Forename	
Surname	
Candidate Signature	

Centre Number						Candidate Number				

GCSE
CHEMISTRY

Higher Tier 2H

Study Hack

Practice Paper 2022

Time allowed: 1 hour 45 minutes

Materials
For this paper you must have:
- a ruler
- a calculator
- the periodic table

Instructions
- Use black ink or black ball-point pen.
- Pencil should only be used for drawing.
- Fill in the boxes at the top of this page.
- Answer **all** questions in the spaces provided. Do not write outsidethe box around each page or on blank pages.
- If you need extra space for your answer(s), use the lined pages at the end ofthis book. Write the question number against your answer(s).
- Do all rough work in this book. Cross through any work you do not want to be marked.
- In all calculations, show clearly how you work out your answer.

For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
8	
9	
TOTAL	

Information
- The maximum mark for this paper is 98.
- The marks for questions are shown in brackets.
- You are expected to use a calculator where appropriate.

You are reminded of the need for good English and clear presentation

Q1.

This question is about lithium carbonate.

Lithium carbonate is used in medicines.

The figure shows a tablet containing lithium carbonate.

(a) Lithium carbonate contains lithium ions and carbonate ions.

A student tested the tablet for lithium ions and for carbonate ions.

The student used:

- a metal wire
- dilute hydrochloric acid
- limewater.

Plan an investigation to show the presence of lithium ions and of carbonate ions in the tablet.

You should include the results of the tests for the ions.

_____

(6)

(b) The tablet also contains other substances.

The substances in tablets are present in fixed amounts.

What name is given to mixtures like tablets?

_____

(1)

(c) The tablet has a mass of 1.20 g and contains 700 mg of lithium carbonate.

Calculate the percentage by mass of lithium carbonate in this tablet.

_____

_____

_____

_____

Percentage by mass of lithium carbonate = _____%

(3)

(Total 10 marks)

Q2.

Crude oil is a fossil fuel.

(a) Describe how crude oil is separated into fractions.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(b) Fuel oil is one of the fractions from crude oil.

Power stations burn fuel oil to generate electricity. The waste gases from the combustion

of fuel oil contain carbon dioxide, water vapour, sulfur dioxide and oxides of nitrogen.

The waste gases are passed through a suspension of limestone in water. Limestone is mainly calcium carbonate.

Suggest how the use of a suspension of limestone decreases one of the environmental impacts that the waste gases would cause.

_____

_____

_____

_____

_____

_____

_____

(3)

(c) Some fractions from crude oil contain large hydrocarbon molecules.

(i) Hydrocarbon molecules, such as decane, can be cracked to produce smaller, more useful molecules.

Write the correct formula of the third product to complete the chemical equation.

You do not need to give the name of this product.

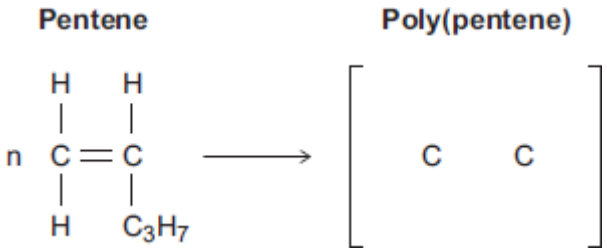
$C_{10}H_{22} \longrightarrow C_5H_{10} + C_3H_8 +$ _____

decane pentene propane

(1)

(ii) Pentene is used to produce poly(pentene).

Complete the equation and the displayed structure of poly(pentene).



(3)

(iii) Some polymers are described as smart polymers.

Suggest **one** property of a smart polymer that is different to that of an ordinary polymer.

_____

_____

(1)
(Total 12 marks)

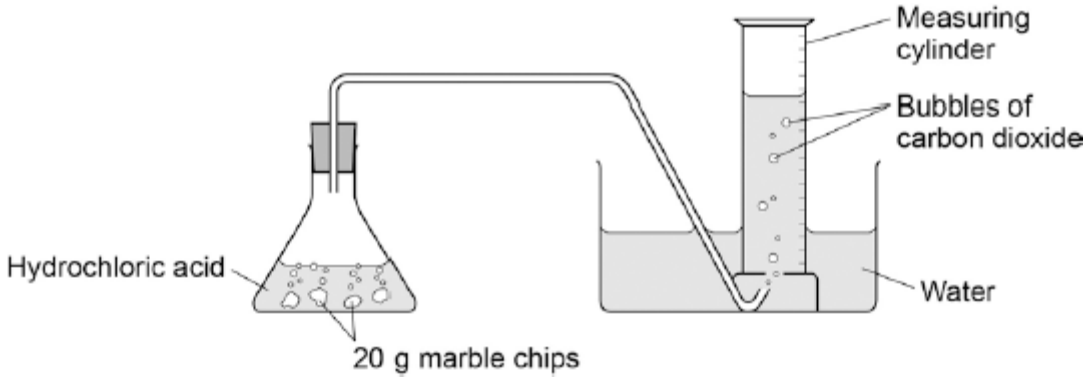
Q3.

