

Unit 27: Chemical Periodicity and Its Applications

Unit code:	D/502/5572
QCF Level 3:	BTEC National
Credit value:	10
Guided learning hours:	60

● Aim and purpose

The aim of this unit is to enable learners to relate properties of elements and their compounds to the position of the elements in the periodic table. It also links the commercial production and uses of inorganic substances to their properties.

● Unit introduction

Society is increasingly reliant on the work of chemists. Any study of science would be incomplete if it failed to recognise the importance of the chemical sector to the economy and the variety of exciting career opportunities it provides. This unit enables learners to explore the physical and chemical properties of elements and their compounds in relation to the periodic table. The concepts are extended to allow learners to explain the uses of inorganic substances in a variety of important applications.

We are surrounded by materials made using inorganic substances. Learners will find out where these are being used and will begin to appreciate the underlying chemistry. Inorganic chemistry contributes to the manufacture of soaps and detergents, fertiliser, dyes, paints, aircraft, buildings and cars, to name just a few. It is also involved in power generation and transmission, and in building reactors. It is used in treating drinking water and effluent.

Process workers and chemical, mechanical, structural and environmental engineers must appreciate the properties of inorganic chemistry. Analysts use inorganic chemistry in the food, construction, water treatment, environmental, aerospace, metals and chemical process industries.

One of the main purposes of this unit is to give learners the opportunity to learn how inorganic chemistry is used commercially. By working in certain industries, the learner will be applying inorganic chemistry.

This unit enables learners to consider what it is like to work in the science sector. It is suitable for all learners who are interested in a career in science.

● Learning outcomes

On completion of this unit a learner should:

- 1 Know how physical and chemical properties of elements and their compounds are related to the positions of the elements in the periodic table
- 2 Understand how the properties of substances influence their production and uses
- 3 Know analytical procedures based on oxidation and reduction
- 4 Be able to investigate practically a range of reactions involving solutions of transition metal ions.

Unit content

1 Know how physical and chemical properties of elements and their compounds are related to the positions of the elements in the periodic table

Electronic arrangement: electronic orbitals; Aufbau principle; s, p, d notation for the first four periods; layout of periodic table in relation to s, p, d notation

Physical properties of elements: first ionisation energy; electron affinity; atomic radius; ionic radius; electronegativity; type of bonding in the element; melting point and boiling point; trends; physical properties of metals, eg electrical conductivity, thermal conductivity, malleability, ductility, appearance

Periodic table: periods 1, 2, 3 and 4; groups; s block; p block; d block

Chemical properties of elements: products and reactivity of all period 2 and 3 elements with oxygen; products and reactivity of common metals with oxygen, water, dilute hydrochloric acid and dilute sulphuric acid, eg potassium, sodium, lithium, calcium, magnesium, aluminium, zinc, iron, tin, lead, copper, silver, gold; position of metals in the reactivity series in relation to position in the periodic table; oxidation; reduction; variable oxidation states of transition metal ions; displacement of a metal in aqueous solution by another; displacement of one halogen in aqueous solution by another

Physical properties of compounds of elements: melting and boiling points of period 3 chlorides and oxides; type of bonding in the period 3 chlorides and oxides

Chemical reactions of compounds of elements: water solubility and acid/base character of period 2 and 3 oxides; water solubility and basic character of group I and group II and first transition series metal oxides; reactions of period 3 chlorides with water; ease of decomposition of carbonates and nitrates of metals in relation to the reactivity series of metals; precipitation reactions; formation of simple complexes, eg with water, ammonia and ethylenediaminetetraacetic acid (EDTA) as ligands; acidity of hexaaqua metal ions

2 Understand how the properties of substances influence their production and uses

Production of substances: purification, eg alumina from bauxite; extraction, eg iron from iron ore, titanium from its ore, aluminium from alumina, electrolysis of brine to produce sodium hydroxide, hydrogen and chlorine; manufacture, eg ammonia, nitric acid, sulphuric acid; costs; abundance

