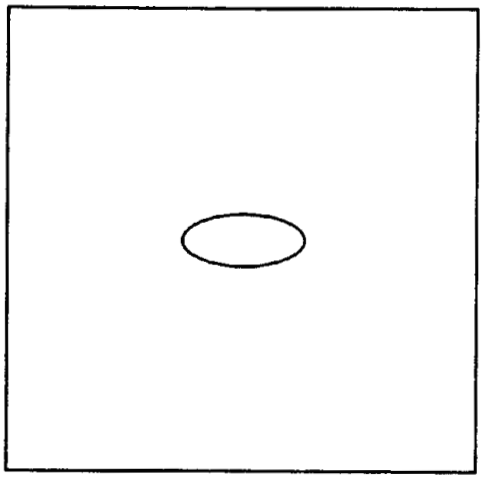
Core 1

(a) The nucleus of the comet is a mixture of solids, including solid carbon dioxide.

Complete the diagram to show the arrangement of molecules in solid carbon dioxide.

 represents a single carbon dioxide molecule



[2]

(b) The coma surrounding the nucleus of the comet is formed when the outer layers of the nucleus change from solid to gas.

(i) State the difference between a gas and a solid in terms of shape.

.....

.....[1]

(ii) Ammonia is present in the coma.

How can you test for ammonia in the laboratory?

test .....

result .....[3]

Core 2

Chlorine, bromine and iodine are halogens.

Some properties of these elements are shown in the table.

element	colour	state at room temperature	melting point / °C	boiling point / °C
chlorine	yellowish -green	gas	–101	–35
bromine	reddish-brown	liquid	–7	59
iodine	greyish-black	solid	114	184

(a) Describe the arrangement and motion of bromine molecules at 25 °C.

Arrangement .....

Motion .....[2]

(b) A solution of chlorine in water reacts with a colourless solution of potassium iodide.

(i) What colour change would you observe in this reaction?

.....[2]

(ii) Complete the word equation for this reaction.

chlorine + potassium iodide ⟶ ..... + ...

[2]

(c) Fluorine is also a halogen.

(i) Predict the colour and state of fluorine at room temperature.

Colour .....

State .....[2]

(ii) Predict the boiling point of fluorine.

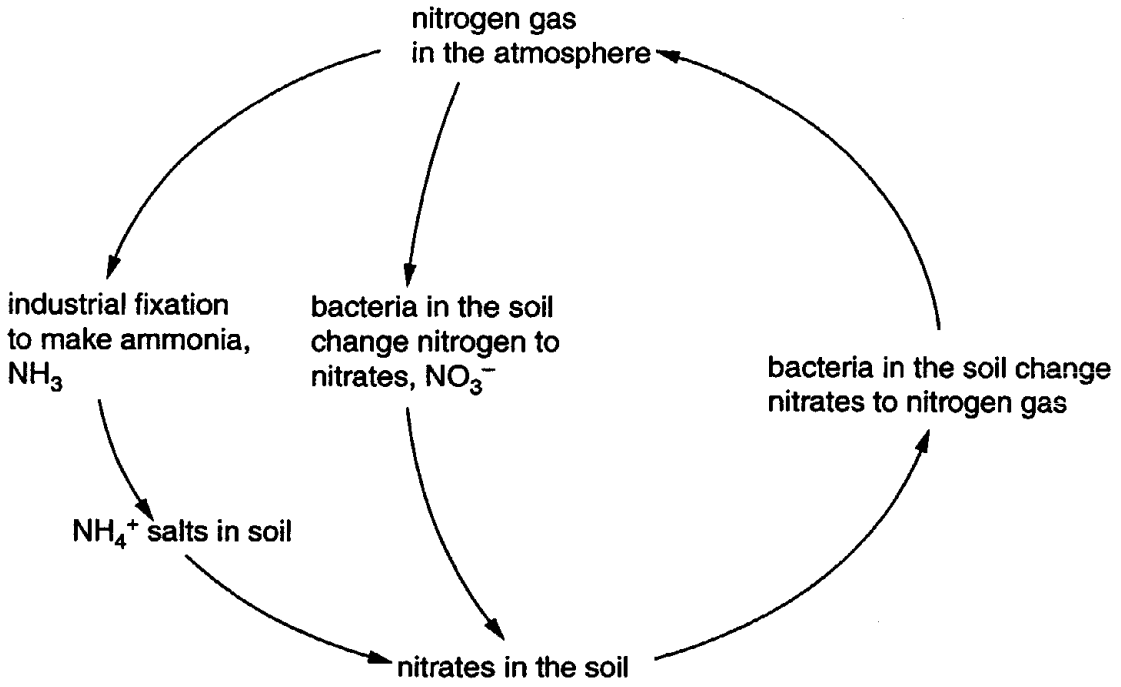
.....[1]

(iii) Give the formula of a fluorine molecule.

