Unit 1 - Mark scheme

Question number	Answer	Mark
1(a)	A R and U	1

Question number	Answer	Mark
1(b)	C Y	1

Question number	Answer	Mark
1(c)	C U^{2+} and T^{2-}	1

Question number	Answer	Mark
2	A P^{3-}	1

Question number	Answer	Mark
3	D 	1

Question number	Answer	Mark
4	C 20.18	1

Question number	Answer	Mark
5	B $^{56}Fe^{2+}$	1

Question number	Answer	Mark
6	B fractional distillation	**1**

Question number	Answer	Mark
7	A ethanol	**1**

Question number	Answer	Mark
8	A E-5-methylhex-2-ene	**1**

Question number	Answer	Mark
9	A π, heterolytic	**1**

Question number	Answer	Mark
10	C 30.0	**1**

Question number	Answer	Mark
11	C 0.20	**1**

Question number	Answer	Mark
12	B C_5H_{12}	**1**

Question number	Answer	Mark
13	D 1.2 dm^3 of nitrogen, N_2, and 1.2 g of magnesium, Mg	**1**

Question number	Answer	Mark
14	B 2 electrons in a 2p orbital, 18 electrons in the third quantum shell	1

Question number	Answer	Mark
15	B covalent and dative covalent bonding only	1

Question number	Answer	Mark
16	D $AlCl_3$ trigonal planar, PH_3 pyramidal	1

Question number	Answer	Mark
17	D C-Cl bond polar, CCl_4 molecule non-polar	1

Question number	Answer	Mark
18	B (C_4H_7Cl)	1

Question number	Answer		Additional guidance	Mark
19(a)	• correct species in equation • correct state symbols	(1) (1)	Examples of equation: $N(g) \rightarrow N^{+}(g) + e^{(-)}$ or $N(g) - e^{(-)} \rightarrow N^{+}(g)$	2

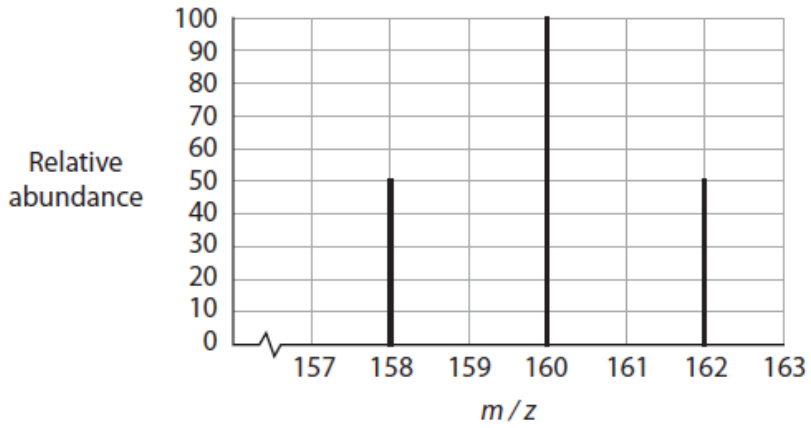
Question number	Answer		Additional guidance	Mark
19(b)	An explanation that makes reference to the following points:			4
	• general increase across a period/atomic numbers 3-10 due to increase in nuclear charge	(1)	Allow increase in effective nuclear charge	
	• the (outer) electrons are added to the same quantum shell or the shielding is the same.	(1)		
	Irregularities:			
	• atom with atomic number 5 has lower IE than atom with atomic number 4 as the (2)p electron is better shielded than the (2)s electron (so requires less energy to be removed)	(1)	Accept reverse arguments Accept names for atomic numbers	
	• atom with atomic number 8 has lower IE than atom with atomic number 7 as there is repulsion between the pair of electrons in the 2(p) orbital (so less energy is required to remove one of them).	(1)	Allow the 2p sub-shell is further from the nucleus than the 2s orbital Allow a half-filled p sub shell is more stable	

Question number	Answer	Additional guidance	Mark
19(c)	An explanation that makes reference to the following points: • (decrease down a group due to) (there is an increase in nuclear charge from 3 to 11 but this is offset by) the outer electron is in a higher quantum shell/higher energy level (1) • therefore further from the nucleus/better shielded. (1)		**2**

