Cambridge Assessment International Education

# Cambridge International AS & A Level

**PHYSICS** **9702/52**

Paper 5 Planning, Analysis and Evaluation **February/March 2023**

MARK SCHEME

Maximum Mark: 30

**Published**

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge International will not enter into discussions about these mark schemes.

Cambridge International is publishing the mark schemes for the February/March 2023 series for most Cambridge IGCSE™, Cambridge International A and AS Level components and some Cambridge O Level components.



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**[Turn over**

**PUBLISHED**

## Generic Marking Principles

These general marking principles must be applied by all examiners when marking candidate answers. They should be applied alongside the specific content of the mark scheme or generic level descriptors for a question. Each question paper and mark scheme will also comply with these marking principles.

GENERIC MARKING PRINCIPLE 1:

Marks must be awarded in line with:

- the specific content of the mark scheme or the generic level descriptors for the question
- the specific skills defined in the mark scheme or in the generic level descriptors for the question
- the standard of response required by a candidate as exemplified by the standardisation scripts.

GENERIC MARKING PRINCIPLE 2:

Marks awarded are always **whole marks** (not half marks, or other fractions).

GENERIC MARKING PRINCIPLE 3:

Marks must be awarded **positively**:

- marks are awarded for correct/valid answers, as defined in the mark scheme. However, credit is given for valid answers which go beyond the scope of the syllabus and mark scheme, referring to your Team Leader as appropriate
- marks are awarded when candidates clearly demonstrate what they know and can do
- marks are not deducted for errors
- marks are not deducted for omissions
- answers should only be judged on the quality of spelling, punctuation and grammar when these features are specifically assessed by the question as indicated by the mark scheme. The meaning, however, should be unambiguous.

GENERIC MARKING PRINCIPLE 4:

Rules must be applied consistently, e.g. in situations where candidates have not followed instructions or in the application of generic level descriptors.

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| GENERIC MARKING PRINCIPLE 5:<br><br>Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen). |
| GENERIC MARKING PRINCIPLE 6:<br><br>Marks awarded are based solely on the requirements as defined in the mark scheme. Marks should not be awarded with grade thresholds or grade descriptors in mind. |

**Science-Specific Marking Principles**

| | |
|---|---|
| 1 | Examiners should consider the context and scientific use of any keywords when awarding marks. Although keywords may be present, marks should not be awarded if the keywords are used incorrectly. |
| 2 | The examiner should not choose between contradictory statements given in the same question part, and credit should not be awarded for any correct statement that is contradicted within the same question part. Wrong science that is irrelevant to the question should be ignored. |
| 3 | Although spellings do not have to be correct, spellings of syllabus terms must allow for clear and unambiguous separation from other syllabus terms with which they may be confused (e.g. ethane / ethene, glucagon / glycogen, refraction / reflection). |
| 4 | The error carried forward (ecf) principle should be applied, where appropriate. If an incorrect answer is subsequently used in a scientifically correct way, the candidate should be awarded these subsequent marking points. Further guidance will be included in the mark scheme where necessary and any exceptions to this general principle will be noted. |
| 5 | <u>'List rule' guidance</u><br><br>For questions that require ***n*** responses (e.g. State **two** reasons …):<br><br>• The response should be read as continuous prose, even when numbered answer spaces are provided.<br>• Any response marked *ignore* in the mark scheme should not count towards ***n***.<br>• Incorrect responses should not be awarded credit but will still count towards ***n***.<br>• Read the entire response to check for any responses that contradict those that would otherwise be credited. Credit should **not** be awarded for any responses that are contradicted within the rest of the response. Where two responses contradict one another, this should be treated as a single incorrect response.<br>• Non-contradictory responses after the first ***n*** responses may be ignored even if they include incorrect science. |

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6 Calculation specific guidance

Correct answers to calculations should be given full credit even if there is no working or incorrect working, **unless** the question states 'show your working'.

For questions in which the number of significant figures required is not stated, credit should be awarded for correct answers when rounded by the examiner to the number of significant figures given in the mark scheme. This may not apply to measured values.

For answers given in standard form (e.g. $a \times 10^n$) in which the convention of restricting the value of the coefficient ($a$) to a value between 1 and 10 is not followed, credit may still be awarded if the answer can be converted to the answer given in the mark scheme.

Unless a separate mark is given for a unit, a missing or incorrect unit will normally mean that the final calculation mark is not awarded. Exceptions to this general principle will be noted in the mark scheme.

7 Guidance for chemical equations

Multiples / fractions of coefficients used in chemical equations are acceptable unless stated otherwise in the mark scheme.

State symbols given in an equation should be ignored unless asked for in the question or stated otherwise in the mark scheme.

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| Question | Answer | Marks |
|---|---|---|
| 1 | **Defining the problem** | |
| | *f* is the independent variable and *Q* is the dependent variable, or vary *f* and measure *Q.* | **1** |
| | Keep *h* constant | **1** |
| | **Methods of data collection** | |
| | Labelled diagram of workable experiment including:<br>• fan is positioned in line with the turbine so that blades of both fan and turbine overlap<br>• base of fan on same bench as turbine<br>• fan labelled and one other label from bench, (wind) turbine, cable, pump, pipe, liquid | **1** |
| | Labelled apparatus showing workable method to collect the liquid from the top of the pipe, e.g. hose / pipe / tube connected to top of pipe with the other end over a beaker / measuring cylinder below top of pipe.<br>At least one label related to collection of liquid. | **1** |
| | Use of stop-watch / timer to measure time to collect liquid **or** to measure time for blades to rotate. | **1** |
| | Use of (top pan) balance to measure mass of liquid leaving the pipe. | **1** |
| | **Method of Analysis** | |
| | Plots a graph of $Q$ against $f^3$ or equivalent (e.g. $f^3$ against $Q$).<br>Do not accept logarithmic graphs. | **1** |
| | $C = gh \times y$-intercept (for $f^3$ against $Q$: $C = -D \times y$-intercept) | **1** |
| | $D = gh \times$ gradient<br>(for $f^3$ against $Q$: $D = \frac{gh}{\text{gradient}}$) | **1** |

| Question | Answer | | Marks |
|---|---|---|---|
| 1 | **Additional detail including safety considerations**<br>Any **six** from: | | **6** |
| | D1 | Precaution with reason linked to prevent liquid spilling (on bench / floor) e.g. use of large bucket / bowl / tray to contain any spilled liquid<br>**or**<br>Precaution with reason linked to prevent air / dust particles in eye, e.g. use of goggles<br>**or**<br>Precaution with reason linked to turbine falling, e.g. clamp turbine to bench. | |
| | D2 | Use rule to measure *h*. | |
| | D3 | Method to determine mass of liquid, e.g.<br>mass of beaker + liquid – mass of empty beaker<br>**or**<br>mass of container / pipe before – mass of container / pipe after. | |
| | D4 | Method to determine *f*, e.g. measure time *t* for many rotations / revolutions *N* and period $T = t/N$ and $f = 1/T$<br>**or**<br>measure time *t* for many rotations / revolutions *N* and $f = N/t$<br>**or**<br>video rotating blades, playback frame by frame and use a time stamp to determine period *T* and $f = 1/T$. | |
| | D5 | Mark one of the blades to assist in counting number of rotations. | |
| | D6 | Method to vary *f*, e.g. change speed of fan / change distance between fan and blades / vary current in fan. | |
| | D7 | Wait for steady air flow before starting timing and / or collecting liquid. | |
| | D8 | $Q = \frac{\text{mass (of liquid)}}{\text{time (to collect liquid)}}$<br>**or**<br>method and explanation to reduce uncertainty in *Q*, e.g. use large value of time or mass of liquid collected. | |
| | D9 | Repeat measurements of *Q* for the same value of *f* **and** average *Q.* | |

