Dot Point Notes

12- Chemistry

chemistry
N noun (plural chemistries)
1 the branch of science concerned with the properties and interactions of the substances of which matter is composed.
2 the chemical properties of a substance or body.
3 the emotional or psychological interaction between two people, especially when experienced as a powerful mutual attraction. (Oxford English Dictionary)

"The nitrogen in our DNA, the calcium in our teeth, the iron in our blood, the carbon in our apple pies were made in the interiors of collapsing stars. We are made of star stuff." Carl Sagan

Matter can be neither created nor destroyed, though it can be rearranged. Mass remains constant in an ordinary chemical change. This principle is known as the conservation of matter.

6.023×10^{23}

PERIODIC TABLE OF THE

KEY
Atomic Number
Symbol
Standard Atomic Weight
Name
79
Au
197.0
Gold

1 H 1.008 Hydrogen									
3 Li 6.941 Lithium	4 Be 9.012 Beryllium								
11 Na 22.99 Sodium	12 Mg 24.31 Magnesium								
19 K 39.10 Potassium	20 Ca 40.08 Calcium	21 Sc 44.96 Scandium	22 Ti 47.87 Titanium	23 V 50.94 Vanadium	24 Cr 52.00 Chromium	25 Mn 54.94 Manganese	26 Fe 55.85 Iron	27 Co 58.93 Cobalt	28 Ni 58.69 Nickel
37 Rb 85.47 Rubidium	38 Sr 87.61 Strontium	39 Y 88.91 Yttrium	40 Zr 91.22 Zirconium	41 Nb 92.91 Niobium	42 Mo 95.96 Molybdenum	43 Tc Technetium	44 Ru 101.1 Ruthenium	45 Rh 102.9 Rhodium	46 Pd 106.4 Palladium
55 Cs 132.9 Caesium	56 Ba 137.3 Barium	57–71 Lanthanoids	72 Hf 178.5 Hafnium	73 Ta 180.9 Tantalum	74 W 183.9 Tungsten	75 Re 186.2 Rhenium	76 Os 190.2 Osmium	77 Ir 192.2 Iridium	78 Pt 195.1 Platinum

Module 5: Equilibrium and Acid Reactions

Outcomes

A student:

- selects and processes appropriate qualitative and quantitative data and information using a range of appropriate media CH11/12-4
- analyses and evaluates primary and secondary data and information CH11/12-5
- solves scientific problems using primary and secondary data, critical thinking skills and scientific processes CH11/12-6
- communicates scientific understanding using suitable language and terminology for a specific audience or purpose CH11/12-7
- explains the characteristics of equilibrium systems, and the factors that affect these systems CH12-12

Content Focus

Chemical systems may be open or closed. They include physical changes and chemical reactions that can result in observable changes to a system. Students study the effects of changes in temperature, concentration of chemicals and pressure on equilibrium systems, and consider that these can be predicted by applying Le Chatelier's principle. Students also analyse the quantitative relationship between products and reactants in equilibrium reactions to determine an equilibrium constant. From this calculation, they predict the equilibrium position, either favouring the formation of products or reactants in a chemical reaction.

This module also allows students to understand that scientific knowledge enables scientists to offer valid explanations and make reliable predictions. Students make reliable predictions by comparing equilibrium calculations and equilibrium constants to determine whether a combination of two solutions will result in the formation of a precipitate.

Working Scientifically

In this module, students focus on processing data to determine patterns and trends that enable them to solve problems and communicate scientific understanding of ideas about equilibrium reactions. Students should be provided with opportunities to engage with all the Working Scientifically skills throughout the course.

Content

Static and Dynamic Equilibrium

Inquiry question: What happens when chemical reactions do not go through to completion?

