Unit title	Investigative Project Skills
Guided learning hours	120
Number of lessons	60
Duration of lessons	2 hours

Links to other units

- Unit 1: Principles and Applications of Biology I
- Unit 2: Principles and Applications of Chemistry I
- Unit 3: Principles and Applications of Physics I
- Unit 5: Principles and Applications of Biology II
- Unit 6: Principles and Applications of Chemistry II
- Unit 7: Principles and Applications of Physics II.

Other units may be relevant, depending on the project selected by the learner.

Key to learning opportunities			
AW	Assignment writing	**V**	Visit
GS	Guest speaker	**GW**	Group work
IS	Independent study		

Lesson	Topic	Lesson type	Suggested activities	Classroom resources
Learning aim A: Undertake a literature search and review to produce an investigative project proposal				
1–2	• Introduction to Unit 4 and assessment **Learning aim A** • Nature of investigative projects	GW	There will be an overlap between the unit content for each of the individual learning aims for this unit. This section of the Scheme of Work gives a broad introduction to learning aims A and B, and to some extent learning aim C. This is to allow learners to be able to attempt assignment A, carry out a literature search and produce a project proposal before attempting learning aim B, and producing an investigative proposal and plan. • **Tutor presentation:** give out the unit specification and discuss learning outcomes, assessment criteria and mode of assessment. • **Tutor-led discussion:** ask learners if they have ever observed something and wondered, 'Why does that happen?' Have they ever used a piece of equipment and thought, 'This needs improvement?' Have they ever considered inventing something? If so, how would they go about solving the questions/inventing something? • **Small group activity/class discussion:** learners should consider some of the suggestions and possible answers raised during the previous tutor-led discussion. Collate responses. **Small group activity:** give learners, or ask them to choose, a question to discuss. Have them outline a plan for 'How would you go about investigating…?', e.g. Which biscuit is best for dunking? Which airlines have the most delays? Can flexible hours help improve job satisfaction? Do all daisies have the same number of petals? Will a bean/pea plant grow better inside or outside? Which seeds do birds prefer? What happens to warm and cold water when left at room	• Specification • Tutor presentation and notes • Small dry-wipe boards for group activity • Large paper for presentation of ideas

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			temperature? (Encourage learners to come up with their own ideas to discuss.) Learners should present their research to the class in the next session.	

3	**Learning aim A**
	• Scientific method
		GW	• **Learner presentation:** ideas about 'how to investigate'
			• **Tutor-led discussion:** what common features do all the 'plans' have? Introduce the idea of the Scientific Method.
			• **Song/video:** the idea of the Scientific Method could be introduced using a song or video about it, using a search engine on the internet. You can find such a song on YouTube by searching for 'Scientific Method song'.
			• **Tutor-led discussion:** to identify and collate the key aspects of the Scientific Method:
			  ○ observation
			  ○ question
			  ○ hypothesis
			  ○ prediction
			  ○ test/experiment/investigate
			  ○ results/conclusion.
			• **Individual/small group activity:** learners should start to produce an annotated flow chart/concept map showing the Scientific Method and key aspects for each section.
				• Learner presentations for discussion
				• Song/video sourced from the internet

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4	**Learning aim A** • Scientific Method	GW	• **Individual/small group activity:** ask learners to complete annotated flowcharts/a concept map of the Scientific Method. • **Learner presentations and discussion:** learners present their flowcharts/concept maps of the Scientific Method to the class. • **Tutor-led discussion:** about the importance of/difference between observing and looking, and questioning what has been 'seen'.	• Learner flowcharts for completion and presentation
5	**Learning aim A** • Hypothesis and prediction	GW	• **Tutor-led discussion:** what is a hypothesis? What is a 'null hypothesis'? • **Small group activity/class discussion:** ask learners to come up with examples of hypotheses and null hypotheses. • **Tutor-led discussion:** what is a prediction? • **Small group activity/class discussion:** ask learners to come up with examples of predictions for observations from everyday life.	• Tutor presentation
6	**Learning aim A** • Variables	GW	• **Tutor-led discussion:** What are independent and dependent variables, and why are they important when investigating a hypothesis? • **Small group activity/class discussion:** ask learners to come up with examples of independent/dependent variables, and possible ways to control them.	• Tutor presentation

