OCR
RECOGNISING ACHIEVEMENT

SPECIMEN

GENERAL CERTIFICATE OF SECONDARY EDUCATION

GATEWAY SCIENCE

B713

SCIENCE B

Unit B713: Science controlled assessment

Controlled assessment
Teacher guidance

INSTRUCTIONS TO TEACHERS

This document contains:

- Teacher guidance on task preparation, task taking and task marking.
- The marking criteria with exemplification.
- This document consists of **16** pages. Any blank pages are indicated.

Teacher guidance – Coolants

Introduction

Controlled assessment tasks for GCSE Science require candidates to:

- plan practical ways to answer scientific questions and test hypotheses
- devise appropriate methods for the collection of numerical and other data
- assess and manage risks when carrying out practical work
- collect, process, analyse and interpret primary and secondary data including the use of appropriate technology
- draw evidence-based conclusions
- evaluate methods of data collection and the quality of the resulting data.

This controlled assessment consists of one task divided into three parts. The task is centred on a particular idea, that the specific heat capacity of brine depends upon the concentration of salt in the solution. This idea is investigated through Parts1, 2 and 3. The parts should be taken in this order.

Preparing for the assessment

It is expected that before candidates attempt this controlled assessment task they will have received general preparation in their lessons. The details of practical techniques, the development of skills associated with these techniques, and the methods and choice of equipment for the task should be covered when teaching the particular part(s) of the specification which the controlled assessment task relates to, and should be completed prior to setting the task.

Further advice on the conduct of controlled assessment tasks can be found in the Guide to Controlled Assessment for this specification, published on the OCR website.

From their work in Module P1 Energy for the Home candidates should understand qualitatively and quantitatively the concept of the specific heat capacity of materials and should be familiar with an experiment to measure the energy required to change the temperature of a body (P1a).

Candidates should be made aware of the:

- health and safety issues
- need to provide a quantitative evaluation of the data collected
- sources of experimental errors.

Candidates should be familiar with the use and meaning of the terms in the formula:

energy = mass x specific heat capacity x change in temperature

Assessment of the quality of written communication

The quality of written communication is assessed in Parts 2 and 3 of this controlled assessment and indicated by a pencil symbol (✎) for the information of candidates. Candidates should be advised that where the pencil symbol occurs, their quality of written communication will be assessed. Further information about the assessment of quality of written communication may be found in the specification.

Part 1 – Research and collecting secondary data

- Research activities **1.5 – 2 hours**

Candidates are given the Part 1 stimulus material which requires them to carry out research using books/internet/surveys. They will need to plan how they are going to carry out the research and collect their results for use in Part 2 and Part 3. The research can be carried out during lessons or as a homework exercise.

Candidates complete Part 1 under limited control. The work of individual candidates may be informed by working with others and work may be completed out of the classroom but candidates must provide an individual response. Teachers may give generic, informal feedback while the work is being completed but may not indicate what candidates need to do to improve their work. Candidates should not be given the opportunity to redraft their work, as this is likely to require an input of specific advice. Candidates should be made aware of the time allowed for carrying out this part of the task. Candidates' access to resources is determined by those available to the centre and/or to candidates at home.

The research information should be brought into the classroom. The candidate working individually should use the information to address the issues on the stimulus sheet. The candidate's individual work must be carried out under supervised conditions and retained by the teacher.

All work should be recorded on loose-leaf paper, and may be hand written or word processed.

The candidate's work and research should be available for Parts 2 and 3. They may not redraft the work completed in Part 1.

The information will be used by the candidates to answer specific questions in the answer booklet and should be attached to the answer booklet for Part 3 by treasury tags so that it can be marked.

Part 1 ends with the collection of the candidates' work and research.

Candidates require the Part 1 stimulus material below.

Coolants

Part 1 stimulus material: Research and collecting secondary data

Nuclear power stations are often located near the coast, near estuaries or by large lakes. This is because they need large quantities of water to use as a coolant.

You are going to carry out some research on coolants. You should find out:

Why coolants are used in nuclear power stations and how much coolant is needed.

The concentration of salt in sea water and the specific heat capacities of sea water and fresh water.

You will need to:

- write a detailed list of all the sources you used
- present the information you have found for use in Part 2 and Part 3.

