7.3 Preparation of salts

01. 0620_m15_qp_62 Q: 4

A student investigated the solubility of salt **D** in water at various temperatures.

Four experiments were carried out.

(a) *Experiment 1*

4 g of salt **D** was added to a boiling tube. A burette was filled with distilled water and 10.0 cm^3 of water added to the boiling tube. The mixture of salt **D** and water was heated carefully until all of the solid had dissolved. The boiling tube was removed from the heat and the solution allowed to cool. The solution was stirred gently with a thermometer.

The temperature at which crystals first appeared was noted.

The boiling tube and its contents were kept for the remaining three experiments.

(b) *Experiment 2*

From the burette another 2.0 cm^3 of water was added to the boiling tube and contents from Experiment 1.

The mixture was heated to dissolve the crystals and allowed to cool as in Experiment 1. The temperature at which crystals first appeared was noted.
Record, in the table, the total volume of water in the boiling tube.

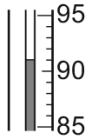
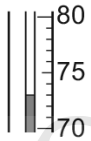
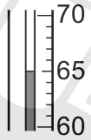
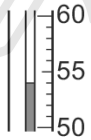
(c) *Experiment 3*

From the burette another 2.0 cm^3 of water was added to the boiling tube and contents from Experiment 2. The experiment was repeated exactly as before.
Record, in the table, the total volume of water in the boiling tube.

(d) *Experiment 4*

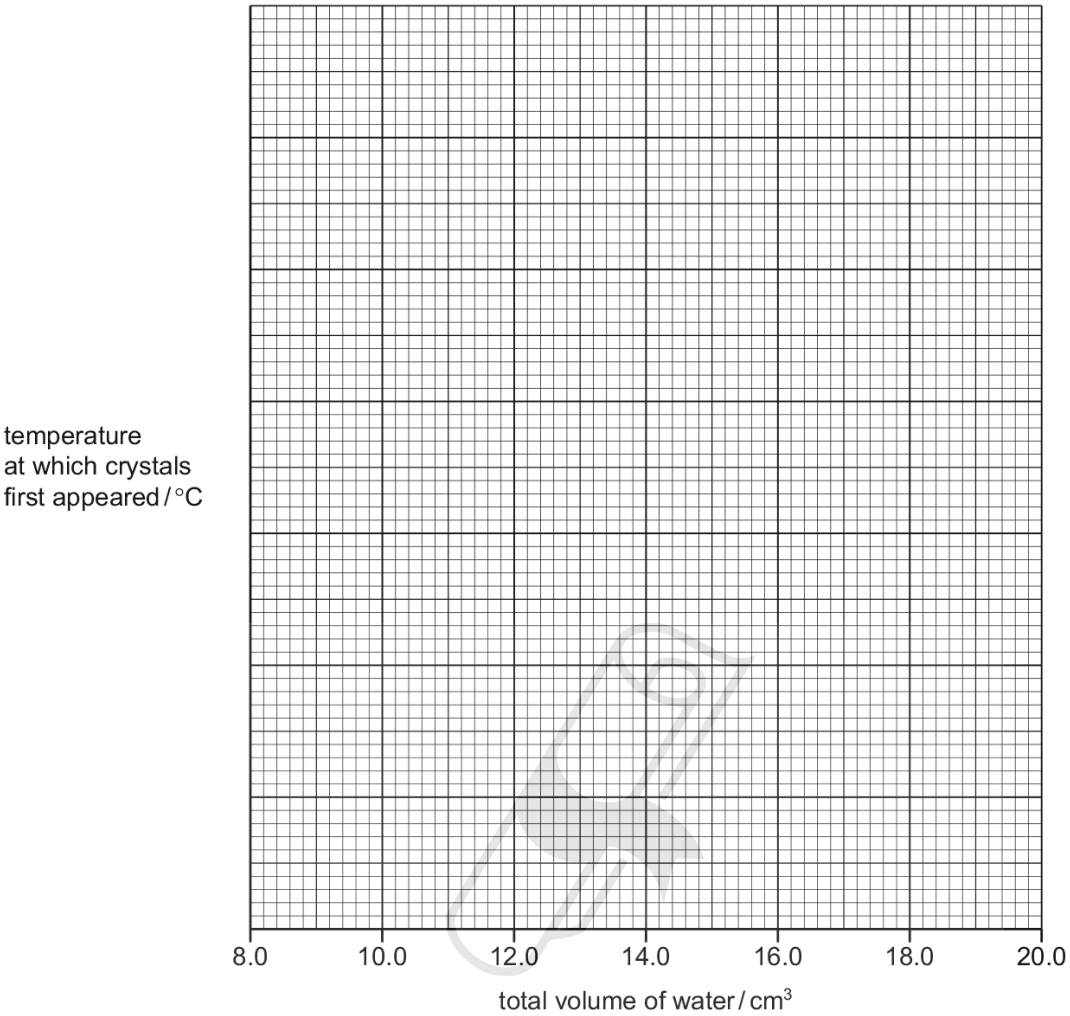
From the burette another 4.0 cm^3 of water was added to the boiling tube and contents from Experiment 3. The experiment was repeated exactly as before.
Record in the table the total volume of water in the boiling tube.

Use the thermometer diagrams in the table to record the temperatures at which crystals first appeared in the four experiments.

Experiment number	total volume of water / cm^3	thermometer diagram	temperature at which crystals first appeared / °C
1	10.0		
2			
3			
4			

[3]

(e) Plot the results on the grid below and draw a smooth line graph.



[5]

(f) **From your graph**, find the temperature at which crystals of **D** would first appear if the total volume of water in the solution was 20.0 cm^3.
Show clearly **on the grid** how you worked out your answer.

..... [3]

(g) How would the student know when salt **D** was completely dissolved in the water?

..... [1]

(h) The solubility of salt **D** at 100 °C is 57 g in 100 cm^3 of water.
Suggest, with a reason, the effect of using 8 g of salt **D** instead of 4 g in these experiments.

.....

..... [2]

(i) Salt **C** is less soluble in water than salt **D**.

Sketch on the grid the graph you would expect for salt **C**. Label this graph. [2]

(j) Describe and explain **one** improvement that could be made to the experimental method to obtain more reliable results in this investigation.

improvement .....

explanation .....

.....

