AQA Qualifications

# A-LEVEL

# Chemistry

## CHEM1 Foundation Chemistry

## Mark scheme

2420
June 2015

Version 1 – Final Mark Scheme

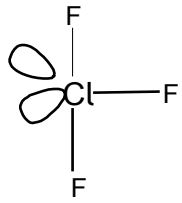
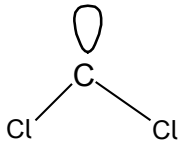
Mark schemes are prepared by the Lead Assessment Writer and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all associates participate in and is the scheme which was used by them in this 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.

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| Question | Marking Guidance | Mark | Comments |
|---|---|---|---|
| 1(a) | Silicon / Si | 1 | If not silicon then CE = 0/3 |
| | covalent (bonds) | 1 | M3 dependent on correct M2 |
| | Strong or many of the (covalent) bonds need to be broken / needs a lot of energy to break the (covalent) bonds | 1 | Ignore hard to break |
| 1(b) | Argon / Ar | 1 | If not argon then CE = 0/3. But if Kr chosen, lose M1 and allow M2+M3 |
| | Large(st) number of protons / large(st) nuclear charge | 1 | Ignore smallest atomic radius |
| | Same amount of shielding / same number of shells / same number of energy levels | 1 | Allow similar shielding |
| 1(c) | Chlorine / Cl | 1 | Not $Cl_2$, Not C**L, not** $Cl^2$ |

| | | | |
|---|---|---|---|
| 1(d)(i) | <br> | 1<br><br><br><br><br><br><br>1 | Or any structure with 3 bonds and 2 lone pairs<br><br><br>Ignore any angles shown<br><br><br><br><br>Or a structure with 2 bonds and 1 lone pair |
| 1(d)(ii) | Bent / v shape | 1 | Ignore non-linear, angular and triangular<br>Apply list principle |
| 1(d)(iii) | $\frac{1}{2}Cl_2 + \frac{3}{2}F_2 \longrightarrow ClF_3$ | 1 | No multiples<br>Ignore state symbols |

| Question | Marking Guidance | Mark | Comments |
|---|---|---|---|
| 2(a) | $5s^2\ 4d^{10}\ 5p^4$ / $4d^{10}\ 5s^2\ 5p^4$ | 1 | $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^{10}\ 4p^6\ 5s^2\ 4d^{10}\ 5p^4$<br>or $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6\ 4d^{10}\ 5s^2\ 5p^4$<br>Allow any order but must finish with $5p^4$ |
| 2(b)(i) | $\frac{(124 \times 2) + (126 \times 4) + (128 \times 7) + (130 \times 6)}{19}$ or $\frac{2428}{19}$<br>127.8<br><br>Or<br><br>$\frac{(124 \times 10.5) + (126 \times 21.1) + (128 \times 36.8) + (130 \times 31.6)}{100}$<br>127.8 | 1<br>1<br>1<br><br>Or<br><br>1<br>1<br>1 | M1 for top line<br>M2 for correct denominator<br>127.8 with no working shown scores 3 marks<br><br><br><br><br>Mark for 100 dependent on top line correct |
| 2(b)(ii) | Other isotopes present/some isotopes absent /different abundances of isotopes | 1 | |
| 2(c) | $Te^+ + e^{(-)} \rightarrow Te$ | 1 | Ignore state symbols<br>Allow $Te^{2+} + 2e^{(-)} \rightarrow Te$ |

| | | | |
|---|---|---|---|
| 2(d) | 128<br><br>Most abundant ion (QoL – superlative) | 1<br><br>1 | Only<br><br>M2 dependent on correct M1 |
| 2(e) | 2+ ion formed / 2 electrons removed<br>From $^{128}$ (Te) | 1<br>1 | Due to $^{128}Te^{2+}$ = 2 marks<br>Mark independently |

