Mark Scheme for January 2011
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This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by Examiners. It does not indicate the details of the discussions which took place at an Examiners’ meeting before marking commenced.

All Examiners are instructed that alternative correct answers and unexpected approaches in candidates’ scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the Report on the Examination.

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<tbody>
<tr>
<td>1 (a)</td>
<td>Rb-87 has <strong>(two)</strong> more neutrons ✓</td>
<td>1</td>
<td>ALLOW Different numbers of neutrons</td>
</tr>
<tr>
<td></td>
<td><strong>ALLOW</strong> 2 neutrons</td>
<td></td>
<td>DO NOT ALLOW incorrect references to protons and electrons</td>
</tr>
<tr>
<td></td>
<td><strong>ALLOW</strong> Rb-85 has 48 neutrons <strong>AND</strong> Rb-87 has 50 neutrons</td>
<td></td>
<td><strong>DO NOT ALLOW</strong> incorrect references to protons and electrons</td>
</tr>
<tr>
<td>(b)</td>
<td>The (weighted) mean <strong>mass</strong> of an <strong>atom</strong> <em>(of an element)</em> <strong>OR</strong></td>
<td>3</td>
<td>ALLOW average atomic mass</td>
</tr>
<tr>
<td></td>
<td>The (weighted) average <strong>mass</strong> of an <strong>atom</strong> *(of an element) ✓</td>
<td></td>
<td>DO NOT ALLOW mean mass of an element</td>
</tr>
<tr>
<td></td>
<td>compared with 1/12th (the mass) ✓</td>
<td></td>
<td>ALLOW mean mass of isotopes <strong>OR</strong> average mass of isotopes</td>
</tr>
<tr>
<td></td>
<td>of (one atom of) carbon-12 ✓</td>
<td></td>
<td>DO NOT ALLOW the singular; ‘isotope’</td>
</tr>
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<td></td>
<td></td>
<td></td>
<td><strong>For second AND third marking points</strong></td>
</tr>
<tr>
<td></td>
<td>ALLOW compared with *(the mass of) carbon-12 which is 12</td>
<td></td>
<td>ALLOW mass of <strong>one mole of atoms</strong> ✓</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>compared to 1/12th ✓</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(mass of) <strong>one mole</strong> <strong>OR</strong> 12 g <strong>of</strong> carbon-12 ✓</td>
</tr>
<tr>
<td></td>
<td><strong>ALLOW</strong> mass of <strong>one mole</strong> of atoms ✓</td>
<td></td>
<td><strong>ALLOW</strong> mass of <strong>one mole</strong> of atoms <strong>OR</strong> 12 g <strong>of</strong> carbon-12</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><strong>ALLOW</strong> 1/12th mass of <strong>one mole</strong> <strong>OR</strong> 12 g <strong>of</strong> carbon-12</td>
</tr>
<tr>
<td>(c)</td>
<td><strong>(85.00 × 72.15) + (87.00 × 27.85) = 100</strong></td>
<td>2</td>
<td>ALLOW two marks for correct answer $A_r = 85.56$ (with no working)</td>
</tr>
<tr>
<td></td>
<td><strong>OR</strong> 61.3275 + 24.2295</td>
<td></td>
<td>ALLOW one mark for ECF from seen incorrect sum provided final answer is between 85 and 87 and is to 2 decimal places, e.g. 85.567 gives ECF of 85.57 for one mark</td>
</tr>
<tr>
<td></td>
<td><strong>OR</strong> 85.557 ✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$A_r = 85.56$ *(to 2 decimal places) ✓</td>
<td></td>
<td></td>
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| 1 (d)    | Spherical OR sphere ✓ | 1 | DO NOT ALLOW ’circular’  
IGNORE unlabelled 2-D diagrams |
| (e) (i)  | Sr⁺(g) → Sr²⁺(g) + e⁻ ✓ | 1 | ALLOW e for electrons  
ALLOW Sr⁺(g) – e⁻ → Sr²⁺(g)  
DO NOT ALLOW Sr⁺(g) + e⁻ → Sr²⁺(g) + 2e⁻  
IGNORE state symbols for electrons |
| (e) (ii) | Sr has one more proton  
OR greater nuclear charge ✓ | 3 | Use annotations with ticks, crosses ECF etc. for this part  
Comparison should be used for each mark  
ALLOW Sr has more protons  
ALLOW ‘across the period’ for ‘Sr’  
IGNORE ‘atomic number increases’, but ALLOW ‘proton number’ increases  
