RECOGNISING ACHIEVEMENT

GCE

Chemistry A

Mark Scheme

Mark Scheme

Annotations

Annotation	Meaning
BOD	Benefit of doubt given
CON	Contradiction
✗	Incorrect response
ECF	Error carried forward
I	Ignore
NAQ	Not answered question
NBOD	Benefit of doubt not given
POT	Power of 10 error
^	Omission mark
RE	Rounding error
SF	Error in number of significant figures
✓	Correct response

Mark Scheme

Annotation	Meaning
DO NOT ALLOW	Answers which are not worthy of credit
IGNORE	Statements which are irrelevant
ALLOW	Answers that can be accepted
( )	Words which are not essential to gain credit
__	Underlined words must be present in answer to score a mark
ECF	Error carried forward
AW	Alternative wording
ORA	Or reverse argument

Subject-specific Marking Instructions

The following questions should be annotated with ticks to show where marks have been awarded in the body of the text: 3(d)(i), 3(d)(ii) and 4(b).

Mark Scheme

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>1</td><td>(a)</td><td>(i)</td><td>mass of the isotope compared to 1/12th
OR
mass of the atom compared to 1/12th ✓

(the mass of a) ^{12}C (atom) ✓</td><td>2</td><td>ALLOW for ^{12}C: carbon-12 OR C-12 OR C 12 OR 12 C

IGNORE reference to average OR weighted mean
(ie correct definition of relative atomic mass scores both marks)

ALLOW mass of a mole of the isotope/atom with 1/12th ✓ the mass of a mole OR 12 g of carbon-12 ✓

ALLOW 2 marks for:
‘mass of the isotope OR mass of the atom compared to ^{12}C atom given a mass of 12.0’
ie ‘given a mass of 12’ communicates the same idea as 1/12th’

ALLOW FOR 2 MARKS:
$\frac{\text{mass of the isotope}}{\text{mass of 1/12th mass of carbon-12}}$

ie fraction is equivalent to ‘compared to’

ALLOW 1 MARK FOR a mix of mass of atom and mass of mole of atoms, ie:
‘mass of the isotope/mass of an atom compared with 1/12th the mass of a mole OR 12 g of carbon-12’

DO NOT ALLOW mass of ion OR mass of element
BUT ALLOW mass of an atom of an element</td></tr>
<tr><td></td><td></td><td>(ii)</td><td>Both rows completed correctly ✓
<table><tr><th></th><th>protons</th><th>neutrons</th></tr><tr><td>iodine-127</td><td>53</td><td>74</td></tr><tr><td>iodine-131</td><td>53</td><td>78</td></tr></table></td><td>1</td><td>ALL four entries in table correct for 1 mark</td></tr>
</table>

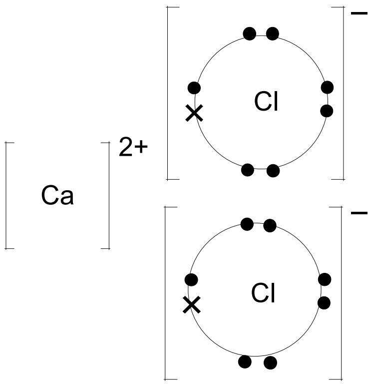
Question			Answer	Marks	Guidance
1	(b)	(i)	FIRST CHECK THE ANSWER ON ANSWER LINE IF answer = 91.6 (µg), must be 3 sf, award 2 marks Amount of I^- mark: = 70.0×10^{-6} /126.9 **OR** = 5.52×10^{-7} ✓ (mol) Mass of KI = ($5.52 \times 10^{-7}/10^{-6}$) x 166.0 = 91.6 (µg) must be 3 sf ✓	2	If there is an alternative answer, check to see if there is any ECF credit possible **FOR ONE MARK ONLY** using working below **ALLOW** 70.0×10^{-x} /126.9 OR 5.52×10^{-x} (ie wrong conversion of µg and g) **ALLOW** calculator values which round to 5.52×10^{-x}, ie 3 significant figures or more **ALLOW** ECF for incorrect calculated amount of I^- x 166.0, must be 3 sf **ALLOW** calculator value or rounding to 3 significant figures or more **BUT IGNORE** 'trailing' zeroes, eg 0.200 allowed as 0.2. Answers with 91.6×10^{-x} (ie wrong conversion of µg and g) would get one mark
		(ii)	***Ethical implications*** Some people feel it is wrong to put additives into the national diet **OR** ***Dietary issues*** Food **OR** diet contains sufficient amounts of iodide ✓	1	**ALLOW** some people disapprove of additives in their food Assume 'it' refers to KI **IGNORE** economic reasons **ALLOW** (excess) potassium **OR** $K^{(+)}$ **OR** KI is harmful **OR** toxic **ALLOW too much** iodine **OR** iodide **OR** $I^{(-)}$is harmful **OR** toxic **ALLOW** iodine **OR** iodide **OR** $I^{(-)}$ **OR** KI is radioactive **ALLOW** any effect which would be detrimental to human health **OR** well-being **OR** eg 'lead to heart problems' **ALLOW** some table salt already contains iodide (eg sea salt) **ALLOW** some countries do not have (access to) KI **IGNORE** references to dangerous **OR** taste **IGNORE** responses referring solely to intake going above GDA **IGNORE** carcinogenic
	(c)	(i)	$Cl_2 + 2I^- \rightarrow 2Cl^- + I_2$ ✓	1	**IGNORE** state symbols

