Unit 5: Science Investigation Skills

Unit overview

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| Unit 5: Science Investigation Skills | |
| **Assessment type: Internal** | |
| **Learning Aim** | **Topics** |
| A Undertake a literature search and review to produce an investigative project proposal | A1 Literature review  A2 Investigative project proposal  A3 Methods of data collection and analysis |
| B Produce a plan for an investigative project based on a proposal | B1 Project scheduling  B2 Project planning  B3 Health and safety and ethical considerations |
| C Safely undertake the project, collecting, analysing and presenting the results | C1 Experimental procedures and techniques  C2 Collect, collate and analyse data  C3 Data presentation |
| D Present the conclusions from the project using correct scientific principles. | D1 Scientific report for the investigative project  D2 Scientific evaluation of findings  D3 Skill development within project work |
| Assessment overview  This unit is Internal assessed through a Pearson-Set Assignment Brief (PASB).  Pearson sets the assignment for the assessment of this unit. The PSAB will take approximately 65 hours to complete. The PSAB will be marked by centres and verified by Pearson. The PSAB will be valid for the lifetime of this qualification. | |

Learning Activities and Resources

This section offers a starting point for delivering the unit by outlining a logical sequence through the unit topics and suggesting practical activities and teacher guidance for covering the main areas of content during guided learning time. Transferable skills are integrated into various activities, with those embedded in a unit indicated by an acronym in square brackets. The acronym combines the letters from the broad skill area and the specific transferable skill, e.g., **[IS-WC]**.

Please note that the activities provided below are suggestions and not mandatory.

**Laboratory Activity**

Experiments and practical investigations within Units 1, 2, 3 and 4 will provide hands on experience for students, and should be mapped to the learning objectives of this unit. Students should use these experiences to select the most appropriate equipment for their project requirements, how to safely handle and calibrate items as appropriate. Encourage learners to develop their own interest in a field of study that they enjoy and are interested in or have found challenging and find a solution to a problem or question.

At the same time, these experiments primarily serve knowledge and understanding for their units rather than extended project work, so there should also be some provision for investigation and project work specifically for this unit. Lead practical sessions within the teaching and learning phase of this unit which allow students to carry out a number of tasks to become more competent in their organisational skills and aptitude with common laboratory equipment (e.g. heating water in different ways, selection and use of different types of thermometer, or measuring quantities using different equipment to ensure accuracy).

Discussions should be held about various health and safety considerations before undertaking experiments. Students should be have the opportunity to undertake formal risk assessments associated with any investigative or practical work before it is conducted and consider any ethical or environmental impacts to their work.

Tasks should also give students opportunity to try different ways of recording and presenting data e.g. tables, graphs, statistical analysis, so that they are prepared and knowledgeable about which will be the best to apply in their in their own investigation.

| Learning Topic | Activities and guidance for unit content delivery | Resources |
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| introduction | * Whole class teaching and learning – introduction to the Scientific Method   Introduce learners to the Scientific Method (observation, question and hypothesis formulation, experimentation, data analysis and conclusion) by discussing what the key components are.   * Task students with producing an annotated flow chart or concept map of the Scientific Method to consolidate their understanding of how to plan a project. * Whole class and individual activity – choosing a hypothesis   Lead a discussion about hypothesis/null hypothesis and predictions for investigations and give examples.   * Students should be encouraged to consider how the robustness of the question or hypothesis will affect the design and rigour of the investigation planned (e.g. exploring a quantitative relationship will require measurements and data collection which are more likely to lead to an objective conclusion and the validation or rejection of a hypothesis). * Ask Students to identify independent and dependent variables, as well as variables that need to be controlled or considered within these project examples. * Individual activity – testing a hypothesis * Task students with application of the Scientific Method to a simple study involving an everyday observation (e.g. observing birds on a bird feeder). * The choice of study should be easy to monitor and collect data for, without the need for lots of equipment but which is over a period of time so that students become accustomed to sustained investigative work. * Students should come up with a question, hypothesis and prediction, and create an outline plan to test the hypothesis within the class. They should then carry out the planned observation and data collection. The data analysis and conclusion can be scheduled as the focus for a future lesson in support of Learning aims C and D. * Whole class teaching and learning – relevant areas of study for a science project * Brief students about the choice of relevant areas of study for a project. * Ask students to collaborate in small groups to come up with examples of different projects that they have experienced. * Each student could then contribute to a class discussion on the type of projects they have experienced in education or through work experience. * Give students the titles of previous projects carried out at the centre and any case studies of those projects. | Science Buddies  [Four Ways to Teach the Scientific Method | Science Buddies Blog](https://www.sciencebuddies.org/blog/scientific-method-examples-for-teachers)  notes and videos  Elsevier  [Step-by-Step Guide: How to Craft a Strong Research Hypothesis](https://scientific-publishing.webshop.elsevier.com/manuscript-preparation/what-how-write-good-hypothesis-research/)  Research Method  [What is a Hypothesis - Types, Examples and Writing Guide](https://researchmethod.net/what-is-a-hypothesis/)  Scribendi  [Examples of Good and Bad Research Questions | Scribendi](https://www.scribendi.com/academy/articles/good_research_question_examples.en.html)  potential topics for investigation  [Science Investigatory Project Topics](https://ideasforstudents.com/science-investigatory-project-topics/)  [Science Research Topics](https://essaypro.com/blog/science-research-topics#:~:text=Science%20Research%20Topics%20for%20High%20School%20Students%201,pH%20levels%20of%20local%20water%20sources.%20More%20items) |
| A: Undertake a literature search and review to produce an investigative project proposal | | |
| A1 – literature review | * **Whole class teaching and learning – principles of a literature search**   Students will need support to understand how to carry out a literature search.   * Give a presentation to students on how to go about carrying out a literature search and review, how to identify relevant sources, analyse and explain its relevance to investigations, and how to reference to a recognised system. * This should cover identification of relevance, accuracy, currency and reliability, the origin and author, and the extraction and referencing of sources of information. * Show examples of a referencing system in use in scientific journals and papers (e.g. Harvard). * Individual activity – analysing sources of information   Provide or task students to gather a selection of articles and sources (newspaper articles from different sources, social media reports, Wikipedia, scientific journals, news broadcasts), for a fictitious scientific investigative project proposal.   * Lead a session where students describe and discuss the validity and usefulness of the articles or sources to the project proposal. * This should include discussion of different methodologies to practical work and scientific theories, as well as consideration of the type of article, accuracy/bias, the relevance and the date of publication. * Small group / Individual activity – planning a literature search * Put students into small groups and present them with potential topics for study. * They should discuss and feedback on areas/types of literature that would need to be researched, possible hypotheses, an outline plan and timescale for the project. * They should also consider what equipment might be needed, health and safety considerations, what trials need to be carried out, and what data they need to collect. | Open University  [Developing good academic practice: Introduction | OpenLearn - Open University](https://www.open.edu/openlearn/education-development/education/developing-good-academic-practice/content-section-0?intro=1)  Edinburgh University  [Literature review | Institute for Academic Development](https://institute-academic-development.ed.ac.uk/study-hub/learning-resources/literature-review#:~:text=When%20doing%20and%20writing%20a%20literature%20review%2C%20it,gaps%20that%20may%20exist%20in%20research%20to%20date.)  [Study\_Guide](https://www.docs.hss.ed.ac.uk/iad/Postgraduate/PhD_researchers/Study_Guide_How_to_Write_an_Effective_Literature_Review_v2.0_.pdf)  notes on how to carry out and analyse a literature search  Students 4 Best Evidence  [Conducting a systematic literature search - Students 4 Best Evidence](https://s4be.cochrane.org/blog/2017/07/18/systematic-literature-search/)  Some online literature search databases  [PubMed](https://pubmed.ncbi.nlm.nih.gov/)  [ScienceDirect](https://www.sciencedirect.com/)  [Clarivate](https://access.clarivate.com/login?app=wos&alternative=true&shibShireURL=https:%2F%2Fwww.webofknowledge.com%2F%3Fauth%3DShibboleth&shibReturnURL=https:%2F%2Fwww.webofknowledge.com%2F&roaming=true)  Students 4 Best Evidence  [Reviewing the evidence: what method should I use? - Students 4 Best Evidence](https://s4be.cochrane.org/blog/2019/10/08/reviewing-the-evidence-what-method-should-i-use/)  [Writing a Scientific Literature Review / Academic Writing - YouTube](https://www.youtube.com/watch?v=Gex46cg9ZTU)  video case study  Open University  [Quick guide to Harvard referencing (Cite Them Right) | Library Services | Open University](https://www5.open.ac.uk/library/referencing-and-plagiarism/quick-guide-to-harvard-referencing-cite-them-right)  guide to Harvard referencing  some sources of science reporting:  [Nature](https://www.nature.com/)  [New Scientist](https://www.newscientist.com/)  [Scientific American](https://www.scientificamerican.com/)  [Science News](https://www.sciencenews.org/)  [BBC News](https://www.bbc.co.uk/news/science_and_environment)  [ScienceBlog](https://scienceblog.com/)  Open University  [Help and Support | Library Services | Open University](https://www5.open.ac.uk/library/help-and-support)  guidance on a literature search |
| A2 - investigative project proposal | * Whole class teaching and learning – components of a project proposal   Give a presentation to students about what needs to be included in a project proposal.   * Their proposals must include a title, aims and objectives, hypothesis, background and rationale, variables, resources, safety and limitations. * Discuss how and why decisions about the project, the influence of reviewing literature and equipment selected must be justified and receive approval before being taken further. * Individual / Small group activity – creating a project proposal   Ask students to decide, as individuals or in a group, the area of study they are interested in, its vocational aspect and industrial sector.   * In arriving at a proposal, encourage students to discuss and consider resources, and any potential limitations (e.g. how the resources available will contribute to the accuracy and validity of results that will be obtained). * Students should then discuss their area of study and then document their proposal with the Assessor to gain approval. * They must carry out a literature search, produce a project proposal with a hypothesis, and identify resources required and safety considerations. | Elsevier  [Writing a Scientific Research Project Proposal | Elsevier](https://scientific-publishing.webshop.elsevier.com/research-process/writing-scientific-research-project-proposal/)  principles  Yale College  [How To Write a Proposal | Science & Quantitative Reasoning Education](https://science.yalecollege.yale.edu/stem-fellowships/how-write-proposal)  notes and examples |
| B: Produce a plan for investigative project based on a proposal | | |
| B3 – health and safety and ethical considerations | * Whole class teaching and learning – health and safety in science investigations   Give a presentation and discuss with learners the need for health and safety, taking into account relevant legislative, COSHH and PPE requirements, as well as environmental impacts of their projects. Examples of risk assessments can be shown, drawing attention to the hazard, risk and control measures documented.   * Task students with the risk assessment of different project proposals and producing the documentation to accompany this. * Whole class teaching and learning – ethics in scientific research   Discuss ethical considerations about experimental design and process, such as integrity of data collection, the use of living test subjects, and respect for confidentiality.   * Provide students with scenarios in research for them to identify and discuss the ethical issues involved.   Guest speaker – health, safety and ethics in scientific places of work  Ask a guest speaker to come in and give a presentation about health and safety or ethics in a project or place of work. This could be related to the students’ projects, or invite an outside speaker charged with responsibility for health and safety within their place of scientific work. One aspect of focus could be the management of health and safety in a project, such as the creation and use of risk assessments for chemicals, equipment and processes used, or the ethical considerations involved with using living test subjects or informed consent and confidentiality when using personal data. | Health and Safety Executive  [Managing risks and risk assessment at work – Overview -HSE](https://www.hse.gov.uk/simple-health-safety/risk/index.htm?utm_source=hse.gov.uk&utm_medium=referral&utm_campaign=guidance-push&utm_term=risk&utm_content=home-page-popular)  [Control of Substances Hazardous to Health (COSHH) - HSE](https://www.hse.gov.uk/coshh/index.htm)  [Personal protective equipment (PPE) at work](https://www.hse.gov.uk/ppe/index.htm)  various health and safety topics  Health and Safety Executive  [Risk assessment: Template and examples - HSE](https://www.hse.gov.uk/simple-health-safety/risk/risk-assessment-template-and-examples.htm)  Edinburgh University  [Risk Assessments | Health and Safety Department](https://health-safety.ed.ac.uk/online-resources/risk-assessments)  Risk assessment templates and examples  Gov.uk  [Universal ethical code for scientists - GOV.UK](https://www.gov.uk/government/publications/universal-ethical-code-for-scientists)  values and responsibilities of scientists  Open University  [Ethics in science? | OpenLearn - Open University](https://www.open.edu/openlearn/science-maths-technology/ethics-science/content-section-0?active-tab=description-tab)  National Library of Medicine  [Detailed Case Histories - Fostering Integrity in Research - NCBI Bookshelf](https://www.ncbi.nlm.nih.gov/books/NBK475955/)  case studies  STEM Learning  [STEM Ambassadors](https://www.stem.org.uk/stem-ambassadors)  information on how to source a STEM ambassador  Royal Society of Chemistry  [Chemistry job profiles | RSC Education](https://edu.rsc.org/future-in-chemistry/career-options/job-profiles)  videos |
| B1 – project scheduling | * Whole class teaching and learning – time and resource management in projects   Give a presentation on the principles of effective time management and examples of this within projects.   * Brief students on how to design a schedule of work, including a start date, completion date, realistic timelines and milestones. * Suggest and show the use of a spreadsheet or Gantt chart to assist learners with their overview of time. * Discuss how best to set and achieve target deadlines. Learners need to consider beyond their own personal schedule, such as if equipment, locations or participants are needed which are only available at certain times. * Discuss the necessity of contingency planning and possible remedial actions if a plan needs to change, such as broken equipment, unavailability / absence of participants, etc. * Guest speaker – science project team member or leader   Ask guest speakers to visit in person or remotely to discuss science projects that they are involved in. This could be the overview of an entire project (e.g. development of a product or drug) or one person’s role of responsibility and management of a stage of a project. One aspect of focus could be the importance of project management skills to employability. This is a useful way of linking the work learners are doing in this unit to the industries in which they may hope to be employed in the future. Another approach may be to walk through the project, highlighting milestones, challenges and solutions to problems. | Learn Free  [Tips for Effective Time Management - YouTube](https://www.youtube.com/watch?v=RiI1NkaDXlQ&t=3s)  Video  Research Voyage  [8 Effective Strategies for Managing Research Time](https://researchvoyage.com/managing-research-time/)  Stemcell Technologies  [How to Plan Experiments and Manage Your Time in the Lab](https://www.stemcell.com/efficient-research/planning-experiments)  Practical advice on project scheduling  Spreadsheet, Gantt chart or other electronic template to track dates and timelines  Guide to Research  [Contingency Planning — Guide To Research](https://www.guidetoresearch.com/posts/contingency-planning#:~:text=Contingency%20planning%20is%20important%20in%20research%20because%20often,if%20there%20is%20no%20contingency%20plan%20in%20place.)  Questions and considerations for contingency planning  STEM Learning  [STEM Ambassadors](https://www.stem.org.uk/stem-ambassadors)  information on how to source a STEM ambassador  Royal Society of Chemistry  [Chemistry job profiles | RSC Education](https://edu.rsc.org/future-in-chemistry/career-options/job-profiles)  videos |
| B2 – project planning | * Whole class and paired activity – project planning   Brief learners about how best to produce a realistic project plan that is both valid and that can be followed i.e. that it tests the hypothesis in the project proposal and can be implemented with the resources and timescale in their project schedule.   * This will include how they will ensure validity of their work, such as whether comparison to a control group is needed or the role and extent of random sampling for a large survey. This will also include how they are going to collect, record, present and analyse data. * Task students with documenting the method that will be followed and share it with another member of the class to peer review. * This should offer feedback on how clear and safe the instructions are, and if there are any errors or problems that are foreseen, which the learner can use to review and update their plan. * Laboratory activity – trial runs   Discuss the value and importance of conducting trial runs before progressing with the full working plan.   * Once students are confident in the working plan for their investigation, they should independently attempt their method. * Make time available for students to carry out trial runs for their project and to amend or confirm the method accordingly. * Give students logbooks and diaries to record their progress as they work through their ideas, research, planning and implementation of their projects. | LibreTexts  [1: Sampling and Data](https://stats.libretexts.org/Bookshelves/Introductory_Statistics/Introductory_Statistics_1e_(OpenStax)/01%3A_Sampling_and_Data)  notes, case studies and problems  Science Buddies  [Increasing the Ability of an Experiment to Measure an Effect](https://www.sciencebuddies.org/science-fair-projects/competitions/experimental-design-increasing-signal-to-noise)  Log book / diary |
| C: Safely undertake the project, collection, analysing and presenting the results | | |
| C1 - experimental procedures and techniques | * Whole class teaching and learning – pre-project implementation briefing   Provide a briefing or introduction to learners before the official start date of investigation work.   * Confirm with learners that they are familiar with: * any centre requirements for working individually in the laboratory * other health and safety requirements/legislation and appropriate PPE * collecting, assembling and using relevant equipment and materials, as identified in their plan * good practice in practical skills, data collection and record-keeping * sources and limitations of assistance that may be needed. * Small group activity – familiarisation sessions   Hold a short practical session in the briefing / introduction session to enable students to familiarise themselves with the equipment they will be using or for a member of staff to demonstrate the correct use of the equipment. (This could be best carried out in small groups with learners who may be using similar equipment.)   * Whole class and individual activity - consultation sessions   Set aside individual 1-to-1 consultation sessions for each student to raise questions or issues that they may have. These can also be used to check that students have identified and can use their required equipment, and that they are confident in their methodology.  Regular consultation sessions could also be arranged throughout the project schedule so that students continue to be able to raise queries and issues, but also to monitor their progress. | equipment, chemicals and other resources |
| C2 – collection and collation of data | * Whole class teaching and learning – handling data   Give a tutor presentation to introduce and discuss the types of data that can be collected and recorded, such as the differences between qualitative and quantitative data, and primary and secondary data. This should also explore definitions of accuracy, reliability, validity and precision, and how these link to integrity when collecting and presenting data   * Thinking about these qualities in data collection, learners should suggest ways in which they will assure these in their investigations and use appropriate methods of data recording. * A mind-map or list summarising all these considerations could be produced. * Paired activity – collecting and collating data   Using a recent practical that students participated in, ask them to work in pairs to discuss and justify the methods used to collect data.   * Students should consider the accuracy of the equipment used in terms of validity and reliability. * They should critique the accuracy, sufficiency and consistency of the data, and if there are any ways to obtain further data or improve the quality. * The way in which the data has been organised should also be critiqued in terms of its presentation and clarity (e.g. tabulation, units, headings, etc). | LibreTexts  [35.1: Evaluation of Analytical Data - Chemistry LibreTexts](https://chem.libretexts.org/Bookshelves/Analytical_Chemistry/Instrumental_Analysis_(LibreTexts)/35%3A_Appendicies/35.01%3A_Evaluation_of_Analytical_Data)  Notes and examples covering collection, collation and organising data  LibreTexts  [1: Introduction to Data](https://stats.libretexts.org/Bookshelves/Introductory_Statistics/OpenIntro_Statistics_(Diez_et_al)./01%3A_Introduction_to_Data)  notes, case studies and problems |
| C2 & C3 – presentation and analysis of data | * Individual activity – processing and presenting data   Students should be familiar with processing data and how to present it in an appropriate format from any practical work for units in this qualification, but there is often little time to explore the pros and cons of different formats.   * Give students tables of data from different types of practical work (this could be from work they have done or from unfamiliar scenarios). * Ask them to try out different ways to present the data, to compare and make a decision on the most effective format for the same data set. * Individual activity – data analysis * Using their chosen presentation from the previous activity, students should identify patterns or trends in the data, making reference to any proportionality or relationship between the independent and dependent variables. * Students should draw conclusions, discussing the extent and limitations of what they believe that the presented data shows. * Anomalous data should also be part of the data set. * Students should explain how they have identified anomalies, how they may have occurred, how it should be dealt with and any remedial action that could be taken. | LibreTexts  [35.1: Evaluation of Analytical Data - Chemistry LibreTexts](https://chem.libretexts.org/Bookshelves/Analytical_Chemistry/Instrumental_Analysis_(LibreTexts)/35%3A_Appendicies/35.01%3A_Evaluation_of_Analytical_Data)  Notes and examples covering different ways to present data  University of Wisconsin-Madison  [Top ten worst graphs](https://www.biostat.wisc.edu/~kbroman/topten_worstgraphs/)  Open University  [Data analysis: visualisations in Excel | OpenLearn - Open University](https://www.open.edu/openlearn/science-maths-technology/data-analysis-visualisations-excel/content-section-0?active-tab=description-tab)  [Presenting information | OpenLearn - Open University](https://www.open.edu/openlearn/digital-computing/presenting-information/content-section-0?active-tab=description-tab)  [Diagrams, charts and graphs | OpenLearn - Open University](https://www.open.edu/openlearn/science-maths-technology/mathematics-statistics/diagrams-charts-and-graphs/content-section-0?active-tab=description-tab)  [Working with charts, graphs and tables: 4.1 Reading data from tables | OpenLearn - Open University](https://www.open.edu/openlearn/science-maths-technology/mathematics-statistics/working-charts-graphs-and-tables/content-section-4.1)  [An introduction to visualising development data | OpenLearn - Open University](https://www.open.edu/openlearn/science-maths-technology/mathematics-and-statistics/statistics/introduction-visualising-development-data)  [Starting with maths: Patterns and formulas | OpenLearn - Open University](https://www.open.edu/openlearn/science-maths-technology/mathematics-statistics/starting-maths-patterns-and-formulas/content-section-0?active-tab=content-tab)  a collection of courses and videos on data presentation and analysis |
| C2 – statistical analysis of data | * Whole class teaching and learning – statistical analysis techniques   Students should be familiar with the use of basic mathematical operations and statistics including mean, mode, median and average, which they could be reminded of. However, they may need considerable support to understand more advanced statistical analysis techniques, including standard deviation, error bars, and significance tests such as t-test, chi-square test, correlation analysis and confidence levels. Give a tutor presentation (or ask a mathematics specialist to present) on some of these methods, and examples of application.   * Paired activity – using statistical analysis techniques   It is important that students are aware of the range of different techniques that could be used in order to be confident that they will be selecting and using the appropriate technique for their investigation.   * Students should consider the fitness for purpose of the methods used. * They should consider sources and magnitudes of error in readings taken. * Put students into small groups or pairs to work through a series of statistical tests, using centre-devised worksheets – more than one session may be necessary in order to ensure that students have sufficient practice. | Open University  [Data analysis: hypothesis testing | OpenLearn - Open University](https://www.open.edu/openlearn/science-maths-technology/data-analysis-hypothesis-testing/content-section-0?active-tab=content-tab)  LibreTexts Statistics  [Introductory Statistics 1e (OpenStax) - Statistics LibreTexts](https://stats.libretexts.org/Bookshelves/Introductory_Statistics/Introductory_Statistics_1e_(OpenStax))  notes on a range of statistical techniques and problems |
| D2 – scientific evaluation of findings | * Whole class teaching and learning – principles and scope of evaluation   Discuss with learners the process of evaluation in relation to the conclusion drawn from an experiment, and ways in which this could be approached.   * This should include consideration of accuracy, reliability, validity and limits of the conclusion. * Encourage consideration of the primary data, its processing, the equipment and methodology used. * Equally, the conclusion may be valid, but the underpinning scientific theory, the literature search and the hypothesis may be flawed. * The discussion should then turn to how an experiment could be improved or extended. * Emphasise that improvements should be tangible and justifiable – for example, the use of more accurate equipment or collection of more data would need to specific about why it is an improvement. * Pair / Small group activity – evaluating and improving experiments   Using recent practical work that students participated in, ask them to work in pairs or a group to evaluate all aspects of the experiment.   * This could be shared so that each student looks at a different aspect i.e. the conclusion, the data collected, the equipment used, underpinning theories and hypothesis. * Students should feedback to the group on their evaluation, justifying their opinion and proposing a way in which the aspect could be improved. * Encourage other students to question and challenge the evaluation or proposal that is being presented – this provides critical feedback to the presenter on how to make plans and suggestions robust. | Royal Society of Chemistry  [Help students evaluate experiments | Ideas | RSC Education](https://edu.rsc.org/ideas/help-students-evaluate-experiments/3008963.article)  [Successful students evaluate every step | Ideas | RSC Education](https://edu.rsc.org/ideas/successful-students-evaluate-every-step/4017001.article)  notes, prompts and exercises for evaluating |
| D: Present the conclusion from the project using correct scientific principles | | |
| D1 - scientific report for the investigative project | * Whole class teaching and learning – features of a scientific report   Give a tutor presentation on how to write scientific reports, using accepted protocols and terminology. Standard structures in scientific reports would include the aims and objectives, hypothesis and scientific theory, equipment and methodology, results and analysis, discussion, conclusion and evaluation, referencing and bibliography. Emphasise the necessity for the past tense, passive voice and third person commentary within reports, and use of correct scientific terminology, referencing and a bibliography. References and bibliography must be present and correctly written, and it may also be helpful to review the Harvard referencing system with learners.   * Small group and individual activity – analysing and writing a scientific report * Give students some scientific reports to review and have them identify the correct scientific principles - structure and format, correct use of scientific terminology, past tense and third person, correctly written references and bibliography in an appendix. * Once the students are confident in the expected standard and format of scientific reporting, task them with writing a formal report on an investigation they have carried out for another unit. Alternatively, give an anonymised example to learners for amending/rewriting. | Sheffield Hallam University  [Scientific reports - Report Writing - LibGuides at Sheffield Hallam University](https://libguides.shu.ac.uk/reportwriting/scientific-reports)  University of Salford  [Scientific-Report-Writing.pdf](https://www.salford.ac.uk/sites/default/files/2020-06/Scientific-Report-Writing.pdf)  Matrix Education  [How to Write a Scientific Report | Step-by-Step Guide](https://www.matrix.edu.au/how-to-write-a-scientific-report/#intro)  guides to scientific report writing  Reed College  [Laboratory Report Instructions - Online Writing Lab - Reed College](https://www.reed.edu/writing/paper_help/labreport.html)  structure for a scientific report and examples of a good and a bad report |
| D3 – skill development within project work | * Whole class teaching and learning – skill development   Lead a discussion with learners to identify when they have used or improved skills, and where they may have missed an opportunity to develop their skills. Student will automatically think of practical skills, but they should also be reminded of personal skills such as communication, organisation, time management or problem-solving.   * Discuss how they have evaluated if they have a skill that is particularly strong or weak, and steps that they intend to take to develop that skill. * Students will probably need support in becoming more reflective and self-critical about their abilities. * This is a good opportunity for students to begin to think about the value of feedback from others, keeping a diary of their work and creating action plans to build upon their existing skills. * Individual activity – reflecting upon and improving own skills   Throughout the programme where practical work is undertaken, encourage student to keep a diary or a log of the skills that they are developing in each practical session. The skills may be practical skills (e.g. the ability to weigh accurately), interpretative (e.g. the ability to draw an accurate tangent to a cooling curve) or personal competences identified (e.g. communication or the ability to recognise problems and apply appropriate scientific methods to identify causes and achieve solutions).   * Ask students to reflect upon the most recent practical work that they have undertaken and appraise the skills that they have used. * They could seek feedback from peers and teachers for an independent perspective to reflect upon. * Provide a template for students to create an action plan for development of practical and personal skills that they have used in the experimental work. | STEM Learning  [1357-LSS\_post\_16\_introduction.pdf](https://www.stem.org.uk/sites/default/files/collection-pdfs/1357-LSS_post_16_introduction.pdf)  skills developed through science  Log book / diary  Feedback forms  [FREE 11+ Observational Feedback Forms in PDF | MS Word](https://www.sampleforms.com/observation-feedback-forms.html)  template examples  Personal action / development plan  [Personal Development Action Plan Template | Qualads](https://www.qualads.com/personal-development-action-plan-template/)  template and examples |

