6 Ethene, C_2H_4, is the first member of a family of similar compounds which contains the alkene functional group.

(a) State the term for a family of similar compounds which contain the same functional group.

..... [1]

(b) Determine the difference in relative molecular mass between C_2H_4 and the next member in this family of similar compounds.

..... [1]

(c) Write the symbol equation for the complete combustion of C_2H_4.

..... [2]

(d) C_2H_4 reacts with steam to form ethanol.

$$C_2H_4(g) + H_2O(g) \rightleftharpoons C_2H_5OH(g) \qquad \Delta H = -45\,kJ/mol$$

The process happens in a closed system and the reaction reaches an equilibrium.
The conditions for this process are 300 °C and 60 atm pressure. H_3PO_4 is used as a catalyst.

(i) Complete Table 6.1 to show the effect, if any, on the concentration of $C_2H_4(g)$ when the following changes to the conditions are applied.

Only use the words **increases**, **decreases** or **no change**.

Table 6.1

change to condition	effect on the concentration of $C_2H_4(g)$ at equilibrium
temperature is decreased	
some $C_2H_5OH(g)$ is removed	
pressure is increased	
a more effective catalyst is used	

[4]

(ii) Explain, in terms of collision theory, why the rate of the forward reaction increases if the temperature increases.

.....

.....

.....

.....

..... [3]

(e) Compound **B** has the displayed formula shown in Fig. 6.1.

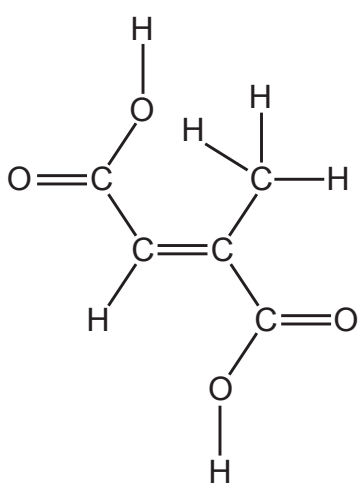


Fig. 6.1

(i) Deduce the molecular formula of compound **B**.

..... [1]

(ii) State why compound **B** is unsaturated.

..... [1]

(iii) Draw the structure of **one** repeat unit of the polymer formed when compound **B** undergoes addition polymerisation.

[2]

(iv) Explain why 1 mol of compound **B** reacts with 2 mol of sodium hydroxide, NaOH.

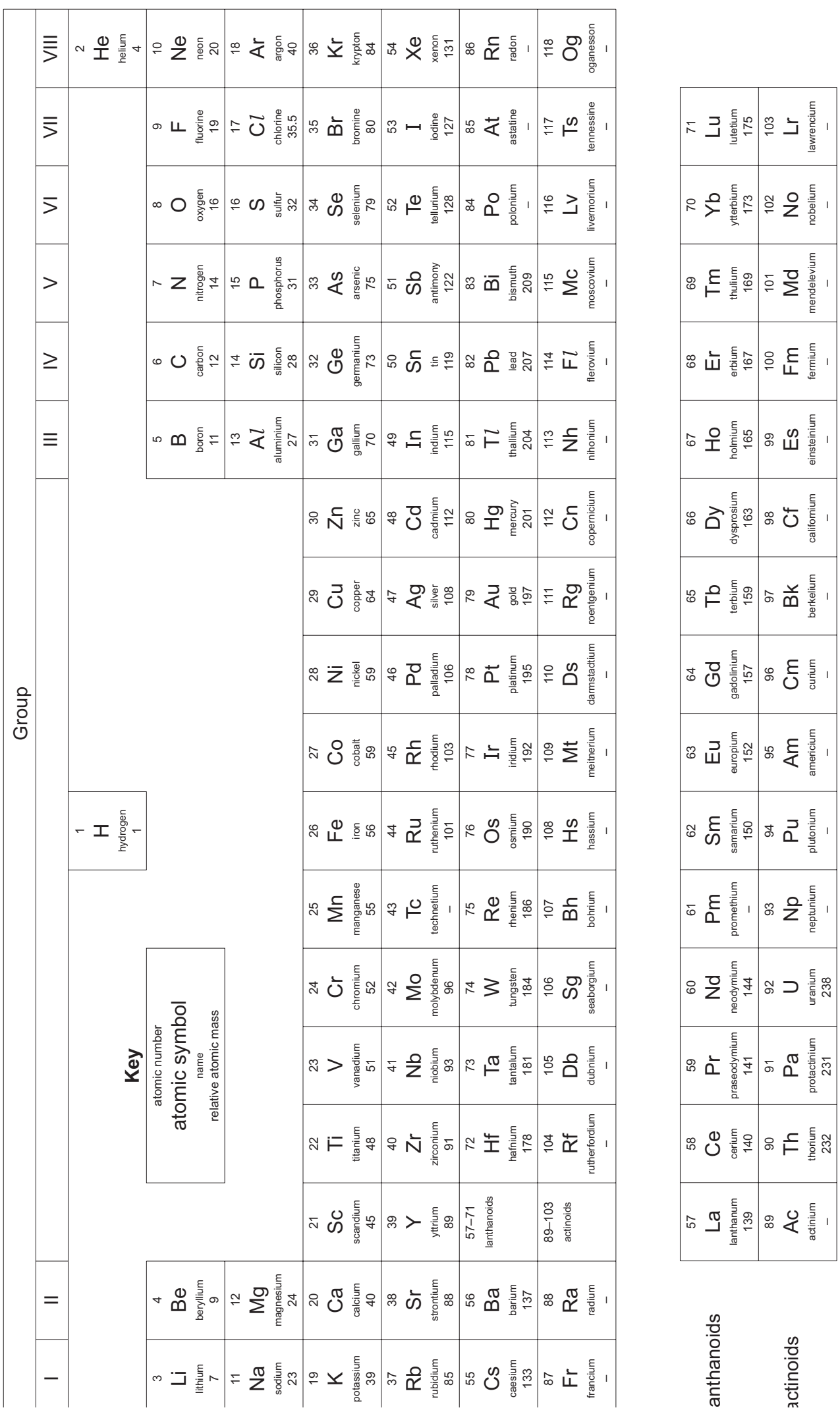
.....

..... [1]

(v) Calculate the volume, in cm^3, of 0.250 mol/dm^3 NaOH that reacts with 0.100 mol of compound **B**.

volume = ... cm^3 [2]

[Total: 18]



The Periodic Table of Elements

Group	I	II	III	IV	V	VI	VII	VIII
								2 He helium 4
			5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
			13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
			31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
			49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
			81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
			113 Nh nihonium –	114 Fl flerovium –	115 Mc moscovium –	116 Lv livermorium –	117 Ts tennessine –	118 Og oganesson –

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

Key

atomic number
atomic symbol
name
relative atomic mass

3 Li lithium 7	4 Be beryllium 9															
11 Na sodium 23	12 Mg magnesium 24															
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65					
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112					
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201					
87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –					

																1 H hydrogen 1

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).