Part 2 – Planning and collecting primary data

- Planning **1 hour**
- Practical **1 hour**

Candidates are given the Part 2 stimulus material which requires them to plan and carry out an investigation to collect primary data. Candidates also need access to their individual work and research from Part 1.

Candidates may work in groups of no more than 3 (2 is recommended) and may collaborate in the development of the plan and the conduct of the investigation. During planning candidates may wish to trial procedures they plan to use, at the discretion of the centre. They are required to provide a risk assessment of the procedures they have planned. **Candidates must record their plan and results individually**. The investigation should be planned and conducted in supervised lessons and written work should be collected in and redistributed if more than one lesson is required.

Teachers are responsible for ensuring appropriate health and safety procedures are carried out, including a risk assessment for the task, prior to candidates attempting the practical work. It is the centre's responsibility to ensure the safety of all candidates involved in any investigation.

Candidates complete Part 2 under limited control. The work of individual candidates may be informed by working with others but candidates must provide an individual response. Teachers may give generic, informal feedback while the task is being completed but may not indicate what candidates need to do to improve their work. Candidates should not be given the opportunity to redraft their work, as this is likely to require an input of specific advice. Candidates should be made aware of the time allowed for carrying out this part of the task. Candidates' access to resources is determined by those available to the centre.

All work should be recorded on loose-leaf paper, and may be hand written or word processed. It should be collected in and redistributed for Part 3 and should be attached to the answer booklet for Part 3 by treasury tags so that it can be marked.

In their investigations, candidates will need to make choices about: whether to measure how quickly a sample of water reaches a given temperature or what temperature the water reaches after a given energy input; the range of concentrations of salt water to use; how to make up solutions of different concentrations; the number of replicates; the accuracy of measurements of the mass of water to be tested, temperature etc.; how to heat the water; whether to replace the tube after each trial; how to ensure that the energy input is consistent and how to measure the energy input; ways in which heat losses can be minimised. **Candidates must not be instructed or advised in these areas** except where they affect safety, use of resources or timescale.

Part 2 ends with the collection of the raw data by the candidate. The work is collected and retained by the teacher. It is processed and analysed in Part 3.

Candidates require the Part 2 stimulus material below.

Coolants

Part 2 stimulus material: Planning and collecting primary data

Nuclear power stations need supplies of water to use as a coolant – from the sea, estuaries or lakes. Scientists working at power stations find that they use more coolant when the concentration of salt in the water is higher.

A scientist suggests a hypothesis:

Salty water heats up more quickly because more concentrated salt solutions have lower specific heat capacities.

Plan an investigation to test this hypothesis.

Carry out your investigation and record your results to use in Part 3.

Part 3 – Analysis and evaluation

- Analysis and evaluation **1.5 – 2 hours**

Part 3 is completed independently under supervision. Candidates will process and analyse the results of their research and the investigation. They will evaluate their data and the methods used to collect it. They will then draw and justify a conclusion. They will be asked to comment on any issues of safety within the practical work. If more than one lesson is necessary then all booklets must be collected in and given out again for subsequent lessons.

Candidates will need access to their individual responses from Part 1 and Part 2.

Candidates complete Part 3 under high control. Candidates must complete all work independently. Teachers may give generic, informal feedback while the task is being completed but may not indicate what candidates need to do to improve their work. Candidates should not be given the opportunity to redraft their work, as this is likely to require an input of specific advice. Candidates should be made aware of the time allowed for carrying out this part of the task. All work should be recorded on the answer booklet provided or on loose-leaf paper (such as graph paper), and may be hand written or word processed. All loose sheets should be attached to the answer booklet for Part 3 by treasury tags so that it can be marked.

In processing data, candidates will have opportunities to use mathematical and graphical skills: specific heat capacities calculated by substituting in the equation; calculation of energy input; mean temperature rises; calculation of concentrations of salt solutions; quantitative treatment of spread of data and thus level of uncertainty; graphs drawn with correct scales and accurate plotting to show heating curves for the solutions tested and the relationship between concentration and specific heat capacity. **Candidates must not be instructed or advised in these areas**.

Candidates require the answer booklet for Part 3.

Materials required:

- Part 1 and Part 2 stimulus materials and answer booklet for Part 3, supplied by OCR
- Marking criteria supplied by OCR in this booklet
- candidates' work for Parts 1 and 2.

