Tin Ka Ping Secondary School
Chemistry
NSS Syllabus

Topic 1: Planet Earth (8 hrs)

Unit	Knowledge & understanding	Skills and processes	Values of attitudes	Chinese culture
The atmosphere	- describe the processes involved in fractional distillation of liquid air, and understand the concepts and procedures involved	- demonstrate how to carry out a test for oxygen		
The ocean	describe various kinds of minerals in the sea - describe the processes involved in evaporation, distillation, crystallisation and filtration as different kinds of physical separation methods and understand the concepts and procedures involved	- demonstrate how to extract common salt and isolate pure water from sea water - evaluate the appropriateness of using evaporation, distillation, crystallisation and filtration for different physical separation situations - demonstrate how to carry out the flame test, test for chloride and test for water	- show concern over the limited reserve of natural resources	
Rocks and minerals	- describe the methods for the extraction of metals from their ores, such as the physical method, heating alone and heating with carbon - describe different forms of calcium carbonate in nature - understand that chemicals may change through the action of heat, water and acids	- use word equations to describe chemical changes - demonstrate how to carry out tests for carbon dioxide and calcium	- limit resources in the earth and save metals	

Topic 2: The microscopic world 1 (20 hrs)

Unit	Knowledge & understanding	Skills and processes	Values of attitudes	Chinese culture
Atomic structure	- state the relationship between element and atom - be aware that some elements possess characteristics of both metals and non-metals - state and compare the relative charges and the relative masses of a proton, a neutron and an electron	- use symbols to represent elements - classify elements as metals or non-metals on the basis of their properties - interpret and use symbols such as $_{23}Na_{11}$ - deduce the numbers of protons,	- appreciate the work of chemists on developing the structure of atom	

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	- describe the structure of an atom in terms of protons, neutrons and electrons - identify isotopes among elements with relevant information - relate the stability of noble gases to the octet rule	neutrons and electrons in atoms and ions with given atomic numbers and mass numbers - perform calculations related to isotopic masses and relative atomic masses - understand and deduce the electronic arrangements of atoms - represent the electronic arrangements of atoms using electron diagrams		
Periodic table	- understand that elements in the Periodic Table are arranged in order of ascending atomic number - define the group number and period number of an element in the Periodic Table - relate the position of an element in the Periodic Table to its electronic structure and vice versa - relate the electronic arrangements to the chemical properties of the Group I, II, VII and 0 elements - describe differences in reactivity of Group I, II and VII elements	- predict chemical properties of unfamiliar elements in a group of the Periodic Table	- Appreciate historical development of scientific knowledge changes over time.	
Metallic bonding and properties of metals	- describe the simple model of metallic bond - describe the general properties of metals - relate the properties of metals to their giant metallic structures			
Ionic and covalent bonding	- identify polyatomic ions - name some common cations and anions according to the chemical formulae of ions	- describe, using electron diagrams, the formation of ions and ionic bonds - draw the electron diagrams of		

Unit	Knowledge & understanding	Skills and processes	Values of attitudes	Chinese culture
	- name ionic compounds based on the component ions - describe the colours of some common ions in aqueous solutions - describe the structure of an ionic crystal - describe the formation of a covalent bond - define and distinguish the terms: formula mass and relative molecular mass	cations and anions - predict the ions formed by atoms of metals and non-metals by using information in the Periodic Table - interpret chemical formulae of ionic compounds in terms of the ions present and their ratios - construct formulae of ionic compounds based on their names or component ions - describe, using electron diagrams, the formation of single, double and triple bonds - interpret chemical formulae of covalent compounds in terms of the elements present and the ratios of their atoms - write the names and formulae of covalent compounds based on their component atoms - communicate scientific ideas with appropriate use of chemical symbols and formulae - perform calculations related to formula masses and relative molecular masses of compounds		
Dative covalent bond	- describe the formation of the dative covalent bond by means of electron diagram using H_3O^+ and NH_4^+ as examples			
Structures and properties of ionic and covalent substances	- describe giant ionic structures of substances such as sodium chloride and caesium chloride - state and explain the properties of ionic compounds in terms of their structures and bonding - describe simple molecular structures	- compare the structures and properties of 1substances with giant ionic, giant covalent, simple molecular and giant metallic structures - deduce the properties of substances from their structures and bonding,	- appreciate the structure of different substances	

