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 (1) • correct state symbols (1)	Examples of equation: $N(g) \rightarrow N^{+}(g) + e^{(-)}$ or $N(g) - e^{(-)} \rightarrow N^{+}(g)$	2

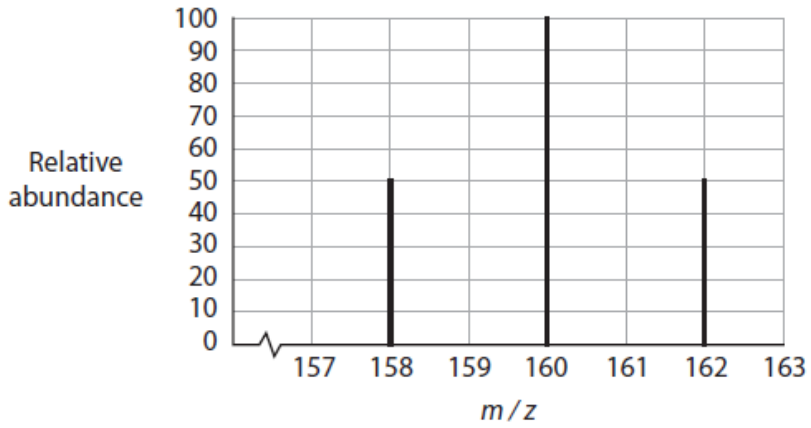
Question number	Answer	Additional guidance	Mark
19(b)	An explanation that makes reference to the following points: • general increase across a period/atomic numbers 3-10 due to increase in nuclear charge (1) • the (outer) electrons are added to the same quantum shell or the shielding is the same. (1) 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) • 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 increase in effective nuclear charge Accept reverse arguments Accept names for atomic numbers Allow the 2p sub-shell is further from the nucleus than the 2s orbital Allow a half-filled p sub shell is more stable	4

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

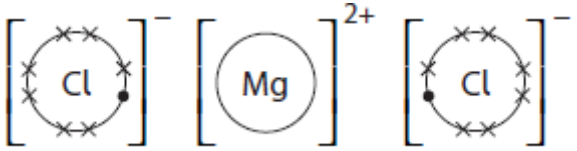
Question number	Answer	Additional guidance	Mark
20(b)(i)		1 mark for each row correct	2

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

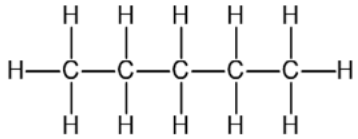
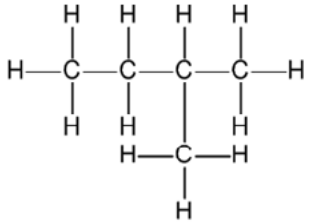
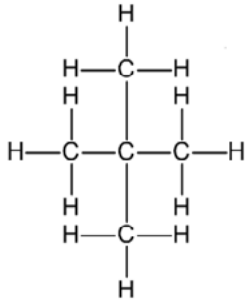
Question number	Answer		Additional guidance	Mark
21(b)	An explanation that makes reference to the following points: • identification of charge carriers: magnesium – electrons **and** magnesium chloride – ions • magnesium conducts electricity when solid because delocalised electrons can flow through • 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) (1) (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

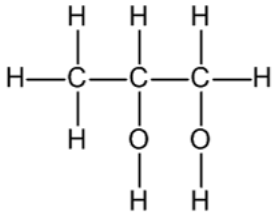
Question number	Answer	Additional guidance	Mark
22(e)(ii)	• the products are 1-chloropropane and 2-chloropropane	Allow any unambiguous formulae Ignore molecular formulae	1

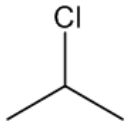
Question number	Answer	Additional guidance	Mark
22(e)(iii)	• the chlorine free radical can remove a hydrogen from either the end carbon atoms or the central carbon atom		1

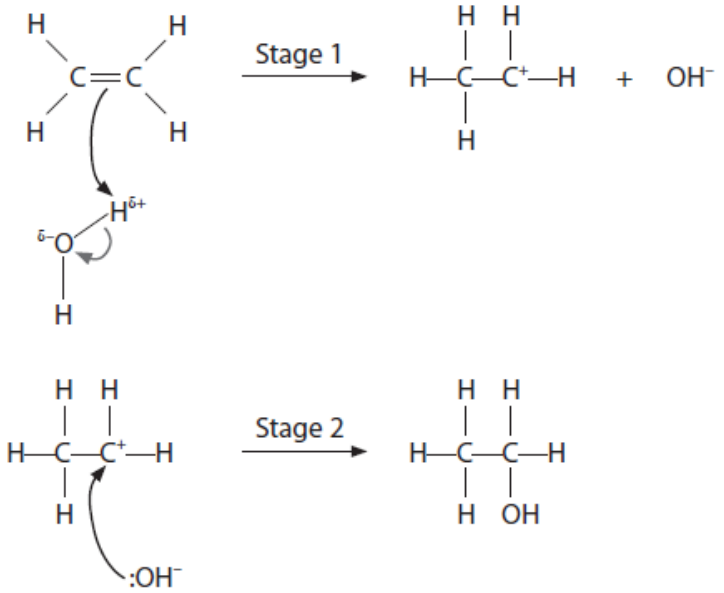
Question number	Answer	Additional guidance	Mark
22(e)(iv)	• two propyl (free) radicals react together or • $C_3H_7\bullet + C_3H_7\bullet \rightarrow C_6H_{14}$	Ignore just '(two free) radicals react together' Do not allow molecules/ions	1

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

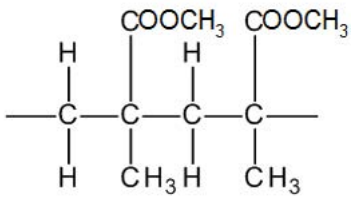
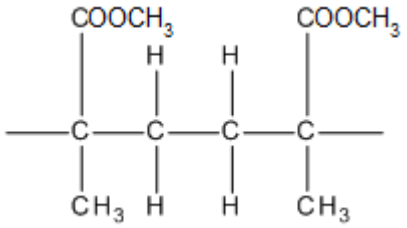
Question number	Answer	Additional guidance	Mark
23(a)(i)	• (reagent **W**) hydrogen/H_2 (1) • (catalyst X) nickel (1)	Allow nickel, Ni/platinum, Pt/palladium, Pd	2

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**