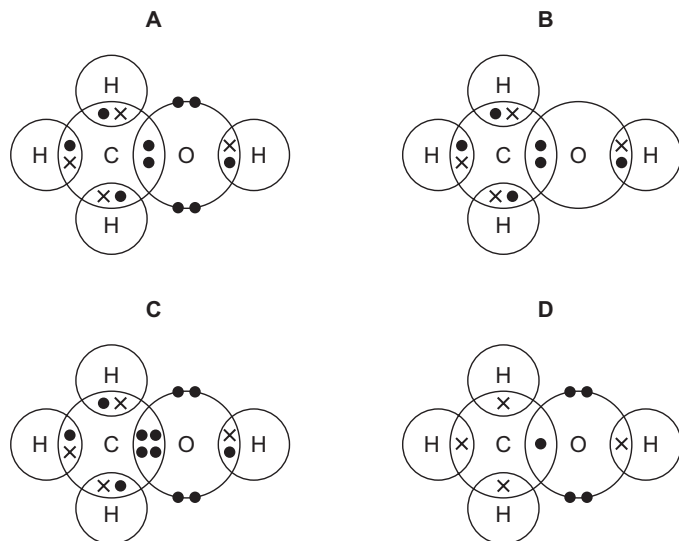


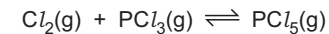
7 Which diagram shows the outer shell electron arrangement for a molecule of methanol, CH₃OH?



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 PCl₅ 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, CH_2ClCH_2Cl .

The equation for this reaction can be represented as shown.

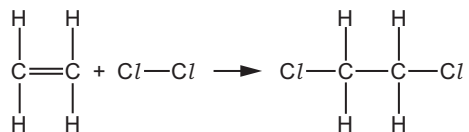


Table 4.2 shows some bond energies.

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 CH_2ClCH_2Cl .

.....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, $NC l_3$.

Complete the dot-and-cross diagram in Fig. 4.1 of a molecule of $NC l_3$.

Show outer shell electrons only.

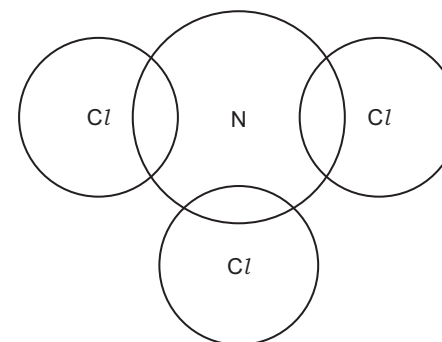


Fig. 4.1

- (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]

- 4 This question is about nitrogen and its compounds.

Nitrogen contains molecules with the formula N_2 .

- (a) Complete the dot-and-cross diagram in Fig. 4.1 to show the electronic configuration in a nitrogen molecule. Show outer-shell electrons only.

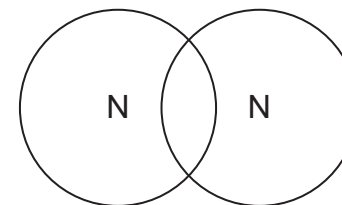


Fig. 4.1

[2]

- (b) Ammonia, NH_3 , is manufactured by reacting nitrogen with hydrogen, H_2 , in the Haber process.

- (i) State **three** typical conditions for the reaction between nitrogen and hydrogen in the Haber process.

1

2

3

[3]

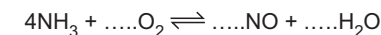
- (ii) Write the symbol equation for the chemical reaction in the Haber process.

..... [1]

- (c) Ammonia is converted into nitric acid in a two-step process.

In step 1, ammonia and oxygen are passed over a catalyst.

- (i) Balance the symbol equation for this reaction.



[1]

- (ii) Give the oxidation number of nitrogen in:

• NH_3

• NO

[2]

(iii) Define oxidation in terms of oxidation number.

