

4 This question is about nitrogen and its compounds.

Nitrogen contains molecules with the formula N<sub>2</sub>.

(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.

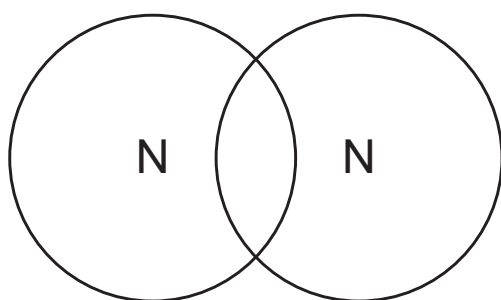


Fig. 4.1

[2]

(b) Ammonia, NH<sub>3</sub>, is manufactured by reacting nitrogen with hydrogen, H<sub>2</sub>, in the Haber process.

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

- 1 .....
- 2 .....
- 3 .....

[3]

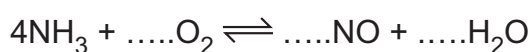
(ii) Write the symbol equation for the chemical reaction in the Haber process.

..... [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<sub>3</sub> .....
- NO. ....

[2]

(iii) Define oxidation in terms of oxidation number.

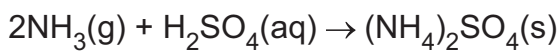
..... [1]

(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, (NH<sub>4</sub>)<sub>2</sub>SO<sub>4</sub>.



360 dm<sup>3</sup> 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 NH<sub>3</sub>(g) in 360 dm<sup>3</sup>.

One mole of any gas occupies 24 dm<sup>3</sup> at r.t.p.

..... mol

- Calculate the number of moles of (NH<sub>4</sub>)<sub>2</sub>SO<sub>4</sub> produced.

..... mol

- Calculate the mass of (NH<sub>4</sub>)<sub>2</sub>SO<sub>4</sub> produced.

The M<sub>r</sub> of (NH<sub>4</sub>)<sub>2</sub>SO<sub>4</sub> is 132.

..... g

[3]

[Total: 15]