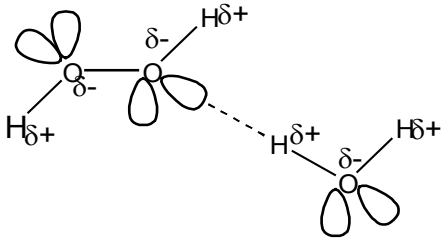
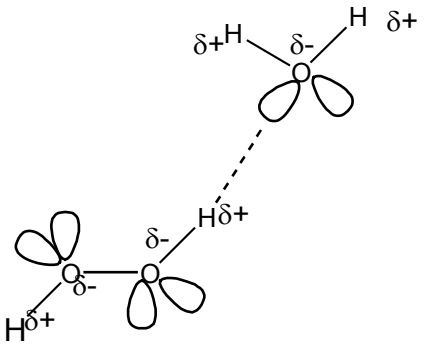
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|---|---|---|---|
| 2(f) | Same<br><br>(Each isotope has the) same number of protons/same nuclear charge <u>and</u> same number of electrons / electronic configuration | 1<br><br>1 | If not same CE = 0/2<br><br>Ignore more neutrons in $^{130}Te$ |

| Question | Marking Guidance | Mark | Comments |
|---|---|---|---|
| 3(a) | Macromolecular / giant covalent / giant molecule | 1 | Not giant atomic |
| 3(b) | No delocalised electrons / no free ions / no free charged particles | 1 | |
| 3(c) | $SiO_2 + 6HF \longrightarrow H_2SiF_6 + 2H_2O$ | 1 | Accept multiples |

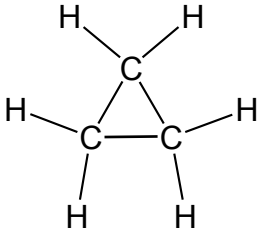
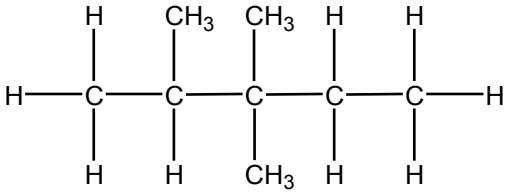
| Question | Marking Guidance | Mark | Comments |
|---|---|---|---|
| 4(a) | 0.943 g water (M1)<br><br>$NiSO_4$ $H_2O$<br>$\frac{1.344}{154.8}$ (M2) $\frac{0.943}{18}$ (M3)<br><br>($8.68 \times 10^{-3}$ 0.052)<br>1 6 or $x = \frac{6}{}$ (M4)<br>Allow other methods eg<br>$M_r$ ($NiSO_4$) = 58.7 + 32.1 + 64.0 = 154.8<br>n($NiSO_4$) = $\frac{1.344}{154.8}$ = 0.008682 mol (M1)<br>$M_r$ ($NiSO_4.xH_2O$) = $\frac{2.287}{0.008682}$ = (263.4) (M2)<br>so $18x$ = 263.4 – 154.8 = (108.6) (M3)<br>so $x$ = $\frac{108.6}{18}$ = $\frac{6}{}$ (M4) | 4 | If Mr of $NiSO_4$ wrong, can allow M1 and M3 from method 1 i.e. max 2<br><br>Allow Mr = 155<br><br>If using alternative method and Mr of $NiSO_4$ wrong, allow ecf to score M2 and M3 only i.e. max 2 |
| 4(b) | re-heat<br>check that mass is unchanged | 1<br>1 | Heat to constant mass = 2 marks<br>M2 dependent on M1<br>Allow as alternative: |

| | | | |
|---|---|---|---|
| | | | M1: record an IR spectrum<br>M2: peak between 3230 and 3550 ($cm^{-1}$) |

| Question | Marking Guidance | Mark | Comments |
|---|---|---|---|
| 5(a) | 94–105.5$^{o}$ | 1 | |
| 5(b)(i) | Hydrogen bond(ing) / H bonding/H bonds | 1 | Not just hydrogen |

| | | | |
|---|---|---|---|
| 5(b)(ii) | <br>**OR**<br> | 3 | 1 mark for all lone pairs<br>1 mark for partial charges on the O and the H that are involved in H bonding<br>1 mark for the H-bond, from Hδ+ on one molecule to lone pair on O of other molecule |
| 5(c) | Electronegativity of S lower than O or electronegativity difference between H and S is lower<br>No hydrogen bonding <u>between $H_2S_2$ molecules</u><br>Or <u>only</u> van der Waals / <u>only</u> dipole-dipole forces <u>between $H_2S_2$ molecules</u> | 1<br>1 | Mark independently<br>If breaking covalent bonds CE = 0 |

