

Mark Scheme (Results)

Summer 2016

Pearson Edexcel GCE
in Chemistry (6CH02) Paper 01
Application of Core Principles of
Chemistry

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General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.
- Mark schemes will indicate within the table where, and which strands of QWC, are being assessed. The strands are as follows:
 - i) ensure that text is legible and that spelling, punctuation and grammar are accurate so that meaning is clear
 - ii) select and use a form and style of writing appropriate to purpose and to complex subject matter
 - iii) organise information clearly and coherently, using specialist vocabulary when appropriate

Using the Mark Scheme

Examiners should look for qualities to reward rather than faults to penalise. This does NOT mean giving credit for incorrect or inadequate answers, but it does mean allowing candidates to be rewarded for answers showing correct application of principles and knowledge. Examiners should therefore read carefully and consider every response: even if it is not what is expected it may be worthy of credit.

The mark scheme gives examiners:

- an idea of the types of response expected
- how individual marks are to be awarded
- the total mark for each question
- examples of responses that should NOT receive credit.

/ means that the responses are alternatives and either answer should receive full credit.

() means that a phrase/word is not essential for the award of the mark, but helps the examiner to get the sense of the expected answer.

Phrases/words in bold indicate that the meaning of the phrase or the actual word is essential to the answer.

ecf/TE/cq (error carried forward) means that a wrong answer given in an earlier part of a question is used correctly in answer to a later part of the same question.

Candidates must make their meaning clear to the examiner to gain the mark. Make sure that the answer makes sense. Do not give credit for correct words/phrases which are put together in a meaningless manner. Answers must be in the correct context.

Quality of Written Communication

Questions which involve the writing of continuous prose will expect candidates to:

- write legibly, with accurate use of spelling, grammar and punctuation in order to make the meaning clear
- select and use a form and style of writing appropriate to purpose and to complex subject matter
- organise information clearly and coherently, using specialist vocabulary when appropriate.

Full marks will be awarded if the candidate has demonstrated the above abilities.

Questions where QWC is likely to be particularly important are indicated (QWC) in the mark scheme, but this does not preclude others.

Section A (multiple choice)

Question Number	Correct Answer	Reject	Mark
1	C		(1)

Question Number	Correct Answer	Reject	Mark
2 (a)	B		(1)

Question Number	Correct Answer	Reject	Mark
2 (b)	D		(1)

Question Number	Correct Answer	Reject	Mark
2 (c)	B		(1)

Question Number	Correct Answer	Reject	Mark
2 (d)	A		(1)

Question Number	Correct Answer	Reject	Mark
3	B		(1)

Question Number	Correct Answer	Reject	Mark
4 (a)	D		(1)

Question Number	Correct Answer	Reject	Mark
4 (b)	A		(1)

Question Number	Correct Answer	Reject	Mark
4 (c)	B		(1)

Question Number	Correct Answer	Reject	Mark
4 (d)	C		(1)

Question Number	Correct Answer	Reject	Mark
5	C		(1)

Question Number	Correct Answer	Reject	Mark
6 (a)	A		(1)

Question Number	Correct Answer	Reject	Mark
6 (b)	C		(1)

Question Number	Correct Answer	Reject	Mark
7	D		(1)

Question Number	Correct Answer	Reject	Mark
8	C		(1)

9	C		(1)
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Question Number	Correct Answer	Reject	Mark
10 (a)	D		(1)

Question Number	Correct Answer	Reject	Mark
10 (b)	D		(1)

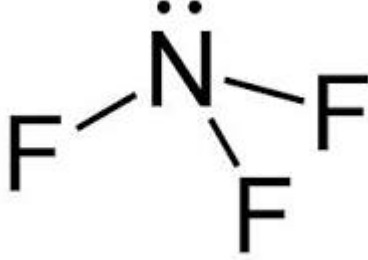
Question Number	Correct Answer	Reject	Mark
11	B		(1)

Question Number	Correct Answer	Reject	Mark
12	B		(1)