Uses: as relevant, eg $\text{Ca}(\text{OH})_2$ in acidic effluent treatment, stainless steel in making reactor vessels, liquid sodium in cooling nuclear reactors, concrete in building, steel in construction of oil platforms, copper in electrical wires, gold in jewellery, titanium in aircraft, transition metals or transition metal oxides or transition metal complexes as catalysts, silicon and germanium in electronics, chromium or zinc in electroplating, titanium dioxide in paints and sunscreens, alumina in refractories, EDTA in toiletries, silica in glass, transition metal compounds in pottery glazes

Properties: physical, eg solubility, melting point, boiling point, electrical conductivity, thermal conductivity, semiconductivity, malleability, ductility, lustre, tensile strength; chemical, eg amphoteric character of alumina, basic character of metal oxides or hydroxides, ease of electrolysis, position in reactivity series

3 Know analytical procedures based on oxidation and reduction

Analytical procedures: use of manganate (VII) as an oxidising agent; determination of Fe^{2+} content of solutions; standardisation of thiosulphate with primary standard, iodate, IO_3^- ; use of KI as a reducing agent; titration of liberated iodine with thiosulphate; determination of, eg hypochlorite content of solutions, ascorbic acid concentration, peroxide content of fats, Cu^{2+} concentration

Oxidation and reduction: oxidation as loss of electrons; reduction as gain of electrons; oxidising agent; reducing agent; oxidation state; half equations; balanced redox equations

4 Be able to investigate practically a range of reactions involving solutions of transition metal ions

Transition metal ions: common ions, eg Ti^{2+} , Ti^{3+} , V^{2+} , V^{3+} , V^{4+} , Cr^{3+} , $\text{Cr}_2\text{O}_7^{2-}$, Mn^{2+} , MnO_4^- , Fe^{2+} , Fe^{3+} , Co^{2+} , Ni^{2+} , Ni^{3+} , Cu^{2+} , Cu^+ ; number of d electrons; ligands; colours of ions in solution

Reactions of transition metal ions in solution: acidity of hexaaqua transition metal ions; common reactions, eg reaction of $[\text{Co}(\text{H}_2\text{O})_6]^{2+}$ and $[\text{Cu}(\text{H}_2\text{O})_6]^{2+}$ with Cl^- from concentrated HCl, reaction of $[\text{Co}(\text{H}_2\text{O})_6]^{2+}$, $[\text{Cu}(\text{H}_2\text{O})_6]^{2+}$, $[\text{Cr}(\text{H}_2\text{O})_6]^{3+}$ with ammonia and hydroxide, reaction of hexaaqua ions with carbonate

Assessment and grading criteria

In order to pass this unit, the evidence that the learner presents for assessment needs to demonstrate that they can meet all the learning outcomes for the unit. The assessment criteria for a pass grade describe the level of achievement required to pass this unit.

Assessment and grading criteria		
To achieve a pass grade the evidence must show that the learner is able to:	To achieve a merit grade the evidence must show that, in addition to the pass criteria, the learner is able to:	To achieve a distinction grade the evidence must show that, in addition to the pass and merit criteria, the learner is able to:
P1 describe how the positions of elements in the periodic table are related to their electronic arrangement, in terms of SPD notation [CT1,2,3]	M1 explain trends in a range of tabulated physical properties of elements and their compounds	D1 analyse the extent to which properties of elements and their compounds may be predicted by knowing the position of the elements in the periodic table
P2 describe periodic trends in a range of tabulated physical properties of elements and their compounds [E1]		
P3 relate chemical reactions of elements and their compounds to the position of the elements in the periodic table [RL2]		
P4 illustrate how the production of industrially important inorganic substances relates to the properties of the substances involved [CT1,2,3]	M2 compare the means of commercial production of inorganic substances in relation to the properties of the substances involved	D2 evaluate how the method of manufacture of substances is related to their properties and uses
P5 illustrate how the uses of substances relate to their properties [CT1,2,3]	M3 explain the uses of substances in terms of their physical and chemical properties	
P6 describe analytical procedures based on redox principles [RL2]	M4 explain analytical procedures in terms of oxidation states of the substances involved	D3 review the applicability of an analytical technique involving oxidation and reduction to a range of industries
P7 carry out selected simple investigations involving transition metal ions in aqueous solution. [EP3; CT5]	M5 explain selected reactions of transition metal ions in solution.	D4 use accurate chemical equations in explaining reactions involving transition metal ions in solution.

PLTS: This summary references where applicable, in the square brackets, the elements of the personal, learning and thinking skills applicable in the pass criteria. It identifies opportunities for learners to demonstrate effective application of the referenced elements of the skills.

Key	IE – independent enquirers	RL – reflective learners	SM – self-managers
	CT – creative thinkers	TW – team workers	EP – effective participators

Essential guidance for tutors

Delivery

There is a lot of content in learning outcome 1 and some of this content can be difficult to deliver in an interesting way! Learners must learn how to use SPD notation and relate the electronic arrangement of elements to the position of the elements in the periodic table – s-block, p-block, d-block. Card-matching games are useful. It is vital that learners have a good knowledge of where elements are in the periodic table before considering trends in behaviour.

There is little benefit to be gained from learners assembling all their own data on properties of elements and their compounds from internet and library searches, although some use of search and collation techniques will develop ICT skills. A suggested approach would be to present learners with most of the data, let them search for some of it and to develop skills in using language in describing trends in group properties and trends in relation to atomic number across a period. The broad range of physical properties listed in the *Unit content* should be studied, the emphasis being on describing trends and explaining the reasons for the trends for the more able learners.

Learners should perform relevant practical work to illustrate the reactions that elements and their compounds undergo, listed in the *Unit content*. Learners could carry out a type of reaction, eg hydrolysis or dissolution of a chloride, dissolving an oxide in water and measuring pH, reacting metals with water, oxygen and acid, displacement reactions of metals or halogens, observing decomposition of metal carbonates, formation of simple transition metal complexes etc. Data on similar reactions could be presented to them. Learners should be encouraged to identify and describe patterns in data, eg non-metal chlorides may be hydrolysed whereas group I and II chlorides dissolve in water.

More able learners should be encouraged to predict the properties of elements and compounds that they have not studied in detail.

Commercial production of inorganic substances depends on the properties of those substances. Case studies of two or more substances should be chosen. There are examples in the *Unit content*. Learners should be encouraged to identify the property or properties of the substances which lead to it being produced in a particular way, eg the solubility of alumina in alkali due to the amphoteric character of alumina; the relative ease of oxidation of chloride in the electrolysis of brine. This can be extended to making learners question why this means of production is not used for another similar substance, eg if iron is produced from its ore by reduction with carbon monoxide, why is aluminium not produced in the same way? This can give the opportunity for group, problem-solving discussions.

Learners should investigate the uses of inorganic substances, selected by the tutor. Each learner could research the uses of two or three substances and present these to other learners. The key properties of the substances which make them suitable for the use should be identified. Learners may be challenged to explain why certain other substances are not used for the same purpose.

Learners should carry out redox titrations involving manganate VII and potassium iodide and thiosulphate. Learners should describe these experiments in a report or other suitable format the underlying principles in detail. Redox titrations are used extensively in industry. Learners could visit an appropriate quality control laboratory to see for themselves how the titrations are used. Alternatively a speaker could explain this or the learners could be presented with case study material from a variety of laboratories.

Learners should investigate test tube reactions of transition metal hexaaqua ions solutions, listed in the *Unit content*, since these reactions are often of industrial importance. Learners should practise writing formulae for complex transition metal ions.

Outline learning plan

The outline learning plan has been included in this unit as guidance and can be used in conjunction with the programme of suggested assignments.

The outline learning plan demonstrates one way in planning the delivery and assessment of this unit.