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7–8	**Learning aim A** • Justification of choice of equipment • Risks and hazards	GW	• **Tutor-led discussion:** show learners different sizes of measuring cylinders/beakers/pipettes, different types of thermometers and different types of balance, etc. Ask them which they would use to measure different quantities and why. • **Tutor-led presentation:** covering calibration of equipment, calculation of error/percentage error. • **Small group activity:** practical work on calibration of thermometers/balances. Learners could use the different pieces of equipment to measure a small/large quantity between the equipment and record the results. • **Small group activity:** give learners data to calculate percentage error. • **Tutor-led discussion:** how would you justify the equipment selected? Remind learners about health and safety and risk assessments. Cover the need for Personal Protective Equipment.	• Tutor presentation • Equipment for calibration and measuring, calculating percentage error • Centre-devised worksheet to calculate percentage error

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9	**Learning aim A** • Analysis of results • Presentation of data • Statistical techniques	GW	• **Small group activity:** using whiteboards or poster paper, ask learners to show different ways of presenting results/data, e.g. different types of tables, charts, graphs and when/how they should be used. Learners could use examples taken for practical work they are doing/have done in other units. • **Tutor-led discussion:** on methods of presenting data/results. Cover the advantages/disadvantages of each. • **Small group/individual activity:** give learners the opportunity to practise/improve their data presentation skills on the computer. • **Tutor-led discussion:** ways of analysing data. This will be covered in more detail in learning aim C. Learners should be encouraged to indicate their familiarity with each method to inform planning for delivery of learning aim C.	• Small whiteboards, poster paper, pens • Tutor presentation of methods of presenting data • Tutor presentation of statistical tests
10	**Learning aim A** • Project proposal	V	• **Guest speaker:** A guest speaker (visitor or via an internet platform like Skype or JoinMe) could be asked to give an overview of different types of vocational projects.	

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11	**Learning aim A** • Project proposal	GW	• **Small group activity/class discussion:** ask learners to collaborate in small groups to come up with examples of a range of science projects from their previous experiences. Each group should then contribute to a class discussion on how successful the projects were. Collate suggestions. • **Tutor presentation:** introducing some ideas of topic areas, learners could research for their own projects. Show learners some of the projects that have been completed in previous years. • **Plenary:** ask learners to consider ideas about areas for study, and to come to the next lesson with some options of topics they might like to research.	• List of suggested projects • Examples of previous projects, if available

12–13	**Learning aim A**
	• Literature review
		GW	• **Tutor-led presentation and discussion:** on literature search and review. Ask learners where they would search for appropriate literature, how many sources might be required and the relevance of the date of the literature. Set aside time to allow learners to be shown how to access materials from libraries/resource centres that are available to learners.
			• **Video:** a video from the internet could be used to remind learners of how to formally reference material they have accessed.
			• **Tutor-led presentation and discussion:** on how to review literature. Points for discussion:
			  ○ **search** for relevant literature
			  ○ **evaluate** sources
			  ○ **identify** themes, debates and gaps
			  ○ **outline** the structure
				• Tutor presentation on literature review and referencing
				• Examples of literature/papers for learners to review

Lesson	Topic	Lesson type	Suggested activities	Classroom resources
			○ **write** your literature review. • **Formative assessment:** give learners examples of journals, scientific reports, etc. and have them write a literature review to present to the class. Encourage learners to create a bibliography.	
14	**Preparation for assessment for learning aim A**	GW/IS	• **Tutor-led presentation and discussion:** remind learners about the assessment criteria, and the need for an in-depth project that must be carried out individually and be fully validated. Hand out and discuss the use of a logbook/diary, and the need for it to be kept up to date. • **Class discussion/Q&A:** to remind learners about the Glossary of terms for internal assessment in the specification, and the need to give sufficient detail. Discuss the format required for the presentation of the project proposal and the need to include a hypothesis. Consider the resources required and safety considerations. The project must be able to generate sufficient data to be able to identify trends or patterns, in order to give quantitative evidence to support or reject their hypothesis. Learners must analyse the data, using one or more statistical techniques. Discuss and remind learners about the need to meet the deadline for handing in work. • **Individual learner work:** ask learners to research and decide on a possible project, and discuss it with you.	• List of possible projects • Glossary of terms used in internal assessment • Arrange appointments with learners to discuss the project proposal • Logbook/diary for learners • Assignment brief for learning aim A

Lesson	Topic	Lesson type	Suggested activities	Classroom resources
15–20	**Assessment of learning aim A** **Assignment A** –Literature review and project proposal	AW	• **Individual learner work:** have learners produce evidence for assessment. Monitor learners and offer general support and guidance. If specific guidance is given, this must be recorded and care must be taken to ensure it will not compromise the opportunity for criteria to be achieved.	• Access to computers • Resources for literature search
Learning aim B: Produce a working plan for an investigative project based on the proposal				
21	**Learning aim B** • Project schedule	GW	• **Tutor-led presentation and discussion:** introduce the learning aim, assessment requirements and time available for the project. Learners need to understand that the timeline for the project must include: o start date o completion date o milestones. Remind learners to complete their logbook/diary. • **Small group activity/class discussion:** learners could use some of the examples from lessons 1–2 to produce a timeline for completion of their projects, including milestones.	• Tutor presentation • Specification

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22–23	**Learning aim B** • Method	GW	• **Tutor-led presentation and discussion:** to ensure learners understand how to write a realistic plan that includes a detailed and logically ordered method which: o would allow the assessor to follow and carry out the investigation without reference to the learner o selects relevant measurements to be collected accurately/reliably and with suitable precision o lists appropriate resources, e.g. equipment, materials, participants o details how variables will be controlled o details how the data/information will be recorded, presented and statistically analysed o identifies and makes contingency plans and remedial actions o identifies and details how health and safety requirements will be taken into account, including any relevant legislation, PPE and risk assessments o identifies any possible ethical considerations and how these will be taken into account o includes a trial run(s) that would allow consideration of the need for modification to the method, if required. • **Formative assessment:** ask learners to discuss and practise writing a method for a given investigation, e.g. investigating the effect on temperature of adding salt to water. • **Tutor-led discussion:** to identify any areas of weakness that may need further support prior to assessment.	• Tutor presentation

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24	**Preparation for assessment of learning aim B**	GW/IS	• **Tutor-led discussion:** remind learners about the assessment criteria and command words, and the importance of meeting the assessment deadline. Remind them to maintain their logbook/diary. Learners will need to give an equipment list for lab technicians.	• Assignment brief for learning aim B • Glossary of terms used
25–30	**Assessment of learning aim B** **Assignment B –** Produce a working plan (including schedule, method, risk assessment and contingency planning), supported by logbook of trial runs	AW/IS	• **Individual learner work:** to produce evidence for assessment. You will need to monitor learners and you can offer general support and guidance. If specific guidance is given, this must be recorded and care must be taken to ensure it will not compromise the opportunity for criteria to be achieved. You should check learners' logbooks/diaries to ensure they are being maintained.	
Learning aim C: Safely undertake the project, collecting, analysing and presenting the results **Learning aim D: Communicate and evaluate the findings of the project**				
31	**Learning aims C and D** • Experimental procedures and techniques	GW/IS	• **Tutor-led presentation and discussion:** introduce the learning aim, assessment requirements and time available for the project. • **Tutor-led presentation and discussion:** remind learners about, and check they are familiar with: o any centre requirements for working individually in the laboratory o other health and safety requirements/legislation o collecting, assembling and using relevant equipment and materials, as identified in their plan.	• Tutor presentation • Specification • Equipment identified by learners for their investigations