IGNORE ‘nucleus gets bigger’  
‘Charge increases’ is insufficient  
ALLOW ‘effective nuclear charge increases’ OR ‘shielded nuclear charge increases’  
**Quality of Written Communication – Nuclear OR proton(s)**  
**OR nucleus spelled correctly** **ONCE** **for the first marking point**  
ALLOW shielding is similar  
ALLOW screening for shielding  
IGNORE sub-shells  
DO NOT ALLOW ‘distance is similar’  
ALLOW ‘greater nuclear pull’ for ‘greater nuclear attraction’  
DO NOT ALLOW ‘nuclear charge’ for nuclear attraction  
ORA throughout |
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| 1 (e)    | 2nd IE of Rb involves removing electron from shell closer to nucleus √ | 2    | **IGNORE** new shell \nALLOW There is one shell fewer in Rb⁺ (than Sr⁺)  
ALLOW Rb⁺ has a smaller radius (than Sr⁺)  
ALLOW Rb⁺ loses an electron from the 4th shell AND Sr⁺ loses an electron from the 5th shell.  
ALLOW responses which do not specifically say ‘nuclear’ attraction (e.g. Rb has greater attraction) as long as nucleus is seen in first point  
A comparison of Rb to Sr must be used, e.g. ‘Because of shielding’ is not enough  
ORA |
|          | Stronger nuclear attraction on (outermost electron) of Rb  
OR (outermost electron) of Rb experiences less  
shielding √ |      |                                                                                                                                         |
<p>|          | Total                                                                | 13   |                                                                                                                                         |</p>
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<tr>
<td>2 (a) (i)</td>
<td>mol of $H_xA = \frac{25.00 \times 0.0500}{1000} = 1.25 \times 10^{-3}$ OR $0.00125$ mol ✓</td>
<td>1</td>
<td>ALLOW $0.0013$ OR $1.3 \times 10^{-3}$ ALLOW correct answer only without working</td>
</tr>
<tr>
<td>(ii)</td>
<td>mol of $NaOH = \frac{12.50 \times 0.200}{1000} = 2.5(0) \times 10^{-3}$ OR $0.0025(0)$ mol ✓</td>
<td>1</td>
<td>ALLOW correct answer without working</td>
</tr>
<tr>
<td>(iii)</td>
<td>Answer 2a(ii) rounded to nearest whole number ✓ Answer 2a(i) If 2a(i) and 2a(ii) are correct this will be $x = \frac{2.50 \times 10^{-3} \text{mol}}{1.25 \times 10^{-3} \text{mol}} = 2$ OR $H_2A$</td>
<td>1</td>
<td>ALLOW answer without working if answers to 2a(i) AND 2a(ii) are seen DO NOT ALLOW responses without seeing answers in 2a(i) AND 2a(ii)</td>
</tr>
<tr>
<td>(b) (i)</td>
<td>$HNO_3 \checkmark$ $CuO + 2HNO_3 \rightarrow Cu(NO_3)_2 + H_2O \checkmark$</td>
<td>2</td>
<td>IGNORE state symbols ALLOW correct multiples</td>
</tr>
<tr>
<td>(ii)</td>
<td>(Electrostatic) attraction between oppositely charged ions ✓</td>
<td>1</td>
<td>Attraction is essential IGNORE references to metal and non-metal</td>
</tr>
<tr>
<td>(iii)</td>
<td>Ions are mobile OR ions can move ✓</td>
<td>1</td>
<td>IGNORE ‘free ions’ IGNORE ‘delocalised ions’ IGNORE ions can move when molten IGNORE charge carriers DO NOT ALLOW Any mention of electrons moving ALLOW ions move when in a liquid IGNORE responses which give liquid ions</td>
</tr>
<tr>
<td>(iv)</td>
<td>(+) 5 ✓</td>
<td>1</td>
<td>ALLOW ✓</td>
</tr>
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<td>---------------------------------------------</td>
</tr>
<tr>
<td>2 (c)</td>
<td>Cu(NO$_3$)$_2$•6H$_2$O ✓</td>
<td>1</td>
<td>ALLOW Cu(NO$_3$)$_2$•6H$_2$O</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>ALLOW Cu(NO$_3$)$_2$(H$_2$O)$_6$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>ALLOW Cu(NO$_3$)$_2$.6H$_2$O</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>DO NOT ALLOW CuN$_2$O$_6$•6H$_2$O</td>
</tr>
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</table>