Apparatus suggested:

- sodium chloride solid and/or stock concentrated solution
- access to deionised water
- access to digital balances

For each candidate or group of candidates:

- thermometers of various calibrations or temperature probe
- stop clock or watch
- retort stand and clamp
- beakers of various sizes
- boiling tubes
- measuring cylinders of various sizes
- labels or chinagraph pencil
- heat mat, Bunsen burner and/or spirit burner and/or immersion heater with power pack and meters.

Candidates plan their own investigation and may therefore require access to other apparatus at the discretion of the centre.

Notes to help teachers and technicians with this controlled assessment

Candidates are expected to make up their own salt solutions from solid or by diluting a stock concentrated solution. Depending on the abilities of the students, this may be in terms of percentages or moles or a simpler measure.

To obtain a suitable range of results candidates will need to use salt solutions of concentration from zero to at least 35%.

Teachers are advised to try out the experiment prior to candidates undertaking the task.

Marking the controlled assessment

The task will be marked by the centre using the **marking criteria** given in the specification. For each skill, mark descriptors are given at each of four levels. Marking is by 'best-fit' to the criteria.

All three parts should be marked together when candidates have completed Part 3. Except for Part 1, candidates should not take work out of the classroom/laboratory.

This Teacher guidance document contains the marking criteria from the specification with exemplification. The first row for each skill quality shows the marking criteria given in the specification. The second row exemplifies how some aspects of these criteria may be applied in the context of this specific task. These points are for guidance only.

For further information about the award of marks, please see Section 5.4.2 in the specification.

Candidates should not be given access to the additional guidance for the task.

Assessment objectives (AOs)

Each of the skill qualities to be assessed addresses one or more of the assessment objectives and these are shown in the marking criteria. The overall balance is shown in the table below.

Assessment Objective	**TOTAL**
AO1: Recall, select and communicate their knowledge and understanding of science	5
AO2: Apply skills, knowledge and understanding of science in practical and other contexts	11
AO3: Analyse and evaluate evidence, make reasoned judgements and draw conclusions based on evidence	32
TOTAL	**48**

BLANK PAGE

PLEASE DO NOT WRITE ON THIS PAGE

Marking criteria

Skill quality	0	1 – 2 marks	3 – 4 marks	5 – 6 marks	AO
Researching collect secondary data including the use of appropriate technology	*	Some information collected and used from at least two sources.	Relevant information collected from at least three sources; information presented clearly and all sources identified.	Range of relevant sources identified and judgement used to select those appropriate to the task. Information collated and presented clearly in appropriate formats including a full bibliography.	**AO1 - 1** **AO2 - 3** **AO3 - 2**
Additional guidance Research for Part 1		*Information collected could include the idea of coolant for safety of the nuclear power station; one or two data values..*	*Information collected could include an outline of reasons for use of coolant; value given for each of: specific heat capacities of sea water and fresh water; volume of coolant used; concentration of salt in sea water.*	*Information collected could include detailed reasons given for use of coolant; accurate value given for each of: specific heat capacities of sea water and fresh water, volume of coolant used and concentration of salt in sea water, in SI units, based on research from several sources. Consideration given to nature of the source.*	

***** No evidence of achievement for this quality, or evidence insufficient for the award of 1 mark

Skill quality	0	1 – 2 marks	3 – 4 marks	5 – 6 marks	AO
Planning plan practical ways to answer scientific questions and test hypotheses; devise appropriate methods for the collection of numerical and other data	*	Outline plan includes equipment and techniques to be used. Plan provides a 'fair test'. No evidence of modifications of plan during the data collection phase. Plan shows limited structure with errors in spelling and punctuation.	Plan gives sufficient detail for experiment to be repeated, including choices of: equipment and techniques; range and number of data points for the independent variable; number of replicates; other variables to be controlled, with the aim of collecting quality data. Some consideration given to how errors will be minimised. No evidence of modifications of plan during the data collection phase. Plan structured clearly with occasional errors in spelling and punctuation.	Comprehensive plan shows scientific understanding in making appropriate choices of: equipment, including resolution, and techniques; range and number of data points for the independent variable; number of replicates; control of all other variables, with the aim of collecting accurate data. Detailed consideration given to: how errors will be minimised; variables which cannot be controlled. Where appropriate, reasoned modifications made to the plan as evidence is collected. Plan structured coherently with few, if any, errors in grammar, punctuation and spelling.	**AO1 1** **AO2 4** **AO3 1**
Additional guidance Plan		*Plan could include use of a limited range of concentrations of salt solution with the same volume used each time. An attempt is made to control/measure energy input by heating for the same time or for a set temperature rise.*	*Plan could include appropriate range of concentrations of salt solution; control of other variables including heat input, volume of solutions used. Errors could include the significance of heat losses.*	*Candidate shows scientific understanding in making choices such as; the range of concentrations of salt water to use; how to make up solutions; the number of replicates; the accuracy of measurements of the mass of water to be tested (to 0.5g), temperature (to 0.5^{o}C) etc.; explanation of resolution chosen (will relate to available equipment); how to heat the water; whether to replace the tube after each trial; how to ensure that the energy input is consistent and how to measure the energy input; ways in which heat losses can be minimised/controlled.*	

