Robert Carre

Multi Academy Trust

Carre’s Grammar School

KEEP
CALM
AND
STUDY
CHEMISTRY

6th Form Induction Day

Welcome to Chemistry.

We hope you enjoy your time with us today and can see that even though Chemistry is challenging, it is also extremely rewarding. Carre's Chemistry department is unique in terms of its breadth of experience and knowledge base. We hope that in this course you will gain a high level of knowledge and understanding of Chemistry enabling you to attain not only the highest grades, but also a real appreciation of Chemistry in the wider context of the outside world.

Expectations

The time allocation for this course is 10 hours over a two week cycle. In order to be successful you are expected to do at least the same number of hours in terms of private study.

Your progress will be monitored regularly and the first test will be within the first two to three weeks of the course. Your progress will be continually assessed in terms of assignments, tests, practical work and presentations. Take every assessment seriously – we do!

Within the constraints of the time allocated, practical work will form a valuable aspect of this course and students will develop a high level of practical skills. Practical skills are assessed as part of the written exams at the end of the year, if students reach the required standard for their practical work, they will receive a practical work endorsement on their A level qualification. Practical work does not directly influence a student's grade unlike coursework at GCSE.

You are expected to know your work from GCSE; we will not have time to go over this material.

Requirements for A Level Chemistry

GCSE double award Science grade AB or GCSE Chemistry at grade B minimum (grade A or above preferred) + a B grade in another Science subject,. We expect students to have passed paper III Chemistry if sat.

The course has a significant mathematical content and A Level Maths being studied is highly recommended.

Grade 7 or above in Maths at GCSE level is very strongly advised; students with a grade 6 attainment level will need to concentrate considerable effort to ensure success.

All students will be expected to acquire and wear a laboratory coat (available for purchase from the Chemistry Department) during all practical sessions.

Experiment 1
Finding the formula of hydrated copper(II) sulphate

Class practical In this experiment, a known mass of hydrated **copper (II) sulphate** is heated to remove the **water of crystallisation**. The mass of water is found by weighing the copper (II) sulphate before and after heating. This information is used to find **x** in the formula $CuSO_4.\mathbf{x}H_2O$ using **mole calculations.**

Apparatus

Eye protection
Each working group will require:
Crucible See (Note) + Crucible tongs
Tripod
Pipe-clay triangle, Bunsen burner, Heat resistant mat
Top-pan balance (± 0.01 g)

Chemicals: Hydrated Copper (II) Sulphate 5.00 g.

N**ote** Crucibles may be of porcelain, stainless steel or nickel, of capacity about 15 cm^3, and should sit safely in the pipe-clay triangle provided.

Health and Safety Goggles must be worn. Assume the copper (II) sulphate is harmful by ingestion.

Apparatus will get hot allow tripod, crucible etc.., to cool down before handling and the crucible must be cool before weighting.

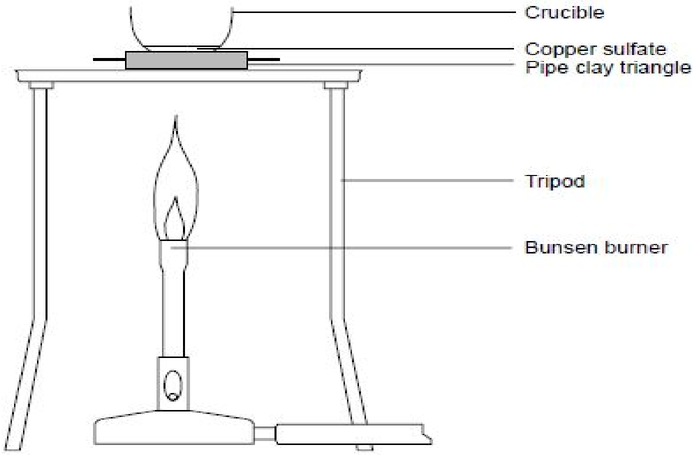
Procedure

a Weigh the empty crucible, and weigh into it 5.00 g of hydrated copper (**II**) sulphate,(**C**).