Total 9
### Question 3

#### (a)
The ability of an **atom** to attract electrons ✓

in a covalent bond ✓

#### (b)

\[ \delta^+\text{N}-%F^- \text{ AND } \delta^-\text{N}-%\text{Br}\delta^+ \]

ALLOW \( \dplus\/\dminus\)

DO NOT ALLOW +/–

#### (c) (i)
octahedral **OR** octahedron ✓

#### (ii)

![Diagram of BF₃ showing three 'dot-and-cross' bonds between B and F and all F atoms with complete octet of electrons ✓](image1)

![Diagram of NH₃ showing three 'dot-and-cross' bonds between N and H and N atom has a lone pair ✓](image2)

*Marking points 3, 4 and 5 may be awarded independently*

- electron pairs repel ✓

- NH₃ has **one lone** pair and **three bonding** pairs of electrons **AND** lone pair of electrons repels **more** than bonding pairs ✓

- BF₃ has **three** (bonding) pairs of electrons (which repel equally) ✓

---

**Mark Scheme January 2011**

**Question** | **Answer** | **Mark** | **Guidance**
---|---|---|---
3 (a) | The ability of an **atom** to attract electrons ✓ | 2 | ALLOW 'attraction of an **atom** for electrons’
ALLOW 'pull' for 'attract'
DO NOT ALLOW 'element' for 'atom'
ALLOW 'shared pair' or 'bond(ing) pair' for 'covalent bond'

(b) | \[ \delta^+\text{N}-%F^- \text{ AND } \delta^-\text{N}-%\text{Br}\delta^+ \] ✓ | 1 | ALLOW \( \dplus\/\dminus\)
DO NOT ALLOW +/–

(c) (i) | octahedral **OR** octahedron ✓ | 1 |

(ii) | ![Diagram of BF₃ showing three 'dot-and-cross' bonds between B and F and all F atoms with complete octet of electrons ✓](image1)

![Diagram of NH₃ showing three 'dot-and-cross' bonds between N and H and N atom has a lone pair ✓](image2)

*Marking points 3, 4 and 5 may be awarded independently*

- electron pairs repel ✓

- NH₃ has **one lone** pair and **three bonding** pairs of electrons **AND** lone pair of electrons repels **more** than bonding pairs ✓

- BF₃ has **three** (bonding) pairs of electrons (which repel equally) ✓

--

ALLOW diagrams without circles
Must be ‘*dot-and-cross’

---

IGNORE 'electrons repel'
DO NOT ALLOW 'atoms repel'
ALLOW 'bonds repel'

ALLOW 'bonds' for ‘bonding pairs’
ALLOW 'four pairs' in place of ‘one lone pair and three bonding pairs’

The third marking point can be gained from statements seen in fourth or fifth marking points
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| 3 (c) (iii) | **BF₃** is symmetrical ✓  
The dipoles cancel out ✓ | 2    | IGNORE 'polar bonds cancel'  
IGNORE 'charges cancel' |
### Question Answer Mark Guidance