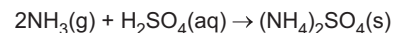
..... [1]

(iv) In step 2, oxygen and water react with NO to produce nitric acid as the only product.

Write a symbol equation for this chemical reaction.

..... [2]

(d) Ammonia is converted into ammonium sulfate, $(\text{NH}_4)_2\text{SO}_4$.



360 dm³ of ammonia gas, measured at r.t.p., reacts with excess sulfuric acid.

Calculate the mass of ammonium sulfate produced, using the following steps.

- Calculate the number of moles of $\text{NH}_3(\text{g})$ in 360 dm³.

One mole of any gas occupies 24 dm³ at r.t.p.

..... mol

- Calculate the number of moles of $(\text{NH}_4)_2\text{SO}_4$ produced.

..... mol

- Calculate the mass of $(\text{NH}_4)_2\text{SO}_4$ produced.

The M_r of $(\text{NH}_4)_2\text{SO}_4$ is 132.

..... g
[3]

[Total: 15]

2 This question is about covalent compounds.

(a) State what is meant by a covalent bond.

.....
..... [2]

(b) Chlorine(I) oxide, Cl_2O , is a simple molecule with covalent bonds.

(i) State what is meant by (I) in the name chlorine(I) oxide.

..... [2]

(ii) Complete the dot-and-cross diagram in Fig. 2.1 of a molecule of chlorine(I) oxide.

Show outer electrons only.

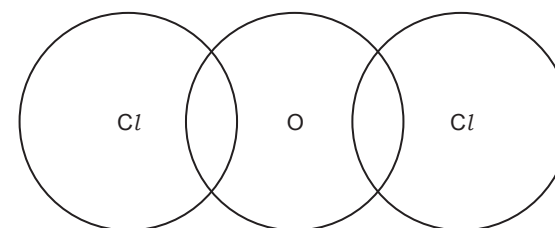


Fig. 2.1

[3]

(iii) Explain, in terms of structure and bonding, why Cl_2O boils at a low temperature and does **not** thermally decompose into its constituent elements, Cl_2 and O_2 .

.....
.....
.....
..... [3]

(iv) Give **two** reasons why liquid Cl_2O is a poor conductor of electricity.

1
2
[2]

(c) Carbon and silicon(IV) oxide both exist as giant covalent structures.

(i) Name a giant covalent structure of carbon which conducts electricity.

..... [1]

(ii) Identify the particles responsible for the conduction of electricity in this covalent structure of carbon.

..... [1]

(iii) Silicon(IV) oxide contains silicon atoms, Si, and oxygen atoms, O.

Fig. 2.2 shows part of the giant covalent structure of silicon(IV) oxide.

Complete the diagram in Fig. 2.2 by adding the symbol for each of the 9 atoms shown.

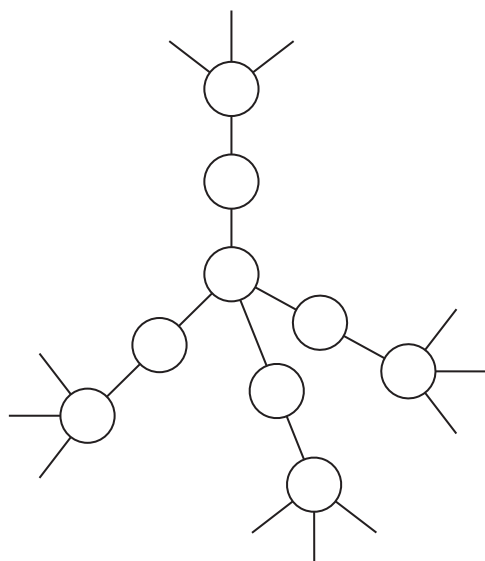


Fig. 2.2

[2]

[Total: 16]

7 For which covalent compound does the dot-and-cross diagram correctly show the outer shell electrons?

