

4: Acids, bases and salts – 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	November	42
3	2016	November	43
5	2016	November	43

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 Dilute nitric acid behaves as a typical acid in some reactions but **not** in other reactions.

- (a) Dilute nitric acid behaves as a typical acid when reacted with copper(II) oxide and with copper(II) carbonate.

Describe what you would **see** if excess dilute nitric acid is added separately to solid samples of copper(II) carbonate and copper(II) oxide followed by warming the mixtures.

copper(II) carbonate

.....
.....

copper(II) oxide

.....
.....

[4]

- (b) When dilute nitric acid is added to pieces of copper and heated, a reaction takes place and copper(II) nitrate is formed.

- (i) Part of the chemical equation for the reaction between copper and dilute nitric acid is shown.

Complete the chemical equation by inserting the formula of copper(II) nitrate and balancing the equation.



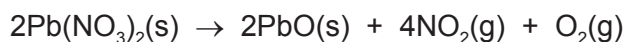
[2]

- (ii) How is the reaction of dilute nitric acid with copper different from that of a typical metal with a typical acid?

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

[Total: 7]

- 3** When lead(II) nitrate is heated, two gases are given off and solid lead(II) oxide remains. The equation for the reaction is shown.



- (a)** Calculate the M_r of lead(II) nitrate.

..... [1]

- (b)** 6.62 g of lead(II) nitrate are heated until there is no further change in mass.

- (i)** Calculate the mass of lead(II) oxide produced.

..... g [2]

- (ii)** Calculate the volume of oxygen, O_2 , produced at room temperature and pressure (r.t.p.).

..... dm^3 [2]

- (c)** Describe a test for oxygen.

test

result

[2]

(d) Lead(II) oxide is insoluble. A student adds solid lead(II) oxide to dilute nitric acid until the lead(II) oxide is in excess. Aqueous lead(II) nitrate and water are produced.

(i) What is meant by the term *excess*?

..... [1]

(ii) How would the student know when the lead(II) oxide is in excess?

..... [1]

(iii) Write a chemical equation for the reaction.

..... [1]

[Total: 10]

- 5 Sulfuric acid can be manufactured from the raw materials sulfur, air and water. The process can be divided into four stages.

- stage 1** converting sulfur into sulfur dioxide
stage 2 converting sulfur dioxide into sulfur trioxide
stage 3 converting sulfur trioxide into oleum, $\text{H}_2\text{S}_2\text{O}_7$
stage 4 converting oleum into sulfuric acid

stage 1

- (a) (i) Describe how sulfur is converted into sulfur dioxide.

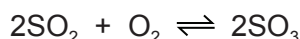
..... [1]

- (ii) Write a chemical equation for the conversion of sulfur into sulfur dioxide.

..... [1]

stage 2

- (b) Sulfur dioxide is converted into sulfur trioxide according to the following equation.



The reaction is carried out at a temperature of 450°C and a pressure of 1–2 atmospheres using a catalyst. The energy change, ΔH , for the reaction is -196 kJ/mol .

- (i) What is the meaning of the symbol \rightleftharpoons ?

..... [1]

- (ii) Name the catalyst used in this reaction.

..... [1]

- (iii) Why is a catalyst used?

..... [1]

- (iv) If a temperature higher than 450°C were used, what would happen to the amount of sulfur trioxide produced? Give a reason for your answer.

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

- (v) Suggest a reason why a temperature lower than 450°C is **not** used.

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

- (vi) If a pressure higher than 1–2 atmospheres were used, what would happen to the amount of sulfur trioxide produced? Give a reason for your answer.

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

stage 3

- (c) (i) What is added to sulfur trioxide to convert it into oleum?

..... [1]

- (ii) Write a chemical equation for the conversion of sulfur trioxide into oleum.

..... [1]

stage 4

- (d) (i) What is added to oleum to convert it into sulfuric acid?

..... [1]

- (ii) Write a chemical equation for the conversion of oleum into sulfuric acid.

..... [1]

- (e) Give **one** use of sulfuric acid.

