Mark Scheme (Results)

Summer 2019

Pearson GCE Advanced Subsidiary Level
In Chemistry (8CH0) Paper 01 Core Inorganic and Physical 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.

Question Number	Answer	Mark
1	**The only correct answer is D** (9.03×10^{24}) ***A*** *is not correct because this is the answer for 1 mol of aluminium oxide as molecules* ***B*** *is not correct because this is the answer for 3 mol of aluminium oxide as molecules* ***C*** *is not correct because this is the answer for the ions in 1 mol of aluminium oxide*	**(1)**

(Total for Question 1 = 1 mark)

Question Number	Answer	Mark
2	**The only correct answer is D** ($1s^2,2s^2,2p^6,3s^2,3p^6$) ***A*** *is not correct because* $1s^2,2s^2,2p^6,3s^2,3p^2$ *is for an* S^{2+} *ion* ***B*** *is not correct because* $1s^2,2s^2,2p^6,3p^4$ *is for an* S^{2+} *ion with electrons removed from the 3s subshell* ***C*** *is not correct because* $1s^2,2s^2,2p^6,3s^2,3p^4$ *is for the sulfur atom*	**(1)**

(Total for Question 2 = 1 mark)

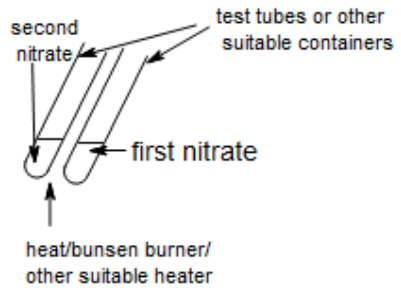
Question Number	Acceptable Answer	Additional Guidance	Mark
3(a)	An answer that makes reference to the following points: • same number of protons **(1)** • different numbers of neutrons **(1)**	Ignore number of electrons Ignore references to atom(s) / 'elements' in the answer	**(2)**

Question Number	Acceptable Answer	Additional Guidance	Mark
3(b)	• correct subtraction to calculate relative abundance of unknown isotope **(1)** • calculation of mass number of unknown isotope of gallium with suitable working **(1)**	Example of calculation 100 – 63.25 = 36.75 **OR** 1.00 – 0.6325 = 0.3675 $\frac{(69 \times 63.25) + (M \times 36.75)}{100} = 69.735$ OR $43.64(25) + \frac{36.75\ M}{100} = 69.735$ M = 71 Ignore any units given with final answer. Correct answer with no working gets M2 only Allow TE from M1	**(2)**

(Total for Question 3 = 4 marks)

Question Number	Answer	Mark
4(a)	**The only correct answer is A** (carbonates – increases, nitrates – increases) ***B*** *is not correct because thermal stability of Group 2 nitrates does not decrease down the group* ***C*** *is not correct because thermal stability of Group 2 carbonates does not decrease down the group* ***D*** *is not correct because thermal stabilities of Group 2 carbonates and nitrates do not decrease down the group*	**(1)**

Question Number	Acceptable Answer	Additional Guidance	Mark
4(b)	A description that makes reference to the following points: • Workable method + time / compare **(1)** • Same heat applied **(1)** • Same amount of each nitrate in separate test tubes **(1)**	<u>Examples of workable methods</u> • First one to re-light a glowing splint / produce brown fumes. Accurate timing not essential. • Use of light sensor / meter to measure colour of gas • Use of gas syringe and measure rate of production of gas / time to produce specific volume • Bubble gas into indicator solution – time to change colour • Collection of gases over water and volume measured Reward any workable alternative. e.g. use the same Bunsen Award if implied by diagram Award 'equal masses'.	**(4)**

	• safety precaution: fume cupboard/hood **(1)**	Example diagram:  Ignore well ventilated room / face mask / goggles / gloves / lab coat This is the only acceptable safety precaution.	

Question Number	Answer	Mark
4(c)	**The only correct answer is B** (hydroxides – increases, sulfates – decreases) ***A*** *is not correct because sulfate solubility does not increase down the group* ***C*** *is not correct because hydroxide solubility does not decrease down the group and sulfate solubility does not increase down the group* ***D*** *is not correct because hydroxide solubility does not decrease down the group*	**(1)**

(Total for Question 4 = 6 marks)

Question Number	Answer	Mark
5(a)	**The only correct answer is C** (36.7%) ***A*** *is not correct because 21.3% is calculated using the atomic number of iron* ***B*** *is not correct because 35.1% is calculated using all atomic numbers* ***D*** *is not correct because 53.8% is calculated using the atomic numbers of sulfur and oxygen*	**(1)**