..... [2]

[Total: 18]

02. 0620_s12_qp_61 Q: 4

A student investigated the reaction between aqueous lead nitrate and aqueous potassium chloride.

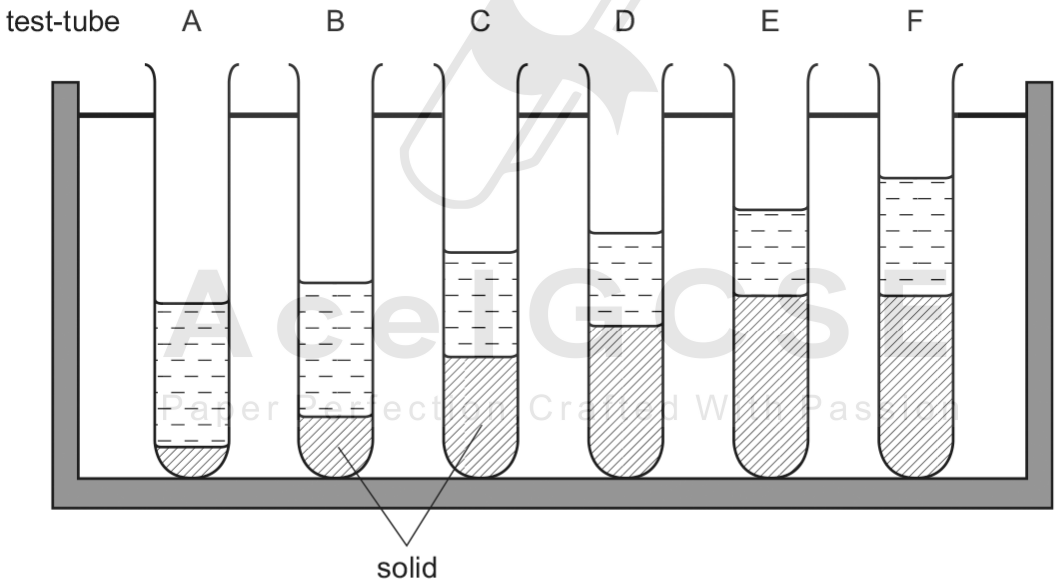
(a) One experiment was carried out.

Using a measuring cylinder, 3 cm^3 of aqueous lead nitrate was poured into each of six test-tubes in a test-tube rack. The test-tubes were labelled A, B, C, D, E and F respectively.

A burette was filled with aqueous potassium chloride. A 1.0 cm^3 sample of the aqueous potassium chloride was added to test-tube A.
A 2.0 cm^3 sample of aqueous potassium chloride was added to test-tube B.
A 4.0 cm^3, 5.0 cm^3, 6.0 cm^3 and 7.0 cm^3 sample of aqueous potassium chloride was added to test-tubes C, D, E and F respectively.

Using a glass rod, the contents of the test-tubes were stirred. The contents of the test-tubes were left to stand for 10 minutes.

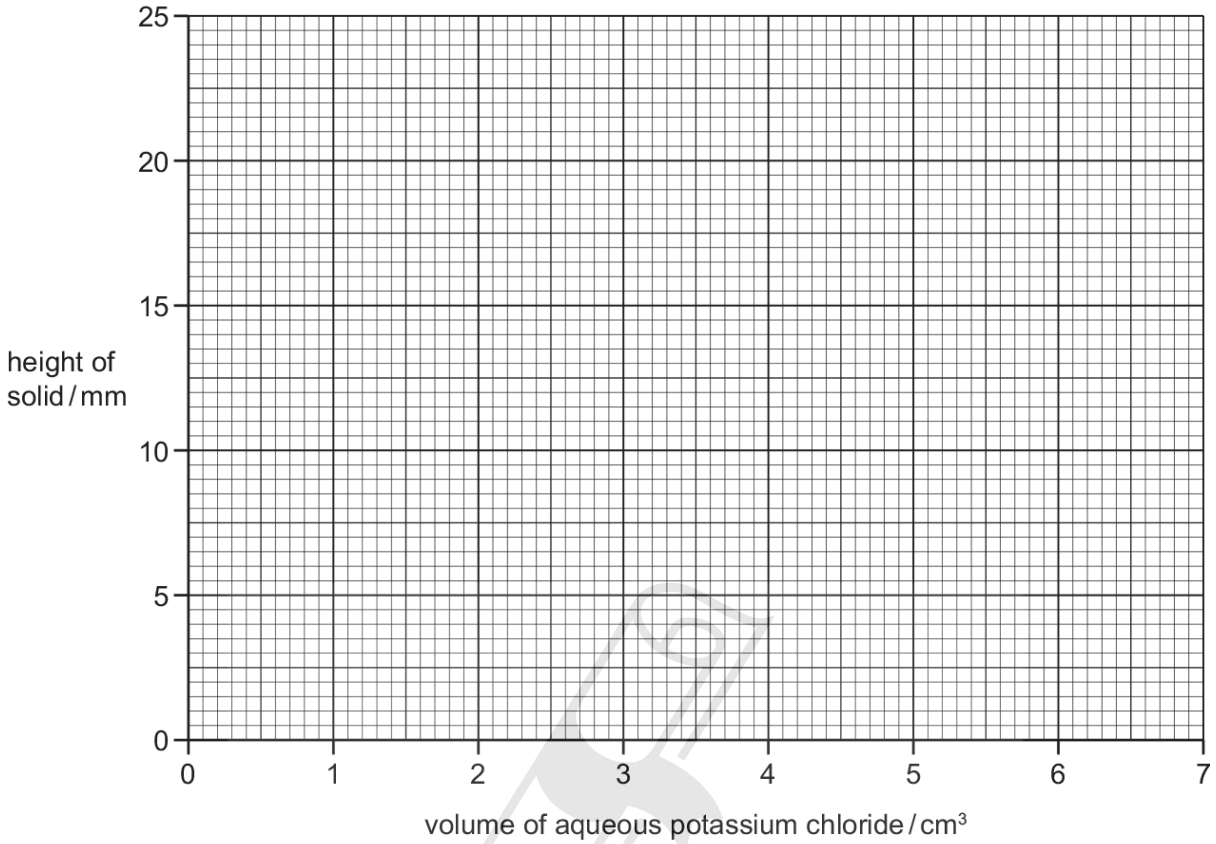
After 10 minutes, a ruler was used to measure the height of the solid in each test-tube. The diagrams show the six test-tubes in a rack. Use a ruler to measure the height of the solid in each test-tube in the diagram. Record the heights of the solid in the table.



test-tube number	volume of aqueous potassium chloride / cm^3	height of solid / mm
A		
B		
C		
D		
E		
F		

[4]

(b) Plot your results on the grid below. Draw two intersecting straight line graphs.



