Acids & Alkalis

Question Paper

Level	GCSE
Subject	Chemistry
Exam Board	Edexcel IGCSE
Module	Single Award (Paper 2C)
Topic	Physical Chemistry
Sub-Topic	Acids & Alkalis
Booklet	Question Paper

Time Allowed: **82 minutes**

Score: **/68**

Percentage: **/100**

Grade Boundaries:

A*	A	B	C	D	E	U
>85%	75%	70%	60%	55%	50%	<50%

1 Lead(II) sulfate, $PbSO_4$, is an insoluble salt.

It can be made as a precipitate from a solution of lead(II) nitrate, $Pb(NO_3)_2$

(a) (i) Identify a substance that could be added to lead(II) nitrate solution to form a precipitate of lead(II) sulfate.

(1)

.....

(ii) Write a chemical equation for the reaction between lead(II) nitrate and the substance you identified in (a)(i).

(2)

.....

(iii) Outline how you would produce a pure, dry sample of lead(II) sulfate from the reaction mixture in (a)(ii).

(3)

.....

.....

.....

.....

.....

.....

(b) A solution of lead(II) nitrate can be made by reacting solid lead(II) carbonate with dilute nitric acid.

The equation for this reaction is:

$$PbCO_3(s) + 2HNO_3(aq) \rightarrow Pb(NO_3)_2(aq) + CO_2(g) + H_2O(l)$$

State **two** observations you would make when dilute nitric acid is added to solid lead(II) carbonate.

(2)

1 .....

.....

2 .....

.....

(Total for Question 1 = 8 marks)

2 Compound **X** is a blue, crystalline solid. It contains copper(II) ions (Cu^{2+}), sulfate ions (SO_4^{2-}) and water of crystallisation.

(a) A student dissolved some of compound **X** in water and then added aqueous sodium hydroxide solution. She obtained a blue precipitate.

Give the formula of the blue precipitate formed in the reaction.

(1)

.....

(b) Another student tested a solution of compound **X** for sulfate ions using dilute hydrochloric acid, followed by a few drops of barium chloride solution. She obtained a white precipitate.

Why is the dilute hydrochloric acid necessary in this test?

(1)

.....

.....

.....

(c) The empirical formula of compound **X** is $CuSO_9H_{10}$

Write the formula of compound **X** to show its water of crystallisation.

(1)

.....

(d) Compound **X** gives a blue-green colour in a flame test.

Outline how you would carry out a flame test.

(2)

.....

.....

.....

.....

.....

.....

(Total for Question 2 = 5 marks)

3 A group of students planned an experiment to find the temperature rise in a neutralisation reaction. This is their method.

- Use a measuring cylinder to add 25 cm^3 of an alkali to a 100 cm^3 beaker
- Record the temperature of the alkali
- Use a burette to add an acid to the alkali in 5.0 cm^3 portions
- Record the temperature of the mixture after adding each portion of acid
- Stop the experiment when the neutralisation is complete

(a) The teacher asked the students about their method.

Suggest an answer to each of her questions.

(i) Why would it be better to use a pipette instead of a measuring cylinder?

(1)

.....

.....

(ii) It would be better if a polystyrene cup were used instead of a beaker.

What property of polystyrene makes this an improvement?

(1)

.....

.....

(iii) What extra step should there be between adding each portion of acid and measuring the temperature?

(1)

.....

.....

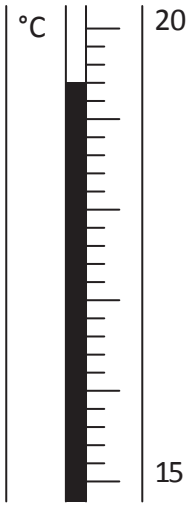
(iv) How would you know when the neutralisation was complete?

(1)

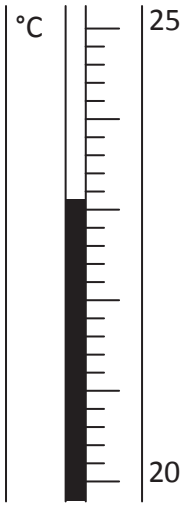
.....

.....

(b) The diagrams show the readings on the thermometer before and after one of the students added a portion of acid.



before adding acid



after adding acid

Write down the thermometer readings and calculate the temperature change.

