Scientific Method

Individual level descriptors and key, qualifying, features

Level 1

Scientific method	Descriptor
Observation	• Make careful observations/measurements using a prepared table. • Record whole number measurements accurately. • Identify/describe they key features and variables to be tested. • Record/make notes to highlight any relevant similarities or differences noticed or changes made in the inquiry.
Questioning	• Ask a question that could be answered, that is suitable for data to be collated. • Suggests ways of working that will help answer the question. • Ask a question that can be developed into a prediction. • Show and understanding of why it is important to collect data to answer questions.
Predicting	• Phrases a question that shows the relationship that is being investigated. • Phrases a question and includes the relevant variables to be tested.
Experimental design and conduct	• Able to correctly use, and select, many pieces of relevant equipment. • Uses a range of equipment to make careful observations/measurements. • Takes accurate measurements using standard units. • Identifies the key variables involved in the inquiry. • Carries out a fair test with help.
Organising, analysing and interpreting data	• Confidently record data in range of different ways. • Use tables and line graphs to analyse results. • Identify and describe patterns in results.
Infer, conclude, decide and evaluate	• Share findings in appropriate ways using a variety of methods. • Explain patterns in results and relates these to science knowledge. • Explain what has been found out in experiments and make connections between the variables involved. • Use science evidence to support findings. • Use test results to make predictions for new tests. • Suggest a variety of sensible improvements to the inquiry. • Show knowledge of safety considerations to minimise risks.

Key features of level 1

IP - Planning an Inquiry

- Makes careful observations/measurements using a prepared table.
- Identifies the key variables.
- Asks a question that is suitable for data to be collated and frames this as a prediction involving the key variables under investigation.

IC - Conducting an Inquiry

- Able to use a range of equipment to make careful observations and measurements.
- Identifies the key variables involved in the inquiry and carries out a fair test with help.

IA - Analysing and Inquiry

- Confidently records data in range of ways and uses tables and graphs to analyse results.
- Identifies, describes and begins to explain patterns in results and begins to relate these to scientific knowledge.
- Explains what has been found out in experiments and makes connections between the variables involved.
- Suggests sensible improvements to the inquiry and the safety considerations to minimise risks.

Level 2

Scientific method	Descriptor
Observation	• Uses scientific ideas to support observations. • Makes more than one set of observations or measurements and explain why this was necessary. • Records observations using decimal values where appropriate. • Describes the ranges and intervals used for observations and measurements. • Uses own tables and charts to record observations accurately.
Questioning	• Uses texts/sources of information to help develop questions to be investigated. • Suggests questions that are relevant to the method of inquiry. • Says what types of data needs to be collected to answer their question(s). • Asks questions and suggest appropriate ways/methods to answer them.
Predicting	• Phrases their question as a hypothesis. • Identifies the key variables to be measured and controlled. • Writes a question as a prediction that shows which relationship is being investigated.
Experimental design and conduct	• Explains why the method chosen will answer the question. • Plans and carries out a fair test, showing which variables are being controlled. • Selects equipment appropriate for the inquiry. • Records data accuracy and reliably.
Organising, analysing and interpreting data	• Records and analyses data using methods that help to answer the question. • Presents findings in ways that help to answer the question. • Uses line graphs to interpret data in a way that helps to answer the question. • Plots a line graph to showing the data using a suitable scale. • Identifies and describes patterns in results and relate these to scientific knowledge.
Infer, conclude, decide and evaluate	• Presents findings in ways that are appropriate. • Uses test results to inform and make future predictions and suggesting further lines of inquiry if relevant. • Identifies patterns in data and present these in a range of ways. • Draws valid conclusions from the data. • Identifies the key evidence being used to support or refute their ideas. • Relates their conclusions to the patterns in their data and scientific knowledge. • Communicates findings using scientific language, describing the important relationships and findings. • Explains why the results are trustworthy. • Suggests further questions to be explored based upon the data and observations. • Takes safety precautions into consideration based upon the risks involved in the inquiry. • Demonstrates an understanding or why warning symbols are helpful in the inquiry.

