PEARSON EDEXCEL GCSE COMBINED SCIENCE (HIGHER) · 1SC0

CHEMISTRY



EXAM QUESTION PACK

TOPIC 4: EXTRACTING METALS AND EQUILIBRIA: REVERSIBLE REACTIONS AND EQUILIBRIA (PAPER 1)

SCORE	PERCENTAGE
/58	%

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Q1.

When nitrogen and hydrogen react to form ammonia, the reaction can reach a dynamic equilibrium.

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

(a) Explain what is meant by a **dynamic equilibrium.**

(2)

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(b) In industry, the reaction between nitrogen and hydrogen is affected by the conditions used.

(i) The pressure used is 250 atmospheres.
Explain how the use of a higher pressure would affect the equilibrium yield of ammonia.

(2)

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(ii) The reaction between nitrogen and hydrogen to form ammonia is exothermic. The temperature used is 450°C.

Explain how the use of a lower temperature would affect the equilibrium yield of ammonia.

(2)

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(ii) The reaction between nitrogen and hydrogen to form ammonia is exothermic.
The temperature used is 450°C.

Explain how the use of a lower temperature would affect the equilibrium yield of ammonia.

(2)

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(iii) Even at 450°C, the reaction is very slow.

State what is used in industry to overcome this problem.

(1)

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(c) (i) Calculate the minimum volume of hydrogen required to completely convert 1000 dm^3 of nitrogen into ammonia.

(1)

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volume of hydrogen = ... dm^3

(ii) Ammonia is reacted with excess nitric acid, HNO_3, to make ammonium nitrate, NH_4NO_3.

$$NH_3 + HNO_3 \rightarrow NH_4NO_3$$

Calculate the mass of ammonium nitrate produced by the complete reaction of 34 g of ammonia.

(Relative atomic masses H = 1.0, N = 14, O = 16)

(3)

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mass of ammonium nitrate produced =.....g

(Total for Question = 11 marks)

Q2.

Some questions must be answered with a cross in a box (☒). If you change your mind about an answer, put a line through the box (☒) and then mark your new answer with a cross (☒).

Ammonia is manufactured in the Haber process by the reversible reaction between nitrogen and hydrogen.

(i) Write the balanced equation for the reversible reaction between nitrogen and hydrogen to make ammonia, NH_3.

(3)

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(ii) Which row shows the typical conditions of temperature and pressure used in the Haber process?

(1)

		temperature in °C	pressure in atmospheres
☒	**A**	250	100
☒	**B**	250	200
☒	**C**	450	500
☒	**D**	450	200

(iii) In the Haber process, iron is added to the vessel where the nitrogen and hydrogen react.

State the purpose of the iron.

(1)

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(iv) The reaction between nitrogen and hydrogen to make ammonia can reach dynamic equilibrium.

The reaction gives out heat.

Explain how the position of equilibrium changes if the temperature is decreased.

(2)

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(Total for question = 7 marks)

(**QU03a 1SC0/1CH, June 2023**)

Q3.

This question is about ammonia.

Ammonia can be made on an industrial scale using the Haber process.

The equation for the reaction is

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

The reaction can reach a dynamic equilibrium.

(i) Explain what happens when the reaction reaches dynamic equilibrium.

(2)

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Answer the question with a cross in the box you think is correct (☒). If you change your mind about an answer, put a line through the box (☒) and then mark your new answer with a cross (☒).

(ii) Figure 4 shows the changes in percentage yield of ammonia at equilibrium as temperature increases, at a pressure of 300 atmospheres and at a pressure of 1000 atmospheres.

