



Australian Government

Department of Education, Employment and Workplace Relations

MSL975018A Perform complex tests to measure chemical properties of materials

Revision Number: 1

MSL975018A Perform complex tests to measure chemical properties of materials

Modification History

Not applicable.

Unit Descriptor

Unit descriptor	This unit of competency covers the ability to isolate analytes from complex matrices and perform multi-staged and/or multi-component analysis on them. The unit requires personnel to apply detailed knowledge of analytical chemistry to plan the analysis, prepare and measure samples, analyse and report results and make approved adjustments to procedures as required. Personnel are required to recognise atypical test data/results and troubleshoot common analytical procedure and equipment problems.
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Application of the Unit

Application of the unit	This unit of competency is applicable to technical working in all industry sectors. All operations must comply with relevant standards, appropriate procedures and/or enterprise requirements. Although a supervisor may not always be present, the technician will follow standard operating procedures (SOPs) that clearly describe the scope of permitted practice, including varying enterprise/test procedures and communicating results to people outside the laboratory. Industry representatives have provided case studies to illustrate the practical application of this unit of competency and to show its relevance in a workplace setting. These can be found at the end of this unit of competency under the section 'This competency in practice'.
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Licensing/Regulatory Information

Not applicable.

Pre-Requisites

Prerequisite units		
	MSL975009A	<i>Perform routine chromatographic techniques</i>
		OR
	MSL975020A	<i>Apply routine spectrometric techniques</i>
		AND
	MSL974003A	<i>Perform chemical tests</i>
		OR
	MSL974004A	<i>Perform food tests</i>
		OR
	MSL974006A	<i>Perform biological procedures</i>
	MSL973007A	<i>Perform microscopic examination, and</i>
	MSL973004A	<i>Perform aseptic techniques</i>
		AND
	MSL973002A	<i>Prepare working solutions</i>
		OR
	MSL974001A	<i>Prepare, standardise and use solutions</i>

Employability Skills Information

Employability skills	This unit contains employability skills.
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Elements and Performance Criteria Pre-Content

Elements describe the essential outcomes of a unit of competency.	Performance criteria describe the performance needed to demonstrate achievement of the element. Where bold italicised text is used, further information is detailed in the required skills and knowledge section and the range statement. Assessment of performance is to be consistent with the evidence guide.
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Elements and Performance Criteria

ELEMENT	PERFORMANCE CRITERIA
1. Develop an analysis plan with supervisor	1.1. Liaise with client or sample provider to determine test requirements and sample characteristics 1.2. Record sample description, compare with specification, record and report discrepancies 1.3. Confirm suitable sample preparation methods, quantification and analytical techniques with supervisor 1.4. Schedule analysis using enterprise procedures
2. Reduce the complexity of the sample	2.1. Obtain a representative analytical portion of the laboratory sample 2.2. Prepare validation checks for analytical portions 2.3. Use enterprise procedures to simplify the sample matrix 2.4. Conduct tests to ensure that sample preparation is complete
3. Apply quantification method	3.1. Add modifiers to remove/minimise interferences 3.2. Conduct preliminary analysis to estimate analyte concentration 3.3. Match the concentration of analyte in the sample with the working range of the instrument 3.4. Prepare calibration standards to suit quantification method
4. Perform analysis	4.1. Set up and optimise instruments to suit sample/test requirements 4.2. Measure analyte response for standards, validation checks and samples 4.3. Conduct sufficient measurements to obtain reliable data 4.4. Return instruments to standby or shutdown condition as required
5. Process and analyse data	5.1. Confirm data is the result of valid measurements 5.2. Perform required calculations and ensure results are consistent with estimations and expectations 5.3. Record results with the appropriate accuracy, precision units and uncertainty 5.4. Analyse trends in data and/or results and report out of specification or atypical results promptly to appropriate personnel 5.5. Troubleshoot analytical procedure or equipment problems which have led to atypical data or results
6. Maintain a safe work environment	6.1. Identify risks/hazards, safety equipment and control measures associated with sample handling,

ELEMENT	PERFORMANCE CRITERIA
	preparation and test methods 6.2. Use personal protective equipment and safety procedures as specified for test method and materials to be tested 6.3. Minimise the generation of wastes and environmental impact 6.4. Ensure the safe disposal of laboratory wastes 6.5. Clean, care for and store equipment and consumables in accordance with enterprise procedures
7. Maintain laboratory records	7.1. Enter approved data and results into laboratory information management system (LIMS) 7.2. Maintain security, integrity and traceability of samples and documentation 7.3. Maintain equipment and logs in accordance with enterprise procedures

Required Skills and Knowledge

REQUIRED SKILLS AND KNOWLEDGE

This section describes the skills and knowledge required for this unit.