..... [1]

- (f) Sulfuric acid reacts with a hydrocarbon called benzene to produce benzenesulfonic acid, $\text{C}_6\text{H}_5\text{SO}_3\text{H}$. Benzenesulfonic acid is a strong acid which ionises to produce hydrogen ions, H^+ , and benzenesulfonate ions, $\text{C}_6\text{H}_5\text{SO}_3^-$.

- (i) What is meant by the term *strong acid*?

..... [1]

- (ii) Describe how to show that a 1 mol/dm^3 solution of benzenesulfonic acid is a strong acid.

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

- (iii) Write a chemical equation for the reaction between benzenesulfonic acid and sodium carbonate, Na_2CO_3 .

..... [2]

[Total: 20]

Question	Answer	Marks
4 (a)	<i>copper(II) carbonate</i> fizzes / bubbles / effervescence dissolves / disappears	2
	<i>copper(II) oxide</i> dissolves / disappears blue (solution formed)	2
4 (b) (i)	$\text{Cu}(\text{NO}_3)_2$ <u>3</u> Cu AND <u>3</u> Cu(NO ₃) ₂	2
4 (b) (ii)	hydrogen (gas) is not produced (when copper reacts with nitric acid)	1
		Total: 7
3 (a)	331	1
3 (b) (i)	M1 mol = 6.62 / 331 OR 0.02	1
	M2 0.02 × 223 = 4.46 (g)	1
3 (b) (ii)	M1 mol O ₂ = 0.02 ÷ 2 OR 0.01	1
	M2 vol = 0.01 × 24 = 0.24 (dm ³)	1
3 (c)	<i>test</i> : glowing splint	1
	<i>result</i> : relights / rekindles	1
3 (d) (i)	more than enough to react (with all the acid) OR some lead oxide remains after the reaction OR (nitric) acid is limiting	1
3 (d) (ii)	solid stops dissolving	1
3 (d) (iii)	$\text{PbO} + 2\text{HNO}_3 \rightarrow \text{Pb}(\text{NO}_3)_2 + \text{H}_2\text{O}$ OR	1
	$\text{PbO} + 2\text{H}^+ \rightarrow \text{Pb}^{2+} + \text{H}_2\text{O}$	
		Total: 10

Continues on next page ...

Question	Answer	Marks
5 (a) (i)	burned / heated in air	1
5 (a) (ii)	$S + O_2 \rightarrow SO_2$	1
5 (b) (i)	equilibrium / reversible	1
5 (b) (ii)	vanadium(V) oxide / vanadium pentoxide	1
5 (b) (iii)	increase rate (of reaction) / allow lower temperature to be used / allow lower pressure to be used	1
5 (b) (iv)	less SO_3	1
	forward reaction is exothermic / it is exothermic / reverse reaction is endothermic	1
5 (b) (v)	rate too low / reaction too slow / slower	1
5 (b) (vi)	more SO_3	1
	fewer moles or molecules (of gas) on right-hand side / more moles or molecules (of gas) on left-hand side	1
5 (c) (i)	concentrated sulfuric acid / concentrated H_2SO_4	1
5 (c) (ii)	$SO_3 + H_2SO_4 \rightarrow H_2S_2O_7$	1
5 (d) (i)	water	1
5 (d) (ii)	$H_2S_2O_7 + H_2O \rightarrow 2H_2SO_4$	1
5 (e)	detergents / car batteries / dyes / paints / synthetic resins / printing inks / metal extraction / cleaning metals	1
5 (f) (i)	exists <u>completely</u> as ions (in solution) / <u>completely</u> dissociates (in solution) / <u>completely</u> ionises (in solution)	1
5 (f) (ii)	Universal Indicator / pH paper / pH indicator / pH meter	1
	Universal Indicator or pH paper or pH indicator turns red / pH 0–1	1
5 (f) (iii)	$Na_2CO_3 + 2C_6H_5SO_3H \rightarrow 2C_6H_5SO_3Na + CO_2 + H_2O$ formula of $C_6H_5SO_3Na$ all formulae correct and balancing correct	2
		Total: 20