Project Number	Area	Description	Special requirements
1	National Centre of Excellence in Mass Spectroscopy Imaging (NiCE-MSI)	**Mapping Molecules using Mass Spectrometry Imaging** *Endogenous biomolecules in plant material will be mapped through analysis with mass spectrometry imaging.* In NiCE-MSI (National Centre of Excellence in Mass Spectrometry Imaging) we use mass spectrometry to help us understand a wide range of samples including biological materials and inorganic materials, such as semi-conductors. The techniques we use are mass spectrometry imaging (MSI) methods which allow us to create spatial maps of molecules from the surface of our samples. This data provides important information to help us understand where specific chemical compounds are localised in 2D, and even 3D, space. This project will focus on the analysis of plant-based materials to determine the localisation of compounds within different samples. Time will be spent preparing samples for analysis, conducting instrument optimisation and calibration, acquiring and analysing data, and culminate in the preparation of a summary presentation.	
2	Ultrasound and Underwater Acoustics	**Acoustic tweezers: an ultrasonic hand for manipulating the micro-scale.** *From micro-medicines to macro-minnows: moving objects with sound. Explore the acoustic manipulation of objects in fluids.* This project will use high-frequency sound waves to control microscopic objects and move them in 2D. Such a system allows for fine control of many microscopic objects at once and can be useful in sorting, filtering and condensing all kinds of particles. In this experiment you will be controlling tiny spheres (0.01 mm!) that act like ultrasound contrast agents (used in the diagnosis of cancer) to demonstrate that they can be sorted into fine size distributions.	The project can be tailored to meet students' abilities, either GCSE or A-level. Knowledge of Excel is desirable.

		The work takes place within NPL's Ultrasound group, who ensure that medical ultrasound remains safe around the world by defining and calibrating equipment to international safety limits. If you've seen an ultrasound machine at work, or the image of a baby in the womb, there is a 9/10 chance that that was made safe by standard measurements provided by NPL. We also perform novel research into tumour detection and non-invasive surgery; all with acoustics. Come help towards our vision of next generation cancer detection.	
3	Quantum Electrical Metrology	**Low-temperature characterisation of single-electron pump devices** NPL is developing a new type of electronic devices that could revolutionise future measurement, information-processing, and communication technologies. Rather than working with "classical" electrical quantities, such as voltage, current, or resistance, we are directly controlling individual electrons. By doing so, we will be able to exploit their indistinguishability (e.g. all electrons have exactly the same charge) and their quantumness (coherence and entanglement) for future quantum technology applications (e.g. to enhance measurement accuracy or computation speed). At the heart of this work are single-electron-pump devices. These are semiconductor devices that are designed to emit one electron at a time. This is difficult to do at room temperature, so NPL has cryogenic facilities that can cool devices down to as low as 10 mK (-273.14°C). In this Academy project, you will do what NPL scientists do first when new devices have been made, the characterisation tests of single-electron pumps at liquid-helium temperature (4.2 K or -269°C), to check if the devices can emit electrons one by one. You will learn cryogenic experimental	

		techniques and the underlying physics that governs the operation of single-electron pumps.	
4	National Centre of Excellence in Mass Spectroscopy Imaging (NiCE-MSI)	**High resolution imaging mass spectrometry for biological and pharmaceutical sciences** *Using world's highest imaging resolution mass spectrometer to identify location of drug labels or isotope tags at and below the single cell level* In this brief project, the student will receive hands-on time operating a high resolution imaging mass spectrometer (NanoSIMS) to identify the location of drug labels or stable isotope tags in biological samples. The time will be spent roughly split between acquiring the data on the instrument and processing the data offline using specialized software on a computer. The student will gain a general knowledge of mass spectrometry (in particular magnetic sector mass spectrometry), applied statistics, and ultrahigh vacuum science and how techniques such as NanoSIMS imaging are becoming more and more necessary in the fields of biological and pharmaceutical sciences.	An interest in analytical chemistry and biology would be useful but not essential. Enthusiasm is essential.
5	Finance	**Support to Finance Team** *This is a great opportunity to glimpse what goes on in a finance team, and have an involved and varied week* The Finance department performs all the management accounting, financial reporting, and accounts payable & receivable activities for the National Physical Laboratory. The role involves working alongside members of the corporate finance team, learning about what the finance department does as well as basic finance principles and processes. Students will be given access to our accounting system and will	Key attributes are enthusiasm and being proactive. Excel experience would be useful but not essential. Laptops will be provided.

		perform tasks using Microsoft Excel, which will give a broad overview of the activities that go on within the finance team. This opportunity will enable students to advance and expand their knowledge of Microsoft software, and benefit in learning how spreadsheets are used within a business. This, in turn, will provide them with valuable skills to use in their future studies and in their future careers.	
6	International	**Updating country information** *NPL aims to be a leader in the international measurement community but who are we leading?* International is the Foreign and Commonwealth Office of NPL helping to guide our relationships with international organisations and other national metrology laboratories. To do this effectively we need to know who our partners/competitors are. But, there are almost 200 countries in the world and things are constantly changing so keeping up to date is difficult. You could help with checking, updating and adding relevant information.	This project involves lots of internet searching. It would be suitable for a GCSE level student and would require a laptop and only basic knowledge of Excel.
7	Atomic Clocks and Sensors	**Frequency Modulation Spectroscopy for Gas Sensing** *Trace Gas Sensing with Lasers* Frequency stabilisation of lasers is a crucial component of atomic clock technology required to realise and even redefine the SI second. However, frequency stabilisation of lasers has many applications beyond frequency metrology and one such application includes trace gas sensing. The Atomic Clocks and Sensors Group within the Time and Frequency Department at NPL work to develop devices capable of detecting a single gas molecule within a billion other gas molecules. To do this, they utilise a variety of spectroscopic techniques that rely upon the fact that laser light incident on a molecular sample will only be	Ideally A-level students where knowledge of excel is preferred, though not essential.

		absorbed by the target gas molecules when its frequency coincides with the energy needed to excite those molecules from one quantum state to another. During this placement the student(s) will learn about infrared absorption spectroscopy and frequency modulation spectroscopy. They will get hands on experience in an optics lab, measure and compare different spectroscopic features of target gas molecules.	
8	Electromagnetic Measurements	**Voltage, power and electricity metering** *What are current, voltage and electrical power and how accurate is your electricity meter at home.* Electrical power is an important area of electromagnetic research and plays a key role in the measuring of mains electricity. The purpose of this project is the gain an understanding of the concepts of voltage, current and electrical power and to then design, build and test an electricity meter. The project is in 3 parts: 1) Theory: what is electrical power, how are voltages and currents measured and how are voltage, current and power linked. 2) Build: what tools can be utilised, what design is most fit for purpose and what are the limitations of the design. 3) Testing: does the device work, how accurate is it and can it be improved. Science is all about exploring new concepts and trying to work out how the world works so there hopefully will be time for these steps to be repeated a couple of times to allow for mistakes, learning opportunities and fun!	More suitable for A-Level students with some level of electrical knowledge and basic computing experience.

9	NPL Training	**Metrology Apprenticeship materials – formal review and reporting** *Discover what goes into a level 3 apprenticeship* NPL Training developed the level 3 Metrology Apprenticeship in 2017 and is now on the Register of Approved Training Providers. We have a total of 14 metrology apprentices at various stages of the programme. We would like to offer A level students the opportunity to review the practical tasks in parts of our metrology apprenticeship materials. They will be working with our Apprenticeship Lead, a Training Deliverer and the Product Development team during their visit and their output will form part of the formal review of our materials.	This would be more suitable for an A level student.
10	Medical Radiation Physics	**Traceability and Standardisation in nuclear medicine imaging and dosimetry** *Image acquisition in the multimodality system SPECT/CT. Image quantification and dosimetry calculations for an 90Y microspheres treatment.* Gamma-cameras are used in nuclear medicine for image acquisition after injection of a radiopharmaceutical for diagnostic and therapy procedures (also called Molecular Radiotherapy (MRT)). Image acquisition in nuclear medicine can be planar (2D images of a 3D distribution) or tomographic (3D images), known as Single Photon Emission Computerised Tomography (SPECT). Historically, SPECT imaging technology has been used in a qualitative matter, i.e. to detect the presence of disease shown in the image as ‘hot’ or ‘cold’ spots or absence of disease. However, it is widely recognised that there is a current need for more accurate image quantification in SPECT. Currently work at NPL is being undergone to investigate the methodology to achieve traceable	Students must be over 16 due to radiation protection regulations. Furthermore, they would need to be comfortable with the use of computers and MS office Excel software.

		quantitative imaging for SPECT imaging which in turn will improve personalised treatment planning. However, obtaining comparable quantitative data is an ongoing challenge the Nuclear Medicine Imaging (NMI) is targeting. The participating student will familiarise themselves on the basic principles surrounding Nuclear Medicine Imaging and dosimetry for MRT. • Some challenges they are able to undertake may include: • Programming for image analysis • Image Quantification using the tools provided • Possibility to perform dosimetry calculations using the tools provided • Performing statistical analysis to compare image quality characterisation between software such as (ImageJ and Fusion)	
11	Product Management, Commercial	**Product Management** *Work with NPL's Product Management team on a commercial project* NPL's Product Management team develops new commercial opportunities from NPL's excellent science and engineering. You will work on a project with the team to support our commercial objectives.	Academy students will need to have an interest in, and some knowledge of, business

12	Materials Characterisation	**Educational Inductive Gravimeter** *Build your own Inductive Gravimeter to take back and demonstrate to your school* The first day is spent building the precision instrument using a plastic pipe and copper wire. This is a painstaking task in which attention must be paid to detail (don't choose this project if you like rushing things!). The task involves rulers, blue-tack, superglue and soldering (instructions on soldering will be given). The remaining days will be spent dropping magnets through the tube and analysing the induced voltage signals produced. With sufficient attention it is possible to calculate the acceleration due to gravity. The experiment is open ended; you will be exploring different ways to modify the experiment in order to reduce errors as much as possible.	You will need to bring your own laptop operating in Windows (not MAC), The custom software used only operates on Windows computers. You must also be familiar with any spreadsheet package with which you can re-arrange data, plot graphs, add lines of best fit, and find the equation of the line. Note: No Windows laptop – No project! This project will suit A level students or gifted (patient and meticulous) GCSE students. Students should be familiar with the equations of motion relating distance, velocity, acceleration and time ("SUVAT equations").
13	Materials Characterisation	**Measuring Young's using a microphone** *Measure the ringing frequency of metal bars. Deduce a relationship with the length of the bar, and use it to calculate the Modulus.* You will be largely working un-supervised, making dimensional and mass measurements and recording then in spreadsheets. Additionally you will receive instructions on how to measure the resonant frequency of aluminium bars using a simple microphone and custom software. You will be trying to find the relationship between the measurements you have made and plotting graphs to demonstrate the relationships. Finally you will use your graphs to find the Elasticity (Young's) Modulus of the metal.	You will need to bring your own laptop with a spreadsheet package and be familiar with it so that you can re-arrange data, plot graphs, add lines of best fit, and find the equation of the line. (some instruction on this can be given, but you need to have the spreadsheet program – preferably Excel - on your computer). Note: No Laptop – No project! This project would suit both GCSE and A level students who are able to work on their own.