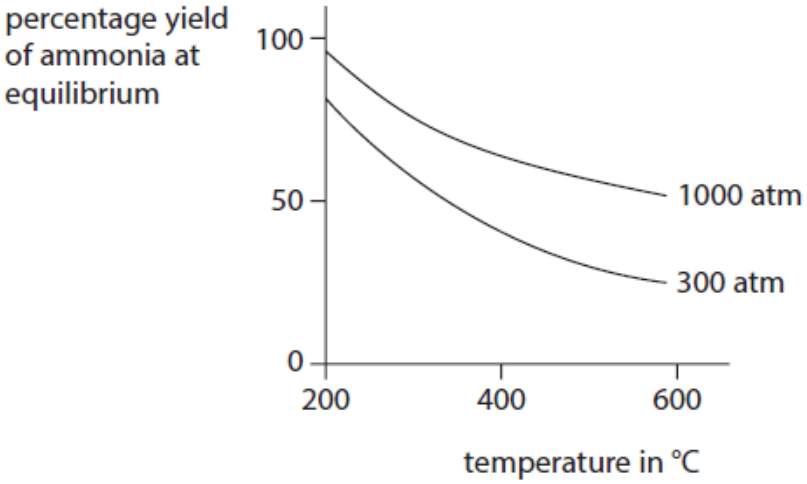


Figure 4

Which row of the table will give the highest percentage yield of ammonia at equilibrium?

(1)

		temperature in °C	pressure in atm
☒	**A**	200	1000
☒	**B**	300	1000
☒	**C**	600	300
☒	**D**	600	1000

(iii) In industry, a pressure of 200 atmospheres is used for the Haber process.

Using Figure 4, explain what happens to the position of dynamic equilibrium if the process is carried out at 100 atmospheres.

(2)

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(Total for question = 5 marks)

(**QU06b 1SC0/1CH, June 2025**)

Q4.

The reaction between nitrogen and hydrogen happens at a pressure of 200 atmospheres.

Another unit of pressure is Pascals, Pa (1 atmosphere = 101 325 Pa).

Calculate the value of 200 atmospheres in Pascals.

(2)

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pressure = ... Pa

(Total for question = 2 marks)

(**Q03c 1SC0/1CF, Nov 2021**)

Q5.

When nitrogen and hydrogen are reacted together, the reaction can reach a dynamic equilibrium.

Use words from the box to complete the sentences about dynamic equilibrium.

(2)

backward	different	equal	faster	reversible

In a dynamic equilibrium two reactions occur at the same time.

These are the forward reaction and the ..... reaction.

The rates of the two reactions are ..... .

(Total for question = 2 marks)

Q6.

Figure 3 shows molecules of nitrogen, hydrogen and ammonia before the reaction and at equilibrium.

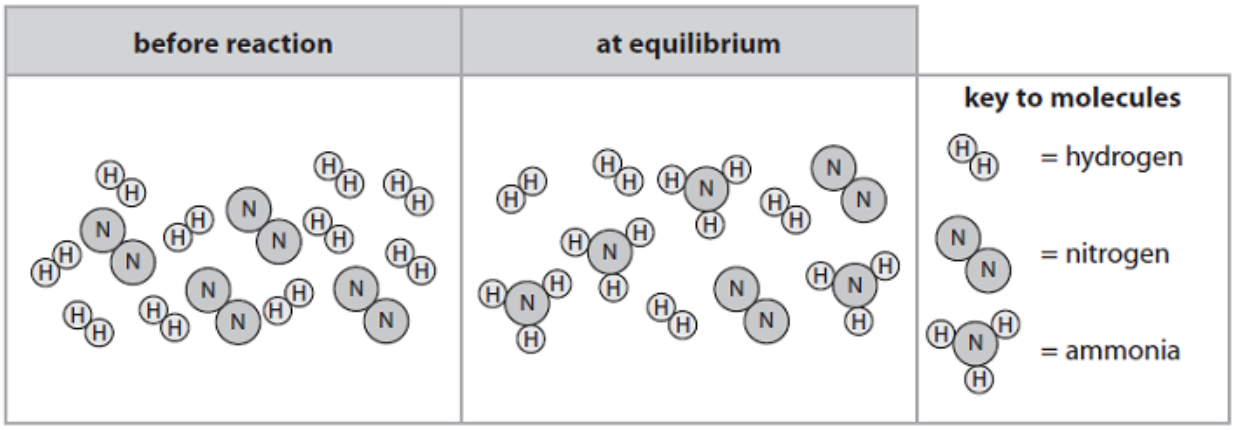


Figure 3

(i) Complete the table showing

- the number of hydrogen molecules before reaction
- the number of hydrogen molecules at equilibrium
- the change in the number of hydrogen molecules.

(1)

	number of molecules before reaction	number of molecules at equilibrium	change in number of molecules
nitrogen	4	2	–2
hydrogen	.....	.....	.....
ammonia	0	4	+4

(ii) Complete the equation for this reaction.