Question Number	Acceptable Answer	Additional Guidance	Mark
5(b)	A description that makes reference to the following points: • (add hydrochloric acid / nitric acid then) add barium chloride / barium nitrate (solution) **(1)** • white precipitate / white solid **(1)**	Ignore omission of acid Do not award just Barium ions / Ba^{2+} M2 is dependent on M1, with the exception of just Ba^{2+} given as reagent	**(2)**

Question Number	Answer	Mark
5(c)	**The only correct answer is A** (392.0) ***B*** *is not correct because 312.0 is calculated from only 6 multiples of the* H_2 *of the 6-water* ***C*** *is not correct because 302.0 is calculated by not multiplying the water by 6* ***D*** *is not correct because 284.0 is calculated by ignoring the 6-water completely*	**(1)**

(Total for Question 5 = 4 marks)

Question Number	Acceptable Answer	Additional Guidance	Mark
6(a)(i)	An answer that makes reference to the following points: • any mention of platinum/nichrome wire **(1)** • dip the wire into (clean/fresh concentrated) hydrochloric acid **(1)** • dip the (wet) wire into the solid and place in a (non-luminous/roaring/blue Bunsen) flame **(1)**	Allow NiCr for nichrome Allow silica/magnesia for platinum or nichrome Allow loop / rod for wire Ignore inoculating / flame-test (wire) Allow any mention of HCl(aq) e.g. cleaning or mixing solid and acid or making a paste Allow HCl for HCl(aq) Ignore dilute Allow on / over / under / near / show / above for 'in'	**(3)**

Question Number	Acceptable Answer	Additional Guidance	Mark
6(a)(ii)	An explanation that makes reference to the following points: • mention of energy or heat or heating (from the flame) **(1)** • electrons promoted to higher energy levels **(1)** • electrons drop down / return (to lower energy levels / ground state) **(1)** • light (in the visible region) is emitted / released / given out **(1)**	Do not award M1 for "burning" Allow just 'electrons excited' for M2 Allow electromagnetic / e.m. radiation / photons instead of light	**(4)**

Question Number	Acceptable Answer	Additional Guidance	Mark
6(a)(iii)	An answer that makes reference to the following point: • no emission of light /energy in the visible region (of the spectrum)	Do not award any mention of (bright) white light emission Allow electromagnetic / e.m. radiation / photons / colour instead of light / energy Allow the light emitted is in the UV or IR Allow any references to frequency or wavelength being too high or too low	**(1)**

Question Number	Acceptable Answer	Additional Guidance	Mark
6(a)(iv)	An answer that makes reference to the following point: • (There are) other ions that do not produce a flame colour	 Allow a specific ion that does not have a flame colour e.g. 'beryllium' / Be^{2+} Allow other "elements" do not produce a flame colour Do not award if any references to "burning"	**(1)**

Question Number	Acceptable Answer	Additional Guidance	Mark
6(b)(i)	• $AgNO_3$	Ignore 'silver nitrate' Ignore state symbols for $AgNO_3$	**(1)**

Question Number	Answer	Mark
6(b)(ii)	**The only correct answer is B** (insoluble in dilute ammonia solution, soluble in concentrated ammonia solution) ***A*** *is not correct because silver bromide is soluble in concentrated ammonia solution* ***C*** *is not correct because silver bromide is insoluble in dilute ammonia solution and soluble in concentrated ammonia solution* ***D*** *is not correct because silver bromide is insoluble in dilute ammonia solution*	**(1)**

(Total for Question 6 = 11 marks)

Question Number	Acceptable Answer	Additional Guidance	Mark
7(a)	An answer that makes reference to the following points: • balanced equation with correct species **(1)** • correct states all correct **(1)**	<u>Example of equation:</u> $Mg(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2(g)$ or $Mg(s) + 2H^+(aq) \rightarrow Mg^{2+}(aq) + H_2(g)$ Do not award M2 for incorrect formulae e.g. MgCl (for $MgCl_2$), or H (for H_2) Allow M2 for unbalanced equation if all species correct	**(2)**

Question Number	Acceptable Answer	Additional Guidance	Mark
7(b)(i)	An answer that makes reference to the following point: • calculation of uncertainty	<u>Example of calculation:</u> $(\pm)\frac{0.5 \times 100}{10.0} = (\pm)5/5.0/5.00(\%)$	**(1)**