* No evidence of achievement for this quality, or evidence insufficient for the award of 1 mark

Skill quality	0	1 – 2 marks	3 – 4 marks	5 – 6 marks	AO
Collecting data collect primary data including the use of appropriate technology	*	Results recorded clearly but not in an appropriate format.	Results tabulated to include all data expected, though not in the most appropriate format. Headings given but units not always correct.	Results tabulated clearly and logically, including use of correct headings and units; all data expected recorded to appropriate levels of precision.	**AO1 2 AO2 4**
Additional guidance Results from Part 2		*Data could include concentrations of solutions, time taken, and start and finish temperatures for each trial.*	*Results of each trial presented in table(s) with data such as: salt concentration and mass or volume of solution used, start and finish temperatures and temperature, time taken).*	*Results could include: salt concentration and mass of solution used (to 0.5g), start and finish temperatures and temperature rise (to 0.5^{o}C), time taken (in seconds),(will relate to aviable equipment), for each trial, all with correct units, presented in a single table*	
Managing risk assess and manage risks when carrying out practical work	*	Limited understanding of risks in procedures with only standard laboratory safety features mentioned. Some teacher intervention required to ensure safety.	Some risks in procedures analysed and some specific responses suggested to reduce risks. Risks managed successfully with no significant incidents or accidents and no requirement for teacher intervention.	All significant risks in the plan evaluated. Reasoned judgments made to reduce risks by use of appropriate specific responses. Risks managed successfully with no incidents or accidents and no requirement for teacher intervention.	**AO3 6**
Additional guidance Part 2 risks in plan and in Part 3 evaluation in Q 4		*Standard laboratory safety procedures are required for this practical.*	*Standard laboratory safety procedures are required for this practical. Risks associated with heating methods understood.*	*Standard laboratory safety procedures are required for this practical. Risks of working with electrical currents (if immersion heaters used) and use of spirit burners etc. comprehensively evaluated. Understanding of risks of boiling concentrated salt solution – spitting etc.*	

***** No evidence of achievement for this quality, or evidence insufficient for the award of 1 mark

Skill quality	0	1 – 2 marks	3 – 4 marks	5 – 6 marks	AO
Processing data process primary and secondary data including the use of appropriate technology	*	Some evidence of processing quantitative data: data presented as simple charts or graphs with some errors in scaling or plotting; use of one simple mathematical technique.	Graphical and mathematical techniques used to reveal patterns in the data: charts or graphs used to display data in an appropriate way, allowing some errors in scaling or plotting; correct use of more than one simple mathematical technique.	Appropriate graphical and mathematical techniques used to reveal patterns in the data: type of graph, scales and axes selected and data plotted accurately, including where appropriate a line of best fit; correct use of complex mathematical techniques where appropriate; appropriate quantitative treatment of level of uncertainty of data.	**AO3 6**
Additional guidance Results table Questions 1 and 3		*Processing and mathematical techniques could include: mean temperature rises or times calculated; calculation of concentrations of salt solutions. Presenting data could include graphs drawn (with some errors) to show temperature changes for the solutions tested.*	*Mathematical techniques could include mean temperature rises or times calculated correctly; correct calculation of concentrations of salt solutions. Presenting data could include graphs drawn (with some errors) to show heating curves for the solutions tested and the relationship between concentration and temperature rise (for a given heat input or time) or time taken to raise the temperature by a given amount.*	*Graphical and mathematical techniques could include: specific heat capacities calculated correctly by substituting in the equation; correct calculation of energy input; average temperature rises shown; correct calculation of concentrations of salt solutions; quantitative treatment of spread of data and thus level of uncertainty; graphs drawn with correct scales and accurate plotting to show heating curves for the solutions tested and the relationship between concentration and specific heat capacity.*	

