# Unit 30: Understand the Principles of Chemistry for Biological and Medical Science

**Unit code:** A/600/9714

**QCF Level 3:** BTEC National

**Credit value:** 10

**Guided learning hours:** 60

## Aim and purpose

The aim of this unit is to enable learners to be familiar with basic chemical concepts which underpin biology and biomedical professions.

## Unit introduction

Biochemistry and physiology are essential components of the pre-clinical curriculum for veterinary and biomedical sciences: a base knowledge of chemistry ensures understanding of key concepts in this area. The regeneration of ATP in the respiratory chain, for example, requires knowledge of redox processes, enthalpy changes, atomic structure and chemical bonding and enzymes; understanding the processes of digestion and absorption requires knowledge of enzymes, chemical bonds and their breakdown, binding to transporter proteins, rates of reaction, properties of monovalent ions, solubility, chemical equilibrium and osmosis.

One of the most useful diagnostic tools available to biomedical practitioners is blood analysis. Though part of this will involve the study of blood cells (haematology), a significant proportion involves analysis of substances in the blood serum, such as sodium, potassium and chloride levels, and blood urea, nitrogen and ammonia. The values of these results can be presented in different units and therefore an understanding of the units, and the ability to convert to different units, is essential.

Accurate interpretation of blood serum analysis requires chemical knowledge in areas such as behaviour of elements/molecules and the periodic table, chemical reactions and kinetics, quantitative chemistry and disassociation of acids and bases.

In order to perform basic procedures and surgical operations, a veterinary practitioner will at some stage have to anaesthetise an animal. Though a lot of anaesthetics are liquids that are injected to induce anaesthesia, maintenance of anaesthesia usually relies on gaseous anaesthetic agents.

A chemical knowledge of physical properties of gases, solubility, substances and volatility is necessary to be able to safely administer these agents. A crucial part of anaesthesia includes monitoring of the patient, including levels of oxygen and carbon dioxide in the blood. A detailed knowledge of pH, acids and bases, and buffers is required to be able to determine if anaesthesia is being performed safely.

All those involved in biomedical sciences need to understand scientific literature. In order to understand the methods and be able to interpret the results of this research, a chemical knowledge is essential. This will include atomic structure, knowledge of substances, chemical reactions and equilibria, enthalpy, quantitative chemistry and acids, bases and buffering systems.

## Learning outcomes

**On completion of this unit a learner should:**

1 Be able to use the necessary skills to safely measure quantities for chemical reactions

2 Understand the effect of environmental conditions on rates of reaction

3 Understand the relationship between molecular bonding and enthalpy changes

4 Be able to interpret key features of equilibrium processes in fluid states.

# Unit content

## 1 Be able to use the necessary skills to safely measure quantities for chemical reactions

*Chemical reactions:* general, empirical and structural formulae; full chemical equations; acid-base equilibria including titration curves; volumetric calculations (eg M=CV; $M_aV_a = M_bV_b$)

*Quantitative chemistry*: Avogadro's constant; calculations based on mass, moles, volume and concentrations; dilution; units and interconversions (mol, $dm^3$, $cm^3$, mol $dm^{-3}$, g, g $mol^{-1}$)

*Practical skills:* laboratory safety symbol interpretation, laboratory hazard identification and risk assessment; use of indicators, titration, making standard solutions; accurate use of measuring cylinders, gas syringes and balances

## 2 Understand the effect of environmental conditions on rates of reaction

*Periodic table:* symbols, names, relative atomic mass and number of elements; periodicity and patterns (atomic structure and electronic configuration; physical and chemical properties of groups and rows)

*Reaction rates*: units (mol $dm^{-3}s^{-1}$); rate constant, reaction orders and mechanisms, rate determining steps; reaction profiles, activation energy

*Environmental conditions*: effects of changing concentration, particle size, surface area, temperature, addition of a catalyst (including enzymes)

*Practical work:* reaction rates under varying reaction conditions eg enzyme kinetics/magnesium and hydrochloric acid/zinc and sulphuric acid

## 3 Understand the relationship between molecular bonding and enthalpy changes

*Bonding*: ionic; covalent; hydrophilic/hydrophobic interactions, electronegativity; dipoles; hydrogen bonds; Van der Waals forces; intermolecular and intramolecular forces; solubility, melting and boiling points in relation to bonding; carbon bonding properties and importance.

