

Technical Description

# Chemical Laboratory Technology

Manufacturing and Engineering Technology



  
worldskills

WorldSkills International, by a resolution of the Competitions Committee and in accordance with the Constitution, the Standing Orders and the Competition Rules, has adopted the following minimum requirements for this skill for the WorldSkills Competition.

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# 1 INTRODUCTION

## 1.1 NAME AND DESCRIPTION OF THE SKILL COMPETITION

1.1.1 The name of the skill competition is

Chemical Laboratory Technician

1.1.2 Description of the associated work role(s) or occupation(s).

The work of laboratory chemical analyst is the basis of the product quality in many industries. Chemical analysis is necessary to control the compliance of the properties of raw materials, intermediate stages of the technological process, and finished products with current standards.

The laboratory chemical analyst performs laboratory analyses, tests, measurements aimed at determining

- the qualitative chemical composition of a substance
- the quantitative ratio of chemical elements and compounds within them
- processing of the obtained data,
- reporting results of analyses and
- other types of laboratory work

according with the requirements of standards and specifications. The scope and complexity of the tests performed depend on the type of tasks set by the employer.

The role includes knowledge of the following objects of professional activity:

- Natural and industrial materials;
- Synthetic materials;
- Equipment and instruments;
- Regulatory and technical documents.

Laboratory chemical analysts should be ready to determine the optimal tools and methods for the analysis of various natural and synthetic materials, to perform qualitative and quantitative tests using modern chemical and physico-chemical analytical methods. They should be able to act logically and systematically, complying with sanitary and hygienic requirements and occupational safety and health standards.

Usually, laboratory chemical analysts work in the chemical laboratories of quality control departments, research and development departments, or in environmental departments in plants in various industries: chemical, petrochemical, pharmaceutical, and the supply of construction materials, paint and varnish, polymers, defence and many others.

1.1.3 Number of Competitors per team

Chemical Laboratory Technology is a single Competitor skill competition.

1.1.4 Age limit of Competitors

The Competitors must not be older than 22 years in the year of the Competition.

## 1.2 THE RELEVANCE AND SIGNIFICANCE OF THIS DOCUMENT

This document contains information about the standards required to compete in this skill competition, and the assessment principles, methods and procedures that govern the competition.

Every Expert and Competitor must know and understand this Technical Description.

In the event of any conflict within the different languages of the Technical Descriptions, the English version takes precedence.

## 1.3 ASSOCIATED DOCUMENTS

Since this Technical Description contains only skill-specific information it must be used in association with the following:

- WSI – Competition Rules
- WSI – WorldSkills Standards Specification framework
- WSI – WorldSkills Assessment Strategy
- WSI Online resources as indicated in this document
- WorldSkills Health, Safety, and Environment Policy and Regulations

## 2 THE WORLDSKILLS STANDARDS SPECIFICATION (WSSS)

### 2.1 GENERAL NOTES ON THE WSSS

The WSSS specifies the knowledge, understanding and specific skills that underpin international best practice in technical and vocational performance. It should reflect a shared global understanding of what the associated work role(s) or occupation(s) represent for industry and business ([www.worldskills.org/WSSS](http://www.worldskills.org/WSSS)).

The skill competition is intended to reflect international best practice as described by the WSSS, and to the extent that it is able to. The Standards Specification is therefore a guide to the required training and preparation for the skill competition.

In the skill competition the assessment of knowledge and understanding will take place through the assessment of performance. There will only be separate tests of knowledge and understanding where there is an overwhelming reason for these.

The Standards Specification is divided into distinct sections with headings and reference numbers added.

Each section is assigned a percentage of the total marks to indicate its relative importance within the Standards Specification. This is often referred to as the “weighting”. The sum of all the percentage marks is 100.

The Marking Scheme and Test Project will assess only those skills that are set out in the Standards Specification. They will reflect the Standards Specification as comprehensively as possible within the constraints of the skill competition.

The Marking Scheme and Test Project will follow the allocation of marks within the Standards Specification to the extent practically possible. A variation of five percent is allowed, provided that this does not distort the weightings assigned by the Standards Specification.

## 2.2 WORLDSKILLS STANDARDS SPECIFICATION

SECTION		RELATIVE IMPORTANCE (%)
1	<b>Work organization and management</b>	<b>10</b>
	<p>The individual needs to know and understand:</p> <ul style="list-style-type: none"> <li>• the internal and external regulatory environment for the sector</li> <li>• the internal business environment including one's personal role, ethical practice and codes of conduct</li> <li>• health and safety legislation, regulations and best practice</li> <li>• scientific principles for laboratory-based activities</li> <li>• principles for work planning, scheduling, organization and completion</li> <li>• the theoretical basis for applied chemistry including how to apply physical, organic and inorganic chemistry to laboratory work</li> <li>• principles and methods for the safe disposal or recycling of chemicals and chemically related substances</li> </ul>	
	<p>The individual shall be able to:</p> <ul style="list-style-type: none"> <li>• maintain personal health and safety at all times, including through personal protective clothing and equipment</li> <li>• perform work taking into account relevant regulations, norms, quality, safety and environmental standards</li> <li>• implement safety data sheets and the measures and procedures derived from them for               <ul style="list-style-type: none"> <li>• handling, maintaining and repairing laboratory devices, apparatus and equipment</li> <li>• handling, maintaining and disposing of/recycling chemicals used in laboratories</li> </ul> </li> <li>• follow risk management systems, proactively</li> <li>• maintain good housekeeping</li> <li>• order and inventory materials to maintain supplies, within budget and budgetary procedures</li> <li>• ensure electronic equipment is fit for purpose</li> <li>• inspect structures and materials for their condition and usability</li> <li>• work independently, taking responsibility for initiating and completing tasks within the parameters of the work role</li> <li>• estimate the requirements of a piece of work in terms of time, costs, resources and materials needed for completion.</li> <li>• develop specific goals and plans to prioritize, organize and accomplish work, relative to set objectives and targets</li> <li>• investigate alternative means of resolving delays</li> <li>• adjust activities as required, keeping relevant others informed.</li> </ul>	

