TLM Level 3 Diploma in Technical Science for Industry and Society

The Level 3 Diploma in Technical Science for Industry and Society builds on key principles of inclusive, accessible education, providing a structured pathway for learners seeking to develop practical knowledge in chemistry and its applications across industry and society. Designed to support progression from Level 2 study, this qualification offers meaningful opportunities for learners to deepen their understanding of atomic structure, bonding, reactivity, materials science, and sustainable chemical processes.

Each unit within the suite focuses on the real-world application of chemical principles, supporting both academic development and practical competence. From exploring reaction mechanisms and industrial processes to investigating green chemistry, analytical techniques, and electrochemistry, the qualification is built around a flexible structure that meets a wide range of learner needs and institutional contexts.

This qualification is suitable for post-16 learners, adult returners, and those preparing for further or higher study in areas such as applied science, healthcare, environmental management, or technical roles within the chemical industries. It supports varied learning styles and assessment approaches, incorporating coursework and applied tasks that enable learners to demonstrate both subject understanding and transferable skills in problem-solving, investigation, and professional communication.

The Regulated Qualifications Framework (RQF) was designed by the UK government's Qualifications and Curriculum Development Agency now replaced by Ofqual. The RQF is referenced to the European Qualifications Framework devised by the European Union

Contents

1. For those in a hurry!

1.1	TLM's assessment model is common to most of its qualifications. It is based on competence-based assessment of coursework using a portfolio of evidence and supported by a free optional cloud-based evidence management system.
1.2	Learners must demonstrate competence against the assessment criteria from their day-to-day work and the tutor assessor must verify that they are competent in relation to the general level descriptor using indicative assessment criteria. TLM's external moderator will check the judgements and the quality of the evidence and provide feedback. This process is not graded; the intention is that it is a flexible way of checking basic practical competence in the subject at the qualification's framework level.
Procedures	
1.3	The first thing to do is to arrange assessor training with TLM. TLM trains at least one assessor as Principal Assessor who must accept responsibility for standards within the Centre. The Principal Assessor can train and appoint assessors within the Centre as long as they are competent to take on the work and are willing to sign an agreement on the web site to uphold standards.
1.4	TLM will provide initial training in the pedagogical model, and using the supporting technologies to provide the evidence needed. The purpose is to get you started and then we provide on-going support to ensure you are confident and we can work as a professional partnership. We advise new Centres to do some coursework assessment early so that they can receive feedback and quickly become confident in doing routine coursework assessment. Our aim is to make this no more onerous than normal routine assessment that anyone would do as a normal part of the teaching job. This gives more time to focus on teaching and therefore to support raising attainment.

2. Introduction

The TLM Level 3 Diploma in Technical Science for Industry and Society offers a progression pathway from prior study by developing advanced skills in chemical principles, experimental techniques, and critical evaluation across a range of real-world contexts. Covering themes such as atomic structure, reaction kinetics and equilibria, organic and inorganic systems, sustainable and industrial chemistry, analytical methods, and professional laboratory practice, the qualification supports learners in building both subject-specific competence and broader transferable skills.

The Level 3 Diploma in Technical Science for Industry and Society **in** will give learners the opportunity to:

- Engage in applied learning that is relevant to industry, society and the environment, developing a range of experimental, analytical, research and problem-solving techniques essential for academic and professional progression
- Achieve a nationally recognised Level 3 qualification
- Strengthen personal growth and confidence through structured, meaningful tasks that encourage deeper engagement with scientific understanding and ethical responsibility

2.1 TLM Level 3 Diploma in Technical Science for Industry and Society

The objective of the qualification is to equip learners with the knowledge, confidence, and transferable skills needed to support their continued personal and professional development.

Mandatory Units

- Unit 1 - Building Blocks of Matter (4 Credits)
- Unit 2 - Exploring Interactions at the Atomic Level (4 Credits)
- Unit 3 - Quantitative Chemistry and Calculations (4 Credits)
- Unit 4 - Energy Flow in Chemical Systems (4 Credits)
- Unit 5 - Uncovering the Speed of Change (4 Credits)
- Unit 6 - Chemical Equilibria and Dynamic Reaction Systems (4 Credits)
- Unit 7 - Investigating Acidity, Alkalinity and Chemical Control (4 Credits)
- Unit 8 – Redox Reactions, Electrochemical Cells, and Industrial Applications (4 Credits)
- Unit 9 - Organic Compounds, Reaction Mechanisms, and Functional Applications (4 Credits)
- Unit 10: Laboratory Safety, Technique, and Professional Practice (4 Credits)

Optional Units

- Unit 11: Transition Metals, Complexes, and Catalytic Functions (3 Credits)
- Unit 12: Sustainable Chemistry, Environmental Impact, and Green Practices (3 Credits)
- Unit 13: Analytical Techniques in Chemistry (3 Credits)
- Unit 14: Industrial Chemistry, Innovation, and Sustainability (3 Credits)
- Unit 15: Independent Research, Investigation, and Scientific Communication (3 Credits)

3. Summary of Qualification Specification

3.1 Level 3 Diploma in Technical Science for Industry and Society (Annexe A)

The Level 3 Diploma in Technical Science for Industry and Society builds on key principles of inclusive, accessible education, providing a structured pathway for learners seeking to develop practical knowledge in chemistry and its applications across industry and society. Designed to support progression from Level 2 study, this qualification offers meaningful opportunities for learners to deepen their understanding of atomic structure, bonding, reactivity, materials science, and sustainable chemical processes

Qualification Title: TLM Level 3 Diploma in Technical Science for Industry and Society
Qualification Number: XXXXXXX
Qualification Level: Level 3
Total Credits: 46
Guided Learning Hours: 322
Total Qualification Time: 460
Assessment Methods: Coursework, E-assessment, Portfolio of Evidence

Assessment
Learners must demonstrate competence against the assessment criteria from their communication and involvement with the training materials and the trainer assessor must verify that they are competent in relation to the general level descriptor using indicative assessment criteria. TLM's external moderator will check the judgements and the quality of the evidence and provide feedback. This process is not graded; the intention is that it is a flexible way of checking basic practical competence in the subject at the qualification's framework level.