Delivering signposted transferable skills

Signposted transferable skills are not mandatory for the delivery of the unit, and it is therefore your decision to deliver these skills as a part of the qualification. Below we have provided some ideas of teaching and learning activities that you could use to deliver these skills if you chose to.

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| Transferable skills | Ideas for delivery |
| MY-TPR – Taking personal responsibility | * Laboratory activity * Emphasise to students the responsibility within their own scientific investigations. Students would need to consider; * Questioning if their investigation is appropriate and timely * Challenging own biases * Breaking stages into manageable tasks * Identifying strengths or weaknesses of investigation plan, proposal or methodologies * Drawing conclusions supported by structured reasoning |
| EL - SRS – Secondary Research Skills | * Individual activity – analysing sources of information * Encourage students to research their own area of interest to gather a selection of articles and sources (newspaper articles from different sources, social media reports, Wikipedia, scientific journals, news broadcasts), for a fictitious scientific investigative project proposal. * Allow students to consider the following points: * Are the articles accurate? * Are the articles reliable? * Are the methodologies appropriate? * Are the sources reputable? * Are the articles timely? |

Resources

This section has been created to provide a range of links and resources that are publicly   
available that you might find helpful in supporting your teaching and delivery of this unit in the qualification. We leave it to you, as a professional educator, to decide if any of these resources are right for you and your students, and how best to use them.

Pearson is not responsible for the content of any external internet sites. It is essential that you preview each website before using it to ensure the URL is still accurate, relevant, and appropriate. We’d also suggest that you bookmark useful websites and consider enabling students to access them through the school/college intranet.

### Websites

The Association for Science Education – ASE  
Organisation for science education – resources and journals  
<https://www.ase.org.uk>

CLEAPSS  
Website for health and safety information when handling chemicals and performing experiments  
<https://www.cleapss.org.uk>

The Health and Safety Executive – HSE  
Regulator for workplace health and safety – information about the Control of Substances Hazardous to Health (COSHH), Personal Protective Equipment (PPE), risk assessment, etc.  
<https://www.hse.gov.uk>

Institute of Physics – IOP  
Professional body for physics education – resources and practical activities for physics  
<https://www.iop.org/education>

LibreTexts  
Open access to different online textbooks and subjects  
<https://libretexts.org>

Nuffield Foundation  
Range of practical experiments  
<https://www.nuffieldfoundation.org/students-teachers>

Open University  
Access to guides on locating resources, literature searches, and referencing  
<https://www5.open.ac.uk/library/help-and-support>

Royal Society of Biology – RSB  
Professional body for biology education – resources and practical activities for biology  
<https://www.rsb.org.uk>

Royal Society of Chemistry – RSC  
Professional body for chemistry education – resources and practical activities for chemistry  
<https://www.rsc.org/teaching-and-learning>

Science Buddies  
Good overview of the Scientific Method and each step of an investigation  
<https://www.sciencebuddies.org/science-fair-projects/science-fair/steps-of-the-scientific-method>

Science Technology Engineering Mathematics Learning – STEM Learning  
Resources and activities in science, links with employers and industry  
<https://www.stem.org.uk>

### Textbooks

*Coyne, GS – The Laboratory Companion: A Practical Guide to Materials, Equipment and Techniques (Wiley-Blackwell, 2005) ISBN 9780471780861. Contains information about material, equipment and techniques.*

*Kumar, R – Research Methodology: A step by step guide for beginners (Sage Publications Ltd 2019) ISBN 9781526449900*

### Pearson paid resources also available

* Pearson Student book
* ActiveBook (a digital version of the Student Book, via ActiveLearn Digital Service)
* Digital Teacher Pack (via ActiveLearn Digital Service)

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