Total for Section A = 20 marks

Section B

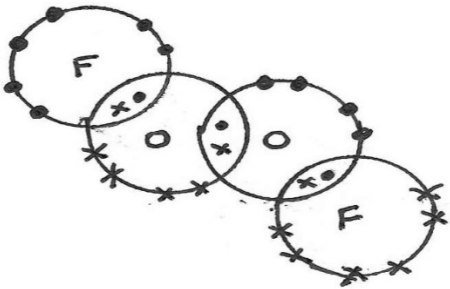
Question Number	Acceptable Answers	Reject	Mark
13(a)(i)	Ignore drawn shapes Shape is trigonal planar/ triangular planar (1) Bond angle 120(°) (1) Mark independently BUT no TE on incorrect shape	...pyramidal Just planar °C	(20)

Question Number	Acceptable Answers	Reject	Mark
* 13(a)(ii)	<p>(Shape) Ignore references to tetrahedral/pyramidal</p>  <p>NOTE: Lone pair on central N atom NOT required ALLOW: Any correct variation as long as the shape is clear (1)</p> <p>(Bond angle) 107° ALLOW Any angle between 106° – 108° OR 102° (as this is the actual bond angle) (1)</p> <p>Mark independently</p> <p>(Explanation)</p> <p>Minimum repulsion/maximum separation (between pairs of electrons) (1)</p> <p>Lone pair-bond pair repulsions are greater/ more than bond pair-bond pair repulsions</p> <p>ALLOW</p> <p>Lone pair(s) repel more than bond pair(s) (1)</p> <p>Mark independently</p>	<p>No M1 if incorrect name for shape eg bipyramidal</p> <p>...between atoms / Just bonds repel</p>	(4)

Question Number	Correct Answer	Reject	Mark
13(a)(iii)	<p>M1</p> <pre> F F F—N→B—F F F </pre> <p>OR</p> <pre> F F F—N—B—F F F </pre> <p>OR</p> <p>Dot and cross diagram, allow all dots or crosses.</p> <p>IGNORE omission of non-bonding electrons on Fs.</p> <p>But no mark if dot and cross shown for N-B bond.</p> <p style="text-align: right;">(1)</p> <p>M2 Dative covalent (bond)</p> <p style="text-align: right;">(1)</p> <p>Mark independently</p>	No M1 if dative bond categorically from B to N	(2)

Question Number	Correct Answer	Reject	Mark
13(b)(i)	+2 ALLOW 2+		(1)

Question Number	Correct Answer	Reject	Mark
13(b)(ii)	$\text{OF}_2 + \text{H}_2\text{O} \rightarrow 2\text{HF} + \text{O}_2$ <p>Ignore state symbols even if incorrect</p> <p>Allow multiples</p>	H_2F_2	(1)

Question Number	Correct Answer	Reject	Mark
13(c)	Accept all dots OR all crosses 		(1)

(Total for Question 13 = 11 marks)

Question Number	Correct Answer	Reject	Mark
14(a)(i)	<p>As a (co-)solvent for both aqueous silver nitrate and bromoalkane</p> <p>OR</p> <p>As a (co-)solvent for polar and non-polar molecules</p> <p>OR</p> <p>To dissolve the halogenoalkane (as it is not water soluble)</p> <p>OR</p> <p>To allow the reagents/reactants to mix/dissolve</p>		(1)

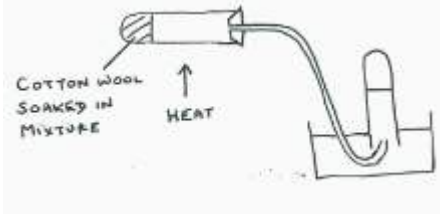
Question Number	Correct Answer	Reject	Mark
14(a)(ii)	<p>$C_4H_9Br + H_2O \rightarrow C_4H_9OH + HBr$</p> <p>OR</p> <p>$C_4H_9Br + H_2O \rightarrow C_4H_9OH + H^+ + Br^-$</p> <p>Ignore state symbols even if incorrect</p>		(1)

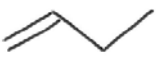
Question Number	Correct Answer	Reject	Mark
14(a)(iii)	<p>Cream</p> <p>ALLOW</p> <p>Pale yellow/off-white</p> <p>(1)</p> <p>$Ag^+(aq) + Br^-(aq) \rightarrow AgBr(s)$</p> <p>(1)</p>	<p>Just "yellow"</p> <p>Just "white"</p>	(2)

Question Number	Correct Answer	Reject	Mark
14(a)(iv)	Concentrated ammonia (solution) / Concentrated NH_3 ((aq)) ALLOW 'c' or 'conc' for concentrated IGNORE References to "excess"		(1)

