Question number	Answer	Marks	Guidance
1	**A**	B1	
2	**D**	B1	
3	**A**	B1	
4	**D**	B1	
5	**D**	B1	
6	**C**	B1	
7	**C**	B1	
8	**B**	B1	
9	**B**	B1	
10	**B**	B1	
11	**B**	B1	
12	**C**	B1	
13	**A**	B1	
14	**B**	B1	
15	**B**	B1	
16	**C**	B1	
17	**D**	B1	
18	**C**	B1	
19	**D**	B1	
20	**D**	B1	
21 (a)	$1s^2 2s^2 2p^6 3s^2 3p^3$	B1	
21 (b) (i)	$P_4O_{10} + 6H_2O \rightarrow 4H_3PO_4$	B1	
21 (b) (ii)	+5	B1	
21 (c) (i)	n(NaOH) = 0.144 mol	B1	
21 (c) (ii)	$n(H_3PO_4)$ = 0.048 mol;	B1	

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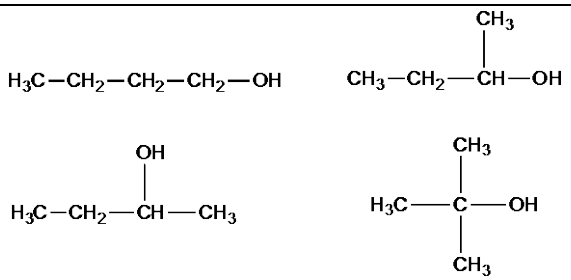
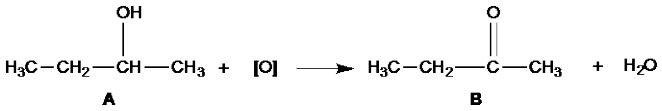
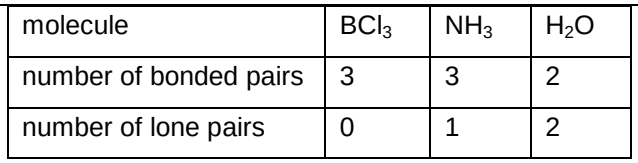
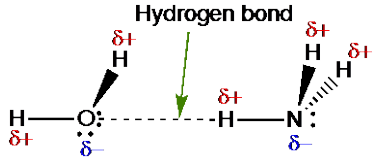
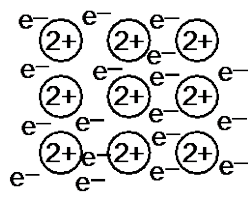
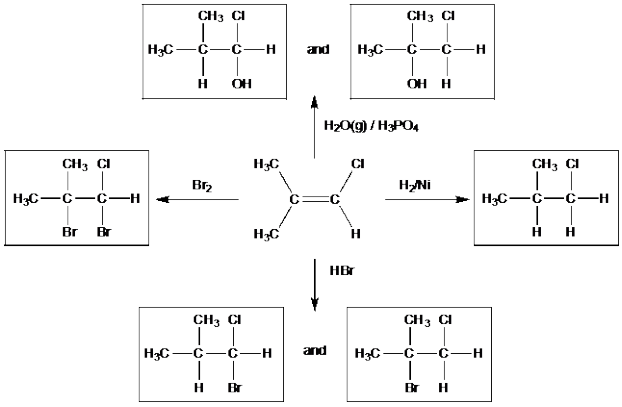
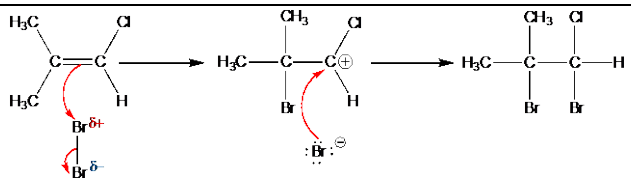
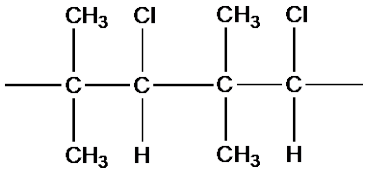
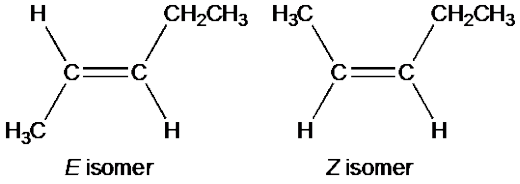
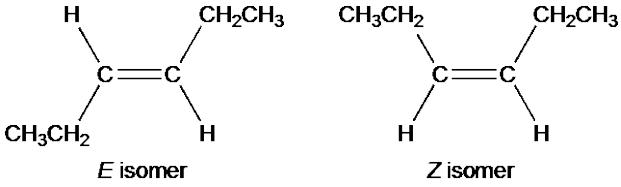
	volume = 96.0 cm^3	B1	
21 (c) (iii)	Evaporate the water	B1	
21 (c) (iv)	$M(Na_3PO_4)$ = 164.0 g mol^{-1}; mass Na_3PO_4 = 0.048 × 164.0 = 7.872 g	B1 B1	
21 (d)	Ca^{2+} and PO_4^{3-}	B1 B1	
22 (a) (i)	Structural isomers have the same molecular formulae and different structural formulae	B1	
22 (a) (ii)	 1 mark for each structure	B1 x 4	
22 (b)	 1 mark for structure of A 1 mark for structure of B 1 mark for equation	B1 x 3	
22 (c)	*m*/*z* = 74: $C_4H_{10}O^+$ (+ essential); *m*/*z* = 45: $C_2H_5O^+$	B1 B1	
23 (a)	The enthalpy change from the complete combustion of 1 mole of a substance under standard conditions of 100 kPa and 298 K	B1 B1 B1	
23 (b) (i)	ΔH = (5 × –394 + 6 × –286) –(–3509) = –177 kJ mol^{-1} 1 mark for use of 5 and 6;	B1 x 3	