Mark Scheme

Question			Answer	Marks	Guidance
1	(c)	(ii)	***Two alternative explanations to award the two marks:***	2	***Quality of Written Communication*: ‘dipole’ OR ‘permanent’ spelled correctly at least once and in context for marking point 1 in explanation 1**
			Explanation 1 IC*l* has **permanent dipole** (–dipole) (interactions) **AND** Cl_2 has (only) van der Waals’ forces ✓		**ALLOW** ‘vdW’ for van der Waals’ **IGNORE** references to van der Waals’ forces in IC*l* in explanation 1 **DO NOT ALLOW** ‘dipole–dipole interactions’ without reference to these being permanent for marking point 1
			Forces are stronger in IC*l* **ORA** **OR** More energy is needed to overcome forces in IC*l* ✓ **ORA**		**DO NOT ALLOW** marking point 2 for comparison of IC*l* having stronger ionic **OR** covalent bonds than Cl_2 ***Quality of Written Communication* – ‘electrons’ spelled correctly once and used in context for marking point 1 of explanation 2**
			Explanation 2 IC*l* has more electrons ✓ **ORA**		**ALLOW** I has more electrons
			Stronger van der Waals’ forces in IC*l* (than in Cl_2) **ORA** **OR** More energy is needed to overcome van der Waals' forces in IC*l* ✓ **ORA**		**ALLOW** more van der Waals’ forces **ALLOW** ‘vdW’ for van der Waals’
			Total	**9**	

Question			Answer	Marks	Guidance
2	(a)		Add (aqueous) silver nitrate OR $AgNO_3$ **OR** Ag^+ ions ✓ white **AND** precipitate ✓	2	**IGNORE** references to nitric acid **DO NOT ALLOW** references to any other additional reagent added to silver nitrate for marking point 1 **ALLOW** 'solid' **OR** 'ppt' for 'precipitate'. Both colour **AND** state is needed. **IGNORE** references to solubility in ammonia for marking point 2 if colour of precipitate is stated **BUT** **ALLOW** 'dissolves in **dilute** ammonia' if **no** colour of precipitate is given **DO NOT ALLOW** marking point 2 if additional reagent leads to invalid test
	(b)		The mixture effervesced **OR** fizzed **OR** bubbled **OR** produced a **gas** ✓ **X** is $CaCO_3$ **OR** calcium carbonate ✓	2	**ALLOW** CaO would not fizz **IGNORE** name of gas
	(c)	(i)	Contains water (of crystallisation) ✓	1	**ALLOW** 'with water' **OR** 'has water' **DO NOT ALLOW** 'in solution' **OR** 'in water'
		(ii)	Working must be marked first 219.1 – 111.1 = 108 ✓ 108/18 (= 6) **AND** $CaCl_2$•$6H_2O$ ✓	2	**ALLOW** $CaCl_2(H_2O)_6$ **ALLOW** $CaCl_26H_2O$ (ie no 'dot') **ALLOW** [219.1 – (40.1 + 2 x 35.5)] / 18 **AND** $CaCl_2$•$6H_2O$ for two marks **ALLOW** ECF for incorrectly calculated mass of H_2O / 18 provided final answer is rounded to nearest whole number for marking point 2