*Substances*: salts; salt solutions; water; organic molecules; solids; liquids; gases; emulsions

*Enthalpy and enthalpy change*: entropy, system and surroundings; units of enthalpy change; standard conditions; exothermic and endothermic reactions; reaction profiles; activation energy; Hess's law

## 4 Be able to interpret key features of equilibrium processes in fluid states

*Proton concentrations*: pH; eg Kw; strength of acids and bases; Ka, pKa; use of the Henderson-Hasselbalch equation; conjugate acid and base; effect of pH on amino acids and enzymes; action, mechanism and biological importance of buffer solutions

*Chemical equilibrium*: principles of equilibrium; Le Chatelier's Principle (effects of concentration, temperature and pressure), equilibrium constants

*Concentrations either side of a membrane*: diffusion and osmosis in terms of water potential ($\psi$); membrane potential; diffusion of gases, kinetic theory of gases; blood serum analysis and indicators of common disorders

*Redox*: oxidation/reduction, oxidation states, oxidation numbers for organic compounds, displacement reactions; redox reactions of ATP in respiration

## Assessment and grading criteria

In order to pass this unit, the evidence that the learner presents for assessment needs to demonstrate that they can meet all the learning outcomes for the unit. The assessment criteria for a pass grade describe the level of achievement required to pass this unit.

| Assessment and grading criteria | | |
|---|---|---|
| **To achieve a pass grade the evidence must show that the learner is able to:** | **To achieve a merit grade the evidence must show that, in addition to the pass criteria, the learner is able to:** | **To achieve a distinction grade the evidence must show that, in addition to the pass and merit criteria, the learner is able to:** |
| **P1** perform volumetric calculations leading to accurate chemical quantities required for reactions [IE, SM] | | |
| **P2** identify hazards and controls associated with chemical reactions [SM] | **M1** outline the stages involved in preparation of standard solutions, including risk assessments | |
| **P3** measure accurately quantities of solid, liquid and gaseous chemicals [SM] | | |
| **P4** summarise properties of elements, groups and rows in the periodic table, in terms of:<br>(a) structure<br>(b) physical properties<br>(c) chemical properties<br>[IE, CT] | | |
| **P5** describe reaction mechanisms and profiles [IE] | | |
| **P6** identify environmental conditions that affect rates of reactions [IE I] | **M2** describe the effect of environmental changes on enzyme-catalysed reactions | |
| **P7** analyse the effect of environmental conditions on rates of reaction [IE I] | | **D1** evaluate the clinical benefits of understanding the effects of environmental changes on rates of reactions |
| **P8** explain ionic and covalent bonding [IE] | **M3** compare and contrast the ability of water and organic solvents to dissolve substances. | |

| Assessment and grading criteria | | |
|---|---|---|
| **To achieve a pass grade the evidence must show that the learner is able to:** | **To achieve a merit grade the evidence must show that, in addition to the pass criteria, the learner is able to:** | **To achieve a distinction grade the evidence must show that, in addition to the pass and merit criteria, the learner is able to:** |
| **P9** describe the bonding properties of carbon [IE] | | |
| **P10** analyse enthalpy changes for endothermic and exothermic reactions [IE, TW] | | |
| **P11** apply Hess's law to determine enthalpy changes in reactions [IE] | | |
| **P12** calculate pH values from proton concentrations and vice versa [IE] | | |
| **P13** analyse equilibria of liquids and gases across membranes [IE] | | |
| **P14** predict shifts in equilibrium due to:<br>(a) concentration<br>(b) temperature<br>(c) pressure<br>[IE] | | **D2** interpret blood serum analysis results, describing the occurrence of indicated disorders. |
| **P15** describe reduction and oxidation processes in biological systems. [IE] | | |

**PLTS**: This summary references where applicable, in the square brackets, the elements of the personal, learning and thinking skills applicable in the pass criteria. It identifies opportunities for learners to demonstrate effective application of the referenced elements of the skills.

| **Key** | IE – independent enquirers | RL – reflective learners | SM – self-managers |
|---|---|---|---|
| | CT – creative thinkers | TW – team workers | EP – effective participators |

# Essential guidance for tutors

## Delivery

Delivery of this unit will involve practical and written assessments, visits to suitable collections and will link to industrial experience placements.