A Mass of Empty Crucible _______g	
B Mass of Crucible **+** $CuSO_4.xH_2O$ **before** heating _______g	**D** Mass of Crucible **+** $CuSO_4.xH_2O$ **after** heating _______g
C Mass of $CuSO_4.xH_2O$ **before** heating (**B – A**) _______g	**E** **Mass** of $CuSO_4.xH_2O$ **after** heating (**D – A**) _______**g**
F **Mass** of H_2O lost _______**g** (**B – E**)	

Record all masses accurate to the nearest 0.01 g.

b Support the crucible securely in the pipe-clay triangle on the tripod over the Bunsen burner.



c Heat the crucible and contents, gently at first, over a medium Bunsen flame, so that the water of crystallisation is driven off steadily. The blue colour of the hydrated compound should gradually fade to the greyish-white of anhydrous copper (**II**) sulphate. Avoid over-heating, which may cause further decomposition, and stop heating immediately if the colour starts to blacken. If over-heated, toxic or corrosive fumes may be evolved. A total heating time of about 10 minutes should be enough.

d Allow the crucible and contents to cool. The tongs may be used to move the hot crucible from the hot pipe-clay triangle onto the heat resistant mat where it should cool more rapidly.

e Re-weigh the crucible and contents **once cold**.

f Calculation:

Atomic Mass Data: Cu = 64, S = 32, O = 16, H = 1

How to Calculate Relative Molecular Mass (Mr)

Molecular Mass of H_2O = (2 x 1) + (1x 16) = **18**

Now Calculate the Mr of $CuSO_4$

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Moles are the Chemists unit of amount. We need to convert our masses (g) into moles.

How to calculate the number of moles

Use this equation: number of moles = Mass (g) / Relative Molecular Mass (Mr)

E.g. to calculate the number of moles in 36 g of H_2O, divide 36 (the mass) by 18 (the Mr) = 2 moles.

Using the masses (g) from your experiment and Relative Molecular Masses (Mr) previously calculated; calculate the number of moles of the anhydrous copper (**II**) sulphate and the number of moles of water lost.

$CuSO_4$

Number of moles of $CuSO_4$ = Mass of $CuSO_4$ after heating (**E**) / Mr of $CuSO_4$

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H_2O

Number of moles of H_2O = Mass of H_2O lost after heating (**F**) / Mr of H_2O

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We now calculate the ratio of $CuSO_4$ to H_2O dividing both numbers of moles (above) each by the smallest number of moles.

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The value for $CuSO_4$ should be 1 and the value rounded to the nearest whole number for H_2O should be the value of **x** in $CuSO_4$.**x**H_2O.

My formula for copper (II) sulphate is: ______________________.

Experiment 2

Catalysis

• Aims and background

Some chemical reactions can be speeded up by the addition of a catalyst. A catalyst speeds up a chemical reaction but is not used up in it.

The catalyst used in this experiment works by lowering the activation energy and provides an alternative route for the reaction to take. It is thought that in these reactions a transition state allows the formation of an 'activated complex'. A two-part equation can be written:

$$3H_2O_2(aq) + C_4H_4O_6^{2-}(aq) \rightarrow 2CO_2(g) + 2HCOO^-(aq) + 4H_2O(l)$$

(Cobalt chloride goes from pink to green here $Co^{2+} \rightarrow Co^{3+}$)

$$2HCOO^-(aq) + 2H_2O_2(aq) \rightarrow 2CO_2(g) + 2H_2O(l) + 2OH^-(aq)$$

(Cobalt chloride goes from green back to pink: $Co^{3+} \rightarrow Co^{2+}$)

This method is unusual in that it allows you to plot the progress of the reaction and to observe the transition state. You will need to work out what is happening at each stage.

• Safety

This reaction can bubble violently if it gets too hot.
Cobalt chloride is classed as toxic and hydrogen peroxide is an irritant.
Use chemical splash-proof eye protection.

