# Appendices

## Appendix 1: Illustrations of core statements on Coherent School Chemistry

| *Statement* | *Illustration of Statement* | *Reference* |
|---|---|---|
| 1 | ... in this book *we* are concerned with the science of chemistry ... emphasis on understanding ... essential for those pupils for whom the work [leads] to more advanced study. | Clynes and Williams, 1960, p. 14 |
| | Many of you will continue with the subject and possibly add to our store of knowledge. | Mathews, 1964 (Coda, p. 347) |
| 2 | [Contrary to] physical change ... chemical change; (1) always produces a new kind of matter; (2) Is generally not reversible; (3) Is usually accompanied by considerable heat change... | Holderness andLambert, 1986, p. 5 |
| 3 | To sum up: chemical laws .. are true until proved false, the laws can be used to predict the results of future experiments; .. new facts have been studied which this simple theory does not explain. | Mathews, 1964, pp. 27 & 228 |
| | Explanations in terms of a Model. | Nuffield Chemistry, 1966, Ch. 2, p. 7 |
| 8 | Concepts to which this book gives *prominence* include the electrical and particulate nature of matter ... redox reactions in terms of electron transfer, ionic equations, the chemical bond and crystal structure ... | Mathews, 1964 (Preface, p. 7) |
| | ... chemical change involves the re-arrangement of atoms. | Clynes & Williams, 1960, p. 21 |
| 9 | ... is intended for children of average and above average in the 11-16 age group. Most of these children will not continue to study science ... the course must also serve as an adequate basis for future work [Ped]... | Nuffield Chemistry, 1966, Preface |
| | ...seek to encourage lively enquiry, understanding and an ability to interpret evidence [Phil]. | Nuffield Chemistry, Ch. 1, p. 1 |
| | However, the chemistry through which pupils attain this ... will often be that used in older syllabuses [Sub]. | Nuffield Chemistry, Ch. 4, p. 18 |

## Appendix 2: List of abbreviations

### Abbreviations specific for England and Wales

| | |
|---|---|
| A-level | Advanced level (16 – 18) |
| ASE | Association of Science Education |
| CSE | Certificate of Secondary Education |
| DES | Department of Education and Science |
| GCE | General Certificate of Education |
| GCSE | General Certificate of Secondary Education |
| HPS | History and Philosophy of Science |
| HMI | Her Majesty's Inspectorate |
| INSET | In-service Education and Training of Teachers |
| ICCE | International Conference for Chemical Education |
| LAMPP | Less Academic Motivated Pupils Project |
| LEAs | Local Education Authorities |
| MEG | Midland Examining Group |
| NC | National Curriculum |
| O-level | Ordinary level (14 – 16) |
| PS | Pure Science |
| SAT | Standard Assessment Tasks (NC) |
| SATIS | Science and Technology in Schools |
| STS | Science, Technology and Society |
| SEAC | Schools Examination and Assessment Council |
| UYSEG | University of York Science Education Group |

## Abbreviations specific to this thesis

| | |
|---|---|
| CC | Chemical Concepts |
| CR | Chemical Relationships |
| CT | Chemical Techniques |
| CSSC | Conceptual Structure of School Chemistry |
| CTS | Chemistry, Technology and Society |
| DF | Dutch Forum |
| DSC | Dominant School Chemistry |
| FC | Foundations of Chemistry |
| FMA | Familiar Materials Approach |
| FS | Foundations of Science |
| IF | Internatonal Forum |
| NCE | Normal Chemistry Education |
| NSE | Normal Science Education |
| MC | Methodology of Chemistry |
| MS | Methodology of Science |
| OGT | Overall Guide for Teachers (UYSEG, 1988) |
| PC | Pure Chemistry |
| Ped | Pedagogical structure |
| Phil | Philosophical structure |
| SAG | Student Activity Guide |
| SIS | Student Information Sheet |
| SLB | Syllabus Salters' Chemistry (1992) |
| Sub | Substantive structure |
| TA | Teaching Approach |

# Appendix 3:

## International Forum on Structures in School Chemistry

The list of international respondents (28) reads, in alphabetical order:

Dr. Philip Adey (UK);

Dr. Michael F. Akeroyd (UK);

Dr. Vanessa Barker (UK);

Dr. Judith Bennett (UK);

Prof. John D. Bradley (South Africa);

Mr. Neil Braund (UK);

Dr. José A. Chamizo (Mexico);

Dr. Glen Chittleborough (Australia);

Prof. Roger Cross (Australia);

Dr Arthur J. Davies (Australia);

Prof. Peter J. Fensham (Australia);

Prof. Ronald J. Gillespie (Canada);

Prof. Altfrid Gramm (Germany);

Dr. Vadim Grot (USSR);

Prof. Stephen J. Hawkes (USA);

Prof. Edgar W. Jenkins (UK);

Prof. Richard F. Kempa (UK);

Dr. Mary Beth Key (USA);

Dr. Andrea Kisfaludi (Hungary);

Prof. Dr. Peter G. Mahaffy (Canada);

Prof. Dr. Robin Millar (UK)

Dr. Mins Minssen (Germany);

Dr. Brandan Schollum (New Zealand);

Mr. Neil C. Smith (UK);

Prof. Dr. John S. Spencer (USA);

Dr. Paul Strube (Australia);

Prof. Dr. Elke Sumfleth (Germany);

Dr. Clive Sutton (UK).

