



GCSE MARKING SCHEME

SUMMER 2019

**GCSE (NEW)
APPLIED SCIENCE (DOUBLE AWARD)
UNIT 4 PACK B - HIGHER TIER
3445UD0-1**

INTRODUCTION

This marking scheme was used by WJEC for the 2019 examination. It was finalised after detailed discussion at examiners' conferences by all the examiners involved in the assessment. The conference was held shortly after the paper was taken so that reference could be made to the full range of candidates' responses, with photocopied scripts forming the basis of discussion. The aim of the conference was to ensure that the marking scheme was interpreted and applied in the same way by all examiners.

It is hoped that this information will be of assistance to centres but it is recognised at the same time that, without the benefit of participation in the examiners' conference, teachers may have different views on certain matters of detail or interpretation.

WJEC regrets that it cannot enter into any discussion or correspondence about this marking scheme.

WJEC GCSE APPLIED SCIENCE (DOUBLE AWARD)

UNIT 4 PACK B (NEW)

SUMMER 2019 MARK SCHEME

HIGHER TIER

GENERAL INSTRUCTIONS

Recording of marks

Examiners must mark in red ink.

Question totals should be entered onto the grid on the front cover and these should be added to give the script total for each candidate.

Marking rules

All work should be seen to have been marked.

Crossed out responses not replaced should be marked.

A banded mark scheme is used. Before applying the mark scheme please read through the whole answer from start to finish. Firstly, decide which level descriptor matches best with the candidate's response: remember that you should be considering the overall quality of the response. Then decide which mark to award within the level. Award the higher mark in the level if there is a good match with all the content statements and the communication statements.

Marking abbreviations

The following may be used in marking schemes or in the marking of scripts to indicate reasons for the marks awarded.

cao = correct answer only

ecf = error carried forward

bod = benefit of doubt

ACTIVITY 1 TASK A: PLANNING

Generic Mark Scheme

| | Level 1 | Level 2 | Level 3 |
|-----------------|---|---|--|
| Planning | <p>The candidate outlines a brief method to solve a practical problem. The candidate makes a plan to collect some relevant data without necessarily controlling variables.</p> <p>There is a basic line of reasoning which is not coherent, largely irrelevant, supported by limited evidence and with very little structure. The candidate uses limited scientific terminology and inaccuracies in spelling, punctuation and grammar.</p> <p>Some equipment is identified for the task. Guidance may be required.</p> <p style="text-align: center;">1-3</p> | <p>The candidate independently devises a method to solve a practical problem which, with some changes or elaboration, could be followed by another person. Most variables are controlled</p> <p>There is a line of reasoning which is partially coherent, largely relevant, supported by some evidence and with some structure. The candidate uses mainly appropriate scientific terminology and some accurate spelling, punctuation and grammar.</p> <p>The candidate identifies the equipment needed for the task.</p> <p style="text-align: center;">4-7</p> | <p>The candidate independently devises a method to solve a practical problem, which would enable the investigation to be carried out successfully by another person. All variables are controlled.</p> <p>There is a sustained line of reasoning which is coherent, relevant, substantiated and logically structured. The candidate uses appropriate scientific terminology and accurate spelling, punctuation and grammar.</p> <p>The candidate identifies the equipment needed for the task, without the inclusion of unnecessary apparatus.</p> <p style="text-align: center;">8-10</p> |
| | Total Available Marks: 10 | | |
| | Zero marks to be awarded where there is insufficient evidence to achieve a mark at level 1. | | |

Indicative content

| | | |
|--|---|--|
| 1. Identifies the independent variable (number of bands) | 4. Identifies the dependent variable (extension OR length). Can be from method | 8. Produces a method that would work. |
| 2. Produces a method | 5. Identifies 1 controlled variable (weight; length/width/depth/size/material/same type of band – any 2) | 9. Identifies 2 or more controlled variables (weight; length/width/depth/size/material/same type of band – any 3) |
| 3. Produces an equipment list | 6. Uses accurate spelling of scientific words(2 mistakes or less) | 10. Uses appropriate scientific language (at least 2 scientific terms) |
| | 7. Uses capital letters and full stops consistently (1 mistake allowed) | |

Activity 1 Task A Planning

Further Marking Guidance – Expected responses – please refer to generic marking scheme and indicative content; candidates may give other acceptable (correct) answers that fulfil the criteria. The responses below are for guidance only.