Mark Scheme

Question			Answer	Marks	Guidance
2	(d)		 Ca shown with either 8 or 0 electrons **AND** Cl shown with 8 electrons with 7 crosses and one dot (or *vice versa*) ✓ correct charges on both sets of ions ✓	2	**For first mark**, if eight electrons are shown in the cation then the 'extra' electron in the anion must match symbol chosen for electrons in the cation **IGNORE** inner shell electrons Circles **not** essential **ALLOW** One mark if both electron arrangement and charges are correct but only one Cl is drawn **ALLOW** $2[Cl^-]$ $2[Cl]^-$ $[Cl^-]_2$ (brackets not required) **DO NOT ALLOW** $[Cl_2]^-$ $[Cl_2]^{2-}$ $[2Cl]^{2-}$ $[Cl]_2^-$
	(e)		Ba is more reactive than Ca ✓ **ORA** Br_2 is less reactive than Cl_2 ✓ **ORA**	2	**ALLOW** reactivity increases down Group 2 **ORA** Provided Ca **and** Ba have been identified as Group 2 elements **ALLOW** reactivity decreases down Group 7 **ORA** Provided C*l* **and** Br have been identified as Group 7 elements **ALLOW** one mark for both sentences if no ascribing to groups **ALLOW** Br for Br_2 and C*l* for Cl_2 **DO NOT ALLOW** Br^- for Br_2 **OR** Cl^-
			Total	**11**	

Question			Answer	Marks	Guidance
3	(a)	(i)	A region (within an atom) that can hold (up to) two electrons ✓ (with opposite spin)	1	**ALLOW** ‘can be found’ **OR** ‘contains’ **OR** ‘has’ etc. for ‘can hold’ **ALLOW** ‘area’ **OR** ‘volume’ **OR** ‘space’ **OR** ‘somewhere’ etc. for region **DO NOT ALLOW** path of an electron **IGNORE** references to ‘orbitals being parts of sub-shells’
		(ii)	$1s^2 2s^2 2p^6 3s^2 3p^4$ ✓	1	**ALLOW** subscripts, capitals **IGNORE** $1s^2$ seen twice
		(iii)	7 ✓	1	
	(b)		(The amount of substance which contains) as many particles as there are carbon **atoms** in 12g of ^{12}C (atoms) ✓	1	**ALLOW** 6.02×10^{23} particles (atoms, molecules, ions etc.) **OR** N_A particles **OR** L particles **ALLOW** ‘Avogadro number’ in place of N_A particles **ALLOW ‘**Number of atoms in 12 g of ^{12}C’ **DO NOT ALLOW** ‘the number of particles in 12g of ^{12}C atoms’
	(c)		Energy (needed) to remove an electron ✓ from **each atom** in **one mole** ✓ of **gaseous atoms** ✓	3	**ALLOW** ‘Energy to remove one mole of electrons from one mole of gaseous atoms’ for three marks **IGNORE** ‘element’ **ALLOW** ‘Energy needed to remove an electron from one mole of gaseous atoms (to form one mole of gaseous 1+ ions’) for two marks For third mark: **ALLOW** ECF if wrong ‘particle’ is used in second marking point but is described as being gaseous eg ‘molecule’ instead of ‘atom’ If no definition, **ALLOW** one mark for $X(g) \rightarrow X^+(g) + e^-$ **OR** $X(g) - e^- \rightarrow X^+(g)$ **ALLOW** e^- for electron **IGNORE** state symbols on e

Question			Answer	Marks	Guidance
3	(d)	(i)	***From F to Ne*** *Nuclear charge mark:* Ne has (one) more proton **OR** Nuclear charge increases ✓ *Same shell or energy level mark:* (Outermost) electrons are in the same shell **OR** energy level **OR** (Outermost) electrons experience the same shielding ✓ *Nuclear attraction mark:* Greater nuclear attraction (on outermost electrons) **OR** Outer electrons are attracted more strongly (to the nucleus) ✓	3	**Use annotations with ticks, crosses, ECF etc for this part** **ALLOW** proton number increases but **IGNORE** atomic number increases **IGNORE** nucleus gets bigger **IGNORE** 'charge increases' ie must be nuclear charge **IGNORE** 'effective nuclear charge increases' **ALLOW** sub-shell for shell but **IGNORE** orbitals **ALLOW** shielding is similar **ALLOW** screening for shielding **IGNORE** Atomic radius decreases *(because given in question)* **OR** outermost electrons are closer **DO NOT ALLOW** 'distance is the same' for second mark **ALLOW** greater nuclear pull for greater nuclear attraction **DO NOT ALLOW** 'greater nuclear charge' instead of 'greater nuclear attraction' for the third mark **IGNORE** 'pulled closer' for 'pulled more strongly'
		(ii)	***From Ne to Na*** *Extra shell or energy level mark:* Na has (one) more shell(s) **OR** energy level ✓ *Shielding mark:* (Outermost) electron experiences greater shielding ✓ *Nuclear attraction mark:* Less nuclear attraction (on outermost electrons) **OR** Outer electrons are attracted less strongly (to nucleus) ✓	3	**Use annotations with ticks, crosses, ECF etc for this part** **ALLOW** 'next' shell **OR** 'new' shell **ALLOW** (outermost) electrons in a higher energy level **ALLOW** outermost electrons **OR** shell further from nucleus **IGNORE** Atomic radius increases *(because given in question)* **DO NOT ALLOW** orbitals **OR** sub-shells **ALLOW** screening for shielding **ALLOW** more electron repulsion from inner shells **ALLOW** 'less nuclear pull' for 'less nuclear attraction' **DO NOT ALLOW** 'less nuclear charge' for 'less nuclear attraction' for third mark. There must be a clear comparison
			Total	**13**	

