AQA Qualifications

A-LEVEL

CHEMISTRY

CHEM1 Foundation Chemistry
Mark scheme

2420
June 2014

Version 1.2 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)(i)	1.6734×10^{-24} (g) 1.6734×10^{-27} <u>kg</u>	1	Only. Not 1.67×10^{-24} (g)
1(a)(ii)	**B**	1	
1(b)(i)	$\frac{10x + 11y}{x + y} = 10.8$ **OR** ratio 10:11 = 1:4 **OR** 20:80 etc	1	Allow idea that there are 5 × 0.2 divisions between 10 and 11
	abundance of ^{10}B is <u>20</u>(%) **OR** $\frac{10x}{100} + \frac{11(100-x)}{100} = 10.8$ 10x + 1100 – 11x = 1080 ∴ x = 1100 – 1080 = 20%	1	Correct answer scores M1 and M2
1(b)(ii)	Same number of electrons (in outer shell or orbital) Same electronic configuration / arrangement	1	Ignore electrons determine chemical properties. Ignore protons unless wrong.

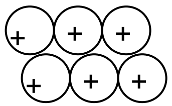
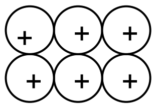
1(c)	Range between 3500 and 10 000 kJ mol^{-1}	1	

1(d)	$B^{+}(g) \longrightarrow B^{2+}(g) + e^{(-)}$ $B^{+}(g) - e^{(-)} \longrightarrow B^{2+}(g)$ $B^{+}(g) + e^{(-)} \longrightarrow B^{2+}(g) + 2e^{(-)}$	1	Ignore state symbol on electron even if wrong.

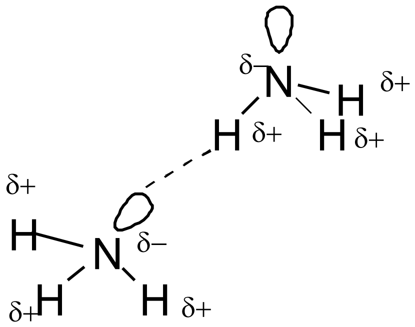
1(e)	Electron being removed from a positive ion (therefore need more energy) / electron being removed is closer to the nucleus	1	Must imply removal of an electron. Allow electron removed from a + particle/ species or from a 2+ ion. Not electron removed from a higher/lower energy level / shell. Not electron removed from a higher energy sub-level / orbital. Ignore electron removed from a lower energy sub-level / orbital. Ignore ‘more protons than electrons’. Not ‘greater nuclear charge’. Ignore ‘greater effective nuclear charge’. Ignore shielding.

Question	Marking Guidance	Mark	Comments
2(a)(i)	2.16 ÷ 241.8 = 0.00893 or 8.93×10^{-3} (mol)	1	Penalise if not 3 significant figures.
2(a)(ii)	$n(O_2)$ = 0.00893 × 0.75 (= 0.00670 mol)	1	Allow (a)(i) × 0.75
2(a)(iii)	M1 = T = 566 K and P = 100 000 Pa	1	If M1 incorrect can only score M2 and M3
	M2 = Moles NO_2 = 0.0268 (mol)	1	If M2 incorrect can only score M1 and M3 Allow moles of NO_2 = student's answer to (a)(i) × 3 **OR** (a)(ii) × 4 and consequential M4 Minimum of 2 significant figures.
	M3 = $V = \frac{nRT}{p}$ **OR** = $\frac{0.0268 \times 8.31 \times 566}{100\ 000}$	1	If M3 incorrect can only score M1 and M2
	M4 = 0.00126 (m^3) or 1.26×10^{-3} (m^3)	1	Allow minimum of 2 significant figures. Allow no units but incorrect units loses M4 **If 0.00642 moles used:** M2 = Moles NO_2 = 0.0193 mol M3 = $V = \frac{nRT}{p} = \frac{0.0193 \times 8.31 \times 566}{100\ 000}$ M4 = 9.06×10^{-4} (m^3) allow 9.06 to 9.08×10^{-4}

2(b)	(Thermal) decomposition	1	Do not allow catalytic decomposition.
2(c)	Other products are gases / other products escape easily	1	Allow no other solid (or liquid) product.