3.5 Assessment

The internally assessed, externally moderated coursework for all qualifications is pass/fail but by submitting the evidence for external moderation, feedback can be given to the tutor on areas to improve for resubmission.

Evidence must be provided against the unit assessment criteria from practical tasks related to the learners' everyday work supported by tutor observations, portfolio completed, and or activities in line with the learning materials

The way evidence is gathered is up to the assessor, the only requirement is that it clearly supports the judgements against the assessment criteria and the relevant learning outcomes.

If on formative assessment the account manager finds gaps in evidence relating to a particular candidate, they will request more evidence before approving the award or the unit certificate. Assessors must then adjust their work to ensure all their learners are providing the appropriate level and breadth of evidence.

We encourage early submission of at least some evidence so that assessors are confident from the feedback that what they are providing is sufficient. In this way we can maintain standards while supporting improved efficiency.

Centres will be subject to the TLM Centre Assessment Standards Scrutiny (CASS) and further details of this, including our centre guidance, is freely available on the TLM website in our Policy Download Centre. https://tlm.org.uk/policy-download-centre/

4. Qualification Content

Mandatory	Optional Unit Bank
None	
• Unit 1 - Building Blocks of Matter • Unit 2 - Exploring Interactions at the Atomic Level • Unit 3 - Quantitative Chemistry and Calculations • Unit 4 - Energy Flow in Chemical Systems • Unit 5 - Uncovering the Speed of Change • Unit 6 - Chemical Equilibria and Dynamic Reaction Systems • Unit 7 - Investigating Acidity, Alkalinity and Chemical Control • Unit 8 – Redox Reactions, Electrochemical Cells, and Industrial Applications • Unit 9 - Organic Compounds, Reaction Mechanisms, and Functional Applications • Unit 10: Laboratory Safety, Technique, and Professional Practice	• Unit 11: Transition Metals, Complexes, and Catalytic Functions • Unit 12: Sustainable Chemistry, Environmental Impact, and Green Practices • Unit 13: Analytical Techniques in Chemistry • Unit 14: Industrial Chemistry, Innovation, and Sustainability • Unit 15: Independent Research, Investigation, and Scientific Communication

5. Support

	Guidance and Assistance
5.1	There is further guidance for coursework assessment on the TLM web site. All centres have an assigned Account Manager who will be pleased to help at any time. Our aim is to give professional assessors, most of whom are qualified tutors, the confidence to make judgements with a minimum of bureaucracy so that they can focus their time on maintaining their professional knowledge, skills and supporting learning through effective teaching rather than "chasing paper". There is often a confusion between bureaucracy and rigour, since unnecessarily complex bureaucracy can actually detract from rigour by obscuring the importance of the outcomes.
5.2	**Web sites** - TLM provides support through cloud-based systems. Providing assessment grades and the management of certification through the Centre Management Site is mandatory and all assessors are provided with training in its use. It is simply a matter of recording learner competence against the unit criteria as the evidence is collected and claiming a certificate on behalf of the learner when a unit has been fully assessed.
5.3	The **community learning site** provides free optional facilities for learners to submit their evidence on-line, linking it to the assessment criteria across single or multiple units. The assessor can accept or reject this evidence and comment on it providing a full audit trail for evidence. Moderator/verifiers can get immediate access to this evidence and so it is potentially a lot more efficient than alternative methods. No paper, no e-mails with file attachments necessary. There are facilities for progress tracking that can be based on criteria and/or units. The system can be linked as an extension to any standards compliant VLE/e-portfolio system for centres that are already committed to a specific VLE product. Training can be provided, and free support is available from your Account Manager. The aim is to eliminate all paper-based bureaucracy, all screen-shots and referencing that draws time away from teaching.
5.4	**Telephone** and e-mail support are available to all Centres. There is a general convention of firstname.secondname@tlm.org.uk for e-mail addresses. It is usually best to e-mail your account manager in the first instance. Google hangouts can be arranged for video conferencing support.

6. Registration & Procedures

	Registration
6.1	TLM's registration model allows centres to enter learners at times convenient to them. There are no late entry fees and no additional fees should a learner fail to produce evidence at a level but can meet the criteria at a lower level. This can reduce costs to the centres when compared to other qualifications There are no fees for replacement certificates or verification of certificates because all certificates can be directly authenticated against TLM's secure database. For details of current subscription costs please contact us or refer to the web site.
	Internal standardisation
6.2	The Principal Assessor has the ultimate responsibility for consistency in assessment standards within a centre. All assessors have signed a contract agreeing to uphold standards and should therefore co-operate with the Principal Assessor and Account Manager at TLM to ensure that standards across the centre are consistent. It is advisable to send work samples to TLM early to check that evidence is at the right standard so that there is time to make any adjustments necessary to the course and learner expectations. TLM will generally check a higher quantity of work from new assessors and feedback to ensure that they are confident to make appropriate judgements over time. This reduces risk and improves efficiency in the longer term.
	Authentication
6.3	All assessors must take reasonable steps to ensure that any coursework evidence submitted by candidates is a true reflection of the candidates' competence. This is in keeping with the assessor undertaking to uphold and maintain standards in the contract with TLM.
6.4	Certificates can be authenticated directly on-line using the certificate number or by scanning the QR code on the certificate. There is no charge and it makes it more likely that certificates will be checked and that in turn improves security. Certificate forgeries are a significant problem when authentication is not simple and straightforward because convincing forgeries are easy to achieve with recent technologies and will get easier as time goes on.

