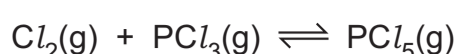


4 This question is about chlorine and compounds of chlorine.

(a) Gaseous chlorine reacts with gaseous phosphorus(III) chloride to form gaseous phosphorus(V) chloride. The reaction is a reversible reaction.

When the three gases are in a closed container the system reaches equilibrium.



(i) Describe a reversible reaction at equilibrium in terms of:

- the rate of the forward reaction and the rate of the reverse reaction

- the concentrations of reactants and products.

[2]

(ii) Complete Table 4.1 using only the words **increases**, **decreases** or **no change**.

Table 4.1

change to condition	effect on the rate of the forward reaction	effect on the equilibrium concentration of PCl_5
the pressure is decreased		
a catalyst is added	increases	

[3]

(iii) When the temperature of the equilibrium mixture is increased, the equilibrium concentration of PCl_5 decreases.

State what conclusion about the forward reaction can be made from this information.

..... [1]

(b) Ethene, C_2H_4 , reacts with chlorine, Cl_2 , to form 1,2-dichloroethane, $\text{CH}_2\text{ClCH}_2\text{Cl}$.

The equation for this reaction can be represented as shown.

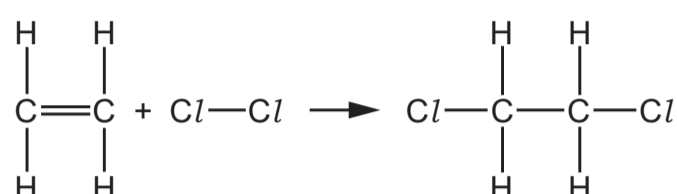


Table 4.2 shows some bond energies.

Table 4.2

bond	bond energy in kJ/mol
C-C	350
C=C	610
C-H	410
Cl-Cl	240
C-Cl	340

Use the bond energies in Table 4.2 to calculate the enthalpy change, in kJ/mol, of the reaction.

Use the following steps.

- Calculate the total energy needed to break the bonds in C_2H_4 and Cl_2 .

.....kJ

- Calculate the total energy released when the bonds form in $\text{CH}_2\text{ClCH}_2\text{Cl}$.

.....kJ

- Calculate the enthalpy change of the reaction. Your answer should include a sign.

.....kJ/mol [3]

(c) Chlorine reacts with nitrogen to form nitrogen trichloride, NCl_3 .

Complete the dot-and-cross diagram in Fig. 4.1 of a molecule of NCl_3 .

Show outer shell electrons only.

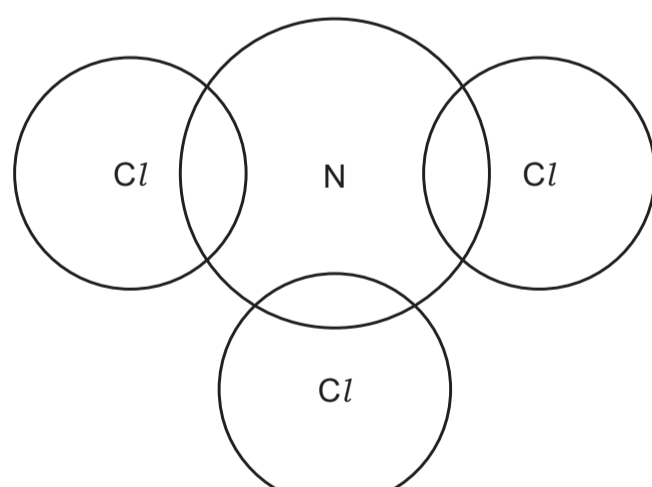


Fig. 4.1

[3]

(d) When solid magnesium carbonate, MgCO_3 , is added to dilute hydrochloric acid, HCl , a chemical reaction occurs. The equation for the reaction is shown.



(i) Give **two** observations when solid magnesium carbonate is added to dilute hydrochloric acid.

1

2

[2]

(ii) Calculate the volume, in cm^3 , of $\text{CO}_2(\text{g})$ that is produced at room temperature and pressure (r.t.p.) when 50.0 cm^3 of 0.100 mol/dm^3 HCl reacts with excess MgCO_3 .

The volume of 1 mol of any gas is $24\,000\text{ cm}^3$ at r.t.p.

Use the following steps.

- Calculate the number of moles of HCl in 50.0 cm^3 of 0.100 mol/dm^3 HCl .

.....mol

- Deduce the number of moles of $\text{CO}_2(\text{g})$ produced.

.....mol

- Calculate the volume, in cm^3 , of $\text{CO}_2(\text{g})$ produced at r.t.p.

..... cm^3 [3]

[Total: 17]