.....[1]

Core 3

A simplified diagram of the nitrogen cycle is shown below.



(a) What is the percentage of nitrogen in clean air?

.....[1]

(b) Name **two** gases, other than nitrogen, which are found in clean air.

.....[2]

(c) Ammonia is made by the Haber process.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

(i) What does the sign $\rightleftharpoons$ mean?

.....

(ii) What is the physical state of ammonia shown in the above equation?

.....[2]

(d) Ammonia is used to make fertilisers.

(i) What effect do fertilisers have on crops?

.....

(ii) Name **one** metal ion which is commonly present in fertilisers.

.....

(iii) The ion, NH_4^+, is shown on the diagram. State the name of this ion.

.....[3]

(e) Bacteria in the soil change NH_4^+ ions to nitrate ions, NO_3^-.
Describe a test for nitrate ions.

test .....

.....

result .....
[4]

(f) Different bacteria change nitrate ions, NO_3^-, back to nitrogen gas, N_2. Enzymes are involved in this reaction.

(i) Explain why this is a reduction reaction.

.....

(ii) What is an *enzyme*?

.....

.....[3]

Core 4

(a) An alternative method of 'transporting' hydrogen is to change it into methanol. This liquid is easily transported and can be decomposed to re-form hydrogen. Methanol can be made by the following reaction.

$$CO(g) + 2H_2(g) \rightleftharpoons CH_3OH(g)$$ the forward reaction is exothermic

The gases are passed over a catalyst at 300 °C.
On cooling, the methanol becomes a liquid.

(i) The reaction is carried out at high pressure. What effect would this have on the position of equilibrium?

.....[1]

(ii) Explain why an increase in pressure would increase the rate of the reaction.

.....

.....[2]

(iii) What would be the effect of decreasing the temperature on the concentration of methanol at equilibrium? Give a reasoned explanation for your answer.

.....

.....

.....[2]

Extension 1

The two non-metals, sulphur and selenium, are in Group VI.

(a) Sulphuric acid is made from sulphur. This acid is used to make detergents called sulphonates. A hydrocarbon is made to react with oleum (fuming sulphuric acid) to form sulphonic acids. These form salts called sulphonates.

(i) Complete the word equations for some reactions of a sulphonic acid.

magnesium + sulphonic acid ⟶ magnesium sulphonate + ...

sodium carbonate + sulphonic acid ⟶ ..... + ... + water.

....

(ii) Sulphonate ions are of the type RSO_3^-, where R is an organic group.
What is the formula of magnesium sulphonate?

.....

(iii) How is oleum made in the Contact Process?

.....

.....

(iv) How is oleum changed into concentrated sulphuric acid?

.....

[7]

(b) Insoluble and soluble sulphates can each be made from dilute sulphuric acid. Describe how a pure sample of the insoluble salt, lead(II) sulphate, can be made.

.....

.....

.....

.....[4]

(c) Predict two **chemical** properties of the non-metal selenium.

.....

.....[2]

(d) Selenium is used to make a device that can change light energy into electrical energy.

(i) Name the process used in green plants to change light energy into chemical energy.

.....

(ii) Explain how a liquid fuel can be obtained from plant material.

.....

.....

[3]

Extension 2

Ammonia is made by the Haber process from nitrogen and hydrogen.

$$N_2 + 3H_2 \rightleftharpoons 2NH_3 \qquad \Delta H = -92\ \text{kJ/mole (reaction is exothermic)}$$

(a) Describe how nitrogen can be obtained from the air.

.....