Question number	Answer	Marks	Guidance
	1 mark for correct subtraction; 1 mark for answer		
23 (b) (ii)	Carbon reacts with hydrogen to form many different hydrocarbons	B1	
23 (c) (i)	UV	B1	
23 (c) (ii)	radical substitution	B1	
23 (c) (iii)	$2Cl\bullet \rightarrow Cl_2$ $C_5H_{12} + Cl\bullet \rightarrow C_5H_{11}\bullet + HCl$ $C_5H_{11}\bullet + Cl_2 \rightarrow C_5H_{11}Cl + Cl\bullet$	B1 B1 B1	
23 (c) (iv)	$2C_5H_{11} \rightarrow C_{10}H_{22}$ OR $C_5H_{11}\bullet + Cl\bullet \rightarrow C_5H_{11}Cl$	B1	
24 (a)	 1 mark for each column	B1 x 3	
24 (b)	 1 mark for 2 molecules with hydrogen bond to lone pair 1 mark for dipoles	B1 x 2	
24 (c) (i)	B : H : O = 17.48/10.8 : 4.85/1.00 : 77.67/16.0 = 1.619 : 4.85 : 4.85 Molecular formula = BH_3O_3 = 61.8	B1 B1	
24 (c) (ii)	$BCl_3 + 3H_2O \rightarrow BH_3O_3 + 3HCl$	B1	
25 (a)		B1 x 2	

Question number	Answer	Marks	Guidance
	1 mark for regular arrangement of 2+ ions 1 mark for random electrons Barium conducts as the delocalised electrons are able to move through the structure	 B1	
25 (b)	**D**: $Ba(OH)_2$; **E**: H_2; **F**: $BaCl_2$; **G**: $BaSO_4$; **H**: AgCl	B1 B1 B1 B1 B1	
26 (a)	$n(AgNO_3) = 0.200 \times 25.0/1000 = 5.00 \times 10^{-3}$ mol	B1	
26 (b)	$n(Zn) = 5.00 \times 10^{-3}/2 = 2.50 \times 10^{-3}$ mol mass of Zn = 0.1635 g	B1 B1	
26 (c)	$q = mc\Delta T = 25.0 \times 4.18 \times 3.5 = 365.75$ J	B1	
26 (d)	Reaction of 1 mol Zn with 2 mol $AgNO_3$ produces $365.75/2.50 \times 10^{-3} = 146\,300$ J. $\therefore \Delta_r H = -146.3$ kJ mol^{-1} 1 mark for value 1 mark for sign	B1 x 2	
26 (e)	The experimental value would be less exothermic than data book values due to heat loss	B1 B1	
27 (a)	 1 mark for each structure	B1 x 6	

Question number	Answer	Marks	Guidance
27 (b) (i)	Bromine is an electron pair acceptor	B1	
27 (b) (ii)	 1 mark for curly arrow from C=C to $Br^{\delta+}$ of Br_2 1 mark for curly arrow from Br–Br and correct dipole 1 mark for correct carbocation AND curly arrow from Br^- to C^+	B1 x 3	
27 (b) (iii)		B1	
28 (a)	 *E* isomer *Z* isomer	B1 × 2	1 mark for correct stereoisomers 1 mark for correct E and Z assignment
28 (b)	 *E* isomer *Z* isomer	B1 × 2	1 mark for correct stereoisomers 1 mark for correct E and Z assignment