DO NOT PENALISE CANDIDATES THAT MEASURE THE LENGTH OF THE RUBBER BAND COMBINATION.

Independent Variable – The number of rubber bands arranged in parallel.

Controlled Variables – The same apparatus; same type of rubber band material; same length of rubber bands; same width/depth/cross-sectional area of rubber bands; same load force; keep eye in line with measurement of extension

Dependent Variables – The extension of the rubber band combination.

Equipment – Candidates may use equipment from the list or other suitable equipment; candidates may use annotated diagrams rather than a list.

Method (exemplification)

Step 1: Hang rubber band from clamp.

Step 2: Adjust position of ruler so that 0 mm corresponds to the (straightened) end of the rubber band.

Step 3: Hang 1 kg mass stack from rubber band.

Step 4: Measure and record the extension of rubber band.

Step 5: Remove mass stack and repeat Steps 2 and 3 twice more.

Step 6: Add a rubber band in parallel.

Step 7: Repeat Steps 2 to 6 for 3, 4 and 5 rubber bands arranged in parallel.

Level 3 – Candidate produces independent, viable method (similar to above); important controlled variables (above) addressed; coherent, relevant and logical plan; appropriate scientific terminology and accurate spelling, punctuation and grammar with few mistakes; all relevant equipment identified (via list or annotated diagram), without unnecessary apparatus.

Level 2 - Candidate produces independent method, that with some changes, could be followed by another person; most of the important controlled variables addressed; partially coherent, relevant and logical plan; mainly appropriate scientific terminology and some accurate spelling, punctuation and grammar; all equipment needed for the task identified, may have some unnecessary apparatus.

Level 1 - Candidate produces brief method that will allow some relevant data to be collected; may not address the controlled variables; basic line of reasoning, not coherent, largely irrelevant with very little structure; limited scientific terminology and inaccurate spelling, punctuation and grammar; some equipment needed for the task identified, may need guidance.

ACTIVITY 1 TASK B: COLLECTING AND RECORDING - Generic Mark Scheme

| | Level 1 | Level 2 | Level 3 |
|--------------------------------------|---|--|---|
| Collecting and Recording Data | The candidate uses procedures to collect data of low quality or of limited value or relevance. The quantity of data may be limited 1 | The candidate uses procedures to collect mainly appropriate data of reasonable quality. The quantity of data is adequate for purposes of investigation. 2-3 | The candidate uses procedures to collect data of high quality. The data is suitable and relevant to their investigation. The candidate collects a wide range of data for the investigation. 4-5 |
| | The candidate partially records data or observations into a given template. 1 | The candidate independently devises methods to record data. Their records of data are clear and largely error free. 2-3 | The candidate independently devises their own format for recording results and accurately records data or observations to an appropriate degree of precision. Their data is recorded to a high standard and is easy to follow. All units correctly recorded. 4-5 |
| | Total Available Marks: 10 | | |
| | Zero marks to be awarded where there is insufficient evidence to achieve a mark at level 1. | | |

Indicative Content

| Measuring | | |
|-----------------------------|--|--|
| 1. At least 3 bands tested | 2. All 5 bands tested | 4. Original length measured |
| | 3. Measurements repeated three times. | 5. Repeats similar in magnitude |
| Recording | | |
| 1. Number of bands recorded | 2. <u>Stretched lengths recorded clearly</u> in suitable columns/rows, next to correct Number of bands. (NB: can be either orientation column/row) | 4. consistent number of sfs or dps (cm or mm) |
| | 3. <u>Suitable column header names</u> (i.e. 'Number of bands' / length of stretched bands) | 5. Units given (centimetres, cm / millimetres, mm) |

Activity 1 Task B Collecting and Recording

Further marking guidance – Expected responses – please refer to generic marking scheme and indicative content; candidates may give other acceptable (correct) answers that fulfil the criteria. The responses below are for guidance only.