(3)

Temperature before adding acid ..... °C

Temperature after adding acid ..... °C

Temperature change ..... °C

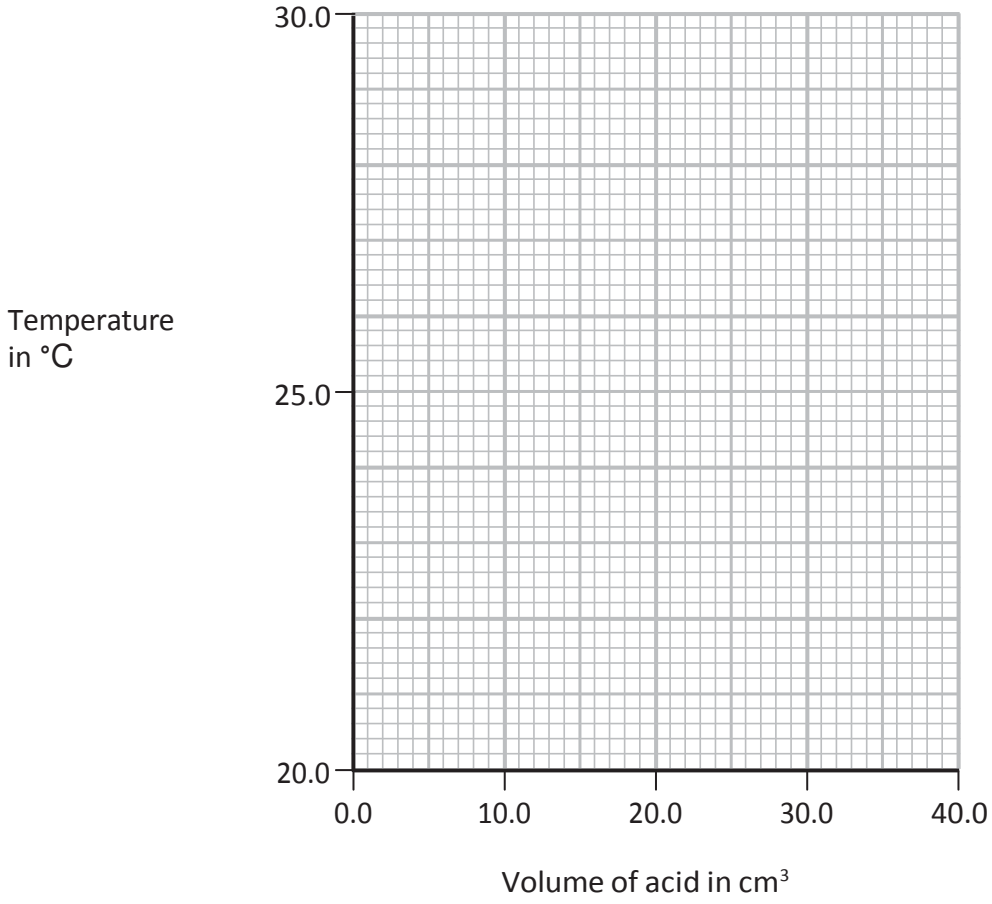
(c) One student obtained these results from an experiment in which she added a total of 40.0 cm^3 of hydrochloric acid to 25 cm^3 of sodium hydroxide solution.

Volume of acid in cm^3	0.0	5.0	10.0	15.0	20.0	25.0	30.0	35.0	40.0
Temperature in °C	21.0	22.3	24.4	26.2	27.8	27.8	27.5	26.7	26.2

(i) Plot a graph of these results on the grid below.

Draw a straight line of best fit through the first five points and another straight line of best fit through the last four points. Make sure that the two lines cross.

(4)



(ii) The point where the lines cross indicates the volume of acid needed to exactly neutralise the alkali, and also the maximum temperature reached.

Use your graph to record these values.

(2)

Volume of acid ..... cm^3

Maximum temperature ..... °C

(d) A second student used the same method and found that 30.0 cm^3 of acid were needed to neutralise 25 cm^3 of alkali.

He obtained a temperature rise of 5.5 °C in his experiment.

Calculate the heat energy change in this experiment using the expression:

heat energy change = total volume of mixture × 4.2 × temperature change

(2)

Heat energy change = ... J

(e) A third student calculated that the heat energy change in her experiment was 1800 J. This heat energy was released by the neutralisation of 25 cm^3 of 1.50 mol/dm^3 sodium hydroxide solution.

(i) Calculate the amount, in moles, of sodium hydroxide neutralised.

