AQA

A-LEVEL
Chemistry

7405/1 - Paper 1 Inorganic and Physical Chemistry

Mark scheme

June 2018

Version/Stage: 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

AS and A-Level Chemistry
Mark Scheme Instructions for Examiners

1. General

The mark scheme for each question shows:

- the marks available for each part of the question
- the total marks available for the question
- the typical answer or answers which are expected
- extra information to help the examiner make his or her judgement and help to delineate what is acceptable or not worthy of credit or, in discursive answers, to give an overview of the area in which a mark or marks may be awarded.

The extra information in the 'Comments' column is aligned to the appropriate answer in the left-hand part of the mark scheme and should only be applied to that item in the mark scheme.

You should mark according to the contents of the mark scheme. If you are in any doubt about applying the mark scheme to a particular response, consult your Team Leader.

At the beginning of a part of a question a reminder may be given, for example: where consequential marking needs to be considered in a calculation; or the answer may be on the diagram or at a different place on the script.

In general the right-hand side of the mark scheme is there to provide those extra details which might confuse the main part of the mark scheme yet may be helpful in ensuring that marking is straightforward and consistent.

The use of M1, M2, M3 etc in the right-hand column refers to the marking points in the order in which they appear in the mark scheme. So, M1 refers to the first marking point, M2 the second marking point etc.

2. Emboldening

2.1 In a list of acceptable answers where more than one mark is available 'any **two** from' is used, with the number of marks emboldened. Each of the following bullet points is a potential mark.

2.2 A bold **and** is used to indicate that both parts of the answer are required to award the mark.

2.3 Alternative answers acceptable for a mark are indicated by the use of **OR**. Different terms in the mark scheme are shown by a / ; eg allow smooth / free movement.

3. Marking points

3.1 Marking of lists

This applies to questions requiring a set number of responses, but for which students have provided extra responses. The general 'List' principle to be followed in such a situation is that 'right + wrong = wrong'.

Each error / contradiction negates each correct response. So, if the number of error / contradictions equals or exceeds the number of marks available for the question, no marks can be awarded.

However, responses considered to be neutral (often prefaced by 'Ignore' in the mark scheme) are not penalised.

For example, in a question requiring 2 answers for 2 marks:

Correct answers	Incorrect answers (i.e. incorrect rather than neutral)	Mark (2)	Comment
1	0	1	
1	1	1	They have not exceeded the maximum number of responses so there is no penalty.
1	2	0	They have exceeded the maximum number of responses so the extra incorrect response cancels the correct one.
2	0	2	
2	1	1	
2	2	0	
3	0	2	The maximum mark is 2
3	1	1	The incorrect response cancels out one of the two correct responses that gained credit.
3	2	0	Two incorrect responses cancel out the two marks gained.
3	3	0	

3.2 Marking procedure for calculations

Full marks should be awarded for a correct numerical answer, without any working shown, unless the question states 'Show your working' or 'justify your answer'. In this case, the mark scheme will clearly indicate what is required to gain full credit.

If an answer to a calculation is incorrect and working is shown, process mark(s) can usually be gained by correct substitution / working and this is shown in the 'Comments' column or by each stage of a longer calculation.

3.3 Errors carried forward, consequential marking and arithmetic errors

Allowances for errors carried forward are most likely to be restricted to calculation questions and should be shown by the abbreviation ECF or consequential in the marking scheme.

An arithmetic error should be penalised for one mark only unless otherwise amplified in the marking scheme. Arithmetic errors may arise from a slip in a calculation or from an incorrect transfer of a numerical value from data given in a question.

3.4 Equations

In questions requiring students to write equations, state symbols are generally ignored unless otherwise stated in the 'Comments' column.

Examiners should also credit correct equations using multiples and fractions unless otherwise stated in the 'Comments' column.

3.5 Oxidation states

In general, the sign for an oxidation state will be assumed to be positive unless specifically shown to be negative.

3.6 Interpretation of 'it'

Answers using the word 'it' should be given credit only if it is clear that the 'it' refers to the correct subject.

3.7 Phonetic spelling

The phonetic spelling of correct scientific terminology should be credited **unless** there is a possible confusion with another technical term or if the question requires correct IUPAC nomenclature.

3.8 Brackets

(…..) are used to indicate information which is not essential for the mark to be awarded but is included to help the examiner identify the sense of the answer required.

3.9 Ignore / Insufficient / Do not allow

Ignore or insufficient is used when the information given is irrelevant to the question or not enough to gain the marking point. Any further correct amplification could gain the marking point.

