Rewarding Learning

eGUIDE//

Chemistry

Practical Manual

Sample Results and Observations

Practical C1

Determine the mass of water present in hydrated crystals

	Mass/g
Mass of evaporating basin	82.45
Mass of evaporating basin and contents before heating	83.98
Mass of evaporating basin and contents after heating for 2 minutes	83.50
Mass of evaporating basin and contents after heating for 4 minutes	83.39
Mass of evaporating basin and contents after heating for 6 minutes	83.29
Mass of evaporating basin and contents after heating for 8 minutes	83.29

Observations

Green solid change to white.

Answers to questions

1. Water of crystallisation is lost during heating as the mass decreases
2. (a) 83.98 - 82.45 = 1.53 g
   (b) 83.29 - 82.45 = 0.84 g
   (c) 83.98 - 83.29 = 0.69 g
   (d) 152
   (e) $\frac{0.84}{152} = 0.00553$
   (f) $\frac{0.69}{18} = 0.0383$
   (g) $\frac{0.0383}{0.00553} = 7$
3. (a) Some iron(II) sulfate decomposed
   (b) Not all water of crystallisation removed

Practical C2

Investigate the reactions of acids, including temperature changes that occur

Experiment 1

Reaction	Observations
Hydrochloric acid + magnesium	bubbles/fizzing grey solid/magnesium disappears solution remains colourless heat released
Hydrochloric acid + zinc	bubbles/fizzing solution remains colourless heat released slower reaction than for Mg and HCl
Hydrochloric acid + copper	No reaction
Testing the gas with a lit splint	Droplets of water on side of test-tube pop sound

Answers to questions

1. Hydrogen – a squeaky pop was produced when the gas burned
2. zinc + hydrochloric acid → zinc chloride + hydrogen
3. $Mg(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2(aq)$
4. $2H_2 + O_2 \rightarrow 2H_2O$
5. Copper

Practical C2

Investigate the reactions of acids, including temperature changes that occur

Experiment 2

Test	Observation
1	red pH 1 – 2
6	black copper oxide reacts with colourless acid blue solution forms
8	orange/yellow pH 4 – 5

Answers to questions

1. Some of the acid had been neutralised
2. $CuO + H_2SO_4 \rightarrow CuSO_4 + H_2O$

Experiment 3

Initial temperature of acid/°C	Initial temperature of sodium hydroxide solution/°C	Average initial temperature /°C	Highest temperature reached /°C	Temperature change /°C
20	20	20	27	7

Answers to questions

1. To keep heat in/insulate
2. To support cup
3. Temperature increased so exothermic
4. $H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$

Practical C2

Investigate the reactions of acids, including temperature changes that occur

Experiment 4

Observations

Bubbles of gas produced/fizzing/effervescence
Limewater changes from colourless to milky

Answers to questions

1. $CaCO_3 + 2HCl \rightarrow CaCl_2 + CO_2 + H_2O$
2. $CO_2(g) + Ca(OH)_2(aq) \rightarrow CaCO_3(s) + H_2O(l)$

Practical C3

Investigate the preparation of soluble salts

Experiment 1

Preparation of a soluble salt from an insoluble solid and acid

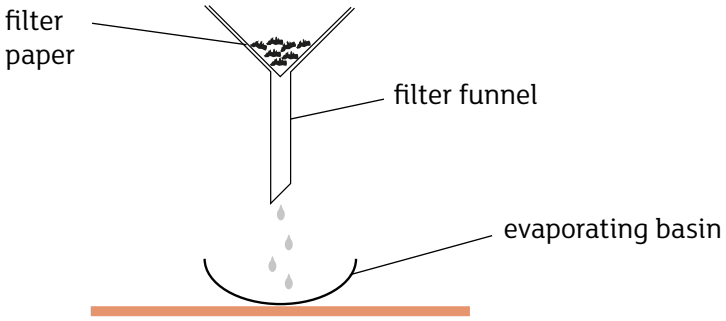
Appearance of copper(II) carbonate	Green solid/powder
Appearance of sulfuric acid	Colourless liquid/solution
Observations in step 2	Bubbles Blue solution produced
Appearance of the residue	Green solid
Appearance of the filtrate	Blue solution
Appearance of the crystals	blue

Practical C3

Investigate the preparation of soluble salts

Answers to questions

1. copper(II) carbonate + sulfuric acid → copper(II) sulfate + water + carbon dioxide
2. $CuCO_3 + H_2SO_4 \rightarrow CuSO_4 + H_2O + CO_2$
3.



