Government of Western Australia
School Curriculum and Standards Authority

SCIENCE IN PRACTICE

Unit GE002 – Acids and bases

Unit overview

Year 11

Acknowledgement of Country

Kaya. The School Curriculum and Standards Authority (the Authority) acknowledges that our offices are on Whadjuk Noongar boodjar and that we deliver our services on the country of many traditional custodians and language groups throughout Western Australia. The Authority acknowledges the traditional custodians throughout Western Australia and their continuing connection to land, waters and community. We offer our respect to Elders past and present.

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Contents

Unit GE002 – Acids and bases

Unit description

Acids and bases are important compounds in our daily lives. They are used in households, industry and agriculture. The effects of acids and bases can have environmental implications and play an important role in the lives of animals, including humans.

In this unit, students will use a range of practical and research inquiry skills to identify the properties of acids and bases and investigate chemical reactions, including the prediction and identification of products. They will investigate how acids and bases work in the human body and affect the environment. Students are encouraged to use information and communication technology to gather and interpret data, and communicate their findings in a variety of ways.

This unit integrates content from the Chemistry and Biology science disciplines.

Unit GE002 – Acids and bases is a semester-long unit equivalent to one course unit. The notional time for the unit is 55 class contact hours.

Unit content

Scientific method

- research a given topic and construct questions for investigation
- determine the appropriate methodology for investigations
- design scientific investigations, including the formulation of investigable questions and/or hypotheses, materials required, selection and/or modification of a procedure to be followed to collect valid and reliable data, and identification of safety and ethical considerations
- use equipment and techniques safely, competently and methodically to collect valid and reliable data, and use equipment with precision, accuracy and consistency
- represent qualitative and quantitative data in meaningful and useful ways, including the construction of appropriately labelled tables, processing of quantitative data using appropriate mathematical relationships and units, and drawing of appropriate graphs
- analyse data to identify and describe trends, patterns and relationships, and recognise errors and limitations in data
- draw conclusions consistent with the evidence and relevant to the question being investigated, identify further evidence that may be required, and recognise limitations of conclusions
- evaluate the investigative procedure, including the relevance, accuracy, validity and reliability of data, and suggest improvements
- communicate information and ideas in a variety of ways using scientific conventions and terminology, including the selection and presentation of data and ideas to convey meaning to selected audiences in written, oral and multimedia formats

Workplace health and safety

- use and apply workplace health and safety documents, including safety data sheets (SDS), and other relevant documents, such as standard operating procedures (SOP), when performing activities
- use appropriate scientific and technological equipment safely to gather data and information
- conduct risk assessments to identify potential hazards and prevent potential incidents and injuries

Scientific literacy

- distinguish between opinion, anecdote and evidence, and scientific and non-scientific ideas
- use reasoning to construct scientific arguments, and to draw and justify conclusions consistent with the evidence and relevant to the question under investigation
- identify examples of where the application of scientific knowledge may have beneficial and/or harmful and/or unintended consequences
- use scientific knowledge to develop and evaluate projected economic, social and environmental impacts and to design action for sustainability

Science understanding

Properties of acids and bases

- define an acid as a substance that can donate protons (H^+), and outline its properties
- define a base as a substance that can release hydroxide ions (OH^-) or accept protons, and outline its properties
- recall the chemical formula of some common acids, including
  - hydrochloric acid (HCl)
  - sulfuric acid (H_2SO_4)
  - nitric acid (HNO_3)
  - carbonic acid (H_2CO_3)
  - acetic acid (CH_3COOH)
- recall the chemical formula of some common bases, including
  - ammonia (NH_3)
  - oxides of metals, e.g. potassium oxide (K_2O)
  - hydroxides of metals, e.g. sodium hydroxide (NaOH) and calcium hydroxide ($Ca(OH)_2$)
  - carbonates of metals, e.g. calcium carbonate ($CaCO_3$)

pH and indicators

- recall that pH is used as a measure of the acidity of solutions and is dependent on the concentration of hydrogen ions in the solution
- use the pH scale to classify substances as acidic, basic or neutral
- select and use indicators, including universal indicator, litmus paper, methyl orange, phenolphthalein and plant-based indicators, to classify substances as acidic, basic or neutral
- use a pH meter or probe to classify substances as acidic, basic or neutral