2	Communication and interpersonal skills	10
	<p>The individual needs to know and understand:</p> <ul style="list-style-type: none"> <li>• principles of communication</li> <li>• principles for human interactivity</li> <li>• the impact of one's own work on others, especially where related to diversity and equality</li> <li>• the specialist terminology associated with the work role and sector</li> <li>• the intention and purpose of statistical methods for data presentation</li> <li>• the limitations in reporting results</li> <li>• the uses of ICT, management information systems, and databases in chemical environments</li> </ul>	
	<p>The individual shall be able to:</p> <ul style="list-style-type: none"> <li>• establish and maintain interpersonal relations</li> <li>• work and interact with others including within teams</li> <li>• provide technical support to chemists or other specialists</li> <li>• communicate using a full range of techniques for speaking, writing, body language, and active listening, for formal and informal purposes</li> <li>• use specialist terminology including where these are in another language</li> <li>• obtain information from all relevant sources, citing sources as required</li> <li>• read and apply the content of technical documents relating to               <ul style="list-style-type: none"> <li>• analyses</li> <li>• formulations</li> <li>• procedural instructions</li> <li>• specifications</li> <li>• diagrams</li> </ul> </li> <li>• listen actively, asking questions appropriately for full understanding</li> <li>• use laboratory information and laboratory management systems, both digital and paper based</li> <li>• order information and actions according to logic or given rules</li> <li>• apply statistical techniques for data presentation</li> <li>• use a range of textual and graphical methods to inform others</li> <li>• communicate scientific information appropriately for the audience or recipient</li> <li>• prepare and give formal and informal presentations</li> <li>• seek, accept and, as appropriate, build on feedback and constructive criticism</li> </ul>	

3	Techniques, procedures, and methods	35
	<p>The individual needs to know and understand:</p> <ul style="list-style-type: none"> <li>• the foundations of inorganic chemistry relative to structure and bonding</li> <li>• the chemistry of important elements and compounds</li> <li>• the principles and practical techniques of organic chemistry</li> <li>• reaction mechanisms and functional group conversions</li> <li>• concepts and practical techniques in physical chemistry, including thermodynamics, reaction kinetics, conductivity, electrochemical cells and electrolysis</li> <li>• principles of laboratory techniques and scientific experimentation</li> <li>• principles of project management, and how these apply to laboratory work</li> <li>• the requirements for the development and validation of analytical methods and instrumentation, including understanding suitable sampling methods</li> <li>• trends in support for experiments, including the use of kits</li> </ul>	



	<p>The individual shall be able to:</p> <ul style="list-style-type: none"> <li>• prepare for laboratory tasks using the appropriate scientific techniques, procedures and methods</li> <li>• use specified instrumentation and laboratory equipment, including calibration as required</li> <li>• evaluate the quality of materials or products to be used</li> <li>• design or fabricate experimental apparatus to develop new products or processes</li> <li>• perform laboratory tasks using specified methodologies, including standard operating procedures</li> <li>• perform specific sampling duties including preparation and processing of samples as well as separation processes for mixtures of liquids and solids</li> <li>• perform cleaning and concentration processes such as           <ul style="list-style-type: none"> <li>• distilling</li> <li>• extracting</li> <li>• evaporating</li> <li>• chromatography</li> <li>• potentiometry</li> <li>• conductometry</li> </ul> </li> <li>• use titrimetric, volumetric and gravimetric methods</li> <li>• use instrumental and electroanalytical methods such as           <ul style="list-style-type: none"> <li>• photometry</li> <li>• chromatography</li> <li>• potentiometry</li> <li>• conductometry</li> <li>• electrophoresis</li> </ul> </li> <li>• set up and conduct experiments, extractions, tests and analyses, using techniques such as           <ul style="list-style-type: none"> <li>• chromatography</li> <li>• spectroscopy</li> <li>• physical or chemical separation techniques</li> <li>• microscopy</li> <li>• electrophoresis</li> </ul> </li> <li>• determine the structures of organic and inorganic compounds</li> <li>• use synthesis techniques for organic, inorganic and polymer synthesis</li> <li>• prepare chemical solutions for products or processes, following standardized formulae, or create experimental formulae</li> <li>• take account of the need for validation of analytical procedures, methods and instrumentation, including the use of suitable sampling methods.</li> </ul>	
<b>4</b>	<b>Data processing and record keeping</b>	<b>10</b>
	<p>The individual needs to know and understand:</p> <ul style="list-style-type: none"> <li>• the rules relating to record keeping, traceability and confidentiality</li> <li>• procedures for maintaining the security of records, in all forms used</li> <li>• the capabilities of software for recording and displaying data</li> <li>• processes for ensuring the accuracy of information</li> <li>• the implications of error and inaccuracy</li> <li>• the required methods for referencing and citations</li> </ul>	