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| Question | Answer | Marks |
|---|---|---|
| 1 | D10 Relationship valid <u>if</u> a straight line is produced (not passing through the origin).<br>Do not accept passing through the origin. | |

| Question | Answer | Marks |
|---|---|---|
| 2(a) | gradient = $\frac{v}{4}$<br>$y$-intercept = $-k$ | **1** |
| 2(b) | <table><tr><th>$1/f$ / $10^{-3}$ Hz$^{-1}$</th><th>$d$ / cm</th></tr><tr><td>0.67 or 0.667</td><td>24.7 ± 0.2</td></tr><tr><td>0.48 or 0.476</td><td>17.4 ± 0.2</td></tr><tr><td>0.36 or 0.357</td><td>12.7 ± 0.3</td></tr><tr><td>0.24 or 0.244</td><td>8.4 ± 0.3</td></tr><tr><td>0.19 or 0.192</td><td>6.6 ± 0.4</td></tr><tr><td>0.13 or 0.132</td><td>4.6 ± 0.4</td></tr></table><br>First mark: values of $1/f$ and $d$ correct as shown.<br>Second mark: uncertainties in $d$ correct as shown. | **2** |
| 2(c)(i) | Six points from **(b)** plotted correctly.<br>Must be within half a small square. Diameter of points must be less than half a small square. | **1** |
| | Error bars in $d$ / cm plotted correctly.<br>All error bars to be plotted. Total length of bar must be accurate to less than half a small square and symmetrical. | **1** |

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| Question | Answer | Marks |
|---|---|---|
| 2(c)(ii) | Straight line of best fit drawn.<br>Do not accept line from top plot to bottom plot.<br>Points must be balanced.<br>Line must pass between (0.170, 6.0) and (0.185, 6.0) **and** between (0.590, 22.0) and (0.610, 22.0) | **1** |
| | Worst acceptable line drawn.<br>Steepest or shallowest possible line that passes through all the error bars.<br>All error bars must be plotted. | **1** |
| 2(c)(iii) | Gradient determined with clear substitution of data points into $\Delta y / \Delta x$; distance between data points must be greater than half the length of the drawn line. | **1** |
| | Gradient determined of worst acceptable line uncertainty = (gradient of line of best fit – gradient of worst acceptable line)<br>**or**<br>uncertainty = ½ (steepest worst line gradient – shallowest worst line gradient) | **1** |
| 2(c)(iv) | *y*-intercept determined by substitution of correct point with consistent power of ten in *m* and *x* into $y = mx + c$.<br>Expect *y*-intercept to be negative. | **1** |
| | *y*-intercept of worst acceptable line determined by substitution into $y = mx + c$.<br><br>uncertainty = *y*-intercept of line of best fit – *y*-intercept of worst acceptable line, or<br>uncertainty = ½ (steepest worst line *y*-intercept – shallowest worst line *y*-intercept) | **1** |

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| Question | Answer | Marks |
|---|---|---|
| 2(d) | *v* determined using gradient **and** *v* and *k* given to 2 or 3 sf.<br>$v = 4 \times \text{gradient} = 4 \times$ **(c)(iii)** | **1** |
| | *k* determined using *y*-intercept **and** units for *v* and *k*<br>$k = -y\text{-intercept} = -$**(c)(iv)**<br><br>Units:<br>*v*: $\text{m s}^{-1}$, $\text{cm s}^{-1}$<br>*k*: m, cm | **1** |
| | Absolute uncertainties in *v* and *k*.<br>$\Delta v$: $\frac{\Delta\,\text{gradient}}{\text{gradient}} \times v$ with correct substitution **or** $\Delta v$: 4 × uncertainty in gradient<br>**and**<br>$\Delta k$: uncertainty in *y*-intercept | **1** |
| 2(e) | *f* determined to a minimum of 2 significant figures from **(c)(iii)** and **(c)(iv)** OR **(d)** with correct substitution **and** correct powers of ten used for all quantities.<br>$f = \frac{v}{4 \times (d + k)}$<br>**or**<br>$f = \frac{\text{gradient}}{d - (y\text{-intercept})}$ | **1** |

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