Question Number	Acceptable Answer	Additional Guidance	Mark
7(b)(ii)	An answer that makes reference to the following points: • calculation of moles of Mg **(1)** • calculation of moles of HCl **(1)** • evidence to support Mg in excess **(1)**	Example of calculation: $\frac{0.12}{24.3}$ = 4.9383×10^{-3} / 0.0049383 (mol) Allow A_r for Mg = 24 $\frac{10 \times 0.20}{1000}$ = 2.0×10^{-3} / 0.002 (mol) 4.9383×10^{-3} mol of Mg requires 9.8765×10^{-3} mol of HCl (and $0.002 < 9.8 \times 10^{-3}$) so Mg in excess or 0.002 mol HCl requires 0.001 mol Mg (and 0.0049 > 0.001) so Mg in excess Ignore SF Do not award **M3** for 0.0049 > 2 x 0.002 OR 0.0049 > 0.004 to show that Mg is in excess Do not award M3 if HCl stated to be in excess	**(3)**

Question Number	Acceptable Answer	Additional Guidance	Mark
7(b)(iii)	calculation of moles of gas	Example of calculation $0.002 \div 2 = 0.001$ or 1×10^{-3} Allow TE from (a) and (b)(ii)	**(1)**

Question Number	Acceptable Answer	Additional Guidance	Mark
7(b)(iv)	• Rearrangement of ideal gas equation **(1)** • conversion of ^{o}C to K **(1)** • calculation of volume in m^3 **(1)** • calculation of volume in cm^3 **(1)**	Example of calculation: pV = nRT rearrange V = $\frac{nRT}{p}$ Allow M1 if equation rearrangement not explicitly shown but used correctly in M3 (273 + 23) = 296 Allow M2 if (273 + 23) used in equation V = $\frac{1.0 \times 10^{-3} \times 8.31 \times (273 + 23)}{98\ 000}$ = 2.51×10^{-5} (m^3) = 25 allow 25.1 (cm^3) Allow TE from (b)(iii) and TE at each stage Allow **2 or 3** SF for final answer **ECF values from (b)(iii)** For 0.002 mol H_2, V = 50.2 cm^3 For 0.00494 mol H_2, V = 124 cm^3 For 0.00894 mol H_2, V = 224 cm^3 For 0.004 mol H_2, V = 100 cm^3	

Question Number	Acceptable Answer	Additional Guidance	Mark
7(c)(i)	An answer that makes reference to the following points: • gas lost before the bung replaced **(1)** • the magnesium was coated with oxide (so water was formed instead of hydrogen) **(1)**	 Ignore 'generic' gas leakages from apparatus Do not award gas may dissolve (in water or acid) Ignore 'generic' references to impurity Ignore references to incomplete reaction	**(2)**

Question Number	Acceptable Answer	Additional Guidance	Mark
7(c)(ii)	An answer that makes reference to the following points: • arrange equipment so that the Mg ribbon drops into the acid **after** the delivery tube was replaced **(1)** • clean the magnesium ribbon **(1)**	 Ignore replace the bung more quickly Allow any workable method	**(2)**

(Total for Question 7 = 15 marks)

Question Number	Acceptable Answer	Additional Guidance	Mark
8(a)	An explanation that makes reference to the following points: • comparison of ionic charges **(1)** • comparison of ionic radii **(1)** • comparison of **energy** required **(1)**	<u>Examples of explanations</u> MgO has doubly charged ions **and** KBr has singly charged ions Allow reference to just one ion in each compound Mg^{2+} smaller than K^{+} and/or O^{2-} smaller than Br^{-} Ignore references to **atomic** radii More **energy** needed to overcome the electrostatic attractions/bonds (between ions) in MgO (than in KBr) Ignore references to 'electronegativity' / (ion) polarisation Award **(0)** overall if any mention of any of the following: London Forces **Molecules** / intermolecular forces Hydrogen bonding Covalent bonding	**(3)**

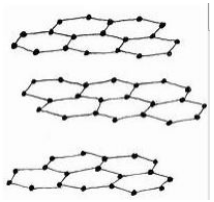
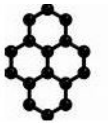
Question Number	Acceptable Answer	Additional Guidance	Mark
8(b)	An explanation that makes reference to the following points: • (solid potassium bromide does not conduct because) the **ions** are in fixed positions / **ions** are not free to move **(1)** • it does conduct in solution because the **ions** are free to move (and carry charge) **(1)**	Do not award any marks if reference to movement of **electrons** or **free electrons** when conduction occurs Do not award any marks if 'molecules'/ London forces mentioned	**(2)**