Question number	Answer	Additional guidance	Mark
20(a)	• $[Ar]3d^{10}4s^{2}4p^{5}$	Allow $4s^{2}3d^{10}4p^{5}$ Ignore $1s^{2}2s^{2}2p^{6}3s^{2}3p^{6}$ for (Ar) written out but do not allow incorrect electronic configuration for Ar	**1**

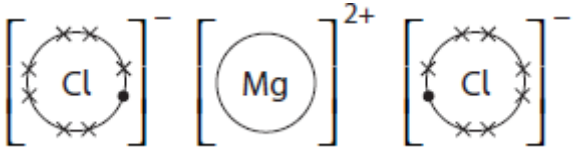
Question number	Answer	Additional guidance	Mark
20(b)(i)		1 mark for each row correct	**2**

Species	Protons	Neutrons	Electrons	
^{79}Br	35	44	35	(1)
$^{81}Br^{-}$	35	46	36	(1)

Question number	Answer	Additional guidance	Mark
20(b)(ii)	 • lines at 158 and 160 and 162 (1) • relative abundances 50:100:50 (1)	Allow relative abundances in any ratio 1:2:1, e.g. 25:50:25	2

Question number	Answer	Additional guidance	Mark
20(b)(iii)	• calculation of amount (mol) of Br_2 (1) • calculation of molecules of Br_2 (1)	Example of calculation: Amount of Br_2 = $\frac{2.00}{160}$ = 0.0125 (mol) Molecules of Br_2 = $0.0125 \times 6.02 \times 10^{23}$ = 7.525×10^{21} or Amount of Br_2 = $\frac{2.00}{(2 \times 79.9)}$ = 0.012516 (mol) Molecules of Br_2 = $0.012516 \times 6.02 \times 10^{23}$ = 7.5344×10^{21} TE on amount Br_2 Correct answer with no working scores both marks Ignore SF except 1 SF	**2**

Question number	Answer	Additional guidance	Mark
20(c)	• conversion of volume to m^3 (1) • conversion of temperature to K (1) • rearrangement of expression (1) • evaluation to give n (1)	Example of calculation: Volume of bromine = $\frac{200}{1 \times 10^6}$ = 2.00×10^{-4} m^3 77+273 = 350 $1.51 \times 10^5 \times 2.00 \times 10^{-4} = n \times 8.31 \times 350$ TE on volume bromine $n = \frac{1.51 \times 10^5 \times 2.00 \times 10^{-4}}{8.31 \times 350}$ $n = 1.03834 \times 10^{-2}$ Ignore SF except 1SF Correct answer with no working scores full marks	**4**

Question number	Answer	Additional guidance	Mark
21(a)	• dot-and-cross diagram, including charges	Example of diagram:  Allow no electrons or 8 electrons on outer shell of Mg Allow any combination of dots or crosses for electrons Ignore missing square brackets	1

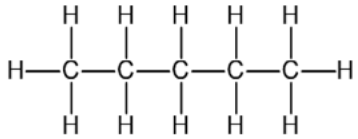
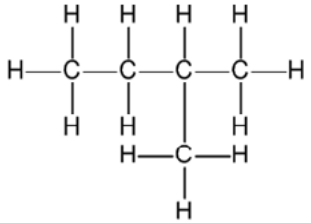
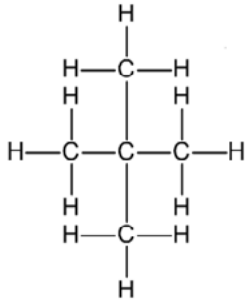
Question number	Answer	Additional guidance	Mark
21(b)	An explanation that makes reference to the following points: • identification of charge carriers: magnesium – electrons **and** magnesium chloride – ions (1) • magnesium conducts electricity when solid because delocalised electrons can flow through (1) • magnesium chloride does not conduct when solid because the ions cannot move **and** it does conduct electricity when molten or dissolved in water as the ions can move. (1)		3

Question number	Answer	Additional guidance	Mark
21(c)(i)	• correct balanced ionic equation with state symbols	Examples of equation: $MgO(s) + 2H^+(aq) \rightarrow Mg^{2+}(aq) + H_2O(l)$ or $MgO(s) + 2H_3O^+(aq) \rightarrow Mg^{2+}(aq) + 2H_2O(l)$	1