• Equipment and materials

For this experiment you will need:

Rochelle salt solution

Cobalt(II) chloride solution, TOXIC
(avoid skin contact)

20 vol. hydrogen peroxide, IRRITANT

Crushed ice

100 cm^3 beaker

250 cm^3 beaker

25 cm^3 measuring cylinder

Test tube

Disposable gloves

Chemical splash-proof eye protection

100 cm^3 measuring cylinder

Thermometer

Bunsen burner

Tripod

Gauze

Heat proof mat

Teat pipette

Ice bath

• Method

1 Set up the apparatus as shown in the diagram.

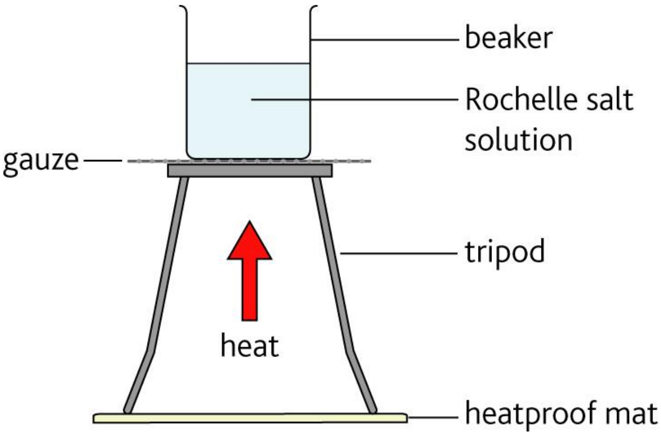
2 Add 100 cm^3 of Rochelle salt solution to the 250 cm^3 beaker.

3 Add 20 cm^3 of the hydrogen peroxide and make observations.

4 Heat the solution to about 70 ºC (no higher) and note any changes.

5 Add 5 cm^3 of cobalt(II) chloride solution. Stand back immediately and note any observations.

6 Repeat the experiment but, this time, when the green intermediate compound is formed, remove some solution carefully with a teat pipette and place it into a test tube.



7 Place the test tube in the ice bath and note any changes.

• Results

Write down your observations and then answer the questions below.

• Discussion

1 When you added the hydrogen peroxide to the Rochelle salt no reaction could be seen even at 70 ºC. However on addition of the cobalt(II) chloride solution the reaction was vigorous. How could you explain this?

2 Co^{2+} ions are pink and are soluble in water. Co^{3+} ions are not stable in aqueous solutions: they are reduced back to Co^{2+} by water. As the reaction proceeds, methanoate ions ($HCOO^-$) are liberated. What do these do to the Co^{2+} ions?

3 Why does the pink colour return?

4 What happened to the green intermediate complex when it was placed into the ice? Why?

Do I need chemistry to. . .

...study medicine?

An A-level (or equivalent) in chemistry is essential if you want to study medicine. Surprisingly, biology is not required but maths and/or physics often are. Very good grades are certainly needed and relevant work experience will significantly increase your chances of gaining a place on a medicine degree course. Details of current requirements can be found on the UCAS website.

...become a dentist?

Normally chemistry and biology at A Level (or equivalent) are compulsory if you wish to study dentistry. Details of current course entry requirements can be found on the UCAS website.

...become a vet?

The qualifications needed to become a veterinary surgeon are similar to those for becoming a doctor. Chemistry is required at A-level (or equivalent), along with A-levels in biology, physics or mathematics. Current requirements can be found on the UCAS website.

...become a pharmacist?

Chemistry A-level is an entry requirement for many pharmacy courses, and is preferable for all institutions.

Many people confuse pharmacy with pharmacology. Pharmacists are involved in the dispensing of medicines and learn not only about the effects of different medicines and how they interact, but also about regulations related to dispensing. Pharmacologists study the effects of chemical compounds on humans and animals. They may work in clinical trials but often work as part of a research team in a laboratory.

...become a materials scientist or metallurgist?

These careers are intimately involved with chemistry, physics, and engineering, so A-levels (or equivalent) in chemistry, physics, engineering and mathematics are the best basis for study in this area. Current entry requirements for courses can be found on the UCAS website.

Materials scientists can work in a very wide range of fields, from sports and aerospace applications to medicine and communications. The Institute of Materials, Minerals and Mining publishes helpful literature on both materials science and metallurgy.

