Please read the MARK SCHEME STANDARDISATION – EXPLANATORY DOCUMENT before authoring your Mark Scheme, and ensure that you are using the correct template for your subject/qualification/component. Please delete this paragraph after reading.

Cambridge Assessment International Education – 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.

GENERIC MARKING PRINCIPLE 5:
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:
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.

PRE-STANDARDISATION

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. ‘List rule’ guidance (see examples below)

   For questions that require ***n*** responses (e.g. State **two** reasons…):

- The response should be read as continuous prose, even when numbered answer spaces are provided
- Any response marked *ignore* in the mark scheme should not count towards ***n***
- Incorrect responses should not be awarded credit but will still count towards ***n***
- 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.
- Non-contradictory responses after the first ***n*** responses may be ignored even if they include incorrect science

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.

Examples of how to apply the list rule

State **three** reasons…. [3]

A

1. Correct	✔	**2**
2. Correct	✔	
3. Wrong	□	

B (4 responses)

1. Correct, Correct	✔, ✔	**3**
2. Correct	✔	
3. Wrong	ignore	

C (4 responses)

1. Correct	✔	**2**
2. Correct, Wrong	✔, □	
3. Correct	ignore	

D (4 responses)

1. Correct	✔	**2**
2. Correct, CON (of 2.)	□, (discount 2)	
3. Correct	✔	

E (4 responses)

1. Correct	✔	**3**
2. Correct	✔	
3. Correct, Wrong	✔	

F (4 responses)

1. Correct	✔	**2**
2. Correct	✔	
3. Correct CON (of 3.)	□ (discount 3)	

G (5 responses)

1. Correct	✔	**3**
2. Correct	✔	
3. Correct Correct CON (of 4.)	✔ ignore ignore	

H (4 responses)

1. Correct	✔	**2**
2. Correct	□	
3. CON (of 2.) Correct	(discount 2) ✔	

I (4 responses)

1. Correct	✔	**2**
2. Correct	□	
3. Correct CON (of 2.)	✔ (discount 2)	

Question	Answer	Marks	Guidance
1	**Defining the problem** *f* is the independent variable and *Q* is the dependent variable, or vary *f* and measure *Q*.	**1**	Annotate with P. This mark could be awarded having read the candidate's script all the way through. **Allow** f^3
	Keep *h* constant	**1**	
	Methods of data collection Labelled diagram of workable experiment including: ● Fan positioned in line with the turbine ● Minimum of two labels.	**1**	STM to determine labels
	Hose/pipe/tube connected to top of pipe with a beaker/measuring cylinder supported.	**1**	
	Use of stop-watch to measure time for blades to rotate / to measure time to collect liquid.	**1**	
	Use of top pan balance to measure mass of liquid.	**1**	
	Method of Analysis Plots a graph of Q against f^3 or equivalent. (e.g. f^3 against *Q*) Do not accept logarithmic graphs.	**1**	**Allow** drawn axes.
	$C = gh \times y - intercept$ (for f^3 against *Q*: $C = -D \times y - intercept$)	**1**	**Note** Must be consistent with drawn graph.
	$D = gh \times gradient$ (for f^3 against *Q*: $D = \frac{gh}{gradient}$)	**1**	**Note** Must be consistent with drawn graph.

Question	Answer	Marks	Guidance
	Additional detail including safety considerations Any **six** from:	**6**	
	D1 Precaution to <u>prevent liquid spilling</u> (on bench / floor) e.g. use of large bucket / bowl to contain any spilled liquid OR Precaution to <u>prevent air / dust particles in eye.</u> e.g. use of goggles.		**Allow** correctly positioned on diagram? STM to decide. **Not** tissues to wipe up spills
	D2 Use clamped rule to measure *h*.		
	D3 Method to determine mass of liquid: mass of beaker + liquid – mass of empty beaker.		
	D4 Method to determine *f* , e.g. Time many rotations and divide by the number of rotations and $f = 1/T$ OR $f = N / t$.		STM to discuss stroboscope
	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.		**Allow** potential difference / p.d.
	D7 Wait for steady air flow / switch off air-conditioning / close windows to prevent other air flows.		
	D8 Method to reduce percentage uncertainty in *Q*, e.g. use large *f* or increase time of mass collection.		**Allow** increase of air speed STM to consider low air speed to reduce uncertainty in *f*.
	D9 Repeat measurements of *Q* for the same *f.*		
	D10 Relationship valid <u>if</u> a straight line is produced (not passing through the origin). Do not accept passing through the origin.		**Note** Must be consistent with drawn graph.