Unit	Knowledge & understanding	Skills and processes	Values of attitudes	Chinese culture
	of substances such as carbon dioxide and iodine - recognise that van der Waals' forces exist between molecules - state and explain the properties of simple molecular substances in terms of their structures and bonding - describe giant covalent structures of substances such as diamond, graphite and quartz - state and explain the properties of giant covalent substances in terms of their structures and bonding	and vice versa - explain applications of substances according to their structures		

Topic 3: Metals (20 hrs)

Unit	Knowledge & understanding	Skills and processes	Values of attitudes	Chinese culture
Occurrence and extraction of metals	- state the sources of metals and their occurrence in nature - explain why extraction of metals is needed - understand that the extraction of metals involves reduction of their ores - describe and explain the major methods of extraction of metals from their ores - relate the ease of obtaining metals from their ores to the reactivity of the metals - describe metal ores as a finite resource and hence the need to recycle metals	- deduce the order of discovery of some metals from their relative ease of extraction - write word equations for the extraction of metals	- evaluate the recycling of metals from social, economic and environmental perspectives	- Extraction metal in China
Reactivity of metals	- describe and compare the reactions of some common metals with	- write the word equations for the reactions of metals with oxygen/air,		

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	oxygen/air, water and dilute acids - construct a metal reactivity series with reference to their reactions, if any, with oxygen/air, water and dilute acids - describe and explain the displacement reactions involving various metals and metal compounds in aqueous solutions - relate the extraction method of a metal to its position in the metal reactivity series	water and dilute acids - write balanced chemical equations to describe various reactions - use the state symbols (*s*), (*l*), (*g*) and (*aq*) to write chemical equations - relate the reactivity of metals to the tendency of metals to form positive ions - deduce the order of reactivity of metals from given information - write balanced ionic equations - predict the feasibility of metal reactions based on the metal reactivity series		
Reacting masses		- understand and use the quantitative information provided by a balanced chemical equation - perform calculations related to moles, Avogadro's constant and molar masses - calculate the percentage by mass of an element in a compound using appropriate information - determine empirical formulae and molecular formulae from compositions by mass and molar masses - calculate masses of reactants and products in a reaction from the relevant equation and state the interrelationship between them - solve problems involving limiting reagents		
Corrosion of metals and their protection	- describe the nature of iron rust - describe the essential conditions for the rusting of iron - describe and explain factors that	- describe the observations when a rust indicator (a mixture of potassium hexacyanoferrate(III) and phenolphthalein) is used in an	- be aware of the socio-economic impact of rusting	

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	influence the speed of rusting of iron - describe and explain the methods of rusting prevention as exemplified by coating with paint, oil or plastic i. galvanizing ii. tin-plating iii. electroplating iv. cathodic protection v. sacrificial protection vi. alloying - understand why aluminium is less reactive and more corrosion-resistant than expected - describe how the corrosion resistance of aluminium can be enhanced by anodisation	experiment that investigates rusting of iron		

Topic 4: Acids and bases (25 hrs)

Unit	Knowledge & understanding	Skills and processes	Values of attitudes	Chinese culture
Introduction to acids and alkalis	- recognise that some household substances are - acidic - state the common acids found in laboratory - describe the characteristics of acids and their typical reactions - relate acidic properties to the presence of hydrogen ions ($H^+(aq)$) - describe the role of water for acids to exhibit their properties - state the basicity of different acids such as HCl, H_2SO_4, H_3PO_4, CH_3COOH - define bases and alkalis in terms of	- write chemical and ionic equations for the reactions of acids - write chemical and ionic equations for the reactions of alkalis	• safety concern of handling acids and alkalis	