A level Chemistry Specification

Exam Board: AQA **Course Code:** 7404 / 7405

These qualifications are linear. Linear means that students will sit three exam papers at the end of their A-level course.

Subject content

3.1 Physical chemistry

- 3.1.1 Atomic structure
- 3.1.2 Amount of substance
- 3.1.3 Bonding
- 3.1.4 Energetics
- 3.1.5 Kinetics
- 3.1.6 Chemical equilibria, Le Chatelier's principle and Kc
- 3.1.7 Oxidation, reduction and redox equations
- 3.1.8 Thermodynamics (**A-level only**)
- 3.1.9 Rate equations (**A-level only**)
- 3.1.10 Equilibrium constant Kp for homogeneous systems (**A-level only**)
- 3.1.11 Electrode potentials and electrochemical cells (**A-level only**)
- 3.1.12 Acids and bases (**A-level only**)

3.2 Inorganic chemistry

- 3.2.1 Periodicity
- 3.2.2 Group 2, the alkaline earth metals
- 3.2.3 Group 7(17), the halogens
- 3.2.4 Properties of Period 3 elements and their oxides (**A-level only**)
- 3.2.5 Transition metals (**A-level only**)
- 3.2.6 Reactions of ions in aqueous solution (**A-level only**)

3.3 Organic chemistry

- 3.3.1 Introduction to organic chemistry
- 3.3.2 Alkanes
- 3.3.3 Halogenoalkanes
- 3.3.4 Alkenes
- 3.3.5 Alcohols
- 3.3.6 Organic analysis
- 3.3.7 Optical isomerism (**A-level only**)
- 3.3.8 Aldehydes and ketones (**A-level only**)
- 3.3.9 Carboxylic acids and derivatives (**A-level only**)
- 3.3.10 Aromatic chemistry (**A-level only**)
- 3.3.11 Amines (**A-level only**)
- 3.3.12 Polymers (**A-level only**)
- 3.3.13 Amino acids, proteins and DNA (**A-level only**)
- 3.3.14 Organic synthesis (**A-level only**)
- 3.3.15 Nuclear magnetic resonance spectroscopy (**A-level only**)
- 3.3.16 Chromatography (**A-level only**)

Exam board: AQA Chemistry

Paper 1	Paper 2	Paper 3
What's assessed: Relevant physical chemistry topics (sections 3.1.1 to 3.1.4, 3.1.6 to 3.1.8 and 3.1.10 to 3.1.12) Inorganic chemistry (section 3.2) Relevant practical skills **Assessed** by written exam: 2 hours 105 marks 35% of A-level **Questions** 105 marks of short and long answer questions	**What's assessed:** Relevant physical chemistry topics (sections 3.1.2 to 3.1.6 and 3.1.9) Organic chemistry (section 3.3) Relevant practical skills **Assessed** by written exam: 2 hours 105 marks 35% of A-level **Questions** 105 marks of short and long answer questions	**What's assessed:** Any content. Any practical skills. **Assessed by** written exam: 2 hours 90 marks 30% of A-level **Questions** 40 marks of questions on practical techniques and data analysis 20 marks of questions testing across the specification 30 marks of multiple choice questions

Mathematical requirements (as specified by AQA).

Arithmetic and numerical computation

	Mathematical skills	Exemplification of mathematical skill in the context of Chemistry
MS 0.0	Recognise and make use of appropriate units in calculation	Students may be tested on their ability to: Convert between units, e.g. cm^3 to dm^3 as part of volumetric calculations **Give units for an equilibrium constant or a rate constant** Understand that different units are used in similar topic areas, so that conversions may be necessary, e.g. entropy in J mol^{-1} K^{-1} and enthalpy changes in kJ mol^{-1}.
MS 0.1	Recognise and use expressions in decimal and ordinary form	Students may be tested on their ability to: Use an appropriate number of decimal places in calculations, e.g. for pH

	Mathematical skills	Exemplification of mathematical skill in the context of Chemistry
		Carry out calculations using numbers in standard and ordinary form, e.g. use of Avogadro's number Understand standard form when applied to areas such as (but not limited to) K_w Convert between numbers in standard and ordinary form Understand that significant figures need retaining when making conversions between standard and ordinary form, e.g. 0.0050 mol dm^{-3} is equivalent to 5.0×10^{-3} mol dm^{-3}.
MS 0.2	Use ratios, fractions and percentages	Students may be tested on their ability to: Calculate percentage yields Calculate the atom economy of a reaction Construct and/or balance equations using ratios.
MS 0.3	Estimate results	Students may be tested on their ability to: **Evaluate the effect of changing experimental parameters on measurable values, e.g. how the value of K_c would change with temperature given different specified conditions**.
MS 0.4	Use calculators to find and use power, **exponential and logarithmic functions**	Students may be tested on their ability to: Carry out calculations using the Avogadro constant **Carry out pH and pK_a calculations** **Make appropriate mathematical approximations in buffer calculations**.

Handling data

MS 1.1	Use an appropriate number of significant figures	Students may be tested on their ability to: Report calculations to an appropriate number of significant figures, given raw data quoted to varying numbers of significant figures Understand that calculated results can only be reported to the limits of the least accurate measurement.
MS 1.2	Find arithmetic means	Students may be tested on their ability to: Calculate weighted means, e.g. calculation of an atomic mass based on supplied isotopic abundances Select appropriate titration data (i.e. identification of outliers) in order to calculate mean titres.
MS 1.3	Identify uncertainties in measurements and use simple techniques to determine uncertainty when data are combined	Students may be tested on their ability to: Determine uncertainty when two burette readings are used to calculate a titre value.

Algebra

MS 2.1	Understand and use the symbols: =, <, <<, >>, >, ∝, ~, equilibrium sign	No exemplification required.
MS 2.2	Change the subject of an equation	Students may be tested on their ability to: Carry out structured and unstructured mole calculations, **e.g. calculate a rate constant *k* from a rate equation**.
MS 2.3	Substitute numerical values into algebraic equations using appropriate units for	Students may be tested on their ability to: Carry out structured and unstructured mole

	physical quantities	calculations **Carry out rate calculations** **calculate the value of an equilibrium constant** K_c.
MS 2.4	Solve algebraic equations	Students may be tested on their ability to: Carry out Hess's law calculations **Calculate a rate constant *k* from a rate equation**.
MS 2.5	**Use logarithms in relation to quantities that range over several orders of magnitude**	Students may be tested on their ability to: **Carry out pH and p**K_a **calculations**.

Graphs

MS 3.1	Translate information between graphical, numerical and algebraic forms	Students may be tested on their ability to: Interpret and analyse spectra **determine the order of a reaction from a graph** **Derive a rate expression from a graph**.
MS 3.2	Plot two variables from experimental or other data	Students may be tested on their ability to: Plot concentration–time graphs from collected or supplied data and draw an appropriate best-fit curve.
MS 3.3	**Determine the slope and intercept of a linear graph**	Students may be tested on their ability to: **Calculate the rate constant of a zero-order reaction by determination of the gradient of a concentration–time graph**.
MS 3.4	**Calculate rate of change from a graph showing a linear relationship**	Students may be tested on their ability to: **Calculate the rate constant of a zero-order reaction by determination of the gradient of a concentration–time graph**.

MS 3.5	**Draw and use the slope of a tangent to a curve as a measure of rate of change**	Students may be tested on their ability to: **Determine the order of a reaction using the initial rates method**.

Geometry and trigonometry

MS 4.1	Use angles and shapes in regular 2D and 3D structures	Students may be tested on their ability to: Predict/identify shapes of and bond angles in molecules with and without a lone pair(s), for example NH_3, CH_4, H_2O etc.
MS 4.2	Visualise and represent 2D and 3D forms including two-dimensional representations of 3D objects	Students may be tested on their ability to: Draw different forms of isomers **Identify chiral centres from a 2D or 3D representation**.
MS 4.3	Understand the symmetry of 2D and 3D shapes	Students may be tested on their ability to: Describe the types of stereoisomerism shown by molecules/complexes **Identify chiral centres from a 2D or 3D representation**.