	<p>The individual shall be able to:</p> <ul style="list-style-type: none"> <li>• log and document laboratory work, including by using given house style, IT and statistical methods</li> <li>• process and collate digital information from automated digital machines</li> <li>• produce reliable, accurate data</li> <li>• present the results of laboratory work and problem solving clearly and concisely in written and oral form</li> <li>• write technical reports, using graphs and charts as appropriate</li> <li>• check own work for codification, categorization, calculations, tabulations and completeness</li> <li>• acknowledge errors, inaccuracies and shortcomings promptly</li> <li>• arrange for information or data to be verified or audited</li> <li>• archive documentation</li> </ul>	
<b>5</b>	<b>Analysis, interpretation, and evaluation</b>	<b>15</b>
	<p>The individual needs to know and understand:</p> <ul style="list-style-type: none"> <li>• principles of quality management</li> <li>• applications of quality management to production processes</li> <li>• mathematical and statistical techniques used in analysis of scientific data</li> <li>• the nature, probabilities, sources and types of errors</li> <li>• principles and methods for quality control</li> <li>• principles and applications for continuous improvement</li> <li>• the physiological implications of the work role</li> </ul>	
	<p>The individual shall be able to:</p> <ul style="list-style-type: none"> <li>• maintain efficient kinaesthetic and fine motor skills</li> <li>• apply personal techniques for sustained attentiveness and focus</li> <li>• follow procedures to meet the workplace's quality standards</li> <li>• analyse, interpret and evaluate data and identify results requiring further investigation</li> <li>• evaluate information to determine compliance with standards</li> <li>• work autonomously within the parameters of the work role</li> <li>• identify the meaning of outputs from the analytical techniques used and assess their importance</li> <li>• use correct computational, statistical and mathematical methods or formulae to solve problems</li> <li>• identify by analysis the underlying principles, reasons, or facts determining results.</li> </ul>	
<b>6</b>	<b>Problem solving through the application of scientific methods</b>	<b>10</b>
	<p>The individual needs to know and understand:</p> <ul style="list-style-type: none"> <li>• principles and applications of scientific rules and methods to solve problems</li> <li>• principles for critical thinking and complex problem solving</li> <li>• the scope and limits of their role and one's understanding and expertise in relation to problem solving</li> </ul>	

	<p>The individual shall be able to:</p> <ul style="list-style-type: none"> <li>• recognize when there is either a problem or the likelihood of a problem</li> <li>• identify or detect patterns within larger and distracting material</li> <li>• apply suitable scientific methods to identify causes and achieve solutions</li> <li>• use logic and reasoning to identify the strengths and weaknesses of alternative solutions, conclusions or approaches to problems by, for example           <ul style="list-style-type: none"> <li>• applying general rules to specific issues to produce reasonable conclusions</li> <li>• combining pieces of information to form reasonable conclusions or rules</li> </ul> </li> <li>• use creative thinking and problem solving to challenge assumptions, innovate, make new proposals and build on existing ideas</li> <li>• seek advice from senior colleagues as appropriate</li> <li>• make recommendations for improved workflows or scientific solutions</li> <li>• support new investigations and follow-up experiments for routine and non-routine analytical tasks</li> <li>• take responsibility for personal development, demonstrating commitment to learning and self-improvement</li> </ul>	
<b>7</b>	<b>Trends in applied Chemistry</b>	<b>10</b>
	<p>The individual needs to know and understand:</p> <ul style="list-style-type: none"> <li>• the interdisciplinary nature of science</li> <li>• the role of applied chemistry in scientific developments</li> <li>• the growing impact of digitization</li> <li>• the growing importance of sustainability</li> <li>• new ethical concerns derived from new possibilities</li> </ul>	
	<p>The individual shall be able to:</p> <ul style="list-style-type: none"> <li>• install, commission and test automated laboratory systems</li> <li>• install and configure programs</li> <li>• develop simple programs</li> <li>• switch on, switch off and operate automated laboratory systems</li> <li>• optimize and implement adjustments and changes to automated laboratory systems</li> <li>• maintain and service automated laboratory systems</li> <li>• systematically search, localize and eliminate faults, defects and malfunctions on automated laboratory systems</li> <li>• respond appropriately to change and change management processes</li> </ul>	
	<b>Total</b>	<b>100</b>

## 3 THE ASSESSMENT STRATEGY AND SPECIFICATION

### 3.1 GENERAL GUIDANCE

Assessment is governed by the WorldSkills Assessment Strategy. The Strategy establishes the principles and techniques to which WorldSkills assessment and marking must conform.

Expert assessment practice lies at the heart of the WorldSkills Competition. For this reason it is the subject of continuing professional development and scrutiny. The growth of expertise in assessment will inform the future use and direction of the main assessment instruments used by the WorldSkills Competition: the Marking Scheme, Test Project, and Competition Information System (CIS).

Assessment at the WorldSkills Competition falls into two broad types: measurement and judgement. For both types of assessment the use of explicit benchmarks against which to assess each Aspect is essential to guarantee quality.

The Marking Scheme must follow the weightings within the Standards Specification. The Test Project is the assessment vehicle for the skill competition, and also follows the Standards Specification. The CIS enables the timely and accurate recording of marks, and has expanding supportive capacity.

The Marking Scheme, in outline, will lead the process of Test Project design. After this, the Marking Scheme and Test Project will be designed and developed through an iterative process, to ensure that both together optimize their relationship with the Standards Specification and the Assessment Strategy. They will be agreed by the Experts and submitted to WSI for approval together, in order to demonstrate their quality and conformity with the Standards Specification.

Prior to submission for approval to WSI, the Marking Scheme and Test Project will liaise with the WSI Skill Advisors in order to benefit from the capabilities of the CIS.

## 4 THE MARKING SCHEME

### 4.1 GENERAL GUIDANCE

This section describes the role and place of the Marking Scheme, how the Experts will assess Competitors' work as demonstrated through the Test Project, and the procedures and requirements for marking.

The Marking Scheme is the pivotal instrument of the WorldSkills Competition, in that it ties assessment to the standards that represent the skill. It is designed to allocate marks for each assessed aspect of performance in accordance with the weightings in the Standards Specification.

By reflecting the weightings in the Standards Specification, the Marking Scheme establishes the parameters for the design of the Test Project. Depending on the nature of the skill and its assessment needs, it may initially be appropriate to develop the Marking Scheme in more detail as a guide for Test Project design. Alternatively, initial Test Project design can be based on the outline Marking Scheme. From this point onwards the Marking Scheme and Test Project should be developed together.

Section 2.1 above indicates the extent to which the Marking Scheme and Test Project may diverge from the weightings given in the Standards Specification, if there is no practicable alternative.

The Marking Scheme and Test Project may be developed by one person, or several, or by all Experts. The detailed and final Marking Scheme and Test Project must be approved by the whole Expert Jury prior to submission for independent quality assurance. The exception to this process is for those skill competitions which use an Independent Designer for the development of the Marking Scheme and Test Project. Please see the Rules for further details.

Experts and Independent Designers are required to submit their Marking Schemes and Test Projects for comment and provisional approval well in advance of completion, in order to avoid disappointment or setbacks at a late stage. They are also advised to work with the CIS Team at this intermediate stage, in order to take full advantage of the possibilities of the CIS.

In all cases a draft Marking Scheme must be entered into the CIS at least eight weeks prior to the Competition using the CIS standard spreadsheet or other agreed methods.

### 4.2 ASSESSMENT CRITERIA

The main headings of the Marking Scheme are the Assessment Criteria. These headings are derived in conjunction with the Test Project. In some skill competitions the Assessment Criteria may be similar to the section headings in the Standards Specification; in others they may be totally different. There will normally be between five and nine Assessment Criteria. Whether or not the headings match, the Marking Scheme as a whole must reflect the weightings in the Standards Specification.

Assessment Criteria are created by the person(s) developing the Marking Scheme, who are free to define criteria that they consider most suited to the assessment and marking of the Test Project. Each Assessment Criterion is defined by a letter (A-I). It is advisable not to specify either the Assessment Criteria, or the allocation of marks, or the assessment methods, within this Technical Description.

The Mark Summary Form generated by the CIS will comprise a list of the Assessment Criteria.

The marks allocated to each Criterion will be calculated by the CIS. These will be the cumulative sum of marks given to each Aspect within that Assessment Criterion.

## 4.3 SUB CRITERIA

Each Assessment Criterion is divided into one or more Sub Criteria. Each Sub Criterion becomes the heading for a WorldSkills marking form. Each marking form (Sub Criterion) contains Aspects to be assessed and marked by measurement or judgement, or both measurement and judgement.

Each marking form (Sub Criterion) specified both the day on which it will be marked, and the identity of the marking team.

## 4.4 ASPECTS

Each Aspect defines, in detail, a single item to be assessed and marked together with the marks, or instructions for how the marks are to be awarded. Aspects are assessed either by measurement or judgement.

The marking form lists, in detail, every Aspect to be marked together with the mark allocated to it .

The sum of the marks allocated to each Aspect must fall within the range of marks specified for that section of the skill in the Standards Specification. This will be displayed in the Mark Allocation Table of the CIS, in the following format, when the Marking Scheme is reviewed from C-8 weeks. (Section 4.1)

	CRITERIA								TOTAL MARKS PER SECTION	WSS MARKS PER SECTION	VARIANCE	
	A	B	C	D	E	F	G	H				
STANDARDS SPECIFICATION SECTION	1	5.00								5.00	5.00	0.00
	2		2.00					7.50			10.00	0.50
	3								11.00	11.00	10.00	1.00
	4			5.00						5.00	5.00	0.00
	5				10.00	10.00	10.00			30.00	30.00	0.00
	6		8.00	5.00				2.50	9.00	24.50	25.00	0.50
	7			10.00				5.00		15.00	15.00	0.00
TOTAL MARKS	5.00	10.00	10.00	10.00	10.00	10.00	15.00	20.00	100.00	100.00	2.00	

## 4.5 ASSESSMENT AND MARKING

There is to be one marking team for each Sub Criterion, whether it is assessed and marked by judgement, measurement, or both. The same marking team must assess and mark all Competitors, in all circumstances. The marking teams must be organized to ensure that there is no compatriot marking in any circumstances. (See 4.6.)

## 4.6 ASSESSMENT AND MARKING USING JUDGEMENT

Judgement uses a scale of 0-3. To apply the scale with rigour and consistency, judgement must be conducted using:

- benchmarks (criteria) for detailed guidance for each Aspect (in words, images, artefacts or separate guidance notes)
- the 0-3 scale to indicate:
  - 0: performance below industry standard
  - 1: performance meets industry standard
  - 2: performance meets and, in specific respects, exceeds industry standard
  - 3: performance wholly exceeds industry standard and is judged as excellent

Three Experts will judge each Aspect, with a fourth to coordinate the marking and acting as a judge to prevent compatriot marking.