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	their reactions with acids - recognise that some household substances are alkaline - state the common alkalis found in the laboratory - describe the characteristics of alkalis and their typical reactions - relate alkaline properties to the presence of hydroxide ions ($OH^-(aq)$) - describe the corrosive nature of acids and alkalis and the safety precautions in handling them			
Indicators and pH	- state the colours produced by litmus, methyl orange and phenolphthalein in acidic solutions and alkaline solutions - describe how to test for acidity and alkalinity using - suitable indicators - relate the pH scale to the acidity or alkalinity of substances	- perform calculations related to the concentration of $H^+(aq)$ and the pH value of a strong acid solution - suggest and demonstrate appropriate ways to determine pH values of substances		
Strength of acids and alkalis	- describe the dissociation of acids and alkalis - relate the strength of acids and alkalis to their extent of dissociation - describe acids and alkalis with the appropriate terms: strong and weak, concentrated and dilute	- suggest and perform experiments to compare the strength of acids or alkalis		
Neutralization and salts	- state the general rules of solubility for common salts in water - suggest a method for preparing a particular salt - name the common salts formed from	- write chemical and ionic equations for neutralisation - describe the techniques used in the preparation, separation and purification of soluble and insoluble		

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	the reaction of acids and alkalis - explain some applications of neutralisation	salts		
Concentration of solutions		- convert the molar concentration of solutions to g dm^{-3} - perform calculations related to the concentration of solution		
Volumetric work involving acids and alkalis		- describe and demonstrate how to prepare solutions of a required concentration by dissolving a solid or diluting a concentrated solution - calculate the concentrations of the solutions prepared - describe and demonstrate the techniques of performing acid-alkali titration - apply the concepts of concentration of solution and use the results of acid-alkali titrations to solve stoichiometric problems - □ communicate the procedures and results of a - volumetric analysis experiment by writing a - laboratory report	• plan carefully before doing • sincere and in preparing a complicated project	

Topic 5: Fossil fuels and carbon compounds (20 hrs)

Unit	Knowledge & understanding	Skills and processes	Values of attitudes	Chinese culture
Hydrocarbons from fossil fuels	- describe the origin of fossil fuels - describe petroleum as a mixture of hydrocarbons and its industrial separation into useful fractions by fractional distillation - relate the gradation in properties (e.g.	- evaluate the impact of using fossil fuels on our quality of life and the environment	- recognise the economic importance of petroleum as a source of aliphatic and aromatic hydrocarbons (e.g. benzene)	

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	colour, viscosity, volatility and burning characteristics) with the number of carbon atoms in the molecules of the various fractions - explain the demand for the various distilled fractions of petroleum - recognise combustion of hydrocarbons as an exothermic chemical reaction - suggest measures for reducing the emission of air pollutants from combustion of fossil fuels		- recognise the pollution from the combustion of fossil fuels - Safety aware of using household fuels - Aware the pollution problems from burning fossil fuel - Save energy sources for environmental protection	
Homologous series, structural formulae and naming of carbon compounds	- explain the large number and diversity of carbon compounds with reference to carbon's unique combination power and ability to form different bonds - explain the meaning of a homologous series - understand that members of a homologous series show a gradation in physical properties and similarity in chemical properties	- write structural formulae of alkanes - give systematic names of alkanes - extend the knowledge of naming carbon compounds and writing structural formulae to alkenes, alkanols and alkanoic acids		
Alkanes and alkenes	- distinguish saturated and unsaturated hydrocarbons from the structural formulae - describe the following reactions of alkanes: a. combustion b. substitution reactions with chlorine and bromine, as exemplified by the reaction of methane and chlorine (or bromine) - recognise that cracking is a means to obtain smaller molecules including alkanes and alkenes - describe the reactions of alkenes with the following reagents:	- describe the steps involved in the monosubstitution of methane with chlorine using electron diagrams - describe how to carry out laboratory cracking of a petroleum fraction - demonstrate how to carry out chemical tests for unsaturated hydrocarbons	- explain the importance of cracking in the petroleum industry	

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	a. bromine b. potassium permanganate solution			
Addition polymers	- recognise that plastics are polymers built up from small molecules called monomers - recognise that alkenes, unsaturated compounds obtainable from cracking of petroleum fractions, can undergo addition reactions - understand that alkenes and unsaturated compounds can undergo addition polymerisation - explain the effect of heat on thermoplastics in terms of their structures	- describe addition polymerisation using chemical equations - deduce the repeating unit of an addition polymer obtained from a given monomer - deduce the monomer from a given section of a formula of an addition polymer	- recognise that plastics are mainly manufactured from chemicals derived from petroleum - understand the economic importance of plastics and pollution problems associated with the use and disposal of plastic items	