Do **not** allow means that this is a wrong answer which, even if the correct answer is given, will still mean that the mark is not awarded.

3.10 Marking crossed out work

Crossed out work that **has not been** replaced should be marked as if it were not crossed out, if possible. Where crossed out work **has been** replaced, the replacement work and not the crossed out work should be marked.

3.11 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 both the name and the formula are used. Specific details will be given in mark schemes.

The guiding principle is that a reagent is a chemical which can be taken out of a bottle or container. Failure to identify complete reagents **will be penalised**, but follow-on marks (e.g. for a subsequent equation or observation) can be scored from an incorrect attempt (possibly an incomplete reagent) at the correct reagent. Specific details will be given in mark schemes.

For example, **no credit** would be given for

- the cyanide ion or CN^- when the reagent should be potassium cyanide or KCN;
- the hydroxide ion or OH^- when the reagent should be sodium hydroxide or NaOH;

- the $Ag(NH_3)_2^+$ ion when the reagent should be Tollens' reagent (or ammoniacal silver nitrate). In this example, no credit is given for the ion, but credit could be given for a correct observation following on from the use of the ion. Specific details will be given in mark schemes.

In the event that a student provides, for example, **both** KCN and cyanide ion, it would be usual to ignore the reference to the cyanide ion (because this is not contradictory) and credit the KCN. Specific details will be given in mark schemes.

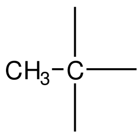
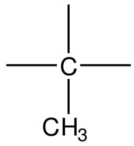
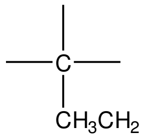
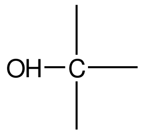
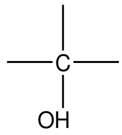
3.12 Organic structures

Where students are asked to draw organic structures, unless a specific type is required in the question and stated in the mark scheme, these may be given as displayed, structural or skeletal formulas or a combination of all three as long as the result is unambiguous.

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.
- Skeletal formulae must show carbon atoms by an angle or suitable intersection in the skeleton chain. Functional groups must be shown and it is essential that all atoms other than C atoms are shown in these (except H atoms in the functional groups of aldehydes, secondary amines and N-substituted amides which do not need to be shown).
- Structures must not be ambiguous, e.g. 1-bromopropane should be shown as $CH_3CH_2CH_2Br$ and not as the molecular formula C_3H_7Br which could also represent the isomeric 2-bromopropane.
- Bonds should be drawn correctly between the relevant atoms. This principle applies in all cases where the attached functional group contains a carbon atom, e.g nitrile, carboxylic acid, aldehyde and acid chloride. The carbon-carbon bond should be clearly shown. Wrongly bonded atoms will be penalised **on every occasion**. (see the examples below)
- The same principle should also be applied to the structure of alcohols. For example, if students show the alcohol functional group as C ─ HO, they should be penalised **on every occasion**.
- Latitude should be given to the representation of C ─ C bonds in alkyl groups, given that CH_3─ is considered to be interchangeable with H_3C─ even though the latter would be preferred.
- Similar latitude should be given to the representation of amines where NH_2─ C will be allowed, although H_2N─ C would be preferred.
- Poor presentation of vertical C ─ CH_3 bonds or vertical C ─ NH_2 bonds should **not** be penalised. For other functional groups, such as ─ OH and ─ CN, the limit of tolerance is the half-way position between the vertical bond and the relevant atoms in the attached group.

By way of illustration, the following would apply.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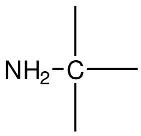	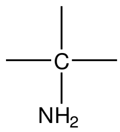	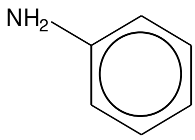	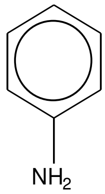	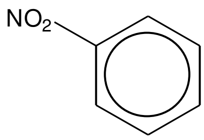
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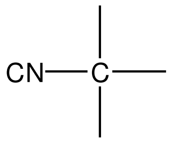	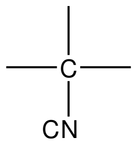	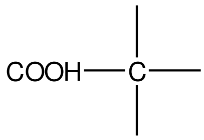	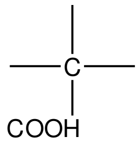	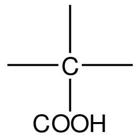
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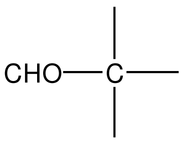
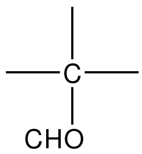
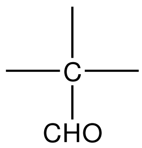
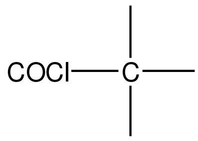
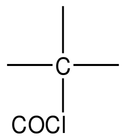
				
not allowed	not allowed	not allowed	not allowed	not allowed

- Representation of CH_2 by C–H_2 will be penalised
- Some examples are given here of **structures** for specific compounds that should **not** gain credit (but, exceptions <u>may</u> be made in the context of balancing equations)

CH_3COH	for	ethanal
CH_3CH_2HO	for	ethanol
$OHCH_2CH_3$	for	ethanol
C_2H_6O	for	ethanol
CH_2CH_2	for	ethene
CH_2**.**CH_2	for	ethene
CH_2**:**CH_2	for	ethene

- Each of the following **should gain credit** as alternatives to correct representations of the structures.

$CH_2 = CH_2$	for	ethene, $H_2C{=}CH_2$
$CH_3CHOHCH_3$	for	propan-2-ol, $CH_3CH(OH)CH_3$

- In most cases, the use of "sticks" to represent C — H bonds in a structure should **not** be penalised. The exceptions to this when "sticks" will be penalised include
  - structures in mechanisms where the C — H bond is essential (e.g. elimination reactions in halogenoalkanes and alcohols)
  - when a displayed formula is required
  - when a skeletal structure is required or has been drawn by the candidate

3.13 Organic names

As a general principle, non-IUPAC names or incorrect spelling or incomplete names should **not** gain credit. Some illustrations are given here.

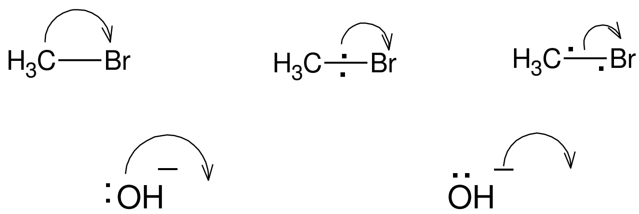
Unnecessary but not wrong numbers will **not** be penalised such as the number '2' in 2-methylpropane or the number '1' in 2-chlorobutan-1-oic acid.

but-2-ol	should be **butan-2-ol**
2-hydroxybutane	should be **butan-2-ol**
butane-2-ol	should be **butan-2-ol**
2-butanol	should be **butan-2-ol**
ethan-1,2-diol	should be **ethane-1,2-diol**
2-methpropan-2-ol	should be **2-methylpropan-2-ol**
2-methylbutan-3-ol	should be **3-methylbutan-2-ol**
3-methylpentan	should be **3-methylpentane**
3-mythylpentane	should be **3-methylpentane**
3-methypentane	should be **3-methylpentane**
propanitrile	should be **propanenitrile**
aminethane	should be **ethylamine** (although aminoethane can gain credit)
2-methyl-3-bromobutane	should be **2-bromo-3-methylbutane**
3-bromo-2-methylbutane	should be **2-bromo-3-methylbutane**
3-methyl-2-bromobutane	should be **2-bromo-3-methylbutane**
2-methylbut-3-ene	should be **3-methylbut-1-ene**
difluorodichloromethane	should be **dichlorodifluoromethane**

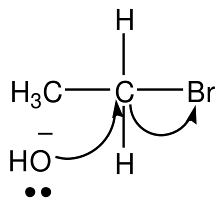
3.14 Organic reaction mechanisms

Curly arrows should originate either from a lone pair of electrons or from a bond.

The following representations should not gain credit **and will be penalised each time** within a clip.



For example, the following would score zero marks



When the curly arrow is showing the formation of a bond to an atom, the arrow can go directly to the relevant atom, alongside the relevant atom or **more than half-way** towards the relevant atom.

In free-radical substitution

- the absence of a radical dot should be penalised **once only** within a clip.
- the use of half-headed arrows is not required, but the use of double-headed arrows or the incorrect use of half-headed arrows in free-radical mechanisms should be penalised **once only** within a clip

The correct use of skeletal formulae in mechanisms is acceptable, but where a C-H bond breaks, both the bond and the H must be drawn to gain credit.

3.15 Extended responses

For questions marked using a 'Levels of Response' mark scheme:

Level of response mark schemes are broken down into three levels, each of which has a descriptor. Each descriptor contains two statements. The first statement is the Chemistry content statement and the second statement is the communication statement.

Determining a level

Start at the lowest level of the mark scheme and use it as a ladder to see whether the answer meets the Chemistry content descriptor for that level. The descriptor for the level indicates the qualities that might be seen in the student's answer for that level. If it meets the lowest level, then go to the next one and decide if it meets this level, and so on, until you have a match between the level descriptor and the answer.

When assigning a level you should look at the overall quality of the answer and not look to pick holes in small and specific parts of the answer where the student has not performed quite as well as the rest. If the answer covers different aspects of different levels of the mark scheme you should use a best fit approach for defining the level.

Once the level has been decided, the mark within the level is determined by the communication statement:

• If the answer completely matches the communication descriptor, award the higher mark within the level.

• If the answer does not completely match the communication descriptor, award the lower mark within the level.

The exemplar materials used during standardisation will help you to determine the appropriate level. There will be an exemplar in the standardising materials which will correspond with each level of the mark scheme and for each mark within each level. This answer will have been awarded a mark by the Lead Examiner. You can compare the student's answer with the exemplar to determine if it is the same standard, better or worse than the example. You can then use this to allocate a mark for the answer based on the Lead Examiner's mark on the exemplar.

You may well need to read back through the answer as you apply the mark scheme to clarify points and assure yourself that the level and the mark are appropriate.

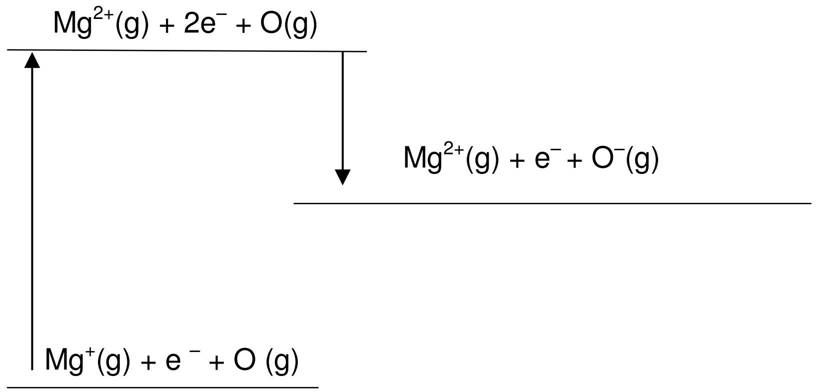
Indicative content in the mark scheme is provided as a guide for examiners. It is not intended to be exhaustive and you must credit other chemically valid points. Students may not have to cover all of the points mentioned in the indicative content to reach the highest level of the mark scheme. The mark scheme will state how much chemical content is required for the highest level.

An answer which contains nothing of relevance to the question must be awarded no marks.

For other extended response answers:

Where a mark scheme includes linkage words (such as 'therefore', 'so', 'because' etc), these are optional. However, a student's marks for the question may be limited if they do not demonstrate the ability to construct and develop a sustained line of reasoning which is coherent, relevant, substantiated and logically structured. In particular answers in the form of bullet pointed lists may not be awarded full marks if there is no indication of logical flow between each point or if points are in an illogical order.

The mark schemes for some questions state that the maximum mark available for an extended response answer is limited if the answer is not coherent, relevant, substantiated and logically structured. During the standardisation process, the Lead Examiner will provide marked exemplar material to demonstrate answers which have not met these criteria. You should use these exemplars as a comparison when marking student answers.

Question	Answers	Additional Comments/Guidance	Mark
01.1		One mark for each level with correct state symbols	1 1 1
01.2	$\Delta_f H = \Delta_a H$ (Mg) + ½ $\Delta_{BD} H$ (O_2) + $\Delta_{1st\ IE} H$ (Mg) + $\Delta_{2nd\ IE} H$ (Mg) + $\Delta_{1st\ EA} H$ (O) + $\Delta_{2nd\ EA} H$(O) + $\Delta_{LE} H$ (MgO) - 602 = 150 + (½ x 496) + 736 +1450 – 142 + 844 + Δ_{LE}H (MgO) $\Delta_{LE} H$ (MgO) = -3888 / -3890 (kJ mol^{-1})	Allow answers to 2sf or more 1 mark for +3888 or +3890 1 mark for -4136 or -4140 (not 496 x 1/2)	1 1 1
Total			6