All concepts should be linked to biological contexts and applications wherever possible – visits to diagnostic laboratories or guest lectures from clinical scientists, practising veterinarians or veterinary nurses are encouraged to ensure relevance of the chemistry to the learner. All practical work should be written up in standard scientific format, which may then be included as assessment evidence.

A varied programme of tuition, guided learning, practical work in the laboratory and problem solving should be used, helping learners to understand science, common scientific instruments and the use of these instruments in a vocationally relevant context.

Prior to any practical work, tutors must complete risk assessments and ensure that learners are aware of laboratory health and safety procedures. Personal protective equipment must be worn as and when appropriate, and learners must be made aware of any hazardous materials that may be used before any practical activity commences.

Learning outcomes 1 and 2 may be taught together as they are closely linked. Practical laboratory work, coupled with animations, games, model-making and diagrams should be used to motivate and enthuse learners. It is important that learners are aware of the health and safety aspects involved in laboratory work and hence this should come at the beginning of the unit.

It is recommended that tutors ensure learners are confident with basic mathematics prior to embarking on the more advanced mathematics throughout the unit.

Learning outcome 3 should be taught with a clinical slant – substances, for example, within the context of their homeostatic importance to animals; solubility in relation to drug administration; enthalpy changes in terms of reaction pathways, enzyme-catalysed reactions and the use of favourable reactions to drive unfavourable reactions. Animations and short videos are available on the internet, which can be used during teaching sessions or for guided tasks for learners to work their way through alone, with group summaries after the tasks have been completed.

Learning outcome 4 again should have a clinical context where possible: anonymous blood serum analysis data and other data relevant to this outcome should be obtainable from veterinary establishments. Case studies could be used to aid teaching and to engage learners so that they can directly see the relevance of the chemistry they are learning.

## Outline learning plan

The outline learning plan has been included in this unit as guidance and can be used in conjunction with the programme of suggested assignments.

The outline learning plan gives **an indication of the volume of learning it would take the average learner** to achieve the learning outcomes. It is **indicative and is one way of achieving the credit value.**

Learning time should address all learning (including assessment) relevant to the learning outcomes, regardless of where, when and how the learning has taken place.

| Topic and suggested assignments/activities and/assessment |
|---|
| Introduction to unit and assessment of prior knowledge. |
| Laboratory safety, hazard symbol interpretation, risk assessments (learners to carry out their own risk assessment of activities). |
| Periodic table and chemical equations: theory and games. |
| Periodicity: structure, physical and chemical properties. |
| Acids, bases and pH (introduction). |
| Quantitative chemistry and unit conversions: theory and practice |
| **Assignment 1: Standard Solutions** (P1, P2, (P3), M1)<br>Tutor introduces assignment brief. |
| Individual support. |
| **Assignment 2: Periodicity** (P4)<br>Tutor introduces assignment brief. |
| Personal study. |
| Rates of reaction: collision theory. Learners play the parts of colliding molecules and draw summary diagrams. |
| Graph drawing, reaction profiles, rate constants. |
| Guided internet research task: environmental conditions that affect rates of reactions. |
| Discussion and introduction to practical techniques for investigating rates of reaction. |
| **Assignment 3: Rates of Reaction** (P5, P6, P7)<br>Tutor introduces assignment brief. |
| Personal study. |
| Enzyme kinetics. |
| **Assignment 4: Rates of Enzyme-catalysed Reactions** ((P3), M2, D1)<br>Tutor introduces assignment brief. |
| Personal study. |
| Individual support. |
| Bonding, substances, solubility (including practical work on solubility of substances). |
| **Assignment 5: Bonding** (P8, P9, M3)<br>Tutor introduces assignment brief. |
| Personal study. |
| Enthalpy (including practical work investigating the standard enthalpy of combustion of fuels). |
| **Assignment 6: Enthalpy** (P10, P11)<br>Tutor introduces assignment brief. |

