MARK SCHEME for the May/June 2015 series

9701 CHEMISTRY

9701/21	Paper 2 (Structured Questions AS Core), maximum raw mark 60
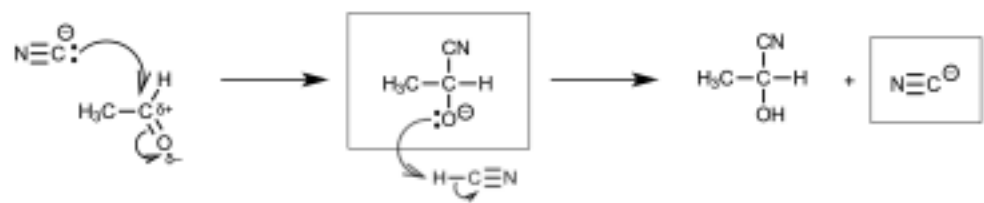
Question		Mark Scheme	Mark	Total
1	**(a)**	<table><tr><td>sub-atomic particle</td><td>relative mass</td><td>relative charge</td></tr><tr><td>**neutron**</td><td>**1**</td><td>0</td></tr><tr><td>**electron**</td><td>1/1836</td><td>**−1**</td></tr><tr><td>**proton**</td><td>**1**</td><td>**+1**</td></tr></table>	[1] [1] [1]	[3]

	(b) (i)	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
			[1]
			[1]
			
			[1]
				[3]

	(ii)	$$\frac{(0.89\times74)+(9.37\times76)+(7.63\times77)+(23.77\times78)+(49.61\times80)+(8.73\times82)}{100}$$ = 79.04 (2 d.p.) **AND** Se	[1] [1]	[2]
	(c) (i)	**Te** **Cl** $\dfrac{47.4}{128}$ $\dfrac{52.6}{35.5}$ $\dfrac{0.370}{0.370}$ $\dfrac{1.48}{0.370}$ 1 4 so EF = TeCl_4 Empirical Formula Mass = 270 so MF = TeCl_4	[1] [1] [1]	[3]
	(c) (ii)	Covalent **AND** simple/molecular low melting point/reaction with water	[1] [1]	[2]
	(iii)	TeCl_4 + 3H$_2$O → H$_2$TeO$_3$ + 4HCl **OR** TeCl_4 + 2H$_2$O → TeO$_2$ + 4HCl	[1]	[1]
	(d) (i)	Yellow/orange flame White fumes/solid Yellow/green gas disappears	[1] [1] [1]	[max 2]

Question			Mark Scheme	Mark	Total
	(ii)		NaCl giant/lattice **AND** ionic	[1]	
			SiCl_4 simple/molecular **AND** covalent	[1]	
			For NaCl large difference in electronegativity (of sodium/Na and chlorine/Cl/Cl_2) (indicates electron transfer/ions)	[1]	
			For SiCl_4 smaller difference (indicates sharing/covalency) with (weak) van der Waals'/IM forces (between molecules) ora	[1]	[4]
					[20]
2 (a)	(i)		Straight line drawn horizontally from same intercept	[1]	[1]
	(ii)		T_1 because it shows greatest deviation/furthest from ideal	[1]	[1]
	(iii)		reducing T (reduces KE of particles) so intermolecular forces of attraction become more significant	[1]	[1]
	(iv)		greatest deviation is at high pressure	[1]	
			increasing pressure decreases volume so volume of particles becomes more significant ora	[1]	[2]
	(b)		Mass of air $= 100 \times 0.00118 = 0.118$ g		
			Mass of flask $= 47.930 - 0.118 = \textbf{47.812}$ g	[1]	
			Mass of **Y** $= 47.989 - 47.812 = \textbf{0.177}$ g	[1]	
			$pV = nRT = \dfrac{m}{M_r} RT$		
			$M_r = \dfrac{mRT}{pV} = \dfrac{0.177 \times 8.31 \times 299}{1 \times 10^5 \times 100 \times 10^{-6}}$	[1]	
			$= \textbf{44.0}$ (43.979 to 2 or more sf)	[1]	[4]
(c)	(i)		strong <u>triple</u> bond	[1]	[1]
	(ii)		high temperature (needed for reaction between N_2 and O_2)	[1]	[1]
	(iii)		$2NO + 2CO \rightarrow N_2 + 2CO_2$	[1]	
			OR $2NO + C \rightarrow N_2 + CO_2$		[1]
	(iv)		$4NO_2 + 2H_2O + O_2 \rightarrow 4HNO_3$	[1]	[1]
	(v)		$NO + \frac{1}{2}O_2 \rightarrow NO_2$	[1]	
			$NO_2 + SO_2 \rightarrow NO + SO_3$	[1]	
			OR $NO_2 + SO_2 + H_2O \rightarrow NO + H2SO_4$		[2]
					[15]

Question	Mark Scheme	Mark	Total
3 **(a)**	Bond breaking = C=O = 740 C–H = 410 = 1150 kJ	[1]	

	Bond forming = C–C = 350
	                          C–O = 360
	                          O–H = 460 = 1170 kJ
		[1]	

	Enthalpy change = 1150 – 1170 = **–20** kJ mol^{-1}	[1]	[3]
(b) **(i)**	Stereoisomerism = (molecules with the same molecular formula and) same structural formula but different spatial arrangements of atoms	[1]	
	Chiral centre = atom with four different atoms/groups attached	[1]	[2]
(ii)	(Planar) carbonyl so (equal chance of nucleophile) attacking either side	[1]	[1]
3 **(c)** **(i)**	 M1 = lone pair **AND** curly arrow from lone pair to carbonyl C M2 = partial charges on C=O **AND** curly arrow from bond (=) to O$^{\delta-}$ M3 = structure of intermediate including charge M4 = lone pair **AND** two correct curly arrows (from lone pair to H **AND** from H—C to C) M5 = CN$^-$	[1] [1] [1] [1] [1]	[5]
(ii)	(CN$^-$ regenerated so) catalyst	[1]	[1]
			[12]

Question	Mark Scheme	Mark	Total
4 (a)		[1] [1] [1] [1] [1] [1] [1] [7]	
(b) (i)	but-1-ene / 1-butene but-2-ene / 2-butene	[1] [1]	[2]
(ii)	but-2-ene **AND** two different groups on each carbon (of C=C) double bond means no free rotation	[1] [1]	[2]
(iii)	 and (either way round)	[1+1]	[2]
			[13]