Question Number	Correct Answer	Reject	Mark
14(a)(v)	C, B, A NOTE The letters must be in this order		1

Question Number	Correct Answer	Reject	Mark
* 14(a)(vi)	<p>Any two from</p> <ul style="list-style-type: none"> • Tertiary is the fastest / primary is the slowest • The C-Br bond is weakest in 2-methylbromopropane / in the tertiary (compound) <p>ALLOW here: The weaker the C-Br bond, the faster the hydrolysis</p> <ul style="list-style-type: none"> • (This is because the) methyl groups donate electrons <p>OR</p> <p>methyl groups are electron releasing</p> <p>OR</p> <p>(positive) inductive effect of methyl groups</p> <p>IGNORE</p> <p>Any resultant effect on the polarity of the C-Br bond, even if incorrect</p> <ul style="list-style-type: none"> • Tertiary carbocation OR intermediate formed by tertiary is (more) stable <p>ALLOW branched for tertiary in all points</p> <p>IGNORE</p> <p>Any references to steric hindrance</p> <p>Any references to S_N1 and/or S_N2</p>	<p>If states that tertiary bromoalkane dissolves fastest</p>	<p>(2)</p>

Question Number	Correct Answer	Reject	Mark
14(b)(i)	 <p>M1: All three of the following points</p> <ul style="list-style-type: none"> • (Cotton) wool / mineral wool / ceramic fibre (soaked in reactant) • in a reasonably horizontal test tube • heating (shown anywhere under horizontal tube) <p style="text-align: right;">(1)</p> <p>M2: Collection of gas over water / in a gas syringe</p> <p style="text-align: right;">(1)</p> <p>Ignore Bunsen valve</p> <p>Mark these scoring points independently</p>		(2)

Question Number	Correct Answer	Reject	Mark
14(b)(ii)	But-1-ene ALLOW 1-butene  (1) (1)	Butene Butan-1-ene Butanene	(2)

Question Number	Correct Answer	Reject	Mark
14(c)(i)	(Type) substitution (1) (Mechanism) nucleophilic (1) Allow words in either order Just "S _N 2" scores one mark	Elimination Electrophilic / (free) radical S _N 1	(2)

Question Number	Correct Answer	Reject	Mark
14(c)(ii)	Butylamine/1-aminobutane/1-butylamine		(1)

(Total for Question 14 = 15 marks)

Question Number	Correct Answer	Reject	Mark
15(a)	<p>M1: The salt dissolves in the water (of crystallization) / the salt dissolves in (its) water of crystallization</p> <p>NOTE:</p> <p>For M1 it needs to be clear that the water came from the initial solid (1)</p> <p>M2: Water boils/water evaporates (1)</p> <p>M3: (Anhydrous) magnesium nitrate / $Mg(NO_3)_2$ crystallizes OR (Anhydrous) magnesium nitrate / $Mg(NO_3)_2$ is formed</p> <p>ALLOW for M3: (White) solid formed as the concentration becomes too high / as water is driven off</p> <p>OR Solid reforms/forms (1)</p>	Any mention of 'melt(s)'	(3)

Question Number	Correct Answer	Reject	Mark
15(b)(i)	<p>NOTE 1: The chemicals identified MUST correspond to the correct Stage number</p> <p>NOTE 2: Award mark in each case for either the correct name or the correct formula. HOWEVER if both a name AND a formula are given, BOTH must be correct.</p> <p>Stage 5: Nitrogen dioxide / NO₂ / N₂O₄ (is the brown gas) (1)</p> <p>Stage 6: Oxygen / O₂ (relights a glowing splint) (1)</p> <p>Stage 7: Magnesium oxide / MgO (is the white solid) (1)</p>	Just "O" for oxygen's formula	(3)

Question Number	Correct Answer	Reject	Mark
15(b)(ii)	<p>$2\text{Mg}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O} \rightarrow 2\text{MgO} + 4\text{NO}_2 + \text{O}_2 + 12\text{H}_2\text{O}$ Ignore state symbols even if incorrect</p> <p>ALLOW multiples ALLOW 2N₂O₄ for 4NO₂</p> <p>M1 Correct entities (1)</p> <p>M2 Balancing (1) M2 depends on M1</p> <p>Special case</p> <p>If the anhydrous salt equation is given: $2\text{Mg}(\text{NO}_3)_2 \rightarrow 2\text{MgO} + 4\text{NO}_2 + \text{O}_2$ scores 1 max</p>		(2)