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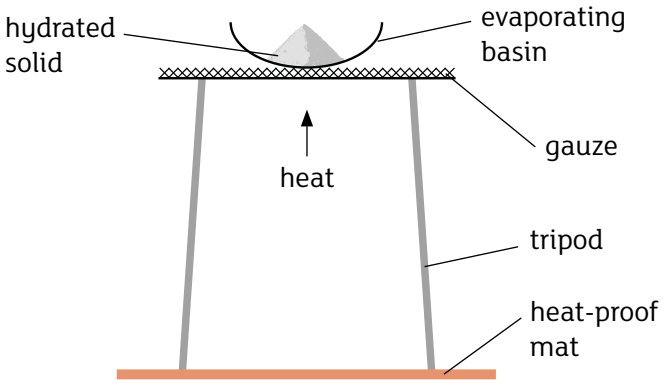

Practical C3

Investigate the preparation of soluble salts

Experiment 2

Preparation of a soluble salt from an alkali and an acid

Initial burette reading /cm^3	0.0
Final burette reading /cm^3	25.0
Volume of acid used /cm^3	25.0
Appearance of hydrochloric acid	colourless solution/liquid
Appearance of sodium hydroxide solution	colourless solution/liquid
Colour change of phenolphthalein at the end point	pink to colourless
Appearance of sodium chloride solution	colourless
Appearance of sodium chloride crystals	white

Alternative method

Appearance of charcoal	Black solid
Appearance of residue	Black solid
Appearance of filtrate	Colourless solution

Answers to questions

1. sodium hydroxide + hydrochloric acid → sodium chloride + water
2. $NaOH(aq) + HCl(aq) \rightarrow NaCl(aq) + H_2O(l)$

Practical C4

Identifying the ions in an ionic compound using chemical tests

Testing for Cations

1. Flame Tests

Compound	Flame colour	Cation present
Calcium chloride	(brick) red	Ca^{2+}
Copper(II) chloride	blue-green	Cu^{2+}
Lithium chloride	crimson	Li^{+}
Potassium chloride	lilac	K^{+}
Sodium chloride	orange/yellow	Na^{+}
X	lilac	K^{+}
Y	orange/yellow	Na^{+}

2. Precipitation tests

Metal ion solution	Metal cation present	Effect of adding NaOH(aq)	Effect of adding excess NaOH(aq)
Aluminium nitrate	Al^{3+}	White ppt	White ppt dissolves and a colourless solution is produced
Copper(II) sulfate	Cu^{2+}	Blue ppt	Blue ppt remains
Iron(II) sulfate	Fe^{2+}	Green ppt	Green ppt remains
Iron(III) nitrate	Fe^{3+}	Brown ppt	Brown ppt remains
Magnesium chloride	Mg^{2+}	White ppt	White ppt remains
Zinc nitrate	Zn^{2+}	White ppt	White ppt dissolves and a colourless solution is produced

Practical C4

Identifying the ions in an ionic compound using chemical tests

Metal ion solution	Metal cation present	Effect of adding $NH_3(aq)$	Effect of adding excess $NH_3(aq)$
Aluminium nitrate	Al^{3+}	White ppt	White ppt remains
Copper(II) sulfate	Cu^{2+}	Blue ppt	Blue ppt dissolves and a deep blue solution is produced
Iron(II) sulfate	Fe^{2+}	Green ppt	Green ppt remains
Iron(III) nitrate	Fe^{3+}	Brown ppt	Brown ppt remains
Magnesium chloride	Mg^{2+}	White ppt	White ppt remains
Zinc nitrate	Zn^{2+}	White ppt	White ppt dissolves and a colourless solution is produced