7. Other Considerations

	Access arrangements and special requirements
7.1	All TLM's qualifications are intended to be accessible, as widely as possible. Please refer to the Annex for further information. Centres should contact TLM if they have any questions related to accessibility issues
	Language
7.2	The language for provision of this qualification is English only. This will only change if we have a significant demand in another language that is sufficient to cover the additional costs involved.
	Malpractice
7.3	TLM has comprehensive policies and procedures for dealing with malpractice. These are documented with links on the web site at https://tlm.org.uk/policy-download-centre/ Assessors should be familiar with these policies and make them clear to candidates. Assessors should inform their account manager if they suspect any instance of malpractice that could have a material effect on the outcome of any assessments, either for themselves or colleagues. This is part of the upholding of standards that is part of the contract with TLM.
	Equality of opportunity
7.4	TLM promotes equality of opportunity through policies and procedures. These are again documented in detail on the web site at https://tlm.org.uk/policy-download-centre/
	Resources, Support and Training
7.5	A clear goal is to enable learners to support all their IT user needs using resources freely and legally available from the internet. This is related directly to national policies for inclusion and equality of opportunity. The reality is that there is so much user dependence on proprietary applications that we can only support the transition to free and open resources through education and common sense.
7.6	TLM does not require centres to use Free and Open-Source applications but it certainly encourages them to do so. Most of the key software applications needed to support any of the assessed units are available freely from the web including office suites, graphics and sound editing. As a nation we could save hundreds of millions if not billions of pounds in software licensing fees by providing users with the skills, knowledge and confidence to migrate to free and open-source applications. You Tube, OpenClipart.org, Wikipedia and many other sites provide free content that supports learning and the number and range of such sites is increasing.

Annexe A

Level 3 Diploma in Technical Science for Industry and Society - Unit assessment - coursework guidance

The **Level 3 learner** has knowledge and understanding of facts, procedures and ideas in an area of study or field of work to complete well-defined tasks and address straightforward problems. Holder can interpret relevant information and ideas. Holder is aware of a range of information that is relevant to the area of study or work. AND/OR Holder can select and use relevant cognitive and practical skills to complete well-defined, generally routine tasks and address straightforward problems. Holder can identify how effective actions have been. Holder can identify, gather and use relevant information to inform actions.	**Moderation/verification:** The assessor should keep a record of assessment judgements made for each candidate and make notes of any significant issues for any candidate. They must be prepared to enter into dialogue with their Account Manager and provide their assessment records to the Account Manager through the on-line mark book. They should be prepared to provide evidence as a basis for their judgements should it be required by the Principal Assessor or their Account Manager/external moderator. Before authorising certification, the Account Manager must be satisfied that the assessor's judgements are sound.

General Information

The Level 3 qualification has the following characteristics for learners:

- Achievement at RQF level 3 (EQF Level 4) reflects the ability to select and use relevant knowledge, ideas, skills and procedures to complete well-defined tasks and address straightforward problems. It includes taking responsibility for completing tasks and procedures and exercising autonomy and judgement subject to overall direction or guidance.
- Use understanding of facts, procedures and ideas to complete well-defined tasks and address straightforward problems. Interpret relevant information and ideas. Be aware of the types of information that are relevant to the area of study or work.
- Complete well-defined, generally routine tasks and address straightforward problems. Select and use relevant skills and procedures. Identify, gather and use relevant information to inform actions. Identify how effective actions have been.
- Take responsibility for completing tasks and procedures subject to direction or guidance as needed.

- The specification for the Level 3 award provides an outcome framework for assessment and is not intended to dictate any particular context for learning and so can be used with any age range of adults.

Requirements

- Standards must be confirmed by a trained Level 4 Assessor
- Assessors must as a minimum record assessment judgement as entries in the on-line mark book on the TLM certification site.
- It is expected that there will be routine evidence of work used for judging assessment outcomes in the candidates' records of their day-to-day work. Samples, including related plans and schemes of work should be available at the annual visit and/or by video conference.
- Different approaches to learning will be required in order to match differing needs, for example, the needs of learners will be different from the needs of those with learning disabilities.
- When the candidate demonstrates secure capability against each of the criteria in the unit, they are entitled to a certificate for passing the unit and the overall award.

