10 Ammonia

Set B **Exam practice**

Name	Time **45 minutes**	Total **24 marks**	Score ____ / 24

Use a copy of the Periodic Table where you need one.

Marks by notes section For the marker: total each row. A score below the target means that section of the notes needs revising.

Notes section	Questions	Marks	Target	Score
1 The Haber Process	2, 3, 4, 6(a), 6(c), 6(d), 6(e), 6(f), 7, 8(a), 8(b)	16	10	
2 Reversible Reactions	1, 5	2	2	
2 Collecting and Drying Gases *(Topic 01)*	8(c)	2	2	
4 Covalent Bonding *(Topic 04-05)*	6(b)	2	2	
07 · 5 Percentage Yield and Purity *(Topic 06-07)*	8(d)	2	2	

A Multiple choice

5 MARKS

1 Ammonia is produced by the Haber process. Which statement about the process is **not** correct?

A Each nitrogen molecule reacts with three hydrogen molecules to form two molecules of ammonia.

B Hydrogen used in the process can be obtained by the cracking of hydrocarbons.

C Powdered iron is used to speed up the reaction.

D The process involves a non-reversible reaction.

/1

Answer ☐ [1]

Source: Zhonghua Prelim P1 Q32 (adapted)

2 Which condition(s) used in the Haber process can increase both the reaction rate and the yield?

1 operating at a high pressure
2 operating at a high temperature
3 using a finely divided catalyst

A 1, 2 and 3 **B** 1 and 2 only **C** 1 only **D** 2 and 3 only

/1

Answer ☐ [1]

Source: 2024 Jurongville Prelim P1 Q23

3 Suppose unreacted gases are not recycled. What volumes of nitrogen and hydrogen are needed to

produce 600 dm^3 of ammonia in a process that is only 15% efficient?

	volume of N_2 / dm^3	volume of H_2 / dm^3
A	45	135
B	255	765
C	300	900
D	2000	6000

/1

Answer ☐ [1]

Source: 2024 Jurongville Prelim P1 Q16

4 The forward reaction of the Haber process is $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$. 15 cm^3 of nitrogen is added to 60 cm^3 of hydrogen in a container. What is the total volume of gas remaining in the container after the reaction is complete?

A 30 cm^3 **B** 40 cm^3 **C** 45 cm^3 **D** 105 cm^3

/1

Answer ☐ [1]

Source: 2023 GESS Sec 3 End-of-Year P1 Q25

5 Ammonium chloride is heated strongly in a boiling tube. Damp blue and red litmus papers are placed at the mouth of the boiling tube. Which row shows the correct sequence of observations that would be made?

	first observed colour change	final colour of both litmus papers
A	The damp blue litmus paper turns red.	red
B	The damp blue litmus paper turns red then bleaches.	white
C	The damp red litmus paper turns blue.	blue
D	The damp red litmus paper turns blue.	red

/1

Answer ☐ [1]

Source: 2024 CGS Prelim P1 Q16

B Structured questions

19 MARKS

6 Ammonia is manufactured by the Haber process: $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$. The economics of the process require that as much ammonia as possible is made as quickly as possible. The table shows how the percentage of ammonia varies with the conditions.

pressure / atm	100	200	300	400
% ammonia at 300 °C	45	65	72	78
% ammonia at 500 °C	9	18	25	31

(a) Describe how hydrogen is obtained for the Haber process.

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[1]

(b) Use the electronic structure of nitrogen to explain why the formula of ammonia is NH_3 and not NH_4.

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.....

..... **[2]**

(c) Describe the effect of changing the temperature on the percentage yield of ammonia.

..... **[1]**

(d) State one advantage of using a high pressure.

..... **[1]**

(e) The conditions actually used are 200 atmospheres, 450 °C and a finely divided iron catalyst. Suggest one reason why a pressure higher than 200 atmospheres is not used.

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..... **[1]**

(f) State what happens to the unreacted nitrogen and hydrogen.

..... **[1]**

/7

Source: 2024 GESS Prelim P2 Q6

7 In the Haber process, $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$. A chemical engineering company evaluated different operating conditions for a new ammonia plant. Table 1 shows the yield of ammonia at 200 atm and different temperatures. Table 2 shows the yield at 450 °C and different pressures, with the estimated annual cost of running the plant.

temperature / °C	yield of NH_3 / %
350	38.5
400	31.4
450	24.8
500	18.9
550	14.1

pressure / atm	yield of NH_3 / %	annual cost / million dollars
100	14.5	105
150	20.3	118
200	24.8	135
250	27.9	167
300	30.1	215

(a) Describe the relationship between temperature and the yield of ammonia.

..... **[1]**

(b) A student stated that an increase in pressure has a greater effect on the yield of ammonia than a decrease in temperature. Do you agree? Explain your answer using the data.

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..... **[3]**

(c) Give one negative environmental effect of the Haber process.

..... **[1]**

/5

Source: 2026 PLMGS Prelim P2 Q7 (adapted)

8 Ammonia is manufactured industrially in the Haber process.

(a) Explain, with the help of an equation, why nitrogen and hydrogen are mixed in a ratio of 1 : 3 by volume.

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.....

..... **[2]**

(b) State the conditions used in the Haber process.

..... **[1]**

(c) Name a method used to collect ammonia gas in the laboratory and give a reason for using that method.

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..... **[2]**

(d) Ammonia is used to manufacture nitric acid, by first converting ammonia to nitrogen monoxide: $4NH_3(g) + 5O_2(g) \rightarrow 4NO(g) + 6H_2O(l)$. Calculate the volume of nitrogen monoxide that can be collected from 440 dm^3 of ammonia if the yield is 40%.

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..... **[2]**

/7

Source: 2025 Christ Church Prelim P2 Q5