

Teaching Analytical Sciences

In partnership with Shimadzu





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Pharmaceuticals



Medical Care



Chemicals



Foods Safety



Environmental

Shimadzu's Commitment to Furthering Education

The corporate philosophy of the Shimadzu Group, to 'Contribute to Society Through Science And Technology', underpins our efforts and determination to raise the level of quality and understanding in Practical Analytical Chemistry in schools, colleges and universities across the United Kingdom.

Technological shifts in scientific analysis have seen the use of analytical instrumentation increasingly employed for measurement and testing purposes. This increase has coincided, with the use of analytical instrumentations broadening use within commercial fields including industry and research.

Improving the quality and skills of tomorrow's Analytical Scientists will enhance the efficiency and productivity of commercial laboratories and further the boundaries in research, in less time. We will work with you to spark interest and inspiration in students, with exciting instrumentation and interesting, relevant experimental challenges.

Our team of industry experts and skilled application scientists with over 100 years combined experience are ready to work with you, tailored to your requirements and aspirations.

Uses of Chromatography in Everyday Life

Chromatography may not be the most well know scientific field but is steeped in history. Decades of scientific advances led us to today's uses of chromatography. Uses that include industry sectors such as forensic science, pharmaceutical, chemical, food and healthcare. Chromatography allows all these industries and more to separate each component within a mixture to accurately identify and quantitate the amounts within varying types of samples.

Let's have a closer look at few sectors:



Forensic testing

Crime dramas such as CSI have brought criminal investigations to mainstream television. You may have heard of Major Mass Spec in NCIS; this Shimadzu gas chromatography mass spectrometer is not only used on this drama series but also in reality. Crime scene samples can all be processed for various compounds, including analysis of chemicals within arson cases, soil analysis from shoes or carpet, or identification of unknown particles found on clothing. These tests can also be used during post mortems to determine conditions such as heart attacks or perhaps drug overdose that may have caused death.



Biological sample analysis

Due to the precision with which chromatography can identify substances in blood and urine, it is widely used not only within hospitals, but also by the police and authorities such as the **World Anti-Doping Agency (WADA)**. No matter if you are having a routine blood test for health reasons, being investigated for taking illegal drugs or an athlete being checked for banned substances, the same chromatography principles are utilised.



Food analysis

Have you ever wondered how manufacturers maintain the quality and consistency of their products? Continuous monitoring of levels of **sugar** going into final products or **alcohol content in spirits** are basic chromatography tests. Chromatography can even determine how “bitter” your beer will taste. However, it can also detect the substances that should not be there! News stories have reported the scandal where **horse meat** replaced beef in processed foods, high heavy metal levels in rice and melamine, a carcinogen within baby milk formula in China. It can also show you what colourants are used in your food and drink – even blue smarties!



Household products

Have you ever picked up a face cream, shampoo or kitchen cleaner and read the ingredients? All these ingredients are individually tested for a variety of reasons. This also includes products we store in sheds and garages. Pesticides, herbicides and insecticides are all tested for their environmental impact and efficacy of their active ingredient, to ensure that product simply does the job effectively and is **not dangerous** to us or the environment.



Pharmaceutical

2020 saw the start of a worldwide pandemic and development of new vaccinations. Chromatography was used to not only analyse **COVID-19 detection test components**, but also run vigorous testing on vaccinations. As well as the vaccines, there were many other medications tested in hope to reduce symptoms. Chromatography has led the way in testing and developing **new drugs and vaccinations** for decades. Who knows what chromatography will help discover next?

We have seen that chromatography is used across a wide variety of compound types and industries. Teaching the fundamentals of chromatography can open avenues across multiple sectors and product types. Who knows what the next generation of scientist will discover?



Analytical Teaching Lab Instrument Portfolio



Liquid Chromatography



Gas Chromatography



Gas Chromatography - Mass Spectrometry



UV-Vis Spectrophotometer



FTIR - Fourier Transform Infra-Red Spectrophotometer



Engineering Lab Instrumentation

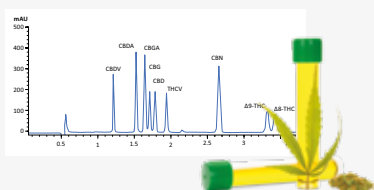
i-Series HPLC System



Liquid Chromatography is the Gold Standard for the Pharmaceutical Industry. The *i*-Series is a COMPACT, ROBUST, and RELIABLE Liquid Chromatography Analyser commonly employed in QA/QC laboratories globally. Ideal for teaching and research where the versatility to handle a broad range of compounds is required. Easy to use common software platform.