# Appendix 4:

## Dutch Forum on Structures in School Chemistry

The list of Dutch respondents (22) reads, in alphabetical order:

Drs. W. Akkermans.

Drs. F. J. C. M. Arnold

Drs S. A. Bakker

Drs A. A. J. van Berkel

Ir. A. Beverloo

Drs. J. Bouma

Drs. F. Brants

Dr. J. van Driel

Ir. A.M. Edelbroek

Prof Dr. M. J. Goedhart

Dr. H. G. de Graaf

Drs A. v.d. Heijden

Drs. J. G.Hondebrink

Dr. C. de Jong

Dr. Ir. G. Laméris

Drs. H. van Lubeck

Prof. Dr. A. Rip

Drs. A. J. Schoneveld

Prof. Dr. H. A. M. Snelders

Dr. P. van der Vet

Dr. M. J. Vogelezang

Dr. H. Zandvoort

# Appendix 5: Lesson plans of unit Metals of Salters Science (1989)

## Lesson Plan M1: What Are Metals?

| Type of activity | Outline | Key points |
|---|---|---|
| Survey | Laboratory survey in which students list things which they think are metals. | Metals are widely-used materials. |
| Teacher-student discussion 1 | Students check their lists against the teacher's list. | Metals have certain properties in common. |
| Laboratory-based practical work | Comparison of the properties of metals and plastics based on experiments using a metal spoon and a plastic spoon. SAG M1.1. | |
| Individual student activity (optional) | Students list the metals they know and identify any known properties. | |
| Teacher-student discussion 2 | Discussion to clarify points from the previous activity and from the class practical. | |
| Teacher-student discussion 3 | Introduction to the use of symbols to represent metals. | Metals can be represented by symbols. |
| Homework suggestion | Completion of a word search for metals. Data analysis and interpretation exercise to explain the reasons for certain uses of metals. SAG M1.2 and SAG M1.3. | The use of a metal is related to its physical properties. |

## LESSON PLAN M2: WHICH METAL IS USED TO MAKE A DRAWING PIN?

| TYPE OF ACTIVITY | OUTLINE | KEY POINTS |
|---|---|---|
| Teacher-student discussion 1 | Discussion to recall that metals have common physical properties and many look alike. Discussion of possible ways of identifying different metals. Introduction to the idea that a more precise identification can be made through study of their chemical reactions. | Metals have certain physical properties in common. |
| Laboratory-based practical work | Simple qualitative tests on known metals. Identification of the dominant metal in a drawing pin. SAG M2.1 | Chemical tests are often better than physical tests at distinguishing between metals. |
| Teacher-student discussion 2 | Brief discussion to reinforce ideas from M1 (homework) looking at the relationship between the properties of metals and their uses. | The use of metals are related to their chemical properties. |

LESSON PLAN M3: WHAT HAPPENS WHEN METALS CORRODE?

| Type of activity | Outline | Key points |
|---|---|---|
| Teacher-student discussion 1 | Samples of corroded metals are displayed and discussion establishes where these might be found. | Metals often corrode. |
| Teacher demonstration | Removal of corrosion by rubbing with an emery cloth. | Corrosion occurs at the surface of metals. |
| Teacher-student discussion 2 Designing an experiment (key activity) | Comparison of corroded and uncorroded metals provokes discussion of the corrosion process. Introduction to the terms element, compound and chemical reaction. Students make suggestions about the conditions needed for corrosion. Class discussion leads to the design of an experiment to investigate air, water, and salt as possible causes of corrosion. | A new substance is formed when metals corrode. Some metal is used up when this new substance forms. An element is the simplest possible substance. A chemical reaction involves the formation of a new substance. A compound is formed when two or more elements combine together. |
| Laboratory-based practical work | Students set up an investigation into the extent and rate of rusting of iron nails in the presence of combinations of air, water and salt. SAG M3.1. | Rusting is the name given to the corrosion of iron |
| Talking and listening in small groups or homework suggestion | Students make and record predictions about the results of their investigation. (key activity) | |

