Atoms, Molecules & Stoichiometry

Mark Scheme 1

Level	International A Level
Subject	Chemistry
Exam Board	CIE
Topic	Atoms, Molecules & Stoichiometry
Sub-Topic	
Paper Type	Theory
Booklet	Mark Scheme 1

Time Allowed: **69 minutes**

Score: **/57**

Percentage: **/100**

Grade Boundaries:

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

1 **(a)**	<table><tr><td></td><td>protons</td><td>electrons</td><td>neutrons</td></tr><tr><td>$^{14}C^{2-}$</td><td>**6**</td><td>**8**</td><td>**8**</td></tr></table>		**1** **1**
(b)	CCl_4: no reaction $GeCl_4$ and $SnCl_4$: for **each** steamy fumes evolved *or* white solid produced $GeCl_4 + 2H_2O \longrightarrow GeO_2 + 4HCl$ $SnCl_4 + 2H_2O \rightarrow SnO_2 + 4HCl$		**1** **1** **1** **1**
(c)	Ge / Sn **use** d–orbitals ***or*** Ge / Sn have low lying d orbitals ***or*** carbon cannot expand its octet ***or*** carbon cannot accommodate more than 4 bonded pairs		**1**
(d)	Sn^{4+}/Sn^{2+} = +0.15V **and** Pb^{4+}/Pb^{2+} = +1.69 V **and** Cl_2/Cl^- = + 1.36 V Sn^{2+} is oxidised by Cl_2 because its $E^{\ominus}$ is less positive / more negative **or** Sn^{2+} is a good reducing agent due to its smaller E value than Cl_2 **ora** **or** Pb^{4+} is a stronger oxidising agent than Cl_2 so Pb^{2+} with Cl_2 reaction is not feasible **or** Sn^{4+} is a weaker oxidising agent than Cl_2 so Sn^{2+} with Cl_2 reaction is feasible $SnCl_2 + Cl_2 \longrightarrow SnCl_4$ ***or*** $Sn^{2+} + Cl_2 \longrightarrow Sn^{4+} + 2Cl^-$ ***or*** $SnCl_2 + Cl_2 + 2H_2O \longrightarrow SnO_2 + 4HCl$		**1** **1** **1**
(e) (i)	F = Le		**1**
(ii)	moles of $O_2(g)$ = 130/24000 = 5.417 x 10^{-3} mol moles of electrons needed = 4 x 5.417 x 10^{-3} ***or*** 2.17 x 10^{-2} mol no. of coulombs passed = 1.2 x 30 x 60 ***or*** 2160 C no. of electrons passed = 2160 / 1.6 x 10^{-19} ***or*** 1.35 x 10^{22} no. of electrons per mole = 1.35 x 10^{22} / 2.17 x 10^{-2} = **6.2 x 10^{23}** (mol^{-1})		**1** **1** **1** **1**
			[Total: 15]

2 **(a)** **(i)** $n(H_2SO_4) = \frac{25.0 \times 1.00}{1000} = 0.025$ mol (1)

(ii) $n(NaOH) = \frac{16.2 \times 2.00}{1000} = 0.0324$ mol (1)

(iii) $n(H_2SO_4)$ reacting with NaOH $= \frac{0.0324}{2} = 0.0162$ mol (1)

(iv) $n(H_2SO_4)$ reacting with NH_3 = 0.025 - 0.0162 = 0.0088 mol (1)

(v) $n(NH_3)$ reacting with H_2SO_4 = 2 x 0.0088 = 0.0176 mol (1)

(vi) $n(NaNO_3)$ reacting = $n(NH_3)$ produced = 0.0176 mol (1)

(vii) mass of $NaNO_3$ that reacted = 0.0176 x 85 = 1.496 g (1)

(viii) % of $NaNO_3$ $= \frac{1.496 \times 100}{1.64} = 91.2195122 = 91.2$

give one mark for the correct expression (1)
give one mark for answer given as 91.2 – i.e to 3 sig. fig. (1)
allow ecf where appropriate

[9]

(b) $NaNO_3$ +5 **and** NH_3 -3 **both** required [1]

[Total: 10]

3 **(a) (i)** mass of C = $\frac{12 \times 1.32}{44}$ = 0.36g (1)

n(C) = $\frac{0.36}{12}$ = 0.03 (1)

(ii) mass of H = $\frac{2 \times 0.54}{18}$ = 0.06 g (1)

n(H) = $\frac{0.06}{1}$ = 0.06 (1)

(iii) yes **because** 0.03 mol of C are combined with 0.06 mol of H **or**
C : H ratio is 1 : 2 **or**
empirical formula is CH_2 **(1)**

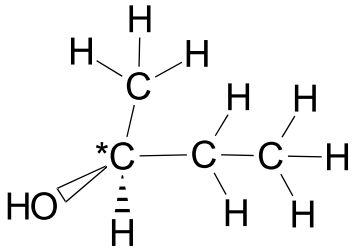
(b) (i) C : H : O = $\frac{64.86}{12}$: $\frac{13.50}{1}$: $\frac{21.64}{16}$ (1)

= 5.41: 13.50 : 1.35

= 4 : 10 : 1

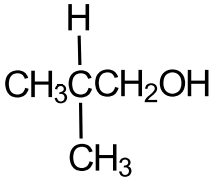
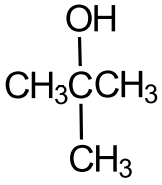
gives $C_4H_{10}O$ (1)

(ii)



correct compound **and** correct chiral C* (1)
correct mirror object/ mirror
image relationship in 3D (1)

(iii)

$CH_3CH_2CH_2CH_2OH$		

(1) [7]

[Total: 12]

<table>
<tr><th>Question</th><th>Mark Scheme</th><th>Mark</th><th>Total</th></tr>
<tr><td>4 (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>

(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]