<table>
<tr><th>Question Number</th><th>Acceptable Answer</th><th>Additional Guidance</th><th>Mark</th></tr>
<tr><td>*8(c)</td><td>This question assesses a student's ability to show a coherent and logically structured answer with linkages and fully-sustained reasoning.
Marks are awarded for indicative content and for how the answer is structured and shows lines of reasoning.
The following table shows how the marks should be awarded for indicative content.
<table>
<tr><th>Number of indicative marking points seen in answer</th><th>Number of marks awarded for indicative marking points</th></tr>
<tr><td>6</td><td>4</td></tr>
<tr><td>5-4</td><td>3</td></tr>
<tr><td>3-2</td><td>2</td></tr>
<tr><td>1</td><td>1</td></tr>
<tr><td>0</td><td>0</td></tr>
</table></td><td>Guidance on how the mark scheme should be applied:

The mark for indicative content should be added to the mark for lines of reasoning.
For example, an answer with five indicative marking points that is partially structured with some linkages and lines of reasoning, scores 4 marks (3 marks for indicative content and 1 mark for partial structure and some linkages and lines of reasoning).

If there are no linkages between points, the same five indicative marking points would yield an overall score of 3 marks (3 marks for indicative content and no marks for linkages).</td><td>(6)</td></tr>
</table>

	The following table shows how the marks should be awarded for structure and lines of reasoning. **Number of marks awarded for structure and sustained lines of reasoning** Answer shows a coherent and logical structure with linkages and fully sustained lines of reasoning demonstrated throughout. — 2 Answer is partially structured with some linkages and lines of reasoning. — 1 Answer has no linkages between points and is unstructured. — 0	In general it would be expected that 5 or 6 indicative points would get 2 reasoning marks, and 3 or 4 indicative points would get 1 mark for reasoning, and 0, 1 or 2 indicative points would score zero marks for reasoning. If there is any incorrect chemistry, deduct mark(s) from the reasoning. If no reasoning mark(s) awarded do not deduct mark(s). Comment: Look for the indicative marking points first, then consider the mark for the structure of the answer and sustained line of reasoning.	

	Indicative content: • **IP1** graphene has a **single** layer / **single** sheet (of hexagons / rings) • **IP2** graphene has delocalised electrons / electrons which are mobile • **IP3** graphite has layers / sheets / planes **and** each carbon bonded to **three** others • **IP4** graphite has delocalised electrons / electrons which are mobile (between the layers) • **IP5** diamond has each carbon bonded to four other carbons / diamond has a tetrahedral arrangement (around each C atom) / tetrahedral structure • **IP6** diamond's C atoms have all their outer / valence / fourth electrons involved in bonding **OR** diamond has no delocalised electrons / all electrons are localised	Allow annotated diagrams for all marking points graphite   diamond graphene  Allow 'free' for delocalised or mobile	

Question Number	Acceptable Answer	Additional Guidance	Mark
8(d)	An answer that makes reference to the following points: • iron atoms have greater mass than carbon atoms **(1)** • iron atoms pack closer than carbon atoms (in graphite) **(1)**	 Allow weigh more / higher *Ar* / greater molar mass Allow idea of more space (between the layers of atoms) in graphite Award (0) overall if mention of iron molecules or graphite molecules	**(2)**

Question Number	Acceptable Answer	Additional Guidance	Mark
8(e)	An answer that makes reference to the following points: • Lower value relates to (weak) London / van der Waals' forces (between the layers) **(1)** • Higher value refers to (strong) covalent (C−C) bonds (within each layer) **(1)**	 Allow 'pi-bonds (between layers)' Allow "(weak) intermolecular forces (between layers)" Allow (C−C) 'sigma bonds'	**(2)**

(Total for Question 8 = 15 marks)

Question Number	Answer	Mark
9(a)(i)	**The only correct answer is C** (Disproportionation) ***A*** *is not correct because oxidation and reduction are occurring* ***B*** *is not correct because oxidation and reduction are occurring* ***D*** *is not correct because two reactants are involved*	**(1)**

Question Number	Acceptable Answer	Additional Guidance	Mark
9(a)(ii)	An answer that makes reference to the following points: • (trigonal) pyramidal **(1)** • (predicted bond angle) 107° **(1)** • three groups / three pairs of bonding electrons and one lone pair **OR** lone pair – bond pair repulsion > bond pair – bond pair repulsion **(1)** • (electron pairs / groups repel to positions of) minimum repulsion / maximum separation **(1)**	For M1, this shape must be **named** Allow answers in the range 106.5° to 107.5° (allow actual value 110°) Allow M2 on an annotated diagram Allow 'regions' for 'groups' or 'pairs' Allow statements such as "lone pair repulsion greater than bond pair repulsion"	**(4)**

Question Number	Acceptable Answer	Additional Guidance	Mark
9(b)(i)	• **4** $KClO_3$ → **1** KCl + **3** $KClO_4$	Allow just KCl with no number in front Allow multiples	**(1)**