Topic and suggested assignments/activities and/assessment
Introduction to unit and programme of assignments.
Learning outcome 1 Structure and properties of elements and their compounds and relation to the periodic table. SPD notation and structure of the periodic table. Assignment 1 – Electronic Arrangement and the Periodic Table (P1) Relation of ionisation energies, atomic radius, electron affinity, electronegativity to position in the periodic table – constructing charts and identifying and describing trends. Properties of metals. MPt and BPt of period 3 chlorides. Assignment 2 – Period Trends in Physical Properties (P2, M1) Investigating chemical properties – metals, non-metals, metalloids; bonding in and solubility of oxides; acid base character of oxides; trends; bonding in and reaction with water of period 3 chlorides; metal reactivity series; investigation of reactions with air, water, acid; metal displacement reactions; decomposition of carbonates. Assignment 3 – Chemical Properties of Elements and Compounds (P3, D1)
Learning outcome 2 Production of substances, eg bauxite and chlorine, titanium and iron. Assignment 4 – Commercial Production of Inorganic Substances (P4, M2, D2)
Uses of metals in relation to their properties. Uses of other inorganic substances, eg calcium oxide in effluent treatment and alumina in refractories. Assignment 5 – Uses of Inorganic Substances (P5, M3)
Learning outcome 3 Oxidation and reduction. Metals displacing other metals from solution – half equations. Manganate (VII) and dichromate (VI) as oxidising agents – half equations – use of manganate (VII) in determination of iron (II). Oxidation number. Iodate/iodide/thiosulphate/hypochlorite experiments and industrial applications. Assignment 6 – Analysis Involving Redox Reactions (P6, M4, D3)
Learning outcome 4 Transition metal ions in solution. Transition metal ions; variable oxidation state; ligands; different colours. Effect of adding concentrated HCl; effect of adding NaOH and ammonia solution to solutions of transition metal ions; explanations. Hydrolysis of metal ions in solution. Assignment 7 – Reactions of Transition Metal Ions (P7 M5, D4)
Review of unit and programme of assignments.

Assessment

The assessment of P1 should be done in a very straightforward way. Learners must write the electronic arrangement of at least the first 36 elements, using SPD notation and relate this notation to the position of the elements in the periodic table. It should be clear that the elements in the s block have their outermost electrons in an s-orbital and so on.

Although learners could find all the information on properties of elements and compounds for themselves, this is time-consuming. To achieve P2, it is suggested that they are presented with most of the data in a suitable format. They may be asked to search and collate some of the data. The emphasis for P2 is on describing trends in data using suitable language, not on collecting data. Production of graphs is not a sufficient description of the data. Trends could be in relation to position in a group or in relation to atomic number across a period. Suitable properties for which to describe trends are first ionisation energy, covalent radius, electron affinity, electronegativity, electrical conductivity, melting point and boiling point. Learners should also consider the melting and boiling points of the period 3 chlorides and oxides.

To achieve M1, learners should explain the reasons for trends for at least first ionisation energy, atomic radius, melting and boiling points of the elements. Additionally, they should be able to relate the melting and boiling points of the chlorides and oxides to the type of bonding in the compounds and to the metallic/non-metallic character of the parent element.

Learners should be familiar with the reactivity series for metals from Key Stage 3. To achieve P3, learners should consider the reactivity of metal elements with respect to oxygen, water, acid and to the solutions of other metal ions and the decomposition of metal carbonates. Learners should relate the reactivity of the metals to their position in the periodic table – most reactive in group 1, next most reactive in group 2 and so on. Learners should be familiar with the fact that transition metal compounds are often coloured and that transition metal ions may form complexes. The chemical behaviour of the period 3 chlorides in relation to water and the solubility and acid/base character of period 3 oxides should be related to the position of the parent element in the periodic table. Although desirable, it is not essential that learners carry out practical work for this criterion.

To achieve D1, learners must show additional knowledge of trends to that demonstrated in P1, P2, P3 and M2. Learners must analyse the properties of elements and their compounds in relation to the position of the parent element in the periodic table and its associated electronic arrangement. Learners should give examples to support their analysis. It would be sufficient for learners to consider at least two elements from different groups and to analyse whether their properties may be predicted accurately from physical and chemical data on other members of the group. Learners are expected to structure their analysis without much input from their tutor.

For P4, learners must relate the means of production of at least two commercially important substances to the properties of those substances and to the properties of other substances involved in the process. Learners should describe the key features of the production processes, highlighting where the chemical and physical properties of the substances are important. They should explain why those properties are important to the production method.

For M2, learners should compare at least one method of producing a substance with the way at least one other substance is produced. These substances may be the substances whose production is illustrated in P4 but they do not have to be the same. For example, for P4, learners may consider the production of bauxite and chlorine but for M2 they may compare the way iron and titanium are produced. Continuous production could be compared with batch production. Centres can select the substances and this selection is likely to relate to local chemical industry if there is any.

To achieve D2, the means of production of at least two substances must be evaluated in relation to their properties and uses. The relation of production to properties must be more detailed/cover more properties than for P4. Since the way a substance is manufactured often relates to its final use, the uses should also be considered. For example, learners should consider why it is produced in small bags/in solution/as a powder etc.

To achieve P5, learners should describe how at least two substances are used and explain the properties of these substances which make them suitable for these applications. Criterion M3 relates to the same substances as P5. To achieve M3, learners should consider whether these substances are the most appropriate for their uses. Learners should consider alternative substances and whether their properties make them more or less suitable, eg using gold or iron rather than copper in electrical cable.

For P6, learners must carry out analytical techniques involving manganate (VII) and iodine/thiosulphate titrations. The emphasis in assessment is on the description of the techniques, rather than on obtaining accurate results.

For M4, learners must explain the procedures in terms of the oxidation states of the substances involved. This is likely to involve accurate chemical oxidation and reduction equations with supporting explanation of the oxidation states of the substances.

For D3, learners should explain at least three instances of where these redox titrations, or similar redox titrations, are used in industry. Learners should state the analyte in each case.

The work for P7 is suggested in the *Unit content*. The emphasis in assessment is on accurate observation. To achieve M5, learners should explain what is happening in each case. If this is supported by accurate chemical equations, the learners will, additionally, achieve D4.

Programme of suggested assignments

The table below shows a programme of suggested assignments that cover the pass, merit and distinction criteria in the assessment and grading grid. This is for guidance and it is recommended that centres either write their own assignments or adapt any Edexcel assignments to meet local needs and resources.

Criteria covered	Assignment title	Scenario	Assessment method
P1	Electronic Arrangement and the Periodic Table	Chemtech is a local company which manufactures research chemicals, involving most groups in the periodic table. As a technician in the training department, you have been asked to produce a periodic table which will help trainees understand the regions of the periodic table.	Produce a periodic table showing clearly the location of the s, p and d block elements and explain their location. The SPD notation for the first 36 elements could be on the periodic table.
P2, M1	Periodic Trends in Physical Properties	Chemtech has asked you to outline the trends in the physical properties of elements and compounds for trainee technicians.	Prepare a presentation, containing definitions of an data for a range of physical properties of elements. Describe and explain trends in properties. Describe and explain trends in the MPt and BPt of the period 3 chlorides.

Criteria covered	Assignment title	Scenario	Assessment method
P3, D1	Chemical Properties of Elements and Compounds	You have impressed Chemtech so much with your presentation that they have asked you to provide notes for their technicians on important reactions for a range of elements and compounds.	Practically investigate and research some important reactions of metals and their compounds and write notes about these reactions. Relate the reactions to the positions of the elements in the periodic table.
P4, M2, D2	Commercial Production of Inorganic Substances	Some of the local chemical plants are finding it hard to recruit school-leavers. You have been asked to produce an article for the science magazine <i>Teensci</i> , aimed at year 10 and 11 school students, which explains commercial production of substances in an interesting way.	Write an article, explaining how two substances are produced commercially and why they are produced in this way. The article should inspire school students to become involved in manufacturing.
P5, M3	Uses of Inorganic Substances	The producers of <i>Teensci</i> magazine want you to write a weekly feature on the work of materials scientists. Your introductory article is expected to relate the uses of inorganic substances to their properties.	Explain the uses of at least two inorganic substances. Consideration of their properties should illustrate clearly why they are chosen for these uses. Evaluate whether other, similar substances may be more or less suitable for these purposes.
P6, M4, D3	Analysis Involving Redox Reactions	<i>Teensci</i> is showcasing the work of analytical chemists in quality control in local companies. You are required to use case studies to write about the sort of analysis that they do, relating it back to titrations which could be done in your centre.	Carry out redox titrations, following given methods and use the experience to write an article explaining how the techniques work and the uses to which the techniques are put locally.
P7, M5, D4	Reaction of Transition Metal Ions	As a research chemist you are investigating transition metal ions.	Practical report on investigation

Links to National Occupational Standards, other BTEC units, other BTEC qualifications and other relevant units and qualifications

This unit forms part of the *BTEC Applied Science* sector suite. This unit has particular links with the units shown below in the BTEC Applied Science suite of qualifications:

Level 2	Level 3
Chemistry and Our Earth	Industrial Chemical Reactions
Applications of Chemical Substances	Chemistry for Biology Technicians

Essential resources

Learners should have access to a laboratory, suitable textbooks and the internet. They should have access to computers in order to vary the way that assignment work is presented. Suitable resources containing a compilation of data on the physical and chemical properties of elements and compounds should be available for learning outcome 1 so that learners may concentrate on identifying trends in data.

Employer engagement and vocational contexts

Where possible, learners should visit or have visitors from local industrial companies. This is important in relation to production of inorganic substances, uses of inorganic substances and to quality control techniques which use redox titrations. Where this is not possible, learners should be provided with appropriate case study material and simulations.

Indicative reading for learners

Textbooks

Beavon R and Jarvis A – *Periodicity, Quantitative Equilibria and Functional Group Chemistry* (Nelson Thornes, 2001) ISBN 9780174482918

Beavon R and Jarvis A – *Structure Bonding and Main Group Chemistry, 2nd Edition (Nelson Advanced Science: Chemistry)* (Nelson Thornes, 2003) ISBN 9780748776559

Chapman B – *Transition Metals, Quantitative Kinetics and Applied Organic Chemistry, 2nd Edition (Nelson Advanced Science: Chemistry)* (Nelson Thornes, 2004) ISBN 9780748446580

Facer G – *Edexcel A2 Chemistry, 2nd Edition* (Hodder Education, 2009) ISBN 9780340957615

Facer G – *Edexcel AS Chemistry, 2nd Edition* (Hodder Education, 2008) ISBN 9780340957608

Facer G – *Make the Grade in AS and A2 Chemistry* (Nelson Thornes, 2003) ISBN 9780748772810

Fullick A and Fullick P – *Chemistry: Evaluation Pack (Heinemann Advanced Science)* (Heinemann Educational Secondary Division, 2000) ISBN 978140587758

Hill B and Hunt A – *Edexcel Chemistry for AS* (Hodder Murray, 2008) ISBN 9780340949085

Hill G and Holman J – *Chemistry in Context, 5th Edition* (Nelson Thornes, 2000) ISBN 9780174482765

Hill G and Holman J – *Chemistry in Context: Laboratory Manual and Student Guide, 5th Edition* (Nelson Thornes, 2000) ISBN 9780174483076

Lewis E and Berry M – *AS and A Level Chemistry* (Longman, 2000) ISBN 9780582337336

Lewis R and Evans W – *Chemistry, 3rd Edition* (Palgrave Macmillan, 2006) ISBN 9780230000117

Lister T and Osborne C – *Sodium Carbonate: A Versatile Material* (Royal Society of Chemistry, 2000) ISBN 9780854049240

Lister T – *Industrial Chemistry Case Studies* (Royal Society of Chemistry, 1999) ISBN 9780854049257

Pearson Education – *Chemical Storylines AS, 3rd Edition* (Heinemann, 2008) ISBN 9780435631475

Ramsden E N – *A-level Chemistry: AND Answers Key* (Nelson Thornes, 2004) ISBN 9780748753017

Journals

Chemistry Review

Chemical Science (RSC)

Chemistry World (RSC)

Journal of Chemical Education

Websites

www.chemguide.co.uk

www.chemsoc.org/viselements

www.ciec.org.uk

www.rsc.org/ChemistryWorld

www.school.co.uk/alevel/chemistry.html

www.webelements.com

Guide to chemistry

Visual interpretation of the table of elements

Chemical Industry Education Centre

Chemistry news online

Chemistry revision

Periodic table

Delivery of personal, learning and thinking skills

The table below identifies the opportunities for personal, learning and thinking skills (PLTS) that have been included within the pass assessment criteria of this unit.

Skill	When learners are ...
Independent enquirers	[IE1] describing periodic trends in a range of tabulated physical properties of elements and their compounds
Creative thinkers	[CT1,2,3] describing how the positions of elements in the periodic table are related to their electronic arrangement, in terms of SPD notation illustrating how the production of industrially important inorganic substances relates to the properties of the substances involved illustrating how the uses of substances relate to their properties [CT5] carrying out a range of simple investigations involving transition metal ions in aqueous solution
Reflective learners	[RL2] relating chemical reactions of elements and their compounds to the position of the elements in the periodic table describing analytical principles based on redox principles
Effective participators	[EP3] carrying out selected simple investigations involving transition metal ions in aqueous solution.

Although PLTS are identified within this unit as an inherent part of the assessment criteria, there are further opportunities to develop a range of PLTS through various approaches to teaching and learning.

Skill	When learners are ...
Independent enquirers	explaining trends in a range of tabulated physical properties of elements and their compounds [IE6] reviewing the applicability of an analytical technique involving oxidation and reduction to a range of industries
Creative thinkers	[CT1,4] analysing the extent to which properties of elements and their compounds may be predicted by knowing the position of the elements in the periodic table [CT3] comparing the means of commercial production of similar inorganic substances in relation to their properties
Reflective learners	[RL5] evaluating uses of substances in terms of their physical and chemical properties explaining analytical procedures in terms of oxidation states of the substances involved explaining selected reactions of transition metal ions in solution [RL6] using accurate chemical equations in explaining reactions involving transition metal ions in solution.

● Functional Skills – Level 2

Skill	When learners are ...
ICT – Use ICT systems	
Select, interact with and use ICT systems independently for a complex task to meet a variety of needs	searching the internet entering data word-processing documents to meet the requirements of assignments
Use ICT to effectively plan work and evaluate the effectiveness of the ICT system they have used	reflecting on the way that an assignment has been tackled
Manage information storage to enable efficient retrieval	saving information in suitable files in suitable folders
Follow and understand the need for safety and security practices	keeping food and drink away from computers not using someone else's login explaining how safety is addressed in the context of the tasks explaining why the it usage policy forbids certain actions
Troubleshoot	carrying out checks to identify the source of a problem encountered, eg missing file of work
ICT – Find and select information	
Select and use a variety of sources of information independently for a complex task	using data from the internet, books, data supplied by the tutor and the results of experiments to describe and explain trends in properties
Access, search for, select and use ICT-based information and evaluate its fitness for purpose	searching for data on trends in properties selecting appropriate data in trends in properties and evaluating whether it meets the requirements of the assignment task
ICT – Develop, present and communicate information	
Enter, develop and format information independently to suit its meaning and purpose including: <ul style="list-style-type: none"> • text and tables • images • numbers • records 	entering first ionisation energy data into a spreadsheet to improve presentation collating data in tables and writing about trends in data taking digital photographs of experiments and uploading these into suitable files saving images of industrial production of substances and uses of substances keeping records of properties studied
Bring together information to suit content and purpose	collecting information in one file for editing into a suitable format, eg to illustrate production methods for inorganic substances
Present information in ways that are fit for purpose and audience	presenting information in the formats required in the assignment briefs
Evaluate the selection and use of ICT tools and facilities used to present information	evaluating whether the presentation of data is appropriate in terms of the grading criteria
Select and use ICT to communicate and exchange information safely, responsibly and effectively including storage of messages and contact lists	sending emails to tutors with appropriate information attached demonstrating to tutors that email has been used appropriately responding to feedback on assignments

Skill	When learners are ...
Mathematics	
Understand routine and non-routine problems in a wide range of familiar and unfamiliar contexts and situations	analysing trends in data on elements and compounds
Identify the situation or problem and the mathematical methods needed to tackle it	using appropriate methods to tackle presentation problems, eg use of graphs
Select and apply a range of skills to find solutions	doing titration calculations and graphs
Use appropriate checking procedures and evaluate their effectiveness at each stage	estimating results making calculations using appropriate software or a calculator
Interpret and communicate solutions to practical problems in familiar and unfamiliar routine contexts and situations	writing reports about trends in data using suitable mathematical language
Draw conclusions and provide mathematical justifications	correctly identifying trends in data, using examples
English	
Speaking and listening – make a range of contributions to discussions and make effective presentations in a wide range of contexts	taking part in class discussions about how trends may be described interacting with external, industrial speakers presenting data on trends in properties of substances
Reading – compare, select, read and understand texts and use them to gather information, ideas, arguments and opinions	reading and comparing information from text and tables using persuasive language in writing an article about careers in the process chemistry industry
Writing – write documents, including extended writing pieces, communicating information, ideas and opinions, effectively and persuasively	writing laboratory reports, articles and notes as required by assignment briefs.