1 Ammonia contains the elements nitrogen and hydrogen. It is manufactured from these elements in the Haber process.

$$N_2(g) + 3H_2(g) \rightleftharpoons \quad _3(g)$$

The forward reaction is exothermic.

(a) (i) Nitrogen is obtained from liquid air by fractional distillation. Why does this technique separate liquid oxygen and nitrogen?

.....

.....

(ii) Name **two** raw materials from which hydrogen is manufactured.

.....[3]

(b) The table shows how the percentage of ammonia in the equilibrium mixture varies with pressure at 600 °C.

percentage ammonia	8	12	15	20
pressure/atm	200	300	400	500

(i) Explain why the percentage of ammonia increases as the pressure increases.

.....

.....[2]

(ii) How would the percentage of ammonia change if the measurements had been made at a lower temperature?
Explain your answer.

.....

.....

.....[2]

(iii) State **two** of the reaction conditions used in the Haber Process.

.....

.....[2]

(c) Ammonia is a base.

(i) Name a particle that an ammonia molecule can accept from an acid.

.....

(ii) Write an equation for ammonia acting as a base.

.....[3]

(d) Given aqueous solutions, 0.1mol/dm^3, of sodium hydroxide and ammonia, describe how you could show that ammonia is the weaker base.

.....

.....[2]

(e) Another compound that contains nitrogen and hydrogen is hydrazine, N_2H_4.

(i) Draw the structural formula of hydrazine. Hydrogen can form only one bond per atom but nitrogen can form three.

(ii) Draw a diagram that shows the arrangement of the valency electrons in one molecule of hydrazine. Hydrazine is a covalent compound.
Use x to represent an electron from a nitrogen atom.
Use o to represent an electron from a hydrogen atom.

[3]

2 This question is about compounds of nitrogen.

(a) (i) Describe the Haber Process giving reaction conditions and a chemical equation. Reference to rate and yield is not required.

.....

.....

.....

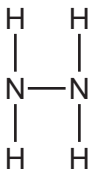
.....

..... [5]

(ii) Give **one** use of ammonia.

..... [1]

(b) The diagram shows the structure of a hydrazine molecule.



Draw the electron arrangement of a hydrazine molecule. Show the outer shell electrons only.

[2]

(c) Hydrazine is a base.

(i) *base*.

..... [1]

(ii) Complete the chemical equation to show that hydrazine acts as a base when added to water.

$N_2H_4 + H_2O \rightarrow$ ..... + ... [1]

(d) Nitrogen dioxide is an atmospheric pollutant.

(i) State **one** environmental problem caused by nitrogen dioxide.

..... [1]

(ii) Explain how oxides of nitrogen, such as nitrogen dioxide, are formed in car engines.

.....

..... [2]

[Total: 13]

3 The Atacama desert in Chile has deposits of the salt sodium nitrate. Very large amounts of this salt were exported to Europe for use as a fertiliser. After the introduction of the Haber process in 1913, this trade rapidly diminished.

(a) (i) Explain why the introduction of the Haber process reduced the demand for sodium nitrate.

.....

..... [2]

(ii) Suggest why surface deposits of sodium nitrate only occur in areas with very low rainfall such as desert areas.

..... [1]

(iii) The desert has smaller surface deposits of potassium nitrate.

Suggest why potassium nitrate is a better fertiliser than the sodium salt.

..... [1]

(b) All nitrates decompose when heated. The extent to which a nitrate decomposes is determined by the metal in the salt.

(i) Sodium nitrate decomposes to form sodium nitrite, $NaNO_2$.

Write the equation for decomposition of sodium nitrate.

..... [2]

(ii) Sodium nitrite is a reducing agent.

What would be observed if an excess of sodium nitrite solution was added to a solution of acidified potassium manganate(VII)?

..... [2]

(iii) Copper(II) nitrate decomposes to form copper(II) oxide, nitrogen dioxide and oxygen.

What is the relationship between the extent of decomposition and the reactivity of the metal in the nitrate?

.....

..... [1]

(c) The equation for the decomposition of copper(II) nitrate is given below.

$$2Cu(NO_3)_2 \rightarrow 2CuO + 4NO_2 + O_2$$

(i) Predict what you would observe when copper(II) nitrate is heated.

.....

.....

..... [3]

(ii) Copper(II) nitrate forms a series of hydrates with the formula $Cu(NO_3)_2.xH_2O$.
All these hydrates decompose to form copper(II) oxide.
1 mole of $Cu(NO_3)_2.xH_2O$ forms 1 mole of CuO.

What is meant by 1 mole of a substance?

.....

..... [2]

(iii) 7.26 g of a hydrate, $Cu(NO_3)_2.xH_2O$, formed 2.4 g copper(II) oxide.

number of moles of CuO formed = ...

number of moles of $Cu(NO_3)_2.xH_2O$ in 7.26 g = ...

mass of 1 mole of $Cu(NO_3)_2.xH_2O$ = ... g

mass of 1 mole of $Cu(NO_3)_2$ is 188 g

the value of *x* in this hydrate = ...

[4]

[Total: 18]