	(3p) higher in energy	1	allow more shielded or weaker nuclear attraction
	or		M3 is dependent on M2
	Sulfur / S (lower than P)		
	(outer) electrons in (3)p orbital begin to pair		If 2p or 4p orbital lose M2 and M3 allow 2 electrons in (3)p
	repel		M3 is dependent on M2
5(c)	Sulfur / S	1	CE if not S
	Large jump after 6^{th} or between 6^{th} and 7^{th}	1	Do not allow M2 if atom/ion is removed

5(d)	Silicon Giant covalent structure / macromolecule Covalent (bonds) Many / strong (covalent bonds) or (covalent bonds) need lots of energy to break	1 1 1 1	CE if not Si Giant covalent scores M2 and M3 CE for M2-M4 if molecules / metallic / ionic / IMFs mentioned

Question	Marking Guidance	Mark	Comments
6(a)	Correct conversion of temperature and pressure (773 and 101 x 10^3)	1	correct answer with or without working scores 4 marks
	No moles P = (220 / 4 x 31.0) = 1.77	1	Max 2 (M1 and M3) if 31.0 used (=0.451 m^3 or if 220/31 rounded to 2 sf ie 7.1 then 0.452)
	V = nRT/P (correct rearrangement **or** insert of values V = 1.77 x 8.31 x 773 / 101 x 10^3 = 0.1128 m^3)	1	Max 2 (M1 and M3) if 284 (P_4O_{10}) used then 0.0493
	V = <u>0.113</u> (m^3)	1	Must be 3 sig figs
6(b)			correct answer with or without working scores 3 marks
	No moles H_3PO_4 = 3 x 10^3 (dm^3) x 5 = 15,000 (mols)	1	If M1 incorrect then can only score M2
	No moles phosphorus(V) oxide = $\frac{15\,000}{4}$ (= 3,750 mols)	1	M2 = $\frac{M1}{4}$ (process) If M2 incorrect can only score M1
	1.1 x 10^6 or 1.07 x 10^6 or 1.065 x 10^6 (g) or 1,100 or 1,070 or 1065 kg or 1.1 or 1.07 or 1.065 tonne	1	= (3.75 x 10^3 x 284.0) Min 2 sig fig

6(c)			correct answer with or without working scores 4 marks
	No moles $Ca_3(PO_4)_2$ (= 3.50kg =) $\frac{\mathbf{3{,}500\ g}}{\mathbf{310}(.\mathbf{3})}$ = 11.28	1	If M1 incorrect can only score M2 and M3
	Theoretical No. moles H_3PO_4 = 11.28 x 2 = 22.56	1	If M2 incorrect can only score M1 and M3
	Theoretical mass H_3PO_4 = 22.56 x 98(.0) = 2211 **or** Actual No. moles H_3PO_4 produced = $\frac{1090}{98}$ = 11.12	1	If M3 incorrect can only score M1and M2
	49 – 49(.312) (%)	1	(% yield (moles) = ($\frac{11/.12}{22.56}$ x 100) or (% yield (mass) = ($\frac{1090}{2211}$ x 100)

6(d)	Method 1 / (a) & (b) because only one product / no other products formed / atom economy = 100% (even though two steps)	1	Allow calculations Do not allow if P_2O_5 is formed Allow converse explanation

General principles applied to marking CHEM1 papers by CMI+ (June 2016)

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.

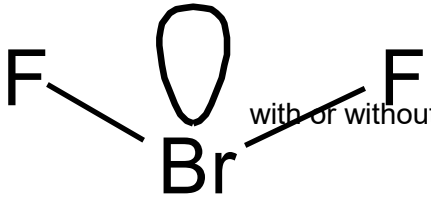
Equations

In general

- Equations **must** be balanced.
- State symbols are generally 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** ••

F 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.

Marking calculations

In general

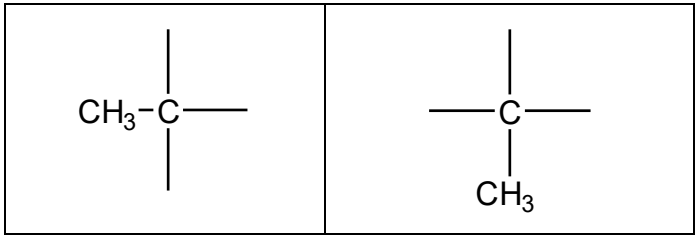
- A correct answer alone will score **full marks** unless the necessity to show working is specifically required in the question.
- If a candidate has made an arithmetical error or a transcription error deduct one mark, but continue marking (error carried forward).

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:-



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19 July 2016