Skill quality	0	1 – 2 marks	3 – 4 marks	5 – 6 marks	AO
Analysing and interpreting analyse and interpret primary and secondary data	*	At least one trend/pattern identified and outlined correctly; an attempt is made to interpret the information linking primary and secondary data/information.	Main trend(s)/pattern(s) described and interpreted with reference to quantitative data and scientific knowledge and understanding, with some errors; reasoned comparison between primary and secondary data/information; any anomalous results identified correctly and implications discussed.	All trend(s)/pattern(s) described and interpreted correctly with reference to quantitative data and relevant scientific knowledge and understanding; links between primary and secondary data/information evaluated; level of uncertainty of the evidence analysed.	**AO3 6**
Additional guidance Part 3 Questions 2 and 3		*Identifies the trend between concentration and temperature rise (for a given heat input or time) or time taken to raise the temperature by a given amount.*	*Relationship between concentration and temperature rise (for a given heat input or time) or time taken to raise the temperature by a given amount described correctly. Makes reference to data from research (salt concentration in sea water and specific heat capacities).*	*Relationship between specific heat capacity and concentration of salt solution described correctly. Compares data from research (salt concentration in sea water and specific heat capacities) with experimental data and uses spread of data to assess level of uncertainty. Understands that the effectiveness of a coolant is determined by its specific heat capacity.*	
Evaluating evaluate methods of data collection and the quality of the resulting data	*	Relevant comments made about the quality of the data and the method used. Answer is simplistic with limited use of specialist terms.	Comments made on the quality of the data including accuracy and sources of error, linked to the method of collection; limitations in the method of data collection identified and suggestions for improvement given. Information is relevant and presented in a structured format. Specialist terms are for the most part used appropriately.	Detailed and critical consideration given to the data and methods used to obtain them: sources of error and quality of the data discussed and explained, including accuracy, repeatability and uncertainty; limitations of the method identified and suggestions for improvements justified. Information is relevant, clear, organised and presented in a coherent format. Specialist terms are used appropriately.	**AO1 1 AO3 5**
Additional guidance Part 3 Question 4		*Comments made on the way in which solutions were prepared or method of heating. Relevant comments made on the accuracy of data collected: measurements of temperature or time.*	*Comments made on the way in which solutions were prepared, method of heating and effect of heat losses, accuracy of data collected: (measurements of temperature, time, and mass/volume). Improvements to method given will depend on method used.*	*Detailed and critical consideration given to the way in which solutions were prepared, method of heating and effect of heat losses, quality of data collected: (measurements of temperature, time, and mass). Improvements to method given will depend on method used.*	

Skill quality	0	1 – 2 marks	3 – 4 marks	5 – 6 marks	AO
Justifying a conclusion draw evidence-based conclusions	*	Conclusion given using the data collected. Answers simplistic with little scientific understanding.	Conclusion given and justified based on an analysis of the data and information from research and investigation, demonstrating an understanding of the underpinning science.	Conclusion given and justified based on a critical analysis of the data and information from research and investigation, and clearly linked to relevant scientific knowledge and understanding.	**AO3 6**
Additional guidance Part 3 Questions 5, 6 and 7		*Links salt concentration to how quickly the solution heats up. Comments on the advantages and disadvantages of building power stations by lakes or the sea.*	*Relates own results to the hypothesis. Briefly comments on the relationship between quantity of coolant used and the concentration of salt in the water. Describes the advantages and disadvantages of building power stations by lakes or the sea, balancing the volume of water needed with type of water (fresh or sea water).*	*Correctly relates own results to the hypothesis. Correctly explains the relationship between quantity of coolant used and the concentration of salt in the water with reference to specific heat capacity. Describes the advantages and disadvantages of building power stations by lakes or the sea, balancing the volume of water needed with effect of specific heat capacity.*	

* No evidence of achievement for this quality, or evidence insufficient for the award of 1 mark