| Topic and suggested assignments/activities and/assessment |
|---|
| Personal study. |
| pH – acid dissociation, Henderson-Hasselbalch equation, effects on biological molecules (including practical work investigating the effects of buffer solutions). |
| Individual support. |
| **Assignment 7: pH calculations** (P12)<br>Tutor introduces assignment brief. |
| Personal study. |
| Chemical equilibrium, equilibrium constants and Le Chatelier's Principle, including demonstration of equilibrium using coloured water. |
| Diffusion in liquids and gases, kinetic theory of gases, osmosis investigation. |
| **Assignment 8: Equilibria** (P13, P14, D2)<br>Tutor introduces assignment brief. |
| Personal study. |
| Redox reactions: oxidation numbers and rules, definitions of reduction and oxidation, reducing and oxidising agents (including practical investigations), biological examples of redox reactions. |
| **Assignment 9: Redox Reactions and Biological Systems** (P15)<br>Tutor introduces assignment brief. |
| Personal study. |
| Unit summary. |
| Individual support. |

## Assessment

P1 requires learners to perform volumetric calculations (those in the specification as a minimum) for at least three separate reactions. This may be assessed during the write-up of practical investigations, with the original calculations included as evidence.

For P2, learners must identify at least three hazards associated with chemical reactions and how each may be controlled. Again this may be as part of write-ups of practical investigations.

A poster would also be suitable evidence.

P3 requires learners to use measuring equipment appropriately to measure two solids, two liquids and two gases, either as reactants or products of chemical reactions. Learners and tutors could complete observation sheets, which could then be attached to the write-up of the practical investigations they relate to.

For P4, learners are required to summarise the structure, physical and chemical properties of at least four elements, three groups and one row of the periodic table. Suitable evidence would be an illustrated essay or pictorial presentation with notes.

P5 requires learners to describe addition, substitution, elimination, condensation and hydrolysis reaction mechanisms, and profiles for at least two reactions. This could be assessed during write ups of practical investigations, or as an illustrated essay.

P6 and P7 should be assessed together, with learners both identifying and analysing the environmental conditions that affect rates of reactions. This could be done during practical investigation write-ups or as part of a short-answer test.

P8 requires learners to explain ionic and covalent bonding. They must include explanations and diagrams for at least two examples of each and discuss the covalent character of bonds between atoms and molecules. Suitable evidence for P8 would be an illustrated essay or pictorial presentation with notes.

P9 requires learners to describe the bonding properties of carbon, linking them to the importance of carbon as a biological molecule. Reference to the number of bonds and types of molecule which include carbon must be made. Suitable evidence would be in the same format as for P8.

P10 and P11 could be assessed together. For P10, learners must analyse the enthalpy changes for two endothermic and two exothermic reactions, describing the meaning of the changes in terms of bond breakage and formation. For P11, learners must determine enthalpy changes in two reactions that cannot be directly measured, such as the standard heat of formation of hydrocarbons, by applying Hess's Law. For both P10 and P11, learners may analyse data selected by the tutor or that which they have obtained experimentally: in the latter case, tutors must compare values with accepted values where applicable in order that the learner is not disadvantaged by problems with technique or equipment.

P12 requires learners to calculate pH from proton concentration and vice versa. At least two examples of each must be given. Suitable evidence would be question sheets completed by learners with the calculation steps and correct answers.

For P13, learners must analyse equilibria of liquids and gases across membranes. They must describe how equilibrium is reached in both cases, with specific reference to diffusion, osmosis; water potential and the resting potential of cells. Suitable evidence would be an illustrated essay.

P14 requires learners to outline Le Chatelier's Principle and describe how it affects the position of equilibrium for reactions when concentration, temperature and pressure are altered. Learners must then apply this to make predictions for increasing and decreasing each of the factors for reactions selected by the tutor. Suitable evidence would be a short report, essay or presentation with notes.

