O Level Pure Chemistry Structured

Salts Test 1.0

Q1

The table below shows the concentration of different ions found in a sample of aqueous industrial waste.

ion	concentration (mol/dm^3)
Ca^{2+}	0.125
H^+	2.300
K^+	0.234
NO_3^-	3.680
Cu^{2+}	0.450

Use the information in the table to answer the following questions.

(a) Write the chemical formula of a coloured salt that could be obtained from the sample.

.....[1]

(b) A student wants to obtain the salt in **(a)** using the following method.

metal + dilute nitric acid $\longrightarrow$ salt in **(a)** + hydrogen

Why is this method **not** feasible?

..... [1]

(c) Suggest a modification to the method in **(b)** to obtain a pure and dry sample of the salt in **(a)**.

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..... [3]

(d) Is the sample of aqueous industrial waste acidic, neutral or alkaline? Explain your answer.

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..... [1]

(e) What would be **observed** when aqueous sodium hydroxide is added to a sample of the aqueous industrial waste until no further change is seen?

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..... [2]

[Total: 8]

Q2

Cadmium is in the same group of the Periodic Table as zinc. Cadmium carbonate is insoluble in water and reacts in the same way as zinc carbonate with dilute acids. Cadmium sulfate is soluble in water.

Describe how you would prepare a pure, dry sample of cadmium carbonate, starting from cadmium sulfate.

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[4]

Q3

PotashCorp is the world's largest producer of fertilisers, most of which are made from salts.

(a) The company reacts acids with other compounds to make the salts.

The table below shows the names of some salts used in fertilisers.

Salts can be prepared by either of the following methods:

(i) titration
(ii) reaction of acid with excess metal, base or metal carbonate
(iii) precipitation

Complete the table by filling in the missing information.

name of salt	**formula of salt**	**name of acid used to make salt**	**name of other compound used to make salt**	**method of preparation (i), (ii) or (iii)**
potassium nitrate				
calcium phosphate *(insoluble in water)*				
ammonium chloride				

[6]

(b) Using your answers in **(a)**, describe briefly how a pure dry sample of potassium nitrate can be obtained.

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..... [4]

(c) State one physical property of potassium nitrate.

Explain this property in terms of the structure and bonding of potassium nitrate.

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..... [2]

(d) Each bag of fertiliser has a label which gives the N : P : K ratio.

The N : P : K ratio shows the ratio by mass of nitrogen, phosphorus and potassium in the fertiliser, and is always quoted as whole numbers.

Determine the N : P : K ratio for each of the salts in the table below.

name of salt	N : P : K ratio
potassium nitrate	
calcium phosphate	
ammonium chloride	

[2]

Q4

A toilet detergent contains the acid salt - sodium dihydrogen phosphate, NaH_2PO_4. Sodium dihydrogen phosphate can be made by reacting sodium hydroxide solution with dilute phosphoric acid, H_3PO_4.

(a) Explain why sodium dihydrogen phosphate is both an 'acid' and a salt. [2]

(b) Suggest the chemical formula of another possible salt formed from sodium hydroxide solution and dilute phosphoric acid. [1]

Q5

A student carried out two experiments to investigate the volume of carbon dioxide gas produced when two different acids react with 1 mole of calcium carbonate.

The acids, hydrochloric acid and sulfuric acid, each 0.2 mol/dm^3, were added in excess in two separate reactions.

The results are as follows:

experiment	acid used	Volume of carbon dioxide produced / cm^3
1	hydrochloric acid	24 000
2	sulfuric acid	600

(a) Write a balanced equation to represent experiment 2.

.....[1]

(b) Explain the difference in the volume of carbon dioxide gas produced in the two reactions.

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.....[2]

(c) Calculate the mass of the salt produced in experiment 2.

[2]

(d) In experiment 2, since the carbon dioxide gas produced is low, the yield of the salt is low too. Describe an alternative method to obtain a higher yield of the salt using different starting reagents.

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..... [3]

(e) When a piece of sodium is added to the resultant mixture in experiment 1, a gas and a white precipitate are formed.

Write an ionic equation, with state symbols, for the formation of the white precipitate formed.