Answers to questions

1. Fe^{2+} Fe^{3+} Mg^{2+} Zn^{2+}
2. Al^{3+} Zn^{2+}
3. Cu^{2+} Zn^{2+}
4. No as it gives the same result with each – white ppt which dissolves on adding excess to form a colourless solution
5. Sodium hydroxide forms a white ppt which remains with $Mg^{2+}(aq)$ however it gives a different result, a white ppt which dissolves to form a colourless solution with Al^{3+} (aq)
   Ammonia has the same result with both – a white ppt which remains
6. $Fe^{2+}(aq) + 2OH^{-}(aq) \rightarrow Fe(OH)_2(s)$

Practical C4

Identifying the ions in an ionic compound using chemical tests

Anion tests

Test for sulfate

Appearance of sodium sulfate solid	white
Appearance of sodium sulfate solution	colourless
Observation on adding barium chloride solution to sodium sulfate solution	white ppt

Answers to questions

1. $Ba^{2+}(aq) + SO_4^{2-}(aq) \rightarrow BaSO_4(s)$

Test for halide ions

Solution	Observation when silver nitrate solution is added
Sodium chloride	white ppt
Potassium bromide	cream ppt
Potassium iodide	yellow ppt

Answers to questions

1. $Ag^+(aq) + Cl^-(aq) \rightarrow AgCl(s)$
   $Ag^+(aq) + Br^-(aq) \rightarrow AgBr(s)$
   $Ag^+(aq) + I^-(aq) \rightarrow AgI(s)$

Test for carbonate ions

Observations of sodium carbonate and acid	Bubbles/fizzing/effervescence White solid sodium carbonate disappears Heat released Solution remains colourless
Observations of limewater test	Limewater changes from colourless to milky

Answers to questions

1. carbon dioxide/CO_2
2. $Na_2CO_3 + 2HCl \rightarrow 2NaCl + CO_2 + H_2O$

Practical C5

Investigate the reactivity of metals

Results

Table 1

	Copper	Magnesium	Iron	Zinc
Copper(II) sulfate		✓	✓	✓
Magnesium sulfate	X		X	X
Iron(II) sulfate	X	✓		✓
Zinc sulfate	X	✓	X	

Table 2: Observations

	Copper	Magnesium	Iron	Zinc
Copper(II) sulfate		Blue solution changes to colourless. Red-brown solid forms. Heat released.	Blue solution fades. Some red-brown solid forms. Some heat released.	Blue solution fades. Some red-brown solid forms. Some heat released.
Magnesium sulfate	No reaction		No reaction	No reaction
Iron(II) sulfate	No reaction	Magnesium darkens as layer deposited on it. Heat released.		Green solution fades. Zinc darkens as layer deposited on it. Heat released.
Zinc sulfate	No reaction	Magnesium darkens as layer deposited on it. Heat released.		

Practical C5

Investigate the reactivity of metals

Answers

1. Magnesium zinc iron copper
2. Magnesium is more reactive than copper and pushes it out of solution
3. $Cu + MgSO_4 \rightarrow CuSO_4 + Mg$
4. $Cu + Mg^{2+} \rightarrow Cu^{2+} + Mg$
5. $Mg \rightarrow Mg^{2+} + 2e^-$

   Magnesium has lost 2 electrons
6. Measure the initial temperature of each metal ion solution

   Add magnesium to each and record the highest temperature reached

   Work out the temperature change

   The greater the difference in temperature, the greater the difference in reactivity

   If there is no temperature change, there is no reaction

Practical C6

Investigate how changing a variable changes the rate of reaction

Volume of hydrochloric acid /cm^3	Volume of deionised water /cm^3	Concentration of hydrochloric acid /mol/dm^3	Time taken for magnesium to disappear /s	Repeat time taken for magnesium to disappear /s	Average time /s	Rate /s^{-1}
25	0	2.0	28	29		
10	5	1.6	35	37		
15	10	1.2	58	60		
10	15	0.8	98	102		
5	20	0.4	196	204		

Answers to questions

1. Increasing the concentration of acid increases the rate/decreases the time
2. Graph drawn using results with best fit line

   Trend: As concentration of acid increases, rate increases

Practical C7

Investigate the reactions of carboxylic acids

Experiment 1:

Acid	Colour of universal indicator paper	pH
Ethanoic acid	orange	3 – 4
Hydrochloric acid	red	1 – 2

Answers to questions

1. Ethanoic acid has pH 3 – 4 so is weak acid
   Hydrochloric acid is pH 1 – 2 so is strong acid
2. Use a pH meter and record to 1 decimal place

Experiment 2: Comparison of the reaction of magnesium with both acids

Reaction	Observations
Ethanoic acid + magnesium	bubbles/fizzing grey solid/magnesium disappears solution remains colourless slower reaction
Hydrochloric acid + magnesium	bubbles/fizzing grey solid/magnesium disappears solution remains colourless more vigorous reaction
Test with lighted splint	Pop sound

Answers to questions

1. Bubbles/fizzing observed
   Positive test with lighted splint
2. (a) ethanoic acid + magnesium → magnesium ethanoate + hydrogen
   $2CH_3COOH + Mg \rightarrow (CH_3COO)_2Mg + H_2$
   (b) hydrochloric acid + magnesium → magnesium chloride + hydrogen
   $2HCl + Mg \rightarrow MgCl_2 + H_2$

Practical C7

Investigate the reactions of carboxylic acids

Reaction 3: Comparing the reactions of calcium with both acids

Reaction	Time/s
Calcium and hydrochloric acid	140
Calcium and ethanoic acid	400

Answers to questions

1. calcium and hydrochloric acid is faster as the time is shorter
2. $2CH_3COOH + Ca \rightarrow (CH_3COO)_2Ca + H_2$

Practical C8

Determining the reacting volumes of solutions of acid and alkali by titration and determine the concentration of solutions of acid and alkali by titration

Sample results and answers

	Initial burette reading /cm^3	Final burette reading /cm^3	Titre /cm^3
Rough titration	0.0	24.8	24.8
First accurate titration	0.0	23.5	23.5
Second accurate titration	0.0	23.7	23.7

Average titre = 23.6 cm^3
Observations at end point: colour changes from pink to colourless

Answers to questions

1. moles of acid = $\frac{23.6 \times 0.125}{1000}$ = 0.00295

2. 0.00295

3. Concentration = 0.00295 × 40 = 0.118 mol/dm^3
   Concentration = 0.118 × 40 = 4.72 g/dm^3

Practical C9

Investigate the preparation, properties, tests and reactions of the gases hydrogen, oxygen and carbon dioxide

Carbon dioxide

Test 1

Lit splint extinguishes

Test 2

Limewater changes from colourless to milky

Test 3

Universal indicator change to orange pH 3 – 4

Answers to questions

1. Not able, acidic, insoluble
2. The lit splint extinguished so it does not support combustion
   It is acidic as the universal indicator indicated a pH of 3 – 4 which is weakly acidic
   The milky colour produced is a white solid which is insoluble
3. hydrochloric acid calcium carbonate
   $CaCO_3 + 2HCl \rightarrow CaCl_2 + CO_2 + H_2O$

Hydrogen

Appearance of hydrochloric acid	Colourless liquid/solution
Appearance of zinc	Grey solid
Observations during the reaction	Bubbles, heat released, solution remains colourless
Observations with a lit split	Pop sound

Answers to questions

1. zinc/magnesium and hydrochloric acid
   $Mg + 2HCl \rightarrow MgCl_2 + H_2$ or $Zn + 2HCl \rightarrow ZnCl_2 + H_2$
2. $H_2 + O_2 \rightarrow H_2O$

Practical C9

Investigate the preparation, properties, tests and reactions of the gases hydrogen, oxygen and carbon dioxide

Oxygen

Appearance of hydrogen peroxide solution	Colourless liquid/solution
Appearance of manganese(IV) oxide	Black solid/black powder
Observations during the reaction	Bubbles/fizzing
Observations with a glowing split	Glowing splint relights

Answers to questions

1. The hydrogen peroxide decomposes to produce oxygen
2. Catalyst to speed up the reaction
3. Hydrogen peroxide and manganese(IV) oxide catalyst

   $2H_2O_2 \rightarrow 2H_2O + O_2$