Marble chips are mainly calcium carbonate ($CaCO_3$).

A student investigated the rate of reaction between marble chips and hydrochloric acid (HCl).

Figure 1 shows the apparatus the student used.

Figure 1



(a) Complete and balance the equation for the reaction between marble chips and hydrochloric acid.

_____ + _____ → $CaCl_2$ + _____ + _____

(2)

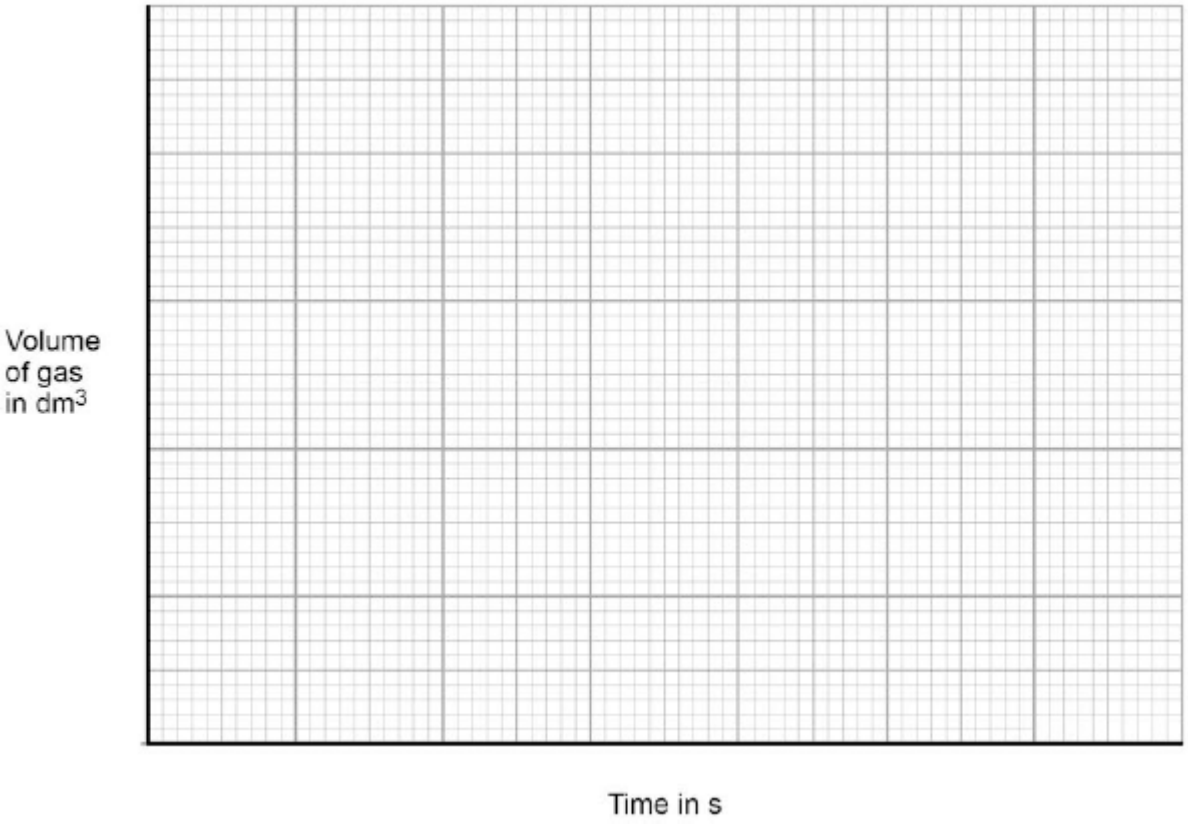
(b) The table below shows the student's results.

Time in s	Volume of gas in dm^3
0	0.000
30	0.030
60	0.046
90	0.052
120	0.065
150	0.070
180	0.076
210	0.079
240	0.080
270	0.080

On **Figure 2**:

- Plot these results on the grid.
- Draw a line of best fit.

Figure 2



(4)

(c) Sketch a line on the grid in **Figure 2** to show the results you would expect if the experiment was repeated using 20 g of smaller marble chips.

Label this line **A**.

(2)

(d) Explain, in terms of particles, how and why the rate of reaction changes during the reaction of calcium carbonate with hydrochloric acid.