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| 4 (a)    | Used to neutralise **acidic** soils ✓ | 2 | ALLOW raises the pH of the soil  
IGNORE references to fertilisers  
ALLOW pH becomes **too** high  
IGNORE ‘harmful’  
IGNORE ‘corrosive’ |
|          | Excess will result in soils becoming **too** alkaline (to sustain crop growth) ✓ | | |
| (b) (i)  | $0.00131 \times 40.1 = 0.0525 \text{ g OR } 5.25 \times 10^{-2}$ ✓ | 1 | ALLOW 0.053 OR 0.05253 OR 0.052531 g  
IGNORE 0.05 if correct answer seen in working  
DO NOT ALLOW 0.052 OR 0.0524 |
| (ii)     | $0.00131 \times 24.0 = 0.0314 \text{ dm}^3 \text{ OR } 3.14 \times 10^{-2}$ ✓ | 1 | ALLOW 0.031 OR 0.03144 dm$^3$  
IGNORE 0.03 if correct answer seen in working  
DO NOT ALLOW 31.4 |
| (iii)    | Mol of OH$^-$ ions = $0.00131 \times 2 = 0.00262 \text{ OR } 2.62 \times 10^{-3}$ ✓ | 2 | ALLOW 0.0026  
ALLOW 0.01048 OR 0.01(0)  
ALLOW ECF from incorrect mol of OH$^-$  
DO NOT ALLOW 2nd mark as ECF if 0.0525 is used as no of mol of OH$^-$ ions  
DO NOT ALLOW 2nd mark as ECF if 0.0314 is used as no of mol of OH$^-$ ions  
0.00524 mol dm$^{-3}$ is a likely ECF as a result of not multiplying 0.00131 by 2, but 0.00131 must be seen in working |
| (c) (i)  | Fewer **moles** of Ba (in 0.0525 g)  
**OR** Fewer **atoms** of Ba (in 0.0525) ✓ | 1 | ORA  
Assume candidate is referring to Ba if not stated  
IGNORE A; Ba > A, Ca |
| (ii)     | Idea of Ba having a quicker **rate** OR more **vigorous** reaction ✓ | 1 | ALLOW more exothermic **OR** gets hotter OR fizzes more  
Assume candidate is referring to Ba if not stated  
Comparison is essential  
IGNORE ‘Ba more reactive’  
ORA |