Question	Answers	Additional Comments/Guidance	Mark
02.1	pp nitrogen = 0.25 x 30 = <u>7.5</u> kPa pp hydrogen = 0.75 x 30 = <u>22.5 or 23</u> kPa pp of ammonia = 0.8 x 150 = <u>120</u> kPa	(pp hydrogen + nitrogen = 150-120 = 30 kPa) Alternative method pp hydrogen = 0.15 x 150 = <u>22.5 or 23</u> kPa pp nitrogen = 0.05 x 150 = <u>7.5</u> kPa	1 1 1
02.2	$K_p = \frac{(ppNH_3)^2}{(ppN_2) \times (ppH_2)^3}$	Penalise [ ]	1
02.3	$K_p = \frac{(1.10 \times 10^3)^2}{(1.50 \times 10^2)^3 \times 1.20 \times 10^2}$ = 0.0029 to 0.003(0) or 2.9×10^{-3} to $3(.0) \times 10^{-3}$ kPa^{-2}	No mark for this expression If expression inverted in 02.2 allow 1 mark for kPa^2 Allow 2.9 to $3(.0) \times 10^{-9}$ Pa^{-2}	 1 1
02.4	decrease/smaller/lower (Reaction/equilibrium) <u>shifts/moves/goes</u> in the endothermic direction (which is to the left) to reduce the temperature OR oppose the increase in temperature	If increase or no change, 0 marks If blank, mark on Allow reaction is exothermic so equilibrium <u>moves</u> to the left side	1 1 1
Total			9

Question	Answers	Additional Comments/Guidance	Mark
03.1	(*ΔS* = Σ(*S products*) - Σ(*S reactants*)) = [(4 x 211) + (6 x 189)] - [(4 x 193) + (5 x 205)] = (1978 – 1797) 181 (J K^{-1} mol^{-1})		1 1
03.2	(*ΔG* = *ΔH* – *TΔS*) = - 905 - (600 + 273) x 181 x 10^{-3} *ΔG* = - 1063 / -1060 (kJ mol^{-1}) If alternative value of ΔS = 211 used, answer = -1089 (kJ mol^{-1})	If answer to 03.1 is incorrect, mark consequentially: • - 905 - (873 x 03.1 x 10^{-3})	1 1
03.3	*ΔG* becomes more negative/less positive The entropy change / Δ*S* is positive / *T*Δ*S* gets bigger / -*T*Δ*S* gets more negative.	Ignore increase/decrease/larger/smaller ΔG Consequential on wrong 03.1 If candidate does a calculation in 03.1 to produce ΔS negative then allow ΔG becomes less negative or more positive	1 1

03.4	Reactant(s) adsorbed onto the (platinum surface) / (platinum) provides a surface / active sites Reaction (on the surface) or bond breaking(weakening) / bond making occurs (on the surface) Desorption (of the product) or wtte		1 1 1
03.5	(Oxidation state changes from) -3 to +2 OR (+) 5		1
03.6	$2NH_3 + 2O_2 \rightarrow N_2O + 3H_2O$	Allow multiples Ignore state symbols	1

Total			11

Question	Answers	Additional Comments/Guidance	Mark
04.1	$1s^2 2s^2 2p^6 3s^2 3p^6 (4s^0)$		1
04.2	M1 In $Ca^{(+)}$ (outer) electron(s) is furth<u>er</u> from nucleus Or $Ca^{(+)}$ loses electron from a high<u>er</u> (energy) orbital Or $Ca^{(+)}$ loses electron from a 4(s) orbital or 4th energy level or 4th energy shell <u>and</u> $K^{(+)}$ loses electron from a 3(p) orbital or 3rd energy level or 3rd energy shell M2 More shielding (in Ca^+)	Must be comparative Allow converse arguments	1 1
04.3	Be /Beryllium		1
04.4	$Mg(OH)_2$		1
04.5	$Ba^{2+} + SO_4^{2-} \rightarrow BaSO_4$ n $BaCl_2$ (6/1000 x 0.25) = 1.5×10^{-3} and n Na_2SO_4 = (8/1000 x 0.15) = 1.2×10^{-3} <u>and</u> $BaCl_2$ /barium chloride in excess <u>10 cm^3</u> (of 0.15 mol dm^{-3} sodium sulfate)	Ignore state symbols Working required or 3×10^{-4} of $BaCl_2$ or <u>0.01dm^3</u>	1 1 1

04.6	M1 Same electronic configuration / same number of electrons (in outer shell) / all have 37 electrons (1) M2 $\frac{86x + 87x + 88(100-2x)}{100} = 87.7$ M3 x = 10% (or x = 0.1) M4 (% abundance of 88 isotope is 100 – 2x10) = 80(.0)%	*Ignore protons and neutrons unless incorrect numbers* *Not just electrons determine chemical properties* Alternative: M2 $\frac{86 + 87 + 88y}{1 + 1 + y} = 87.7$ M3 y= 8 M4 % of 88 isotope is 100 – 10y = 80(.0) % Allow other alternative methods	1 1 1 1
04.7	$^{138}Ba^{+}$		1