Required skills

Required skills include:

- interpreting client requests, test methods and procedures accurately
- safely setting up, starting up and shutting down equipment using enterprise procedures
- checking calibration/qualification status of equipment
- preparing samples and standards
- optimising procedures and equipment to suit sample/test requirements
- maintaining close attention to measurement procedures, accuracy and precision during lengthy complex tests
- calculating analyte concentrations with appropriate accuracy, precision, units and uncertainty
- recognising atypical data/results
- troubleshooting common analytical procedure and equipment problems
- recording and reporting data/results
- maintaining security, integrity and traceability of samples and documentation
- following occupational health and safety(OHS) procedures and principles of good laboratory practice (GLP)

Required knowledge

Required knowledge includes:

- principles and concepts underpinning the analysis, such as:
 - effects of interferents with analyte behaviour, such as ionisation, complexation, precipitation, masking and association
 - quantification methods, such as internal standards, standard additions, Gran's Plot and recovery checks
 - chemical, physical treatments to minimise interferences
- function of key components of equipment
- effects of modifying instrumental variables on outputs and results
- handling of hazardous chemicals and samples and/or the fragile/labile nature of biological material
- sample preparation procedures
- preparation and use of calibration charts and/or standards
- calculation steps to give results in appropriate units, precision and uncertainty
- enterprise and/or legal traceability requirements
- basic procedure and equipment troubleshooting techniques

REQUIRED SKILLS AND KNOWLEDGE

- basic equipment maintenance procedures
- relevant health, safety and environment requirements

Specific industry

Additional knowledge requirements may apply for different industry sectors. For example:

- nature of specific sample matrices
- special needs for sample treatment/pre-treatment
- industry specific instrumentation

Evidence Guide

EVIDENCE GUIDE	
<p>The Evidence Guide provides advice on assessment and must be read in conjunction with the performance criteria, required skills and knowledge, range statement and the Assessment Guidelines for the Training Package.</p>	
Overview of assessment	
Critical aspects for assessment and evidence required to demonstrate competency in this unit	<p>Assessors should ensure that candidates can:</p> <ul style="list-style-type: none"> • interpret client request, test methods and procedures accurately • safely set up, start up and shut down equipment using enterprise procedures • check calibration/qualification status of equipment • prepare samples and standards appropriately • optimise procedures and equipment to suit sample/test requirements • maintain close attention to measurement procedures, accuracy and precision during lengthy complex tests • calculate analyte concentrations with appropriate accuracy, precision and units • recognise atypical data/results • troubleshoot common analytical procedure and equipment problems • record and reports data/results using enterprise procedures • maintain security, integrity and traceability of samples and documentation • follow OHS procedures and principles of GLP.
Context of and specific resources for assessment	<p>This unit of competency is to be assessed in the workplace or simulated workplace environment. This unit of competency may be assessed with:</p> <ul style="list-style-type: none"> • <i>MSL925001A Analyse data and report results.</i> <p>Resources may include:</p> <ul style="list-style-type: none"> • standard laboratory with appropriate analytical instruments, laboratory reagents and equipment • SOPs and test methods.
Method of assessment	<p>The following assessment methods are suggested:</p> <ul style="list-style-type: none"> • review of test data/results obtained by the candidate over time to ensure accuracy, consistency and timeliness of results

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	<ul style="list-style-type: none"> • inspection of test records and workplace documentation completed by the candidate • observation of candidate conducting a range of complex tests to measure chemical properties of materials • feedback from clients, peers and supervisors • oral or written questioning of relevant chemical principles, concepts, analytical techniques and enterprise procedures. <p>In all cases, practical assessment should be supported by questions to assess underpinning knowledge and those aspects of competency which are difficult to assess directly.</p> <p>Where applicable, reasonable adjustment must be made to work environments and training situations to accommodate ethnicity, age, gender, demographics and disability.</p> <p>Access must be provided to appropriate learning and/or assessment support when required.</p> <p>The language, literacy and numeracy demands of assessment should not be greater than those required to undertake the unit of competency in a work like environment.</p>
This competency in practice	<p>Industry representatives have provided the case study below to illustrate the practical application of this unit of competency and to show its relevance in a workplace setting.</p> <p>Environmental</p> <p>The analysis of a soil sample for nutrient profiles requires a complex procedure for simplifying the soil matrix and then performing multiple analyses on the sample in order to obtain data on both macro and micro soil nutrients. To determine the chemical suitability of a particular soil for agricultural activity, a detailed analysis is required of macro-nutrients, such as nitrate, phosphate and potassium as well as micro-nutrients, such as metals (including copper (Cu), selenium (Se) molybdenum (Mo), iron (Fe) and sulphate.</p> <p>A technician is given a composite soil sample from a client and uses the standard techniques of riffing and coning and quartering to obtain representative sub-samples for laboratory analysis. The technician then removes the soil matrix by one of several methods depending on the type of nutrient analysis being</p>

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performed.