Collecting –

Level 3 – 5 different combinations of rubber band arranged in parallel; repeats similar in magnitude; extensions measured to the appropriate precision of the ruler; load force measured in newtons.

Level 2 – Repeats may be very different; may not measure load force; may round measurements.

Level 1 – May not test 5 different combinations; may not repeat measurements.

Recording –

Level 3 – Candidate devises own table; extensions clearly recorded for each repeat, for each rubber band combination; load force recorded; appropriate precision used for all measurements; all units recorded clearly and correctly.

Level 2 – Candidate devises own table; may not record load force; measurements may not be to appropriate precision; not all units recorded correctly.

Level 1 – Candidate uses a template; not all measurements recorded.

Activity 1 Task C: Analysis - Generic Mark Scheme

| | Level 1 | Level 2 | Level 3 |
|---|---|---|---|
| Analysis of Data | The candidate carries out very simple and limited processing of data. | The candidate carries out mainly suitable and appropriate processing of data. | The candidate carries out suitable and appropriate processing of data, transforming data into useful information. |
| | The candidate makes a very limited attempt to analyse and interpret data. | The candidate makes an appropriate interpretation of the data using mainly appropriate methods of analysis. | The candidate makes a detailed interpretation of data using suitable methods of data analysis. All their work can be easily followed. |
| | The candidate gives a simple statement of findings. | The candidate gives detailed conclusions largely consistent with the evidence. | The candidate makes detailed conclusions consistent with the evidence. They identify and explain all the patterns within the data. |
| | The candidate demonstrates a limited ability to structure the work in an appropriate way. | The work is well structured and logically argued with relatively minor errors. | The work is logically argued and is well structured. |
| | 1-3 | 4-7 | 8-10 |
| Total Available Marks: 10 | | | |
| Zero marks to be awarded where there is insufficient evidence to achieve a mark at level 1. | | | |

Indicative content

| | | |
|---|---|--|
| 1. All 5 mean <u>stretched</u> length calculated correctly | 4. All 5 mean <u>extensions</u> calculated correctly (ecf) | 8. Explanation of why action of rubber bands and muscle fibres are different (can contract and extend) |
| 2. Mean <u>extension</u> v number of bands graph plotted (NB: no marks for bar chart as question told candidates to plot graph). AND suitable linear scale filling most of graph paper | 5. All points plotted correctly ($\pm < 1$ small square tolerance) | 9. Explanation of why two sets of bands needed (to extend and contract owtte) |
| 3. Suitable number of bands used to lift 3 N stated consistent with graph – (NB: range can be given, can be based on stretched length OR extension). | 6. Explanation of 3. given consistent with graph (ecf) | 10. Mean stiffnesses calculated with the same precision down the column |
| | 7. All mean stiffnesses calculated correctly (ecf) | |

Activity 1 Task C Analysis

Further Marking Guidance – Expected responses – please refer to generic marking scheme and indicative content; candidates may give other acceptable (correct) answers that fulfil the criteria. The responses below are for guidance only.

Mean extensions calculated in metres for each rubber band combination.

Graph plotted of mean extension (y-axis) against number of rubber bands in parallel (x-axis).

Mean stiffnesses calculated.

Explanation of why rubber bands and muscle fibres are different due to contraction and extension.

Explanation given as to why two bands are needed in terms of the need to extend and contact joint.

Candidate suggests a suitable number of rubber bands for use in the arm based on own data.

Explanation given based on candidates own data and/or graph.

Answers may be in extended prose

Level 3 – Candidates address all the points in the generic mark scheme in detail.

Level 2 – Candidates address all the points in the generic mark scheme.

Level 1 – Candidates briefly address some of the points in the generic mark scheme.

