Cambridge Assessment International Education

Cambridge IGCSE™

12: Equilibria – Topic questions

Paper 4

The questions in this document have been compiled from a number of past papers, as indicated in the table below.

Use these questions to formatively assess your learners' understanding of this topic.

Question	Year	Series	Paper number
4	2016	June	41
5	2016	November	41
5	2016	November	42

The mark scheme for each question is provided at the end of the document.

You can find the complete question papers and the complete mark schemes (with additional notes where available) on the School Support Hub at www.cambridgeinternational.org/support

4 **(a)** Ammonia, NH_3, is made by reacting nitrogen with hydrogen in the Haber process.

(i) Write a chemical equation for the formation of ammonia in the Haber process.

..... [2]

(ii) Name the raw materials from which nitrogen and hydrogen are obtained.

nitrogen .....

hydrogen .....
[2]

(iii) State the temperature and pressure used in the Haber process. Include the units.

temperature .....

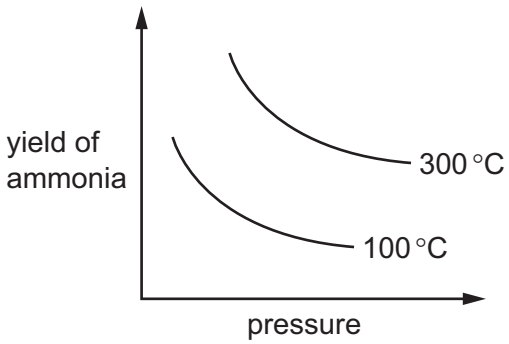
pressure .....
[2]

(b) Ammonia is also made when ammonium carbonate decomposes.

$$(NH_4)_2CO_3(s) \rightleftharpoons 2NH_3(g) + H_2O(g) + CO_2(g)$$

The reaction is reversible and can reach a position of equilibrium.

The graph shows how the yield of ammonia at equilibrium changes with temperature and pressure.



(i) What is meant by the term *equilibrium* for a reversible reaction?

.....

.....

..... [2]

(ii) Using information from the graph, explain whether the reaction is endothermic or exothermic.

.....

..... [1]

(iii) State and explain the effect of increasing the pressure on the yield of ammonia in this reaction.

.....

.....

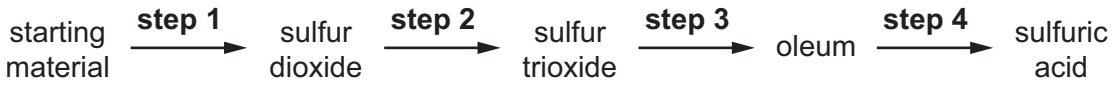
.....

.....

..... [3]

[Total: 12]

5 Sulfuric acid is produced by the Contact process. The steps of the Contact process are shown.



(a) Sulfur is a common starting material for the Contact process.

Name a source of sulfur.

..... [1]

(b) Describe **step 2**, giving reaction conditions and a chemical equation. Reference to reaction rate and yield is not required.

.....

.....

.....

.....

.....

.....

..... [5]

(c) **Step 3** involves adding sulfur trioxide to concentrated sulfuric acid to form oleum.

Complete the chemical equation for this reaction.

$$H_2SO_4 + SO_3 \rightarrow .....$$

[1]

(d) Dilute sulfuric acid is a typical acid.

A student adds excess dilute sulfuric acid to a sample of solid copper(II) carbonate in a test-tube.

(i) Give **three** observations the student would make.

.....

.....

..... [2]

(ii) Give the **names** of all products formed.

.....

..... [1]

(e) Concentrated sulfuric acid has different properties to dilute sulfuric acid.

When concentrated sulfuric acid is added to glucose, $C_6H_{12}O_6$, steam is given off and a black solid is formed.

(i) Name the black solid.

..... [1]

(ii) What type of reaction has occurred?

..... [1]

[Total: 12]

5 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.

.....

.....

.....

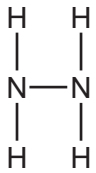
.....

..... [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) Define the term *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]

Question	Answer	Marks
4 (a) (i)	$N_2 + 3H_2 \rightleftharpoons 2NH_3$ **M1** formulae **M2** balancing	**2**
4 (a) (ii)	(nitrogen) air / atmosphere (hydrogen) steam / water / hydrocarbons / natural gas	**1** **1**
4 (a) (iii)	(temperature) answer in range 370–470°C (pressure) answer in range 150–300 atm	**1** **1**
4 (b) (i)	**M1** forward and reverse reactions (occur) **M2** amounts / moles / concentrations (of reagents and products) constant **OR** **M2** rate of forward and reverse reactions equal	**1** **1**
4 (b) (ii)	endothermic **AND** yield increases as temperature increases	**1**
4 (b) (iii)	**M1** yield decreases (as pressure increases) **M2** because more moles / molecules (of gas) on the right **M3** so position of equilibrium moves left	**1** **1** **1**
		Total: 12
5 (a)	(sulfur-containing) fossil fuels;	**1**
5 (b)	**M1** vanadium pentoxide / vanadium(V) oxide / V_2O_5 (catalyst); **M2** 1–5 atmospheres (units required); **M3** 450°C (units required); **M4** $2SO_2 + O_2 \rightarrow 2SO_3$; **M5** equilibrium / reversible reaction;	**5** 1 1 1 1 1
5 (c)	$H_2S_2O_7$;	**1**
5 (d) (i)	3 correct (2 marks) 2 correct (1 mark) bubbles / effervescence / fizzing; dissolves / disappears / forms a solution; blue (solution);	**2**
5 (d) (ii)	carbon dioxide and water and copper(II) sulfate;	**1**
5 (e) (i)	carbon;	**1**
5 (e) (ii)	dehydration;	**1**
		Total: 12

Question	Answer	Marks
5 (a) (i)	pressure in range 150–300 atmospheres / atm; temperature in range 370–470°C; iron (catalyst); balanced equation: $N_2 + 3H_2 \rightarrow 2NH_3$; equilibrium / reversible;	**5**
5 (a) (ii)	manufacture of fertilisers / nylon / nitric acid / cleaning agent (allow oven cleaner) / hair dye / urea / refrigeration / explosives;	**1**
5 (b)	**M1** all shared electrons correct (5 bonds) **M2** exactly two non-bonding electrons on each N and no additional non-bonding electrons	**2**
5 (c) (i)	proton / H+ acceptor;	**1**
5 (c) (ii)	$(N_2H_4 + H_2O) \rightarrow N_2H_5^+ + OH^-$; **OR** $(N_2H_4) + 2H_2O \rightarrow N_2H_6^{2+} + 2OH^-$;	**1**
5 (d) (i)	acid rain / effect of acid rain / (photochemical) smog / (producing) low level ozone;	**1**
5 (d) (ii)	**M1** nitrogen and oxygen (from the air) react / combine or word equation; **M2** at high temperature / spark / very hot;	**2**
		Total: 13