Unit 1: Building Blocks of Matter

1 Understand atomic structure and subatomic particles	1.1: Describe the structure of the atom in terms of protons, neutrons, and electrons. 1.2: Compare the relative mass and charge of subatomic particles. 1.3: Explain how atomic number and mass number define an element.
2 Understand isotopes and relative atomic mass	2.1: Describe the characteristics of isotopes in relation to atomic structure. 2.2: Explain how isotopes of the same element differ 2.3: Calculate relative atomic mass using isotopic abundance data. 2.4: Identify data from mass spectrometry to determine isotope composition.
3 Understand electron configuration and chemical behaviour	3.1: Explain the arrangement of electrons in energy levels, sublevels, and orbitals. 3.2: Identify electron configurations for elements up to atomic number 36 using standard notation. 3.3: Analyse how electron configuration influences chemical reactivity and periodic trends.
4 Understand ionisation energy and its trends in the periodic table	4.1: Describe first ionisation energy and the factors that affect it 4.2: Identify graphs of successive ionisation energies to deduce electron shell structure. 4.3: Explain how ionisation energy trends vary across periods and down groups.
5 Understand periodic trends in the properties of elements	5.1: Describe the layout of the modern periodic table. 5.2: Explain trends in atomic radius, electronegativity, and ionisation energy across periods and groups. 5.3: Explain how periodic trends affect the chemical properties and reactivity of different element groups.
6 Understand the development of atomic theory	6.1: Describe how models of the atom have changed over time 6.2: Explain how experimental evidence led to revisions in atomic structure theory 6.3: Compare different models of the atom, highlighting their strengths and limitations.

Unit 2: Exploring Interactions at the Atomic Level

1 Understand different types of chemical bonding	1.1: Describe the key features of ionic, covalent, and metallic bonding. 1.2: Explain how chemical bonds form through electron transfer or sharing 1.3: Explain how dot-and-cross diagrams are used to model bonding in simple compounds
2 Understand electronegativity and bond polarity	2.1: Explain the concept of electronegativity and how it influences bonding. 2.2: Describe how to distinguish between polar and non-polar covalent bonds. 2.3: Analyse molecular structure to predict overall molecular polarity.
3 Understand molecular shapes and electron pair repulsion	3.1: Use electron pair repulsion theory to determine the shape of molecules and ions. 3.2: Predict bond angles based on the number and type of electron pairs. 3.3: Explain how molecular shape affects physical and chemical properties.
4 Understand intermolecular forces and their effects	4.1: Describe van der Waals forces, dipole–dipole interactions, and hydrogen bonding. 4.2: Explain how intermolecular forces influence boiling point, melting point, and solubility. 4.3: Compare the strength and impact of different intermolecular forces using real examples.
5 Understand how bonding affects the properties of substances	5.1: Explain how bonding type and structure determine physical properties such as conductivity and hardness. 5.2: Describe the properties of substances like sodium chloride, diamond, graphite, and metals in terms of bonding and structure. 5.3: Predict the properties of unknown substances based on bonding models.

Unit 3: Quantitative Chemistry and Calculations

1 Understand the mole concept and its use in calculations	1.1 Explain the mole as a unit for counting particles in chemistry. 1.2 Convert between mass, moles, and number of particles using appropriate equations. 1.3 Apply the mole concept to solve problems involving elements and compounds.
2 Understand how to determine empirical and molecular formulae	2.1 Calculate empirical formulae from experimental data. 2.2 Determine molecular formulae using molar mass and empirical formulae. 2.3 Identify percentage composition data to support formula determination.
3 Understand chemical equations and stoichiometric relationships	3.1 Identify how to write and balance chemical equations accurately. 3.2 Perform stoichiometric calculations using balanced equations. 3.3 Use mole ratios to calculate the quantities of reactants and products.
4 Understand limiting reactants and reaction yield	4.1 Identify the limiting reactant in a chemical reaction using molar calculations. 4.2 Calculate theoretical, actual, and percentage yields. 4.3 Explain why reactions may not go to completion and discuss common causes of yield loss.
5 Understand concentration and titration calculations	5.1 Calculate the concentration of solutions in mol/dm^3 and g/dm^3. 5.2 Identify how to use titration data to calculate unknown concentrations. 5.3 Interpret titration curves to identify the equivalence point and reaction completion.
6 Understand gas laws and molar volumes	6.1 Use the ideal gas equation to calculate pressure, volume, temperature, or amount of gas. 6.2 Convert between standard units used in gas calculations 6.3 Apply molar volume concepts to determine the volume of gases at standard conditions.

Unit 4: Energy Flow in Chemical Systems

1 Understand enthalpy change and thermochemical equations	1.1 Explain the concept of enthalpy and how enthalpy change is measured. 1.2 Classify reactions as exothermic or endothermic based on energy flow. 1.3 Write balanced thermochemical equations, including energy changes and physical states.
2 Understand how calorimetry is used to measure heat energy	2.1 Describe the principles of calorimetry and how it is used to measure heat transfer. 2.2 Calculate the energy transferred in a chemical reaction using appropriate data and a relevant method. 2.3 Evaluate sources of error and assumptions in calorimetric experiments.
3 Understand indirect methods of calculating enthalpy change	3.1 Explain how enthalpy change can be calculated using indirect methods. 3.2 Construct enthalpy cycles using known data from combustion or formation reactions. 3.3 Calculate overall enthalpy change using standard enthalpy values.
4 Understand bond enthalpies and energy profile diagrams	4.1 Describe average bond enthalpies and their use in estimating reaction energy change. 4.2 Calculate enthalpy change using bond enthalpy values for reactants and products. 4.3 Interpret energy profile diagrams, including activation energy and reaction pathway.
5 Understand how energy changes apply to real-world processes	5.1 Explain how exothermic and endothermic reactions are used in industrial and biological contexts. 5.2 Discuss the role of energy changes in fuel combustion and improving energy efficiency. 5.3 Analyse the sustainability of chemical reactions based on energy demand and enthalpy change.