## 4.7 ASSESSMENT AND MARKING USING MEASUREMENT

Three Experts will be used to assess each aspect. Unless otherwise stated only the maximum mark or zero will be awarded. Where they are used, the benchmarks for awarding partial marks will be clearly defined within the Aspect.

## 4.8 THE USE OF MEASUREMENT AND JUDGEMENT

Decisions regarding the selection of criteria and assessment methods will be made during the design of the competition through the Marking Scheme and Test Project.

## 4.9 COMPLETION OF SKILL ASSESSMENT SPECIFICATION

Marking Scheme design will begin with the broad allocation of marks referenced to WSSS weightings, according to the scope of each Module and the requirement to match those weightings. The Marking Scheme and Modules will then be designed in detail and completed together. This will ensure that:

- there is a full match between the Marking Scheme and the WSSS;
- there is consistency of approach and standards across the Modules;
- the results of assessment will authentically reflect the quality of the Competitor relative to their work role in detail and overall.

The nature of the WSSS indicates that, for validity, the ratio of measurement to judgement will be in the range of 3.5:1 to 4:1,

## 4.10 SKILL ASSESSMENT PROCEDURES

The Test Project will be organized in six modules to be completed in three-and-a-half days. The Modules may be of different durations, and have different values in marks, according to the WorldSkills Standards Specification.

The modular structure will limit the numbers of judges available to assess and mark work processes in each module. To mitigate the limitations of this during the Demonstration Skill stage, one leading judge will be identified for each module, based on their particular expertise. They will assess and mark work processes as they are carried out. The judges will also be paired in order to change places to avoid compatriot marking.

When each module has been completed by the Competitor, judges will form marking teams of three, or four for supervision, to assess and mark outcomes. This will support compliance with assessment procedures and enable cross-module parity of assessment and marking.

One or more independent assessors may be available to support standardization and increase openness.

Trials have shown this approach to be effective and efficient for the Demonstration Skill stage.

## 5 THE TEST PROJECT

### 5.1 GENERAL NOTES

Sections 3 and 4 govern the development of the Test Project. These notes are supplementary.

Whether it is a single entity, or a series of stand-alone or connected modules, the Test Project will enable the assessment of the skills in each section of the WSSS.

The purpose of the Test Project is to provide full, balanced and authentic opportunities for assessment and marking across the Standards Specification, in conjunction with the Marking Scheme. The relationship between the Test Project, Marking Scheme and Standards Specification will be a key indicator of quality, as will be its relationship with actual work performance.

The Test Project will not cover areas outside the Standards Specification, or affect the balance of marks within the Standards Specification other than in the circumstances indicated by Section 2.

The Test Project will enable knowledge and understanding to be assessed solely through their applications within practical work.

The Test Project will not assess knowledge of WorldSkills rules and regulations.

This Technical Description will note any issues that affect the Test Project's capacity to support the full range of assessment relative to the Standards Specification. Section 2.1 refers.

### 5.2 FORMAT/STRUCTURE OF THE TEST PROJECT

The Test Project will consist of standalone modules, which in combination will sample the full range of performance of a Chemical Laboratory Technician. This means that each module will be distinct in its tasks and focus of assessment. The modules are not just a series of skills tests.

### 5.3 TEST PROJECT DESIGN REQUIREMENTS

The Test Project will cover all features of the role: both specific functions and overall role execution. It will sample both traditional and modern digitalized methods, and the purposes for which they are carried out. In common with all WorldSkills Competitions the competition focuses on the occupation and not jobs. That will be a challenge because Chemical Laboratory Technicians often specialize in certain techniques. The test project may consist of:

- Sampling;
- Sample preparation;
- Identification of material constants and chemical parameters;
- Qualitative analysis;
- Quantitative analysis;
- Gravimetry;
- Elementary analysis;
- Photometry;
- Gas chromatography;
- High pressure liquid chromatography;
- Mass spectrometry;
- Spectroscopy;
- Titrimetric analysis;
- Electrochemical analysis;
- Inorganic and organic synthesis;



- Data documentation and interpretation;
- Quality management;
- Work management and health and safety;
- Waste disposal.

The competition will assess Competitors' ability to solve problems, be accurate, meticulous, creative and innovative, through the modules set, which will be practical.

The competition will be set up with stations (one for each task instead of setting up a workplace for each Competitor). Each station will cover a different analysing method and additionally different tasks covering sectors 1, 2, 4, 5, 6 and 7 so that the whole range of the WorldSkills Standards Specification will be covered. For all tasks where we use equipment for instrumented analytics (which can be from a lot of different suppliers) just the preparation of the sample and the interpretation of the results will be done by the Competitor; the operating of the equipment will be done by a Technician.

## 5.4 TEST PROJECT DEVELOPMENT

The Test Project MUST be submitted using the templates provided by WorldSkills International ([www.worldskills.org/expertcentre](http://www.worldskills.org/expertcentre)). Use the Word template for text documents and DWG template for drawings.

### 5.4.1 Who develops the Test Project or modules

The Test Project/modules are developed by an Independent Designer.

How and where is the Test Project or modules developed

The Test Project or modules are developed independently.

### 5.4.2 When is the Test Project developed

The Test Project is developed according to the following timeline:

TIMELINE	TASK
Six (6) months before the Competition	Competitors are notified of any Competition Organizer requirements with regard to safety and/or equipment.
At the Competition	The complete Test Project is presented to the panel of Experts by the Independent Designer. No Expert including the Chief Expert is to receive any information relating to the project design before this time.

## 5.5 TEST PROJECT VALIDATION

Test Project proposals (modules) must be validated and tested through being executed and timed to prove that it is reasonable for the constraints of the Competition.