Students:

- conduct practical investigations to analyse the reversibility of chemical reactions, for example:
  - cobalt(II) chloride hydrated and dehydrated
  - iron(III) nitrate and potassium thiocyanate
  - burning magnesium
  - burning steel wool (ACSCH090)

Students:

- model static and dynamic equilibrium and analyse the differences between open and closed systems (ACSCH079, ACSCH091)

Students:

- analyse examples of non-equilibrium systems in terms of the effect of entropy and enthalpy, for example:
  - combustion reactions
  - photosynthesis

Students:

- investigate the relationship between collision theory and reaction rate in order to analyse chemical equilibrium reactions (ACSCH070, ACSCH094)

Factors that Affect Equilibrium

Inquiry question: What factors affect equilibrium and how?

Students:

- investigate the effects of temperature, concentration, volume and/or pressure on a system at equilibrium and explain how Le Chatelier's principle can be used to predict such effects, for example:
  - heating cobalt(II) chloride hydrate
  - interaction between nitrogen dioxide and dinitrogen tetroxide
  - iron(III) thiocyanate and varying concentration of ions (ACSCH095)

Students:

- explain the overall observations about equilibrium in terms of the collision theory (ACSCH094)

Students:

- examine how activation energy and heat of reaction affect the position of equilibrium

Calculating the Equilibrium Constant (K_{eq})

Inquiry question: How can the position of equilibrium be described and what does the equilibrium constant represent?

Students:

- deduce the equilibrium expression (in terms of K_{eq}) for homogeneous reactions occurring in solution (ACSCH079, ACSCH096)

Students:

- perform calculations to find the value of K_{eq} and concentrations of substances within an equilibrium system, and use these values to make predictions on the direction in which a reaction may proceed (ACSCH096)

Students:

- qualitatively analyse the effect of temperature on the value of K_{eq} (ACSCH093)

Students:

- conduct an investigation to determine K_{eq} of a chemical equilibrium system, for example:
  - K_{eq} of the iron(III) thiocyanate equilibrium (ACSCH096)

Students:

- explore the use of K_{eq} for different types of chemical reactions, including but not limited to:
  - dissociation of ionic solutions
  - dissociation of acids and bases (ACSCH098, ACSCH099)

Solution Equilibria

Inquiry question: How does solubility relate to chemical equilibrium?

Students:

- describe and analyse the processes involved in the dissolution of ionic compounds in water

Students:

- investigate the use of solubility equilibria by Aboriginal and Torres Strait Islander Peoples when removing toxicity from foods, for example:
  - toxins in cycad fruit

Students:

- conduct an investigation to determine solubility rules, and predict and analyse the composition of substances when two ionic solutions are mixed, for example:
  - potassium chloride and silver nitrate
  - potassium iodide and lead nitrate
  - sodium sulfate and barium nitrate (ACSCH065)

Students:

- derive equilibrium expressions for saturated solutions in terms of K_{sp} and calculate the solubility of an ionic substance from its K_{sp} value

Students:

- predict the formation of a precipitate given the standard reference values for K_{sp}

Students:

Module 6: Acid/Base Reactions

Outcomes

A student:

- develops and evaluates questions and hypotheses for scientific investigation CH11/12-1
- designs and evaluates investigations in order to obtain primary and secondary data and information CH11/12-2
- conducts investigations to collect valid and reliable primary and secondary data and information CH11/12-3
- analyses and evaluates primary and secondary data and information CH11/12-5
- describes, explains and quantitatively analyses acids and bases using contemporary models CH12-13

Content Focus

Students analyse how and why the definitions of both an acid and a base have changed over time, and how the current definitions characterise the many chemical reactions of acids. Acids react in particular ways to a variety of substances. These reactions follow a pattern that students identify and explore in detail.

Acids and bases, and their reactions, are used extensively in everyday life and in the human body. The chemistry of acids and bases contributes to industrial contexts and the environment. Therefore, it is essential that the degree of acidity in these situations is continually monitored. By investigating the qualitative and quantitative properties of acids and bases, students learn to appreciate the importance of factors such as pH and indicators.

Working Scientifically

In this module, students focus on developing questions and testing hypotheses through designing, evaluating and conducting investigations to process and analyse data from acid/base reactions. Students should be provided with opportunities to engage with all the Working Scientifically skills throughout the course.

