Acids, Bases and Salt preparations

Question paper 3

Level	IGCSE(9-1)
Subject	Chemistry
Exam Board	Edexcel IGCSE
Module	Single Award (Paper 2C)
Topic	Inorganic Chemistry
Sub-Topic	Acids, Bases and salt preparations
Booklet	Question paper 3

Time Allowed: **80 minutes**

Score: **/66**

Percentage: **/100**

Grade Boundaries:

9	8	7	6	5	4	3	2	1
>90%	80%	70%	60%	50%	40%	30%	20%	10%

1 This question is about the laboratory preparation of salts.

(a) A student writes this plan for preparing a sample of hydrated magnesium sulfate crystals.

step 1 Pour about 100 cm^3 of dilute nitric acid into a 250 cm^3 beaker.

step 2 Add a solution of magnesium carbonate to the acid until there is no more effervescence.

step 3 Heat the solution until all of the water has boiled off.

This plan will not succeed because there is one mistake in each step.

Identify the mistake in each of the steps.

(3)

step 1 ....

....

step 2 ....

....

step 3 ....

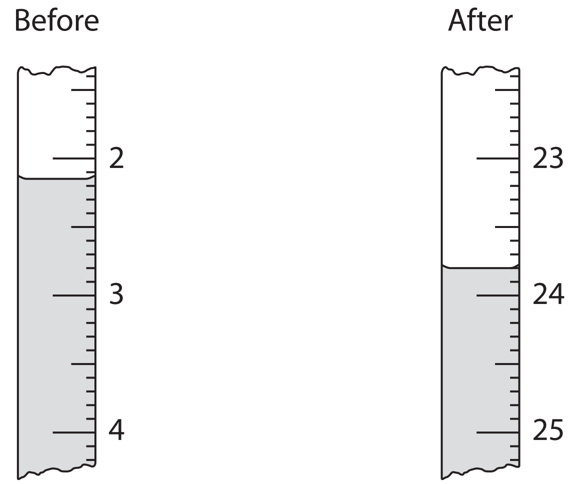
....

(b) Another student uses the following plan to prepare a sample of ammonium hydrogenphosphate, formed in this reaction between aqueous ammonia and dilute phosphoric acid

$$2NH_3(aq) + H_3PO_4(aq) \rightarrow (NH_4)_2HPO_4(aq)$$

- use a pipette to transfer 25.0 cm^3 of phosphoric acid to a conical flask
- add 3 drops of indicator
- use a burette to add aqueous ammonia until the indicator just changes colour permanently

(i) The diagram shows the burette readings in one experiment before and after adding aqueous ammonia.



Use the readings to complete the table, entering all values to the nearest 0.05 cm^3.
(3)

burette reading in cm^3 after adding aqueous ammonia	
burette reading in cm^3 before adding aqueous ammonia	
volume in cm^3 of aqueous ammonia added	

(ii) In another titration, the student made a mistake. After he filled the burette, he noticed that the space between the tap of the burette and the tip contained air. After adding the aqueous ammonia, he noticed that it now contained liquid.

Explain how, if at all, this mistake affects the calculated volume of aqueous ammonia added.
(2)

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(c) He repeats the experiment until he obtains concordant results.

The table shows the results.

burette reading in cm^3 after adding ammonia	27.95	28.05	28.00	26.75
burette reading in cm^3 before adding ammonia	0.80	1.60	1.20	0.50
volume in cm^3 of aqueous ammonia added	27.15	26.45	26.80	26.25
concordant results (✓)				

Concordant results are those volumes that differ from each other by 0.20 cm^3 or less.

(i) Identify the concordant results by placing ticks (✓) in the table where appropriate.
(1)

(ii) Use the concordant results to calculate the average (mean) volume of aqueous ammonia added.
(2)

average volume of aqueous ammonia = ... cm^3

(d) The student then mixed the volumes of aqueous ammonia and phosphoric acid found in the titration.

Describe how to use the method of crystallisation to obtain a pure dry sample of the salt from this mixture.

(3)

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(Total for Question 1 = 14 marks)

2 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 2 = 9 marks)

3 Part of the pH scale is shown.

pH 1 - - - - - - - - - - - - - - - - - 7 - - - - - - - - - - - - - - - - - 14

strongly acidic solution — neutral — strongly alkaline solution

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.

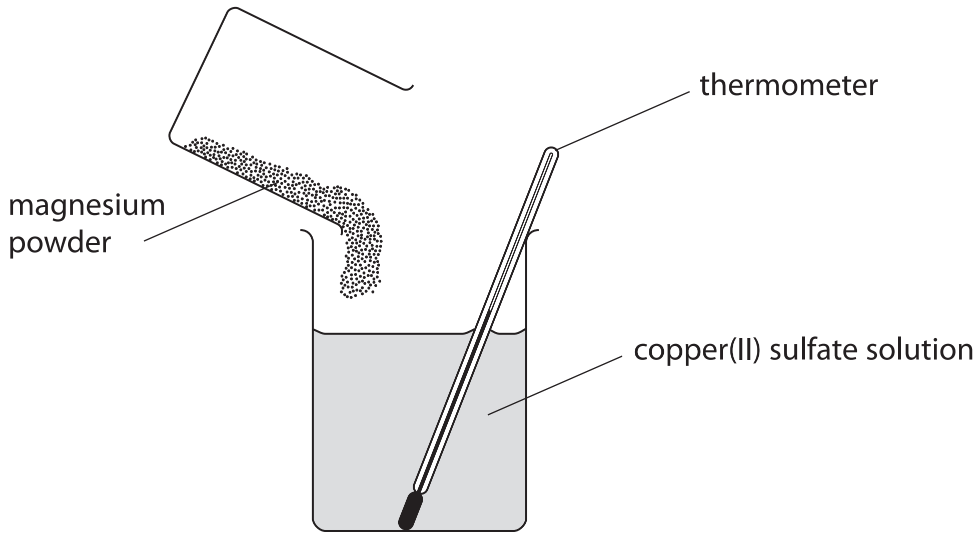
(4)

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

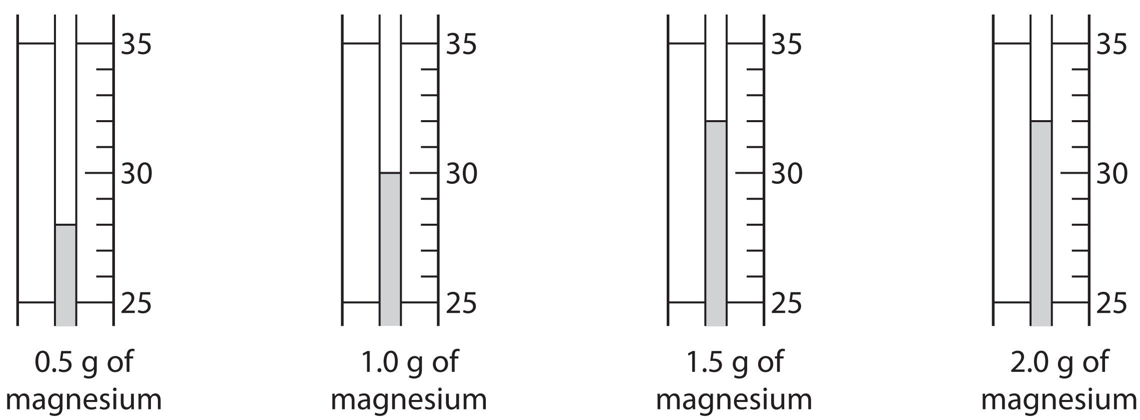
(Total for Question 3 = 4 marks)

4 A student measured the temperature change when 0.5 g of magnesium powder was added to 50 cm^3 of copper(II) sulfate solution.

She repeated the experiment using 1.0 g, 1.5 g and 2.0 g of magnesium powder.



The diagrams of the thermometer show the highest temperature, in °C, reached in each of the experiments.



(a) Use the thermometer readings to complete the table of results.

(2)

Mass of magnesium in g	**Initial temperature in °C**	**Highest temperature in °C**	**Temperature rise in °C**
0.5	25		
1.0	24		
1.5	23		
2.0	23		

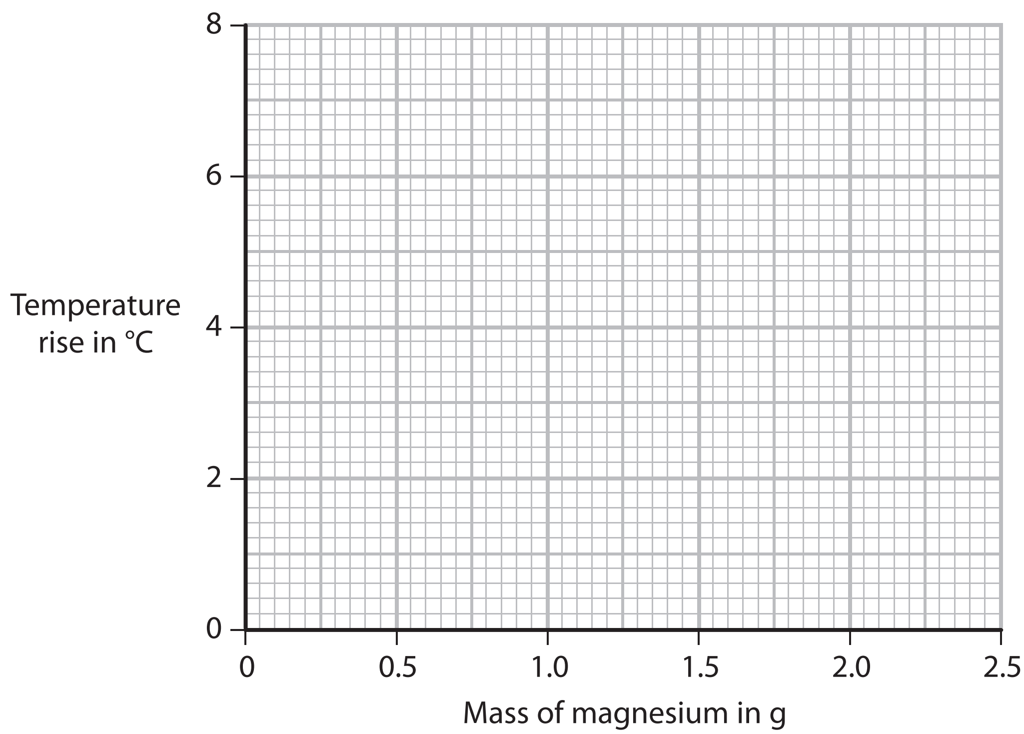
(b) A second student carried out the experiment. The table shows his results.

Mass of magnesium in g	**Temperature rise in °C**
0.5	2
1.0	4
1.5	6
2.0	6
2.5	6

(i) Plot the points on the grid.

Draw a straight line through the first three points and another straight line through the last two points. Make sure that the two lines cross.

(3)



(ii) Use your graph to find the mass of magnesium required to produce a temperature rise of 3 °C.

(1)

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(c) Suggest why the last three temperature rises were the same.

(1)

....

(d) State and explain the effect on the temperature rises if the student were to repeat the experiment using the same masses of zinc powder instead of magnesium powder.

Do not refer to the difference in reactivity of the two metals.

[relative atomic masses: Mg = 24; Zn = 65]

(2)

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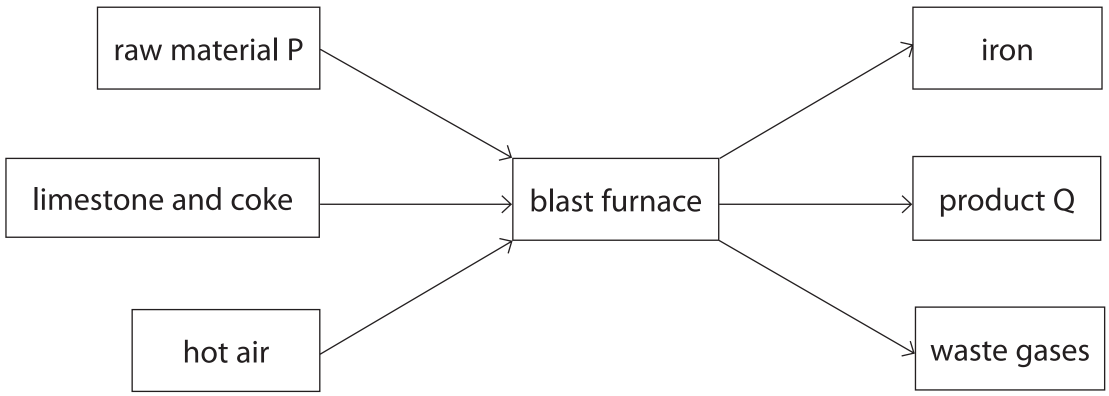
(Total for Question 4 = 9 marks)

5 The diagram shows how iron is produced in a blast furnace.



(a) Give the name of raw material P and of product Q.

(2)

raw material P ....

product Q ....

(b) The equations for some reactions in a blast furnace are

A $C + O_2 \rightarrow CO_2$

B $C + CO_2 \rightarrow 2CO$

C $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$

D $CaCO_3 \rightarrow CaO + CO_2$

E $CaO + SiO_2 \rightarrow CaSiO_3$

The table shows some types of reaction that occur in a blast furnace.

Complete the table by writing a letter, A, B, C, D, or E, to link each type of reaction to an appropriate reaction equation.

Each letter may be used once, more than once or not at all.

The first one has been done for you.

(3)

Type of reaction	Letter
one that gives out heat	A
one that is a thermal decomposition	
one that is a neutralisation	
one that forms a poisonous gas	

(c) The rusting of iron objects is a major problem.

Name the two substances needed for iron to rust.

(2)

1 ....

2 ....

(d) The order of reactivity of three metals is

most reactive
zinc
iron
tin
least reactive

Iron objects can be prevented from rusting by coating them with zinc or tin.

Some of these objects may be scratched when used, so the coating may come off.

Use the order of reactivity of the metals to suggest why coating these objects with zinc is more effective than coating them with tin.

(3)

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(Total for Question 5 = 10 marks)

6 **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)

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(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)

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(Total for Question 6 = 12 marks)

7 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)

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(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 ....

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(Total for Question 7 = 8 marks)