Concentration versus strength

- outline the difference between a strong acid (e.g. hydrochloric acid or sulfuric acid) and a weak acid (e.g. acetic acid)
- define concentration and describe how concentration can affect reaction rate

Chemical reactions

- write the word equation and identify reactants and products in balanced chemical equations for reactions, including
    - acid and base (metal oxides or hydroxides)
    - acid and metal
    - acid and carbonate
- predict the products from observations of reactions, including
    - acid and base (metal oxides or hydroxides)
    - acid and metal
    - acid and carbonate

Acids and bases in the biological world

- explain the causes and impacts of ocean acidification on organisms and propose possible solutions to rectify or minimise the impacts
- explain acid rain formation and describe its possible impacts on organisms, rocks and metals
- describe ways in which organisms use and/or produce acids or bases for survival, including stings, venom and human digestion
- describe the different types of nitrogenous waste (i.e. ammonia, uric acid and urea) produced by different vertebrate groups and relate the properties of the waste product to the amount of water available in their environment

Course outline

The scientific method, workplace health and safety and scientific literacy content will be taught in each unit. The content from these areas aligns with the science understanding content of the unit and are integrated throughout the learning experiences.

Weeks	Teaching points
1	**Properties of acids and bases** • define an acid as a substance that can donate protons (H^+), and outline its properties • define a base as a substance that can release hydroxide ions (OH^-) or accept protons, and outline its properties • use equipment and techniques safely, competently and methodically to collect valid and reliable data, and use equipment with precision, accuracy and consistency • represent qualitative and quantitative data in meaningful and useful ways, including the construction of appropriately labelled tables, processing of quantitative data using appropriate mathematical relationships and units, and drawing of appropriate graphs • analyse data to identify and describe trends, patterns and relationships, and recognise errors and limitations in data • draw conclusions consistent with the evidence and relevant to the question being investigated, identify further evidence that may be required, and recognise limitations of conclusions • communicate information and ideas in a variety of ways using scientific conventions and terminology, including the selection and presentation of data and ideas to convey meaning to selected audiences in written, oral and multimedia formats • use and apply workplace health and safety documents, including safety data sheets (SDS), and other relevant documents, such as standard operating procedures (SOP), when performing activities • use appropriate scientific and technological equipment safely to gather data and information • conduct risk assessments to identify potential hazards and prevent potential incidents and injuries Examples of acids and bases, including their chemical formulae • recall the chemical formula of some common acids, including ▪ hydrochloric acid (HCl) ▪ sulfuric acid (H_2SO_4) ▪ nitric acid (HNO_3) ▪ carbonic acid (H_2CO_3) ▪ acetic acid (CH_3COOH) • recall the formula of some common bases, including ▪ ammonia (NH_3) ▪ oxides of metals, e.g. potassium oxide (K_2O) ▪ hydroxides of metals, e.g. sodium hydroxide (NaOH) and calcium hydroxide ($Ca(OH)_2$) ▪ carbonates of metals, e.g. calcium carbonate ($CaCO_3$) Effect of acid rain on plant growth – set up investigation • determine the appropriate methodology for investigations • use and apply workplace health and safety documents, including safety data sheets (SDS), and other relevant documents, such as standard operating procedures (SOP), when performing activities • use appropriate scientific and technological equipment safely to gather data and information