Key features of level 2

IP - Planning an Inquiry

- Uses scientific ideas and texts/sources of information to develop questions to be investigated.
- Makes more than one set of observations/measurements and explains why this was necessary.
- Uses own tables and charts to record observations accurately.
- Phrases their question as a hypothesis, suggesting appropriate ways/methods to answer them.
- Identifies the key variables to be measured and controlled.

IC - Conducting an Inquiry

- Selects equipment that is appropriate for the inquiry.
- Plans and carries out a fair test, showing which variables are being controlled.
- Collects a range of data, explaining the intervals used to ensure this is reliable and accurate.

IA - Analysing and Inquiry

- Presents findings in ways that help to answer the question, using line graphs to interpret data.
- Identifies and describes patterns in results, relating these to science knowledge.
- Draws valid conclusions from the data and communicates findings using scientific language and knowledge to describe the key relationships and findings.
- Suggests further questions to be explored based upon their data/observations.
- Takes into consideration safety precautions based upon the risks involved in the inquiry.

Level 3

Scientific method	Descriptor
Observation	• Uses scientific ideas/models to support their observations. • Uses two steps in reasoning when describing observations. • Selects suitable ranges and intervals for the measurements and observations. • Uses ideas such as mean, mode, median values to explain the measurements to be collected.
Questioning	• Puts forward ideas about how to find the answer with confidence. • Phrases and develops their question as a hypothesis. • Explains how their question relates to science knowledge.
Predicting	• Explains how their hypothesis is based upon scientific understanding. • Identifies the independent and dependent variables in the prediction. • Describes the strategies that will be used to control the variables.
Experimental design and conduct	• Explains which variables are the most relevant in the inquiry. • Carries out a fair test and coherently identifies all of the key variables. • Explains why the equipment/information sources being used are appropriate. • Repeats sets of observations or measurements if it helps to answer the question. • Keeps track of the impact of the variables involved in the inquiry.
Organising, analysing and interpreting data	• Interprets data in a variety of formats, recognising obvious inconsistencies in the data collected. • Uses test results to make predictions for new tests that could be carried out. • Uses graphs to describe and show different types of relationship i.e. inverse proportion. • Explains any differences/anomalies in repeated observations and measurements.
Infer, conclude, decide and evaluate	• Interprets data in a variety of ways and recognises obvious inconsistencies. • Provides straightforward explanations for differences in repeated observations or measurements. • Draws valid conclusions that involve more than one piece of supporting evidence, including data and graphs. • Uses abstract ideas/models, including two step reasoning, to describe and explain results. • Uses appropriate scientific and mathematical conventions and terminology to communicate abstract ideas. • Suggests how collaborative approaches to scientific inquiry may improve the evidence collected. • Evaluate the effectiveness of the methods undertaken and make practical suggestions for improving them.

Key features of level 3

IP - Planning an Inquiry

- Uses scientific ideas/models to help support/describe their observations.
- Selects suitable ranges and intervals for the measurements including repeating measurements and uses ideas such as mean, mode, median values to support their chosen method of data collation.
- Explains how the prediction/hypothesis is based scientific understanding.
- Identifies the independent and dependent variables in the prediction, describing the strategies that will be used to control them.

IC - Conducting an Inquiry

- Carries out a fair test and coherently identify all of the key variables involved in this specific inquiry.
- Explain why the equipment/information sources being used are appropriate for the question(s) under investigation.
- Repeat sets of observations or measurements if it helps to answer the question.

IA - Analysing an Inquiry

- Interprets data in a variety of formats, recognising obvious inconsistencies.
- Uses graphs to describe and show different types of relationship i.e. inverse proportion.
- Draws valid conclusions that involve more than one piece of supporting evidence (including data and graphs).
- Uses abstract ideas/models, including two step reasoning, to describe and explain results.
- Evaluate the effectiveness of the methods undertaken and make practical suggestions for improving them.

