Atomic Structure

Mark Scheme 1

Level	International A Level
Subject	Chemistry
Exam Board	CIE
Topic	Atomic Structure
Sub-Topic	
Paper Type	Theory
Booklet	Mark Scheme 1

Time Allowed: **68 minutes**

Score: **/56**

Percentage: **/100**

Grade Boundaries:

A*	A	B	C	D	E	U
>85%	777.5%	70%	62.5%	57.5%	45%	<45%

<table>
<tr><th>Question</th><th>Mark Scheme</th><th>Mark</th><th>Total</th></tr>
<tr><td>1 (a)</td><td>
<table>
<tr><td>sub-atomic particle</td><td>relative mass</td><td>relative charge</td></tr>
<tr><td>neutron</td><td></td><td>0</td></tr>
<tr><td>electron</td><td>1/1836</td><td>–</td></tr>
<tr><td>proton</td><td></td><td>+</td></tr>
</table>
</td><td>[1]
[1]
[1]</td><td>[3]</td></tr>
<tr><td>(b) (i)</td><td>RAM = mean / average mass of the isotopes / an atom(s)
relative to 1/12 the mass of an atom of ^{12}C / on a scale where an atom of ^{12}C is (exactly) 12 (units)

isotope = atoms with the same number of protons / atomic number / proton number with different mass numbers / numbers of neutrons / nucleon number</td><td>[1]
[1]

[1]</td><td>[3]</td></tr>
<tr><td>(ii)</td><td>$\frac{(0.89\times74)+(9.37\times76)+(7.63\times77)+(23.77\times78)+(49.61\times80)+(8.73\times82)}{100}$

= 79.04 (2 d.p.) AND Se</td><td>[1]

[1]</td><td>[2]</td></tr>
<tr><td>(c) (i)</td><td>Te Cl

$\frac{47.4}{128}$ $\frac{52.6}{35.5}$

$\frac{0.370}{0.370}$ $\frac{1.48}{0.370}$

1 4 so EF = $TeCl_4$

Empirical Formula Mass = 270 so MF = $TeCl_4$</td><td>[1]

[1]

[1]</td><td>[3]</td></tr>
<tr><td>(c) (ii)</td><td>Covalent AND simple / molecular

low melting point / reaction with water</td><td>[1]

[1]</td><td>[2]</td></tr>
<tr><td>(iii)</td><td>$TeCl_4 + 3H_2O \rightarrow H_2TeO_3 + 4HCl$
OR $TeCl_4 + 2H_2O \rightarrow TeO_2 + 4HCl$</td><td>[1]</td><td>[1]</td></tr>
<tr><td>(d) (i)</td><td>Yellow / orange flame
White fumes / solid
Yellow / green gas disappears</td><td>[1]
[1]
[1]</td><td>[max 2]</td></tr>
</table>

Question	Mark Scheme	Mark	Total
(ii)	$NaCl$ giant / lattice **AND** ionic $SiCl_4$ simple / molecular **AND** covalent For $NaCl$ large difference in electronegativity (of sodium / Na and chlorine / Cl / Cl_2) (indicates electron transfer/ions) For $SiCl_4$ smaller difference (indicates sharing/covalency) with (weak) van der Waals' / IM forces (between molecules) ora	[1] [1] [1] [1]	[4]
			[20]

<table>
<tr><th>Question</th><th>Scheme</th><th>Mark</th><th>Total</th></tr>
<tr><td>2 (a)</td><td>
<table>
<tr><td>name of particle</td><td>relative mass</td><td>relative charge</td></tr>
<tr><td>proton</td><td></td><td>+</td></tr>
<tr><td>electron</td><td>1/1836</td><td>–</td></tr>
<tr><td>neutron</td><td></td><td>0</td></tr>
</table>
</td><td>[1]
[1]
[1]</td><td>[3]</td></tr>
<tr><td>(b) (i)</td><td>Mass of an atom(s)

relative to 1 / 12th (the mass) of (an atom of) carbon-12
OR
relative to carbon-12 which is (exactly) 12</td><td>[1]