## 5.6 TEST PROJECT SELECTION

The Test Project is independently designed in line with the specifications described in the Technical Description.

## 5.7 TEST PROJECT CIRCULATION

The Test Project is circulated via the website as follows:

The Test Project is not circulated, it is released at the Competition.

## 5.8 TEST PROJECT COORDINATION (PREPARATION FOR COMPETITION)

Coordination of the Test Project will be undertaken by the Skills Competition Manager.

## 5.9 TEST PROJECT CHANGE AT THE COMPETITION

There are no changes made to the Test Project at the Competition.

## 5.10 MATERIAL OR MANUFACTURER SPECIFICATIONS

Specific material and/or manufacturer specifications required to allow the Competitor to complete the Test Project will be supplied by the Competition Organizer and are available from [www.worldskills.org/infrastructure](http://www.worldskills.org/infrastructure) located in the Expert Centre.

The Competition Organizer will upload specifications of the used equipment in the Infrastructure List after the Competition Preparation Week.

## 6 SKILL MANAGEMENT AND COMMUNICATION

### 6.1 DISCUSSION FORUM

Prior to the Competition, all discussion, communication, collaboration, and decision making regarding the skill competition must take place on the skill specific Discussion Forum (<http://forums.worldskills.org>). Skill related decisions and communication are only valid if they take place on the forum. The Chief Expert (or an Expert nominated by the Chief Expert) will be the moderator for this Forum. Refer to Competition Rules for the timeline of communication and competition development requirements.

### 6.2 COMPETITOR INFORMATION

All information for registered Competitors is available from the Competitor Centre ([www.worldskills.org/competitorcentre](http://www.worldskills.org/competitorcentre)).

This information includes:

- Competition Rules
- Technical Descriptions
- Mark Summary Form (where applicable)
- Test Projects (where applicable)
- Infrastructure List
- WorldSkills Health, Safety, and Environment Policy and Regulations
- Other Competition-related information

### 6.3 TEST PROJECTS [AND MARKING SCHEMES]

Circulated Test Projects will be available from [www.worldskills.org/testprojects](http://www.worldskills.org/testprojects) and the Competitor Centre ([www.worldskills.org/competitorcentre](http://www.worldskills.org/competitorcentre)).

### 6.4 DAY-TO-DAY MANAGEMENT

The day-to-day management of the skill during the Competition is defined in the Skill Management Plan that is created by the Skill Management Team led by the Skill Competition Manager. The Skill Management Team comprises the Skill Competition Manager, Chief Expert and Deputy Chief Expert. The Skill Management Plan is progressively developed in the six months prior to the Competition and finalized at the Competition by agreement of the Experts. The Skill Management Plan can be viewed in the Expert Centre ([www.worldskills.org/expertcentre](http://www.worldskills.org/expertcentre)).

## 7 SKILL-SPECIFIC SAFETY REQUIREMENTS

Refer to WorldSkills Health, Safety, and Environment Policy and Regulations for Host country or region regulations.

## 8 MATERIALS AND EQUIPMENT

### 8.1 INFRASTRUCTURE LIST

The Infrastructure List details all equipment, materials and facilities provided by the Competition Organizer.

The Infrastructure List is available at [www.worldskills.org/infrastructure](http://www.worldskills.org/infrastructure).

The Infrastructure List specifies the items and quantities requested by the Experts for the next Competition. The Competition Organizer will progressively update the Infrastructure List specifying the actual quantity, type, brand, and model of the items. Items supplied by the Competition Organizer are shown in a separate column.

At each Competition, the Experts must review and update the Infrastructure List in preparation for the next Competition. Experts must advise the Director of Skills Competitions of any increases in space and/or equipment.

At each Competition, the Technical Observer must audit the Infrastructure List that was used at that Competition.

The Infrastructure List does not include items that Competitors and/or Experts are required to bring and items that Competitors are not allowed to bring – they are specified below.

### 8.2 COMPETITORS TOOLBOX

Competitors are not required to bring a toolbox.

### 8.3 MATERIALS, EQUIPMENT, AND TOOLS SUPPLIED BY COMPETITORS IN THEIR TOOLBOX

Competitors are able to bring the following items with them on Familiarization Day:

- Basic tools like tweezers, spatula, different kind of pens, calculator, etc.
- Personal Protective Equipment as outlined in the Health, Safety, and Environment Policy and Regulations document.

### 8.4 MATERIALS, EQUIPMENT, AND TOOLS SUPPLIED BY EXPERTS

Not applicable

### 8.5 MATERIALS AND EQUIPMENT PROHIBITED IN THE SKILL AREA

The only materials and equipment allowed in the workshop are those supplied by the Competition Organizer. All other materials and equipment are prohibited.

### 8.6 PROPOSED WORKSHOP AND WORKSTATION LAYOUTS

Workshop layouts are available at [www.worldskills.org/sitelayout](http://www.worldskills.org/sitelayout).