04.8	M1 mass = $\frac{137 \times 10^{-3}}{6.022 \times 10^{23}}$ = 2.275×10^{-25} (kg)	Calculation of m in kg If not converted to kg, max 4 If not divided by L lose M1 and M5, max 3	1
	M2 $v^2 = \frac{2KE}{m} = \frac{2 \times 3.65 \times 10^{-16}}{2.275 \times 10^{-25}} = 3.2088 \times 10^9$	For re-arrangement	1
	M3 $v = \sqrt{2KE/m}$ ($v = 5.6646 \times 10^4$)	For expression with square root	1
	M4 v = d/t or d = vt or with numbers		1
	M5 d = ($5.6646 \times 10^4 \times 2.71 \times 10^{-5}$) = 1.53 - 1.54 (m)	M5 must be to 3sf If not converted to kg, answer = 0.0485-0.0486 (3sf). This scores 4 marks	1
04.8	Alternative Method M1 m = $\frac{137 \times 10^{-3}}{6.022 \times 10^{23}}$ = 2.275×10^{-25} M2 v = d/t M3 $d^2 = \frac{KE \times 2t^2}{m}$ M4 $d = \sqrt{\frac{KE \times 2t^2}{m}}$ (= $\sqrt{(3.65 \times 10^{-16} \times 2 \times (2.71 \times 10^{-5})^2 / 2.275 \times 10^{-25})}$) M5 d = 1.53 – 1.54 (m)	M1 Calculation of m in kg M2, M3 and M4 are for algebraic expressions or correct expressions with numbers M5 must be to 3sf	1 1 1 1 1
Total			18

Question	Answers	Additional Comments/Guidance	Mark
05.1	completely dissociates/ionises (to form H^+ ions)		1
05.2	M1 moles HCl = 1.035×10^{-3} and moles $Ba(OH)_2$ = 3.75×10^{-3}	If M1 incorrect, lose M1 and M6	1
	M2 moles OH^- = **2 x** (3.75×10^{-3} = 7.50×10^{-3})	If M2 not x2, lose M2 and M6	1
	M3 XS n OH^- = 7.50×10^{-3} **-** 1.035×10^{-3} = 6.465×10^{-3} mol in 35.35 cm^3	If no subtraction for M3, lose M3 and M6	1
	M4 [OH] = 6.465×10^{-3} / 35.35×10^{-3} = 0.182885 mol dm^{-3}	= M3/35.35×10^{-3} If M4 not /35.35×10^{-3}, lose M4 and M6 However, if divided by 35.35 only lose M4 and allow M6 (ecf = 10.09)	1
	M5 $[H^+]$ = $K_w/[OH^-]$ = 1.47×10^{-14} /0.182885 = 8.0378×10^{-14} mol dm^{-3}	= 1.47×10^{-14} / M4 If incorrect rearrangement or wrong equation, lose M5 and M6 If K_w = 1.00×10^{-14} used only lose M5 and allow M6 (ecf = 13.26)	1
	M6 pH = 13.09 to 13.10	Must be 2dp	1
	Alternative MS to get M2: Starting amounts are 1.035×10^{-3} mol HCl and 3.75×10^{-3} mol $Ba(OH)_2$ M1 So the HCl will react with 5.175×10^{-4} mol of the $Ba(OH)_2$ leaving an excess of 3.2325×10^{-3} mol of $Ba(OH)_2$ (as alternative M2) So n OH^- = 2 x 3.2325×10^{-3} = 6.465×10^{-3} mol M3	Credit other methods eg limiting reagent method since HCl limiting reagent	

05.3	$[H^+] = [OH^-]$		1
05.4	SO_2		1
05.5	$K_a = \frac{[CH_3COO^-][H^+]}{[CH_3COOH]}$		1
05.6	M1 moles HCl added = 0.01 mol <u>and</u> moles CH_3COOH = 0.035 mol M2 moles CH_3COO^- = 0.025 – 0.01 (= 0.015) M3 moles CH_3COOH = 0.035 + 0.01 (= 0.045) M4 $[H^+] = 1.76 \times 10^{-5} \times \frac{M3\ (/\ V)}{M2\ (/\ V)}$ (= 5.28×10^{-5}) M5 pH = <u>4.28</u>	If used 0.07 mol for CH_3COOH can score M2, M3 and M4 (pH = 4.03) M2 mol CH_3COO^- = 0.025 - M1(HCl) M3 mol CH_3COOH = M1 (CH_3COOH) + M1 (HCl) M4 is conditional on an attempt at an addition/subtraction in M2 OR M3 M5 must be 2dp	1 1 1 1 1