| Question | Marking Guidance | Mark | Comments |
|---|---|---|---|
| 6(a) | Saturated – single bonds only / no double bonds | 1 | |
| | Hydrocarbon – contains carbon and hydrogen (atoms) only | 1 | |
| 6(b) | $C_{16}H_{34} + 16.5O_2 \longrightarrow 16CO + 17H_2O$ | 1 | Allow multiples |
| 6(c) | (On combustion) $SO_2$ produced | 1 | Allow equation to produce $SO_2$. Ignore sulfur oxides. |
| | Which causes acid rain | 1 | If formula shown it must be correct<br>M2 is dependent on M1. But if M1 is sulfur oxides, allow M2.<br>For M2 allow consequence of acid rain or $SO_2$.<br>Ignore greenhouse effect and toxic |
| 6(d)(i) | $C_{16}H_{34} \longrightarrow C_8H_{18} + C_2H_4 + 2C_3H_6$ | 1 | Allow multiples |

| | | | |
|---|---|---|---|
| 6(d)(ii) | polypropene / propan(-1 or 2-)ol / propane(-1,2-)diol / isopropanol / propanone / propanal | 1 | Accept alternative names<br>Ignore plastic and polymer |
| 6(d)(iii) |  | 1 | |
| 6(e) |  | 1 | Allow any unambiguous representation |
| 6(f) | 2,4-dichloro-2,4-dimethylhexane | 1 | Only but ignore punctuation |

| Question | Marking Guidance | Mark | Comments |
|---|---|---|---|
| 7(a) | M1 $550 \times \frac{100}{95} = 579$ g would be 100% mass<br><br>M2 So $\frac{579}{65} = 8.91$ moles $NaN_3$<br>**or**<br>M1 $\frac{550}{65} = 8.46$ moles $NaN_3$ (this is 95%)<br>M2 So 100% would be $8.46 \times \frac{100}{95} = 8.91$ moles $NaN_3$<br><br>Then M3 Moles $NaNH_2 = 8.91 \times 2 = (17.8(2)$ moles)<br><br>M4 mass $NaNH_2 = 17.8(2) \times 39$<br><br>M5 693 or 694 or 695 (g) | 1<br><br>1<br><br>1<br><br>1 | Allow alternative methods.<br>There are 4 process marks:<br><br>1: mass ÷ 65<br>2: mass or moles × 100/95 or × 1.05<br>3: moles $NaN_3$ × 2<br>4: moles $NaNH_2$ × 39<br><br>If 693, 694 or 695 seen to 3 sig figs award 5 marks |

| | | | |
|---|---|---|---|
| 7(b) | M1 308 K and 150 000 Pa | 1 | |
| | M2 $n = \frac{PV}{RT}$ or $\frac{150\,000 \times 7.5 \times 10^{-2}}{8.31 \times 308}$ | 1 | |
| | M3 = 4.4(0) or 4.395 moles $N_2$ | 1 | Allow only this answer but allow to more than 3 sig figs |
| | M4 Moles $NaN_3$ = 4.395 $\times \frac{2}{3}$ (= 2.93) | 1 | M4 is for M3 $\times \frac{2}{3}$ |
| | M5 Mass $NaN_3$ = (2.93) $\times$ 65 | 1 | M5 is for moles M4 × 65 |
| | M6 = 191 g | 1 | Allow 190 to 191 g allow answers to 2 sig figs or more |

| | | | |
|---|---|---|---|
| 7(c)(i) | 150/65 = 2.31 moles $NaN_3$ or 2.31 moles nitrous acid | 1 | |
| | Conc = $2.31 \times \frac{1000}{500}$ | 1 | M2 is for M1 × 1000/500 |
| | 4.6(1) or 4.6(2) (mol $dm^{-3}$) | 1 | Only this answer |
| 7(c)(ii) | $3HNO_2 \longrightarrow HNO_3 + 2NO + H_2O$ | 1 | Can allow multiples |
| 7(d) | Ionic | 1 | If not ionic then CE = 0/3 |
| | Oppositely charged ions / $Na^+$ and $N_3^-$ ions | 1 | Penalise incorrect ions here but can allow M3 |
| | Strong attraction between (oppositely charged) ions / lots of energy needed to overcome (strong) attractions (between ions) | 1 | M3 dependent on M2 |

| | | | |
|---|---|---|---|
| 7(e)(i) | $N \equiv N \longrightarrow N^-$ | 1 | Only |
| 7(e)(ii) | $CO_2$ / $N_2O$ / $BeF_2$/$HN_3$ | 1 | Allow other correct molecules |
| 7(e)(iii) | $MgN_6$ | 1 | Only |

## General principles applied to marking CHEM1 papers by CMI+ (June 2015)

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 <u>required information</u> 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.

NB 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).

NB 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:-