Question Number	Correct Answer	Reject	Mark
15(c)(i)	(Magnesium chloride) Colourless / no colour (1)	UV/white/bright white	(2)
	(Calcium chloride) Yellow-red OR brick-red OR red ALLOW Orange-red (1)	Crimson Just 'orange' Just 'yellow'	

Question Number	Correct Answer	Reject	Mark
* 15(c)(ii)	M1 – for idea of electrons being promoted (Heating) promotes electrons / excites electrons (to higher energy levels) (1)	Just molecules gain energy	(3)
	M2 – for idea of electrons falling back down Electrons fall back (to lower levels / ground states) (1)		
	M3 – for idea of emission of light Emitting (visible) light / emitting photons (1)	No M3 if mention of energy / light absorbed	

Question Number	Correct Answer	Reject	Mark
15(c)(iii)	<p>M1:</p> <p>EITHER</p> <p>In magnesium the energy levels are further apart / the energy levels are different</p> <p>OR</p> <p>In calcium the energy levels are closer / the energy levels are different</p> <p>IGNORE</p> <p>Any comparison of the relative numbers of energy levels</p> <p>M2:</p> <p>For magnesium, the energy released is outside the visible spectrum / visible region</p> <p>OR</p> <p>For calcium, the energy released is inside the visible spectrum / visible region</p> <p>OR</p> <p>the energy released is in the red region (of the spectrum)</p> <p>OR</p> <p>Different amounts of energy are released</p> <p>OR</p> <p>Different frequencies / wavelengths emitted</p> <p>(1)</p> <p>Mark these points independently</p>	Just "no transitions for magnesium"	(2)

(Total for Question 15 = 15 marks)

Total for Section B = 41 marks

Section C

Question Number	Correct Answer	Reject	Mark
16(a)(i)	$ \begin{array}{c} \text{Cl} \quad \text{H} \\ \quad \\ \text{Cl}-\text{C}-\text{C}-\text{H} \\ \quad \\ \text{Cl} \quad \text{H} \end{array} $	Skeletal / structural formulae	(1)

Question Number	Correct Answer	Reject	Mark
16(a)(ii)	<p>Read the whole answer first</p> <p>Any two from</p> <ul style="list-style-type: none"> (Higher boiling temperature) because it has stronger/more London forces (Because it has) more electrons (66 compared with 50) <p>IGNORE</p> <p>References to larger electron cloud / higher electron density / greater M_r / incorrect 'counting' of electrons in either or both molecules</p> <ul style="list-style-type: none"> 1,1,1-trichloroethane has dipole-dipole interactions (Because the molecule is polar due to) polar C-Cl bonds <p>OR</p> <ul style="list-style-type: none"> Cl is more electronegative than C OR Cl is more electronegative than H <p>OR</p> <p>Cl atoms on same side (of molecule)</p> <p>OR</p> <p>C-Cl dipoles do not cancel</p> <ul style="list-style-type: none"> Hexane has only London forces 	Any reference to breaking covalent bonds scores (0) overall	(2)

Question Number	Correct Answer	Reject	Mark
16(a)(iii)	<p>Because they damage the ozone layer</p> <p>OR</p> <p>(Halothane products like) 1,1,1-trichloroethane are narcotic inhalants / poisonous / toxic</p> <p>IGNORE</p> <p>References to just:</p> <ul style="list-style-type: none"> • formation of chlorine radicals • formation of Cl• • carcinogen 	Any statement that this compound is a CFC / forms Cl ₂ (on breaking down)	(1)

Question Number	Correct Answer	Reject	Mark
16(b)(i)	<p>ICI is a stronger electrophile / better electrophile</p> <p>Allow a correct description of an electrophile even if the term is not used. e.g. ICl has a vacancy for a bonding pair of electrons</p> <p>OR</p> <p>the ICl (bond) is polar</p> <p>NOTE:</p> <p>ALLOW the ICl (bond) is more polar</p> <p>OR</p> <p>Mention of presence of the I^{δ+} (in ICl)</p> <p>ALLOW</p> <p>'It' for ICl</p>	Any references to Cl attacking the C=C	(1)