Level 4

Scientific method	Descriptor
Observation	• Uses abstract ideas/models to describe the processes involved in the inquiry. • Identifies several variables/factors involved in the inquiry. • Carefully and accurately collects and organises measurements/observations.
Questioning	• Shows how the question is underpinned by scientific ideas. • Identifies and explains the key pieces of evidence being used to answer the question. • Explains why the approach taken in the inquiry (survey, fair test etc) will allow the question(s) to be answered. • Ask questions that involve more than one prediction.
Predicting	• Investigates more than one hypothesis, each of which is based upon scientific knowledge and understanding. • Phrases their prediction to focus upon the quantitative relationship, between the independent and dependent variables, being investigated.
Experimental design and conduct	• Applies scientific knowledge and understanding to their experimental design. • Applies scientific knowledge when identifying the significant variables involved. • Explains the choice of data collection method and the number of observations/measurements to be taken. • Collects data choosing appropriate ranges and values for the inquiry. • Uses equipment with an appropriate degree of precision. • Explains where sources of error may occur in the inquiry.
Organising, analysing and interpreting data	• Uses data recording and analysis that is in line with the complexity of the inquiry. • Analyses data using scatter graphs and lines of best fit if appropriate. • Selects and uses data/information to develop and support their conclusions.
Infer, conclude, decide and evaluate	• Draws conclusions that are consistent with the evidence collected. • Explains conclusions using scientific knowledge and understanding. • Uses abstract ideas/models, including multiple variables, to explain results. • Chooses ways to show qualitative or quantitative data that are appropriate to the audience. • Highlights the use of data from primary and secondary sources, presenting them in the most appropriate way. • Suggests reasons, based upon scientific knowledge and understanding, for any limitations or inconsistencies in their evidence. • Comments upon the validity of their data suggesting improvements for future inquiry work.

Key features of level 4

IP - Planning an Inquiry

- Uses abstract ideas/models to describe the processes involved in the inquiry
- Identifies multiple variables/factors involved in the inquiry.
- Carefully and accurately organises measurements and observations.
- Explains where sources of error may occur in the inquiry.
- Shows how the question is underpinned by scientific ideas.
- Plans work of a level that involves more than one prediction.

IC - Conducting an Inquiry

- Applies scientific knowledge and understanding to the planning of an inquiry and the identification of the significant variables.
- Collect data choosing appropriate ranges and values for the inquiry.
- Uses equipment with an appropriate degree of precision.

IA - Analysing an Inquiry

- Analyses data using scatter graphs and lines of best fit where appropriate.
- Draws conclusions that are consistent with the evidence collected.
- Uses abstract ideas/models, including multiple variables, when explaining results.
- Chooses ways to show qualitative or quantitative data that are appropriate to the audience.
- Suggests reasons, using scientific knowledge and understanding, for any limitations or inconsistencies in their evidence and suggests improvements

Level 5

Scientific method	Descriptor
Observation	• Makes connections between abstract ideas and models when describing and explaining processes and phenomena. • Independently sets out to collects data that is reliable and accurate. • Explains how to take into account of sources of error in order to collect reliable data.
Questioning	• Demonstrates how the questions being asked are based upon ideas/theories that are accepted by the scientists. • Develops hypotheses that involve several relevant variables. • Suggests alternative approaches that could be taken to improve the inquiry.
Predicting	• Describes any explicit connections between the abstract ideas/models that underpin the hypothesis. • Discusses the possible effect of each of the independent variables being investigated and makes appropriate predictions.
Experimental design and conduct	• Identifies and describes the key variables in complex contexts. • Explains why some variables cannot readily be controlled and shows how the inquiry takes this into account. • Explains how to take account of sources of error so that the data can be reliable and trustworthy.
Organising, analysing and interpreting data	• Shows how data could be interpreted in different ways and decides upon the most appropriate method. • Explains how unexpected outcomes could change the conclusion and findings. • Presents and describes quantitative relationships between variables.
Infer, conclude, decide and evaluate	• Identifies quantitative relationships between variables and use them to inform conclusions and make further predictions. • Explains how data can be interpreted in different ways and how unexpected outcomes could be significant. • Makes explicit connections between abstract ideas/models when explaining results. • Shows abstract ideas using appropriate symbols, flow diagrams and different kinds of graphs when presenting explanations and arguments. • Assesses the strength of the evidence used to help decide if, and how well, it supports the conclusion. • Explains ways of modifying their working methods to improve reliability.