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>2(a)</td><td>Gradient = $\frac{v}{4}$
y-intercept = $-\ k$</td><td>1</td><td></td></tr>
<tr><td>2(b)</td><td><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>First mark: values of $1/f$ and d.
Second mark: uncertainties in d.</td><td>2</td><td></td></tr>
<tr><td>2(c)(i)</td><td>Six points from (b) plotted correctly.
Must be within half a small square. Diameter of points must be less than half a small square.</td><td>1</td><td>Check second and fifth plots from the left.
Allow ecf from (b)</td></tr>
<tr><td></td><td>Error bars in d / cm plotted correctly.
All error bars to be plotted. Total length of bar must be accurate to less than half a small square and symmetrical.</td><td>1</td><td>Check second and fifth plots from the left.
Allow ecf from (b)</td></tr>
<tr><td>2(c)(ii)</td><td>Straight line of best fit drawn.
Do not accept line from top plot to bottom plot.
Points must be balanced.
Line must pass between
(0.165, 6.0) and (0.185, 6.0) and between
(0.585, 22.0) and (0.605, 22.0)</td><td>1</td><td>Note no ecf
STM to finalise range</td></tr>
<tr><td></td><td>Worst acceptable line drawn.
Steepest or shallowest possible line that passes through all the error bars.
All error bars must be plotted.</td><td>1</td><td>Allow ecf from points/error bars plotted incorrectly – examiner judgement.
Note error bar cut STM to decide</td></tr>
<tr><td>2(c)(iii)</td><td>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.</td><td>1</td><td>Check the read offs. Work to half a small square.
Allow half the line
Ignore POT.
Expect ≈ 37 × 10^3</td></tr>
<tr><td></td><td>Gradient determined of worst acceptable line
uncertainty = (gradient of line of best fit – gradient of worst acceptable line)
or
uncertainty = ½ (steepest worst line gradient – shallowest worst line gradient)</td><td>1</td><td>Method of determining absolute uncertainty.
Check subtraction.</td></tr>
</table>

Question	Answer	Marks	Guidance
2(c)(iv)	*y*-intercept determined by substitution of correct point into *y*=m*x*+c Expect *y*-intercept to be negative.	**1**	Check the read offs. Work to less than half a small square in each direction. **Allow** ecf from (c)(iii) **Ignore** POT carefully check method
	y-intercept of worst acceptable line determined by substitution into y = mx + c. uncertainty = *y*-intercept of line of best fit – *y*-intercept of worst acceptable line, or uncertainty = ½ (steepest worst line *y*-intercept – shallowest worst line *y*-intercept) Do not accept ecf from false origin method.	**1**	Use of gradient from WAL and method of determining absolute uncertainty.
2(d)	*v* determined using gradient **and** *v* and *k* given to 2 or 3 sf. $v = 4\times gradient = 4\times(c)(iii)$	**1**	**Ignore** POT **Allow** ecf from (c)(iii) **Expect** *v* ≈ 1500 ms^{-1}
	k determined using *y*-intercept **and** units with correct power of ten for *v* and *k* $k = -\ y\ -\ intercept = -\ (c)(iv)$	**1**	**Allow** ecf from (c)(iv) **Expect** *k* ≈ 0.005 m (Note this value can vary)
	Absolute uncertainties in *v* and *k*. Δ*v*: $\frac{\Delta\ gradient}{gradient}\times v$ with correct substitution or v: $4\times uncertainty\ in\ gradient$ Δ*k*: uncertainty in *y*-intercept	**1**	**Allow** max/min methods
2(e)	*f* determined to a minimum of 2 sf from (c)(iii) and (c)(iv) OR (d) with correct substitution **and** correct power of ten. $f = \frac{v}{4\times(d+k)}$ OR $f = \frac{gradient}{d-y-intercept}$	**1**	**Allow** ecf from (c)(iii), (c)(iv) and (d) **Expect** ≈ 1.2 kHz