(2)

Amount = ... mol

(ii) Calculate the molar enthalpy change, in kJ/mol, for the neutralisation of sodium hydroxide.

(2)

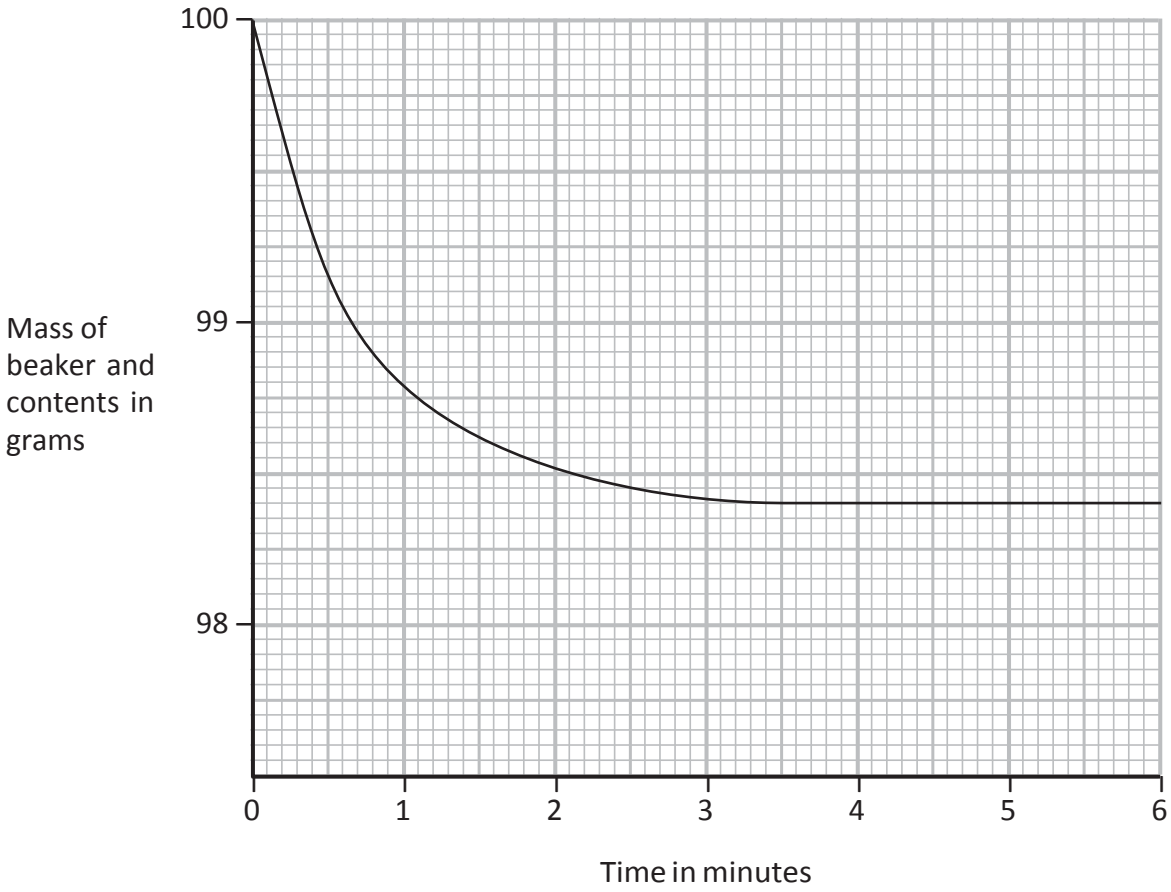
Molar enthalpy change = ... kJ/mol

(Total for Question 3 = 19 marks)

4 An excess of dilute hydrochloric acid was added to a lump of calcium carbonate in a beaker.

The mass of the beaker and contents was recorded every 30 seconds.

The graph shows the results.



The equation for the reaction is

$$CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + H_2O(l) + CO_2(g)$$

(a) State **two** observations that can be made when dilute hydrochloric acid is added to calcium carbonate.

(2)

1 .....

2 .....

(b) Give the test for carbon dioxide gas.

(2)

Test .....

Result .....

(c) Describe the relationship between the mass of the beaker and contents, and the time.

(1)

.....

.....

(d) (i) After how many minutes did the reaction stop?

(1)

.....

(ii) State why the reaction eventually stopped.

(1)

.....

.....

(e) Identify the compounds, other than water, present in the solution in the beaker

(i) after two minutes

(1)

.....

(ii) after five minutes

(1)

.....

(f) The experiment was repeated using the same mass of calcium carbonate, but as a powder instead of a single lump.

On the graph, sketch the curve you would expect to obtain from this second experiment.

(2)

(Total for Question 4 = 11 marks)

5 **Soluble salts** can be made by reacting an acid with a metal hydroxide, a metal oxide, or a metal carbonate.

Insoluble salts can be made by using a precipitation reaction.

(a) Complete the table to show which acid or metal compound is used to make each salt listed.

For each metal compound, state whether it would be used as a solid or in aqueous solution.

(5)

Salt made	Acid used	Metal compound	
		Name	Solid or aqueous solution
copper(II) sulfate		copper(II) oxide	
silver chloride	hydrochloric acid		aqueous solution
potassium nitrate		potassium carbonate	

(b) An acid is a source of hydrogen ions, H^+

Write an equation to show the ions formed when sulfuric acid is dissolved in water.

(2)

.....

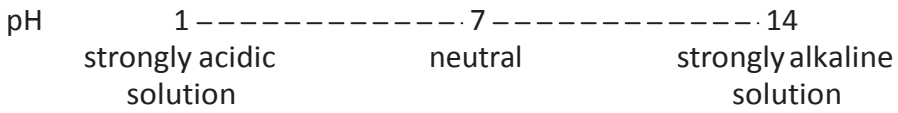
(c) Lead(II) chloride is an insoluble salt that can be prepared by reacting lead(II) nitrate with sodium chloride.

Describe how you would prepare a **pure**, **dry** sample of lead(II) chloride starting from solid lead(II) nitrate and solid sodium chloride.

(5)

(Total for Question 5 = 12 marks)

6 Part of the pH scale is shown.



Some of these experiments involve a pH change.

A sodium chloride (common salt) is dissolved in pure water

B carbon dioxide gas is dissolved in pure water

C sodium hydroxide solution is neutralised by adding dilute hydrochloric acid

D excess sodium hydroxide solution is added to a weakly acidic solution

E ammonia gas is dissolved in pure water

The table shows the pH at the start and at the end of the five experiments.
Complete the table by inserting the appropriate letter in each box. You may use each letter only once.

The first one has been done for you.

(4)

pH at start	pH at end	Experiment
5	14	D
7	7	
7	11	
14	7	
7	6	

(Total for Question 6 = 4 marks)

7 Solutions of lead(II) nitrate and sodium sulfate react together to form the insoluble salt lead(II) sulfate.

(a) A student wrote this plan to prepare a pure dry sample of lead(II) sulfate.

step 1 pour some lead(II) nitrate solution into a beaker

step 2 add sodium sulfate solution until the reaction is complete

step 3 filter the mixture

step 4 heat the filtrate to evaporate some of the water

step 5 cool the filtrate and remove the crystals

(i) How will the student know when the reaction in step 2 is complete?

(1)

.....

.....

(ii) Which compound could the student use in this preparation instead of sodium sulfate?

(1)

☒ **A** lead(II) hydroxide

☒ **B** nitric acid

☒ **C** sodium hydroxide

☒ **D** sulfuric acid

(iii) State why the student should not have included steps 4 and 5 in his plan.

(1)

.....

.....

(iv) Suggest replacement steps to obtain a pure dry sample of lead(II) sulfate.

(2)

step 4 .....

.....

step 5 .....

.....

(v) Lead(II) carbonate cannot be used instead of lead(II) nitrate in this preparation.

This is because lead(II) carbonate

(1)

- ☒ **A** contains ionic bonding
- ☒ **B** has a high relative formula mass
- ☒ **C** is insoluble in water
- ☒ **D** is toxic

(b) The equation for the reaction in the student's plan is

$$Pb(NO_3)_2(aq) + Na_2SO_4(aq) \rightarrow PbSO_4(s) + 2NaNO_3(aq)$$

(i) Deduce the amount of each reactant needed to form 0.150 mol of lead(II) sulfate.

(1)

$Pb(NO_3)_2$ ..... mol

Na_2SO_4 ..... mol

(ii) What volume of 0.500 mol/dm^3 lead(II) nitrate solution is needed to form 0.150 mol of lead(II) sulfate?

(2)

volume = ...

(Total for Question 7 = 9 marks)