Unit 5: Uncovering the Speed of Change

1 Understand how to measure the rate of a chemical reaction	1.1 Describe different methods for measuring reaction rate, including changes in mass, volume, or concentration over time. 1.2 Identify how to interpret rate data to identify how concentration changes during a reaction. 1.3 Compare fast and slow reactions using real-world or laboratory examples.
2 Understand the factors that influence reaction rate	2.1 Describe how concentration, temperature, surface area, and pressure affect the rate of reaction. 2.2 Explain these effects using particle collision theory and energy distribution. 2.3 Describe how changes in reaction conditions affect rate.
3 Understand activation energy and the collision theory	3.1 Explain the requirements for effective particle collisions in a chemical reaction. 3.2 Describe activation energy and illustrate it using energy profile diagrams. 3.3 Analyse how temperature affects energy distribution and reaction rate.
4 Understand the role of catalysts and enzymes in reaction rate	4.1 Explain how catalysts increase the rate of a reaction without being consumed. 4.2 Compare homogeneous and heterogeneous catalysis, including examples. 4.3 Describe enzyme catalysis and factors that influence enzyme activity.
5 Understand rate equations and reaction order	5.1 Express rate using rate equations involving concentration and rate constants. 5.2 Determine the order of reaction with respect to each reactant using experimental data. 5.3 Calculate rate constants and overall reaction order from data.
6 Understand how to collect and analyse kinetic data	6.1 Design experiments to investigate reaction rate using concentration or volume measurements. 6.2 Analyse data graphically 6.3 Evaluate the accuracy, reliability, and sources of error in kinetic experiments.

Unit 6: Chemical Equilibria and Dynamic Reaction Systems

1 Understand reversible reactions and dynamic equilibrium	1.1 Describe the difference between reversible and irreversible reactions. 1.2 Explain how dynamic equilibrium is established in closed systems. 1.3 Interpret chemical equations to identify reversible reactions.
2 Understand equilibrium constants and their calculation	2.1 Explain the meaning of the equilibrium constant in terms of concentration. 2.2 Write expressions for Kc using balanced chemical equations. 2.3 Calculate Kc values from experimental data and rearrange to find unknown concentrations.
3 Understand how changing conditions affect equilibrium	3.1 State and apply Le Chatelier's Principle to predict changes in equilibrium position. 3.2 Describe the effects of temperature, pressure, and concentration changes on equilibrium. 3.3 Use examples to explain observable changes in equilibrium systems.
4 Understand factors affecting equilibrium in real-world systems	4.1 Analyse how reaction conditions affect the position of equilibrium and product yield. 4.2 Relate changes in equilibrium to industrial and laboratory applications. 4.3 Use equilibrium data to assess the extent of a reaction.
5 Understand the application of equilibrium in industry and biology	5.1 Describe the role of equilibrium in industrial processes such as the Haber and Contact processes. 5.2 Evaluate how temperature and pressure are chosen in industry to balance yield, rate, and cost. 5.3 Explain how equilibrium concepts apply in biological systems

Unit 7: Investigating Acidity, Alkalinity and Chemical Control

1 Understand the nature of acids and bases	1.1 Explain different theoretical definitions of acids and bases and how they apply in chemical contexts. 1.2 Identify acids and bases in chemical equations using appropriate definitions. 1.3 Compare how each definition applies in different chemical contexts.
2 Understand the pH scale and related calculations	2.1 Explain the pH scale and its logarithmic relationship to hydrogen ion concentration. 2.2 Calculate the pH of strong acids and bases using concentration data. 2.3 Calculate the pH of weak acids and bases using Ka and Kb values.
3 Understand the strength of acids and bases	3.1 Distinguish between strong and weak acids and bases in terms of ionisation. 3.2 Calculate ionisation constants and interpret their values in relation to acid/base strength. 3.3 Predict the effect of dilution and concentration on pH for weak and strong solutions.
4 Understand titrations and the use of indicators	4.1 Describe the process of acid-base titration and its purpose. 4.2 Identify appropriate indicators for different titrations based on pH range. 4.3 Interpret titration curves to determine equivalence points and calculate unknown concentrations.
5 Understand buffer systems and their role in pH control	5.1 Explain how buffer solutions resist changes in pH using conjugate acid-base pairs. 5.2 Calculate pH changes in buffer systems following the addition of acid or base. 5.3 Evaluate the importance of buffer systems in biological and industrial contexts.
6 Understand the applications of acid-base chemistry	6.1 Describe how acids and bases are used in industrial processes 6.2 Explain the chemical causes and environmental consequences of acid rain. 6.3 Explain how acid-base balance is maintained in biological systems

Unit 8: Redox Reactions, Electrochemical Cells, and Industrial Applications

1 Understand oxidation, reduction, and redox processes	1.1 Explain oxidation and reduction in terms of electron transfer and changes in oxidation number. 1.2 Identify oxidising and reducing agents in chemical equations. 1.3 Describe redox processes using examples from every day or industrial contexts.
2 Understand how to assign oxidation numbers and balance redox equations	2.1 Assign oxidation numbers to elements in compounds and ions using standard rules. 2.2 Use oxidation numbers to determine whether a reaction is redox. 2.3 Balance redox equations using the half-equation method in acidic and basic conditions.
3 Understand electrochemical cells and electrode potentials	3.1 Describe how electrochemical cells work and how electrical energy is generated. 3.2 Explain standard electrode potentials and how they are measured. 3.3 Calculate overall cell potential and predict whether a redox reaction is spontaneous.
4 Understand practical applications of electrochemistry	4.1 Describe how electrochemical principles are applied in batteries and fuel cells. 4.2 Explain the electroplating process and its industrial uses. 4.3 Evaluate the benefits and limitations of different electrochemical technologies.
5 Understand corrosion and methods of prevention	5.1 Explain how corrosion occurs through redox processes. 5.2 Describe methods used to prevent corrosion, including coatings and sacrificial protection. 5.3 Analyse the environmental and economic impact of corrosion.
6 Understand electrolysis and its industrial applications	6.1 Describe how electrolysis works, including electrode reactions and ion movement. 6.2 Calculate the quantities of substances produced using Faraday's laws. 6.3 Explain how electrolysis is used in industry.