## Lesson plan M4: Do all metals corrode?

| Type of activity | Outline | Key points |
|---|---|---|
| Teacher-student discussion 1 | Examination of rusting experiments and recording of results. Discussion to summarise information collected about rusting at this stage. | Air and water are both needed for rusting. Salt makes rusting happen more quickly. Iron is used up during rusting. A new substance is formed when iron rusts. |
| Teacher demonstration | i) Burning of a piece of magnesium ribbon in the air.<br>ii) Heating of a piece of magnesium ribbon in a crucible with the lid lifted and replaced at frequent intervals. | Air is needed for magnesium to burn. Magnesium is used up during burning. A new substance is formed when magnesium burns. |
| Talking and listening in small groups | Students discuss their ideas in small groups in order to agree a theory as to what happens during the processes of rusting and burning. | |
| Teacher-student discussion 2 | Reporting back of the ideas.<br>The teacher might pose the question:<br>* How can we prove that iron and magnesium gain something from the air during rusting and burning? | |
| Laboratory-based practical work and / or Teacher demonstration | Study of possible changes in mass:<br>i) as magnesium burns,<br>ii) as iron rusts.<br>SAG M4.1. | When a metal corrodes or burns it gains mass. Corrosion and burning involve reaction with oxygen. When elements react with ogygen compounds are formed. Reactions with oxygen are called oxidation reactions. |
| Teacher-student discussion 3 | Discussion should allow the production of word equations to summarise the processes of corrosion and burning and should reinforce ideas about elements and compounds from M3. | Elements can combine to form compounds, but they cannot be made to weigh less. |

LESSON PLAN M5: DO ALL METALS CORRODE?

| TYPE OF ACTIVITY | OUTLINE | KEY POINTS |
|---|---|---|
| Datacollection / presenting a report. | Examination of rusting experiments. Recording of results on SAG M3.1. Each group should prepare a written report from their results. | Air and water are both needed for rusting. Salt accelerates rusting. |
| Teacher-student discussion 1 | The display of corroded metals in M3 suggests that there may be an order of ease of corrosion. | |
| Teacher demonstration | Samples of the five metals are displayed. Demonstration of the rapid tarnishing of freshly-cut sodium. Demonstration of the reaction of sodium with water. | Sodium corrodes quickly in air and reacts violently in cold water. |
| Laboratory-based practical work | Investigation of the corrodibility of the remaining four metals by observing their action with water. SAG M5.l. | Hydrogen explodes when mixed with air and ignited. A small-scale conversion of this reaction is used to test for hydrogen. |
| Teacher-student discussion 2 | Discussion of the class experiment. Introduction to the term oxidation. Use of word equations to summarise the reactions of metals with oxygen. | The order of decreasing corrodibility and reactivity with water of the metals is sodium, calcium, magnesium, iron and copper. This order forms a reactivity series for the metals. |
| Homework suggestion | Completion of a question sheet to examine how corrosion can be prevented. SAG M5.2. | A number of methods are available for preventing corrosion. |

## LESSON M5X1: HOW CAN WE PREVENT RUSTING?

| Type of activity | Outline | Key points |
|---|---|---|
| Teacher-student discussion | Examination of a bicycle to consider how rusting is prevented on various parts of the machine. SAG M5X1.1. | Rusting is prevented by excluding air and / or water. |
| Laboratory-based practical | Students set up an investigation to answer the question: * Do rust stoppers work? Students prepare their samples and examine them daily to determine the length of time necessary for the cans to rust. The results of this experiment will be discussed in M6. SAG M5X1.2. | |

## LESSON M5X2: DO OTHER METALS STOP IRON PROM RUSTING?

| Type of activity | Outline | Key points |
|---|---|---|
| Teacher-student discussion | Recall the need to cover iron and steel to prevent rusting (from MS and MSX1). | |
| Laboratory-based practical work or Teacher demonstration | Students set up an investigation into the effect that other metals have on the rusting of iron. Students investigate the rusting of iron in salt solution in the presence of a second metal. Samples are examined daily. The results of this experiment will be discussed in M6. | (see Lesson M6) |

LESSON M6: WHAT ARE METAL ALLOYS?

| Type of activity | Outline | Key points |
|---|---|---|
| (If M5X1 covered) Teacher-student discussion 1 | Discussion of the experimental results from M5X1 and method of rust prevention. | Several methods are available for the prevention of rust. |
| (If M5X2 covered) Teacher-student discussion 2 | Discussion of the experimental results from M5X2 and methods of rust prevention. Explanation of the differences in behaviour of metals in terms of differences in corrodibility. | Metals above iron in the reactivity series slow down rusting; those below iron speed it up. |
| Teacher-student discussion 3 | Introduction to the word alloy. Reference to the fact that steel rusts readily in moist air but steel containing chromium (stainless steel) hardly rusts at all. | An alloy is a mixture if one metal with one or more other elements. Forming an alloy changes the properties of a metal. |
| Teacher demonstration 1 | Comparison of the bendability and brittleness of a paper clip and a darning needle both of which are made from steel. | The composition of an alloy determines its properties. |
| Teacher demonstration 2 | Preparation of solder. Comparison of the melting points of tin, lead and 50% tin / 50% lead alloy. | The melting point of a metal can be lowered by the presence of a second metal. |
| Homework suggestion | Completion of a question sheet on the use and properties of alloys. SAG M6.1. SIS M6.1. | The use of an alloy depends on its properties. |

# Appendix 6: List of Figures