(2)

..... + ... ↔ 2 NH_3

(Total for question = 3 marks)

(**Q03d 1SC0/1CF, Nov 2021**)

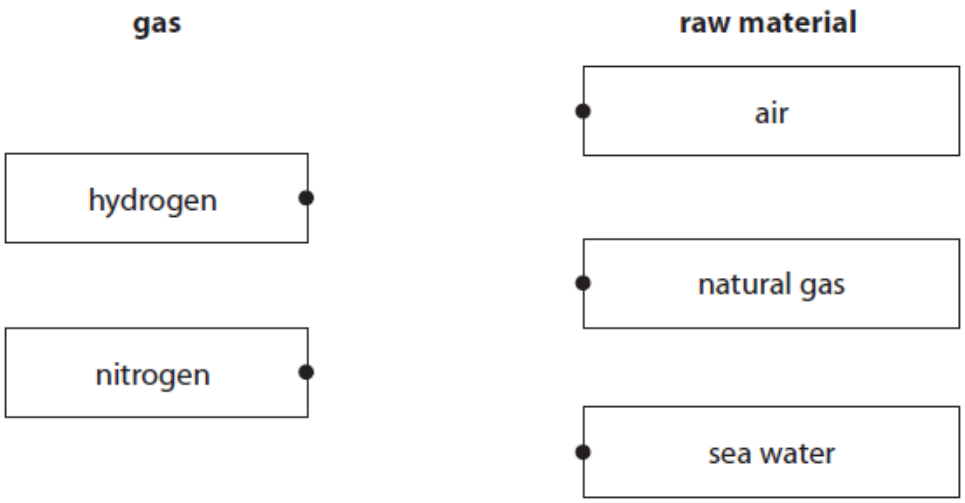
Q7.

Ammonia is made by reacting nitrogen with hydrogen.

The nitrogen and hydrogen are obtained from raw materials.

Draw one straight line from each gas to the raw material it is obtained from.

(2)



(Total for question = 2 marks)

(**Q03a 1SC0/1CF, Nov 2021**)

Q8.

When nitrogen and hydrogen react to form ammonia, the reaction can reach a dynamic equilibrium.

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

Explain what is meant by a **dynamic equilibrium.**

(2)

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(**Q39 1SC0/1CH, June 2013**)

Q9.

Compound **A** is a dark brown gas.

Compound **B** is a colourless gas.

Two molecules of **A** combine to form one molecule of **B** in a reversible reaction.

You are given

- a sealed glass tube containing an equilibrium mixture of **A** and **B**
- a beaker
- a kettle
- some ice

At room temperature, the equilibrium mixture is a pale brown colour.

Devise an experiment to show how the position of equilibrium of this reaction is affected by temperature.

The sealed tube must **not** be opened.

(3)

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(Total for question = 3 marks)

(**QU03b 1SC0/1CH, June 2023**)

Q10.

Hydrated copper sulfate, $CuSO_4.5H_2O$, is a blue solid.
Anhydrous copper sulfate, $CuSO_4$, is a white solid.

Heat energy is needed to convert hydrated copper sulfate to anhydrous copper sulfate.
This is a reversible reaction.

$$CuSO_4.5H_2O \rightleftharpoons CuSO_4 + 5H_2O$$

Devise an experiment to show that this is a reversible reaction.

(4)

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(Total for question = 4 marks)

(**Q04a 1SC0/1CH, June 2019**)

Q11.

When nitrogen and hydrogen react to form ammonia, the reaction can reach a dynamic equilibrium.

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

In industry, the reaction between nitrogen and hydrogen is affected by the conditions used.

(i) The pressure used is 250 atmospheres.
Explain how the use of a higher pressure would affect the equilibrium yield of ammonia.

(2)

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(ii) The reaction between nitrogen and hydrogen to form ammonia is exothermic. The temperature used is 450°C.

Explain how the use of a lower temperature would affect the equilibrium yield of ammonia.

(2)

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(iii) Even at 450°C, the reaction is very slow.

State what is used in industry to overcome this problem.

(1)

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(**Q40 1SC0/1CH, June 2013**)

Q12.

This question is about ammonia.

Ammonia can be made by heating ammonium chloride.

$$NH_4Cl(s) \rightleftharpoons NH_3(g) + HCl(g)$$

A sample of solid ammonium chloride is heated in a boiling tube.

After a few minutes ammonium chloride, a white solid, is also seen at the top of the boiling tube, as shown in Figure 5.

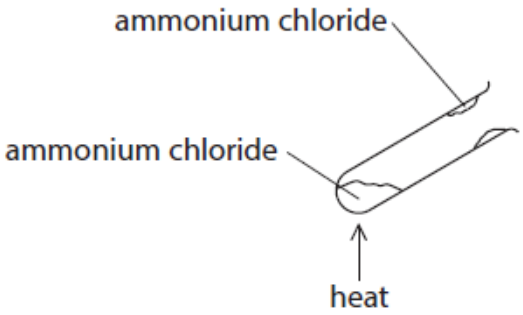


Figure 5

Explain how ammonium chloride is formed at the top of the boiling tube.

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(Total for question = 4 marks)

(**QU06c 1SC0/1CH, June 2025**)

Q13.

Hydrogen reacts with iodine to form hydrogen iodide.
Iodine gas is purple and hydrogen iodide gas is colourless.

$$H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$$

Hydrogen and iodine are placed in a sealed container.
The container is left until equilibrium is reached.

The conditions are changed favouring the forward reaction.

Explain what you would **see.**

(2)

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(Total for question = 2 marks)

(**Q04b 1SC0/1CH, June 2019**)

Q14.

Fertilisers and ammonia

(a) State why farmers spread fertilisers on their fields.

(1)

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(b) Using too much fertiliser can harm the environment.

Describe how the spreading of too much fertiliser on fields can harm the environment.

(2)

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(c) Ammonium nitrate is a fertiliser.

Ammonium nitrate is formed when nitric acid reacts with ammonia.

(i) Write the word equation for this reaction.

(2)

..... + ... → .....

(ii) This hazard symbol appears on a bottle of nitric acid.



Complete the sentence by putting a cross (☒) in the box next to your answer.

This hazard symbol shows that the nitric acid is

(1)

☒ **A** corrosive

☒ **B** explosive

☒ **C** flammable

☒ **D** toxic

(d) In the Haber process, nitrogen and hydrogen react to form ammonia.

$$\text{nitrogen} + \text{hydrogen} \rightleftharpoons \text{ammonia}$$

(i) The ⇌ symbol in the word equation shows that the reaction goes forwards and backwards at the same time.

Give the name of this type of reaction.

(1)

.....

(ii) Complete the sentence by putting a cross (☒) in the box next to your answer.

The formula for a molecule of ammonia is

(1)

☐ **A** Am_3

☐ **B** HN

☐ **C** NH_3

☐ **D** N_3O

(Total for question = 8 marks)

(**Q07 1SC0/1CF, June 2014**)

Q15.

(a) Nitrogen reacts with hydrogen to form ammonia.

(i) Which of these is the balanced equation for this reaction?

Put a cross (☒) in the box next to your answer.

(1)

☐ **A** $N + 3H \rightleftharpoons NH_3$

☐ **B** $N_2 + H_2 \rightleftharpoons NH_3$

☐ **C** $N_2 + 3H_2 \rightleftharpoons 2\ NH_3$

☐ **D** $N + H_3 \rightleftharpoons NH_3$

(ii) State the meaning of the symbol $\rightleftharpoons$ in an equation.

(1)

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(b) Ammonia is used in the manufacture of some fertilisers.

(i) The table shows information about three fertilisers manufactured from ammonia.

substance	% by mass of nitrogen	% by mass of oxygen
ammonium nitrate	35	60
ammonium sulfate	21	48
urea	47	27

Use the information in the table to explain why urea might be the best fertiliser.

(2)

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(ii) When rivers flow through areas where fertilisers have been spread on the land, plants and animals that live in the rivers can be affected.

Explain how this happens.

(2)

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(**Q09 1SC0/1CF, June 2015**)

Q16.

Gases and ammonia

(a) Hydrogen reacts with oxygen to form water vapour.

$$2H_2(g) + O_2(g) \rightarrow 2H_2O(g)$$

If 200 cm^3 of hydrogen react completely with 100 cm^3 of oxygen, what is the maximum volume of water vapour formed, if all volumes are measured at the same temperature and pressure?

