Dot Point Notes

11- 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 1: Properties and Structure of Matter

Outcomes

A student:

- 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
- explores the properties and trends in the physical, structural and chemical aspects of matter CH11-8

Content Focus

Students analyse trends and patterns in relation to the properties of pure substances and use these to predict the properties of other pure substances. This knowledge is used to determine the ways in which substances can be separated from each other and those that allow them to remain together.

Matter can be either pure substances with distinct measurable properties (eg melting and boiling points, reactivity, strength, density) or mixtures with properties that are dependent on the identity and relative amounts of the substances that make up the mixture. The analysis of these properties has led to the expansion of the periodic table of elements and the advancement of atomic theory. This understanding has allowed for the development of complex models that have been subject to extensive peer review, and has contributed to advances in many disciplines over time.

Students use knowledge obtained from the study of the periodic table to examine trends and patterns that exist between chemical elements and atoms in order to discover that fundamental particles, and their role in the structure of an atom, give all chemicals their properties.

Working Scientifically

In this module, students focus on: designing, evaluating and conducting investigations; obtaining and processing data in the most appropriate manner; and communicating ideas about the structural, physical and chemical aspects of matter. Students should be provided with opportunities to engage with all Working Scientifically skills throughout the course.

Content

Properties of Matter

Inquiry question: How do the properties of substances help us to classify and separate them?

Students:

- explore homogeneous mixtures and heterogeneous mixtures through practical investigations:
  - using separation techniques based on physical properties (ACSCH026)
  - calculating percentage composition by weight of component elements and/or compounds (ACSCH007)

Students:

- investigate the nomenclature of inorganic substances using International Union of Pure and Applied Chemistry (IUPAC) naming conventions

Students:

- classify the elements based on their properties and position in the periodic table through their:
  - physical properties
  - chemical properties

Atomic structure and atomic mass

Inquiry question: Why are atoms of elements different from one another?

Students:

- investigate the basic structure of stable and unstable isotopes by examining:
  - their position in the periodic table
  - the distribution of electrons, protons and neutrons in the atom
  - representation of the symbol, atomic number and mass number (nucleon number)

Students:

- model the atom's discrete energy levels, including electronic configuration and spdf notation (ACSCH017, ACSCH018, ACSCH020, ACSCH022)

Students:

- calculate the relative atomic mass from isotopic composition (ACSCH024)

Students:

- investigate energy levels in atoms and ions through:
  - collecting primary data from a flame test using different ionic solutions of metals (ACSCH019)
  - examining spectral evidence for the Bohr model and introducing the Schrödinger model

Students:

- investigate the properties of unstable isotopes using natural and human-made radioisotopes as examples, including but not limited to:
  - types of radiation
  - types of balanced nuclear reactions

Periodicity

Inquiry question: Are there patterns in the properties of elements?

Students:

- demonstrate, explain and predict the relationships in the observable trends in the physical and chemical properties of elements in periods and groups in the periodic table, including but not limited to:
  - state of matter at room temperature
  - electronic configurations and atomic radii
  - first ionisation energy and electronegativity
  - reactivity with water

Bonding

Inquiry question: What binds atoms together in elements and compounds?

Students:

- investigate the role of electronegativity in determining the ionic or covalent nature of bonds between atoms

Students:

- investigate the differences between ionic and covalent compounds through:
  - using nomenclature, valency and chemical formulae (including Lewis dot diagrams) (ACSCH029)
  - examining the spectrum of bonds between atoms with varying degrees of polarity with respect to their constituent elements' positions on the periodic table
  - modelling the shapes of molecular substances (ACSCH056, ACSCH057)

Students:

- investigate elements that possess the physical property of allotropy

Students:

- investigate the different chemical structures of atoms and elements, including but not limited to:
  - ionic networks
  - covalent networks (including diamond and silicon dioxide)
  - covalent molecular
  - metallic structure

Students:

- explore the similarities and differences between the nature of intermolecular and intramolecular bonds and the strength of the forces associated with each, in order to explain the:
  - physical properties of elements
  - physical properties of compounds (ACSCH020, ACSCH055, ACSCH058)

Module 2: Introduction to Quantitative Chemistry

Outcomes

A student:

- designs and evaluates investigations in order to obtain primary and secondary data and information CH11/12-2
- selects and processes appropriate qualitative and quantitative data and information using a range of appropriate media CH11/12-4
- solves scientific problems using primary and secondary data, critical thinking skills and scientific processes CH11/12-6
- describes, applies and quantitatively analyses the mole concept and stoichiometric relationships CH11-9

Content Focus

Students are introduced to the quantitative nature of chemistry. Chemists must be able to quantify reactions in order to make predictions about yields and communicate with specific audiences for specific purposes using nomenclature, genres and modes unique to the discipline. Using the mole concept, students will have the opportunity to select and use appropriate mathematical representations to solve problems, make predictions and calculate the mass of reactants and products, whether solid, liquid or gas.