**Total**: 8
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<tr>
<td>5 (a)</td>
<td><strong>Creating the dipole mark</strong>&lt;br&gt;uneven distribution of electrons ✓</td>
<td>3</td>
<td>Use annotations with ticks, crosses ECF etc. for this part&lt;br&gt;ALLOW movement of electrons&lt;br&gt;ALLOW changing electron density&lt;br&gt;ALLOW ‘transient’, ‘oscillating’, ‘momentary’, ‘changing’&lt;br&gt;ALLOW ‘induces a dipole in neighbouring molecules’&lt;br&gt;ALLOW ‘causes a resultant dipole in neighbouring molecules’&lt;br&gt;ALLOW ‘atoms’ for ‘molecules’</td>
</tr>
<tr>
<td>(i)</td>
<td><strong>Type of dipole mark</strong>&lt;br&gt;creates an instantaneous dipole OR temporary dipole ✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Induction of a second dipole mark</strong>&lt;br&gt;causes induced dipole(s) in neighbouring molecules ✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(ii)</td>
<td>boiling points increase down the group ✓</td>
<td>3</td>
<td>Use annotations with ticks, crosses ECF etc. for this part&lt;br&gt;ALLOW Bpt of iodine is highest OR Bpt of chlorine is lowest&lt;br&gt;ALLOW Cl for chlorine etc.&lt;br&gt;For ‘down the group’ ALLOW ‘as molecules get bigger’&lt;br&gt;ALLOW number of electron shells increases&lt;br&gt;IGNORE ‘more shells’ (if no reference to electrons)&lt;br&gt;ALLOW ‘more’ for ‘stronger’&lt;br&gt;ALLOW iodine has most electrons&lt;br&gt;ALLOW chlorine has fewest electrons&lt;br&gt;DO NOT ALLOW any implication that the attraction is between atoms not molecules for third mark</td>
</tr>
<tr>
<td></td>
<td>greater number of electrons OR stronger intermolecular forces OR stronger van der Waals’ forces ✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>more energy needed to break intermolecular OR van der Waals’ forces ✓</td>
<td></td>
<td></td>
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<tr>
<td>(b)</td>
<td>Same number of <strong>outer(most)</strong> electrons OR same <strong>outer(most)</strong> electron structure ✓</td>
<td>1</td>
<td>ALLOW same number of electrons in outer shell&lt;br&gt;ALLOW It has seven outer electrons&lt;br&gt;IGNORE same group&lt;br&gt;DO NOT ALLOW ‘same number of electrons’</td>
</tr>
<tr>
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| 5 (c) (i) | **Colours:** *(Add Br₂ to NaCl, (Cyclohexane layer) turns orange OR yellow ✓)* *(Add Br₂ to NaI, (Cyclohexane layer) turns purple OR lilac OR violet OR pink OR mauve ✓)* | 6 | **Use annotations with ticks, crosses ECF etc. for this part**  
ALLOW any combination of these but no others  
ALLOW any combination of these but no others  
DO NOT ALLOW 'precipitate' with either colour  
DO NOT ALLOW equation mark if incorrect equation(s) also seen  
IGNORE Br₂ + 2Cl⁻ → Br₂ + 2Cl⁻  
IGNORE correct non-ionic version of equation  
IGNORE state symbols  
ALLOW Chlorine is the most reactive  
ALLOW Cl for chlorine etc.  
ALLOW Iodine is the least reactive  
ALLOW chlorine is best at electron capture  
ALLOW chlorine has ‘greatest’ electron affinity  
IGNORE chlorine is most electronegative  
DO NOT ALLOW explanations in terms of displacement  
**Quality of Written Communication** – Electron(s) OR negative spelled correctly at least ONCE for marking point 5  
ALLOW Chlorine atom has fewest shells  
ALLOW outer(most) shell closest to the nucleus  
ALLOW Chlorine atom has lowest shielding  
ORA for marking points 4, 5 and 6 |
| **Equation:** Br₂ + 2I⁻ → I₂ + 2Br⁻ ✓ | **Reactivity:**  
Reactivity decreases down the group  
OR Oxidising power decreases down the group ✓  
**Explanations:**  
Chlorine will gain electron easiest  
OR form negative ion easiest ✓  
Because chlorine (atom) is smallest  
OR Outer(most) shell of chlorine least shielded  
OR Nuclear attraction on electrons of chlorine is greatest ✓ | | |
<p>| | | | |
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</table>
| 5 (c) (ii) | Bromine is toxic ✓ | 1 | ALLOW cyclohexane is toxic  
ALLOW bromine irritates the lungs  
DO NOT ALLOW Cl₂ is toxic  
IGNORE ‘strong smelling’  
IGNORE ‘halogens’ are toxic |
| (d) (i) | 2F₂ + 2H₂O → 4HF + O₂ ✓ | 1 | ALLOW correct multiples, including use of ½ O₂  
ALLOW 4HF  
IGNORE state symbols |
| (ii) | Oxygen has been oxidised as (oxidation number has increased from) O = −2 to O = 0 ✓  
Fluorine has been reduced as (oxidation number has decreased from) F = 0 to F = −1 ✓ | 2 | IGNORE references to oxygen in any incorrect products  
DO NOT ALLOW O₂ = −2 → O = 0 but ALLOW F₂ = 0 → F = −1  
ALLOW ‘F is reduced from 0 to −1’ regardless of product (or no product) in 5d(i) except ALLOW ECF for F = −2 if H₂F is seen  
ALLOW one mark for O = −2 and O₂ = 0 AND F₂ = 0 and F = −1 if no reference OR incorrect reference to oxidation / reduction is seen  
Look at equation in 5d(i) for oxidation numbers if not seen in 5d(ii)  
IGNORE reference to electron loss / gain if correct  
DO NOT ALLOW incorrect reference to electron loss / gain |
| (e) (i) | (1s²) 2s² 2p⁶ 3s² 3p⁶ 3d¹⁰ 4s² 4p¹ ✓ | 1 | IGNORE 1s² twice  
ALLOW 4s² before 3d¹⁰  
ALLOW ‘3D’ |
| (ii) | GaF₃ ✓ | 1 | |
| | Total | 19 | |
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