Unit 9: Organic Compounds, Reaction Mechanisms, and Functional Applications

1 Understand the structure and classification of organic molecules	1.1 Identify common functional groups in organic compounds. 1.2 Describe naming rules for simple organic molecules using standard conventions 1.3 Explain different types of isomerism, including structural and stereoisomerism.
2 Understand the structure and reactions of hydrocarbons	2.1 Describe the structure and bonding in alkanes, alkenes, and alkynes. 2.2 Explain the physical and chemical properties of different hydrocarbons. 2.3 Predict the products of typical hydrocarbon reactions such as combustion and addition.
3 Understand haloalkanes and nucleophilic substitution reactions	3.1 Describe the structure and reactivity of haloalkanes. 3.2 Explain the mechanisms of nucleophilic substitution (SN1 and SN2). 3.3 Predict the products and stereochemical outcomes of substitution reactions.
4 Understand alcohols and elimination reactions	4.1 Classify alcohols and describe their chemical properties. 4.2 Explain elimination reaction mechanisms involving alcohols. 4.3 Describe the oxidation reactions of primary, secondary, and tertiary alcohols.
5 Understand reaction pathways in organic chemistry	5.1 Compare substitution and elimination mechanisms in organic reactions. 5.2 Illustrate reaction pathways using curly arrow notation. 5.3 Analyse how conditions affect the rate and outcome of organic reactions.
6 Understand electrophilic addition and polymerisation	6.1 Explain the mechanism of electrophilic addition in alkenes. 6.2 Describe how addition and condensation polymerisation occur. 6.3 Evaluate the uses and environmental impact of synthetic polymers.
7 Understand aromatic chemistry and substitution reactions	7.1 Describe the structure of benzene and the concept of aromatic stability. 7.2 Explain electrophilic substitution reactions in aromatic compounds. 7.3 Predict the products of common substitutions such as nitration and halogenation.
8 Understand multistep synthesis and planning	8.1 Plan synthetic routes using known organic reactions and reagents. 8.2 Identify multi-step reaction schemes and intermediate structures. 8.3 Evaluate strategies to improve yield and efficiency in organic synthesis.

Unit 10: Laboratory Safety, Technique, and Professional Practice

1 Understand laboratory safety protocols and responsibilities	1.1 Explain the importance of safety procedures in the laboratory environment. 1.2 Describe standard operating procedures and good laboratory practices. 1.3 Identify common hazards and the associated risks in laboratory settings.
2 Understand personal protective equipment and risk minimisation	2.1 Identify different types of PPE and explain when and how they should be used. 2.2 Identify chemical, physical, and biological hazards in laboratory contexts. 2.3 Apply strategies to minimise risk through hazard assessment and control measures.
3 Understand safe handling and storage of chemicals	3.1 Demonstrate appropriate techniques for handling hazardous substances. 3.2 Explain how chemicals should be labelled, stored, and segregated safely. 3.3 Describe how compatibility is managed in chemical storage systems.
4 Understand how to use laboratory equipment and perform common techniques	4.1 Carry out standard laboratory techniques such as titration, filtration, and distillation. 4.2 Identify common laboratory equipment and describe their safe and effective use. 4.3 Explain the principles behind each technique and when they are applied.
5 Understand how to collect, record, and interpret experimental data	5.1 Use appropriate measuring instruments to obtain accurate data. 5.2 Record experimental data clearly, systematically, and in line with scientific conventions. 5.3 Evaluate sources of error, uncertainty, and variability in experimental results.
6 Understand waste disposal and environmental considerations	6.1 Describe procedures for the disposal of different types of laboratory waste. 6.2 Identify the environmental impact of laboratory waste. 6.3 Explain how laboratory practices can be modified to reduce environmental harm.
7 Understand emergency procedures and incident response	7.1 Identify common laboratory emergencies and the appropriate first aid response. 7.2 Describe emergency equipment and evacuation protocols. 7.3 Explain how to report accidents and maintain incident records appropriately.