Content

Properties of Acids and Bases

Inquiry question: What is an acid and what is a base?

Students:

- investigate the correct IUPAC nomenclature and properties of common inorganic acids and bases (ACSCH067)

Students:

- conduct an investigation to demonstrate the preparation and use of indicators as illustrators of the characteristics and properties of acids and bases and their reversible reactions (ACSCH101)

Students:

- predict the products of acid reactions and write balanced equations to represent:
  - acids and bases
  - acids and carbonates
  - acids and metals (ACSCH067)

Students:

- investigate applications of neutralisation reactions in everyday life and industrial processes

Students:

- conduct a practical investigation to measure the enthalpy of neutralisation (ACSCH093)

Students:

- explore the changes in definitions and models of an acid and a base over time to explain the limitations of each model, including but not limited to:
  - Arrhenius' theory
  - Brønsted–Lowry theory (ACSCH064, ACSCH067)

Using Brønsted–Lowry Theory

Inquiry question: What is the role of water in solutions of acids and bases?

Students:

- conduct a practical investigation to measure the pH of a range of acids and bases

Students:

- calculate pH, pOH, hydrogen ion concentration ($[H^+]$) and hydroxide ion concentration ($[OH^-]$) for a range of solutions (ACSCH102)

Students:

- conduct an investigation to demonstrate the use of pH to indicate the differences between the strength of acids and bases (ACSCH102)

Students:

- write ionic equations to represent the dissociation of acids and bases in water, conjugate acid/base pairs in solution and amphiprotic nature of some salts, for example:
  - sodium hydrogen carbonate
  - potassium dihydrogen phosphate

Students:

- construct models and/or animations to communicate the differences between strong, weak, concentrated and dilute acids and bases (ACSCH099)

Students:

- calculate the pH of the resultant solution when solutions of acids and/or bases are diluted or mixed

Quantitative Analysis

Inquiry question: How are solutions of acids and bases analysed?

Students:

- conduct practical investigations to analyse the concentration of an unknown acid or base by titration

Students:

- investigate titration curves and conductivity graphs to analyse data to indicate characteristic reaction profiles, for example:
  - strong acid/strong base
  - strong acid/weak base
  - weak acid/strong base (ACSCH080, ACSCH102)

Students:

- model neutralisation of strong and weak acids and bases using a variety of media

Students:

- calculate and apply the dissociation constant (K_a) and pK_a ($pK_a = -log_{10}(K_a)$) to determine the difference between strong and weak acids (ACSCH098)

Students:

- explore acid/base analysis techniques that are applied:
  - in industries
  - by Aboriginal and Torres Strait Islander Peoples
  - using digital probes and instruments

Students:

- conduct a chemical analysis of a common household substance for its acidity or basicity (ACSCH080) , for example:
  - soft drink
  - wine
  - juice
  - medicine

Students:

- conduct a practical investigation to prepare a buffer and demonstrate its properties (ACSCH080)

Students:

- describe the importance of buffers in natural systems (ACSCH098, ACSCH102)

Module 7: Organic Chemistry

Outcomes

A student:

- analyses and evaluates primary and secondary data and information CH11/12-5
- solves scientific problems using primary and secondary data, critical thinking skills and scientific processes CH11/12-6
- communicates scientific understanding using suitable language and terminology for a specific audience or purpose CH11/12-7
- analyses the structure of, and predicts reactions involving, carbon compounds CH12-14

Content Focus

Students focus on the principles and applications of chemical synthesis in the field of organic chemistry. Current and future applications of chemistry include techniques to synthesise new substances – including pharmaceuticals, fuels and polymers – to meet the needs of society.

Each class of organic compounds displays characteristic chemical properties and undergoes specific reactions based on the functional groups present. These reactions, including acid/base and oxidation reactions, are used to identify the class of an organic compound. In this module, students investigate the many classes of organic compounds and their characteristic chemical reactions. By considering the primary, secondary and tertiary structures of organic materials, students are provided with opportunities to gain an understanding of the properties of materials – including strength, density and biodegradability – and relate these to proteins, carbohydrates and synthetic polymers.