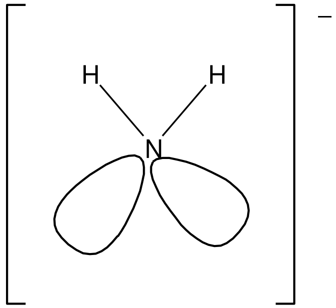
Total			15

Question	Answers	Additional Comments/Guidance	Mark
06.1	It has mobile ions / ions can move through it / free ions	Do not allow movement of electrons.	1
06.2	(+) 0.18 V		1
06.3	The concentration is not 1.(0) (mol dm^{-3})		1
06.4	Cu (s)│ Cu^{2+}(aq) ‖ Cu^{2+}(aq) │ Cu(s)		1
06.5	(Concentration) increases or ([Cu^{2+}] ions) increase The [Cu^{2+}] ions in the two solutions become equal/same	Mark independently Not, concentrations are constant	1 1
Total			6

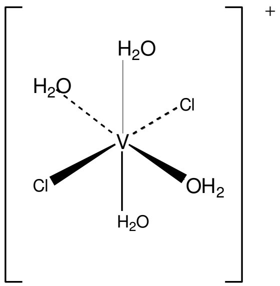
Question	Answers	Additional Comments/Guidance	Mark
07.1	$AlCl_3 + 6H_2O \rightarrow [Al(H_2O)_6]^{3+} + 3Cl^-$	Allow $AlCl_3 + 6H_2O \rightarrow Al(H_2O)_5(OH)^{2+} + H^+ + 3Cl^-$ Or equation to form $Al(H_2O)_4(OH)_2^+$	1
07.2	$[Al(H_2O)_6]^{3+} + \underline{H_2O} \rightarrow [Al(H_2O)_5(OH)]^{2+} + \underline{H_3O^+}$	allow equations to form $[Al(H_2O)_4(OH)_2]^+$	1
07.3	<u>white</u> ppt/solid effervescence/bubbles/fizzing $2[Al(H_2O)_6]^{3+} + 3CO_3^{2-} \rightarrow 2[Al(H_2O)_3(OH)_3] + 3CO_2 + 3H_2O$	M1 and M2 in either order accept multiples only allow spectator ions in a balanced equation	1 1 1
07.4	<u>White</u> ppt/solid $[Al(H_2O)_6]^{3+} + 3OH^- \rightarrow \underline{[Al(H_2O)_3(OH)_3]} + 3H_2O$ Colourless solution forms / ppt or solid dissolves $[Al(H_2O)_3(OH)_3] + OH^- \rightarrow [Al(H_2O)_2(OH)_4]^- + H_2O$ OR $[Al(H_2O)_3(OH)_3] + OH^- \rightarrow [Al(OH)_4]^- + 3H_2O$	 only allow spectator ions in a balanced equation only allow 6 or 4 co-ordination Allow $[Al(OH)_6]^{3-}$ in a balanced equation	1 1 1 1
Total			9

Question	Answers		Additional Comments/Guidance	Mark
08.1	This question is marked using Levels of Response. Examiners should apply a 'best-fit' approach to the marking.		Indicative chemistry content. Contradictions (eg molecules, IMFs, covalent bonding,) negate statements. <u>Stage 1- **Na**</u> 1a) Na has metallic bonding 1b) there is attraction/ bonding between the positive nucleus/ ion and the <u>delocalised</u> electrons in Na 1c) Na has a giant/lattice structure <u>Stage 2 – **NaBr or NaI**</u> 2a) Ionic bonding in NaBr and/or NaI 2b) There is attraction/ bonding between the + and – ions in NaBr and/or NaI 2c) NaBr and/or NaI have a giant/lattice structure <u>Stage 3 - **comparison** of bonding</u> 3a) The ionic bonds are stronger (or wtte) than the metallic bonds 3b) there is stronger attraction (or wtte) between the + and – ions in NaBr than in NaI 3c) since the Br^- **ion** is smaller than the I^- **ion**	6
	Level 3 5-6 marks	All stages are covered and the explanation of each stage is generally correct and virtually complete. Answer is communicated coherently and shows a logical progression from stage 1 to stage 2 and then stage 3. Coherent communication requires that there is a comparison between the types of bonding and that the bonding is correct for each substance.		
	Level 2 3-4 marks	All stages are covered but the explanation of each stage may be incomplete or may contain inaccuracies OR two stages are covered and the explanations are generally correct and virtually complete. Answer is mainly coherent and shows some progression from stage 1 to stage 2 and then stage 3.		
	Level 1 1-2 marks	Two stages are covered but the explanation of each stage may be incomplete or may contain inaccuracies OR only one stage is covered but the explanation is generally correct and virtually complete. Answer shows some progression between two stages		