Unit 11: Transition Metals, Complexes, and Catalytic Functions

1 Understand the properties of transition elements	1.1 Describe the position of transition elements in the periodic table and how they differ from main group elements. 1.2 Explain the general physical and chemical properties of transition metals. 1.3 Describe the significance of variable oxidation states in transition elements.
2 Understand the electronic structure and trends in transition metals	2.1 Write electronic configurations for transition metals using standard notation. 2.2 Explain how electronic structure affects reactivity and bonding behaviour. 2.3 Describe trends in ionisation energy and atomic/ionic radii across the transition series.
3 Understand complex ions and coordination chemistry	3.1 Describe the structure and composition of complex ions and coordination compounds. 3.2 Explain the roles of central metal ions and ligands in complex formation. 3.3 Use standard naming conventions to write names and formulae for complex ions.
4 Understand coordination number, geometry, and isomerism	4.1 Classify ligands as monodentate, bidentate, or polydentate. 4.2 Explain coordination number and predict the shape of metal complexes. 4.3 Describe structural and stereoisomerism in coordination compounds.
5 Understand the origin of colour and magnetism in transition metal complexes	5.1 Explain how d-orbital splitting leads to colour in transition metal complexes. 5.2 Describe how ligand field strength and geometry affect observed colour. 5.3 Relate magnetic properties of complexes to unpaired electron configurations.
6 Understand the catalytic properties and industrial applications of transition metals	6.1 Describe how transition metals and their compounds act as catalysts. 6.2 Compare homogeneous and heterogeneous catalysis with examples. 6.3 Explain how transition metals are used in large-scale industrial processes.
7 Understand the biological importance and environmental impact of transition metals	7.1 Describe the role of metal ions in biological systems such as haemoglobin and enzymes. 7.2 Explain how transition metals contribute to biochemical reactions like electron transport. 7.3 Discuss the essential and toxic properties of transition metals in living organisms.

Unit 12: Sustainable Chemistry, Environmental Impact, and Green Practices

1 Understand the role of chemistry in environmental sustainability	1.1 Describe the scope of environmental chemistry and its relevance to modern challenges. 1.2 Explain the impact of chemical processes and substances on ecosystems and human health. 1.3 Analyse key environmental issues caused by chemical pollution.
2 Understand pollution sources and their chemical impact	2.1 Identify major sources of air, water, and soil pollution. 2.2 Describe common chemical pollutants and their environmental effects. 2.3 Explain the short- and long-term consequences of pollution on living systems.
3 Understand the principles and application of green chemistry	3.1 State and explain the 12 principles of green chemistry. 3.2 Identify sustainable chemical practices to reduce waste and minimise environmental harm 3.3 Evaluate case studies demonstrating green chemistry in industrial or research settings.
4 Understand sustainable chemical processes and materials	4.1 Describe sustainable methods of synthesis and the use of catalysts to improve efficiency. 4.2 Explain the concept of atom economy and its role in sustainable process design. 4.3 Discuss the use of alternative solvents and energy-efficient technologies in chemistry.
5 Understand waste management and recycling in chemistry	5.1 Outline the types of chemical waste and appropriate disposal methods. 5.2 Describe techniques used to recycle or repurpose chemical materials. 5.3 Analyse challenges involved in treating hazardous or non-biodegradable waste.
6 Understand the use of renewable resources and alternative energy	6.1 Describe renewable feedstocks used in chemical manufacturing. 6.2 Explain how solar, wind, and biofuels are integrated into sustainable energy systems. 6.3 Evaluate the environmental trade-offs of different energy technologies.
7 Understand the legal and ethical responsibilities of chemists	7.1 Describe key environmental regulations that govern chemical manufacturing and use. 7.2 Discuss the ethical responsibilities of chemists in promoting sustainability. 7.3 Evaluate the role of scientific innovation in solving global environmental challenges.

Unit 13: Analytical Techniques in Chemistry

1 Understand the purpose and scope of analytical techniques	1.1 Describe the role of modern analytical methods in chemical investigation and quality control. 1.2 Explain the underlying principles of spectroscopy and chromatography. 1.3 Identify key analytical instruments and their common applications.
2 Understand the use of spectroscopy to identify chemical compounds	2. Explain the principles of common spectroscopic techniques used to identify chemical compounds. 2.2 Interpret spectroscopic data to identify functional groups and molecular structures. 2.3 Assess sample composition and purity using spectral analysis.
3 Understand how mass spectrometry is used to determine molecular structure	3.1 Explain the ionisation process and interpretation of mass-to-charge ratios. 3.2 Interpret mass spectra to determine molecular mass and fragmentation patterns. 3.3 Combine MS data with other spectroscopic evidence to identify unknown compounds.
4 Understand chromatography and its applications	4.1 Describe the principles and uses of common chromatographic techniques used in chemical analysis 4.2 Carry out qualitative and quantitative chromatographic analysis. 4.3 Interpret chromatograms to identify components and assess sample purity.
5 Understand accuracy, precision, and method selection in analysis	5.1 Distinguish between qualitative and quantitative methods of analysis. 5.2 Select appropriate analytical techniques based on the properties of the sample and required information. 5.3 Evaluate the accuracy, precision, and limitations of different analytical methods.
6 Understand how analytical chemistry is used in industry and research	6.1 Describe the use of analytical techniques in pharmaceuticals, environmental testing, and materials science. 6.2 Evaluate how analytical methods support product development, quality assurance, and regulatory compliance. 6.3 Explore recent innovations and future trends in chemical analysis.