For P15, learners must describe the processes of reduction and oxidation including half equations to supplement the description and with at least three biological examples described.

For M1, learners need to explain how to prepare at least three concentrations of two standard solutions (for example HCl and NaOH). The explanation must include an equipment list; calculations of quantities of chemical required; dilution calculations and an accompanying risk assessment. Suitable evidence would be a protocol sheet or report.

M2 requires learners to describe the effect of environmental factors (concentration of substrate, concentration of enzyme, pH and temperature) on reactions catalysed by enzymes. Illustrative graphs and diagrams must be included. Suitable evidence would be an illustrated essay or part of a write-up of an enzyme kinetics practical.

For M3, learners must explain the process of solutes dissolving in solvents and go on to compare and contrast water and organic solvents in terms of their dissolving capabilities. At least one organic solvent should be named and explained. Evidence should be in the form of an illustrated essay, series of posters, pictorial presentation with notes or as part of a write-up of a practical investigation into solubility.

D1 requires learners to evaluate the clinical benefits of understanding the theory of rates of reaction. This may be in the context of drug metabolism, anaesthesia, monitoring patients/animals or other relevant context. Suitable evidence would be a hypothetical magazine article or illustrated essay.

For D2, learners must comment on the results of two blood serum analyses selected or created by tutors. Tutors should ensure that the results learners are given are indicative of one or more disorders. Learners must state the normal ranges of results for whichever species the blood is taken from and then describe the disorder that anomalous results indicate. Suitable evidence for D2 would be short-answer questions completed by learners accompanied by the blood serum analyses.

## Programme of suggested assignments

The following table shows a programme of suggested assignments that cover the pass, merit and distinction criteria in the grading grid. This is for guidance and it is recommended that centres either write their own assignments or adapt any Edexcel assignments to meet local needs and resources.

| Criteria covered | Assignment title | Scenario | Assessment method |
|---|---|---|---|
| P1, P2, (P3), M1 | Standard Solutions | Prepare, carry out and write up a practical investigation in order to prepare standard solutions of hydrochloric acid and sodium hydroxide, each at 0.1M, 1M and 2M. *Preparation:* Carry out the necessary volumetric calculations for the quantities of chemicals required and identify the hazards associated with the preparation. For merit level, carry out a full risk assessment.<br>*Carrying out:* Prepare the standard solutions safely, measuring accurately the solids and liquids involved.<br>For merit level, the process will be written up in full, with all calculations, materials and methods included. | Practical/written. |
| P4 | Periodicity | Write an illustrated essay to describe the structure, physical and chemical properties of four individual elements. Then describe the patterns in structure, physical and chemical properties for three groups and one row. | Written. |
| P5, P6, P7 | Rates of Reaction | Plan, carry out and write up an investigation into the effects of altering environmental conditions on rates of reaction. | Practical/written. |
| (P3), M2, D1 | Rates of Enzyme-Catalysed Reactions | Carry out an investigation into the effect of catalase on hydrogen peroxide produced by liver cells. Then look at the effects of temperature, varying concentrations of hydrogen peroxide and catalase, following a suitable protocol and measuring the amount of oxygen produced using a gas syringe.<br>For distinction level, you need to discuss the clinical benefits of understanding the effect of environmental conditions on rates of reactions. | |
| P8, P9, M3 | Bonding | Give a pictorial presentation entitled 'Bonding'. Explain ionic and covalent bonding, using suitable diagrams. They Describe the bonding in carbon-based molecules and analyse the link between the different number of bonds carbon can form and its versatility.<br>For merit level, you need to describe how substances dissolve, and compare and contrast the ways in which water and organic solvents dissolve substances, naming at least one specific organic solvent and a solute it will dissolve. | Presentation. |

| Criteria covered | Assignment title | Scenario | Assessment method |
|---|---|---|---|
| P10, P11 | Enthalpy | Learners are given a short answer test in which they are given data from two endothermic and two exothermic reactions and asked to a) identify which are endothermic and which are exothermic and b) compare the data in terms of bond breakage and bond formation.<br><br>Learners use the given data to calculate energy changes (of two separate reactions) that cannot be directly observed, such as the standard heat of formation of hydrocarbons. | Written. |
| P12 | pH Calculations | From given proton concentrations for three substances calculate the pH. Also, from the given pH of three substances calculate the proton concentrations | Written. |
| P13, P14, D2 | Equilibria | Write an illustrated essay to explain equilibria in liquids and gases across membranes, specifically discussing the processes of diffusion and osmosis, water potential and the resting potential of cells.<br><br>For distinction level, this should be followed by an explanation of dynamic equilibrium in chemical reactions and a discussion of how homeostatic mechanisms ensure that relatively constant levels of substances are carried in the blood. You need to analyse the blood serum results of two animals, one of which has abnormal glucose and alanine aminotransferase levels. Indicate those results that are within the normal range, identify those which are outside normal ranges and infer potential disorders that may produce those abnormal results. | Written. |
| P15 | Redox Reactions and Biological Systems | Produce a presentation with notes, explaining the processes of reduction and oxidation with the aid of half equations to illustrate the processes. Then outline three biological examples where redox reactions take place. | Presentation. |

## Links to National Occupational Standards, other BTEC units, other BTEC qualifications and other relevant units and qualifications

This unit forms part of the BTEC land-based sector suite. This unit has particular links with:

| Level 3 |
|---|
| Understand the Principles of Inheritance and Genetic Manipulation |
| Chemistry for Biology Technicians |

## Essential resources

Learners must have access to standard laboratory equipment, glassware and reagents. They also need access to the internet and good library facilities, with scientific textbooks and journals.

## Employer engagement and vocational contexts

Experience of any laboratory, especially veterinary and diagnostic laboratories, will be of great use to learners.

## Indicative reading for learners

### Textbooks


Atkins P and de Paula J – *Elements of Physical Chemistry* (Oxford University Press, 2009) ISBN 9780199226726

Burrows A, Parsons A, Price G, Holman J, and Pilling G – *Chemistry3: Introducing Inorganic, Organic and Physical Chemistry* (Oxford University Press, 2009) ISBN 9780199277896

Chapman C – *Basic Chemistry for Biology* (McGraw-Hill Education, 1998) ISBN 9780697360878

Clark J – *Calculations in AS/A Level Chemistry* (Longman, 2000) ISBN 978058241 1272

Dean J, Jones A, Reed R, Jones A, Weyers J and Holmes D – *Practical Skills in Chemistry* (Prentice Hall, 2001) ISBN 9780130280022

Lobban C and Sheffer M – *Successful Lab Reports: A Manual for Science Students* (Cambridge University Press, 1992) ISBN 9780521407410

Parsons R – *Head Start to AS Level Chemistry* (Coordination Group Publications, 2008) ISBN 9781847621160

Sackheim G – *An Introduction to Chemistry for Biology Students 9th Edition* (Pearson Education, 2007) ISBN 9780805395716

Winter M – *Chemical Bonding* (Oxford University Press, 1994) ISBN 9780198556947


### Journals

*Biological Sciences Review*

*Journal of Biological Chemistry*

*New Scientist*

*Pure and Applied Chemistry*

### Websites

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| Acids, bases and pH (University of British Columbia) | www.chem.ubc.ca/courseware/pH/launch.html |
| A-Level chemistry notes | www.a-levelchemistry.co.uk |
| BBC Schools, science, 16+ | www.bbc.co.uk/schools/websites/16/site/science.shtml |
| ChemBuddy chemical calculators | www.chembuddy.com |
| Chemguide | www.chemguide.co.uk |
| CLEAPSS | www.cleapss.org.uk |
| Creative Chemistry | www.creative-chemistry.org.uk/alevel |
| Demonstration protocol for teaching chemical equilibrium by Mike Briggs PhD | www.chem.purdue.edu/BCCE/Teaching_Chemical_Equilibrium.pdf |
| Human Touch of Chemistry | www.humantouchofchemistry.com |
| Information on blood serum analysis | www.matnet.com/~divs/disease/lab_tests.html |
| Teach interactive online resources for teachers | www.yteach.com |