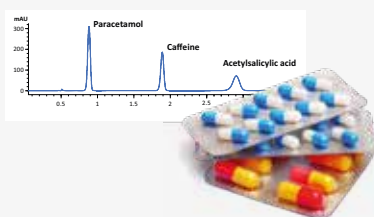
- Most popular model for academia and industry
- Graphical user interface for simplified operation
- Easy use with automation and remote control
- High sample capacity
- Includes A.I. to ensure data reliability

Laboratory experiments



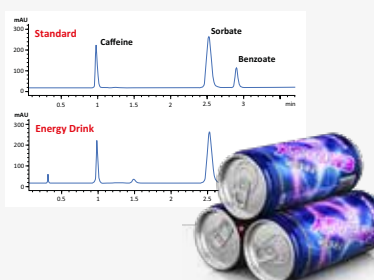
Cannabinoid testing

Cannabinoid plant extracts, such as CBD, have gained significant media interest in recent years. There are many variants of cannabinoids with similar structures, making them difficult to analyse. However, modern analytical techniques can differentiate these compounds and identify each moiety. Using this package students can analyse various samples, similar to the U.K. Food Standards Agency (FSA), to confirm the stated concentration as well as check for the legality of the samples.



Pharmaceutical drug testing

The pharmaceutical industry has to ensure that their drugs, vaccines, and ointments have not only the correct active ingredients but also at the correct dosage level. HPLC is "the gold standard" for analysing the concentration of the active compounds within the pharmaceutical industry. In this package, students will learn to interpret and draw conclusions from chromatograms from standards and over-the-counter drugs, such as aspirin, paracetamol or caffeine. Utilising calibration curves to cover a wide range of concentrations students can answer the questions of: Which compounds are present and quantify how much? Do the amounts match the stated concentrations?



Consumer drinks analysis

The food and beverage industry uses chromatography testing to ensure products are safe for the consumer. Typical tests within the beverage industry are sugar or caffeine analysis. These simple tests on widely available products show students both sample pre-treatment and testing for common ingredients. Students will learn to identify peaks using retention times of standards, in addition to using library compounds. It is also commonplace to utilise this technique to analyse colourants in drinks, what exactly does give Irn Bru its distinct colouring?

GC-2050 Brevis



The new GC-2050 Brevis is ideal for use in academic and teaching facilities. This compact GC comes with a multitude of features geared towards ease of use, flexibility, and long-term robustness. These include:

- Compact space saving design
- Standard columns and consumables
- Easy, tool free, injection port maintenance with the Easy sTop function
- ClickTek column fittings for fast, leak-free installation
- Gas saver functions to reduce consumption
- Fast oven heating and cooling to reduce analysis time
- Flexibility to have two injectors and three detectors installed
- Compatible with liquid and headspace sample introduction techniques

Laboratory experiments



Glycols in toothpaste

This application requires the preparation and analysis of samples of commercially available toothpastes. The students will be able to identify target compounds, ethylene glycol, diethylene glycol and glycerine and see how the amounts can differ between products. The experiment demonstrates how target compounds can be reliably detected in complex matrices.



Engine oil/fuel analysis

This application requires students to analyse a range of petroleum and dieselbased products using a GC with a flame ionisation detector. The experiment focuses on interpretation of the data, being able to put the results into hydrocarbon bands based on retention time and enable the students to draw conclusion on the different types of samples being assessed.



Solvent impurities

This application involves the analysis of various solvent mixes prepared in the laboratory and compares them to commercially available spirits available from hardware stores. The students will be required to develop a method to separate the solvents using columns with different phases and will develop their knowledge of boiling point versus polarity separation. This exercise also offers practical method set up and basic maintenance of the GC.

GCMS-QP2050 System



The next generation GCMS, QP-2050, contains the latest technology from Shimadzu to lead the way in mass spectrometry. Its simple operation, reliability, and minimum maintenance, make it the perfect choice for the academic teaching and research. Benefits of the GCMS-QP2050 include:

- Compact space saving design
- High sensitivity for ppm level analysis
- Gas saver and ecology shutdown functions to reduce gas and energy consumption
- Easy macro function for customised automated programs
- The new Dura Ease source increases sensitivity and reduces maintenance requirements
- Automated tune procedure, providing a "Pass" or "Fail" statement to demonstrate the system suitability
- Ability to perform simultaneous SIM/Scan analysis with improved sensitivity
- Compatible with liquid and headspace sample introduction

Laboratory experiments



Fragrance analysis

This application using the GCMS will allow to students to look at the various chemicals used to fragrance their perfumes and personal care products. The experiment aims to get the students to analysis the organic aromatic compounds that contribute to the different 'smells' found in commercially available products. This exercise will also teach them how to interpret the spectral information and to carry out a search the mass spectral library to aid identification.