Topic 6: Microscopic world 2 (8 hrs)

Unit	Knowledge & understanding	Skills and processes	Values of attitudes	Chinese culture
Bond polarity	- define the electronegativity of an atom - explain the unequal sharing of electrons in covalent bonds - explain the non-polar nature of CH_4 and BF_3	- identify the partial charges of polar molecules such as HF, H_2O, NH_3 and $CHCl_3$		
Intermolecular forces	- explain the existence of van der Waals' forces in non-polar and polar covalent substances - state the factors affecting the strength of van der Waals' forces between molecules - describe the formation of hydrogen bonding as exemplified by HF, H_2O and NH_3 - understand the effect of hydrogen bonding on properties of substances	- compare the strength of van der Waals' forces with that of covalent bonds - compare the strength of van der Waals' forces with that of hydrogen bonding		

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	such as water and ethanol			
Structures and properties of molecular crystals	- describe the structures of ice and fullerenes - state and explain the properties of ice and fullerenes in terms of their structures and bonding			
Simple molecular substances with non-octet structures	- recognise the existence of covalent molecules with non-octet structures	- draw the electron diagrams of some non-octet molecules such as BF_3, PCl_5 and SF_6		
Shapes of simple molecules		- describe and draw three-dimensional diagrams to represent shapes of the following molecules: CH_4, NH_3, H_2O, BF_3, PCl_5 and SF_6		

Topic 7: Redox reactions, chemical cells and electrolysis (26 hours)

Unit	- Knowledge & understanding	Skills and processes	Values of attitudes	Chinese culture
Chemical cells in daily life	- distinguish between primary and secondary cells - describe the characteristics of common primary and secondary cells: i. zinc-carbon cell ii. alkaline manganese cell iii. silver oxide cell iv. lithium ion cell v. nickel metal hydride (NiMH) cell vi. lead-acid accumulator - understand the environmental impact of using dry cells	- justify uses of different chemical cells for particular purposes	• pollution problem on disposal of cells	
Reactions in simple	- explain the problems associated with a simple chemical cell consisting of two	- describe and demonstrate how to build simple chemical cells using		

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chemical cells	metal electrodes and an electrolyte - explain the functions of a salt bridge/porous device - explain the differences in voltages produced in chemical cells when different metal couples are used as electrodes	metal electrodes and electrolytes - measure the voltage produced by a chemical cell - describe and demonstrate how to build simple chemical cells using metal-metal ion half cells and salt bridges/porous devices - write a half equation representing the reaction at each half cell of a simple chemical cell - write overall equations for simple chemical cells - predict the electron flow in the external circuit and the chemical changes in the simple chemical cells		
Redox reactions	- identify redox reactions, oxidising agents and reducing agents on the basis of gain or loss of oxygen/hydrogen atom(s) gain or loss of electron(s) changes in oxidation numbers - describe the chemical changes of some common oxidising agents and reducing agents	- assign oxidation numbers to the atoms of elements and compounds - construct a general trend of the reducing power of metals and the oxidising power of metal ions - relate the trends of the reducing power and oxidising power of chemical species to their positions in a given electrochemical series - balance half equations of reduction and oxidation - balance redox equations by using half equations or changes in oxidation numbers		
Redox reactions in chemical cells	- describe the structure of a zinc-carbon dry cell - understand the principles of fuel cells as exemplified by the hydrogen-oxygen fuel cell	- predict the chemical changes at each half cell of the chemical cells with inert electrodes - write the half equation for reaction occurring at each electrode and the overall equation		