Weeks	Teaching points
	• conduct risk assessments to identify potential hazards and prevent potential incidents and injuries
2–3	**pH and indicators** • recall that pH is used as a measure of the acidity of solutions and is dependent on the concentration of hydrogen ions in the solution • use the pH scale to classify substances as acidic, basic or neutral • select and use indicators, including universal indicator, litmus paper, methyl orange, phenolphthalein and plant-based indicators, to classify substances as acidic, basic or neutral • use a pH meter or probe to classify substances as acidic, basic or neutral • use equipment and techniques safely, competently and methodically to collect valid and reliable data, and use equipment with precision, accuracy and consistency • represent qualitative and quantitative data in meaningful and useful ways, including the construction of appropriately labelled tables, processing of quantitative data using appropriate mathematical relationships and units, and drawing of appropriate graphs • analyse data to identify and describe trends, patterns and relationships, and recognise errors and limitations in data • draw conclusions consistent with the evidence and relevant to the question being investigated, identify further evidence that may be required, and recognise limitations of conclusions • communicate information and ideas in a variety of ways using scientific conventions and terminology, including the selection and presentation of data and ideas to convey meaning to selected audiences in written, oral and multimedia formats • use and apply workplace health and safety documents, including safety data sheets (SDS), and other relevant documents, such as standard operating procedures (SOP), when performing activities • use appropriate scientific and technological equipment safely to gather data and information • conduct risk assessments to identify potential hazards and prevent potential incidents and injuries
4	**Concentration versus strength** • outline the difference between a strong acid (e.g. hydrochloric acid or sulfuric acid) and a weak acid (e.g. acetic acid) • define concentration and describe how concentration can affect reaction rate • use equipment and techniques safely, competently and methodically to collect valid and reliable data, and use equipment with precision, accuracy and consistency • represent qualitative and quantitative data in meaningful and useful ways, including the construction of appropriately labelled tables, processing of quantitative data using appropriate mathematical relationships and units, and drawing of appropriate graphs • analyse data to identify and describe trends, patterns and relationships, and recognise errors and limitations in data • draw conclusions consistent with the evidence and relevant to the question being investigated, identify further evidence that may be required, and recognise limitations of conclusions • evaluate the investigative procedure, including the relevance, accuracy, validity and reliability of data, and suggest improvements

Weeks	Teaching points
	• communicate information and ideas in a variety of ways using scientific conventions and terminology, including the selection and presentation of data and ideas to convey meaning to selected audiences in written, oral and multimedia formats • use and apply workplace health and safety documents, including safety data sheets (SDS), and other relevant documents, such as standard operating procedures (SOP), when performing activities • use appropriate scientific and technological equipment safely to gather data and information • conduct risk assessments to identify potential hazards and prevent potential incidents and injuries
5–7	**Chemical reactions** • write the word equation and identify reactants and products in balanced chemical equations for reactions, including ▪ acid and base (metal oxides or hydroxides) ▪ acid and metal ▪ acid and carbonate • predict the products from observations of reactions, including ▪ acid and base (metal oxides or hydroxides) ▪ acid and metal ▪ acid and carbonate • use equipment and techniques safely, competently and methodically to collect valid and reliable data, and use equipment with precision, accuracy and consistency • represent qualitative and quantitative data in meaningful and useful ways, including the construction of appropriately labelled tables, processing of quantitative data using appropriate mathematical relationships and units, and drawing of appropriate graphs • analyse data to identify and describe trends, patterns and relationships, and recognise errors and limitations in data • draw conclusions consistent with the evidence and relevant to the question being investigated, identify further evidence that may be required, and recognise limitations of conclusions • evaluate the investigative procedure, including the relevance, accuracy, validity and reliability of data, and suggest improvements • communicate information and ideas in a variety of ways using scientific conventions and terminology, including the selection and presentation of data and ideas to convey meaning to selected audiences in written, oral and multimedia formats • use and apply workplace health and safety documents, including safety data sheets (SDS), and other relevant documents, such as standard operating procedures (SOP), when performing activities • use appropriate scientific and technological equipment safely to gather data and information • conduct risk assessments to identify potential hazards and prevent potential incidents and injuries **Assessment task 1 – Supervised written assessment (20%)**
8–10	**Identifying unknown substances as acidic** **Assessment task 2 – Investigation (40%)** • define an acid as a substance that can donate protons (H^+) and outline its properties • define a base as a substance that can release hydroxide ions (OH^-) or accept protons and outline its properties