Caffeine detection

The testing of human samples for drugs is simulated in this application using a legal and easily available component, caffeine. The students will use the GCMS to identify caffeine in a difficult matrix, such as urine, or synthetic serum. They will then prepare a series of analytical standards to be used in the calibration of the analytical method and provide accurate quantification in a human sample.



Solvent analysis by GCMS

This application builds on the experiment looking at solvent impurities available for the GC-FID. Having identified how best to separate the different components in the solvents, the students will now be able to analyse their samples using the GCMS to correctly identify all the impurities. The focus of this part of the experiment will be on how to identify the different components using the mass to charge (m/z) ratios of the functional groups and fragments, rather than relying on automated library searching.

UV-1900i UV-Vis Spectrophotometer



The UV-1900i UV-Vis spectrophotometer offers full research grade performance in a compact, affordable design. The true double beam dual detector, touchpad interface, fast scanning facility and common software platform all add to the performance and ease of use.

- 6 measurement modes – choose between: Spectrum, Quantitation, Kinetics, Photometric, Time Course and Bio Method
- Dual beam optic system including patented low-ray-light diffraction grating
- Lowest stray light for extended linearity range (up to 4 Abs.)
- High resolution of 1 nm
- Ultra-fast scan function: 29,000 nm/min

Laboratory experiments



Analysis of soft and alcoholic drinks for caffeine content

Following a solvent extraction of caffeine from various sources, the samples are measured in the UV-1900i against a calibration curve created from a set of weight/volume standards using the 'Concentration' software module within the instrument software or Labsolutions UV software.

The experiment requires accuracy in creating the standards and precision when making the extractions and will show the relative caffeine content of beverages.



Identification of paracetamol

UV-Vis spectrophotometry is a powerful analytical technique widely utilised in pharmaceutical analysis for its sensitivity, versatility, and ease of use. Paracetamol, a commonly used analgesic and antipyretic agent, presents an ideal candidate for analysis via UV-Vis spectrophotometry due to its characteristic absorption spectra in the ultraviolet-visible range. Accurate determination of paracetamol concentration is essential for ensuring product quality, efficacy, and patient safety. By following this experiment, students will gain practical experience in instrument operation, data acquisition, and analysis, thereby enhancing their understanding of UV-Vis spectroscopy principles and its application in pharmaceutical analysis. Safety procedures, calibration techniques, and quality control measures are emphasised to ensure reliable and reproducible results.



Determination of DNA in extracts

DNA can be recovered from a wide variety of sources and can be measured directly in a UV spectrophotometer. The very high absorbance of DNA (from lysed bacterial cultures, saliva, etc) allows direct determination at low concentrations at the absorbance maximum of 260 nm. Measurements are usually made at 260, (DNA peak Absorbance) 280 (protein peak absorbance for contaminating protein), and 320nm which should be a baseline position for both biomolecules, though with the high-speed scanning UV-1900i measurements can be made in scanning mode with a digital selection of 260nm, 280nm and 320nm in the software.

IRSpirit - X



Powerful, space-efficient design with unmatched functionality – for stable, reliable performance. Easy to use Windows 11 common software platform.

- 10 year part warranty on all non-consumables parts*
- Easy and quick analysis
- High sensitivity: S/N ratio up to 37000:1 (KBr)
- Space-efficient with high expandability
- Large choice of accessories
- Easy macro function for routine analysis
- IRPilot program
 - 23 pre-set application programs
 - Analysis of multiple samples with only one click

Laboratory experiments



Identification of environmental plastics

The challenge of identifying plastics recovered from the environment can be illustrated so that the challenge of automated sorting in waste recovery systems can be understood. Students should collect small fragments of plastic from everyday locations, their own gardens, or from the grounds of the institute. These can then be directly measured using the FTIR-ATR before and after the samples are cleaned with a mild acid, mild alkali, and mechanical cleaning. The results of each approach can be compared. This experiment also gives an opportunity to discuss the 'working depth' of the ATR approach to Infrared spectroscopy and the physical principles behind total internal reflectance measurement and the nature of the photon.



Identification of paracetamol

Paracetamol, also known as acetaminophen, is one of the most used over-the-counter medications worldwide. Its widespread use necessitates accurate and efficient analytical methods for quality control and dosage determination. FTIR has emerged as a vital tool in pharmaceutical analysis due to its rapid, non-destructive nature and its ability to provide detailed information about molecular structure and functional groups. In this procedure, the analysis of paracetamol using FTIR offers students a hands-on opportunity to understand fundamental principles of infrared spectroscopy while gaining practical experience in pharmaceutical analysis.



Alcohol and base emulsifier/conditioner in commercial hand sanitisers

This experiment shows the power of FTIR analysis by testing both the alcohol content and the emulsifier base of commercial hand sanitisers. A sample is directly applied to the FTIR ATR crystal and scans made at fixed time intervals. The experiment can be sped up by using a hand-held hairdryer or similar to encourage the evaporation of both the ethanol and water from the sample. The initial scans will show the alcohol content, which should be greater than 70% of the formulation, whilst evaporation to dryness will allow a scan of the emulsifier or skin conditioner left behind, and this can be identified from the spectrum library match.



Engineering Solutions

Shimadzu offers a range of materials testing instrumentation to suit academic requirements. The EZ Test is a compact solution for performing a wide variety of tests up to a maximum of 5kN, while the AGS-X table top universal testing machines series offers practical testing solutions for a variety of tests requiring force of up to 50kN.

Shimadzu's material testing solutions are supported by Trapezium X operating software allowing for user friendly programming and set up. Safety features are at the core of our machine development, with multiple levels of safety triggers built into both the machine and software.



High-precision testing system

Test Force Measurements Guaranteed with a High-Precision Load Cell with a Capacity of 5 kN Max.

The system uses a high-precision load cell that guarantees accuracy to within $\pm 0.5\%$ of the indicated value (high-precision type) over a wide range from 1/500 to 1/1 of the rated capacity.

This helps ensure highly reliable evaluation tests over a wide range of loads.

COMPLIANCE

JIS B7721 Class 1

ISO 7500-1 Class 1

EN 10002-2 Grade 1

ASTM E4

Note: Shimadzu recommends validation at an installation site that meets the requirements specified in these standards.



AGS-X:

- ✓ Real-time auto tuning of control parameters
- ✓ Easy comparisons to unknown samples without the need for preliminary tests
- ✓ Quick stress control test to an ISO 6892-2009
- ✓ Achieve an accurate S-S curve with high-precision load cells

± 0.5

Load Cell
Precision

FROM
1/500
TO 1/1

Load Cell
Precision
Range

1msec
(1000Hz)

High-Speed
Sampling

Materials Testing Experiments



Tensile test: What is it?

A Shimadzu material testing system is ideal for measuring tensile properties. Tensile tests are used to determine how materials will behave under tension load. In a simple tensile test, a sample is typically pulled to its breaking point to determine the ultimate tensile strength of the material. The amount of force (F) applied to the sample and the elongation (ΔL) of the sample are measured throughout the test. Material properties are often expressed in terms of stress (force per unit area, σ) and strain (percent change in length, ϵ). To obtain stress, the force measurements are divided by the sample's cross-sectional area ($\sigma = F/A$). Strain measurements are obtained by dividing the change in length by the initial length of the sample ($\epsilon = \Delta L/L$). These values are then presented on an XY plot called a stress-strain curve. Testing and measuring procedures vary based on the material being tested and its intended application.



3-point bend test

A Shimadzu material testing system is ideal for 3-point bend testing. This test measures the flexural strength and flexural modulus of materials, usually **reinforced and unreinforced plastics**.

These calculations allow you to choose materials that do not bend when supporting the loads you require for your application.

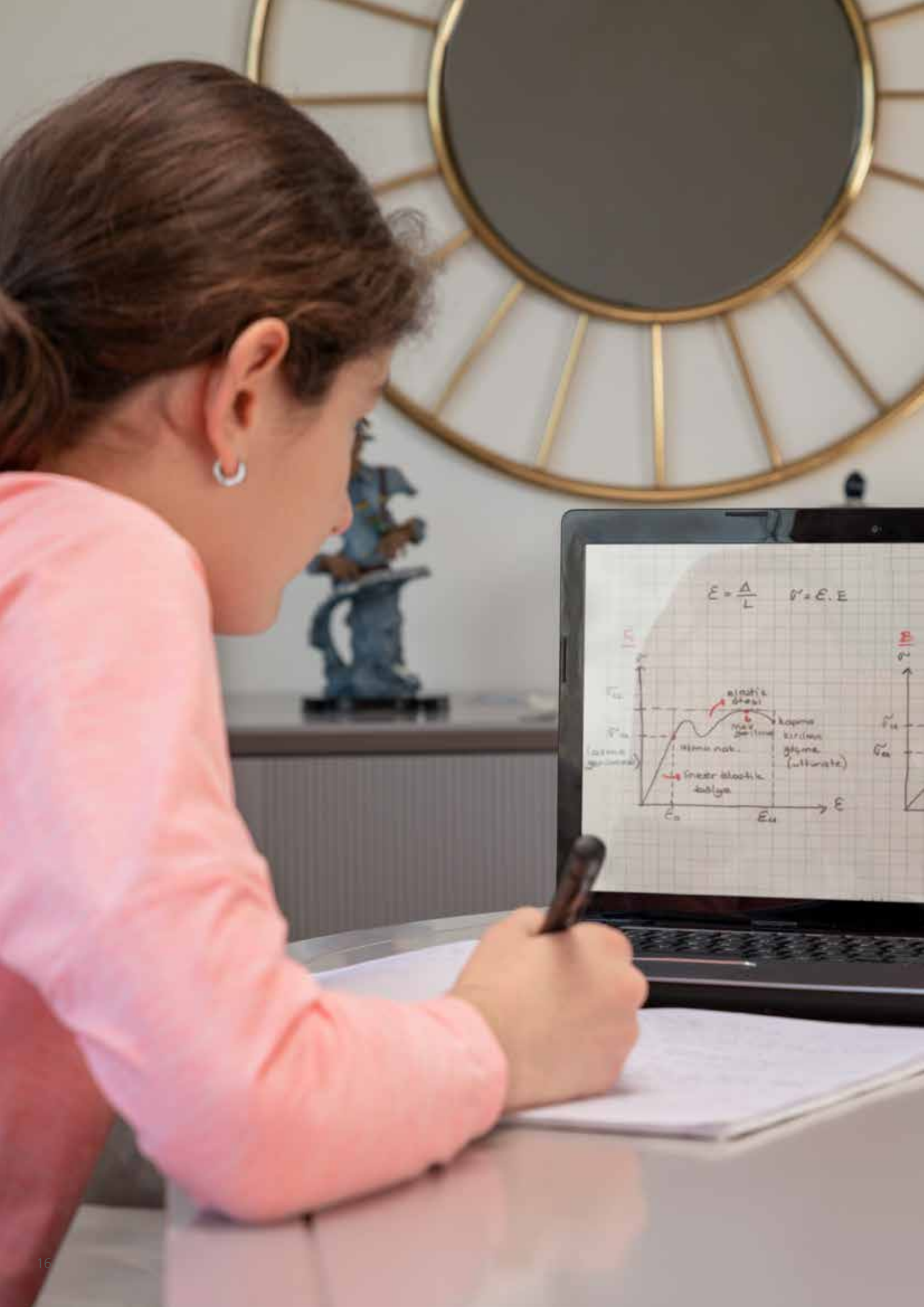
The test uses an EZ-Test universal testing machine and a three-point bend fixture to bend **plastic test bars** to acquire the data needed to make the calculations.



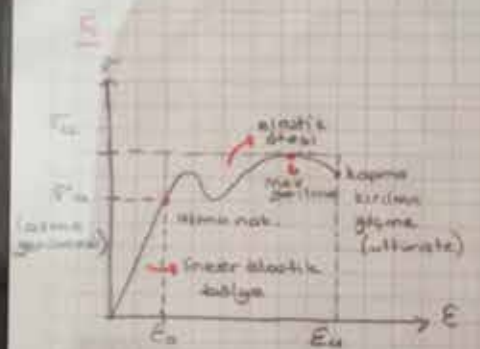
Peel test

A Shimadzu material testing system is ideal for measuring the **peel, tear, and friction** properties of **elastomers, adhesives, glues, cements, laminates, packaging, fabrics, coatings, labels, tapes, medical devices, and other products, materials, and components**.