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| National Physical Laboratory | www.npl.co.uk |
| Nuffield Advanced Chemistry | www.chemistry-react.org |
| Online games and quizzes for teaching chemical equations | www.funbasedlearning.com/chemistry |
| Practical Biology | www.practicalbiology.org |
| Practical Chemistry | www.practicalchemistry.org |
| Royal Society of Chemistry | www.rsc.org |
| Scientific Journals International | www.scientificjournals.org |
| Wellcome Trust (education resources) | www.wellcome.ac.uk/education-resources/index.htm |
| University of Newfoundland – interactive tutorial on diffusion and osmosis | www.mun.ca/biology/Osmosis_Diffusion/tutor2.html |
| Virtual CrezLab – resources by Crescent Girls' School | www.crescent.edu.sg/crezlab/Welcome.htm |

## Delivery of personal, learning and thinking skills (PLTS)

The following table identifies the PLTS opportunities that have been included within the assessment criteria of this unit:

| Skill | When learners are ... |
|---|---|
| **Independent enquirers** | identifying and carrying out volumetric calculations for correct chemical quantities in chemical reactions<br>analysing information to support comments on the properties of elements, groups and rows in the periodic table<br>planning and carrying out practical investigations into reaction mechanisms, profiles and rates of reactions<br>supporting conclusions about bonding types in substances<br>analysing enthalpy changes in reactions<br>analysing equilibria of liquids and gases across membranes<br>using information to predict shift in chemical equilibria<br>applying knowledge of redox reactions to explain biological examples |
| **Creative thinkers** | relating personal experiences to help explain the properties of elements, groups and rows in the periodic table |
| **Reflective learners** | using information about the properties of chemicals to explain shifts in chemical equilibria |
| **Team workers** | carrying out practical investigations into enthalpy changes |
| **Self-managers** | organising time, equipment and resources in order to carry out practical investigations safely and effectively<br>anticipating and managing risks in laboratory settings. |

Although PLTS opportunities are identified within this unit as an inherent part of the assessment criteria, there are further opportunities to develop a range of PLTS through various approaches to teaching and learning.

| Skill | When learners are ... |
|---|---|
| **Independent enquirers** | planning, carrying out and writing up practical investigations<br>researching information about chemical properties and practical techniques |
| **Creative thinkers** | investigating clinical applications of chemical knowledge |
| **Reflective learners** | presenting information in a variety of ways, including hypothetical magazine articles, posters and presentations |
| **Team workers** | working with others to carry out practical investigations and presenting results |
| **Self-managers** | organising time and resources to plan investigations and complete assignments. |

## Functional Skills – Level 2

| Skill | When learners are ... |
|---|---|
| **ICT – Find and select information** | |
| Select and use a variety of sources of information independently for a complex task | using the internet and online databases to find information |
| **ICT – Develop, present and communicate information** | |
| Enter, develop and format information independently to suit its meaning and purpose including:<br>• text and tables<br>• images<br>• numbers<br>• records | using software to produce assignments |
| Bring together information to suit content and purpose | using software to produce assignments |
| Present information in ways that are fit for purpose and audience | using software to produce posters, presentations and essays |
| **Mathematics** | |
| Identify the situation or problem and the mathematical methods needed to tackle it | calculating quantities of chemicals required for chemical reactions |
| Select and apply a range of skills to find solutions | investigating the effect of environmental conditions on reaction rates |
| Interpret and communicate solutions to practical problems in familiar and unfamiliar routine contexts and situations | investigating the effect of environmental conditions on reaction rates |
| Draw conclusions and provide mathematical justifications | calculating pH, proton concentrations and Ka<br>predicting movement of water across a membrane based on water potentials each side |
| **English** | |
| Speaking and listening – make a range of contributions to discussions and make effective presentations in a wide range of contexts | discussing key concepts and giving presentations |
| Reading – compare, select, read and understand texts and use them to gather information, ideas, arguments and opinions | collating research for producing written assignments |
| Writing – write documents, including extended writing pieces, communicating information, ideas and opinions, effectively and persuasively | producing written assignments. |