_____

_____

_____

_____

_____

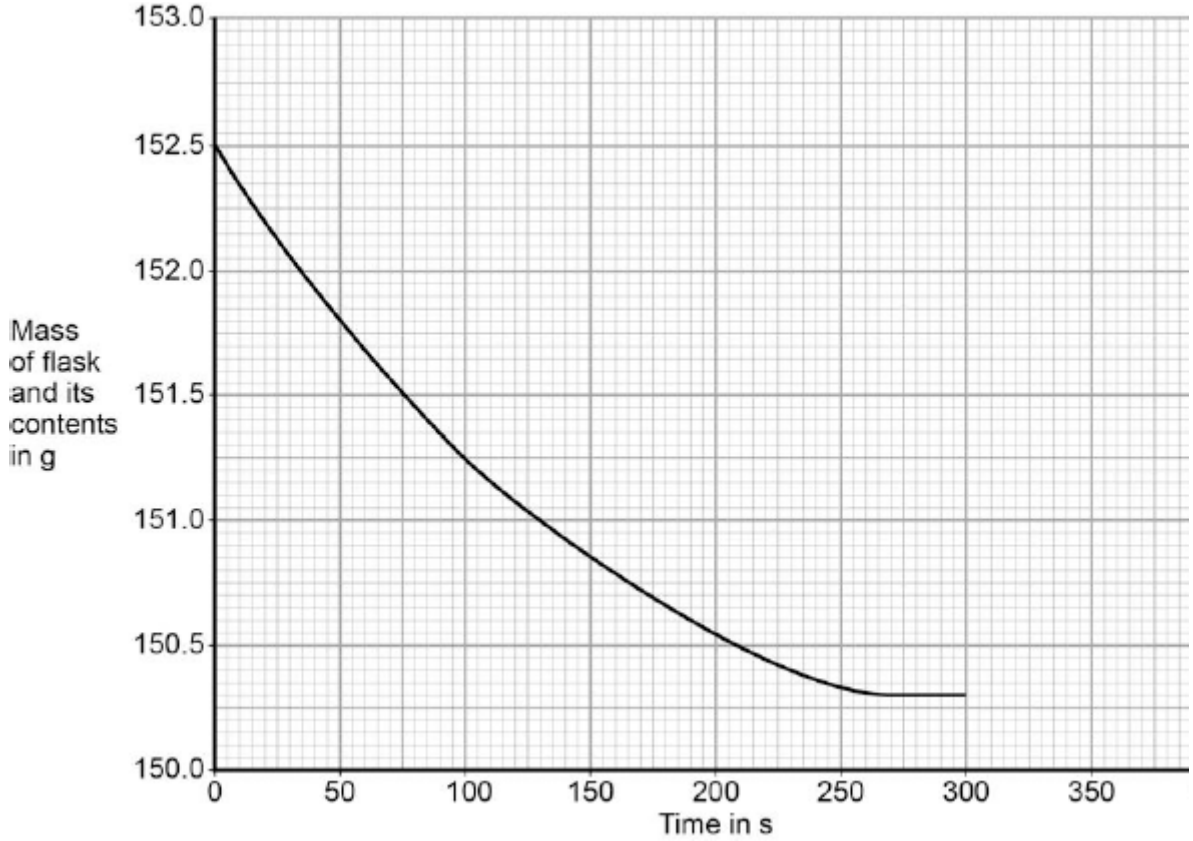
_____

(4)

(e) Another student investigated the rate of reaction by measuring the change in mass.

Figure 3 shows the graph plotted from this student's results.

Figure 3



Use **Figure 3** to calculate the mean rate of the reaction up to the time the reaction is complete.

Give your answer to three significant figures.

Mean rate of reaction = _____ g / s

(4)

(f) Use **Figure 3** to determine the rate of reaction at 150 seconds.

Show your working on **Figure 3**.

Give your answer in standard form.

Rate of reaction at 150 s = _____ g / s

(4)

(Total 20 marks)

Q4.

Titan is a moon of the planet Saturn.

The following table shows the percentages of the gases in the atmosphere of Titan.

Gas	**Percentage of gas in atmosphere (%)**
Nitrogen	98.4
Methane	1.4
Other gases	0.2

(a) Some scientists think that living organisms could have evolved on Titan.

Explain why these organisms could **not** have evolved in the same way that life is thought to have evolved on Earth.

Use the table.

(3)

(b) Saturn has other moons.

The other moons of Saturn have no atmosphere.

Titan is warmer than the other moons of Saturn because its atmosphere contains the greenhouse gas methane.

Explain how this greenhouse gas keeps Titan warmer than the other moons of Saturn.

_____

_____

_____

_____

_____

_____

_____

_____

(3)

(c) The atmosphere of Titan contains small amounts of propene.

Describe a test to show that propene is an unsaturated hydrocarbon.

Give the result of the test.

Test _____

_____

Result _____

_____

(2)

(Total 8 marks)

Q5.

Water in Britain is taken from reservoirs to use as drinking water.

(a) What are the **two** main steps used to treat water from reservoirs?

Give **one** reason for each step.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(b) Some people use water filters to treat water before drinking it.

(i) Water filters remove hardness from hard water.

What is in water filters that removes hardness from water?