08.1 cont.	Level 0 0 marks	Insufficient correct chemistry to gain a mark.		
08.2	M1 $Na + H_2O \rightarrow NaOH + ½ H_2$		Allow multiples	1
	M2 (Mass Na = 0.250 g so moles Na = 0.250/23.0) = 0.0109		CE: If not divided by 23, max 3/5 calculation marks – M3, M4 and M5 AE: If not divided by 1000 and final answer is 1.33 x 10^5 cm^3 4/5	1
	M3 moles H_2 = 5.43 x 10^{-3} to 5.45 x 10^{-3}		M3 = M2 /2 CE: If incorrect ratio used max 3/5 calculation marks – M2, M4 and M5	1
	M4 T = 298 (K) and P = 101000 (Pa)			1
	M5 V = nRT/P or (5.435 x 10^{-3} x 8.31 x 298)/101000 or 1.33 x 10^{-4} (m^3)			1
	M6 V = 133 – 134 cm^3		Allow to 2 significant figures or more	1
08.3	Conc = 0.0109/ 500 x 10^{-3} = 0.0217-0.022 (mol dm^{-3})		Allow M2 from question 08.2 / 0.5	1

08.4	M1  M2 104.5° M3 (4) electron pairs repel to be as far apart as possible M4 lp/lp repulsion> lp/bp repulsion (> bp/bp repulsion)	Ignore charge and brackets Allow 104-106 For M4 allow lone pairs repel more than bonding pairs Mark independently	1 1 1 1

Total			16

Question	Answers	Additional Comments/Guidance	Mark
09.1	Fe^{2+} $E^{\ominus}$ VO_2^{+}(/ VO^{2+}) > $E^{\ominus}$ Fe^{3+}(/Fe^{2+}) > $E^{\ominus}$ VO^{2+}(/V^{3+})	Accept any Fe(II) compound – correct formula or name If calculations of EMF are provided producing EMFs = 0.23(V) and -0.43(V), with a comment, allow M2 allow $E^{\ominus}$ Fe^{3+} (/Fe^{2+}) value of +0.77 is between the $E^{\ominus}$ values for the electrode half-equations containing the V species or wtte	1 1
09.3	 Cis/trans	Ignore absence of charge Wedges, dotted lines and [ ] not required Do not penalise bond from H to V (in water ligands) allow E/Z, geometric and stereo(isomerism)	1 1
09.2	(+) 4	IV or four	1
09.4	2 NH_4VO_3 → V_2O_5 + H_2O + 2NH_3	Accept multiples Ignore state symbols	1
09.5	V_2O_5 + SO_2 → V_2O_4 + SO_3 V_2O_4 + ½ O_2 → V_2O_5	Both equations needed for 1 mark in this order Allow multiples	1

Total			7

Question	Answers	Additional Comments/Guidance	Mark
10.1	M1 HCl added = 0.050 mol and NaOH used in titration = 3.99×10^{-3} mol		1
	M2 So moles that would be needed to neutralise total excess HCl = 3.99×10^{-3} **x 10** = 3.99×10^{-2} mol	Alternative: divide moles HCl by 10 = 0.005 and $0.005 - 3.99 \times 10^{-3} = 0.00101$	1
	M3 Therefore the moles of HCl reacted with the $Na_2CO_3.xH_2O$ = $0.050 - 3.99 \times 10^{-2} = 0.0101$ mol	Alternative: 0.00101 x 10 to produce 0.0101	1
	M4 So moles $Na_2CO_3.xH_2O$ reacted with the HCl = 0.0101 /**2** = 5.05×10^{-3} mol		1
	M5 Conversion of mg to g = 0.627 (g) or 627×10^{-3} (g)		1
	M6 $xH_2O = 0.627/5.05 \times 10^{-3} - 106.0 = 18$ (.16)	Alternative: mass Na_2CO_3 that reacted with the HCl $5.05 \times 10^{-3} \times 106.0 = 0.5353$ g and mass H_2O = 0.627- 0.5353 = 0.0917 g	1
	M7 so x =**1**	Alternative: $0.0917 / 18.0 = 5.094 \times 10^{-3}$ so ratio Na_2CO_3 to H_2O = 1:1.009 ie 1:1 so x = **1**	1
Total			7