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		for reaction in a zinc-carbon dry cell - describe and construct chemical cells with inert electrodes - write a half equation for reaction occurring at each half cell and the overall ionic equation for reaction in the chemical cells with inert electrodes - write the half equation for reaction occurring at each electrode and the overall equation for reaction in a hydrogen-oxygen fuel cell - justify the use of fuel cells for different purposes		
Electrolysis	- describe the anodic and cathodic reactions, overall reaction and observable changes of the electrolyte in electrolytic cells - understand the principles of electroplating and the purification of copper - describe the anodic and cathodic reactions, overall reaction and observable changes of electrolyte in electroplating and the purification of copper - understand the environmental impact of the electroplating industry	- describe the materials needed to construct an electrolytic cell - predict products at each electrode of an electrolytic cell with reference to the factors affecting the preferential discharge of ions		
Importance of redox reactions in modern ways of living			- recognise the use of redox reactions in a wide range of industries and technological development - discuss the importance	

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			of redox reactions in modern ways of living	

Topic 8: Chemical reactions and energy (9 hours)

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Energy changes in chemical reactions	- explain energy changes in chemical reactions in terms of the concept of conservation of energy - describe enthalpy change, ΔH, as heat change at constant pressure	- explain diagrammatically the nature of exothermic and endothermic reactions in terms of enthalpy change - explain the nature of exothermic and endothermic reactions in terms of the breaking and forming of chemical bonds		
Standard enthalpy change of neutralization, solution, formation and combustion		- explain and use the terms: enthalpy change of reaction and standard conditions, with particular reference to neutralisation, solution, formation and combustion - carry out experimental determination of enthalpy changes using simple calorimetric method - calculate enthalpy changes from experimental results		
Hess's law		- apply Hess's law to construct simple enthalpy change cycles and enthalpy level diagrams - perform calculations involving such cycles and relevant energy terms, with particular reference to determining enthalpy change that cannot be found directly by experiment		

Topic 9: Rate of reactions (9 hours)

Unit	Knowledge & understanding	Skills and processes	Values of attitudes	Chinese culture
Rate of chemical reaction	- describe and justify the following techniques to follow the progress of a reaction: o titrimetric analysis o measurement of the changes in: volume /pressure of gases, mass of a mixture, colour intensity of a mixture and transmittance of light	- interpret a graph showing the progress of a reaction - determine instantaneous and average rate from a suitable graph		
Factors affecting rate of reaction	- explain qualitatively the effect of changes in concentration, surface area and temperature on the rate of reaction	- design and perform experiments to study the effects of o concentration, o temperature, o surface area, and o catalyst on rate of reaction - analyse data, interpret results and draw conclusions based on evidence collected through first-hand investigations	- appreciate the importance of catalyst in chemical industries and biological systems	
Molar volume of gases at room temperature and pressure		- deduce the molar volume of gases at r.t.p. as 24 dm^3 using a given data set - perform stoichiometric calculations involving molar volume of gases at r.t.p.		

Topic 10: Chemical equilibrium (10 hours)

Unit	Knowledge & understanding	Skills and processes	Values of attitudes	Chinese culture
Dynamic equilibrium	- describe reversible and irreversible reactions by using suitable examples - describe characteristics of a system existing in dynamic equilibrium			
Equilibrium constant		- express the mathematical relationship		

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		between concentrations of reactants and products at equilibrium and K_c		
The effect of changes in concentration and temperature on chemical equilibria	- recognise that the value of *Kc* for an equilibrium system is a constant at constant temperature irrespective of changes in concentration of reactants and products	- perform calculations involving K_c - perform practical work on the determination of K_c - derive inductively the relation of temperature and the value of K_c from given data sets - predict qualitatively the effect of temperature on the position of equilibrium from the sign of ΔH for the forward reaction - deduce the effect of change in concentration on the position of chemical equilibrium		

Topic 11: Chemistry of carbon compounds (27 hours)

Unit	Knowledge & understanding	Skills and processes	Values of attitudes	Chinese culture
Introduction to selected homologous series	- understand the effects of functional groups and the - length of carbon chains on physical properties of carbon compounds - identify common trivial names of some carbon compounds (e.g. formaldehyde, chloroform, acetone, isopropyl alcohol, acetic acid)	- give systematic names, general formulae, condensed formulae and structural formulae for: alkanes, alkenes, haloalkanes, alcohols, aldehydes and ketones, carboxylic acids, esters, unsubstituted amides and primary amines - draw the structures of the compounds based on their systematic names		
Isomerism	- understand that isomerism occurs when two or more compounds have the same molecular formula but different structures - recognise the existence of geometrical (*cis-trans*) isomerism in acyclic carbon compounds resulting from restricted rotation about a C=C bond - recognise the existence of enantiomerism in compounds with only one chiral carbon	- recognise and predict the existence of structural isomerism which includes isomers containing the same functional group and isomers containing different functional groups - show an understanding of structural and geometrical isomerism by predicting structures of the isomers of some given carbon compounds - use structural formulae and molecular models to demonstrate the arrangement of atoms in isomers of carbon compounds		
Typical reactions of various functional groups	- describe the following reactions, in terms of reagents, reaction conditions and observations,: ■ alkanes: substitution with halogens ■ alkenes: addition of hydrogen, halogens andhydrogen halides ■ haloalkanes: substitution with OH^-(aq) alcohols: substitution with halides using hydrogen halides or phosphorus trihalides; dehydration to alkenes; oxidation	- write the relevant chemical equations: ■ alkanes: substitution with halogens ■ alkenes: addition of hydrogen, halogens andhydrogen halides ■ haloalkanes: substitution with OH^-(aq) alcohols: substitution with halides using hydrogen halides or phosphorus trihalides; dehydration to alkenes; oxidation of primary alcohols to aldehydes and carboxylic acids; oxidation of secondary alcohols to ketones		Fermentation of alcohol in ancient China

Unit	Knowledge & understanding	Skills and processes	Values of attitudes	Chinese culture
	of primary alcohols to aldehydes and carboxylic acids; oxidation of secondary alcohols to ketones ■ aldehydes and ketones: oxidation and reduction using $K_2Cr_2O_7$ and $LiAlH_4$ respectively ■ carboxylic acids: esterification, reduction and amide formation ■ esters: hydrolysis ■ amides: hydrolysis	■ aldehydes and ketones: oxidation and reduction using $K_2Cr_2O_7$ and $LiAlH_4$ respectively ■ carboxylic acids: esterification, reduction and amide formation ■ esters: hydrolysis ■ amides: hydrolysis - □ predict and name the products of the above reactions		
Inter-conversions of carbon compounds	- suggest routes to convert one functional group into another by using the reactions described in (c) - state the reagents and conditions to accomplish conversions of carbon compounds using the reactions described in (c)	- predict the major organic products of reactions, with given starting materials, reagents and reaction conditions - describe how to carry out laboratory preparations and purification of simple carbon compounds such as ethanoic acid and ester - calculate the percentage yield of a product obtained from a reaction		
Important organic substances	- identify the functional groups of the acetylsalicylic acid molecule - recognise that aspirin is used as a drug to relieve pain, reduce inflammation and fever, and the risk of heart attack - describe the structures of soaps and soapless detergents - recognise that detergents can be made from chemicals derived from petroleum - explain the wetting and emulsifying properties of detergents in relation to their structures - relate the cleansing action of soaps and soapless detergents to their structures - describe the structures of nylon and polyesters - state the uses of nylon and polyesters - recognise the structures of glucose and	- explain the difference in cleaning abilities of soaps and soapless detergents in hard water		

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	fructose - recognise the functional groups present in fats, oils and polypeptides			

Topic 12: Patterns in the chemical world (8 hours)

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Periodic variation in physical properties of the elements from Li to Ar	- describe the nature of bonding and structures of elements of Group I through Group 0 of the Periodic Table - describe the periodic variations of melting point and electrical conductivity of the elements	- interpret the variations in melting point and in electrical conductivity in terms of the bonding and structures of the elements, viz. the presence of metallic structures, covalent structures and molecular structures		
Bonding, stoichiometric composition and acid-base properties of the oxides of elements from Na to Cl	- describe the nature of bonding and stoichiometric composition of the oxides of elements from Na to Cl - describe the variation in behaviour of the following oxides in water: Na2O, MgO, Al2O3, SiO2, P4O10, SO2 and Cl2O	- recognise the variations of acid-base properties of the oxides of elements from Na to Cl as exemplified by Na2O, Al2O3 and SO2		
General properties of transition metals	- identify positions of the transition metals in the Periodic Table - recognise that most aqueous ions of transition metals are coloured - describe the colours of some transition metal ions such as $Fe^{3+}(aq)$, $Cr^{3+}(aq)$, $Cu^{2+}(aq)$ - describe that transition metals can exist in more than one oxidation states in their compounds, e.g. Fe^{2+} and Fe^{3+}; Mn^{2+}, MnO2 and $MnO4^{-}$			

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	- describe that transition metals and their compounds can be used as catalysts - describe the importance of transition metals			

Elective Part (select any 2 out of 3)
Topic 13: Industrial chemistry (26 hours)

Unit	Knowledge & understanding	Skills and processes	Values of attitudes	Chinese culture
Importance of industrial processes	- understand the recent progress in industrial processes such as the production of vitamin C to solve problems of inadequate or shrinking supply of natural products	- □ discuss the advantages and disadvantages of using industrial processes such as petrochemistry for manufacturing products from social, economic and environmental perspectives		Industrial preparation of Vitamin C in China
Rate equation	- understand the interrelationship between reaction rate, rate constant, concentration of reactants and order of reaction	- determine the rate equation of a chemical reaction by method of initial rate		
Activation energy		- draw an energy profile of a reaction - explain the relationship between temperature and reaction rate using Maxwell-Boltzmann distribution curve - determine the activation energy of a chemical reaction by i. gathering first-hand experimental data ii. with a given set of data		
Catalysis and industrial processes	- describe the characteristics of catalysts using suitable examples - understand that catalysts work by providing an alternative reaction route	-		

	- describe the effect of catalyst on reversible reactions - describe the applications of catalysis in industrial processes with examples such as iron in the Haber process and enzymes in the production of alcoholic drinks			
Industrial processes	- describe feedstock, principles, reaction conditions, procedures and products for processes involved in the production of ammonia - describe the process of the conversion of ammonia to fertilisers - explain the physicochemical principles involved in the production of ammonia - describe the importance of fertilisers to our world - describe the importance of the chloroalkali industry - explain the underlying chemical principles involved in the chloroalkali industry - describe the importance of methanol - describe feedstock, reaction conditions, procedures and products for processes involved in the manufacturing of methanol via syngas	- explain how industrial processes such as the Haber process often involve a compromise between rate, yield and economic considerations - describe and explain the practices associated with the use of raw materials, transportation and storage of products using the case of the production of fertilisers - discuss the advancement of the methanol production technology - evaluate the choice of a site for establishing a chemical plant using suitable criteria - discuss social, economic and environmental considerations of industrial processes as illustrated by the Haber process, the chloroalkali industry or the manufacturing of methanol via syngas	- recognise the significance of the conversion of methane to methanol	Fertilizer production in China
Green chemistry	- describe the relation between sustainable development and green chemistry	- calculate the atom economy of a chemical reaction - relate principles of green chemistry and practices adopted in the industrial processes as exemplified by the manufacture of acetic acid		

		(ethanoic acid) - evaluate industrial processes using principles of green chemistry		

Topic 14: Materials chemistry (26 hours)

Unit	Knowledge & understanding	Skills and processes	Values of attitudes	Chinese culture
Naturally occurring polymers	- explain the properties of cellulose and chitin in terms of their structures - explain the effect of structures on the properties of silicates as exemplified by chain silicates, sheet silicates and network silicates	- compare structural features of cellulose and chitin		
Synthetic polymers and plastics	- explain the terms "thermoplastics" and "thermosetting plastics" - describe the characteristics of addition polymers using examples like PTFE, PMMA and cyanoacrylate - describe the characteristics of condensation polymers: poly(ethylene terephthalate) (PET), nylon, Kevlar and urea-methanal - state the similarities and differences between addition polymerisation and condensation polymerisation - explain the properties of polymers in terms of their structures - recognise the applications of polymeric biomaterials - describe the process of making biodegradable plastics using PLA as an example - discuss the importance and problems of recycling plastics	- deduce the type of polymerisation reaction for a given monomer or a pair of monomers - deduce the repeating unit of a polymer obtained from a given monomer or a pair of monomers - write equations for the formation of addition and condensation polymers - relate the choice of fabrication processes to the properties of plastics and the uses of their products		
Metals and alloys	- describe the close-packed and open structures of metals - identify the unit cell and determine the coordination number of a given metallic	- relate the uses of alloys (e.g. steel and brass) to their properties as compared with the pure metals from		Metal building in China

