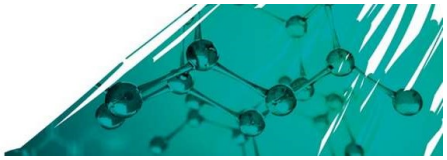


Unit title	Principles and Applications of Chemistry I
Guided learning hours	60
Number of lessons	30
Duration of lessons	2 hours

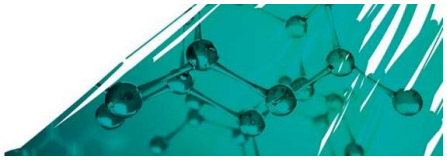
Links to other units

This unit links to:

- Unit 6: Principles and Applications of Chemistry II
- Unit 16: Applications of Inorganic Chemistry
- Unit 20: Applications of Physical Chemistry
- Unit 21: Applications of Organic Chemistry.

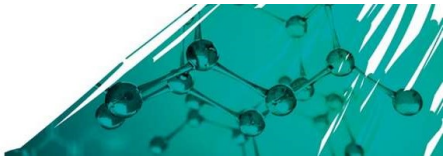
Key to lesson types			
AW	Assignment writing	**V**	Visit
GS	Guest speaker	**GW**	Group work
IS	Independent study		

Lesson	Topic	Lesson type	Suggested activities	Classroom resources
Learning aim A: Understand how atomic and electronic structure influence the arrangement of elements in the Periodic Table				
1-3	**A1: The Periodic Table and atomic structure** • Development of the Periodic Table • Features of the Periodic Table • Structure of the atom • Atomic and ionic radius • Mass number, isotopes and relative atomic mass	IS/GW	• **Introduce the unit:** outline the nature of the topics, and the examination that learners will be expected to complete for this unit. • **Paired activity:** as a means of checking prior knowledge, pairs identify elements from the symbols (or vice versa), charges and masses of the subatomic particles, etc. To engage learners, you could make this a competitive activity. • **Individual/small group activity:** give learners a list of substances and ask them to identify the elements, compounds and mixtures. • **Tutor presentation:** features and arrangement of the Periodic Table. Watch a video (or a series of videos) on YouTube which details the development of the Periodic Table. • **Paired activity:** label a blank Periodic Table, identifying the groups, numbering the periods/rows, and highlighting the metals and non-metals. • **Tutor-led activity:** discussion to clarify element symbols, atomic number, mass number/relative atomic mass, groups, periods, blocks, metallic elements, non-	• Paper and pens • Sticky notes • Tutor-created worksheets • Computers/interactive whiteboard • Periodic Table worksheet • Values for atomic and ionic radii • Mass spectra for a range of elements • Question sheets e.g. on RAM and isotopic abundances



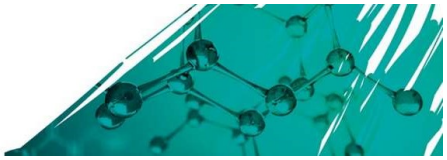
Lesson	Topic	Lesson type	Suggested activities	Classroom resources
			metallic elements and those that have a degree of metallic and non-metallic character. • **Individual activity:** create an information booklet to describe the features of the modern Periodic Table. • **Tutor presentation:** use short YouTube video clips to show the location of the subatomic particles. Learners could then complete a mix-and-match worksheet to identify the relative and actual charges and masses of subatomic particles. • **Paired activity:** ask learners to draw the atomic structures of the elements from hydrogen to calcium. • **Tutor presentation:** explanation of why atomic radii increase down a group and decrease across a period. • **Paired activity:** give learners a list of values for atomic radii and those for equivalent ionic radii (e.g. Cl vs.Cl^-, Na^+ vs. Mg^{2+}) and ask them to try and explain why some ionic radii decrease across a period while others increase. • **Tutor presentation:** discussion to explain trends in ionic radii across a period. This could include watching the video 'Ionic Radius vs Atomic Radius Periodic Trend' on YouTube • **Tutor-led activity:** recap of the structure of the atomic nucleus, in terms of protons and neutrons, and definition of isotopes. Have the class discuss: What is	

Lesson	Topic	Lesson type	Suggested activities	Classroom resources
			relative atomic mass (RAM)? How does it differ from mass number? • **Individual, pair and small group activity:** Give the class mass spectra of different elements and ask them to explain why there is more than one peak present and why some are higher than others. Lead a directed Q&A session to consolidate the explanation for the presence of isotopes. • **Tutor presentation:** explain that the relative atomic mass (RAM) is a weighted mean of the isotopes of the element, relative to the carbon 12 scale. This could be followed by giving learners a set of questions involving calculation of relative atomic mass from isotopic masses and abundances.	
4-5	**A2: Electronic structure** • Components of electronic structure • Rules that determine electronic structure and exceptions • Representations of electronic structure	IS/GW	• **Tutor presentation:** explain that electrons are arranged in energy levels or shells, and these can be further subdivided into subshells and orbitals (with reference to s, p and d). Learners can also watch a video on YouTube which explains shells, subshells and orbitals and the rules for building electronic configuration, and exceptions to this. • **Paired activity:** learners complete a worksheet whereby they write the electronic configurations for the elements from hydrogen to krypton, showing spin pairing in the orbitals. Follow this by giving learners a list	• Paper and pens • Interactive whiteboard • Internet access/computers • Tutor-created worksheet • Values of successive ionisation energies for a range of elements



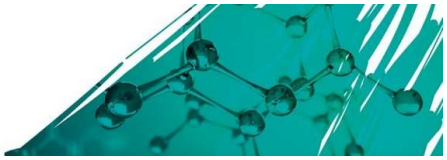
Lesson	Topic	Lesson type	Suggested activities	Classroom resources
	• Ionisation energy and evidence for electronic structure • Trends in ionisation energy.		of ions and ask them to write the s, p and d electronic configurations for these. • **Tutor presentation:** explanation of ionisation energy, highlighting its relationship with electronic configuration. • **Paired activity:** learners complete a worksheet whereby they write equations for the first and second ionisation energies for a range of elements. Then give them a list of successive ionisation energies for a particular element and ask them to plot a graph which they match to the electronic configuration of the element. • **Individual activity:** give learners a list of the successive ionisation energies for several elements and ask them to determine the likely ions formed by the elements. • **Whole group activity:** give learners data on the first ionisation energies of the elements from hydrogen to krypton, and discuss the trends down groups and across periods • **Paired activity:** ask learners to identify how the first ionisation energies of the elements from hydrogen to krypton can give evidence for theories on electronic configuration.	

Learning aim B: Understand how bonding and structure influence physical properties of substances				
6-7	**B1: Bonding and structure** • Metallic bonding • Ionic bonding • Covalent bonding • Double and triple bonds and dative covalent bonding, and properties	GW	• **Tutor presentation:** explanation of ionic, covalent and metallic bonding. Show short video clips and ask learners to complete an accompanying worksheet. Several of these are available on video sharing websites. • **Paired or small group activity:** learners create a picture board to illustrate the bonding arrangement in metals. Groups present feedback to the rest of the class. • **Paired or small group activity:** learners draw dot and cross diagrams to illustrate ionic and covalent bonding (single bonds) in a range of substances. Groups present feedback to the rest of the class. • **Paired or small group activity:** learners draw dot and cross diagrams to illustrate covalent bonding double and triple bonds in a range of substances. Groups present feedback to the rest of the class. • **Tutor presentation:** re-visit videos watched previously. Ask learners to complete an accompanying worksheet focusing on aspects of dative covalent bonding. • **Group activity:** some practical demonstration or participation in investigation of the properties of ionic, covalent and metallic substances, e.g. electrical/heat conductivity, hardness, tensile strength, crystalline structure, solubility, conductivity in solution etc.	• Pens and paper • Internet access/computers • Interactive whiteboard • Laboratory facilities • A range of metals, ionic and covalent substances • Ammeters/voltmeters/electrodes • Bunsen burners/heaters • Microscopes • Other apparatus and equipment as appropriate



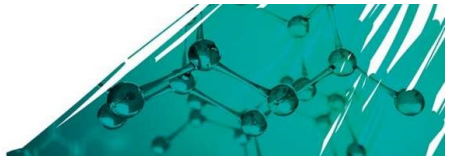
8	**B2: Molecular shape, polarity and intermolecular forces** • Electron pair repulsion theory	GW	• **Tutor presentation:** explanation of how electron pair repulsion theory is used to predict the shape of molecules, including compound ions. This could involve watching a video such as 'VSEPR Theory – Basic Introduction' on YouTube. • **Pair or small group activity:** learners use ball and stick models to build the structures of a range of molecular substances, e.g. water, ammonia, methane. Groups present feedback to the rest of the class. • **Individual activity:** ask learners to carry out further research into electron pair repulsion theory and the determination of molecular shape and bond angles. You can give learners test questions which check their understanding.	• Pens and paper • Internet access/computers • Interactive whiteboard • Ball and stick models
9-10	**B2: Molecular shape, polarity and intermolecular forces** • Electronegativity • Dipole-dipole forces • Hydrogen bonding	GW	• **Tutor presentation:** explanation of electronegativity and how it determines the polarity of bonds. Give learners a list of bonds to illustrate the dipoles present. • **Whole group activity:** Ask learners to research the electronegativity values for the elements in the Periodic Table from hydrogen to barium. Discuss trends down groups and across periods. Compare patterns of electronegativity with other aspects previously dealt with, such as atomic radius and ionisation energy. • **Paired activity:** give learners worksheets to determine the degree of polarity in different bonds, in terms of being full ionic, polar covalent or non-polar.	• Pens and paper • Internet access/computers • Interactive whiteboard • Tutor-devised worksheets • Values of melting/boiling point for hydrocarbons and halogenoalkanes • Values of melting/boiling point for the group 5, 6 and 7 hydrides

			• **Group activity:** ask learners to draw how the positive end of a dipole in one molecule can be attracted to the negative end of the same dipole in another molecule (for a range of compounds). Groups present feedback to the rest of the class. • **Tutor presentation:** explain that, as well as permanent dipoles in polar molecules, there can be temporary dipoles in non-polar molecules which can also lead to intermolecular attractions. • **Paired activity:** give learners melting/boiling point values for different types of hydrocarbons, e.g. alkanes, alkenes, halogenoalkanes, and investigate how this is related to the intermolecular forces present. • **Tutor presentation:** explain how hydrogen bonding is an important category of intermolecular attraction which has implications not only for chemistry but also for life in general. Learners could watch a video on Hydrogen bonding, such as 'Hydrogen Bonding | A-level Chemistry | AQA, OCR, Edexcel' on YouTube. • **Paired/group task:** give learners the values for the boiling points of the group 5, 6 and 7 hydrides and ask them to plot these against relative molecular mass. Groups present feedback to the rest of the class.	



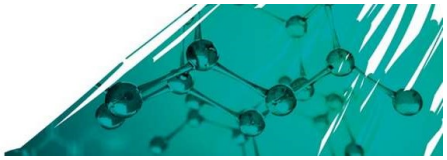
Learning aim C: Investigate how the properties of elements change in the Periodic Table and methods of extraction from compounds				
11	**C1: The s block elements**	IS/GW	• **Tutor presentation:** a more detailed description of the physical and chemical properties of the s block elements. This could involve watching a video on the s-block elements on YouTube • **Paired activity:** ask learners to investigate how the properties of the s block elements differ with regard to the two groups and as you go down the groups. • **Tutor-led activity:** discussion to review the trends in properties of the alkali and alkaline earth metals. This could also involve a quiz or Q&A session. • **Paired or small group activity:** learners partake in practical activities which investigate the reactions of s block elements with water and oxygen, displacement reactions (e.g. Mg/Cu), flame tests and the solubility of sulphates and hydroxides. Groups present feedback to the rest of the class. • **Individual activity:** give learners a worksheet which contains reactions for the s block elements and ask them to write balanced equations.	• Pens and paper • Internet access/computers • Interactive whiteboard • Laboratory facilities • Lithium, sodium, magnesium and calcium, salts of these • Test tubes/beakers/flasks • Bunsen burners/heaters Other apparatus and equipment as appropriate
12	**C2: The halogens**	IS/GW	• **Tutor presentation:** a detailed description of the physical and chemical properties of the halogens. This could involve watching a YouTube video. • **Individual task:** begin with 'as easy as A, B, C', where this time each particular property of the halogens is labelled A, B or C and each learner is given a letter (A, B or C). Learners work independently to research the	• Pens and paper • Internet access/computers • Interactive whiteboard • Laboratory facilities • Chlorine and bromine water, iodine, a range of