Key features of level 5

IP - Planning an Inquiry

- Makes connections between abstract ideas and models when describing and explaining processes and phenomena.
- Explains how to take into account of sources of error in order to collect reliable data.
- Demonstrates how the questions being asked are based upon ideas/theories that are accepted by the scientists.
- Develops hypotheses that involve several relevant variables.
- Discusses the possible effect of each of the independent variables being investigated.

IC - Conducting an Inquiry

- Explains why some variables cannot readily be controlled and show how the inquiry takes this into account.
- Explains how to take account of sources of error so that the data can be reliable and trustworthy.
- Works independently, and safely, with high degree of precision and trust.

IA - Analysing and Inquiry

- Shows how data could be interpreted in different ways and decides upon the most appropriate method.
- Presents and describes quantitative relationships between variables and uses these to inform conclusions and make further predictions.
- Explains how unexpected outcomes could be significant.
- Makes explicit connections between abstract ideas and/or models when explaining results.
- Assesses the strength of the evidence to help decide if it supports the conclusion.
- Explains ways of modifying their working methods to improve reliability.

Level 6

Scientific method	Descriptor
Observation	• Describes and explain processes logically and in sufficient scientific detail. • Uses abstract ideas and/or models from different areas of science to support the observations to be made. • Plans to collect data with a high degree of accuracy and precision, choosing and justifying data collection methods that will minimise error.
Questioning	• Demonstrates how the questions asked are based upon, new, evidence and ideas. • Develops hypotheses that involve multiple and interacting variables. • Plans more than one different approach to explore their key hypothesis.
Predicting	• Explains in logical detail how scientific ideas and models have been used to develop their hypothesis. • Shows that the different possible impacts of the variables identified have been considered and ordered based upon their importance within this inquiry.
Experimental design and conduct	• Explains how their chosen data collection methods will minimise error and produce precise and reliable data. • Shows how their approach uses appropriate resources and expert advice has been used to limit the risks involved in the inquiry.
Organising, analysing and interpreting data	• Processes data to identify complex relationships between variables. • Uses multi-step calculations and compound measures to support conclusions. • Critically interprets, evaluates and synthesises conflicting evidence.
Infer, conclude, decide and evaluate	• Explains results logically and in sufficient detail using abstract ideas and models from different areas of science. • Processes data, including using multi-step calculations and compound measures, to identify any complex relationships between variables. • Critically evaluates information and evidence from various sources, explaining limitations, misrepresentation or lack of balance. • Critically interprets, evaluates and synthesises conflicting evidence. • Suggests and justifies improvements to experimental procedures using appropriate levels of scientific knowledge and understanding. • Suggests coherent strategies to take particular investigations further. • Presents robust and well-structured explanations, arguments or counter arguments. • Propose scientific explanations for unexpected observations and measurements to make allowance for anomalies.

Key Features of level 6

IP – Planning an Inquiry

- Describes and explains processes logically and in detail, using abstract ideas from different areas of science to support observations.
- Collects data with a high degree of accuracy and precision.
- Develops hypotheses that involve multiple and interacting variables, showing how the different possible impacts of the variables identified have been considered.
- Plans more than one different approach to explore their key hypothesis.
- Explains in logical detail how scientific ideas and models have been used to develop their hypothesis.

IC – Conducting an Inquiry

- Explains how the data collection methods chosen will minimise error and produce precise and reliable data.
- Shows the steps taken to limit the risks involved.
- Works independently with high degree of trust and reliability to collect data that is appropriate to their inquiry.

IA – Analysing an Inquiry

- Suitably processes data to help identify any complex relationships between variables.
- Critically interprets, evaluates and synthesises conflicting evidence if appropriate.
- Explains results logically and in sufficient detail using abstract ideas and models from different areas of science.
- Suggests and justifies improvements to experimental procedures using detailed scientific knowledge and understanding.
- Presents robust and well-structured explanations, arguments or counter arguments.
- Presents a clear and well-reasoned argument for future work to build upon their current level of understanding.