Question number	Answer	Additional guidance	Mark
21(c)(ii)	• calculation of moles of MgO (1) • calculation of moles of HCl (1) • calculation of volume of HCl (1)	Example of calculation: moles MgO = $\frac{2.45}{40.3}$ = 0.060794 moles HCl = 2 × 0.060794 = 0.121588 volume HCl = 0.121588 × $\frac{1000}{2.00}$ = 60.794 cm^3 Ignore SF except 1 SF Allow use of A_r(Mg) = 24 (61.25 cm^3) Correct answer with no working scores full marks	3

Question number	Answer	Additional guidance	Mark
21(d)	Either • calculation of moles of $MgCO_3$ (1) • calculation of mass of $MgCl_2$ (1) or • use of both molar masses (1) • calculation of mass of $MgCl_2$ (1)	Example of calculation: moles $MgCO_3 = \frac{2.25}{84.3} = 0.02669$ mass $MgCl_2 = 0.02669 \times 95.3 = 2.5436$ (g) or 84.3 g $MgCO_3$ makes 95.3 g $MgCl_2$ so 2.25 g $MgCO_3$ makes $\frac{95.3}{84.3} \times 2.25 = 2.5436$ (g) $MgCl_2$ Ignore SF except 1 SF Allow use of A_r(Mg) = 24 (2.5446 g) Correct answer with no working scores full marks	2

Question number	Answer	Additional guidance	Mark
21(e)	An explanation that makes reference to the following points: • (in the reaction with magnesium oxide) there are fewer waste products/no carbon dioxide is released/water is the only waste product (1) • so the molar mass of all products is lower/the denominator of the equation for atom economy is lower (1) or • 1 mol of magnesium compound produces 1 mol of magnesium chloride (1) • but the M_r of magnesium carbonate is greater than the M_r of magnesium oxide/carbon dioxide is an additional waste product from magnesium carbonate. (1)	Ignore calculations Allow reverse arguments	**2**

Question number	Answer	Additional guidance	Mark
22(a)	•  (1) •  (1) •  (1)	Allow CH_3 in branches Allow 2 marks for 3 correct structural or skeletal formulae or any combination of these	3

Question number	Answer	Additional guidance	Mark
22(b)	• 2,4-dimethylhexane	Ignore punctuation errors	1

Question number	Answer	Additional guidance	Mark
22(c)	• molecular formula: C_5H_{12} (1) • boiling temperature 25 – 40 °C (1)	Allow any temperature or range within the given range	2

Question number	Answer	Additional guidance	Mark
22(d)(i)	• $C_3H_8 + 3½O_2 \rightarrow C + CO + CO_2 + 4H_2O$	Allow multiples Ignore state symbols, even if incorrect	1

Question number	Answer	Additional guidance	Mark
22(d)(ii)	An explanation that makes reference to the following points: • (carbon monoxide) reacts with haemoglobin (in the blood) (1) • preventing it from carrying oxygen (around the body). (1)	Allow forms carboxyhaemoglobin	2

Question number	Answer	Additional guidance	Mark
22(e)(i)	• $C_3H_8 + Cl\bullet \rightarrow C_3H_7\bullet + HCl$ (1) • $C_3H_7\bullet + Cl_2 \rightarrow C_3H_7Cl + Cl\bullet$ (1)	Allow equations in either order Penalise missing • once only	2

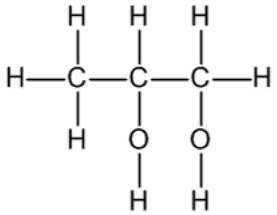
Question number	Answer	Additional guidance	Mark
22(e)(ii)	• the products are 1-chloropropane and 2-chloropropane	Allow any unambiguous formulae Ignore molecular formulae	1

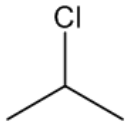
Question number	Answer	Additional guidance	Mark
22(e)(iii)	• the chlorine free radical can remove a hydrogen from either the end carbon atoms or the central carbon atom		1