Weeks	Teaching points
	• select and use indicators, including universal indicator, litmus paper, methyl orange, phenolphthalein and plant-based indicators, to classify substances as acidic, basic or neutral • write the word equation and identify reactants and products in balanced chemical equations for reactions, including ▪ acid and base (metal oxides or hydroxides) ▪ acid and metal ▪ acid and carbonate • predict the products from observations of reactions, including ▪ acid and base (metal oxides or hydroxides) ▪ acid and metal ▪ acid and carbonate • research a given topic and construct questions for investigation • determine the appropriate methodology for investigations • design scientific investigations, including the formulation of investigable questions and/or hypotheses, materials required, selection and/or modification of a procedure to be followed to collect valid and reliable data, and identification of safety and ethical considerations • use equipment and techniques safely, competently and methodically to collect valid and reliable data, and use equipment with precision, accuracy and consistency • represent qualitative and quantitative data in meaningful and useful ways, including the construction of appropriately labelled tables, processing of quantitative data using appropriate mathematical relationships and units, and drawing of appropriate graphs • analyse data to identify and describe trends, patterns and relationships, and recognise errors and limitations in data • draw conclusions consistent with the evidence and relevant to the question being investigated, identify further evidence that may be required, and recognise limitations of conclusions • evaluate the investigative procedure, including the relevance, accuracy, validity and reliability of data, and suggest improvements • communicate information and ideas in a variety of ways using scientific conventions and terminology, including the selection and presentation of data and ideas to convey meaning to selected audiences in written, oral and multimedia formats • use and apply workplace health and safety documents, including safety data sheets (SDS), and other relevant documents, such as standard operating procedures (SOP), when performing activities • use appropriate scientific and technological equipment safely to gather data and information • conduct risk assessments to identify potential hazards and prevent potential incidents and injuries • distinguish between opinion, anecdote and evidence, and scientific and non-scientific ideas • use reasoning to construct scientific arguments, and to draw and justify conclusions consistent with the evidence and relevant to the question under investigation
11–12	**Acids and bases in the biological world** • explain the causes and impacts of ocean acidification on organisms and propose possible solutions to rectify or minimise the impacts. • communicate information and ideas in a variety of ways using scientific conventions and terminology, including the selection and presentation of data and ideas to convey meaning to selected audiences in written, oral and multimedia formats

Weeks	Teaching points
	• distinguish between opinion, anecdote and evidence, and scientific and non-scientific ideas • use reasoning to construct scientific arguments, and to draw and justify conclusions consistent with the evidence and relevant to the question under investigation • identify examples of where the application of scientific knowledge may have beneficial and/or harmful and/or unintended consequences • use scientific knowledge to develop and evaluate projected economic, social and environmental impacts and to design action for sustainability **Assessment task 3 – Project (30%)**
13–15	**Acids and bases in the biological world** • explain acid rain formation and describe its possible impacts on organisms, rocks and metals • describe ways in which organisms use and/or produce acids or bases for survival, including stings, venom and human digestion • describe the different types of nitrogenous waste (i.e. ammonia, uric acid and urea) produced by different vertebrate groups and relate the properties of the waste product to the amount of water available in their environment • recall the chemical formula of some common acids, including ▪ hydrochloric acid (HCl) ▪ sulfuric acid (H_2SO_4) ▪ nitric acid (HNO_3) ▪ carbonic acid (H_2CO_3) ▪ acetic acid (CH_3COOH) • recall the chemical formula of some common bases, including ▪ ammonia (NH_3) ▪ oxides of metals, e.g. potassium oxide (K_2O) ▪ hydroxides of metals, e.g. sodium hydroxide (NaOH) and calcium hydroxide ($Ca(OH)_2$) ▪ carbonates of metals, e.g. calcium carbonate ($CaCO_3$) • recall that pH is used as a measure of the acidity of solutions and is dependent on the concentration of hydrogen ions in the solution • use the pH scale to classify substances as acidic, basic or neutral • select and use indicators, including universal indicator, litmus paper, methyl orange, phenolphthalein and plant-based indicators, to classify substances as acidic, basic or neutral • outline the difference between a strong acid (e.g. hydrochloric acid or sulfuric acid) and a weak acid (e.g. acetic acid) • define concentration and describe how concentration can affect reaction rate • write the word equation and identify reactants and products in balanced chemical equations for reactions, including ▪ acid and base (metal oxides or hydroxides) ▪ acid and metal ▪ acid and carbonate • predict the products from observations of reactions, including ▪ acid and base (metal oxides or hydroxides) ▪ acid and metal ▪ acid and carbonate • research a given topic and construct questions for investigation • determine the appropriate methodology for investigations