Working Scientifically

In this module, students focus on collecting, analysing and processing data and information to identify trends, patterns and relationships to solve problems and communicate scientific understanding of ideas about organic chemistry. Students should be provided with opportunities to engage with all the Working Scientifically skills throughout the course.

Content

Nomenclature

Inquiry question: How do we systematically name organic chemical compounds?

Students:

- investigate the nomenclature of organic chemicals, up to C8, using IUPAC conventions, including simple methyl and ethyl branched chains, including: (ACSCH127)
  - alkanes
  - alkenes
  - alkynes
  - alcohols (primary, secondary and tertiary)
  - aldehydes and ketones
  - carboxylic acids
  - amines and amides
  - halogenated organic compounds

Students:

Students:

- explore and distinguish the different types of structural isomers, including saturated and unsaturated hydrocarbons, including: (ACSCH035)
  - chain isomers
  - position isomers
  - functional group isomers

Hydrocarbons

Inquiry question: How can hydrocarbons be classified based on their structure and reactivity?

Students:

- construct models, identify the functional group, and write structural and molecular formulae for homologous series of organic chemical compounds, up to C8 (ACSCH035):
  - alkanes
  - alkenes
  - alkynes

Students:

- conduct an investigation to compare the properties of organic chemical compounds within a homologous series, and explain these differences in terms of bonding (ACSCH035)

Students:

- analyse the shape of molecules formed between carbon atoms when a single, double or triple bond is formed between them

Students:

- explain the properties within and between the homologous series of alkanes with reference to the intermolecular and intramolecular bonding present

Students:

- describe the procedures required to safely handle and dispose of organic substances (ACSCH075)

Students:

- examine the environmental, economic and sociocultural implications of obtaining and using hydrocarbons from the Earth

Products of Reactions Involving Hydrocarbons

Inquiry question: What are the products of reactions of hydrocarbons and how do they react?

Students:

- investigate, write equations and construct models to represent the reactions of unsaturated hydrocarbons when added to a range of chemicals, including but not limited to:
  - hydrogen (H_2)
  - halogens (X_2)
  - hydrogen halides (HX)
  - water (H_2O) (ACSCH136)

Students:

- investigate, write equations and construct models to represent the reactions of saturated hydrocarbons when substituted with halogens

Alcohols

Inquiry question: How can alcohols be produced and what are their properties?

Students:

- investigate the structural formulae, properties and functional group including:
  - primary
  - secondary
  - tertiary alcohols

Students:

- explain the properties within and between the homologous series of alcohols with reference to the intermolecular and intramolecular bonding present

Students:

- conduct a practical investigation to measure and reliably compare the enthalpy of combustion for a range of alcohols

Students:

- write equations, state conditions and predict products to represent the reactions of alcohols, including but not limited to (ACSCH128, ACSCH136):
  - combustion
  - dehydration
  - substitution with HX
  - oxidation

Students:

- investigate the production of alcohols, including:
  - substitution reactions of halogenated organic compounds
  - fermentation

Students:

- investigate the products of the oxidation of primary and secondary alcohols

Students:

- compare and contrast fuels from organic sources to biofuels, including ethanol

Reactions of Organic Acids and Bases

Inquiry question: What are the properties of organic acids and bases?

Students:

- investigate the structural formulae, properties and functional group including:
  - primary, secondary and tertiary alcohols
  - aldehydes and ketones (ACSCH127)
  - amines and amides
  - carboxylic acids

Students:

- explain the properties within and between the homologous series of carboxylic acids amines and amides with reference to the intermolecular and intramolecular bonding present

Students:

- investigate the production, in a school laboratory, of simple esters

Students:

- investigate the differences between an organic acid and organic base

Students:

- investigate the structure and action of soaps and detergents

Students:

- draft and construct flow charts to show reaction pathways for chemical synthesis, including those that involve more than one step

Polymers

Inquiry question: What are the properties and uses of polymers?