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	structure - recognise that alloys are formed by the introduction of other elements into metals - explain the differences in properties (e.g. hardness and conductivity) between metals and alloys	given information		
Synthetic materials in modern life	- describe the chemical structures and different phases of organic liquid crystals - identify the structural features of substances that exhibit liquid-crystalline behaviour - recognise that ceramic materials come in a variety of chemical forms - explain the high melting point, electrical and - thermal insulating properties of ceramics in terms of their giant molecular structures - describe nanomaterials as organic or inorganic materials that have particle sizes up to 100 nm - state the uses of nanomaterials	- relate the uses of liquid crystals to their properties - relate the uses of ceramics to their properties		
Green chemistry	- describe the relation between sustainable development and green chemistry - understand the green chemistry practices in the production of synthetic materials including the use of less hazardous chemical synthesis and safer solvents and auxiliaries	- evaluate processes for the production of synthetic materials using the principles of green chemistry		

Topic 15: Analytical chemistry (26 hours)

Unit	Knowledge & understanding	Skills and processes	Values of attitudes	Chinese culture
Detecting the presence of chemical species	- select appropriate tools and apparatus for chemical tests - gather empirical information using chemical tests - decide on and carry out an appropriate chemical test to detect the presence of a chemical species - state the reaction conditions and	- justify the conclusion of the presence of a chemical species either orally or in written form - record observations accurately and systematically - assess possible risks associated with chemical tests - devise a scheme to separate a mixture of		

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	observations of the tests for the presence of carbonyl compounds using 2,4-dinitrophenylhydrazine and Tollens' reagent	known substances		
Separation and purification methods	- describe various separation and purification methods separate and purify substances by the following methods: i. crystallisation ii. distillation / fractional distillation iii. liquid-liquid extraction iv. chromatographic methods	- determine the R_f values of substances in a chromatogram - determine the melting point or boiling point of a substance - examine the purity of a substance by measuring its melting or boiling point - justify the choice of an appropriate method used for the separation of substances in a mixture		
Quantitative methods of analysis		- gather data with appropriate instruments and apparatus in quantitative analysis - record observations and data accurately and systematically - be aware of and take necessary steps to minimize possible sources of error - perform calculations on data obtained to draw evidence-based conclusions - present observations, data, results, conclusions and sources of error either orally or in written form - justify the choice of an appropriate quantitative method for the determination of the quantity of a substance - assess possible risks associated with quantitative analysis	-	
Instrumental analytical methods	- understand the basic principles deployed in the instrumental analytical methods, viz. colorimetry, IR spectroscopy and mass spectrometry - identify the following groups from an IR	- construct a calibration curve by measuring absorbance of standard solutions - determine the concentration of a solution using a calibration curve		

Unit	Knowledge & understanding	Skills and processes	Values of attitudes	Chinese culture
	spectrum and a given correlation table: C−H, O−H, N−H, C=C, C≡C, C=O and C≡N - identify the following groups from a mass spectrum: R^+, RCO^+ and $C_6H_5CH_2^+$	- analyse data from primary sources and draw evidence-based conclusions - analyse data from secondary sources, including textual and graphical information, and draw evidence-based conclusions - communicate information, and justify and defend evidence-based conclusions in both written and oral forms		
Contribution of analytical chemistry to our society	- recognise the use of modern instrumentation for analysis in daily life - discuss the role of analytical chemistry in modern ways of living such as gauging levels of atmospheric pollutants like CO and dioxin, and indoor air pollutants like formaldehyde - describe the role of forensic chemistry in providing legal evidence - discuss the role of analytical chemistry in the diagnosis, treatment and prevention of diseases			