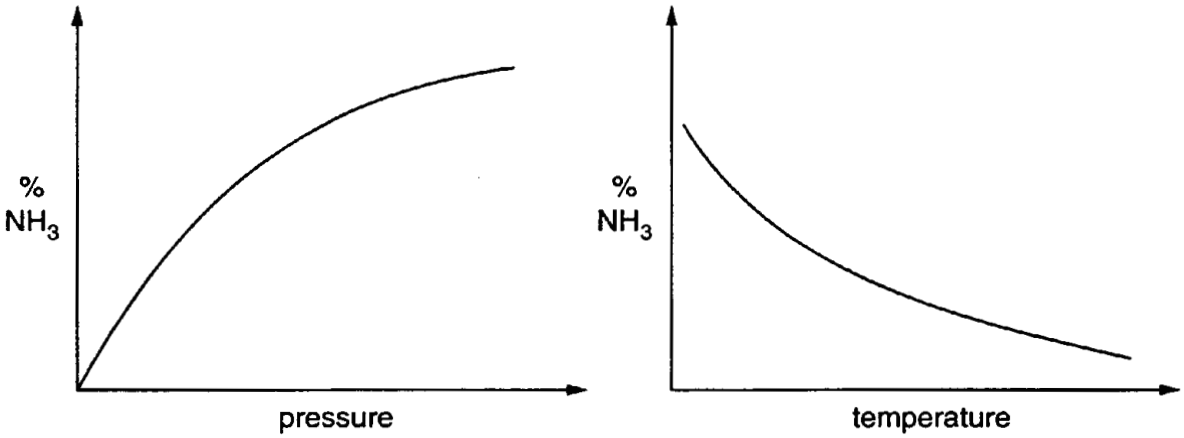
.....[2]

(b) Describe how hydrogen can be made from an alkane.

.....

.....[2]

(c) The diagram below shows how the percentage of ammonia in the equilibrium mixture changes with the conditions.



The y axis is the percentage of ammonia at equilibrium.

Fig. 1

(i) What is the effect of increasing the temperature on the percentage of ammonia in the equilibrium mixture?

.....[1]

(ii) What is the effect of increasing the pressure upon the position of equilibrium. Does it move to the the left, stay the same or move to the right?

.....[1]

(iii) Why does the position of equilibrium move as stated in **(ii)**?

.....

.....[2]

(iv) Suggest an explanation why an increase in pressure increases the reaction rate.

.....

.....[1]

(d) Large amounts of ammonia are used in the manufacture of ammonium sulphate.

(i) What is the main use of this salt?

.....[1]

(ii) Describe how crystals of ammonium sulphate can be made in the laboratory from aqueous ammonia.

.....

.....

.....

.....[4]

Core 1

a the molecules regular and of approximately the same size
the molecules very close to / touching each other

b(i) gas has no (fixed) shape / has takes up shape of container whereas solid has fixed shape

(ii) test damp red litmus paper / damp full range indicator paper / damp universal indicator
paper / damp pH paper / full range indicator solution

result turns blue

Core 2

a close together / randomly arranged
sliding over each other / moving slowly

b(i) yellow – green / green
to brown

(ii) potassium chloride + iodine

c(i) colour yellow / yellow - green
state gas

(ii) below $-45^{o}C$

(iii) F_2

Core 3

a 78

b any two of oxygen / carbon dioxide / argon / krypton / xenon

c(i) reversible (reaction) / equilibrium

(ii) gas

d(i) increase growth / increase yield / increase mass / grow faster

(ii) potassium

(iii) ammonium

e <u>test</u> add aluminium / Devarda's alloy / zinc and sodium hydroxide
<u>result</u> ammonia given off / damp universal indicator paper or red litmus goes blue

f(i) oxygen removed / oxidation number of nitrogen decreases / nitrogen gains electrons

(ii) catalyst / description of catalyst

Extension 1

i move to right / more methanol / greater yield favours

ii molecules closer
collide more frequently

iii increased concentration of methanol
decrease in temperature favours exothermic reaction

Extension 2

a(i) hydrogen
sodium sulphonate + carbon dioxide

(ii) $Mg(RSO_3)_2$

(iii) sulphur trioxide
dissolved in (conc) sulphuric acid

(iv) add water

b any three points but it must be a precipitation method
- mix lead nitrate and sulphuric acid or any soluble sulphate
- filter
- wash and dry
- evaporate

c any two from
- acidic oxide
- covalent chloride or covalent bonds
- accepts electrons
- oxidising agent
- ion Se^{2-}
- valency 2
- forms oxide SeO_2 and / or SeO_3
- forms selenides

d(i) photosynthesis

(ii) alcohol or ethanol
fermentation

OR
vegetable oil
distil or crush seeds

Extension 3

a liquefaction of air
fractional distillation

b cracking or decompose
heat or catalyst or forms alkene and hydrogen or simpler alkane and hydrogen

OR
mix with water / steam
use of catalyst

c(i) it decreases

(i) right

(ii) pressure favours the side with fewer moles

increased pressure favours side with smaller volume

reduces pressure by reducing volume or number of molecules

increases rate of forward reaction more than back reaction

(iii) increase collision rate / molecules closer / higher concentration

d(i) fertiliser

(ii) (dilute) sulphuric acid
any three from these
add indicator
burette or titration
repeat without indicator / remove with carbon
evaporate solution / heat to form crystals