..... [2]

Answers

Salts Test 1.0

Q1

A2a	$Cu(NO_3)_2$	1
b	Copper does not react with dilute acids.	1
c	Add excess copper(II) oxide / copper(II) carbonate with dilute nitric acid and stir. Filter to remove the excess copper(II) oxide and collect copper(II) nitrate as the filtrate. Heat copper(II) nitrate solution until it is saturated. Cool the saturated solution. Wash the crystals with a little cold water and dry between sheets of filter paper.	1 1 1
d	Acidic. There are H^+ ions present.	1
e	A white precipitate is formed. The precipitate is insoluble in excess sodium hydroxide. OR A blue precipitate is formed. The precipitate is insoluble in excess sodium hydroxide.	1 1 1 1

Q2

1. Add aqueous cadmium sulfate to aqueous sodium carbonate (or any soluble carbonate).
2. Filter the mixture to obtain the precipitate (cadmium carbonate).
3. Wash the residue.
4. Dry the residue (using sheets of filter paper). [4]

Q3

(a)

name of salt	formula of salt	name of acid used to make salt	name of other compound used to make salt	method of preparation (i), (ii) or (iii)
potassium nitrate	KNO_3	nitric acid	potassium hydroxide / potassium carbonate	(i)
calcium phosphate	$Ca_3(PO_4)_2$	phosphoric acid	calcium hydroxide / nitrate / chloride	(iii)
ammonium chloride	NH_4Cl	hydrochloric acid	aqueous ammonia / ammonium carbonate	(i)

1 mark for any 2 correct answers (max. 6)

(b)

Titrate nitric acid (in burette) with potassium hydroxide / potassium carbonate (in pipette) using a suitable indicator (e.g. methyl orange). [1]

Repeat titration using the same volume of nitric acid obtained earlier but without adding the indicator. [1]

Heat the salt solution obtained to obtain a saturated solution (using evaporating dish). Leave the solution to cool for crystallisation to take place. [1]

Filter the solution, and collect the crystals from the filter paper onto a paper towel, and allow to dry. [1]

(c)

High m.p/b.p / hard [1]

due to giant ionic lattice structure with strong electrostatic forces of attraction between oppositely charged K^+ and NO_3^- ions that require a lot of energy to break/overcome [1]

OR

Good conductor of electricity in molten or aqueous state [1]

due to presence of mobile K^+ and NO_3^- ions that can move to conduct electricity when a potential difference is applied [1]

OR

Brittle [1]

ions of the same charge are brought close together and repel each other when a stress/force is applied to the ionic lattice [1]

OR

Soluble in water [1]

K^+ and NO_3^- ions are able to form strong ion-solvent interactions with water that releases sufficient energy to cause the detachment of ions from the giant ionic lattice

(d)

name of salt	N : P : K ratio
potassium nitrate	14 : 0 : 39
calcium phosphate	0 : 31 : 0 or 0 : 62 : 0
ammonium chloride	14 : 0 : 0

1 mark for 2 correct answers

2 marks for 3 correct answers

Q4

a		It is an acid as it can produce hydrogen ion, H^+, when dissolved in water [1] It is a salt as it is a compound formed from the reaction of an acid and a base [1].	2
b		Na_2HPO_4 or Na_3PO_4	1

Q5

a) $CaCO_3 + H_2SO_4 \rightarrow CaSO_4 + CO_2 + H_2O$

b)
Calcium chloride is a soluble salt while calcium sulfate is an insoluble salt;

Calcium sulfate forms a layer around calcium carbonate, thus reduces reaction between calcium carbonate and sulfuric acid;

c)
No. of moles of CO_2 = 0.6/24 = 0.025 mol;
No. of moles of $CaSO_4$ = 0.025 mol
Mass of $CaSO_4$ = 0.025 X 136 = 3.4g;

d)
Mix aqueous calcium nitrate and sulfuric acid/aqueous sodium sulfate together.
Filter the mixture to obtain the residue/precipitate $CaSO_4$
Wash the residue with distilled water and dry the residue between pieces of filter paper;

e) $Ca^{2+}(aq) + 2OH^-(aq) \rightarrow Ca(OH)_2(s)$ (balanced equation; state symbols;)