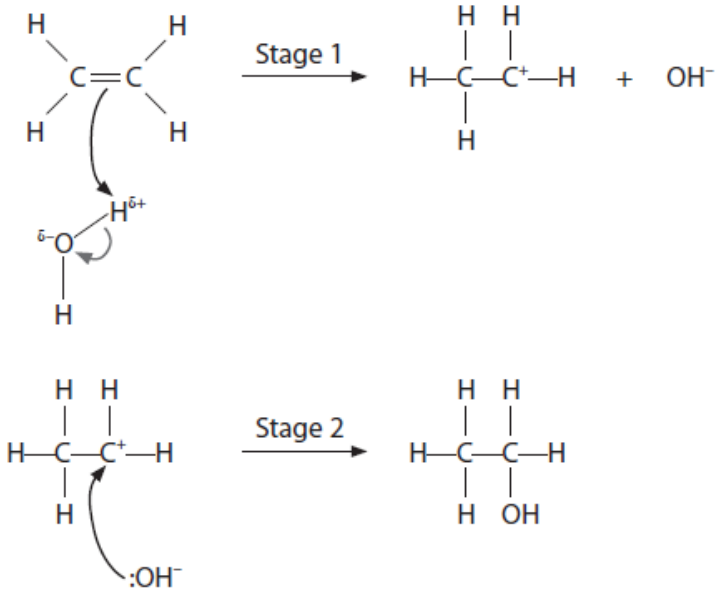
Question number	Answer	Additional guidance	Mark
22(e)(iv)	• two propyl (free) radicals react together or • $C_3H_7\bullet + C_3H_7\bullet \rightarrow C_6H_{14}$	Ignore just '(two free) radicals react together' Do not allow molecules/ions	1

Question number	Answer	Additional guidance	Mark
22(e)(v)	• structure (1) • corresponding name (1)	Examples of structures and names: $CH_3CH_2CHCl_2$ 1,1-dichloropropane $CH_3CHClCH_2Cl$ 1,2-dichloropropane $CH_3CCl_2CH_3$ 2,2-dichloropropane $CH_2ClCH_2CH_2Cl$ 1,3-dichloropropane Allow displayed, structural or skeletal formulae or any combination of these	2

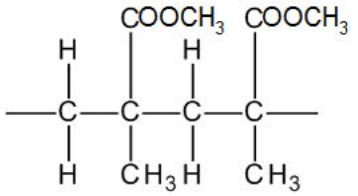
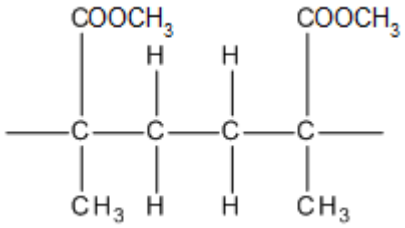
Question number	Answer	Additional guidance	Mark
23(a)(i)	• (reagent **W**) hydrogen/H_2 (1) • (catalyst X) nickel (1)	Allow nickel, Ni/platinum, Pt/palladium, Pd	2

Question number	Answer	Additional guidance	Mark
23(a)(ii)	• 	Allow OH Do not allow C-H-O	1

Question number	Answer	Additional guidance	Mark
23(a)(iii)	• 		1

Question number	Answer	Additional guidance	Mark
23(b)(i)	• correct dipole ($O^{\delta-} - H^{\delta+}$) (1) • curly arrow from C=C to H in H_2O (1) • curly arrow from O-H bond to O (1) • curly arrow from lone pair on O of OH^- to C^+ (1)	Example of mechanism: 	**4**

Question number	Answer	Additional guidance	Mark
23(b)(ii)	• trigonal planar (1) • 3 bond pairs/electron pairs (around the carbon atom) (1) • bond pairs/electron pairs arranged to minimise repulsion (1)	Allow M1 and M2 shown on a diagram Allow bond pairs/electron pairs as far apart as possible	**3**

Question number	Answer	Additional guidance	Mark
23(c)	• 4 carbon backbone with continuation bonds (1) • all side chains correct (1)	Example of polymer:  or  Allow CO_2CH_3 in side chains Allow CH_3 and $COOCH_3$ groups above or below the carbon chain Ignore square brackets and n Any structure with C=C scores 0	**2**