_____

_____

(1)

(ii) Suggest why water filters used in the home contain particles of silver.

_____

_____

(1)

(c) Pure water can be produced by distillation.

Why is distillation **not** usually an economic method of treating water for drinking?

_____

_____

(1)

(d) Drinking hard water has health benefits.

State **one** health benefit of drinking hard water.

_____

_____

(1)

(Total 8 marks)

Q6.

Sodium thiosulfate solution reacts with dilute hydrochloric acid.

The solution becomes cloudy as the reaction takes place.

(a) The equation for the reaction is:

$$Na_2S_2O_3(aq) + 2\,HCl(aq) \longrightarrow 2\,NaCl(aq) + SO_2(g) + H_2O(l) + S(s)$$

Explain why the solution becomes cloudy.

(2)

(b) Plan an investigation to show how the concentration of the sodium thiosulfate solution affects the rate of the reaction with dilute hydrochloric acid.

Your plan should give valid results.

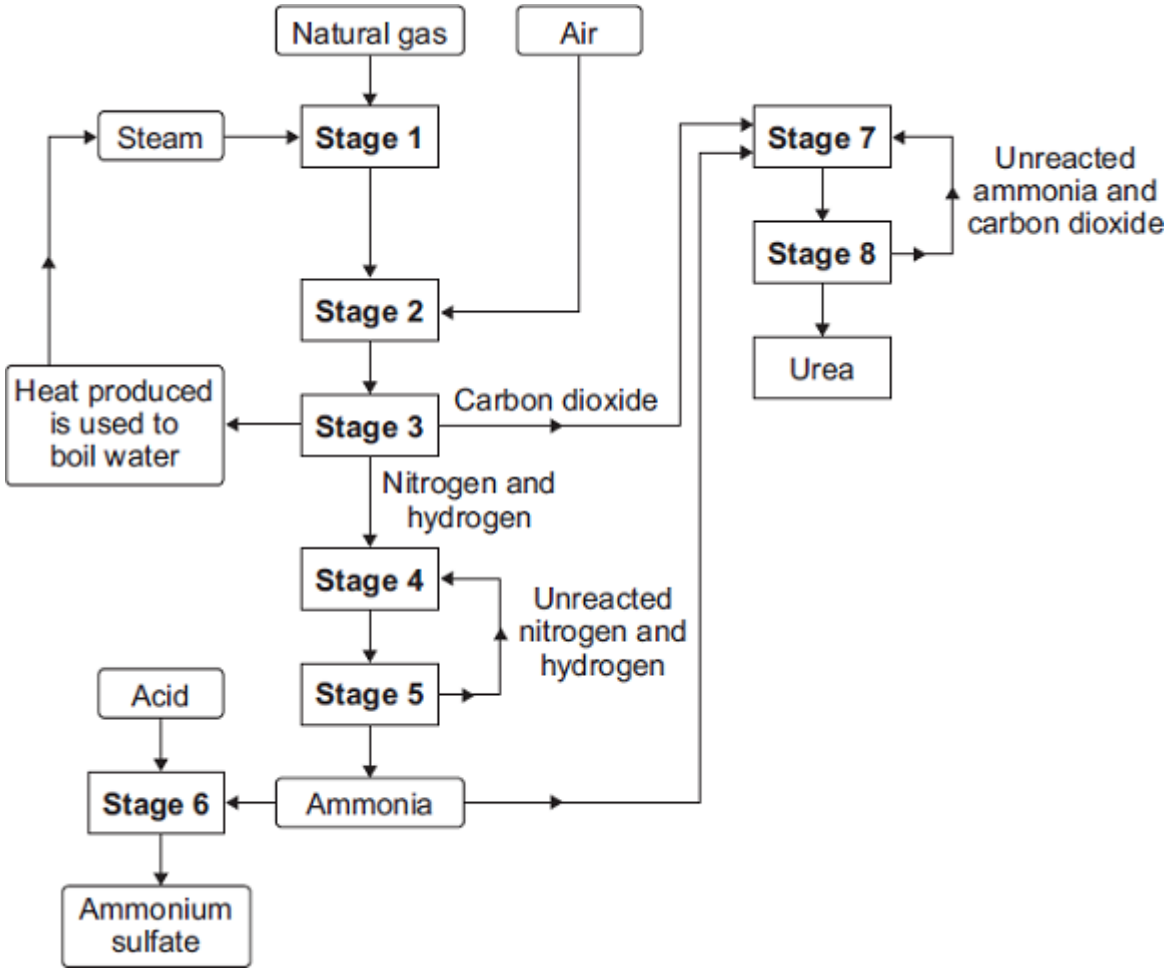
(6)

(Total 8 marks)

Q7.

Ammonium sulfate and urea are made from ammonia. These compounds are used by farmers.

The flow diagram shows the stages to make ammonium sulfate and urea.



(a) Give **two** examples from the flow diagram of the efficient use of energy and raw materials.

(2)

(b) The equation for the reaction in Stage **4** is shown below.

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

The forward reaction is exothermic.

State **and** explain:

(i) how a **decrease** in temperature would affect the yield of ammonia at equilibrium

(2)

(ii) how an **increase** in pressure would affect the yield of ammonia at equilibrium.

(2)

(c) The equation for the reaction in Stage **7** is shown below.

$$\underset{\text{ammonia}}{2\,NH_3} + CO_2 \rightleftharpoons \underset{\text{urea}}{NH_2CONH_2} + H_2O$$

The table gives the relative formula masses (M_r) of the reactants and the products for this reaction.

Formula of reactant or product	Relative formula masses (M_r)
NH_3	17
CO_2	44
NH_2CONH_2	60
H_2O	18

Percentage atom economy can be calculated using:

$$\text{Percentage atom economy} = \frac{M_r \text{ of useful product}}{\text{total } M_r \text{ of all reactants added together}} \times 100\%$$

Calculate the percentage atom economy for the reaction in Stage **7**.

Percentage atom economy = _____ %

(2)

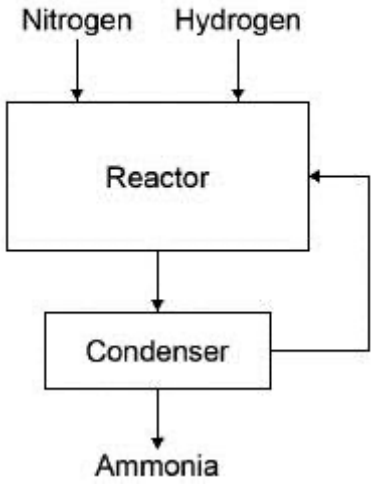
(Total 8 marks)

Q8.

Nitrogen and hydrogen react to produce ammonia in the Haber process.

Figure 1 shows the Haber process.

Figure 1



A gaseous mixture of ammonia, hydrogen and nitrogen leaves the reactor.

Table 1 shows the boiling points of the gases.

Table 1

Gas	Boiling point in °C
Ammonia	−33

Nitrogen	−196
Hydrogen	−253

(a) Suggest how ammonia is separated from the other gases.

(2)

(b) What happens to the unreacted hydrogen and nitrogen?

(1)

The equation for the reaction is:

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

The forward reaction is exothermic.

(c) Calculate the volume of ammonia produced from the complete reaction of 825 dm^3 of hydrogen.

Volume of ammonia = _____ dm^3

(2)

(d) The Haber process uses a temperature of 450 °C and a pressure of 200 atmospheres.

Why are these conditions used?

Tick **two** boxes.

A higher pressure is maintained using less energy ☐

A higher temperature would increase the equilibrium yield ☐

A lower pressure would decrease the equilibrium yield ☐

A lower temperature would make the reaction too slow ☐

There are more product molecules than reactant molecules ☐

(2)

Most of the ammonia produced is used to make fertilisers.

Table 2 shows information about compounds used as fertilisers.

Table 2

Compound	Formula	Cost in £ / tonne
A	NH_4NO_3	220
B	$(NH_4)_2HPO_4$	350
C	KCl	235

(e) Which element in compound A improves agricultural productivity?

_____

(1)

(f) Which **two** compounds can be mixed to make a fertiliser containing three elements that improve agricultural productivity?

Give a reason why you have chosen these compounds.

Compounds _____ and _____

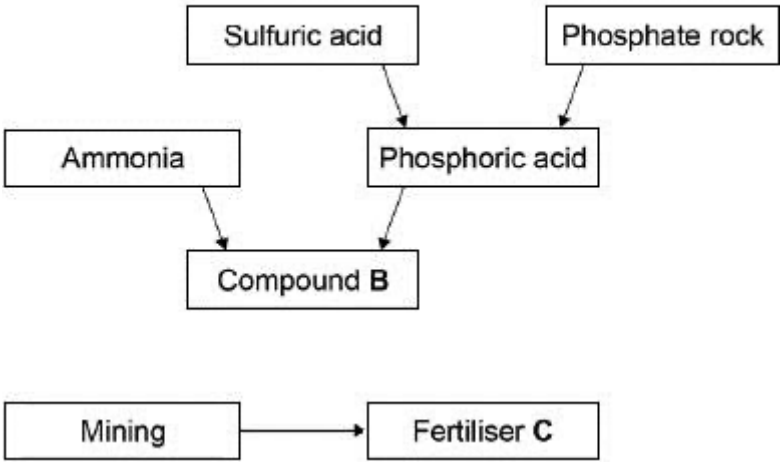
Reason _____

_____

(2)

(g) **Figure 2** shows a flow chart for the production of compounds B and C.

Figure 2



Suggest **two** possible reasons for the difference in cost between compounds **B** and **C**.

1. _____

_____

2. _____

_____

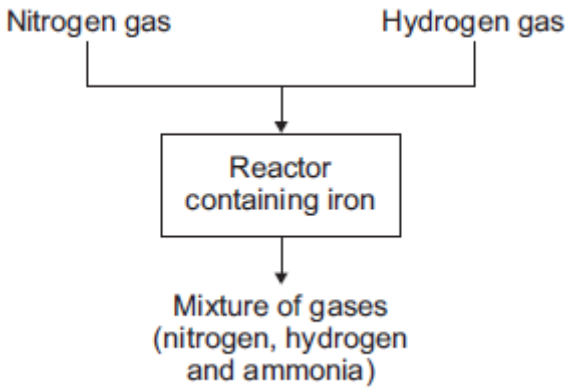
(2)

(Total 12 marks)

Q9.

The graph in **Figure 1** shows a flow diagram for the Haber process.

Figure 1



(a) (i) Hydrogen gas is obtained from methane.
Name **one** source of methane.

_____

(1)

(ii) Air is the source used to produce nitrogen for the Haber process.
Suggest why air must **not** get into the reactor.

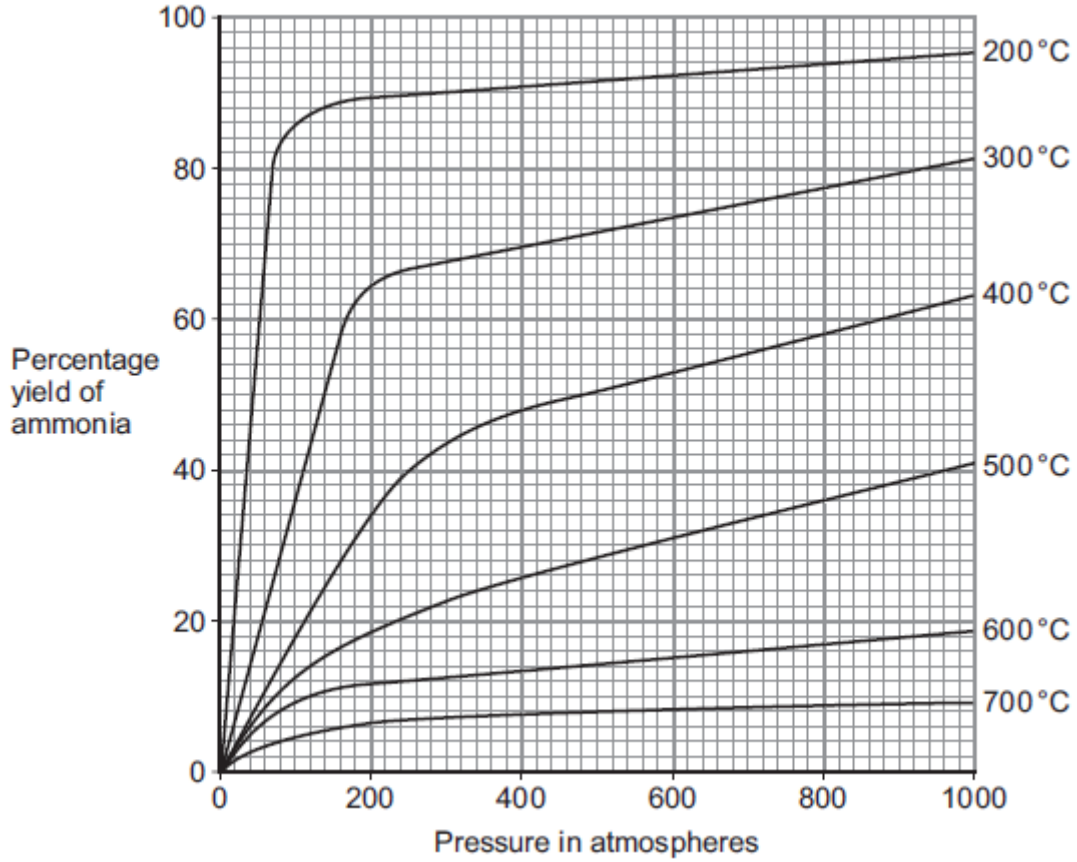
(2)

(iii) Describe what happens to the mixture of gases from the reactor.

(3)

(b) The graph in **Figure 2** shows the percentage yield of ammonia using different conditions.

Figure 2



(i) Use **Figure 2** to suggest the conditions that produce the greatest yield of ammonia.

(1)

(ii) Use **Figure 2** to suggest and explain why the conditions used to produce ammonia in the Haber process are a temperature of 450 °C and a pressure of 200 atmospheres.

(5)

(Total 12 marks)

Q1.

(a) **Level 3:** The design/plan would lead to the production of a valid outcome. All key steps are identified and logically sequenced.

5–6

Level 2: The design/plan would not necessarily lead to a valid outcome. Most steps are identified, but the plan is not fully logically sequenced.