Activity 1 Task D: Evaluation

Generic Mark Scheme

| | Level 1 | Level 2 | Level 3 |
|---|---|--|--|
| Evaluating | The candidate gives a simple evaluation of the data or procedure. | The candidate gives a clear evaluation of their investigation/ procedure. | The candidate gives a detailed evaluation of their investigation/procedure. They suggest suitable/relevant improvements to their method. |
| | 1 | The candidate makes an assessment of the validity and quality of evidence. 2-3 | The candidate makes a detailed assessment of the validity and quality of data. 4-5 |
| | | Total Available Marks: 5 | |
| Zero marks to be awarded where there is insufficient evidence to achieve a mark at level 1. | | | |

Indicative content

| | | |
|---|--|---|
| 1. Suitability of method discussed (Comment about METHOD) | 2. 1 or more inaccuracy stated | 4. 1 or more suggested improvement |
| | 3. Statement about the repeatability of the data. (Yes/No) | 5. Qualification of statement about repeatability (related to Yes/No) |

Activity 1. Task D Evaluation

Marking Guidance – Expected responses – please refer to generic marking scheme and indicative content; candidates may give other acceptable (correct) answers that fulfil the criteria. The responses below are for guidance only.

Candidates should consider:

Suitability of the method to accurately determine the mean extensions of the rubber band combinations. Candidates should make a comment on whether the method is able to determine the spring constants accurately or not; explanation of the comment.

Sources of inaccuracy in the method. - Inaccuracies may include: measuring the extension (parallax/rounding/precision/zero error/length not extension); measuring load force (rounding/precision/zero error) using different rubber bands with very different materials/dimensions.
Ways to improve the method. – any sensible suggestions to the method or equipment.

Quality of data - Repeatability of results. – Candidates should make a comment on whether the results are repeatable or not; explanation of comment.

Comment on the suitability of the experiment to determine how the spring constants vary with the number of bands – Comment about whether (or not) the procedure actually determines the pattern; comment about the ability of the procedure to measure differences between the extensions for each different combination.

Comments may be in extended prose.

Level 3 – Candidates address all the points in the generic mark scheme in detail.

Level 2 – Candidates address all the points in the generic mark scheme

Level 1 – Candidates briefly address some of the points in the generic mark scheme.

Activity 2 Task A: Analysis

Generic Mark Scheme

| | Level 1 | Level 2 | Level 3 |
|---|---|---|---|
| Analysis of Data | The candidate carries out very simple and limited processing of data. | The candidate carries out mainly suitable and appropriate processing of data. | The candidate carries out suitable and appropriate processing of data, transforming data into useful information. |
| | The candidate makes a very limited attempt to analyse and interpret data. | The candidate makes an appropriate interpretation of the data using mainly appropriate methods of analysis. | The candidate makes a detailed interpretation of data using suitable methods of data analysis. All their work can be easily followed. |
| | The candidate gives a simple statement of findings. | The candidate gives detailed conclusions largely consistent with the evidence. | The candidate makes detailed conclusions consistent with the evidence. They identify and explain all the patterns within the data. |
| | The candidate demonstrates a limited ability to structure the work in an appropriate way. | The work is well structured and logically argued with relatively minor errors. | The work is logically argued and is well structured. |
| | 1-3 | 4-7 | 8-10 |
| Total Available Marks: 10 | | | |
| Zero marks to be awarded where there is insufficient evidence to achieve a mark at level 1. | | | |

| Activity 2 – Task A – Analysis | | |
|--|-----|---|
| Marking Guidance – Expected responses – please refer to generic marking scheme; candidates may give other acceptable (correct) answers that fulfil the criteria. The responses below are for guidance only. ALL solubilities read from either graph have a tolerance of ± 2 °C. | | |
| 1 | (a) | (i) Sodium nitrate = 80; Sodium chloride = 35; 46 = Lead nitrate; Cerium sulfate = 8 (1 Level 1) |
| | | (ii) Cerium sulfate; Potassium chlorate; Potassium chromate; Sodium chloride; Lead nitrate; Sodium nitrate (1 Level 1) |
| | (b) | The solubility <u>increases</u> (from 35 g/100 cm ³ at 0 °C to 40 g/100 cm ³ at 100 °C as a straight line)(or they are proportional to each other / or at a rate of 0.05 (g/100 cm ³)/°C). Data not required (1 Level 1) |
| | (c) | The solubility of potassium chromate increases (from 5 g/100 cm ³ at 0 °C to 81 g/100 cm ³ at 100 °C) (as a curve getting gradually steeper). The solubility of cerium sulfate decreases from 18 g/100 cm ³ at 0 °C to 3 g/100 cm ³ at 30 °C as a curve getting gradually shallower, and then stays constant at 3 g/100 cm ³ between 30 °C and 100 °C. Correct use of pairs of data from graphs (1 Level 3) |
| 2 | (a) | (i) 33.2 (T = 60 °C) (1 Level 2) |
| | | (ii) 5.2; 32.6; 47.5; 43.8; 43.3 (1 Level 2) |
| | (b) | The solubility of potassium chlorate (from Graph 1) <u>increases</u> with temperature (with an increasing rate); the solubility of sodium sulfate <u>increases</u> up to a maximum value at 30 °C, then <u>decreases</u> above this value. (1 Level 2) |
| | (c) | For 100 g of saturated sodium sulfate solution: <i>Mass formed</i> = 50 g(at 30°C) – 10 g(at 10°C) = 40 g . (1 Level 3) So for 25 g of saturated sodium sulfate solution: Mass formed = 40 g /4 = 10 g (1 Level 3) |
| | (d) | Choices: Sodium chloride, lead nitrate have closest solubilities to sodium sulfate at 30 °C. Lead nitrate unsuitable as it is a lead salt (Toxic); best choice is sodium chloride, OR other suitable (correct) choice with explanation. (1 Level 2) |
| | | Level 3 – Candidates address all the points in the generic mark scheme in detail. Level 2 – Candidates address all the points in the generic mark scheme. Level 1 – Candidates briefly address some of the points in the generic mark scheme. |

ACTIVITY 2 TASK B: EVALUATION - Generic Mark Scheme

| | Level 1 | Level 2 | Level 3 |
|---|---|--|--|
| Evaluating | <p>The candidate gives a simple evaluation of the data or procedure.</p> <p style="text-align: center;">1</p> | <p>The candidate gives a clear evaluation of their investigation/ procedure.</p> <p>The candidate makes an assessment of the validity and quality of evidence.</p> <p style="text-align: center;">2-3</p> | <p>The candidate gives a detailed evaluation of their investigation/procedure. They suggest suitable/relevant improvements to their method.</p> <p>The candidate makes a detailed assessment of the validity and quality of data.</p> <p style="text-align: center;">4-5</p> |
| | | | Total Available Marks: 5 |
| Zero marks to be awarded where there is insufficient evidence to achieve a mark at level 1. | | | |

Indicative Content

| | | |
|---|---|---|
| 1. <u>Statement of suitability</u> of method to determine the solubility (Suitable) | 2. <u>Statement of suitability</u> of method to operate best between 30°C and 60°C (Unsuitable) | 4. <u>One way suggested</u> (e.g. smaller temperature increments; use more water baths at each temperature; smaller powder increments; other correct, valid suggestion) |
| | 3. <u>Explanation of (1.)</u> – procedure is valid; the solubilities are different at each temperature; the method identifies that the solubility increases, up to an optimum value and then decreases (and nearly levels off). | 5. <u>Explanation of (2.)</u> – (range of temperature needs to be between 30 °C and 60 °C as currently does not measure solubility at 30 °C; increments of temperature need to be smaller between this range; increments of added mass need to be smaller.) |

Activity 2 – Task B: Evaluation

Marking Guidance – Expected responses – please refer to generic marking scheme and indicative content; candidates may give other acceptable (correct) answers that fulfil the criteria. The responses below are for guidance only.