With the Shimadzu UTM, you can accurately calculate average peel strength load over a specified distance and strength per unit width of adhesive. All adhesive testing systems feature constant-rate-of-extension (CRE) and constant-rate-of-load (CRL) control which allows you to perform a **wide variety of adhesive tests with only one testing machine**.



$$\epsilon = \frac{\Delta L}{L} \quad \sigma = E \cdot \epsilon$$

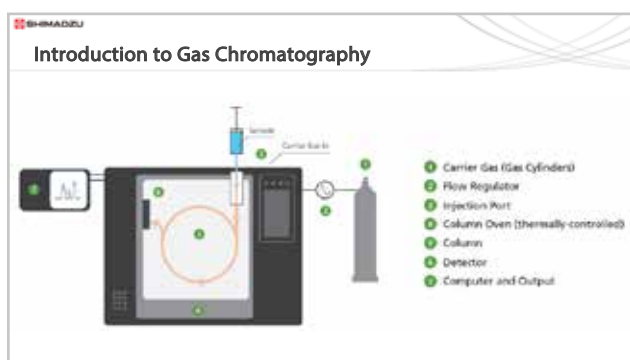


e-Learning Resources

All college students and personnel will gain access to Shimadzu e-learning resources.

The resources are geared towards students and young scientist. These cover the theory and key principles of chromatography and mass spectrometry techniques.

There are numerous e-learning videos available including such topics as:



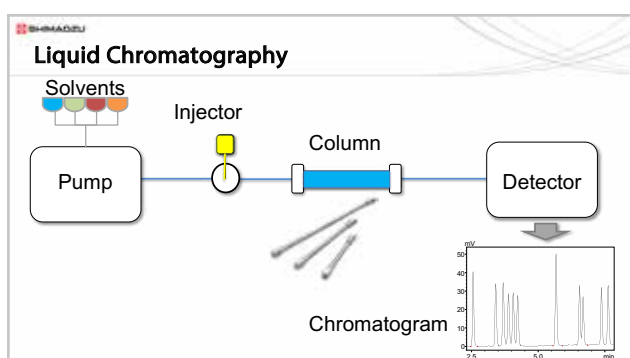
Gas Chromatography (GC)

- Introduction to gas chromatography
- GC columns
- GC injection techniques
- GC detectors
- Processing GC data
- Maintenance and troubleshooting
- Method development



Gas Chromatography – Mass Spectrometry (GCMS)

- Introduction to GCMS
- Single Quadrupole (SQ) vs Triple Quadrupole (TQ) GCMS
- GCMS operation and maintenance
- Introduction to GCMS method development



High Performance Liquid Chromatography (HPLC)

- Introduction to liquid chromatography
- Types of liquid chromatography and separation techniques
- Separation process
- Method development

Maintenance, Service and On-going Support



Shimadzu UK is dedicated to providing the best possible service to enable our customers to make the most of their equipment. With our team of Factory Trained & Certified Field Service Engineers and Product Applications Specialists, we are easily accessible to support and answer any questions that might arise.

Maintenance and support of analytical instrumentation is a vital part of laboratory operation. For our customer's peace of mind, Shimadzu instrumentation is supplied with 12 months warranty, commencing on the installation of the equipment.

In addition, we offer an academic maintenance plan, specifically developed to meet the needs of teaching laboratories. This plan includes an annual preventive maintenance visit to keep instrumentation running smoothly, as well as a 35% discount on emergency labour and travel charges.

The training sessions tailored to end user's needs and requirements will also be provided as a part of the package. In addition, we pride ourselves on providing continuous technical support for the lifetime of the instrument at no extra cost. Our customers have full online access to the Shimadzu online support portal and direct contact details of your key technical specialist.

Additional Value Offerings

In line with Shimadzu's ethos of Excellence in Science, we highly value the importance of investing in the next generation of talent. The students of today will be the driving force for the future of science and technological advances.

As part of the purchase of new analytical instrumentation, Shimadzu's proposal extends to the following areas:

- Supporting the implementation of the new teaching laboratory with the latest instrumentation at a collaborative subsidised rate
- Supporting guest teaching seminars by Shimadzu Application Specialists at the University site
- Shimadzu to invite key students/personnel to their Centre of Excellence HQ in Milton Keynes, providing access to the latest industry-standard analytical equipment
- Access to annual training courses at the Shimadzu Centre of Excellence HQ in Milton Keynes
- Shimadzu to create and support co-promotional activities, focusing on science teaching capabilities of the University
- Supporting teaching via e-learning platforms



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Shimadzu Products

LC | GC | LCMS | GCMS | Consumables | Molecular Spectroscopy | Elemental Analysis
| Life Sciences | TOC | Material Testing | Software