3–4

Level 1: The design/plan would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.

1–2

No relevant content

0

Indicative content

lithium:
- crush tablets or dissolve tablet (in water or acid)
- clean wire
- place on wire
- place in (roaring / blue / non-luminous) flame
- observe flame colour
- crimson flame

carbonate:
- add hydrochloric acid
- effervescence / fizzing
- bubble gas through limewater
- limewater becomes cloudy

(b) formulation(s)

1

(c)

*an answer of 58.3333333 (%) correctly rounded to at least 2 significant figures scores **3** marks*

1.20 g = 1200 mg
or
700 mg = 0.700 g

1

$\frac{700}{1200} \times 100$ **or** $\frac{0.700}{1.20} \times 100$

allow correct use of incorrectly or not converted values from step1

1

= 58.3 (%)

allow 58.3333333 (%) correctly rounded to at least 2 significant figures

1

[10]

Q2.

(a) any **four** from:

- (crude oil is) heated
- to evaporate / vaporise / boil (the substances / hydrocarbons)
- the column is hotter at the bottom or is cooler at the top
- (vapours / fractions) condense
- at their boiling points or at different levels.

marks can be taken from a diagram

max 3 marks for reference to cracking

allow fractional distillation allow vapours (enter the column)

allow temperature gradient or (vapours) cool as they rise

allow description e.g. vapour turns to liquid)

allow they have different boiling points

4

(b) acid rain is caused by

allow consequences of acid rain

1

sulfur dioxide or oxides of nitrogen

second marking point is dependent on first marking point

1

they react with / are neutralised by calcium carbonate or limestone

OR

global warming is caused by

carbon dioxide

carbon dioxide will react or dissolve in suspension of limestone

allow greenhouse effect is caused by or allow consequences of global warming

1

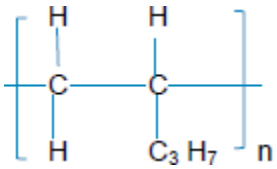
(c) (i) C_2H_4

must be formula

ignore any name

1

(ii) a single bond between carbon atoms



would score 3 marks

1

other four bonds linking hydrogen atoms and C_3H_7 group plus two trailing / connecting bonds

1

n at the bottom right hand corner of the bracket

1

(iii) has a shape memory

or

(a smart polymer) can return to original shape (when conditions change)

1

[12]

Q3.

(a) $CaCO_3 + 2HCl \rightarrow CaCl_2 + H_2O + CO_2$

2

*allow **1** mark for correct formulae*

(b) sensible scales, using at least half the grid for the points

1

all points correct

± ½ small square

*allow **1** mark if 8 or 9 of the points are correct*

2

best fit line

1

(c) steeper line to left of original

1

line finishes at same overall volume of gas collected

1

(d) acid particles used up

allow marble / reactant used up

1

so concentration decreases

allow surface area of marble decreases

1

so less frequent collisions / fewer collisions per second

*do **not** accept fewer collisions unqualified*

1

so rate decreases / reaction slows down

1

(e) mass lost of 2.2 (g)

1

time taken of
270 s

allow values in range 265 − 270

1

$\frac{2.2}{270} = 0.00814814$

allow ecf for values given for mass and time

1

0.00815 (g / s)

or

8.15×10^{-3}

*allow **1** mark for correct calculation of value to 3 sig figs*
*accept 0.00815 or 8.15×10^{-3} with no working shown for **4** marks*

1

(f) correct tangent

1

eg 0.35 / 50

1

0.007

allow values in range of 0.0065 − 0.0075

1

7×10^{-3}

1

*accept 7×10^{-3} with no working shown for **4** marks*

[20]

Q4.

(a) (Titan has) little / no oxygen

ignore references to respiration

1

(so) photosynthesis has not occurred (on Titan)

allow (so) no plants / algae to produce oxygen (on Titan)

1

(therefore) little / no carbon dioxide present (on Titan)
or
(therefore) oxygen-using animals cannot have evolved (on Titan)

1

(b) (methane) allows short(er) wavelength radiation to pass through (from the sun)

allow (methane) allows uv / ultraviolet radiation to pass through (from the sun)

1

(which is) re-emitted from the surface as long(er) wavelength radiation

allow (which is) re-emitted from the surface as ir / infra-red radiation

1

(which is) absorbed (by methane in the atmosphere)

allow (which is) trapped (by methane in the atmosphere)

1

*if no other mark is awarded, allow **1** mark for methane absorbs long(er) wavelength radiation*
or
methane absorbs ir / infra-red radiation

(c) (add) bromine (water)

*do **not** accept bromide*

1

(changes from) orange to colourless

dependent on correct test in MP1
allow (changes from) brown to colourless
ignore clear

1

[8]

Q5.