## 9 SKILL-SPECIFIC RULES

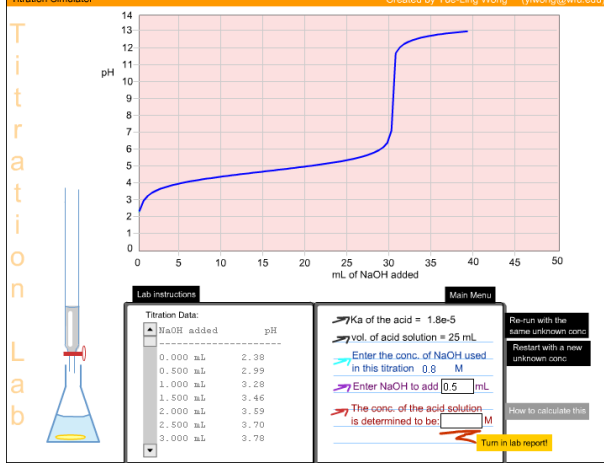
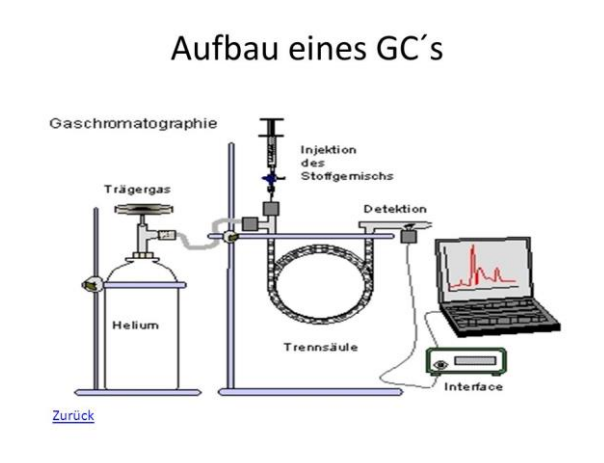
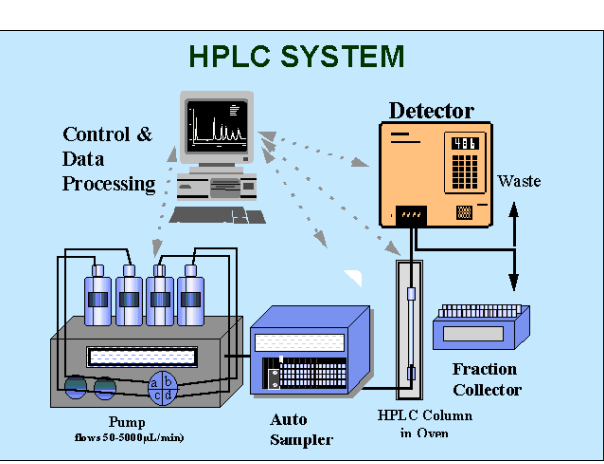
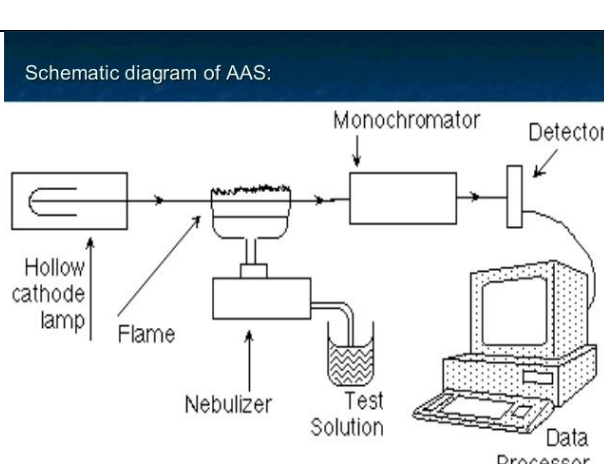
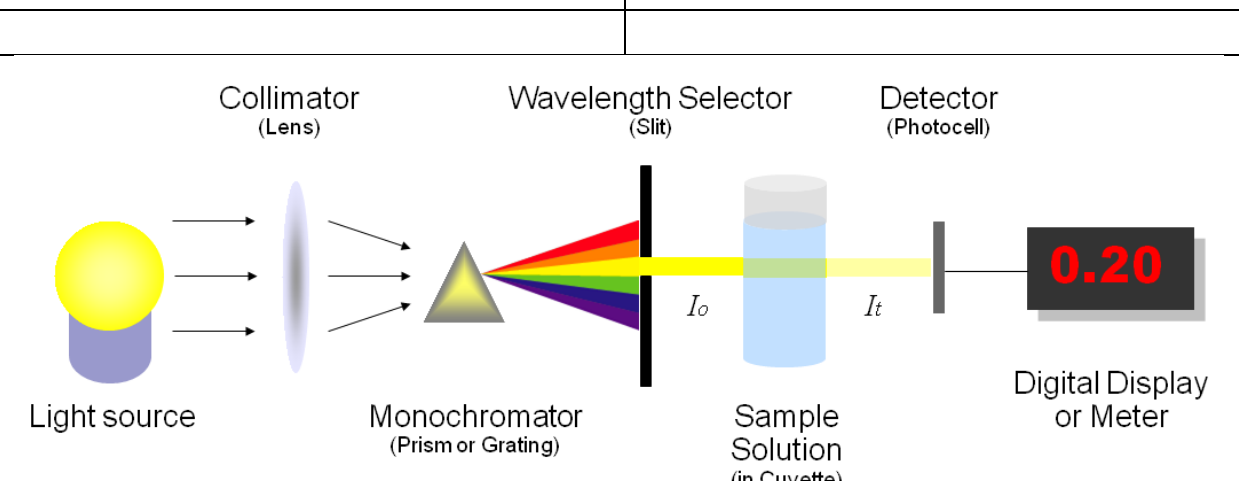
Skill-specific rules cannot contradict or take priority over the Competition Rules. They do provide specific details and clarity in areas that may vary from skill competition to skill competition. This includes but is not limited to personal IT equipment, data storage devices, internet access, procedures and work flow, and documentation management and distribution.