Question Number	Acceptable Answer	Additional Guidance	Mark
9(b)(ii)	An answer that makes reference to the following points: • use of **water only** as solvent **(1)** • add the mixture of solids / products to any one of the following : water only **or** ethanol only **or** a water plus ethanol mixture **or** water followed by ethanol **or** ethanol followed by water **(1)** • **filter** off the undissolved potassium chlorate(VII) $KClO_4$ **(1)**	Use of separating funnel or electrolysis scores (0) overall NB: If water **only** used as the solvent, both M1 and M2 are awarded Allow 'insoluble solid' / 'less soluble solid' / 'the precipitate' for $KClO_4$ Allow salt for solid	**(3)**

Question Number	Acceptable Answer	Additional Guidance	Mark
9(c)	An answer that makes reference to the following points: • conversion of water volume to cm^3 or g **(1)** • calculation of the mass of chlorine in 2.5×10^9 g/cm^3 of water **(1)** • conversion of the mass of chlorine to moles of chlorine gas (Cl_2) by dividing by 71 **(1)**	<u>Example of calculation:</u> 2 500 m^3 = 2 500 x 10^6 cm^3 = 2.5 x 10^9 cm^3 **or** = 2 500 x 10^6 g = 2.5 x 10^9 g $\frac{2 \times 2.5 \times 10^9}{1 \times 10^6} = 5.0 \times 10^3$ g $\frac{5.0 \times 10^3}{(35.5 \times 2)} = 70(.4)$(mol) Allow alternative calculation methods Ignore SF for final answer Answer of 35.2 / 140.8 mol Cl_2 scores (2) marks	**(3)**

Question Number	Acceptable Answer	Additional Guidance	Mark
9(d)	An explanation that makes reference to the following points: Lower than 1 ppm • HClO will be low(er) **(1)** • ineffective (as a disinfectant) **(1)** Higher than 3 ppm • HCl will be high(er) **(1)** • any relevant effect of increased HCl **(1)**	Ignore reference to amount of Cl_2 being too low M2 dependent on correct M1 M4 dependent on correct M3 Award effects including corrosive, alters or lowers pH NB: Do not award high(er) pH Award increases acidity / strongly acidic / toxicity Award any reasonable negative effect on swimmers e.g. irritation / irritant Ignore just 'harmful' / just 'dangerous' Ignore reference to amount of Cl_2 being too high and its effects	**(4)**

Question Number	Acceptable Answer	Additional Guidance	Mark
9(e)(i)	A description that makes reference to the following points: • diagram showing **both** Na^+ ion **and** ClO^- ion surrounded by water molecules/solvated **(1)** • correct orientation of the water molecules around **both** ions with a relevant dipole shown on at least one water molecule for each ion, (i.e. $\delta-$ on O for a water molecule next to Na+ and a $\delta+$ on at least one H atom on a water molecule next to a ClO^-) **(1)**	Allow any number of water molecules **(>1)** for **both** ions For M1 to be awarded there must be more than one H_2O molecule around each ion M2 can be awarded even if only one H_2O molecule is shown next to each ion Allow one mark for one ion surrounded by correctly orientated water molecules. Written description only, covering the same two marking points scores one mark max **Mention of hydrogen bonding or water drawn as "HO_2" or NaClO shown as covalent scores (0) overall**	**(2)**

Question Number	Acceptable Answer	Additional Guidance	Mark
9(e)(ii)	An answer that makes reference to the following points: • ethanol forms hydrogen bonds (with water) **(1)** • chloroethane forms (permanent) dipole-dipole attractions **and** London forces (with water) **(1)**	 Allow "London forces and dipole forces" Ignore 'chloroethane does not form hydrogen bonds with water	**(2)**

Question Number	Acceptable Answer	Additional Guidance	Mark
9(f)	 • calculation of mol of ClO^- in 1 000 dm^3 of water **(1)** • calculation of mol of $Ca(ClO)_2$ **(1)** • calculation of mass of $Ca(ClO)_2$ **(1)**	Example of calculation: $5.6 \times 10^{-6} \times 10^3 = 5.6 \times 10^{-3}$ (mol) $\frac{5.6 \times 10^{-3}}{2}$ (mol) $= 2.8 \times 10^{-3}$ (mol) $2.8 \times 10^{-3} \times 143.1 = 0.40068$ (g) = 0.4 (g) Allow use of 143 instead of 143.1 in M3 Ignore SF Answer of 0.8(01) (g) scores (2) marks	**(3)**

(Total for Question 9 = 23 marks)

Total for Question Paper = 80 marks

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