Lesson	Topic	Lesson type	Suggested activities	Classroom resources
			(This may be best carried out in small groups with learners who may be using similar equipment.) • **Individual learner work:** to ensure learners have identified and can use all the equipment they require for their project, and that they are confident with their method, encourage learners to identify questions/queries that they may have. Discuss them with individual learners. • **Individual learner work:** hold a practical session to enable learners to familiarise themselves with the equipment they will be using.	
32–33	**Learning aims C and D** • Collection, collation and presentation of data	GW/IS	• **Tutor-led presentation and discussion:** remind learners of the methods of data collection discussed in lesson 9. Expand on the following aspects of data collection and collation: o qualitative vs quantitative data o recording with accuracy, integrity and precision o use of correct units o tabulation o labelling of graphs. Discuss, with examples, anomalous data and appropriate actions: o identifying when repeats are appropriate o identifying patterns and trends o comparison of primary and secondary data. • **Individual learner work:** to enable learners to improve/extend their data handling skills.	• Tutor presentation, including examples of good and bad practice of the points identified • Computers • Centre-devised worksheets on data handling and presentation

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34–37	**Learning aims C and D** • Analysis and interpretation of data	GW	• **Tutor-led presentation and discussion:** support learners to: o understand and calculate mean, average and mode o use and transpose formulae o use standard form. • **Tutor-led presentation:** learners need to understand and carry out statistical analysis to be able to validate their data. They will need to be familiar with the following: o standard deviation o use and interpretation of error bars o t-test o chi-square test o correlation analysis. Learners must consider the fitness for purpose of the methods used. They must consider sources and magnitudes of error in readings taken. This lesson will link with lesson 9. • **Small group activity:** put learners into groups to work through the statistical tests, using centre-devised worksheets. It is important that learners are aware of the different techniques in order to be confident in selecting and using the appropriate statistical analysis techniques required for their investigation.	• Tutor presentation • Centre-devised worksheets or examples • The maths department may have worksheets or activities that could be used to support learners

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38	**Learning aims C and D** • Evaluation of data/findings	GW	• **Tutor-led presentation and discussion:** to support learners in evaluating their findings. To conclude the unit, learners will: o evaluate all of the information they have obtained from their literature research and practical investigation work o make judgements on its accuracy, reliability and validity, including whether the original hypothesis has been met (and if it was valid) o evaluate the limitations of the project and make recommendations for improvement. • **Formative assessment:** using an example(s) of reports learners have found on the internet or been given, they can evaluate the report and suggest improvements.	• Tutor presentation • Internet access or examples of reports for evaluation
39–40	**Learning aim D** • Scientific report writing	GW	• **Tutor-led presentation and discussion:** support learners in producing a correctly structured scientific report. • **Small group activity:** Give learners some scientific reports to review and have them identify the correct scientific principles: o structure and format o correct use of scientific terminology o past tense and third person o correctly written references and bibliography in an appendix. • **Individual work:** encourage learners to practise writing a formal report on an investigation they have carried out in another unit. Alternatively, give an anonymised example to learners for amending/rewriting.	• Tutor presentation • Examples of scientific reports • Example of an anonymised learner report on a practical that has been carried out • Computer access

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41	**Preparation for assessment for learning aims C and D**	GW/IS	• **Tutor-led discussion:** remind learners about the assessment criteria and command words, and the importance of meeting the assessment deadline. Remind them to maintain their logbooks/diaries. Learners will need to give an equipment list for laboratory technicians and be confident in carrying out the practical work and producing a report.	• Assignment brief for learning aims C and D
42–60	**Assessment of learning aims C and D** **Assignments C and D –** safely undertake, communicate and evaluate the findings of the project	AW	• **Individual learner work:** to produce evidence for assessment. Learners will need to demonstrate the appropriate practical skills to implement their plan, collect, record and statistically analyse the data, and produce their findings in a correctly structured scientific report. • Remind learners about the need for health and safety. • You will need to monitor learners and you can offer general support and guidance. If specific guidance is given, this must be recorded and care must be taken to ensure it will not compromise the opportunity for criteria to be achieved. • You will need to observe learners assembling the apparatus effectively and efficiently, and check and sign the learner logbook/diary. • Remind learners to ensure they include evidence that can be validated, e.g. photographs, logbook/diary.	• Equipment identified by individual learners

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