Put a cross (☒) in the box to show your answer.

(1)

☒ **A** 100 cm^3

☒ **B** 200 cm^3

☒ **C** 300 cm^3

☒ **D** 400 cm^3

(b) Zinc reacts with dilute hydrochloric acid to form zinc chloride and hydrogen.

$$Zn(s) + 2HCl(aq) \rightarrow ZnCl_2(aq) + H_2(g)$$

Calculate the maximum volume of hydrogen formed, at room temperature and pressure, when 13.0 g of zinc reacts completely with excess hydrochloric acid.
(relative atomic mass: Zn = 65.0,
1 mol of any gas occupies 24 dm^3 at room temperature and pressure)

(2)

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volume of hydrogen = ... dm^3

(c) In industry, ammonia is produced by the Haber process.

$$\text{nitrogen} + \text{hydrogen} \rightleftharpoons \text{ammonia}$$

(i) What is the source of the hydrogen used in the Haber process?

Put a cross (☒) in the box to show your answer.

(1)

☒ **A** air

☒ **B** reaction of zinc with dilute sulfuric acid

☒ **C** electrolysis of water

☒ **D** natural gas

(ii) When nitrogen reacts with hydrogen, the amount of ammonia gradually increases until it becomes constant.

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

Explain why the amount of ammonia remains constant.

(2)

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*(d) The reaction between nitrogen and hydrogen is exothermic.

$$N_2 + 3H_2 \rightleftharpoons 2NH_3$$

If nitrogen and hydrogen were reacted at 90 atm pressure and 300 °C, without a catalyst, some ammonia would be formed eventually.

In the Haber process a pressure of 150 atm and a temperature of 450 °C are used, in the presence of an iron catalyst.

Explain, with reasons, why the Haber process conditions are better for the manufacture of ammonia.

(6)

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(Total for question = 12 marks)

Q17.

Nitrogen reacts with hydrogen to form ammonia.

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

(i) Calculate the minimum volume of nitrogen, in dm^3, required to react completely with 1000 dm^3 of hydrogen.

All volumes are measured at the same temperature and pressure.

Put a cross (☒) in the box next to your answer.

(1)

☒ **A** 333 dm^3

☒ **B** 1000 dm^3

☒ **C** 3000 dm^3

☒ **D** 4666 dm^3

(ii) The minimum volumes of nitrogen and hydrogen that must react completely to form 5000 dm^3 of ammonia are calculated.

These volumes are mixed and left, under appropriate conditions, until the reaction reaches equilibrium.

Explain which gas or gases will be present when equilibrium is reached.

(2)

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(iii) The Haber process is carried out under a pressure of about 200 atm.

Explain the effect on the **equilibrium yield** of ammonia, if the process is carried out at a pressure higher than 200 atm.

(2)

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(iv) Explain the effect on the **rate of attainment of equilibrium**, if the process is carried out at a pressure higher than 200 atm.

(3)

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(**Q07 5CH1H/01, June 2015**)

Q18.

Covalent substances can be simple molecular covalent or giant covalent.

(i) Ammonia is a simple molecular, covalent substance.

Which is the most likely set of properties for ammonia?

(1)

	melting point in °C	boiling point in °C	ability to conduct electricity in liquid state
☒ **A**	1713	2950	does not conduct
☒ **B**	−78	−33	does not conduct
☒ **C**	−39	357	conducts
☒ **D**	801	1413	conducts

(ii) Ammonia, NH_3, is made by reacting nitrogen with hydrogen.

Write the balanced equation for this reaction.

(2)

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(Total for question = 3 marks)

(**Q14 1SC0/1CH, June 2018**)

Q19.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

When chloride ions are added to a pale blue solution containing copper ions, the mixture turns yellow.

This is a reversible reaction.

pale blue solution + chloride ions ↔ yellow solution + water

What effect does the removal of chloride ions have on the colour of the yellow mixture?

(1)

☐ **A** does not change colour

☐ **B** turns blue

☐ **C** turns colourless

☐ **D** turns darker yellow

(Total for question = 1 mark)

(**Q04c 1SC0/1CH, Nov 2021**)