Question Number	Correct Answer	Reject	Mark
16(b)(ii)	$\begin{array}{c} \text{I} \quad \text{Cl} \\ \quad \\ \text{CH}_3(\text{CH}_2)_7 - \text{C} - \text{C} - (\text{CH}_2)_7\text{COOH} \\ \quad \\ \text{H} \quad \text{H} \end{array}$ <p>I and Cl can be interchanged and on either side</p> <p>Look out for only I or Cl added without hydrogen, also 2I and 2Cl added.</p>	I and Cl on the same carbon	(1)

Question Number	Correct Answer	Reject	Mark
16(b)(iii)	<p>To prevent formation of free radicals</p> <p>OR</p> <p>To prevent (free radical) substitution</p> <p>OR</p> <p>To prevent (I-Cl) bonds breaking homolytically</p> <p>ALLOW</p> <p>UV causes it to react / to decompose</p> <p>IGNORE</p> <p>light causes it to react / to decompose</p>	<p>Causes oxidation</p> <p>C-Cl breaks</p>	(1)

Question Number	Correct Answer	Reject	Mark
16(b)(iv)	<p>ALL THREE oxidation numbers must be correct:</p> <p>(Iodine monochloride) +1 ALLOW 1+</p> <p>(Iodide ion) -1 ALLOW 1-</p> <p>(Iodine) 0 (1)</p> <p>(Ionic equation)</p> $\text{ICl} + \text{I}^- \rightarrow \text{I}_2 + \text{Cl}^-$ <p>Ignore state symbols even if incorrect</p> <p>Both partial and full charges on ICl are acceptable, provided they are the right way around (1)</p>		(2)

Question Number	Correct Answer	Reject	Mark
16(c)	<p>(Indicator)</p> <p>Starch (solution) (1)</p> <p>(Colour change from) Blue-black to colourless</p> <p>ALLOW Blue to colourless OR Black to colourless</p> <p>IGNORE References to 'clear' (1)</p> <p>Mark independently</p>	No M2 if states "From purple to ..."	(2)

In 16(d) penalise incorrect units once only

Question Number	Correct Answer	Reject	Mark
16(d)(i)	Number of moles of thiosulfate = $\frac{20.0 \times 0.100}{1000} = 2(.00) \times 10^{-3} / 0.002(00)$		(1)

Question Number	Correct Answer	Reject	Mark
16(d)(ii)	$(2S_2O_3^{2-}(aq) + I_2(aq) \rightarrow S_4O_6^{2-} + 2I^-)$ IGNORE state symbols even if incorrect		(1)

ALLOW TE in all remaining parts from the previous part(s) Calculators needed!

PENALISE rounding errors in (d)(v) to (d)(vii) only once

Also penalise 1 SF in (d)(v) to (d)(vii) only once

Question Number	Correct Answer	Reject	Mark
16(d)(iii)	Number of moles of iodine $= 0.002(00) \div 2$ $= 1(.00) \times 10^{-3} / 0.001(00)$ (mol)		(1)

Question Number	Correct Answer	Reject	Mark
16(d)(iv)	$1(.00) \times 10^{-3} / 0.001(00)$ (mol)		(1)

Question Number	Correct Answer	Reject	Mark
16(d)(v)	$(0.001(00) - 0.000365)$ $= 6.35 \times 10^{-4} / 0.000635$ (mol)		(1)

Question Number	Correct Answer	Reject	Mark
16(d)(vi)	$(\frac{0.000635 \times 100}{0.2(00)} \text{ OR } 0.000635 \times 500)$ $= 0.3175$ (mol)		(1)

Question Number	Correct Answer	Reject	Mark
16(d)(vii)	$0.3175 \times 2 \times 126.9 = 80.5815$ (g) If student uses A_r for I = 127, final answer equals 80.645 (g)		(1)

If d(iii)/(iv) is 0.002 this gives 0.001635, 0.8175 and 207.4815 for (v) to (vii)

If d(iii)/(iv) is 0.0005 this gives 0.000135, 0.0675 and 17.1315 for (v) to (vii)

Question Number	Correct Answer	Reject	Mark
16(e)	(Sample titre) Higher and (Iodine value) Lower		1

(Total for Section C = 19 Marks)

TOTAL FOR PAPER = 80 MARKS

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