[1]</td><td>[2]</td></tr>
<tr><td>(ii)</td><td>% of third isotope = 10

$\frac{(24\times79)+(26\times11.0)+10x}{100}=24.3$

10x = 248

x = 24.8 (3s.f.)</td><td>[1]

[1]

[1]</td><td>[3]</td></tr>
<tr><td>(c) (i)</td><td>anode $l^- \rightarrow Cl_2 + 2e^-$
cathode $^{2+} + 2e^- \rightarrow$ Mg</td><td>[1]
[1]</td><td>[2]</td></tr>
<tr><td>(ii)</td><td>Mg O H Cl
$\frac{31.65}{24.3}$ $\frac{20.84}{16}$ $\frac{1.31}{1}$ $\frac{46.2}{35.5}$

1.30 1.30

MgOHCl</td><td>[1]

[1]</td><td>[2]</td></tr>
<tr><td>(d) (i)</td><td>Na_2O basic / alkaline; Al_2O_3 amphoteric / acidic and basic; SO_3 acidic
Na_2O (giant) ionic AND SO_3 (simple / molecular) covalent</td><td>[1]
[1]</td><td>[2]</td></tr>
<tr><td>(ii)</td><td>$Na_2O + 2HCl \rightarrow 2NaCl + H_2O$

$Al_2O_3 + 6HCl \rightarrow 2AlCl_3 + 3H_2O$

$Al_2O_3 + 2NaOH + 7H_2O \rightarrow 2NaAl(OH)_4(H_2O)_2$ OR
$Al_2O_3 + 2NaOH + 3H_2O \rightarrow 2NaAl(OH)_4$ OR
$Al_2O_3 + 2NaOH \rightarrow 2NaAlO_2 + H_2O$ OR
$Al_2O_3 + 2OH^- + 7H_2O \rightarrow 2[Al(OH)_4(H_2O)_2]^-$ OR
$Al_2O_3 + 2OH^- + 3H_2O \rightarrow 2[Al(OH)_4]^-$ OR
$Al_2O_3 + 2OH^- \rightarrow 2AlO_2^- + H_2O$

$SO_3 + NaOH \rightarrow NaHSO_4$ OR
$SO_3 + 2NaOH \rightarrow Na_2SO_4 + H_2O$</td><td>[1]

[1]

[1]

[1]</td><td>[4]</td></tr>
</table>

Question	Scheme	Mark	Total
3 **(a)**	$(1s^2)2s^22p^6$	[1]	[1]
(b) (i)	The amount of energy required/energy change when one electron is removed from each atom in one mol of gaseous atoms	[1] [1] [1]	[3]
(ii)	Greater nuclear charge/number of protons Same shielding/number of shells/energy level	[1] [1]	[2]
(c) (i)	mean/average mass of the isotopes/an atom(s) relative to 1/12 of the mass of an atom of ^{12}C/on a scale where an atom of ^{12}C is (exactly) 12	[1] [1]	[2]
(ii)	$20.2 = \frac{(20 \times 90.48) + (21 \times 0.27) + (9.25y)}{100}$ $\frac{2020 - 1815.27}{9.25} = 22.133$ y = 22	[1] [1]	[2]
(d) (i)	$pV = \frac{mRT}{M_r}$ $M_r = \frac{mRT}{pV} = \frac{0.275 \times 8.31 \times 298}{100 \times 10^3 \times 200 \times 10^{-6}}$ M_r = 34.05/34.1	 [1] [1]	[2]
(ii)	(Let % Ne = x so % Ar = 100-x) $\frac{20.2x + 39.9(100 - x)}{100} = 34.05$ % Ne = 29.7	 [1]	[1]
1 (e) (i)	Van der Waal's/London/dispersion Uneven electron distribution/temporary dipole Induced dipole-dipole attraction	[1] [1] [1]	[3]
(ii)	more electrons more polarisable/greater attraction/stronger IMFs	[1] [1]	[2]
			[18]