Mark Scheme

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>4</td><td>(a)</td><td></td><td>
<table>
<tr><th>solid</th><th>melting point / ºC</th><th>type of lattice</th></tr>
<tr><td>K</td><td>63</td><td></td></tr>
<tr><td>KBr</td><td>734</td><td>giant ionic ✓</td></tr>
<tr><td>H_2O</td><td>0</td><td>simple molecular ✓</td></tr>
</table>
</td><td>2</td><td>giant AND ionic required

simple AND molecular required
ALLOW simple covalent</td></tr>
<tr><td></td><td>(b)</td><td></td><td>Particle mark 1:
In K, (electrostatic attraction between)
positive ions/cations AND e^- / electrons ✓

Particle mark 2:
In KBr, (electrostatic attraction between) oppositely OR positively AND negatively charged ions ✓

Forces mark:
K has metallic bonding OR K has attraction between positive ions and electrons
AND
KBr has ionic bonding OR KBr has attraction between oppositely charged ions ✓

In H_2O,
Forces mark:
hydrogen bonding ✓

Particles mark (QWC):
(Between) molecules ✓

Order of strength of forces: KBr > K > H_2O
OR
ionic bonding > metallic bonding > hydrogen bonding ✓</td><td>6</td><td>Use annotations with ticks, crosses, ECF etc for this part

ALLOW labels from diagrams if not seen in text

ALLOW K^+ and Br^- for ‘oppositely charged ions’

DO NOT ALLOW ‘atoms’ in KBr

IGNORE ‘metallic lattice’ for metallic bonding’ AND ‘ionic lattice’ for ‘ionic bonding’
DO NOT ALLOW , for forces mark, incorrect forces for K and KBr, such as covalent, van der Waals’ seen anywhere in the response

IGNORE references to van der Waals’ forces in water

ALLOW ‘intermolecular’ OR ‘molecular’ for particles mark
Quality of Written Communication: ‘molecules’ OR ‘intermolecular’ OR ‘molecular’ spelt correctly once and used in context for the fifth marking point

The order of all three substances OR bonding must be referred to for this mark
ALLOW responses which use comparatives such as strong and extremely strong to differentiate strength of forces
ALLOW answers that inform KBr > K > H_2O IGNORING incorrect forces used above</td></tr>
</table>

Question			Answer	Marks	Guidance
4	(c)		FIRST CHECK THE ANSWER ON ANSWER LINE IF answer = 72(.0) (cm^3) award 3 marks amount of K = 0.2346 / 39.1 **OR** = 6.(00) × 10^{-3} **OR** 0.006(00) mol ✓ amount of H_2 = (mol of K) / 2 **OR** = 3.(00) × 10^{-3} **OR** 0.003(00) mol ✓ Volume of gas = (mol of H_2) × 24000 **OR** = 72(.0) (cm^3) ✓	3	If there is an alternative answer, check to see if there is any ECF credit possible using working below **ALLOW** mol of K x 0.5 correctly calculated for 2nd mark **ALLOW** mol of H_2 x 24000 correctly calculated for 3rd mark **ALLOW** 144 (cm^3) from 0.006 x 24000 for two marks **ALLOW** 0.072 from 0.003 x 24 for two marks **ALLOW** calculator value or rounding to 2 significant figures or more **BUT IGNORE** ‘trailing’ zeroes, eg 0.200 allowed as 0.2
			Total	**11**	