Students:

- model and compare the structure, properties and uses of addition polymers of ethylene and related monomers, for example:
  - polyethylene (PE)
  - polyvinyl chloride (PVC)
  - polystyrene (PS)
  - polytetrafluoroethylene (PTFE) (ACSCH136)

Students:

- model and compare the structure, properties and uses of condensation polymers, for example:
  - nylon
  - polyesters

Module 8: Applying Chemical Ideas

Outcomes

A student:

- develops and evaluates questions and hypotheses for scientific investigation CH11/12-1
- designs and evaluates investigations in order to obtain primary and secondary data and information CH11/12-2
- conducts investigations to collect valid and reliable primary and secondary data and information CH11/12-3
- selects and processes appropriate qualitative and quantitative data and information using a range of appropriate media CH11/12-4
- communicates scientific understanding using suitable language and terminology for a specific audience or purpose CH11/12-7
- describes and evaluates chemical systems used to design and analyse chemical processes CH12-15

Content Focus

The identification and analysis of chemicals is of immense importance in scientific research, medicine, environmental management, quality control, mining and many other fields.

Students investigate a range of methods used to identify and measure quantities of chemicals. They investigate and process data involving the identification and quantification of ions present in aqueous solutions. This is particularly important because of the impact of adverse water quality on the environment. Students deduce or confirm the structure and identity of organic compounds by interpreting data from qualitative tests of chemical reactivity and determining structural information using proton and carbon-13 nuclear magnetic resonance (NMR) spectroscopy.

Working Scientifically

In this module, students focus on developing and evaluating questions and hypotheses when: designing, evaluating and conducting investigations; analysing trends, patterns and relationships in data; and communicating scientific understanding about applying chemical ideas. Students should be provided with opportunities to engage with all the Working Scientifically skills throughout the course.

Content

Analysis of Inorganic Substances

Inquiry question: How are the ions present in the environment identified and measured?

Students:

- analyse the need for monitoring the environment

Students:

- conduct qualitative investigations – using flame tests, precipitation and complexation reactions as appropriate – to test for the presence in aqueous solution of the following ions:
  - cations: barium (Ba^{2+}), calcium (Ca^{2+}), magnesium (Mg^{2+}), lead(II) (Pb^{2+}), silver ion (Ag^{+}), copper(II) (Cu^{2+}), iron(II) (Fe^{2+}), iron(III) (Fe^{3+})
  - anions: chloride (Cl^{-}), bromide (Br^{-}), iodide (I^{-}), hydroxide (OH^{-}), acetate (CH_3COO^{-}), carbonate (CO_3^{2-}), sulfate (SO_4^{2-}), phosphate (PO_4^{3-})

Students:

- conduct investigations and/or process data involving:
  - gravimetric analysis
  - precipitation titrations

Students:

- conduct investigations and/or process data to determine the concentration of coloured species and/or metal ions in aqueous solution, including but not limited to, the use of:
  - colourimetry
  - ultraviolet-visible spectrophotometry
  - atomic absorption spectroscopy

Analysis of Organic Substances

Inquiry question: How is information about the reactivity and structure of organic compounds obtained?

Students:

- conduct qualitative investigations to test for the presence in organic molecules of the following functional groups:
  - carbon–carbon double bonds
  - hydroxyl groups
  - carboxylic acids (ACSCH130)

Students:

- investigate the processes used to analyse the structure of simple organic compounds addressed in the course, including but not limited to:
  - proton and carbon-13 NMR
  - mass spectrometry
  - infrared spectroscopy (ACSCH130)

Chemical Synthesis and Design

Inquiry question: What are the implications for society of chemical synthesis and design?

Students:

- evaluate the factors that need to be considered when designing a chemical synthesis process, including but not limited to:
  - availability of reagents
  - reaction conditions (ACSCH133)
  - yield and purity (ACSCH134)
  - industrial uses (eg pharmaceutical, cosmetics, cleaning products, fuels) (ACSCH131)
  - environmental, social and economic issues

Students:

Students:

Students: