Supporting Technical Education Teaching:

**Curriculum Resources**

Teaching Guide

Topic: Good scientific and clinical practice

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| **Route** | Health & Science |
| **Qualification** | T Level Technical Qualification in Science (Level 3) (Delivered By NCFE) [www.ncfe.org.uk/qualification-search/qualification-detail/t-level-technical-qualification-in-science-level-3-delivered-by-ncfe-883](http://www.ncfe.org.uk/qualification-search/qualification-detail/t-level-technical-qualification-in-science-level-3-delivered-by-ncfe-883) |
| **Topic** | Good scientific and clinical practice |
| **Specification coverage** | **A8: Good scientific and clinical practice**A8.1, A8.2, A8.3, A8.4, A8.5, A8.6, A8.7, A8.8, A8.9, A8.10 |

This resource is part of a series of materials to support technical education teaching. The approach to developing the materials draws from research led by Professor Kevin Orr that sets out a model for understanding of technical education pedagogy.

The curriculum development begins with the knowledge that students are working to learn and apply. Teachers draw from their subject and industry expertise, and their knowledge of their students, to make decisions about the core concepts the curriculum will focus on, how they will sequence these concepts, and the activities that are selected to support students’ learning. The decisions behind the resources suggested in this topic are the result of choices made by the curriculum development team, which will be reviewed and improved by teachers’ decision-making and ongoing reflection in their own circumstances.

The materials also seek to support teachers in bringing classroom and industry closer together, by providing assets that draw from authentic industry materials, and using opportunities to capture current workplace practices that can be shared with students.



HEALTH AND SAFETY

This topic has been safety checked but not trialled by CLEAPSS.

It is assumed that activities outlined in this Teaching Guide will be undertaken in suitable facilities or work areas and that good practices, appropriate use policies and procedures will be observed. Teachers should consult their employers’ risk assessments before use and consider whether any modification is necessary for the particular circumstances of their own class/institution.

For practical activities, the Technical Education Networks programme has tried to ensure that experiments are healthy and safe to use in colleges and schools, and that any recognised hazards have been indicated together with appropriate control measures (safety precautions). It is assumed that experiments and activities will be undertaken in suitable laboratories or work areas and that good laboratory practices will be observed. To access the CLEAPSS materials in this suite, institutions will need to be a member of CLEAPSS. Further details are available at: [www.cleapss.org.uk](http://www.cleapss.org.uk) If necessary, CLEAPSS members can obtain further advice by contacting the Helpline by email at science@cleapss.org.uk or on 01895 251496.

Acknowledgments

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Materials for other topics are available at: [www.technicaleducationnetworks.org.uk](http://www.technicaleducationnetworks.org.uk)

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Introduction

This document for teachers outlines the topic area covered, and approach to using the suite of resources and assets for each lesson.

# Topic purpose

This topic introduces the key principles of good scientific and clinical practice, including standard operation procedures (SOPs) and the importance of following these correctly. It then covers the necessity of calibrating equipment and being appropriately trained to use equipment correctly and concludes by looking at some of the potential consequences of not storing and using products correctly, such as cross-contamination.

This topic could be taught at the beginning of the course as it introduces practical work students may undertake in their industry placements. It also evolves understanding of the importance of a SOP, which will be revisited by students throughout the course, and may be discussed in industry placements.

There are five lessons, and each is assumed to be 1.5 hours. You may want to adapt the suggested sequencing of concepts and activities as appropriate for your students and circumstances. The lessons are broken down to provide teacher flexibility on the depth covered in the activities; lessons can also be split over multiple shorter lessons if required.

There are also opportunities to build several essential skills that are developed during the course and general competencies for maths, English and digital.

The content in the lessons can be reinforced throughout the course to support students’ learning. For example, when discussing a forthcoming industry placement, one objective could be for students to look for a particular SOP in the workplace (this could be one they have used in a lesson or on a similar theme) and discuss the importance of following this SOP with their supervisor. This learning can then be noted in their logbook. For example: [www.support.tlevels.gov.uk/hc/en-gb/articles/360015345420-Industry-placement-logbook-for-students](http://www.support.tlevels.gov.uk/hc/en-gb/articles/360015345420-Industry-placement-logbook-for-students)

# Industry importance

It is essential to work safely in the workplace within the healthcare and science sectors. It is therefore necessary to have a clear understanding of the benefits of SOPs, how to follow one, and the potential consequences of an organisation not having SOPs in place or not following them correctly.

When carrying out any practical procedure or investigation, it is essential that SOPs are followed to make sure the employee and other stakeholders are kept safe, and the procedures achieve accurate results. Examples include:

* formulating medicinal drugs (e.g. Pharmacist)
* using a piece of equipment such as electron microscope (e.g. Medical Research Scientist)
* completing maintenance tasks to devices or machinery, such as calibrating a balance (Science Technician)
* storing or transporting chemical substances which may be toxic, corrosive or damaging to the environment (e.g. Engineer)
* growing a sample of bacteria (e.g. Microbiologist).

“Good practice correctly follows procedures; great practice understands how they work, how they may fail, and how they can improve.”

**Adam Kampff, Director at Voight-Kampff**

# Industry links

* CLEAPSS provides guidance on using equipment and chemicals safely: [www.science.cleapss.org.uk](http://science.cleapss.org.uk/)
* The Health and Safety Executive provides risk assessments and guidance documents on the control of substances hazardous to health (COSHH): [www.hse.gov.uk/coshh](http://www.hse.gov.uk/coshh)
* NHS England has SOP requirements for risk assessments such as coronavirus. Each Trust will have their own SOPs: [www.england.nhs.uk/coronavirus/primary-care/general-practice/standard-operating-procedures](http://www.england.nhs.uk/coronavirus/primary-care/general-practice/standard-operating-procedures)
* NHS England also has technical guidance on the national standards for cleanliness for all organisations to adhere to: [www.england.nhs.uk/estates/national-standards-of-healthcare-cleanliness-2021/](https://www.england.nhs.uk/estates/national-standards-of-healthcare-cleanliness-2021/)
* The Global Health Training Centre provides a course to gain understanding of Good Clinical Laboratory Practice guidelines in a clinical trial laboratory setting: [www.globalhealthtrainingcentre.tghn.org/good-clinical-laboratory-practice-course/](http://www.globalhealthtrainingcentre.tghn.org/good-clinical-laboratory-practice-course/)
* The Organisation for Economic Co-operation and Development (OECD) has guidance on good laboratory practice. These are the standards used in laboratories testing chemicals and shows the importance of SOPs: [www.oecd.org/chemicalsafety/testing/good-laboratory-practiceglp.htm](http://www.oecd.org/chemicalsafety/testing/good-laboratory-practiceglp.htm)
* The Open University has a free course on Health and Safety in Science: [www.open.edu/openlearn/mod/oucontent/view.php?printable=1&id=2712](http://www.open.edu/openlearn/mod/oucontent/view.php?printable=1&id=2712)

# Prior learning

Students may be familiar with the following Science concepts at Key Stage 4 and may have been introduced to risk assessments. However, most students are unlikely to have seen a SOP unless they have been shown these on a work experience placement or within part-time working roles.

Students may have carried out a range of practical work in Key Stage 3 and Key Stage 4 Science, as well as in Key Stage 3 Design and Technology. Some students may have experience of a more technical nature from their Key Stage 4 curriculum, such as from a Level 2 engineering qualification. Students should be familiar with the need to work with care and precision to achieve specified goals, but students’ experiences of practical work will be varied depending on their prior experiences.

# Accessibility

The teaching materials have been designed to provide teachers with a flexible framework, including different approaches to activities, suggested consolidation activities to further embed knowledge, and adaptable study questions to assess learning. As with all resources, teachers will wish to consider the specific needs of their students when using the materials, including Special Educational Needs and Disabilities (SEND).

Learning outcomes and specification coverage

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| --- | --- | --- | --- | --- |
| **Lesson** | **Learning outcomes** | **Specification coverage** | **Skills and General competencies** | **Links to other content in the specification** |
| **1** | Students will be able to:* Describe what a standard operating procedure (SOP) is and why their use is essential.
* State the key principles of good practice in scientific and clinical settings.
* Discuss potential consequences of not following good practice in scientific and clinical settings.
 | **A8.1** The principles of good practice in scientific and clinical settings:• using standard operating procedures (SOPs) • effectively managing calibration and maintenance of equipment and work areas • effectively managing stock • appropriately storing products, materials and equipment**A8.2** What a SOP is: • a set of sequential steps or instructions designed to standardise the approach to a process or action**A8.3** Why it is important for everyone to follow SOPs: • maintaining health and safety • enabling consistency of approach • meeting any legal or organisational requirements • upholding professional standards • demonstrating compliance for audit purposes | Skills**CS3.2** Meet their responsibilities when working in a wider team by ensuring that the project is compliant with relevant SOPs specific to the lab in which they are workingGeneral competenciesEnglish:**GEC4** Summarise information/ideas**GEC6** Take part in/lead discussions | **A1.1** The purpose of organisational policies and procedures in the Health and Science sector**A1.2** The importance of adhering to quality standards, quality management and audit processes within the Health and Science sector**A1.4** The purpose of following professional codes of conduct |
| **2** | Students will be able to:* Follow a SOP.
* Perform a search to locate a specific SOP for a given activity.
* Identify missing statutory requirements on a SOP.
 | **A8.2** What a SOP is: • a set of sequential steps or instructions designed to standardise the approach to a process or action **A8.3** Why it is important for everyone to follow SOPs: • maintaining health and safety • enabling consistency of approach • meeting any legal or organisational requirements • upholding professional standards • demonstrating compliance for audit purposes **A8.4** How to access SOPs for a given activity: • carrying out detailed index searches (for example via intranet/manual) • completing detailed staff induction and ongoing training • ensuring the SOP is the most up-to-date version • ensuring all relevant documentation has been completed and signed | Skills**CS3.2** Meet their responsibilities when working in a wider team by ensuring that the project is compliant with relevant SOPs specific to the lab in which they are working**CS2** ResearchingGeneral competenciesEnglish:**GEC5** Synthesise information**GEC6** Take part in/lead discussionsMaths:**GMC1** Measuring with precision**GMC6** Understanding data and riskDigital:**GDC1** Use digital technology and media effectively |  |
| **3** | Students will be able to:* Explain why it is important to calibrate and test equipment so it is fit for use.
* Describe the potential impacts of not maintaining, cleaning and servicing equipment.
* Outline how to escalate concerns over faulty or unsuitable equipment.
 | **A8.6** The potential impacts of not maintaining, cleaning and servicing equipment: • risks to health and safety: increased risk of injury, spread of infection • invalid results: contamination or cross-contamination (for example environmental, samples, reagents) • reduced function of equipment: decreased lifespan of equipment, increased cost and timescales (for example equipment needing repair or being out of service) **A8.7** Why it is important to calibrate and test equipment to ensure it is fit for use: • ensuring accuracy of measurements • prolonging the life of equipment • meeting legal requirements**A8.8** How to escalate concerns if equipment is not correctly calibrated/unsuitable for intended use: • taking the equipment out of action • labelling the equipment as being out of use, if appropriate • reporting concerns to the relevant person, in line with organisational policies and procedures • recording concerns according to organisational procedures | Skills**CS3.2:** Working with others**CS6:** Communication**CS7.1** Evaluate the project’s processes and outcomesGeneral competenciesEnglish:**GEC5** Synthesise information**GEC6** Take part in/lead discussionsMaths:**GMC1** Measuring with precision**GMC2** Estimating, calculating and error spotting | **A1.1** The purpose of organisational policies and procedures in the Health and Science sector**A1.2** The importance of adhering to quality standards, quality management and audit processes within the Health and Science sector**A10.1** Common causes of equipment and technical faults that may have an impact on scientific results |
| **4** | Students will be able to:* Describe the difference between contamination and cross-contamination.
* Explain the importance of regular cleaning of work areas and equipment.
* Analyse some potential consequences of incorrectly storing, cleaning and maintaining products, materials and equipment, and work areas.
 | **A8.5** The potential impacts of not regularly cleaning and preparing work areas for use: • risks to health and safety spread of infection o production of toxic/dangerous by-products • invalid results: contamination or cross-contamination (for example environmental, samples, reagents, DNA) • inefficient working practices: leads to increased costs and timescales • damage to equipment: leads to increased costs and timescales **A8.6** The potential impacts of not maintaining, cleaning and servicing equipment: • risks to health and safety: increased risk of injury, spread of infection • invalid results: contamination or cross-contamination (for example environmental, samples, reagents) • reduced function of equipment: decreased lifespan of equipment, increased cost and timescales (for example equipment needing repair or being out of service) **A8.10** The potential consequences of incorrectly storing products, materials and equipment: • cross-contamination • breakdown of limited stability products • products exceeding expiry dates • loss of samples or degradation of reagents not stored at the correct temperature (-20°C, -4°C, 4°C or room temperature) • risks to health and safety (for example spread of infection, release of dangerous chemicals or heavy items not stored at correct height) • stock is difficult to locate • financial loss | Skills**CS3.2:** Meet their responsibilities when working in a wider team by ensuring that the project is compliant with relevant requirements/regulations/SOPs/time-scales**CS6.1** Provide results and recommendations (written and verbal) to customers/clientsGeneral competenciesEnglish:**GEC1** Convey technical information to different audiences**GEC2** Present information and ideas**GEC3** Create texts for different purposes and audiencesDigital:**GDC1** Use digital technology and media effectively | **A10.7** The reasons for using aseptic techniques**A10.8** How to follow aseptic techniques |
| **5** | Students will be able to:* Discuss reasons why it is important to order and manage stock effectively.
* Explain some potential impacts of not storing materials and chemicals properly.
 | **A8.9** Why it is important to order and manage stock: • ensuring sufficient supply of required consumables and materials • ensuring that materials are used before their expiry date • reducing the costs of excess stock • improving efficiency • improving productivity • ensure safety of stock (bottles aren’t damaged/degraded) **A8.10** The potential consequences of incorrectly storing products, materials and equipment: • cross-contamination • breakdown of limited stability products • products exceeding expiry dates • loss of samples or degradation of reagents not stored at the correct temperature (-20°C, -4°C, 4°C or room temperature) • risks to health and safety (for example spread of infection, release of dangerous chemicals or heavy items not stored at correct height) • stock is difficult to locate • financial loss | Skills**CS3.2** health and safety requirements (for example, if storing and handling hazardous substances)**CS5.1** Solve a problem within a science context**CS6.1** Provide results and recommendations (written and verbal) to customers/clientsGeneral competenciesEnglish:**GEC2** Present information and ideas**GEC4** Summarise information/ideas**GEC6** Take part in/lead discussionsMaths:**GMC2** Estimating, calculating and error spotting**GMC8** Communicating using mathematics**GMC10** Optimising work processesDigital:**GDC3** Communicate and collaborate**GDC4** Process and analyse numerical data | **A10.4** The appropriate techniques for handling a range of different substances (for example, solids, liquids and gases) |

Lesson guidance

# Lesson 1: What is a standard operating procedure (SOP)? (A8.1, A8.2, A8.3)

This lesson introduces students to the key principles of good practice in scientific and clinical settings. These are essential for students to follow so that they operate in a safe and appropriate manner on placement. Students need to understand the purpose of a SOP and what the consequences might be of not following one. In this lesson students look at a range of different SOPs in industry. They also consider the principles of good practice in scientific and clinical settings, and consider examples where they have been followed, or not.

## Preparation

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| Resources provided | L1 Slide deckL1 Activity 2 Principles WorksheetConsolidation Worksheet |
| Equipment needed | 10cm3 pipette50cm3 beaker50cm3 measuring cylinderWaterInstitution SOPs (optional) |
| Safety factors | Teachers are required to carry out their own risk assessments for these activities. |
| CLEAPSS references | None |
| Prior learning | Students are unlikely to have met a SOP (unless via a prior work experience placement or in part-time jobs). However, students will be familiar with following methods from Key Stage 4 and will have been introduced to risk assessments. This prior learning should be referred to when introducing SOPs.Students will have been introduced to a range of organisational policies and procedures in the Health and Science sectors in A1 Working within the health and science sectors, if delivered before this topic (<https://www.technicaleducationnetworks.org.uk/health-science/working-in-the-health-and-science-sectors/>). |
| Common misconceptions | Standard operating procedures (SOPs) are not mandatory.Standard operating procedures (SOPs) only exist for machinery or when using equipment. |
| Accessibility | Seek to ensure wide representation for any visiting speakers and case studies used.You may wish to group students in groups of different abilities to support each other when working on group tasks. |

## Activity guide

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| IntroductionSUGGESTED TIME: 20 minutesRESOURCES: L1 Slide deck – slides 2–510cm3 pipette50cm3 beaker50cm3 measuring cylinderWater | The slide deck summarises what will be covered in the lesson. You may wish to use this with students.Start the lesson by introducing the lesson objectives using the slide deck.Continue with the lesson starter, which introduces students to the importance of providing and following clear instructions.Ask students to work in pairs. One student verbally tells another how to use a pipette to fill a beaker to exactly 30cm3. The other student must follow the verbal instructions exactly. Then they swap roles. Students use the measuring cylinder to accurately measure the volume of water in each beaker.Discuss what happened: Did all students manage to use the pipette to measure out exactly 30cm3? Use this discussion to introduce the importance of providing clear instructions that all must follow to result in a desired outcome. You may choose to introduce the importance of calibration and other key concepts when taking precise measurements at this stage.Share the example of a SOP on slide 4 for using a pipette with the students, by either linking from the slide deck or printing copies for groups to share.Ask students to read the SOP and, in groups, discuss their initial ideas about what a SOP is, and why they think they are used. After listening to their ideas, use the slide deck to explain what a SOP is.Explain that SOPs are used to standardise the approach to a process or action. |
| **Activity 1: Purposes of SOPs**Suggested time: 20 minutesResources: L1 slide deck – slides 6–10 Institution SOPs (optional) | This activity introduces students in more detail to the purposes of a SOP.Share some more examples of real SOPs with students, by either sharing the slide deck with students so they can click on the links, or printing some copies of the SOPs. There are ten examples on the slide deck to choose from, so you may wish to split the class into groups to look at different examples and share their findings. If useful, you could provide physical copies of relevant SOPs used in your institution for practicals not yet undertaken.Ask each group to identify what the image shows, then read the SOP by clicking on the image.When introducing the industry SOPs, it is worth remembering that the general concept and significance of an SOP is more important for students to understand than any specific example. When looking at the SOPS students should think about: * + Which of the key features, discussed previously, can they find in multiple SOPs?
	+ Do SOPs contain any other type of information not previously discussed?

You may choose to look at all the images or select specific ones for your students. Possible points of discussion for the SOPs in the slide deck: * + Image 1 – Flammable storage area. Purpose of SOP: Maintain health and safety.
		- Flammable storage area needs a SOP to minimise the risk of fire and explosions.
	+ Image 2 – Testing soil pH. Purpose of SOP: Consistency of approach.
		- Needs a SOP for enabling consistency of approach. Not following a SOP could lead to the equipment not being used correctly and giving an inaccurate result.
	+ Image 3 – Portable Appliance Testing (PAT). Purpose of SOP: Meet any legal or organisational requirements.
		- PAT is carried out to mitigate the risk of electrical faults that may injure the user or cause fires, etc. Although PAT testing is not a legal requirement, the Electricity at Work Regulations 1989 mean that employers are required to ensure that electrical equipment is in good working order and will not pose a risk to the employees that are using it. PAT testing is one of the best standardised ways to ensure that electrical equipment is in a safe condition.
	+ Image 4 – Storage of radioactive sources. Purpose of SOP: Demonstrate compliance for audit purposes.
		- Radioactive sources must be stored and used correctly due to the hazards they may cause to health, such as increased risk of cancer.
	+ Image 5 – Science technician in training. Purpose of SOP: To ensure professional standards are met.
		- The Institute of Science Technology is the professional body for technicians and has a code of practice detailing the expected standards of the institute and the profession.
	+ Image 6 – Manual handling training. Purpose of SOP: Meet any legal or organisational requirements.
		- Heavy objects lifted incorrectly can cause injuries, particularly to the back. Manual handling training is mandatory.
	+ Image 7 – Disposal of tissue samples (biohazard). Purpose of SOP: Demonstrate compliance for audit purposes.
		- A biohazard is a biological substance that can cause harm to humans and the environment. Correct disposal is needed to nullify this threat.
	+ Image 8 – Spillage of anti-cancer drugs. Purpose of SOP: Meet any legal requirements/maintain health and safety.
		- Chemotherapy drugs are very powerful and can be very harmful to health if they come into contact with someone other than a cancer patient.
	+ Image 9 – Fume cupboard. Purpose of SOP: Maintain health and safety.
		- Fume cupboards need to be checked to ensure they are operating efficiently and correctly to prevent poisoning of the user.
	+ For image 9, students could find an example of a SOP for a fume cupboard online, from their industry placement, or from their provider. The SOP should demonstrate ways to maintain health and safety. Ask students to critique the SOP based on what they have learned so far. Review the SOPs that students find online and talk through the content of them.
 |
| Activity 2: Principles of good practiceSuggested time: 20 minutesResources: * L1 Slide deck – slides 11–18
* L1 Activity 2 Principles Worksheet
 | This activity introduces students to the principles of good practice in scientific and clinical settings.Use the visual prompts on slide deck (slides 11–16) to introduce the principles of good practice in scientific and clinical settings. On each slide, the students should try to come up with the principle being introduced and use this to produce a list of key features of good practice. Click on the question mark icon to reveal the principle being shown.Use slide 17 to summarise the five key principles of good practice.You may also wish to introduce ‘reporting concerns or ideas for improvement’ as another feature of good practice, such as ways to do things faster or cheaper. Although this is not specifically stated in the specification, it is vital that students/employees are engaged in the improvement process. They may be the first to identify problems and potential improvements, and this reporting should be encouraged as good practice. Fundamentally, everyone in an organisation should be seen as having an important role to play.Show students the case studies on slide 18 (case study 1 ‘Insight into a microbiology lab’’ and case study 2 ‘Toluwani Alade: Healthcare Laboratory Technician’). As the students watch each video, they should identify principles of good practice such as wearing gloves in the laboratory, storing chemicals appropriately, wiping down surfaces, inspecting and maintaining equipment, safety checking. Students can use the Principles Worksheet tables to add the specific examples identified, allocating them to the correct key principle column. Note on case study 1: The autoclave is a useful example in this video (up to 4.10).Students may wish to search for a similar video in a career they are interested in. Technicians.org has a range of technician profiles: [www.technicians.org.uk/technician-profiles/real-life-stories/](http://www.technicians.org.uk/technician-profiles/real-life-stories/) |
| Activity 3: What could go wrong?Suggested time: 15–20 minutesResources: L1 Slide deck – slides 19–27 | * This activity is designed to make students think about the potential consequences of not following the principles of good practice in scientific and clinical settings.
* Use the slide deck to introduce a number of different scenarios where good practice has not been followed. For each scenario, students should consider what could go wrong and how they could rectify the situation/prevent it having occurred.
* Slides 26–27 provide some real-life examples of what happened when good practice was not followed in two industry settings.

Suggested points for discussion: * + Scenario 1 – Lost keys: Report to a manager immediately to ensure that the contents of the radioactive samples in the cupboard are not stolen or taken and used inappropriately. There are strict legal guidelines about the use and storage of radioactive materials. This scenario is about appropriately storing products, materials and equipment. It also points to the need for a SOP on the storage of radioactive materials.
	+ Scenario 2 – Lunch in the medicine refrigerator: This is not acceptable. There is the possibility of contamination from poisonous chemicals and subsequent problems due to this. There is also the danger of cross-contamination of some of the chemicals from the packed lunch. This scenario is about appropriately storing products, materials and equipment.
	+ Scenario 3 – The biological sample refrigerator was switched off: Do not switch it on straight away. You should report it immediately. The temperature of the fridge should be taken to see whether there may be damage to temperature-sensitive samples. This scenario is about appropriately storing products, materials and equipment and about potential consequences of incorrect storage. In particular, it addresses the breakdown of limited stability products and the loss of samples or degradation of reagents not stored at the correct temperature.
	+ Scenario 4 – Zero error: You do not know when the zero error happened so you will need to report this immediately, and all of the samples you have produced will have to be checked or disposed of.
	+ Scenario 5 – Use of the autoclave: You must follow the SOP irrespective of what you are asked to do. The SOP is a legal document, and you will be liable for the consequences if you do not follow it. You must seek advice from a senior colleague as to what to do.
	+ Scenario 6 – An unidentifiable spillage: The spillage should be treated as a potentially hazardous chemical. A SOP must be followed to clear up the spill.
* This could lead onto a discussion about how much personal responsibility a student has whilst on placement, for example, to report incidents such as these to their supervisor (and how this is likely to increase as they progress through the course and into their careers). Discussion of whistleblowing policies could be included, and links made to other relevant organisational policies and professional codes of conduct. This role-modelling will help students to develop into good practitioners for the future.
* Discuss why people may not follow good practice in the workplace even when they have been trained how to. The discussion should focus on human factors, such as the workplace may be busy, noisy, or cramped; people are trying to juggle many things like work projects and/or homelife; there may be time pressures or fatigue.
 |
| PlenarySuggested time: 10 minutesResources: L1 Slide deck – slides 28–30 | In pairs, give students one minute to tell their partner what a SOP is and why they are so important in a range of settings.Can their partner add any further detail to their description or is there anything they missed?Alternatively, you can use the multiple-choice question on slides 28 and 29 to consolidate the learning from the lesson.Revisit the learning objectives to close the lesson on slide 30. Discuss the consolidation activity below (where appropriate).  |
| Follow-up/ consolidationSuggested time: 30–45 minutesResources: L1 Slide deck – slide 31Consolidation Worksheet | SOPs can be very large documents as many do not cover practical applications but instead share information on how a service is run and standardised. You may wish to provide students with one of these documents, which they could then critique elements of (What is done well? What could be improved?).Alternatively, students could write a SOP for using a piece of standard laboratory equipment for which they are confident in using, such as a light microscope, or a practical procedure they have recently carried out. They can use the template on the worksheet. |

# Lesson 2: Using a SOP (A8.2, A8.3, A8.4)

This lesson provides further opportunities for students to become familiar with working with SOPs within the Health and Science industries. They begin by following a SOP for an unfamiliar situation before carrying out their own searches for specific SOPs. They also analyse a SOP that is missing key information.

## Preparation

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| Resources provided | L2 Slide deckActivity 1 – L2 Activity 1 WorksheetActivity 1 – CLEAPSS guide to using a burette (GL320 – Filling and using a burette)Plenary – L2 Plenary WorksheetFollow up/consolidation – L2 Consolidation Worksheet |
| Equipment needed | Each student will need:Sodium hydroxide (0.1 mol dm-3)Ethanoic acid (0.1 mol dm-3)PipetteBuretteClamp standEye protectionConical flaskBeakerpH meterColoured water (optional) |
| Safety factors | Teachers are required to carry out their own risk assessments for these activities including but not limited to:Wear eye protection |
| CLEAPSS references | CLEAPSS – Student safety sheet 23 Ethanoic acid: <https://science.cleapss.org.uk/resource/sss023-ethanoic-acetic-acid.pdf> CLEAPSS – Student safety sheet 31 Sodium hydroxide: [http:/science.cleapss.org.uk/resource/sss031-sodium-hydroxide.pdf](http://science.cleapss.org.uk/resource/sss031-sodium-hydroxide.pdf)  |
| Prior learning | The key principles of good practice in scientific and clinical settings (Lesson 1).What is a SOP and why are they important? (Lesson 1).Some students may be familiar with neutralisation practicals and have the opportunity to use a burette in Key Stage 4. For others, this piece of equipment will be new. |
| Common misconceptions | SOPs are not mandatory. |
| Accessibility | * Seek to ensure wide representation for any visiting speakers and case studies used.
* You may wish to use pair work to help students of different abilities to support one another.
* You may wish to use tactile markings on equipment or text to audio apps for instructions.
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## Activity guide

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| IntroductionSUGGESTED TIME: 5 minutesRESOURCES: L2 Slide deck – slides 2–3 | The slide deck summarises what will be covered in the lesson. You may wish to use this with students.Start the lesson by introducing the lesson objectives using the slide deck.This lesson starter checks that students can recall the principles of good practice in scientific and clinical settings.Ask students to list the five key principles (covered in Lesson 1). |
| Activity 1: Following a SOPSuggested time: 45–60 minutesResources: L2 Slide deck – slides 4–5L2 Activity 1 WorksheetCLEAPSS guide to using a buretteSodium hydroxide (0.1 mol dm-3)Ethanoic acid (0.1 mol dm-3)PipetteBuretteClamp standEye protectionConical flaskBeakerpH meterColoured water (optional) | This activity is designed to support student’s learning and ability to follow a SOP and illustrate why it is essential that everyone follows a SOP.Students follow a SOP on the worksheet (without any further guidance) to simulate the manufacture of Drug X. Students will also need access to the CLEAPSS guide to using a burette. This can be found on the CLEAPSS website here: <https://science.cleapss.org.uk/Resource-Info/GL320-Filling-and-using-a-burette.aspx>You may also find the following CLEAPSS guide to be of use: * + GL319 Filling and using a volumetric (or graduated) pipette <https://science.cleapss.org.uk/Resource-Info/GL319-Filling-and-using-a-volumetric-or-graduated-pipette.aspx>

Students may make mistakes. For example, they may not fill the burette slightly past zero and allow to drip into a clean beaker until it reaches the correct level, or they may not read the scale from the meniscus correctly.Once complete, test the pH of their resulting solution to determine how well they have followed the procedure and their ability to accurately use a burette and pipette. It should have a pH in the range 4.5–4.6.If their pH is in the range of 4.5–4.6, they have followed the SOP correctly. Students can then answer the follow-up questions on the slide deck. If students did not get the correct pH, more practice at using a burette would be beneficial. Ask them to follow the instructions on the CLEAPSS guide using water (you can supply coloured water if helpful).Students can also repeat the activity to see if their technique has improved.Discuss the findings of the class using the questions on slide 5. Did everyone achieve the same result? If not, why do they think this may be? Does this matter? If so, why is this important? Why is it essential that everyone follows a SOP? Use the experiment to introduce the importance of training, for example, the guide would be used for training on how to use a burette correctly. |
| Activity 2: Finding and comparing SOPsSuggested time: 15–20 minutesResources: L2 Slide deck – slides 6–8 | This activity is designed to enable students to perform a search to locate a specific SOP for a task that needs to be performed. It also provides students with a further opportunity to see the diverse range of SOPs that exist within the industry. Discuss with students where SOPs are located in your institution, and the different places they may be found in a workplace. For example, hard copies given to an employee; located in a central store; printed off and kept in relevant locations, such as next to a piece of machinery or in an online intranet.Students carry out an online search to find specific SOPs for a range of scenarios presented on the slide and decide what key points should be in the SOP. You may wish to add more of your own examples. Examples of suitable SOPs to search for:* + Scenario 1 – Preparing a meal in a school kitchen: A SOP that outlines procedures to keep catering staff safe when working in a kitchen.
	+ Scenario 2 – Moving contents of an old hazardous chemical store: A SOP that outlines storage, handling and disposal of waste chemicals and solvents.
	+ Scenario 3 – New strain of COVID: A SOP that outlines the correct procedure to use a COVID-19 lateral flow test.
	+ Depending on the time available and the size of the group, you may wish to split the class into small groups to look at one scenario each. Groups can then feed back to each other with their findings.
* Once they’ve looked up the SOP, students consider:
	+ How many of the key points had you already suggested?
	+ Identify which points in the SOP are critical? (i.e. could have disastrous outcomes if done wrongly). Did you include these in your approach?
* Students can then share their findings in small groups – did all the SOPs look the same? Did they contain the same essential features?

Use the slide to recap how to find and compare SOPs. |
| PlenarySuggested time: 10 minutesResources: L2 Slide deck – slides 9–12L2 Plenary Worksheet | Use slide 9 to recap what is required in a good SOP.Provide students with the worksheet, which is a SOP on preparing agar plates. Students read through the document and highlight any mistakes:* + The SOP has not been reviewed or authorised.
	+ The users have not dated when they read the policy.
	+ The scope and the purpose have been muddled up and placed in the wrong boxes.
	+ Temperature missing at step 2 in the procedure.
	+ Final step is missing in procedure where they disinfect the area they worked in with ethanol.

Discuss the mistakes and any potential problems that could arise.Revisit the learning objectives to close the lesson on slide 12. Discuss the consolidation activity below (where appropriate). |
| Follow-up/ consolidationSuggested time: 30–45 minutesResources: L2 Slide deck – slide 13L2 Consolidation Worksheet | * While on placement, students could collect examples of SOPs they have used. When returning to their provider, students should then compare the different SOPs they have met including their purpose and format.
* Students search for two SOPs online for the same piece of equipment or procedure and then compare them using the worksheet provided. The activity describes looking for a SOP for how to use a pipette. A suitable example is here: [www.learn.lboro.ac.uk/pluginfile.php/1128655/mod\_folder/content/0/SOP057 Use and Maintenance of Pipettes .pdf?](https://learn.lboro.ac.uk/pluginfile.php/1128655/mod_folder/content/0/SOP057%20Use%20and%20Maintenance%20of%20Pipettes%20.pdf)
* This task could be amended for other laboratory equipment or procedures.
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# Lesson 3: Use of equipment (A8.6, A8.7, A8.8)

This lesson introduces students to the importance of calibrating equipment and knowing how to test equipment correctly to ensure it is fit for purpose. The students are also presented with ways in which they should escalate any concerns over faulty or unsuitable equipment whilst on placement (and in their future career).

## Preparation

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| Resources provided | L3 Slide deckActivity 3 – L3 Activity 2 WorksheetCards cut from L3 Activity 3 Worksheet |
| Equipment needed | Various pieces of faulty equipment, for example, an overstretched spring in a Newton meter, mass balance that does not tare to zero, faulty temperature sensor.A range of items for students to measure using the faulty equipment, for example, objects of various mass that can be weighed using the mass balance and the Newton meter; boiling water; iced water; water taken from a water bath to be used with the temperature sensors. For each student:Bathroom scales or mass balanceP1000 micropipettePipette tips Distilled water (50cm3 for each student)A beakerDigital thermometer or temperature probeDigital balance, resolution ±0.0001gBalance draught shieldWeighing boatFor the classroom carousel:Balance4 Í 50cm3 beakersBeaker containing salt (unknown mass)Measuring cylinderWaterThermometerBunsen burnerGauzeTripodMatSafety glassesPipette/syringe |
| Safety factors | Teachers are required to carry out their own risk assessments for these activities. |
| CLEAPSS references | CLEAPSS resource handbook – Section 9 General equipment: <https://science.cleapss.org.uk/Resource-Info/Handbook-Section-9-General-Equipment-A-L.aspx> |
| Prior learning | The purpose of a SOP (Lesson 1).The purpose of organisational policies and procedures in the Health and Science sectors ([A1 Working within the health and science sectors](https://www.technicaleducationnetworks.org.uk/health-science/working-in-the-health-and-science-sectors) - Lesson 1 Organisational policies and procedures).The importance of adhering to quality standards, quality management and audit processes within the Health and Science sectors ([A1 Working within the health and science sectors](https://www.technicaleducationnetworks.org.uk/health-science/working-in-the-health-and-science-sectors) - Lesson 1 Organisational policies and procedures). |
| Common misconceptions | Confusion over the terms accuracy and precision.Students sometimes think that measurement error means a mistake rather than the difference between the measurement and the true value. |
| Accessibility | * Seek to ensure wide representation for any visiting speakers and case studies used.
* If you do not have access to class sets of micropipettes, you may wish to replace activity 3 by turning activity 2 into a class practical, by asking students to check and re-calibrate mass balances using a range of masses. It is worth noting that while a balance may be calibrated correctly within the middle of its operating range, at the extremities (particularly approaching the maximum permissible mass) students may find the balance reading incorrectly, and hence re-calibration is required.
* You may also wish to choose to carry out the alternative activity suggested above if you are short on time and your class needs a high degree of support with practical skills.
* The feedback/consolidation contains different activities which can be chosen depending on student’s needs.
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## Activity guide

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| IntroductionSUGGESTED TIME: 5 minutesRESOURCES: L3 Slide deck – slides 2–4 | The slide deck summarises what will be covered in the lesson. You may wish to use this with students.Start the lesson by introducing the lesson objectives using the slide deck.This activity is designed to introduce students to a wide range of measurements that are used by scientists.Use the image on the slide of a busy street to introduce the importance of measurement in science. Ask the students what different things do scientists measure in the world around us? What measurements are critically important? |
| Activity 1: Why is it important to regularly test equipment?Suggested time: 10–15 minutesResources: L3 Slide deck – slides 5–6Various pieces of faulty equipment | * This activity is designed to introduce students to the importance of calibrating and testing equipment to ensure it is fit for use. It partially covers the potential impacts of not maintaining, cleaning and servicing equipment (which will be looked at further in lesson 4).
* Provide students with some equipment, some of which is faulty, for example, an overstretched spring in a Newton meter, mass balance that does not tare to zero, faulty temperature sensor or a stopwatch that has dead batteries. If possible, provide some equipment with visible calibration labels and a servicing record. Ask students to use their equipment to make measurements, which should be identical, and then compare their results – whose group is correct? How do they know?
* As an additional task, reveal the true measurements and ask students to calculate the percentage difference in their measurement and the true measurement.
* When discussing their results, talk about the importance of making sure that any equipment used is not faulty to ensure accuracy of measurements, how regular testing can help to ensure equipment is fit for use, and that it is often needed to meet legal requirements. If you can provide equipment with calibration labels and a service record, point this out and note that the calibration dates should be checked. Slides 9–10 cover this in more detail.
* Introduce the concept of calibration, and that each piece of equipment has a regular calibration cycle which should be followed to ensure a piece of measuring apparatus reads correctly and to extend its life. This will be standard procedure in the workplace. (Examples you could use to illustrate the differences in lengths of calibration cycles: the calibration cycle of a Newton meter varies by manufacturer but, generally, they recommend about once a year. Most manufacturers recommend educational balances are recalibrated once a month, but for more accurate measurements, they should be recalibrated each time they are moved.)
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| Activity 2: Calibrating equipmentSuggested time: 35–40 minutesResources: L3 Slide deck – slides 7–10Laboratory scales or mass balanceL3 Activity 2 WorksheetP1000 micropipettePipette tips Distilled water A beakerDigital thermometer or temperature probeDigital balance, resolution ±0.0001gBalance draught shieldWeighing boats | * This activity is designed to introduce students to some ways equipment is calibrated to ensure it remains fit for purpose.
* To introduce how to calibrate equipment, demonstrate calibrating a set of laboratory scales or mass balance, as this is a familiar context for students. Many balances can be calibrated using the following approach or similar (check with the manufacturer for the specific approach for your balances):
	+ Place the scale on a flat surface and turn on.
	+ Press the ‘calibrate’ button and wait for the display to read zero. This indicates that the scale has been reset to its default settings and is ready for calibration.
	+ Next, use a mass and place it on top of the scale platform.
	+ Then press ‘calibrate’ again, adjusting the scale reading up or down until the display shows the correct mass reading of your item.
* Discuss the questions on the slide with the students. If you wanted to use some specialist equipment to calibrate, this could be used in the same way for this activity.
* Students then follow the instructions on the worksheet to complete a practical activity to check the calibration of a micropipette by comparing the volume of liquid transferred by the micropipette, and a calculated volume transferred via measurements of its mass. From these readings, students are asked to calculate a ‘% measurement error’ figure for the micropipette used, and to consider any potential sources of error in their experimental approach.
* Using slides 9–10 to discuss with students why it is important to calibrate and test equipment to ensure it is fit for use. Links can be drawn here with the use of organisational policies which they met in A1 Working within the health and science sectors.
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| Activity 3: Identifying mistakesSuggested time: 20 minutesResources: L3 Slide deck – slide 11–12Cards cut from L3 Activity 3 WorksheetBalance4 Í 50cm3 beakersSaltMeasuring cylinderWaterThermometerBunsen burnerGauzeTripodMatSafety glassesPipette/syringe | * This activity is designed to introduce the importance of identifying and reporting errors/mistakes, and the potential consequences of not doing so. It links to their previous work on the principles of good practice.
* Students complete a carousel activity set up prior to the lesson, using the scenario cards on L3 Activity 3 Worksheet. Print and cut the scenarios and divide between carousel stations.
	+ Scenario 1 – Using a balance to measure the mass of salt.
	+ Scenario 2 – Using a measuring cylinder to measure a volume of water.
	+ Scenario 3 – Using a thermometer to measure the temperature of a liquid whilst heating. (Before the students do the activity, set up the equipment and heat a beaker containing water. The water should be hot when students come to carry out the activity.)
	+ Scenario 4 – Using a beaker to measure a 12cm3 volume of liquid.
* Each scenario is set with a card that describes the equipment by a student, and how the equipment was used (cut from the worksheet). Students spot what has been done wrong, and then use the supplied equipment to carry out the measurement correctly.
* Discuss with the students what mistakes they spotted, how they corrected them and why using the correct technique when making measurements is important.
* Discuss the correct procedures with the students (slide 12):
	+ Scenario 1 – Place the empty beaker on the balance, press tare, then remeasure the mass of the beaker with the salt added.
	+ Scenario 2 – Place the measuring cylinder on a table whilst filling the cylinder and reading the volume. To determine the correct volume of liquid, line up the eye to the level of where the liquid sits on the scale before taking the reading (this avoids parallax error).
	+ Scenario 3 – The thermometer should be held in the liquid away from the beaker sides when measuring the temperature. The liquid should be stirred before a measurement is taken.
	+ Scenario 4 – Use a pipette/syringe to accurately measure out the volume of liquid and transfer to the beaker. Beakers are not suitable for accurate volume measurements due to their larger graduations.
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| Activity 4: Escalating concernsSuggested time: 10 minutesResources: L3 Slide deck – slides 13–14 | Ask students to read through the scenario on the slide about a potentially faulty chemical storage fridge. With their partners, they should discuss what the trainee chemist should do next, before discussing the appropriate steps as a class. Students should realise that they are not responsible for determining if the equipment is faulty (testing whether an electrical appliance is faulty is the responsibility of an electrical technician, but it is their responsibility to report the fault), so they should not switch off the equipment. The chemicals should also not be moved before discussing with a line manager because if the equipment is faulty, the chemicals may need to be appropriately discarded as they may have degraded and therefore may yield invalid results. Marking the equipment as faulty and not in use and completing a proforma report form is important so that another staff member does not use the chemicals. It is also important to note that concerns should be escalated to a more senior member of staff if they come across equipment which is not fit for purpose while on placement, and later in their careers.Use slide 14 to recap the key points in the discussion. |
| PlenarySuggested time: 5 minutesResources: L3 Slide deck – slides 15-16 | Ask students to write down three reasons why it is important to calibrate and test equipment (ensuring accuracy of measurements, prolonging the life of equipment, meeting legal requirements).Revisit the learning objectives and check learning has been achieved.* Revisit the learning objectives to close the lesson on slide 16.
* Discuss the consolidation activity below (where appropriate).
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| Follow-up/ consolidationSuggested time: 30–45 minutesResources: L3 Slide deck – slide 17 | Students could be asked to look at online animations to help develop practical skills they lack confidence in, for example, how to make a solution. Some examples can be found here: [www.labxchange.org/library](http://www.labxchange.org/library)Students may wish to make a video(s) of either correct, or subtly incorrect, procedures to show to the rest of the group in a later session for them to critique. Students could join in with a measurement challenge, courtesy of the National Physical Laboratory (NPL), using their measurement skills at home: <https://www.npl.co.uk/measurement-at-home> |

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# Lesson 4: Maintaining clean work areas, machinery and resources (A8.5, A8.6, A8.10)

This lesson introduces students to some potential consequences of incorrectly storing, cleaning and maintaining products, materials, equipment and workspaces. Using contamination as a focus, students look at how this may occur and control measures which can be taken to mitigate the risk of this happening.

## Preparation

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| Resources provided | L4 Slide deckActivity 2 – L4 Activity 2 WorksheetActivity 3 – L4 Activity 3 Worksheet |
| Equipment needed | Boiling tubes – one per student. Place boiling tubes part-filled with milk and water into a rack. Add strong starch solution to one of the tubes to make it ‘infected’. Check it can be detected with iodine when further diluted.Iodine in a dropper bottleEye protectionMeasuring cylinderBeaker (to mix milk solutions)Stirring rodsORFluorescent tracking gel and UV light/ hand washing light box.If available, a science technician may be able to support with the setup of the equipment required in this lesson.  |
| Safety factors | Teachers are required to carry out their own risk assessments for these activities.  |
| CLEAPSS references | Iodine – see CLEAPSS Student Safety Sheet 56: <http://science.cleapss.org.uk/resource/sss056-iodine.pdf> |
| Prior learning | The purpose of a SOP (Lesson 1).The purpose of organisational policies and procedures in the Health and Science sectors ([A1 Working within the health and science sectors](https://www.technicaleducationnetworks.org.uk/health-science/working-in-the-health-and-science-sectors) - Lesson 1 Organisational policies and procedures).The importance of adhering to quality standards, quality management and audit processes within the Health and Science sectors ([A1 Working within the health and science sectors](https://www.technicaleducationnetworks.org.uk/health-science/working-in-the-health-and-science-sectors) - Lesson 1 Organisational policies and procedures). |
| Common misconceptions | Contamination only occurs when food or a medical product contains a microorganism.Cross-contamination and contamination are the same thing. |
| Accessibility | * Seek to ensure wide representation for any visiting speakers and case studies used.
* Choice of practical depending on equipment available. Students can visualise the spreading of contamination using a fluorescent dye or complete the practical using milk and starch solution.
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## Activity guide

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| IntroductionSUGGESTED TIME: 5–10 minutesRESOURCES: L4 Slide deck – slides 2–4 | The slide deck summarises what will be covered in the lesson. You may wish to use this with students.Start the lesson by introducing the lesson objectives using the slide deck.This introduction is designed to remind students about the importance of regularly cleaning surfaces and equipment and preparing the work area for use.Show students the images on the slide. Ask them to list as many reasons as they can why surfaces and equipment needs to be regularly cleaned and prepared for use. These include:* + Cleaning surfaces in a laboratory – to avoid issues with health and safety involving spillages of toxic/dangerous substances, and to avoid the spread of infection.
	+ Cleaning laboratory glassware – to avoid issues with contamination/cross-contamination, which will prevent invalid results and the possible production of dangerous by-products.
	+ Cleaning industrial equipment – to avoid any contamination/cross-contamination, to increase the function/lifespan of the equipment, to avoid damage to the equipment.
	+ Preparation of work area – to increase efficiency and avoid increased costs and timescales if preparation is not complete.
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| Activity 1: The importance of correct storageSuggested time: 10 minutesResources: L4 Slide deck – slides 5–6 | * This activity is designed to introduce students to the importance of storing chemicals, materials and products carefully (this will be revisited in Lesson 5).
* Ask students to identify the potential issue with the way materials are being stored in each scenario on the slide. Discussion points could include:
	+ Scenario 1 – Stock is being stored too high so it’s difficult to locate and may cause a health and safety risk of falling on a person when trying to reach it. It may also cause a financial loss if the item can’t be found and has to be reordered.
	+ Scenario 2 – Stock looks very old so could be past its expiry date. It may no longer work in the desired manner and could even pose a safety risk, for example by releasing a dangerous gas, especially if stored in a bag suggesting bottle may be leaking. This could also lead to cross-contamination/the breakdown of limited stability products.

Ask the class if there are any other potential issues that they can think of. Slide 6 summarises some of the key issues of incorrect storage. Explain that in today’s lesson, the students are going to study contamination. |
| Activity 2: Contamination and cross-contaminationSuggested time: 30–40 minutesResources: L4 Slide deck – slides 7–11L4 Activity 2 WorksheetBoiling tubes of milk and water – one per student (one will be ‘infected’ with starchIodine in a dropper bottleEye protectionMeasuring cylinderBeaker (to mix milk solutions)Stirring rodsORFluorescent tracking gel and UV light | * Introduce students to the difference between contamination and cross-contamination using the definitions and examples on the slide deck. Discuss the potential consequences of this, such as risks to health, spread of infection, and invalid results from a practical procedure. If students have not come across the term ‘reagent,’ explain that this refers to a substance or mixture used in chemical reactions.
* Students complete an activity to demonstrate how cross-contamination can occur, by either completing the ‘contaminated milk’ practical (on the worksheet) or through using a hand rub containing a fluorescent tracking gel that can be seen under a UV lamp/handwashing light box. Explain to the students that this is a simulation, so any references to ‘infection’ are fictional.
* In preparation for the contaminated milk practical, prepare boiling tubes part-filled with milk and water. Add starch solution to one of the tubes to make it ‘infected’.
* During the activity, students make ‘contact’ with each other by sharing and then redistributing their solutions; therefore, the ‘infection’ spreads as contacts are made. This simulates a number of people shaking hands, and hence potentially transferring a pathogen. The details of how to do this are provided on the accompanying worksheet. You may wish to blow a whistle to tell students when to move on to meet a new contact.
* After students have made five contacts, test which of them have been ‘infected’ by adding iodine to the boiling tubes; these will turn blue-black in the presence of starch.
* You may wish to use the following questions to lead a discussion:
	+ How might you find out who was originally infected? This can be related to COVID outbreaks.
	+ How might a workplace respond to a reported infection outbreak, or the presence of a contaminant in one of its products? You may wish to talk about the Genomic Surveillance Unit at Sanger that sequences the genome of pathogens so they can identify mutations that affect transmission, disease severity and susceptibility to treatment: [www.sanger.ac.uk/collaboration/genomic-surveillance-unit/](http://www.sanger.ac.uk/collaboration/genomic-surveillance-unit/)
	+ Why is handwashing and clean nails so important in a health setting?
	+ Would it be possible for a workplace to introduce a control measure to prevent the spread of an infection or contaminant, using the simulated approach above?
* Links can be drawn between this activity and the handwashing audit they carried out in [A1 Working within the health and science sectors](https://www.technicaleducationnetworks.org.uk/health-science/working-in-the-health-and-science-sectors), linking together professional conduct and the importance of adhering to quality standards, quality management and audit processes within the Health and Science sectors.
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| Activity 3: The importance of regular cleaning, preparation and maintenance of equipmentSuggested time: 40 minutesResources: L4 Slide deck – slides 12–13L4 Activity 3 Worksheet | * This activity is designed to show students the importance of regular cleaning in a workplace of their choice.
* In small groups, students complete a research activity using the worksheet; they look into specific work areas where regular cleaning and maintenance of work areas and equipment is important to prevent contamination, as well as ensuring accurate results are gathered and machinery and equipment life is maximised.
* Students may also wish to choose a specific piece of machinery/equipment and research how it is maintained to use as an example in their report.
* Then they present their findings as a written report for the management of a company working in that field, which they can use as a training resource for employees within the relevant workplace.
* Students share three key findings from their research with a person from another group, who has researched another workplace.
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| PlenarySuggested time: 10 minutesResources: L4 Slide deck – slides 14–16 | Students complete the exam-style question on the slide deck about the incorrect storage of a blood sample. They mark their answer using the mark scheme provided.Revisit the learning objectives to close the lesson on slide 16. Discuss the consolidation activity below (where appropriate). |
| Follow-up/ consolidationSuggested time: 30–45 minutesResources: L3 Slide deck – slide 17 | Students produce a checklist to be placed inside a fridge to ensure its contents are stored correctly, minimising the risk of cross-contamination. The fridge stores food products which are checked for the safety of being eaten up until their ‘use-by’ date. To help with this task students could use the following website: [www.foodstandards.gov.scot/consumers/food-safety/at-home/washing-and-preparing-food-1](http://www.foodstandards.gov.scot/consumers/food-safety/at-home/washing-and-preparing-food-1) |

# Lesson 5: Ordering and storing stock correctly (A8.9, A8.10)

This lesson introduces students to the importance of managing and storing stock correctly. The lesson begins by looking at the reasons why stock levels need to be carefully managed, as well as carrying out an activity to decide when different types of stock need to be reordered. Students then carry out a practical to simulate how chemical degradation can occur over time, or if a chemical is not stored correctly, and the potential consequences of this.

## Preparation

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| Resources provided | L5 Slide deckActivity 1 – L5 Activity 1 Worksheet 1, L5 Activity 1 Worksheet 2Activity 2 – L5 Activity 2 WorksheetPlenary – L5 Plenary Worksheet 1, L5 Plenary Worksheet 2 |
| Equipment needed | Each student will need:Solutions A, B, C and D (see below for details):* + Solution A – ‘Freshly prepared sample’. Use 1.7 mol dm-3 hydrogen peroxide solution.
	+ Solution B – ‘3-month-old sample, stored in a darkened glass bottle’. Use 1 mol dm-3 hydrogen peroxide solution.
	+ Solution C – ‘6-month-old sample, stored in a darkened glass bottle’. Use 0.34 mol dm-3 hydrogen peroxide solution.
	+ Solution D – ‘3-month-old sample, stored in a clear glass bottle’. Use water.

These solutions will need to be prepared before the lesson. 12 Í paper discs (use a hole punch to cut these from filter paper)Catalase solution (alternatively, an adequate substitute can be prepared by blending equal volumes of potato and water)Glass rod50 cm3 measuring cylinder or pipette4 Í boiling tubesSmall beakerBoiling tube rackStopwatchEye protection |
| Safety factors | Teachers are required to carry out their own risk assessments for these activities.  |
| CLEAPSS references | Student safety sheet 57 hydrogen peroxide: [www.science.cleapss.org.uk/resource/sss057-hydrogen-peroxide.pdf](https://science.cleapss.org.uk/resource/sss057-hydrogen-peroxide.pdf) RB045 Hydrogen Peroxide: <https://science.cleapss.org.uk/Resource-Info/RB045-Hydrogen-peroxide.aspx> |
| Prior learning | The purpose of a SOP (Lesson 1).The purpose of organisational policies and procedures in the Health and Science sectors ([A1 Working within the health and science sectors](https://www.technicaleducationnetworks.org.uk/health-science/working-in-the-health-and-science-sectors) - Lesson 1 Organisational policies and procedures).The importance of adhering to quality standards, quality management and audit processes within the Health and Science sectors ([A1 Working within the health and science sectors](https://www.technicaleducationnetworks.org.uk/health-science/working-in-the-health-and-science-sectors) - Lesson 1 Organisational policies and procedures). |
| Common misconceptions | Chemicals and drugs can be stored indefinitely.Chemicals do not have a ‘use-by’ date as they are not a food product. |
| Accessibility | * Seek to ensure wide representation for any visiting speakers and case studies used.
* Activity 1: 'Managing stock levels' requires some mathematical problem-solving skills. If individual students require additional support to complete this activity, you may wish to pair students up to work on this task collaboratively.
* There are two options for the follow-up/consolidation activity. Choose depending on your student’s needs.
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## Activity guide

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| IntroductionSUGGESTED TIME: 5 minutesRESOURCES: L5 Slide deck – slides 2–3 | The slide deck summarises what will be covered in the lesson. You may wish to use this with students.* Start the lesson by introducing the lesson objectives using the slide deck.
* Give students two minutes to list as many reasons as possible for why it is important to order and manage stock effectively. Students could then verbally share their thoughts and add examples they have not included from their peers on their lists.
* Where students have experience of working with stock already, encourage the sharing of their experiences of issues they may have encountered when stock was not managed effectively.
 |
| Activity 1: Managing stock Suggested time: 20–25 minutesResources: L5 Slide deck – slides 4–5L5 Activity 1 Worksheet 1L5 Activity 1 Worksheet 2 | This activity introduces students to the reasons why it is important to order and manage stock.Using ideas generated in the introduction as a starting point and the examples in the slide deck, hold a discussion about why it is important to order and manage stock, resulting in students producing a list of key reasons. Introduce key terms of *consumables* – items that are often used once and then disposed of (some are used more than once), and *materials* – items used in the creation of a product such as ingredients and/ or components. To support students further in understanding this concept (and to introduce an initial understanding of the potential complexity of ensuring materials, chemicals, stock, etc., are ordered and arrive on time), students complete Worksheet 1, a maths activity, where students are asked to perform a series of calculations to identify some of the challenges around managing chemical stock levels.Students then self-assess using Worksheet 2. |
| Activity 2: Chemical storageSuggested time: 45 minutesResources: L5 Slide deck – slides 6–9L5 Activity 2 WorksheetSolutions A, B, C and D12 x paper discs Catalase solution Glass rod50 cm3 measuring cylinder or pipette4 x boiling tubesSmall beakerBoiling tube rackStopwatchEye protection | Students complete the practical activity on the worksheet, which introduces some of the potential impacts of storing chemicals incorrectly. Students are given four samples to evaluate, labelled as solutions A, B, C and D, as per the guidance in the equipment section. Explain that the solutions of hydrogen peroxide were all prepared at the same concentration (1.7 mol dm-3). However, only one sample is freshly prepared; the others were prepared some time ago and were stored in different conditions and for different periods of time.Students will be using catalase, an enzyme. You could ask students what the role of a catalyst is or remind them that the presence of a catalyst speeds up a reaction, so the addition of the catalase simply speeds up a process that would happen naturally over time.Students write a conclusion. Suitable answers could include:* Data displayed as either a summary results table (showing the storage conditions and the mean disc rise time), rank order of ‘remaining concentration of solution’, or the equivalent information as a bar chart.
* Hydrogen peroxide becomes less concentrated, i.e. decomposes over time, and more rapidly catalysed in the presence of light. Descriptions of their results should include valid references to their data.
* Accept valid suggestions, e.g. water may react differently to hydrogen peroxide if added to another chemical substance, oxygen produced in the decomposition over time could lead to fire/explosion.
* Examples could include:
	+ - incorrectly stored chemicals could synthesise into a different substance which could be toxic, or lead to a dangerous or unintended reaction with other reagents
		- reactions may not lead to the intended product
		- rates of reactions may be slower than normal or not economically viable/harmful gases could be released.

You could ask students to suggest factors, other than light and time, which may cause chemicals to degrade. Examples may include temperature or exposure to oxygen/water/other substance (see slide deck). This may result in the release of toxic gases or cause changes to chemical stability. Discuss that these primarily cause a health and safety risk to employees, but may also lead to financial loss, and a risk of being unable to locate stock which has been stored for extended periods of time. There is also a risk of chemicals being stored at inappropriate heights, which poses a further health and safety risk. Use slide 8 to go over the consequences of incorrect storage of chemicals.At this point, it may be worth discussing with students that, although a material/chemical might be correctly stored at one point, this does not guarantee that it was stored correctly throughout its lifecycle. Having steps in a SOP for quality control and validation are critical to ensure chemical stocks are useful and safe to use. |
| PlenarySuggested time: 20 minutesResources: L5 Slide deck – slides 10-11L5 Plenary Worksheet 1L5 Plenary Worksheet 2 | Students complete the worksheet, which is an exam-style question on managing stock. Then they swap their answer with a partner and mark their response using the mark scheme provided on Worksheet 2. Finally, they go back through their marked response and add in detail where appropriate to fill any gaps in learning. Revisit the learning objectives to close the lesson on slide 11. Discuss the consolidation activity below (where appropriate).  |
| Follow-up/ consolidationSuggested time: 30–45 minutesResources: L5 Slide deck – slide 12 | The Pfizer COVID vaccine has a different lifespan, depending on whether a vial has been opened or is unopened, and the temperature at which it has been stored. Ask students to produce a timeline for the storage of a sample of vaccines with an expiration date a maximum of six months from manufacture. They should mark the changes in the way the vaccine can be stored along the line. The conditions for storage can be found here: [www.cdc.gov/vaccines/covid-19/info-by-product/pfizer/downloads/storage-handling-label.pdf](http://www.cdc.gov/vaccines/covid-19/info-by-product/pfizer/downloads/storage-handling-label.pdf) Or, as an alternative, ask students to choose a temperature-sensitive drug: chloramphenicol, amoxicillin, leukeran, insulin or botox, and create a SOP for its storage based on their own literature search. This links together their study of SOPS and chemical storage.  |

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| Teacher Guide page 30Lesson 4 Slide 17 | [www.foodstandards.gov.scot/consumers/food-safety/at-home/washing-and-preparing-food-1](http://www.foodstandards.gov.scot/consumers/food-safety/at-home/washing-and-preparing-food-1) | Food Standards Scotland | June 2024 |
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