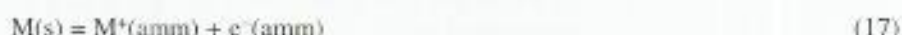


compartment, where chloride is oxidized to chlorine, which can be piped off. Sodium ions from the positive compartment can move through the membrane into the negative compartment, where hydroxide ions are being produced by reduction of water. The solution therefore accumulates dissolved sodium hydroxide. It can be drained off, and the solid crystallized from it. *The working of the membrane is shown in Book 4 Figure 24.4.* It is permeated with negatively charged groups such as $-\text{SO}_3\text{O}^-$, which can bind positive ions like Na^+ , but not negative ions such as Cl^- or OH^- .

The positive ions can therefore be passed through the membrane from site to site, but negative ions are denied this possibility. So chloride ions cannot pass from the positive to the negative compartment to contaminate the sodium hydroxide solution. Likewise, hydroxide ions cannot escape to the positive compartment, where they would react with chlorine.

(iii) The brine added to the positive compartment replenishes lost sodium chloride, but because water cannot pass through the membrane, other measures must be taken to replenish the water reduced in the negative compartment. A separate addition of water is made to achieve this, *as indicated in Figure 24.4.*

(b) The peak at 1450 nm in the absorption spectra of the solutions of the alkali metals in liquid ammonia is characteristic of the ammoniated electron, $e^-(\text{amm})$. It imparts a blue colour to the solutions, and it shows that the alkali metals all dissolve in a similar way:



The positive ions, $\text{M}^+(\text{amm})$, do not absorb in the visible region.

When the alkali metals are dissolved in aminoethane (a solvent that also coordinates through a nitrogen atom attached to hydrogen atoms), the peaks in the absorption spectra occur at wavelengths characteristic of the different metals. There is no longer evidence for a common species whose presence survives a change in the metallic element. The proposed reaction in this case is



The different peaks are characteristic of the solvated alkali metal anions, $\text{M}^-(\text{ameth})$, whose nature changes with a change in the dissolving metal.

The solubility of the metals with respect to this second process is small. It could be increased by adding to the aminoethane a ligand that forms a complex with the positive alkali metal ion. Cryptand 222 (*Book 4, p. 179*) is such a ligand. It coordinates through its six oxygen and two nitrogen atoms, and dissolves in aminoethane. The dissolving process then becomes, for example,



and the solubility of the metal is much increased. (*A full discussion of these points can be found in Book 4 Section 27.1.*)

Question 21

(a) The elements of Groups I and II and Al are metallic.

Elements B, C and Si have extended covalent structures.

Elements of Groups V (15), VI (16) and VII (17) have molecular covalent structures.

The structures of elemental nitrogen, oxygen, phosphorus and sulfur are shown in Figure 5

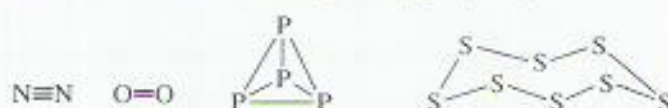


Figure 5 The structures of the elements of Groups V(15) and VI(16) in Periods 2 and 3.

(b) A trend is observed across the Periodic Table of metallic to semi-metal to covalent structures.

A trend is observed down the Periodic Table of covalent to metallic structures.