			corresponding property, and use the information gained to create an information booklet. On completion, learners join others working on the same properties to feed back to the rest of the class. • **Paired activity:** ask learners to investigate how the properties of the halogens differ with regard to the two groups and as you go down the groups. • **Paired or small group activity:** learners partake in practical activities which investigate reactivity of the halogens with metals, displacement reactions and reactivity with metal halides. They should also carry out tests for the halide ions using silver nitrate and ammonia solutions, as well as with concentrated sulphuric acid. Groups present feedback to the rest of the class. • **Individual activity:** give learners a worksheet which contains reactions of the halogens and ask them to write balanced equations.	metal halides, silver nitrate and ammonia solutions • Test tubes/beakers/flasks • Bunsen burners/heaters • Other apparatus and equipment as appropriate
13	**C3: Transition metals** **C4: Noble gases**	IS/GW	• **Individual activity:** give learners a worksheet whereby they can write the electronic configuration of the first row transition metals and some of their ions, to recap on previous learning. • **Individual or paired activity:** ask learners to research the physical and chemical properties of transition elements, including tensile strength, hardness, density, melting and boiling points, catalysis, coloured	• Pens and paper • Internet access/computers • Interactive whiteboard • Laboratory facilities • Transition metals such as iron, copper, zinc, dilute hydrochloric • Test tubes/beakers/flasks



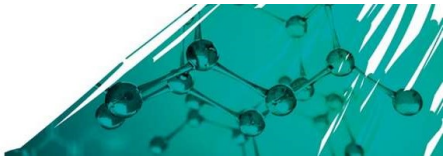
			compounds, formation of more than ion, and formation of complex ions. • **Paired or small group activity:** learners partake in practical activities which investigate physical properties and chemical reactivity of the transition metals, particularly reactivity with water, oxygen and dilute acids. Groups present feedback to the rest of the class. • **Whole group/class activity:** recap on the fact that the noble gases have a complete outer shell of electrons and therefore do not bond with each other and are generally unreactive. • **Tutor presentation:** a more detailed look at the physical properties of the noble gases and some of the few chemical reactions that some might partake in. This could include watching a video such as 'Noble Gases - The Gases In Group 18 | Properties of Matter | Chemistry | FuseSchool' on YouTube.	• Bunsen burners/heaters • Other apparatus and equipment as appropriate
14	**C5: Reduction and oxidation C6: Extraction of elements**	GW/IS	• **Tutor presentation:** explain the relationship between addition/removal of oxygen and gain/loss of electrons, giving useful examples (e.g. Mg + O). Explain rules for assigning oxidation numbers to elements, even in covalent compounds and compound ions. This could involve watching a YouTube video on redox reactions. • **Paired activity:** give learners a list of compounds and compound ions and ask them to determine the oxidation number of a particular element.	• Pens and paper • Internet access/computers • Interactive whiteboard • Tutor-devised list of compounds • Laboratory facilities • Solutions such as permanganate, dichromate, KI

			• **Tutor demonstration:** practical demonstration of a range of redox reactions, particularly those involving simple displacement and colour changes. • **Paired/individual activity:** give learners a list of reactions, including some looked at in the demonstration above. Ask them to write balanced half equations for oxidation and reduction, highlighting changes in oxidation number. • **Tutor presentation:** explain the principles behind extraction of metals – link to redox and reactivity series. This could involve watching a YouTube video on the extraction of metals. • **Individual task:** 'as easy as A, B, C', where a particular method used for extraction is labelled A, B or C and each learner is given a letter (A, B or C). Learners work independently to research the corresponding property, and use the information gained to create an information booklet. On completion, learners join others working on the same method to feed back to the rest of the class. • **Paired/group activity:** ask learners to research methods of extraction and make a leaflet or poster, explaining the methods of extraction and the application of the elements in terms of their properties.	• Test tubes/beakers/flasks • Other reagents, apparatus and equipment as appropriate



Learning aim D: Be able to determine reacting quantities in chemical reactions				
15	**D1: Reacting quantities** ● Relationship between mole, mass and molar mass ● Relationship between mole, gas molar volume and volume of a gas ● Relationship between mole, concentration and volume of a solution	GW/IS	● **Tutor presentation:** explain the mole concept and Avogadro's number, and relate molar mass to relative atomic, formula and molecular masses. This could involve watching a video such as 'Avogadro's Number, The Mole, Grams, Atoms, Molar Mass Calculations – Introduction' on YouTube. ● **Paired/individual activity:** give learners a worksheet to work out the number of atoms/ions, molecules/formula units in given masses of substances. ● **Tutor presentation:** explain the relationship between mole, gas molar volume and volume of a gas. This could involve watching a YouTube video on molar volume and calculating the volume of a gas using moles. ● **Individual/paired activity:** give learners examples to calculate the number of moles in a given volume of gas, the mass of a given volume of gas, the volume of gas produced in a reaction, etc. Again, this could be accompanied by a demonstration or practical activity, e.g. involving the determination of the volume of hydrogen produced from the reaction of magnesium with hydrochloric acid.	● Pens and paper ● Internet access/computers ● Interactive whiteboard ● Tutor-devised worksheet containing questions relating to moles, molar volumes of gases concentration and volume of a solution
16-18	**D2: Gravimetric and volumetric techniques**	GW/IS	● **Tutor presentation:** explain the principles behind gravimetric and volumetric analysis and again relate these to chemical stoichiometry and reacting masses. This could involve watching a video on the practical aspects of volumetric and gravimetric analysis on YouTube.	● Pens and paper ● Interactive whiteboard ● Laboratory facilities

			• **Group activity:** allow learners to practise the techniques involved in volumetric and gravimetric analysis. • **Paired activity:** give learners a solution containing a particular ion (e.g. Ca^{2+}) which they have to find the concentration of. Firstly they must plan the investigation, identifying the apparatus and equipment required, reagents, procedures involved and safety requirements. Once you have reviewed and approved the plan, the learners proceed with their gravimetric analysis to find the concentration of the ion in the given solution. Using their results obtained for the mass of precipitate formed, they use the appropriate calculation to work out the concentration. Feed back to the group as a whole and compare values obtained with those given by you for the solutions. • **Whole group/class activity:** discuss the practical activity with learners in the light of the results obtained, identifying common errors and making suggestions for improvement. • **Paired activity:** give learners a solution of unknown concentration (acid and/or base) which they have to find the concentration of by volumetric analysis. Firstly, they must plan the investigation, identifying the apparatus and equipment required, reagents, procedures involved and safety requirements. Once you have reviewed and approved the plan, the learners proceed with the volumetric analysis to find the concentration of the	• Solutions such as calcium chloride, barium chloride, sodium sulphate • Sodium hydroxide, sulphuric and hydrochloric acids, ethanoic acid, ammonia solution, methyl orange and phenolphthalein indicators • Beakers/conical/ volumetric flasks/pipettes, burettes, evaporating dishes, wash bottles • Other reagents, apparatus and equipment as appropriate



			given solution. Firstly, they must prepare a standard solution and then titrate the unknown solution with this, using a suitable indicator. Using the readings obtained from their titration (averaged), learners use the appropriate calculations to work out the concentration of the unknown solution. Feed back to the group as a whole and compare values obtained with those given by you for the unknown solution. • **Whole group/class activity:** discuss the practical activity with learners in the light of the results obtained for all analyses, identifying common errors and making suggestions for improvement.	
19	Revision		• **Individual activity:** Learners produce a revision list for all four learning aims and identify questions to ask and topics that need further researching.	• Pens and paper • Computer access • Research materials
20-30	Assessment using Pearson Set Assignment	IS	• 22 hours under controlled conditions are required for assessment. • Before learners start work on the formal assessment, ensure they are fully prepared and understand the assessment rules.	• Pearson Set Assignment

Pearson is not responsible for the content of any external internet sites. It is essential for tutors to preview each website before using it in class so as to ensure that the URL is still accurate, relevant and appropriate. We suggest that tutors bookmark useful websites and consider enabling learners to access them through the school/college intranet.