(a) filter

1

to remove *solids* ***or*** *insoluble particles*

OR

add coagulant (1)

flocculation / settling / remove solids (1)

1

(add) chlorine

accept ozone / UV

1

to reduce the number of microbes

accept to kill microbes / bacteria / germs
accept sterilise
allow disinfect
ignore remove microbes

1

(b) (i) ion exchange resin

allow ion exchange column
allow sodium ions / Na^+
allow hydrogen ions / H^+

1

(ii) prevent growth of microbes

accept sterilise
accept to kill microbes / bacteria / germs
accept to reduce the number of microbes
ignore remove microbes

1

(c) high cost of energy / *heating*

allow uses a lot of energy

1

(d) any **one** from:

- helps to develop / maintain bones
  allow any suitable positive effect on bones
- helps to develop / maintain teeth
  allow any suitable positive effect on teeth
- reduces heart disease

1

[8]

Q6.

(a) sulfur (formed)

allow S / S_8 (formed)

1

(which is a) precipitate

allow (which is a) solid
allow (which is) insoluble

1

(b) **Level 3:** The method would lead to the production of a valid outcome. All key steps are identified and logically sequenced.

5–6

Level 2: The method would not necessarily lead to a valid outcome. Most steps are identified, but the method is not fully logically sequenced.

3–4

Level 1: The method would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.

1–2

No relevant content

0

Indicative content

method

- measure (indicated) volume of sodium thiosulfate
- place sodium thiosulfate in (conical) flask
- measure (indicated) volume of hydrochloric acid
- place on cross or between light sensor
  or
  connect to a gas syringe
  or
  other suitable method for timing a change
- add hydrochloric acid to (conical) flask
- swirl
- start stopclock / stopwatch
- measure time for cross to become no longer visible
  or
  log light transmission over time
  or
  measure time for fixed volume of gas to be produced
- repeat and find mean
- repeat for different concentrations of sodium thiosulfate
  or change ratio of sodium thiosulfate volume : water volume

control variables

- concentration of hydrochloric acid
- volume of hydrochloric acid
- (total) volume of sodium thiosulfate solution

[8]

Q7.

(a) any **two** from:

- heat water / make steam / boil water **or** heat / steam used in stage 1 or from stage 3
- carbon dioxide from stage 3 used in stage 7 /to make urea
- nitrogen and / or hydrogen recycled
- ammonia and / or carbon dioxide recycled

allow unreacted material / gas recycled from stage 5 (to 4)

allow unreacted material / gas recycled from stage 8 (to 7)

*NB: if neither of the last two points are awarded unreacted material recycled = **1** mark*

2

(b) (i) increase yield

because (forward) reaction is exothermic

ignore references to rate

1

allow because (forward) reaction gives out heat

1

(ii) increase yield

ignore references to rate

1

because more (gaseous) reactant molecules than (gaseous) product molecules

accept because greater volume on the left than the right

1

(c) 76.9 - 77

correct answer gains 2 marks with or without working
*allow 77 **or** 76.923…*
*allow 76 **or** 0.77 **or** 0.76923 for **1** mark*
*if answer incorrect allow **1** mark for **either***

$$\frac{60}{\text{attempt at total } M_r \text{ of all reactants}} \times 100$$

or

$$\frac{\text{attempt at total } M_r \text{ of area}}{78} \times 100$$

2

[10]

Q8.

(a) cool

1

to −34 °C

allow temperatures below −34 °C but above −196 °C

1

(b) recycled (to the reactor)

1

(c) $825 \times \frac{2}{3}$

1

= 550 (dm^3)

1

*an answer of 550 (dm^3) scores **2** marks*

(d) a lower pressure would decrease the equilibrium yield

1

a lower temperature would make the reaction too slow

1

(e) nitrogen / N

1

(f) **B** and **C**

1

contain nitrogen, phosphorus and potassium

1

(g) (**B**)

any **two** from:
- more stages
- uses more energy
- uses more raw materials
- takes longer

*allow converse for **C***

2

[12]

Q9.

(a) (i) natural gas

allow fossil fuels / biogas generator

1

(ii) air contains oxygen

1

this would react with / oxidise the hydrogen

allow this would react with / oxidise the iron
ignore nitrogen

1

(iii) cooled

1

ammonia condenses / liquefies (so can be separated)

1

nitrogen and hydrogen (remain as gases and) are returned to the reactor

allow recycled

1

(b) (i) 200 °C **and** 1000 atmospheres

1

(ii) the reaction is reversible

allow stated as equilibrium or forward / backward reaction anywhere in answer

1

forward reaction is exothermic so increased temperature lowers the yield of ammonia

allow converse

1

a lower temperature would decrease rate of reaction

allow converse

1

a higher pressure would increase the yield of ammonia because the forward reaction produces the least number of (gaseous) molecules / moles

allow converse

1

higher pressures would involve high cost / energy

1

ignore risk / explosion

[12]