For soil micro-nutrients, such as trace metals, they dry the sample (to remove moisture and obtain the dry weight), then wet ash it with concentrated sulphuric acid (to remove carbonaceous components), and finally resuspend it in dilute nitric acid. Once the technician is satisfied that the matrix has been simplified sufficiently, they then use an inductively coupled plasma spectrophotometer to ascertain the concentration of trace metals in the soil.

The analysis for macro-nutrients, such as phosphate, is performed in several ways due to the enormously variable processes involved in weathering of parent material into soil. One common macro-nutrient test is for leachable phosphate, which involves extraction of labile phosphate from the soil matrix. In this case, the technician uses the Olsen method. They remove the analyte from the complex soil matrix by extracting it with hydrogen carbonate solution and quantify the liberated analyte using visible spectrophotometry.

Range Statement

RANGE STATEMENT

The range statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold italicised wording, if used in the performance criteria, is detailed below. Essential operating conditions that may be present with training and assessment (depending on the work situation, needs of the candidate, accessibility of the item, and local industry and regional contexts) may also be included.

Codes of practice

Where reference is made to industry codes of practice, and/or Australian/international standards, it is expected the latest version will be used

Standards, codes, procedures and/or enterprise requirements

Standards, codes, procedures and/or enterprise requirements may include:

- Australian and international standards, such as:
 - AS 2252 Biological safety cabinets
 - AS ISO 17025-2005 General requirements for the competence of testing and calibration laboratories
 - AS/NZS 2243 Set:2006 Safety in laboratories set
 - AS/NZS 2982.1:1997 Laboratory design and construction - General requirements
 - AS/NZS ISO 14000 Set:2005 Environmental management standards set
 - AS/NZS ISO 9000 Set:2008 Quality management systems set
 - AS 2830.1 Good laboratory practice - Chemical analysis
 - AS 2162.1 General - Volumetric glassware
 - AS 2134.1 Flame atomic absorption spectroscopy
 - ISO/IEC Guide 98-3:2008 Uncertainty of measurement - Part 3 Guide to the expression of uncertainty in measurement (GUM)
- Eurachem/CITAC Guide CG4 Quantifying uncertainty in analytical measurement
- use of specific standards such as:
 - Association of Analytical Communities International (AOAC International) Official Methods of Analysis

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- American Society for Testing and Materials (ASTM)
- United States Environmental Protection Agency (US EPA)
- Australian code of good manufacturing practice for medicinal products (GMP)
- calibration and maintenance schedules
- cleaning, hygiene and personal hygiene requirements
- data quality procedures
- enterprise procedures, SOPs and operating manuals
- enterprise recording and reporting procedures
- equipment startup, operation and shutdown procedures
- incident and accident/injury reports
- material safety data sheets (MSDS)
- material, production and product specifications
- national measurement regulations and guidelines
- principles of GLP
- production and laboratory schedules
- quality manuals, equipment and procedure manuals
- quality system and continued improvement processes
- safety requirements for equipment, materials or products
- sampling procedures (labelling, preparation, storage, transport and disposal)
- schematics, work flows and laboratory layouts
- statutory and enterprise OHS requirements
- stock records and inventory
- test procedures (validated and authorised)
- training program contents
- waste minimisation, containment, processing and disposal procedures