Unit 14: Industrial Chemistry, Innovation, and Sustainability

1 Understand the scope and importance of industrial chemistry	1.1 Describe the role of industrial chemistry in the production of everyday materials and goods. 1.2 Identify common raw materials and final products in key chemical sectors. 1.3 Explain how chemical processes are scaled for industrial manufacturing.
2 Understand major industrial chemical processes	2.1 Describe how ammonia is synthesised using the Haber process. 2.2 Explain the production of sulfuric acid using the Contact process. 2.3 Identify additional large-scale processes and their industrial relevance.
3 Understand the role of catalysts in industrial chemistry	3.1 Explain how catalysts improve reaction rate and efficiency in industry. 3.2 Compare homogeneous and heterogeneous catalysis using examples. 3.3 Describe how catalyst deactivation and regeneration are managed in industrial systems.
4 Understand chemical engineering principles in industrial design	4.1 Describe the function of chemical reactors and separation techniques. 4.2 Explain how yield, safety, and efficiency are optimised in process design. 4.3 Discuss the challenges of scaling up chemical processes from lab to plant.
5 Understand how green chemistry principles apply to industry	5.1 Apply the principles of green chemistry to industrial chemical production. 5.2 Evaluate strategies to reduce energy consumption, waste, and environmental harm. 5.3 Discuss the use of renewable raw materials and sustainable process alternatives.
6 Understand the role of chemistry in modern technology and medicine	6.1 Describe chemical applications in sectors such as pharmaceuticals, materials science, and diagnostics. 6.2 Explain how sensors, imaging agents, and smart materials are developed using chemical principles. 6.3 Evaluate the impact of chemical innovation on healthcare and environmental solutions.
7 Understand the economic and environmental considerations of industrial chemistry	7.1 Analyse the costs involved in raw materials, energy use, and waste disposal. 7.2 Evaluate how environmental regulations influence chemical production. 7.3 Discuss how industry balances profitability with sustainability and environmental responsibility.

Unit 15: Independent Research, Investigation, and Scientific Communication

1 Understand the purpose and process of scientific research	1.1 Explain the role of independent research in scientific progress and problem-solving. 1.2 Describe ethical responsibilities when conducting and reporting scientific investigations. 1.3 Identify clear research questions and objectives for a scientific enquiry.
2 Understand how to design and plan an investigation	2.1 Develop a structured research plan with timelines, resources, and success criteria. 2.2 Select appropriate methods, materials, and equipment to meet research objectives. 2.3 Assess potential risks and plan for safety and ethical compliance.
3 Understand how to gather and evaluate background information	3.1 Identify how to conduct a literature search using reliable scientific sources. 3.2 Summarise and critique relevant information to inform the research context. 3.3 Identify gaps in current understanding to justify the need for investigation.
4 Understand how to conduct an experiment and collect data	4.1 Carry out practical procedures following scientific protocols. 4.2 Collect data accurately and record observations using appropriate formats. 4.3 Ensure reliability through repeat trials, consistent methods, and equipment calibration.
5 Understand how to analyse and interpret experimental data	5.1 Apply appropriate statistical or graphical methods to analyse results. 5.2 Interpret data in relation to research aims and identify patterns, trends, or anomalies. 5.3 Evaluate sources of error and suggest improvements to the method.
6 Understand how to communicate research findings effectively	6.1 Prepare a clear and structured research report using scientific language and conventions. 6.2 Reference sources using an accepted citation format. 6.3 Present findings through oral, visual, or written means appropriate to audience and purpose.
7 Understand how to reflect on and evaluate a research project	7.1 Reflect on the planning, execution, and outcomes of the research process. 7.2 Evaluate the strengths and limitations of the investigation. 7.3 Propose possible future research directions based on findings.

Accessibility Policies

TLM firmly believes that every learner should have an equal chance to excel in their studies and assessments, regardless of any disabilities they may have. To achieve this goal, TLM has developed a comprehensive and well-structured reasonable adjustment policy that is specifically tailored to cater to the needs of learners with disabilities. This policy is not only an essential aspect of TLM's commitment to inclusivity but also an integral part of creating a diverse and accessible learning environment.

The reasonable adjustment policy is designed to support learners with disabilities in various ways. It encompasses a range of accommodations, such as providing additional time for examinations, offering alternative formats for study materials, permitting the use of assistive technology, arranging for sign language interpreters, and ensuring accessible physical facilities. The implementation of these reasonable adjustments is meticulously carried out to ensure that they meet the individual needs of each learner, acknowledging the unique challenges they may face.

TLM is dedicated to making the reasonable adjustment process transparent and easily accessible for all stakeholders. Thus, the details of the policy are made readily available to all, including learners, educators, and TLM Centres. These details can be found on TLM's official website, ensuring that everyone is well-informed about the support and accommodations available to learners with disabilities.

Additionally, TLM Centres play a crucial role in facilitating this process. They are empowered to submit requests for other reasonable adjustments on behalf of learners, based on their specific requirements and circumstances.
TLM firmly believes that promoting a culture of inclusivity and understanding is fundamental to fostering an environment where learners can thrive, irrespective of their abilities or disabilities. By continuously evaluating and refining its reasonable adjustment policy, TLM ensures that it remains up to date with the best practices in the field of inclusive education.

TLM Qualifications is deeply committed to its duty as an awarding organisation to provide reasonable adjustments for learners with disabilities in accordance with the Equality Act 2010. By adhering to its comprehensive reasonable adjustment policy and collaborating closely with TLM Centres, TLM strives to create a learning landscape that supports and empowers all learners, ensuring they can reach their full potential and achieve academic success

TLM Accessibility Policy: https://tlm.org.uk/policies/general-requirements-for-regulated-qualifications/#3

TLM reasonable adjustment policy: https://tlm.org.uk/reasonable-adjustments-and-special-considerations-policy-2/

TLM reasonable adjustments request form: https://tlm.org.uk/wp-content/uploads/2022/03/TLM-RASC-form-1.docx

TLM reasonable adjustments request form: https://tlm.org.uk/wp-content/uploads/2022/03/TLM-RASC-form-1.docx