Students further develop their understanding of the universal language of chemistry. They are introduced to the idea that science is a global enterprise that relies on clear communication, international conventions, peer review and reproducibility.

Working Scientifically

In this module, students focus on designing and evaluating investigations that enable them to obtain quantitative data to help them solve problems related to quantitative chemistry. Students should be provided with opportunities to engage with all the Working Scientifically skills throughout the course.

Content

Chemical Reactions and Stoichiometry

Inquiry question: What happens in chemical reactions?

Students:

- conduct practical investigations to observe and measure the quantitative relationships of chemical reactions, including but not limited to:
  - masses of solids and/or liquids in chemical reactions
  - volumes of gases in chemical reactions (ACSCH046)

Students:

- relate stoichiometry to the law of conservation of mass in chemical reactions by investigating:
  - balancing chemical equations (ACSCH039)
  - solving problems regarding mass changes in chemical reactions (ACSCH046)

Mole Concept

Inquiry question: How are measurements made in chemistry?

Students:

- conduct a practical investigation to demonstrate and calculate the molar mass (mass of one mole) of:
  - an element
  - a compound (ACSCH046)

Students:

- conduct an investigation to determine that chemicals react in simple whole number ratios by moles

Students:

- explore the concept of the mole and relate this to Avogadro's constant to describe, calculate and manipulate masses, chemical amounts and numbers of particles in: (ACSCH007, ACSCH039)
  - moles of elements and compounds $n = \frac{m}{MM}$ (n = chemical amount in moles, m = mass in grams, MM = molar mass in $gmol^{-1}$)
  - percentage composition calculations and empirical formulae
  - limiting reagent reactions

Concentration and Molarity

Inquiry question: How are chemicals in solutions measured?

Students:

- conduct practical investigations to determine the concentrations of solutions and investigate the different ways in which concentrations are measured (ACSCH046, ACSCH063)

Students:

- manipulate variables and solve problems to calculate concentration, mass or volume using:
  - $c = \frac{n}{V}$ (molarity formula) (ACSCH063)
  - dilutions (*number of moles before dilution* = *number of moles of sample after dilution)*

Students:

- conduct an investigation to make a standard solution and perform a dilution

Gas Laws

Inquiry question: How does the Ideal Gas Law relate to all other Gas Laws?

Students:

- conduct investigations and solve problems to determine the relationship between the Ideal Gas Law and:
  - Gay-Lussac's Law (temperature)
  - Boyle's Law
  - Charles' Law
  - Avogadro's Law (ACSCH060)

Students:

Module 3: Reactive Chemistry

Outcomes

A student:

- 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
- explores the many different types of chemical reactions, in particular the reactivity of metals, and the factors that affect the rate of chemical reactions CH11-10

Content Focus

All chemical reactions involve the creation of new substances and associated energy transformations, which are commonly observable as changes in the temperature of the surroundings and/or the emission of light. These reactions are harnessed and controlled by chemists to produce substances that lead to the development of useful products.

Chemicals can react at many different speeds and in many different ways, yet they basically involve the breaking and making of chemical bonds. Students study how chemicals react, the changes in matter and energy that take place during these reactions, and how these chemical reactions and changes relate to the chemicals that are used in everyday life.

Working Scientifically

In this module, students focus on designing, evaluating and conducting investigations to obtain and process data in the most appropriate manner in relation to chemical reactions. Students should be provided with opportunities to engage with all the Working Scientifically skills throughout the course.

Content

Chemical Reactions

Inquiry question: What are the products of a chemical reaction?

Students:

- investigate a variety of reactions to identify possible indicators of a chemical change

Students:

- use modelling to demonstrate
  - the rearrangement of atoms to form new substances
  - the conservation of atoms in a chemical reaction (ACSCH042, ACSCH080)

Students:

- conduct investigations to predict and identify the products of a range of reactions, for example:
  - synthesis
  - decomposition
  - combustion
  - precipitation
  - acid/base reactions
  - acid/carbonate reactions (ACSCH042, ACSCH080)

Students:

- investigate the chemical processes that occur when Aboriginal and Torres Strait Islander Peoples detoxify poisonous food items

Students:

- construct balanced equations to represent chemical reactions

Predicting Reactions of Metals

Inquiry question: How is the reactivity of various metals predicted?