Question	Marking Guidance	Mark	Comments
3(a)(i)	d (block) **OR** D (block)	1	Ignore transition metals / series. Do not allow any numbers in the answer.
3(a)(ii)	Contains positive (metal) ions or protons or nuclei and delocalised / mobile / free / sea of electrons Strong attraction between them or strong metallic bonds	1 1	Ignore atoms. Allow 'needs a lot of energy to break / overcome' instead of 'strong'. If strong attraction between incorrect particles, then CE = 0/2 If molecules / intermolecular forces / covalent bonding / ionic bonding mentioned then CE=0
3(a)(iii)	 **OR** 	2	M1 is for regular arrangement of atoms / ions (min 6 metal particles). M2 for + sign in each metal atom / ion. Allow 2+ sign.
3(a)(iv)	Layers / planes / sheets of atoms or ions can slide over one another	1	QoL
3(b)(i)	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^8\ (4s^0)$	1	Only.

3(b)(ii)	$NiCl_2{\cdot}6H_2O$ + **6** $SOCl_2$ ⟶ $NiCl_2$ + **6** SO_2 + **12** HCl	1	Allow multiples.
	NaOH / NH_3 / $CaCO_3$ / CaO	1	Allow any name or formula of alkali or base. Allow water.

Question	Marking Guidance	Mark	Comments
4(a)(i)	Hydrogen bonds / H bonds	1	Not just hydrogen.
4(a)(ii)		3	M1 – lone pair on each N M2 – correct partial charges must be shown on the N and H of a bond in each molecule. M3 – for the H bond from lone pair on N to the Hδ+ on the other NH_3 molecule. If not ammonia molecules, CE = 0/3
4(b)	Lone pair / both electrons / 2 electrons / electron pair on $N(H_3)$ is donated to $B(Cl_3)$	1	Allow both electrons in the bond come from $N(H_3)$

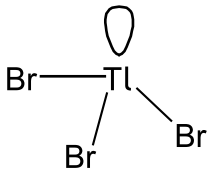
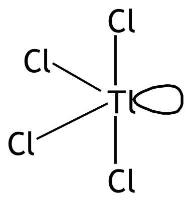
4(c)(i)	The power of an atom or nucleus to withdraw or attract electrons or electron density or a pair of electrons (towards itself) in a covalent bond	1 1	
4(c)(ii)	LiF **OR** Li_2O **OR** LiH	1	Allow Li_2O_2, allow correct lithium carbide formula.
4(c)(iii)	BH_3 / H_3B	1	Allow B_2H_6 / H_6B_2 Do not allow lower case letters.

Question	Marking Guidance	Mark	Comments
5(a)	Crude oil **OR** petroleum Fractional distillation / fractionation	1 1	Not petrol. Not distillation alone.
5(b)	$C_{12}H_{26} + 12.5O_2 \longrightarrow 12CO + 13H_2O$	1	Allow balanced equations that produce CO_2 in addition to CO Accept multiples.
5(c)(i)	M1 Nitrogen and oxygen (from air) react / combine / allow a correct equation M2 at high temperatures	1 1	If nitrogen from petrol / paraffin / impurities CE=0/2 Allow temperatures above 1000 °C or spark. Not just heat or hot. M2 dependent on M1 But allow 1 mark for nitrogen and oxygen together at high temperatures.
5(c)(ii)	$2NO + O_2 \longrightarrow 2NO_2$	1	Allow multiples.
5(c)(iii)	$4NO_2 + 2H_2O + O_2 \longrightarrow 4HNO_3$	1	Allow multiples.
5(d)(i)	C_nH_{2n+2} CnH2n+2	1	Allow C_xH_{2x+2} Allow CxH2x+2

5(d)(ii)	$C_{12}H_{26} \longrightarrow C_6H_{14} + C_6H_{12}$	1	Only.
	C_3H_7	1	Only.
	Zeolite / aluminosilicate(s)	1	Ignore aluminium oxide.
5(d)(iii)	Larger molecule / longer carbon chain / more electrons / larger surface area	1	
	More / stronger <u>van der Waals' forces between molecules</u>	1	Allow dispersion forces / London forces / temporary induced dipole-dipole forces <u>between molecules.</u> If breaking bonds, CE = 0/2
5(e)	2,2,3,3,4,4-hexamethylhexane	1	Only. Ignore punctuation.
	Chain	1	Ignore branch(ed).
5(f)	Cl_2 Cl–Cl	1	Only. Not CL_2 or Cl2 or CL2 or Cl^2 or CL^2 Ignore Chlorine.

Question	Marking Guidance	Mark	Comments
6(a)(i)	M1 - M_r calcium phosphate = 310(.3)	1	If M_r wrong, lose M1 and M5
	M2 - Moles calcium phosphate = $\frac{7.26}{M1}$ (= 0.0234)	1	0.0234 moles can score M1 and M2 If M_r incorrect, can score M2 for $\frac{7.26}{M1}$ Allow M2 and/or M3 to 2 significant figures here but will lose M5 if answer not 1.23
	M3 - Moles phosphoric acid = 2 × 0.0234 = 0.0468	1	Allow student's M2 × 2. If not multiplied by 2 then lose M3 and M5
	M4 - Vol phosphoric acid = 0.038(0) dm^3	1	If not 0.038(0) dm^3 then lose M4 and M5
	Conc phosphoric acid = $\frac{0.0468}{0.038(0)}$		
	M5 = <u>1.23</u> **(**mol dm^{-3})	1	This answer only – unless arithmetic or transcription error that has been penalised by 1 mark. Allow no units but incorrect units loses M5

6(a)(ii)	$\frac{492.3}{688.3} \times 100$ **OR** $\frac{492}{688} \times 100$ = 71.5%	2	1 mark for both M_r correctly placed.
6(b)	$3Ca(OH)_2 + 2H_3PO_4 \longrightarrow Ca_3(PO_4)_2 + 6H_2O$	1	Allow multiples.
6(c)			If x=2 with no working, allow M4 only.
	Ca: $\frac{1.67}{40.1}$ (H: $\frac{0.17}{1}$) P: $\frac{2.59}{31}$ (O: $\frac{5.33}{16}$)	1 1	Ca = 1.67 g (M1). Mark for dividing by correct A_r in Ca and P (M2). If M1 incorrect can only score M2
	= 0.042 (0.17) 0.084 (0.333) 1 (4) 2 (8)	1	Correct ratio (M3).
	$CaH_4P_2O_8$ **OR** $Ca(H_2PO_4)_2$ **OR** x = 2	1	Value of x or correct formula (M4).
	Alternative Ca: $\frac{1.67}{40.1}$ H_2PO_4: $\frac{8.09}{97.0}$		Ca = 1.67 g (M1). Mark for dividing by correct A_r / M_r in Ca and H_2PO_4 (M2). If M1 incorrect can only score M2
	= 0.042 0.083 1 2		Correct ratio (M3).
	$CaH_4P_2O_8$ **OR** $Ca(H_2PO_4)_2$ **OR** x = 2		Value of x or correct formula (M4).

Question	Marking Guidance	Mark	Comments
7(a)	 	2	Mark is for correct number of bonds and lone pair in each case. Ignore charges if shown.
	Pyramidal/ trigonal pyramid	1	Allow tetrahedral.
	107^0	1	Allow 107 to 107.5º
7(b)	M1 Ionic	1	CE = 0/3 if not ionic.
	M2 Oppositely charged ions / Tl^+ and Br^- ions	1	If molecules / intermolecular forces / metallic bonding, CE=0
	M3 Strong attraction between ions	1	M3 dependent on M2 Allow 'needs a lot of energy to break / overcome' instead of 'strong'.
7(c)	$Tl + \frac{1}{2}Br_2 \longrightarrow TlBr$	1	Allow multiples. Ignore state symbols even if incorrect.

General principles applied to marking CHEM1 papers by CMI+ (June 2014)

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).

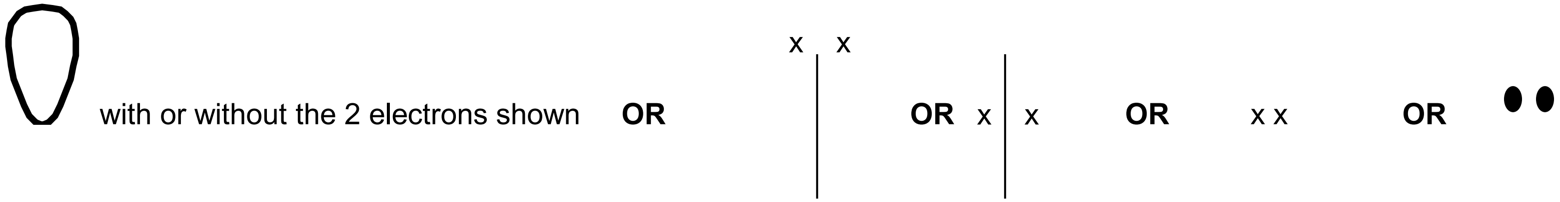
NB Some terms may be required to be spelled correctly or an idea needs to be articulated with clarity, as part of the "Quality of Language" (**QoL**) marking. These will be identified in the mark scheme and marks are awarded only if the QoL criterion is satisfied.

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.



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:-