Mark Scheme

Question			Answer	Marks	Guidance
5	(a)	(i)	The H^+ **OR** hydrogen **ions OR** protons in (sulfuric) acid have been replaced by ammonium ions **OR** NH_4^+ ✓	1	**ALLOW** 'a positive ion' for 'ammonium ions' **BUT** **IGNORE** 'a positive metal ion' **OR** 'metal ions' for 'ammonium ions' **IGNORE** references to being produced by the reaction of an acid and a base **DO NOT ALLOW** hydrogen atoms **OR** ammonia ions **DO NOT ALLOW** 'H for H^+ OR NH_4 for NH_4^+
		(ii)	FIRST CHECK THE ANSWER ON ANSWER LINE IF answer = 0.104 (mol) award 3 marks Amount of H_2SO_4 = 0.100 × 32.5/1000 = 3.25 × 10^{-3} **OR** 0.00325 mol ✓ Amount of NH_3 = (mol of H_2SO_4) × 2 = 6.50 × 10^{-3} **OR** 0.0065 mol ✓ No. of mol of NH_3 = (mol of NH_3) × 400 / 25.0 = 0.104 (mol) ✓	3	If there is an alternative answer, check to see if there is any ECF credit possible using working below **ALLOW ECF** for amount of H_2SO_4 × 2 **ALLOW ECF** for amount of NH_3 × 400 / 25.0 **ALLOW** concentration approach for marking point 3 Conc ammonia = 6.50 × 10^{-3} x 1000 / 25.0 = 0.260 mol dm^{-3} mol of NH_3 = (conc of NH_3) × 400 / 1000 = 0.104 (mol) **ALLOW** calculator value or rounding to 2 sig figs or more **BUT IGNORE** 'trailing' zeroes, eg 0.200 allowed as 0.2
	(b)		Predicted bond angle 107º ✓ *Explanation* There are 3 bonded pairs **and** 1 lone pair ✓ Electron **pairs** repel ✓ Lone pairs repel more than bonded pairs ✓	4	**ALLOW** range 106–108º **ALLOW** a response which is equivalent to 3 bp and 1 lp, eg 'There are four pairs of electrons. One is a lone pair' **ALLOW** 'bonds' for 'bonded pairs' **ALLOW** diagram showing N atom with 3 dot-and-cross bonds and 1 lone pair clearly drawn onto it for second mark **IGNORE** stick versions of bonding **DO NOT ALLOW** 'atoms repel' for 'electron pairs repel' **IGNORE** 'electrons repel' **ALLOW** 'bonds repel'

Mark Scheme

Question			Answer	Marks	Guidance
5	(c)	(i)	OH^- ✓	1	Correct charge must be seen **ALLOW** OH^- if seen as the ONLY negative product of an equation
		(ii)	$N_2H_5^+$ **OR** $N_2H_6^{2+}$ ✓	1	**ALLOW** $H_2N–NH_3^+$ **OR** $H_3N–NH_3^{2+}$
	(d)	(i)	C*l* goes from (+)1 to –1 ✓ N goes from –3 to –2 ✓ C*l* is reduced **AND** N is oxidised ✓	3	**ALLOW** 1(+), 1–. Only look for oxidation numbers seen above or below equation if not seen in text **IGNORE** Cl^- Cl^+ **DO NOT ALLOW** If a second species is seen going down in oxidation number with the exception of N going from –3 to –4 **ALLOW** 3 –, 2 –. Only look for oxidation numbers seen above or below equation if not seen in text **IGNORE** N^{3-} N^{2-} **DO NOT ALLOW** If a second species is seen going up in oxidation number **ALLOW** ECF for oxidation of any species showing an increase in oxidation number **AND** for reduction of any species showing a decrease in oxidation number **IGNORE** references to electron loss **OR** gain **ALLOW** 3 marks for labelled equation such as below $2NH_3 + NaClO \rightarrow N_2H_4 + NaCl + H_2O$ –3 +1 –2 –1 oxidation reduction
		(ii)	sodium chlorate(I) ✓	1	**ALLOW** sodium chlorate I (ie no brackets) **ALLOW** sodium hypochlorite **IGNORE** bleach **DO NOT ALLOW** sodium chlorate (with no Roman numeral)
		(iii)	$N_2H_4 + 2NH_2Cl \rightarrow 2NH_4Cl + N_2$ ✓✓	2	One mark for N_2 One mark for NH_4Cl **AND** balancing
			Total	**16**	