TOPIC/TASK	SKILL-SPECIFIC RULE
Use of technology – USB, memory sticks	<ul style="list-style-type: none"> <li>Competitors are not allowed to bring memory sticks into the workshop</li> <li>Experts and Interpreters are allowed to bring memory sticks into the workshop</li> </ul>
Use of technology – personal laptops, tablets and mobile phones	<ul style="list-style-type: none"> <li>Competitors are not allowed to bring personal laptops, tablets or mobile phones into the workshop.</li> <li>Experts and Interpreters are allowed to bring personal laptops, tablets or mobile phones into the w</li> </ul>
Use of technology – personal photo and video taking devices	<ul style="list-style-type: none"> <li>Competitors, Experts, and Interpreters are allowed to use personal photo and video taking devices in the workshop at the conclusion of the competition only.</li> </ul>
Equipment failure	<ul style="list-style-type: none"> <li>If equipment or tools which are brought by the Competitor fail, no extra time will be allowed.</li> <li>If equipment or tools supplied by the Competition Organizer fail extra time will be allowed only if the Technician of the sponsor or supplying company specifies and proves it is not a "user error".</li> </ul>
Assessment	<ul style="list-style-type: none"> <li>Competitors, Experts, and Interpreters a not permitted to take paper or digital copies of the Assessment out of the workshop until the competition has finished on C4.</li> </ul>
Drawings, recording information	<ul style="list-style-type: none"> <li>Competitors are not allowed to bring any prepared drawings or documented information to the Competition.</li> <li>All Test Project documents must be stored in the Expert room in lockers by the Chief Expert.</li> </ul>
Health, Safety and Environment	<ul style="list-style-type: none"> <li>Refer to the WorldSkills Health, Safety, and Environment policy and guidelines document.</li> </ul>

# 10 VISITOR AND MEDIA ENGAGEMENT

Following is a list of possible ways to maximize visitor and media engagement:

All can be explained to the audience in a very simple way because a lot of simulation software and education material exists (see below some examples):

<p><b>Titration Simulator</b> Created by Yue-Ling Wong (ylwong@wfu.edu)</p>  <table border="1"> <caption>Titration Data</caption> <thead> <tr> <th>NaOH added</th> <th>pH</th> </tr> </thead> <tbody> <tr><td>0.000 mL</td><td>2.98</td></tr> <tr><td>0.500 mL</td><td>2.99</td></tr> <tr><td>1.000 mL</td><td>3.28</td></tr> <tr><td>1.500 mL</td><td>3.46</td></tr> <tr><td>2.000 mL</td><td>3.59</td></tr> <tr><td>2.500 mL</td><td>3.79</td></tr> <tr><td>3.000 mL</td><td>9.78</td></tr> </tbody> </table>	NaOH added	pH	0.000 mL	2.98	0.500 mL	2.99	1.000 mL	3.28	1.500 mL	3.46	2.000 mL	3.59	2.500 mL	3.79	3.000 mL	9.78	<p><b>Aufbau eines GC's</b></p>  <p>Zurück</p>
NaOH added	pH																
0.000 mL	2.98																
0.500 mL	2.99																
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1.500 mL	3.46																
2.000 mL	3.59																
2.500 mL	3.79																
3.000 mL	9.78																
<p><b>HPLC SYSTEM</b></p> 	<p><b>Schematic diagram of AAS:</b></p> 																
 <p>Light source → Collimator (Lens) → Monochromator (Prism or Grating) → Wavelength Selector (Slit) → Sample Solution (in Cuvette) → Detector (Photocell) → Digital Display or Meter</p> <p>Labels in diagram: <math>I_0</math>, <math>I_t</math>, 0.20</p>																	

- to invite visitors to try themselves in the profession: an interactive site where visitors and members of the press can try themselves as a chemist (a simple titrimetric analysis can be done by the spectators themselves. If wanted a simple water - brought by visitors - analysis can be offered to visitors of which parts can be done by visitors themselves too).
- to use demonstration screens showing the work progress and information about the Competitor, advertising career prospects



## 11 SUSTAINABILITY

This skill competition will focus on the sustainable practices below:

With the format of using stations we can ensure another main goal of WorldSkills, besides the quality and excellence of a competition, the sustainability of it. That means we can reduce the needed infrastructure (devices, equipment, tools and so on) to a minimum.

Working with a station approach means also to reduce needed glassware (max. two sets per station plus some spare parts) and number of instruments (max. one per station plus one spare instrument).

All equipment and glassware can be reused again. The amount of needed chemicals is almost zero and some of them can be recycled too.

Competition Organizer (IL minimized by using stations as competition format):

- Glassware for different task;
- Analytical equipment (including Technicians);
- Chemicals;
- Laboratory benches and chairs;
- Exhausts;
- Energy supply like electricity, water, gas, and so on.

## 12 REFERENCES FOR INDUSTRY CONSULTATION

WorldSkills is committed to ensuring that the WorldSkills Standards Specifications fully reflect the dynamism of internationally recognized best practice in industry and business. To do this WorldSkills approaches a number of organizations across the world that can offer feedback on the draft Description of the Associated Role and WorldSkills Standards Specification on a two-yearly cycle.

In parallel to this, WSI consults three international occupational classifications and databases:

- ISCO-08: (<http://www.ilo.org/public/english/bureau/stat/isco/isco08/>)
- ESCO: (<https://ec.europa.eu/esco/portal/home> )
- O\*NET OnLine ([www.onetonline.org/](http://www.onetonline.org/))