Suitability – procedure is valid; the solubilities are different at each temperature; the method identifies that the solubility increases, up to an optimum value and then decreases (and nearly levels off).

Suggested improvements – smaller temperature increments (will allow maximum solubility to be determined more accurately); method will be quite slow as the water will take a long time to heat up, could use more water baths at each temperature; powder is only added in 0.5 g increments which will reduce resolution of solubilities (owtte).

Comment on the suitability of the method to determine solubility over range – range (of temperature) needs to be between 30 °C and 60 °C as currently does not measure solubility at 30 °C; increments of temperature need to be smaller between this range; increments of added mass need to be smaller.

Comments may be in extended prose.

Level 3 – Candidates address all the points in the generic mark scheme in detail.

Level 2 – Candidates address all the points in the generic mark scheme.

Level 1 – Candidates briefly address some of the points in the generic mark scheme.

Activity 3: Managing Safety

Generic Mark Scheme

| | Level 1 | Level 2 | Level 3 |
|---|---|--|---|
| Managing Safety | <p>The candidate identifies some hazards and risks associated with the activity. Not all significant hazards or risks are identified.</p> | <p>The candidate writes a risk assessment which identifies the significant hazards with the activity and risks associated with the activity. They identify some suitable control measures.</p> | <p>The candidate writes a complete and suitable risk assessment for the activity. They accurately describe all the reasonable hazards and risks associated with the activity. Where necessary, they identify suitable and sensible control measures for hazards/risks listed.</p> |
| | <p>The candidate demonstrates a limited ability to communicate their knowledge and understanding of safety issues.</p> <p style="text-align: center;">1-3</p> | <p>The candidate demonstrates a reasonable ability to communicate their knowledge and understanding of safety issues.</p> <p style="text-align: center;">4-7</p> | <p>The candidate demonstrates an ability to communicate their knowledge and understanding of safety issues to a high standard.</p> <p style="text-align: center;">8-10</p> |
| Total Available Marks: 10 | | | |
| Zero marks to be awarded where there is insufficient evidence to achieve a mark at level 1. | | | |

Activity 3 Managing Safety

Marking Guidance – Expected responses – please refer to generic marking scheme; candidates may give other acceptable (correct) answers that fulfil the criteria. The responses below are for guidance only.

Penalise once for hazard in wrong stage (first time seen)

Stage 1

| Hazard | Risk | Control Measure |
|----------------------------------|---|---|
| Bunsen burner flames are hot (1) | Burn to skin; hair; clothing catch fire whilst {handling/using Bunsen burner to flame neck of bottle} AND | Only use roaring flame for flaming bottle neck, otherwise keep on safety flame / Keep away from skin / hair / loose clothing/ put out flame when not required (1) |
| Agar powder is an irritant (1) | Irritation to {skin / eyes} whilst {handling/mixing agar powder with water} AND | Wear goggles / Wash off skin.(1) |
| Glassware/apparatus is hot (1) | Burn to skin whilst handling AND | Allow hot agar solution bottle to cool to warm before handling.(1) (Allow credit for safe mechanism of removal from hot water bath). |

Stage 2

| Hazard | Risk | Control Measure |
|------------------------------|---|--|
| Any 2 × (1) for hazard: | Any 2 × (1) for corresponding risk and control measure | |
| Microbes are a biohazard | Possibility of infection whilst handling | Keep agar plate sealed. Do not open. |
| Hot inoculating loop | Burn to skin whilst handling | Allow hot apparatus to cool before handling apparatus. |
| Ethanol is flammable | Burn to skin; hair; clothing catch fire whilst cleaning surface | Allow ethanol to evaporate before using workspace |
| Bunsen burner flames are hot | | |

Level 3 – Candidates address all the above points

Level 2 – Candidates address some hazards and risks and identify corresponding control measures

Level 1 – Candidates address some hazards / risks and may identify corresponding control measures