Weeks	Teaching points
	• design scientific investigations, including the formulation of investigable questions and/or hypotheses, materials required, selection and/or modification of a procedure to be followed to collect valid and reliable data, and identification of safety and ethical considerations • use equipment and techniques safely, competently and methodically to collect valid and reliable data, and use equipment with precision, accuracy and consistency • represent qualitative and quantitative data in meaningful and useful ways, including the construction of appropriately labelled tables, processing of quantitative data using appropriate mathematical relationships and units, and drawing of appropriate graphs • analyse data to identify and describe trends, patterns and relationships, and recognise errors and limitations in data • draw conclusions consistent with the evidence and relevant to the question being investigated, identify further evidence that may be required, and recognise limitations of conclusions • evaluate the investigative procedure, including the relevance, accuracy, validity and reliability of data, and suggest improvements • communicate information and ideas in a variety of ways using scientific conventions and terminology, including the selection and presentation of data and ideas to convey meaning to selected audiences in written, oral and multimedia formats • use and apply workplace health and safety documents, including safety data sheets (SDS), and other relevant documents, such as standard operating procedures (SOP), when performing activities • use appropriate scientific and technological equipment safely to gather data and information • conduct risk assessments to identify potential hazards and prevent potential incidents and injuries • identify examples of where the application of scientific knowledge may have beneficial and/or harmful and/or unintended consequences • use scientific knowledge to develop and evaluate projected economic, social and environmental impacts and to design action for sustainability **Assessment task 4 – Practical assessment (10%)**

Assessment outline

Assessment type	Assessment type weighting	Assessment task weighting	When	Assessment task
Investigation	40%	40%	Weeks 8–10	**Assessment task 2: Identifying unknown substances as acidic, basic or neutral** Students work in groups to plan and conduct the investigation and summarise their findings in a live or virtual poster presentation. Each student will prepare a written report to communicate their findings. Planning, working safety and group contributions will be monitored via student logbooks, responses to reflection questions, peer and self-assessments and teacher observations. Time: 12 hours
Project	30%	30%	Weeks 11–12	**Assessment task 3: Ocean acidification** Students will work individually to analyse and synthesise information from at least two different sources to illustrate a claim by explaining the relevant scientific concepts and describing the impact and/or influence on the selected organism, ecosystem and society. Students will use their research to produce a persuasive article a science magazine or newspaper. Time: 6 hours
Practical assessment	10%	10%	Week 15	**Assessment task 4: Observing acids and bases** Students will work individually to demonstrate their ability to perform simple tests and make observations to identify substances as acidic, basic or neutral following safety guidelines. Time: 50 minutes
Supervised written assessment	20%	20%	Week 7	**Assessment task 1: Acids and Bases** Students will work individually to answer short and extended answer questions on the identified syllabus content. Time: 50 minutes
Total	**100%**	**100%**		