[4]

(c) **From your graph**, find the height of the solid formed when 3.5 cm^3 of aqueous potassium chloride was added to 3 cm^3 of aqueous lead nitrate.
Show clearly **on the graph** how you obtained your answer.

..... [3]

(d) What type of chemical reaction occurs when aqueous potassium chloride reacts with aqueous lead nitrate?

..... [1]

(e) **(i)** Compare the heights of the solids in test-tubes E and F.

..... [1]

(ii) Suggest an explanation for the heights of the solids in **(e)(i)**.

.....

..... [1]

(f) Predict what would happen if the experiment were continued using three further test-tubes with 8 cm^3, 9 cm^3 and 10 cm^3 of aqueous potassium chloride. Explain your answer.

.....

.....

..... [2]

(g) What difference would be observed if the experiment was repeated using aqueous silver nitrate and aqueous potassium iodide?

.....

..... [1]

(h) Explain **one** improvement the student could make to the experiment to obtain more accurate results.

improvement .....

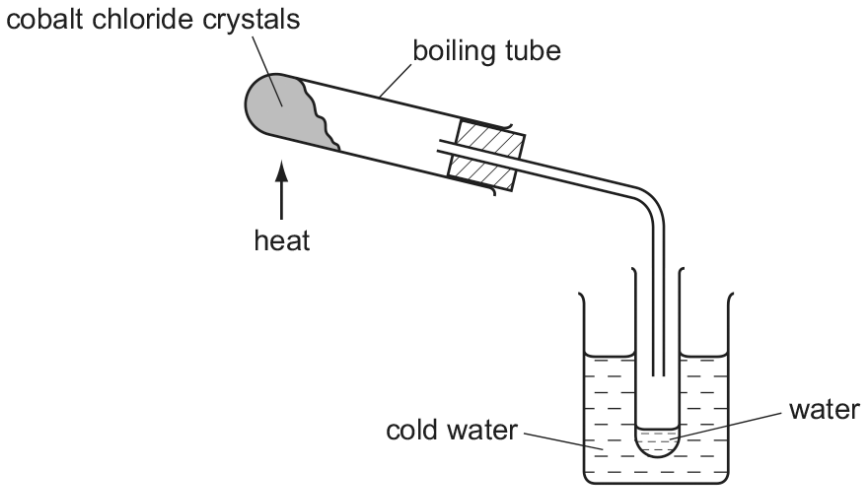
explanation .....

..... [2]

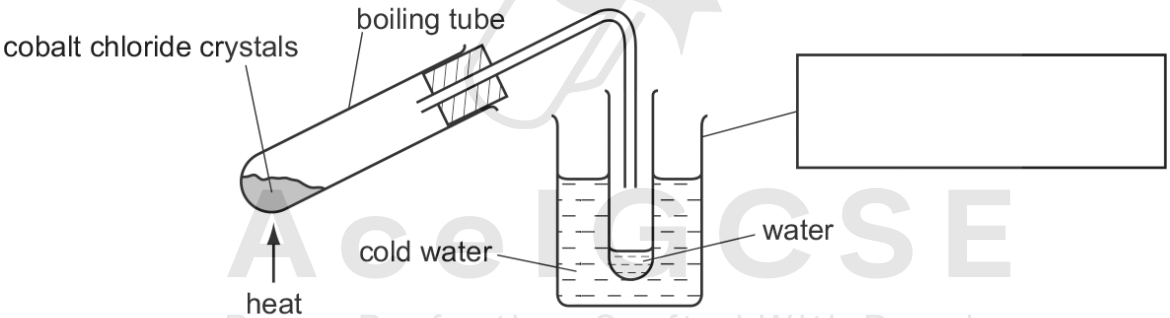
[Total: 19]

03. 0620_s12_qp_62 Q: 1

A student heated red crystals of hydrated cobalt(II) chloride, $CoCl_2.6H_2O$, to obtain a sample of water. He used two different sets of apparatus, **A** and **B**.



A



B

(a) Complete the box to identify the piece of apparatus labelled. [1]

(b) The steam could have been condensed more efficiently using a condenser.
Draw a labelled diagram of a condenser.

[2]

(c) The colour of the solid remaining in the boiling tube after heating was blue.
Predict the effect of adding water to this solid. Explain your answer.

effect .....

explanation ..... [2]

(d) Suggest why the boiling tube cracked using set of apparatus **B** but not set **A**.

.....

..... [2]

[Total: 7]

04. 0620_s12_qp_63 Q: 4

A student prepared some crystals of sodium nitrate. The following extract was taken from her notes.

Preparing sodium nitrate crystals
Into a conical flask was placed 25.0 cm^3 of aqueous sodium hydroxide and 5 drops of indicator. Dilute nitric acid was added to the flask until the indicator changed colour. The volume of nitric acid used was 29.0 cm^3. Crystals of sodium nitrate were obtained from the mixture in the flask.

(a) What piece of apparatus should be used to measure the aqueous sodium hydroxide?

..... [1]

(b) **(i)** Name a suitable indicator that could be used.

..... [1]

(ii) This indicator would change colour from ..... to ..... . [1]

(c) Which solution was less concentrated? Explain your answer.

Solution of .....

Explanation .....

..... [2]

(d) How could the student obtain pure crystals of sodium nitrate using this method?

.....

.....

.....

..... [3]

[Total: 8]

05. 0620_s14_qp_61 Q: 2

The following paragraph was taken from a student's notebook.

> *Preparation of lead chloride*
>
> *10 cm³ of aqueous lead nitrate was placed in a beaker and 10 cm³ of aqueous potassium chloride added. Lead chloride, a white solid, was formed. The solid was separated from the mixture.*
> *Water was then added to the solid and the mixture boiled. A clear liquid was formed. On cooling, white crystals were deposited.*

(a) What type of chemical reaction resulted in the formation of the lead chloride?

..... [1]

(b) What is the solubility of lead chloride in

(i) cold water, ...

(ii) hot water? ..... [2]

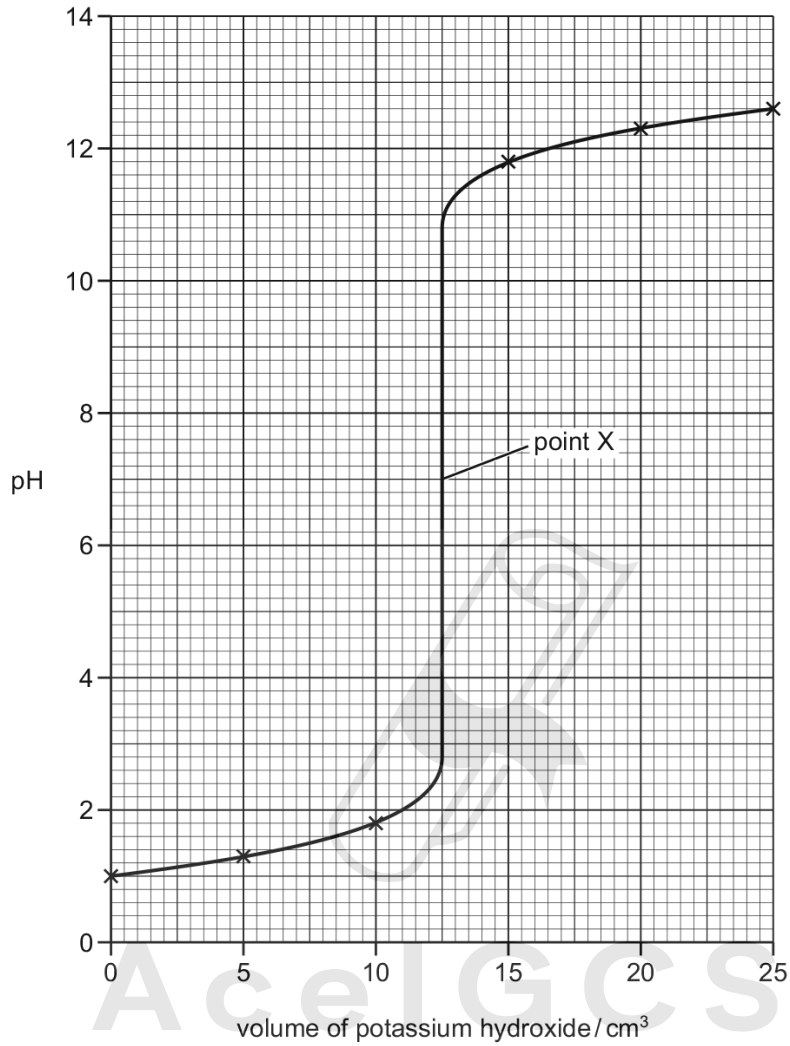
(c) What method should be used to separate the crystals from the mixture?

..... [1]

[Total: 4]

06. 0620_s14_qp_62 Q: 2

The graph shows the change in the pH when aqueous potassium hydroxide is added to 25.0 cm^3 of dilute nitric acid to form a solution of potassium nitrate. A pH meter was used.



(a) Name a suitable piece of apparatus to measure 25.0 cm^3 of dilute nitric acid.

..... [1]

(b) What could be used instead of a pH meter in this experiment?

..... [1]

(c) Describe how the pH of the mixture changes as the potassium hydroxide is added.

.....

.....

..... [2]

(d) (i) What has happened at point X?

..... [1]

(ii) What volume of aqueous potassium hydroxide had been added to the mixture at point X?

..... [2]

(iii) What conclusion can you draw about the concentrations of the dilute nitric acid and the aqueous potassium hydroxide? Explain your answer.

.....

.....

..... [3]

(e) Suggest the effect of heating the solution of potassium nitrate to boiling point and then heating for a further ten minutes.

.....

..... [2]

[Total: 12]

07. 0620_s15_qp_62 Q: 2

A student prepared some crystals of chromium(III) nitrate, $Cr(NO_3)_3.6H_2O$.
The following extract was taken from his practical notes.

> Making chromium(III) nitrate crystals
>
> Step 1 I poured 50 cm^3 of acid into a beaker. Solid chromium(III) oxide was then added a little at a time and the mixture stirred.
>
> Step 2 When no more chromium(III) oxide reacted I separated the mixture and collected the solution in an evaporating dish.
>
> Step 3 I boiled the solution strongly for ten minutes.

(a) Name the acid used in this preparation.

..... [1]

(b) What would be used in Step 1 to

(i) add the chromium(III) oxide to the acid,

..... [1]

(ii) stir the mixture?

..... [1]

(c) Name the separation method used in Step 2.

..... [1]

(d) (i) Suggest what was left in the evaporating dish at the end of Step 3.

..... [1]

(ii) How should the student have changed the method in Step 3 to obtain pure, dry crystals of chromium(III) nitrate?

.....

.....

.....

..... [3]

[Total: 8]

08. 0620_s16_qp_62 Q: 4

Potassium sulfate is the salt produced when sulfuric acid is neutralised by potassium hydroxide solution.
The correct amount of potassium hydroxide solution must be added to neutralise all of the sulfuric acid.
Plan an experiment to obtain pure crystals of potassium sulfate from sulfuric acid and potassium hydroxide solution.
You are provided with common laboratory apparatus.

.....

.....

.....

.....

.....

.....

.....

.....

..... [6]

[Total: 6]

09. 0620_s16_qp_63 Q: 4

Nickel sulfate-6-water, $NiSO_4.6H_2O$, is a blue crystalline salt.

Plan an experiment to obtain a sample of pure water from this salt. Your answer should include a diagram of the apparatus, any expected observations and a test to show the presence of pure water.
You are provided with common laboratory apparatus.

.....

.....

.....

.....

.....

.....

..... [6]

[Total: 6]

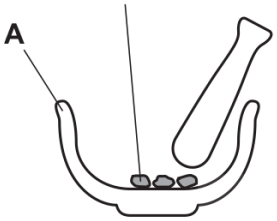
10. 0620_s20_qp_63 Q: 1

A sample of rock salt contains sodium chloride and sand.

Sodium chloride is soluble in water. Sand is insoluble in water.

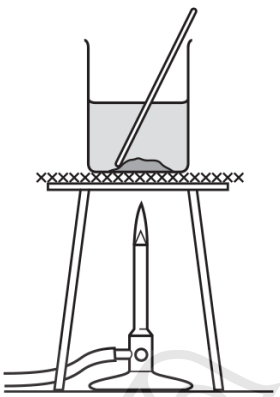
A student obtained dry crystals of pure sodium chloride from a lump of rock salt.
These are some of the steps the student used.

step 1



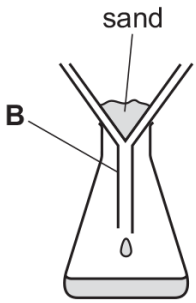
grind the rock salt into smaller pieces

step 2



add the rock salt to water and heat while stirring with a glass rod

step 3



filter the mixture

(a) Name the apparatus labelled **A** in **step 1**.

..... [1]

(b) Explain why the mixture is heated and stirred in **step 2**.

..... [1]

(c) (i) Name the apparatus labelled **B** in **step 3**.

..... [1]

(ii) State the scientific term for the sand left on the filter paper in **step 3**.

..... [1]

(d) Describe what the student must do after **step 3** to obtain dry crystals of pure sodium chloride.

.....

.....

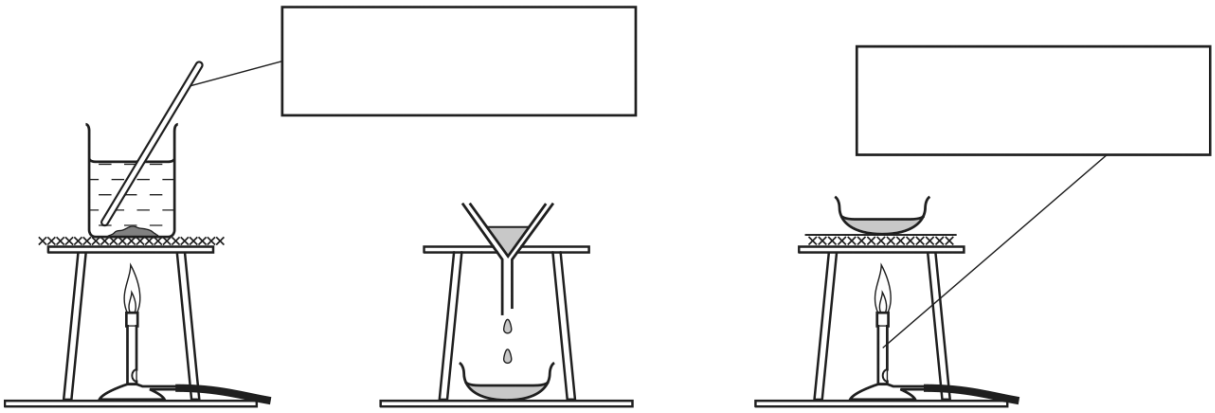
.....

..... [3]

[Total: 7]

11. 0620_w13_qp_63 Q: 1

A student tried to separate a mixture of salt and sand. Salt, sodium chloride, is soluble in water. Sand, silicon(IV) oxide, is insoluble in water. He added the mixture to water. Three sets of apparatus are shown.



A B C

(a) Complete the boxes to identify the pieces of apparatus. [2]

(b) Fill in the blanks in the following sentences.

Liquids that dissolve substances are called ..... .

The clear liquid formed is a ..... . [2]

(c) Which set of apparatus should be used to obtain

the sand, ...

salt crystals? ..... [2]

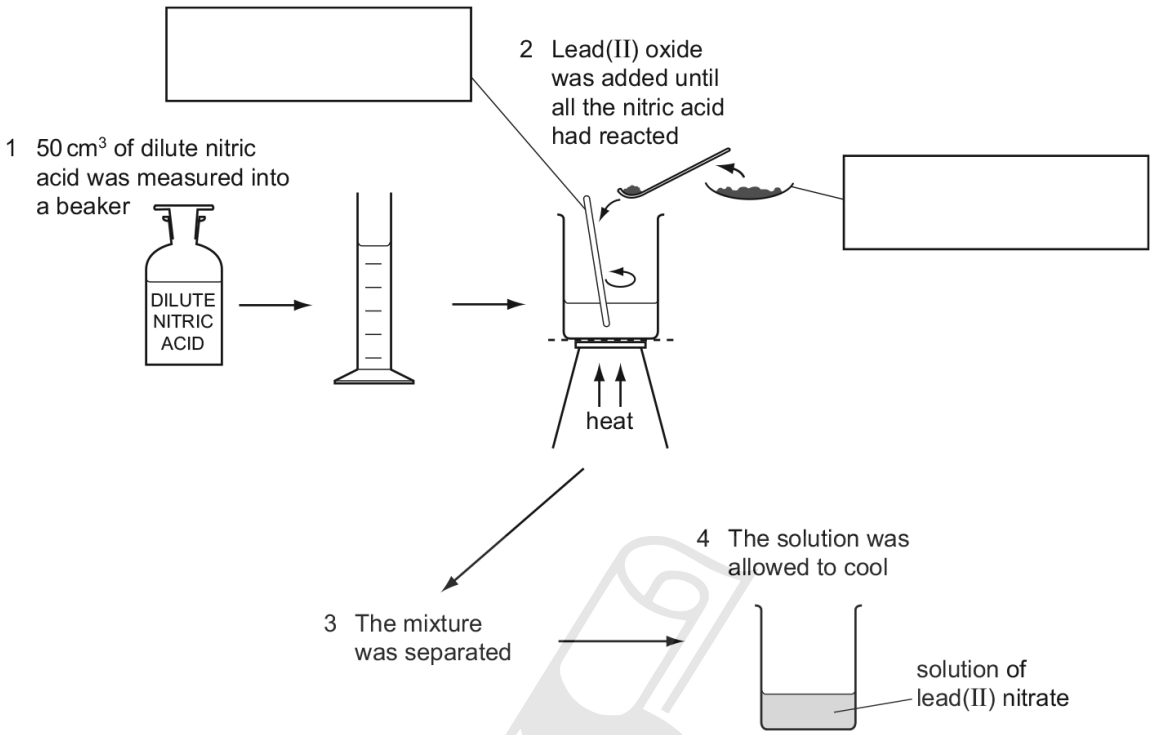
(d) What happened to the water used in the experiment?

..... [1]

[Total: 7]

12. 0620_w14_qp_61 Q: 1

A student reacted dilute nitric acid with lead(II) oxide to prepare lead(II) nitrate. The diagram shows the stages in the method used.



(a) Complete the boxes to identify the pieces of apparatus. [2]

(b) Why is the dilute nitric acid heated?

..... [1]

(c) The lead(II) oxide was weighed before and after the additions.

before after

Use the balance diagrams to work out the mass of lead(II) oxide added to the dilute nitric acid.

..... [2]

(d) (i) How would the student know when all of the dilute nitric acid had reacted in stage 2?

..... [1]

(ii) What method is used to separate the mixture in stage 3?

..... [1]

(iii) What term is used to describe the unreacted lead(II) oxide?

..... [1]

(e) Describe the effect of heating the solution of lead(II) nitrate until it boils and then heating for a further ten minutes.

.....

.....

..... [2]

[Total: 10]

13. 0620_w14_qp_62 Q: 3

A student prepared crystals of magnesium sulfate, $MgSO_4.7H_2O$, from magnesium carbonate. The procedure followed was in three steps.

Step 1 Some solid magnesium carbonate was transferred from a bottle into a beaker.

Step 2 A dilute acid was slowly added to the beaker until all the magnesium carbonate had reacted. Magnesium sulfate solution was produced.

Step 3 The solution was evaporated to crystallising point in an evaporating dish.

(a) What should be used to transfer the magnesium carbonate in Step 1?

..... [1]

(b) (i) Name the acid used in Step 2.

..... [1]

(ii) Why was the acid not heated in Step 2?

..... [1]

(c) (i) Which reactant was in excess?

..... [1]

(ii) Suggest why this reactant should not have been in excess.

.....

..... [1]

(d) (i) How would the student know when the crystallisation point had been reached in Step 3?

.....

..... [1]

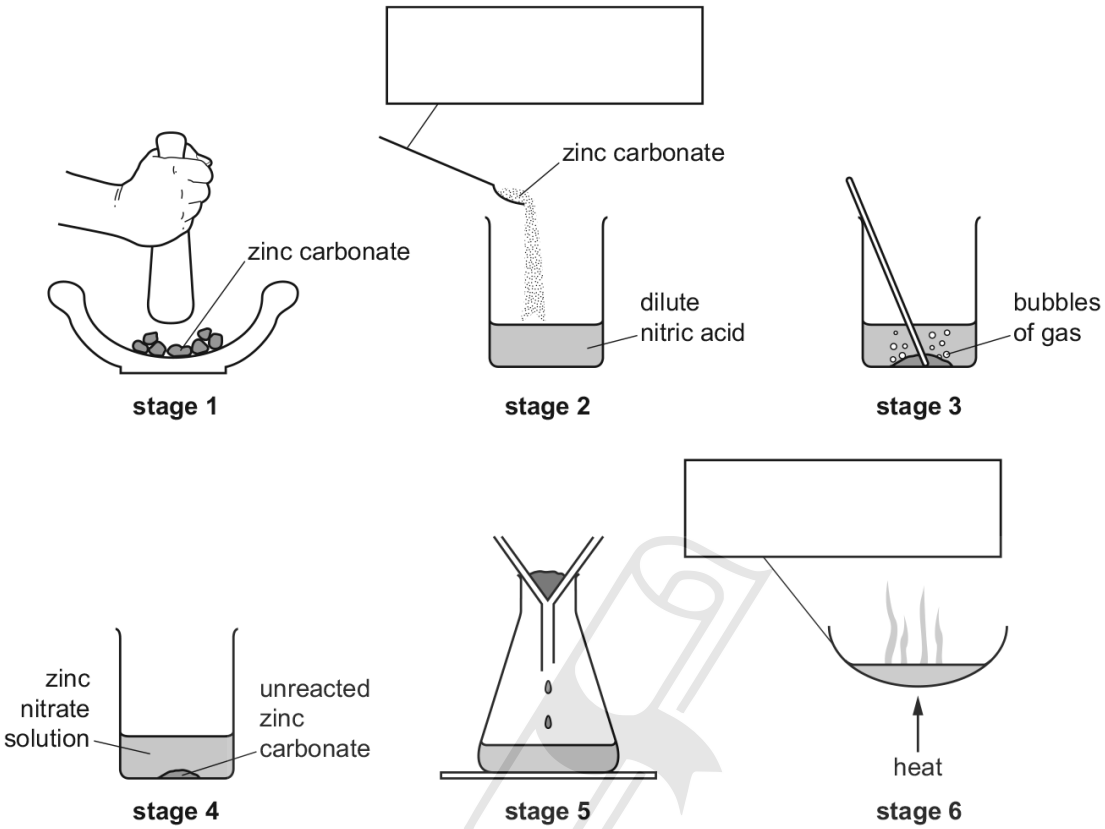
(ii) Suggest the effect of heating the magnesium sulfate crystals.

..... [1]

[Total: 7]

14. 0620_w15_qp_63 Q: 1

The diagrams show the stages in the preparation of zinc nitrate crystals from lumps of zinc carbonate.



(a) Complete the boxes to show the apparatus used. [2]

(b) Use the diagrams to write a list of instructions for the stages of this preparation.

(i) stages 1, 2, 3 and 4

.....

.....

..... [3]

(ii) stage 5

..... [1]

(iii) stage 6

.....

..... [2]

[Total: 8]

15. 0620_w17_qp_63 Q: 4

Washing soda crystals are crystals of hydrated sodium carbonate, $Na_2CO_3.10H_2O$. When exposed to the air, some of the water is lost from the crystals and a new substance is formed. This process occurs faster in hotter climates.

Plan an experiment to determine the percentage of water by mass present in the new substance.

You are provided with common laboratory apparatus.

.....

.....

.....

.....

.....

.....

.....

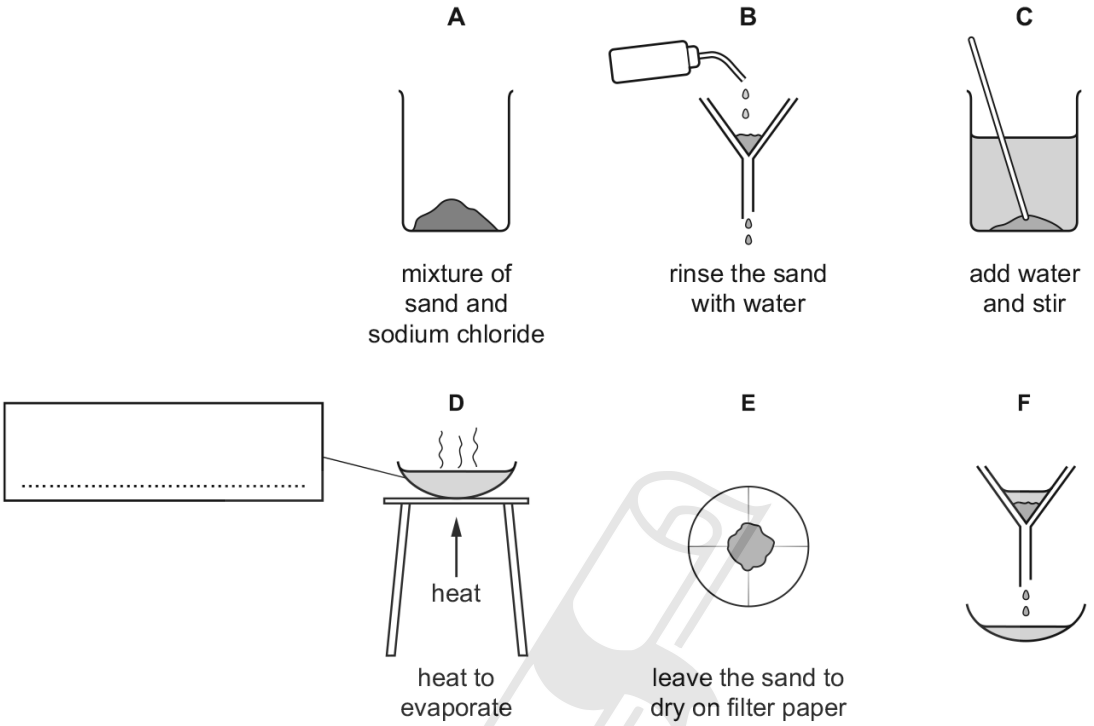
.....

..... [6]

[Total: 6]

16. 0620_w18_qp_61 Q: 1

A student obtains pure, dry samples of sand and sodium chloride from a mixture of sand and sodium chloride.
The student uses the apparatus shown. The method consists of six steps, **A**, **B**, **C**, **D**, **E** and **F**, which are shown in the wrong order.



(a) Order the steps in the method.

A → ..... → ..... → ..... → ..... → .....

[2]

(b) Complete the box to name the apparatus in **D**. [1]

(c) Why is the sand rinsed with water in **B**?

.....

..... [1]

(d) Name the process in **F**.

..... [1]

(e) How could the purity of the sodium chloride obtained be checked?

..... [1]

[Total: 6]

01. 0620_m15_ms_62 Q: 4

(d) Table of results

total volume of water boxes completed correctly (1),

10, 12, 14, 18

temperature boxes completed (2)
all 4 correct (2)
3 correct (1)
2 or fewer correct (0)

91, 73, 65, 54 [3]

(e) appropriate scale for y axis (1)
note: must use at least 4 large squares vertically to plot points

all points correctly plotted (3),
all 4 correct (3)
3 correct (2)
2 correct (1)
1 or fewer correct (0)
note: origin should not be included

smooth line graph (1) [5]

(f) value from graph for 20 cm^3 water, 50–53 (1) ± half a small square

shown clearly by extrapolation (1)

unit, °C (1) [3]

(g) clear / colourless liquid forms / no solid / crystals / salt visible (1) [1]

(h) salt would not all dissolve (1)

use of figures (1) [2]
e.g. only 5.7 g would dissolve in 10 cm^3 water at 100 °C

(i) sketch graph always above line (1)

label (1) [2]

(j) any **one** improvement from: (1)

do not remove thermometer from solution
use IT method / second person to note formation of crystals
repeat
do separate experiments
use smaller volumes of water
evaporation

linked explanation (1)

loss of solid on thermometer
observing formation of first crystals may vary
average
more results to plot on graph
method of avoiding evaporation e.g. separate experiments, lid [2]

0620_s12_ms_6Q: 4

(a) Table of results **ignore**: units in table
volume of aqueous potassium chloride boxes completed correctly (1) 1, 2, 4. 5, 6, 7
heights of solid boxes completed ±1mm (2) 4, 8, 16, 20, 24, 24
in mm (1) [4]

(b) all points correctly plotted (2), –1 for any incorrect
straight line graphs (2) **note**: one for each line, doesn't have to go through origin [4]

(c) value from graph 14 (1) unit (1) shown clearly (1) [3]

(d) precipitation (1) **allow**: double decomposition ignore: exo/endothermic [1]

(e) **(i)** same (1) no ecf **not**: almost the same
all lead nitrate reacted/reaction finished/lead nitrate is limiting factor (1) [2]

(ii) same heights/owtte (1)
lead nitrate is limiting factor/same amount of lead nitrate/excess potassium chloride (1) [2]

(g) yellow (precipitate) (1) [1]

(h) improvement (1) e.g. use burette/pipette/leave solid to settle longer/repeat
explanation (1) e.g. instead of a measuring cylinder/heights more accurate/take average [2]

[Total: 19]

03. 0620_s12_ms_62 Q: 1

(a) beaker (1) [1]

(b) any through tube with (only) two open ends (1)
outer tube with 'water' labelled and a way in and out (1) [2]

(c) turns red/pink (1)
reversible/rehydration/owtte/$CoCl_2$ going pink is the test for water (1) [2]

(d) water condensed at top of tube (1)
runs back onto hot tube/water onto $CoCl_2$ generates heat/owtte (1) **not**: suck back [2]

[Total: 7]

---

04. 0620_s12_ms_63 Q: 4

(a) pipette/burette (1) [1]

(b) **(i)** methyl orange/phenolphthalein/litmus (1) **not**: Universal Indicator

(ii) yellow/pink to orange or pink/colourless (1) [2]

(c) nitric acid (1) more volume added than sodium hydroxide (1) [2]

(d) repeat experiment (1) without indicator (1)
evaporate solution (1) [3]

[Total: 8]

---

05. 0620_s14_ms_61 Q: 2

(a) precipitation / double decomposition (1) [1]
allow: ppt

(b) **(i)** low / insoluble / does not dissolve (1) [1]

(ii) high / soluble / dissolves (1) [1]

(c) filtration (1) [1]

---

06. 0620_s14_ms_62 Q: 2

(a) pipette / burette (1) [1]
ignore: measuring cylinder

(b) Universal / pH indicator / pH paper / full range (1) [1]
ignore: indicator
not: other named indicator

(c) pH value rises / increases / becomes more alkaline (1)

steep change in middle (1) [2]
allow: suddenly / drastically / quoted figures

(d) **(i)** end / neutralisation / equivalence point / becomes neutral (1) [1]
allow: reaction finished / changes from acid to alkali / basic

(ii) 12.5 (1)

cm^3 (1) [2]

(iii) potassium hydroxide solution is 2 × (1)

more concentrated / stronger (1) ORA

half volume of potassium hydroxide used / twice volume of nitric acid used (1) [3]

(e) evaporation / steam (1)

solid / crystals formed (1) [2]
allow: decomposes or named products

---

07. 0620_s15_ms_62 Q: 2

(a)	nitric acid / HNO_3;	1	
(b)(i)	spatula;	1	
(b)(ii)	(stirring / glass) rod;	1	**A** magnetic stirrer
(c)	filtration / decanting;	1	**A** description of decanting
(d)(i)	anhydrous chromium nitrate / $Cr(NO_3)_3$ / chromium oxide / Cr_2O_3 / hydrated chromium nitrate / $Cr(NO_3)_3.6H_2O$ / solid chromium nitrate;	1	**A** solid / powder / crystals
(d)(ii)	heat / evaporate / boil; to crystallising point owtte; award one mark for any two ideas: cool / filter / decant / wash / dry;	3	**A** description

08. 0620_s16_ms_62 Q: 4

	making the salt any 4 from: • known volume sulfuric acid; • add named indicator; • add potassium hydroxide solution to the acid until the indicator changes colour / is neutralised; • note / measure the volume of potassium hydroxide solution added; • repeat without indicator **OR** add (decolourising) charcoal; **obtaining crystals** any 2 from: • heat / evaporate solution to crystallising point until half evaporated **OR** until crystals (start to) form **OR** until saturated; • leave to cool; • filter to get crystals; • dry crystals (on filter paper) / leave to dry;	**6**

09. 0620_s16_ms_63 Q: 4

	method heat the salt; condenser shown on diagram; drops of water / condensation; colour change / blue solid becomes paler; **test pure water** boiling point; 100 °C;	**6**

10. 0620_s20_ms_63 Q: 1

Question	Answer	Marks
(a)	mortar	**1**
(b)	(to) speed up (the dissolving)	**1**
(c)(i)	funnel	**1**
(c)(ii)	residue	**1**
(d)	**p**lace in an evaporating basin and heat	**1**
	to the point of crystallisation	**1**
	cool **and** filter **and** dry crystals with filter / absorbent paper	**1**

11. 0620_w13_ms_63 Q: 1

(a) stirring / glass rod / stirrer (1)
Bunsen and / or burner (1) [2]

(b) solvents (1)
solution (1) [2]

(c) B (1)
allow: filter
C (1) [2]
allow: evaporating dish / basin

(d) evaporated / lost into air owtte / turned into steam / turned into water vapour (1) [1]

---

12. 0620_w14_ms_61 Q: 1

(a) boxes completed to show stirrer / glass rod (1)
watchglass / evaporating dish (1) [2]

(b) to speed up the reaction (1) [1]

(c) correct answer 4.2 g (2)
if incorrect, evidence of 17.8 – 13.6 (1) [2]

(d) **(i)** solid / lead oxide visible / remaining (1) [1]
do not allow: mention of precipitate

(ii) filtration (1) [1]

(iii) excess (1) [1]
allow: residue

(e) Any **two** from:
evaporation / steam (1)
solid / crystals formed (1)
breakdown / decomposition of solid (1) [2]

---

13. 0620_w14_ms_62 Q: 3

(a) spatula (1) [1]
do not allow: spoon

(b) (i) sulfuric (1) [1]

(ii) reacts quickly at room temperature (1) [1]
allow: heat not needed / reacts anyway

(c) (i) sulfuric acid / the acid (1) [1]

(ii) solution will be acidic / not neutral / impure salt (1) [1]

(d) (i) crystals appear / description of using glass rod (1) [1]
not: precipitate / evaporate to dryness

(ii) lose water / dehydrate (1) [1]
allow: reference to anhydrous
ignore: break down of crystals / powder forms

---

14. 0620_w15_ms_63 Q: 1

(a)	spatula; evaporating dish / basin;	1 1	**A:** spoon **R:** watch glass / clock glass / crucible / petri dish
(b)(i)	crush / powder / grind / pound zinc carbonate; add to acid **and** stir / mix; (until) no more bubbles / excess carbonate / solid remains;	1 1 1	**I:** reaction is over
(b)(ii)	filter / filtration etc.;	1	**R:** 'filter funnel' / 'filter paper' only
(b)(iii)	2 from: • evaporate; • until crystallisation point / crystals (start to) form / saturated; • leave to cool;	1	**I:** heat or evaporating basin (in diagram) **R:** 'to dryness'

15. 0620_w17_ms_63 Q: 4

	heating to dryness method max [6]: **M1** weigh (any) sample of washing soda **M2** heat (to remove water of crystallisation) **M3** in named container **M4** cool **M5** reweigh **M6** repeat heating **M7** to constant mass **M8** appropriate calculation suggested for the percentage of water *mass of water method* max [6]: **M1** weigh (any) sample of washing soda **M2** heat to remove water of crystallisation **M3** in named container **M4** using apparatus capable of collecting water (vapour) **M5** cool / condense (water vapour) **M6** continue until no more collects **M7** weigh water **M8** appropriate calculation suggested for the percentage of water	**6**

16. 0620_w18_ms_61 Q: 1

(a)	**M1** (A),C,F		**1**
	M2 B,D,E **OR** B,E,D **OR** D,B,E		**1**
(b)	Evaporating / crystallising	basin / dish	**1**
(c)	To wash-out / dissolve / remove	sodium chloride / salt	**1**
(d)	Filtration		**1**
(e)	Melting point		**1**