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Test requirements	<p>Test requirements may include:</p> <ul style="list-style-type: none"> • specification of concentration and limits of analytes • time and cost limitations
Sample preparation	<p>Sample preparation may include:</p> <ul style="list-style-type: none"> • identification of any hazards associated with the samples and/or analytical chemicals • grinding, mulling, preparation of disks, digestion, dissolving, ashing, refluxing, extraction, filtration, evaporation, flocculation, precipitation, washing, drying and centrifugation • solid-phase micro-extraction • determination of, and if appropriate, removal of any contaminants or impurities • ultra-trace procedures requiring high purity solvents, clean rooms, ultra clean glassware and specialised glassware
Quantification techniques	<p>Quantification techniques may include:</p> <ul style="list-style-type: none"> • matrix matched standards • standard additions • international standards
Analytical techniques	<p>Analytical techniques may include:</p> <ul style="list-style-type: none"> • spectrometric techniques, such as inductively coupled plasma optical emission spectroscopy (ICP-OES) and inductively coupled plasma mass spectroscopy (ICP-MS) • chromatographic techniques, such as gas chromatography mass spectroscopy (GC-MS), ion chromatography (IC) • electrometric techniques, such as ion selective electrodes, voltammetry (polarography) and anodic stripping voltammetry • electrophoretic techniques, such as capillary electrophoresis
Typical analytes and samples requiring complex tests	<p>Typical analytes and samples requiring complex tests may involve:</p> <ul style="list-style-type: none"> • contaminants in food, such as heavy metals and aflatoxins

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- trace level (microgram and nanogram/litre) analytes
- forensic testing, drug testing in body tissues and fluids
- multiple analytes, such as organochlorins and polyaromatic hydrocarbons
- environmental contaminants in water, soil and air (such as pesticides)
- sludge, waste water and sewage
- samples with matrix interferences

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Validation checks	Validation checks may include: <ul style="list-style-type: none"> • recovery checks • use of standard/certified samples
Common analytical procedure and equipment problems	Common analytical procedure and equipment problems may include: <ul style="list-style-type: none"> • matrix interference • spectral interference • problems associated with the physical state of the analyte, such as blockages and viscosity changing flow rates to instruments
Hazards	Hazards may include: <ul style="list-style-type: none"> • electric shock • biohazards: <ul style="list-style-type: none"> • microbiological organisms and agents associated with soil, air, water, blood and blood products, and human or animal tissue and fluids • mycotoxins • chemicals: <ul style="list-style-type: none"> • acids (e.g. sulphuric, perchloric and hydrofluoric) • heavy metals and pesticides • anions (e.g. fluoride) • hydrocarbons (e.g. mono-aromatics) • radiation (nuclear, lasers and ultraviolet (UV)) • sharps and broken glassware • aerosols from broken centrifuge tubes and pipetting • flammable liquids and gases • cryogenics, such as dry ice and liquid nitrogen • fluids under pressure, such as hydrogen in gas liquid chromatography, acetylene in atomic absorption spectrometry • sources of ignition • high temperature ashing processes • disturbance or interruption of services
Addressing hazards	Addressing hazards may include: <ul style="list-style-type: none"> • MSDS

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	<ul style="list-style-type: none"> • labelling of samples, reagents, aliquoted samples and hazardous materials • use of personal protective equipment, such as gloves, safety glasses and coveralls • use of fumehoods and direct extraction of vapours and gases • use of appropriate equipment, such as biohazard containers, laminar flow cabinets, Class I, II and III biohazard cabinets • handling and storage of all hazardous materials and equipment in accordance with labelling, MSDS and manufacturer's instructions • minimising exposure to radiation ionising, such as lasers, electromagnetic and UV radiation
Tests for completeness of sample preparation	<p>Tests for completeness of sample preparation may include:</p> <ul style="list-style-type: none"> • visual inspection for colour and solids • odour • pH and conductivity • chemical tests for interferents, such as precipitation and colour forming • basic screening instrumental tests, such as IR, ultraviolet-visible (UV-VIS) and gas chromatography
Modifiers	<p>Modifiers may include:</p> <ul style="list-style-type: none"> • ionisation suppressants, such as Caesium for Ca, Na, K in atomic absorption spectroscopy (AAS) • ionic strength and pH buffers, such as TISAB for fluoride in ion-selective electrode (ISE) • releasing agents, such as Lanthanum and Strontium for Ca in AAS • volatility suppressants, such as phosphate for Pb in electrothermal AAS
Occupational health and safety (OHS) and environmental management requirements	<p>OHS and environmental management requirements:</p> <ul style="list-style-type: none"> • all operations must comply with enterprise OHS and environmental management requirements, which may be imposed through state/territory or federal legislation - these requirements must not be compromised at any

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	<p>time</p> <ul style="list-style-type: none"> • all operations assume the potentially hazardous nature of samples and require standard precautions to be applied • where relevant, users should access and apply current industry understanding of infection control issued by the National Health and Medical Research Council (NHMRC) and State and Territory Departments of Health
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Unit Sector(s)

Unit sector	Testing
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Competency field

Competency field	
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Co-requisite units

Co-requisite units		