Students:

- conduct practical investigations to compare the reactivity of a variety of metals in:
  - water
  - dilute acid (ACSCH032, ACSCH037)
  - oxygen
  - other metal ions in solution

Students:

- construct a metal activity series using the data obtained from practical investigations and compare this series with that obtained from standard secondary-sourced information (ACSCH103)

Students:

- analyse patterns in metal activity on the periodic table and explain why they correlate with, for example:
  - ionisation energy (ACSCH045)
  - atomic radius (ACSCH007)
  - electronegativity (ACSCH057)

Students:

- apply the definitions of oxidation and reduction in terms of electron transfer and oxidation numbers to a range of reduction and oxidation (redox) reactions

Students:

- conduct investigations to measure and compare the reduction potential of galvanic half-cells

Students:

- construct relevant half-equations and balanced overall equations to represent a range of redox reactions

Students:

- predict the reaction of metals in solutions using the table of standard reduction potentials

Students:

- predict the spontaneity of redox reactions using the value of cell potentials (ACSCH079, ACSCH080)

Rates of Reactions

Inquiry question: What affects the rate of a chemical reaction?

Students:

- conduct a practical investigation, using appropriate tools (including digital technologies), to collect data, analyse and report on how the rate of a chemical reaction can be affected by a range of factors, including but not limited to:
  - temperature
  - surface area of reactant(s)
  - concentration of reactant(s)
  - catalysts (ACSCH042)

Students:

- investigate the role of activation energy, collisions and molecular orientation in collision theory

Students:

- explain a change in reaction rate using collision theory (ACSCH003, ACSCH046)

Module 4: Drivers of Reactions

Outcomes

A student:

- develops and evaluates questions and hypotheses for scientific investigation CH11/12-1
- 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 energy considerations in the driving force for chemical reactions CH11-11

Content Focus

Students investigate factors that initiate and drive a reaction. They examine the relationship between enthalpy and entropy in calculating the Gibbs free energy. They also examine the roles that enthalpy and entropy play in the spontaneity of reactions. Students are provided with opportunities to understand that all chemical reactions involve the creation of new substances and associated energy transformations, which are commonly observable as changes in temperature of the surrounding environment and/or emission of light.

Students conduct investigations to measure the heat energy changes that occur in chemical reactions. They describe reactions using terms such as endothermic and exothermic, and explain reactions in terms of the law of conservation of energy. They use Hess's Law to calculate enthalpy changes involved in the breaking and making of bonds.

Working Scientifically

In this module, students focus on developing questions and hypotheses to analyse trends, patterns and relationships in data in order to solve problems and communicate scientific understanding of ideas about the driving forces in chemical reactions. Students should be provided with opportunities to engage with all the Working Scientifically skills throughout the course.

Content

Energy Changes in Chemical Reactions

Inquiry question: What energy changes occur in chemical reactions?

Students:

- conduct practical investigations to measure temperature changes in examples of endothermic and exothermic reactions, including:
  - combustion
  - dissociation of ionic substances in aqueous solution (ACSCH018, ACSCH037)

Students:

- investigate enthalpy changes in reactions using calorimetry and $q = mc\Delta T$ (heat capacity formula) to calculate, analyse and compare experimental results with reliable secondary-sourced data, and to explain any differences

Students:

- construct energy profile diagrams to represent and analyse the enthalpy changes and activation energy associated with a chemical reaction (ACSCH072)

Students:

- model and analyse the role of catalysts in reactions (ACSCH073)

Enthalpy and Hess's Law

Inquiry question: How much energy does it take to break bonds, and how much is released when bonds are formed?

Students:

- explain the enthalpy changes in a reaction in terms of breaking and reforming bonds, and relate this to:
  - the law of conservation of energy

Students:

- investigate Hess's Law in quantifying the enthalpy change for a stepped reaction using standard enthalpy change data and bond energy data, for example: (ACSCH037)
  - carbon reacting with oxygen to form carbon dioxide via carbon monoxide

Students:

- apply Hess's Law to simple energy cycles and solve problems to quantify enthalpy changes within reactions, including but not limited to:
  - heat of combustion
  - enthalpy changes involved in photosynthesis
  - enthalpy changes involved in respiration (ACSCH037)

Entropy and Gibbs Free Energy

Inquiry question: How can enthalpy and entropy be used to explain reaction spontaneity?

Students:

- analyse the differences between entropy and enthalpy

Students:

- use modelling to illustrate entropy changes in reactions

Students:

- predict entropy changes from balanced chemical reactions to classify as increasing or decreasing entropy

Students:

- explain reaction spontaneity using terminology, including: (ACSCH072)
  - Gibbs free energy
  - enthalpy
  - entropy

Students:

- solve problems using standard references and $\Delta G^o = \Delta H^o - T\Delta S^o$ (Gibbs free energy formula) to classify reactions as spontaneous or nonspontaneous

Students:

- predict the effect of temperature changes on spontaneity (ACSCH070)

Students: